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Classification and Management of Aquatic, Riparian, and Wetland Sites on the National Forests of Eastern Washington: Series Description

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ABSTRACT

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This is a classification of aquatic, wetland, and riparian series and plant associations found within the Colville, Okanogan, and Wenatchee National Forests. It is based on the potential vegetation occurring on lake and pond margins, wetland fens and bogs, and fluvial surfaces along streams and rivers within Forest Service lands. Data used in the classification were collected from 1,650 field plots sampled across the three forests. This classification identifies 32 series separated into four physiognomic classes: coniferous forests, deciduous forests, shrubs, and herbaceous vegetation. In addition, keys to the identification of 163 plant associations or community types are presented. The report includes detailed descriptions of the physical environment, geomorphology, ecosystem function, and management of each series. This classification supplements and expands information presented in upland forest plant association classifications previously completed for the three eastern Washington forests. It is a comprehensive summary of the aquatic, riparian, and wetland series and contributes to the understanding of ecosystems and their management in eastern Washington.

Keywords: Riparian, aquatic, wetland, vegetation classification, series description, plant association, plant community, riparian vegetation, riparian ecosystems, eastern Washington.

CONTENTS

PREFACE

There is tremendous diversity in the aquatic, wetland, and riparian ecosystems of eastern Washington. Bernard L. Kovalchik describes this variation at the series level in this vegetation guide for national forest lands in Washington. Here "series" refers to the group of plant associations having the same climax species characterizing the dominant plant cover. For example, the Pacific silver fir series is composed of all plant associations potentially dominated by Pacific silver fir at climax. The series is a level in the classification hierarchy above the plant association level. This level is useful in describing environmental conditions, community composition, and management opportunities and limitations at a scale broader than plant association descriptions. The guide describes ecosystem diversity in a manner helpful to resource managers with a fundamental understanding of wetland ecology and vegetation.

Included in this guide are series descriptions and keys to hydrophytic vegetation dominated by conifers, deciduous trees, shrubs, and herbaceous plants. The author describes the biotic and abiotic environments; the series distribution within the Colville, Okanogan, and Wenatchee National Forests; and ecosystem management of the series and its components. Plant association keys and association tables are presented for those who want additional information for site classification. Future classification efforts can build on this framework and expand descriptions of the lower levels in the classification taxonomy (plant associations).

Kovalchik has expanded the work of other Area 2 plant ecologists in his treatment of the coniferous series; he defines and describes those wetland and riparian sites dominated by mountain hemlock, Pacific silver fir, western hemlock, western redcedar, subalpine fir, Engelmann spruce, grand fir, Douglas-fir, subalpine larch, and lodgepole pine. In addition, he describes conifer types occupying moist sites adjacent to streams, rivers, lakes, and ponds that are transitional to upland vegetation described in earlier guides.

Vegetation dominated by deciduous trees is summarized in the descriptions of the quaking aspen, black cottonwood, red alder, paper birch, Oregon white oak, and bigleaf maple series. The author describes the composition, distribution, and management of these important landscape elements in northeast Washington forests. He demonstrates that these series provide habitat diversity fundamental to maintaining wildlife, fish, and rare plant resources of the area, and he provides the framework for ecosystem management of these types.

The shrub-dominated series include the willow, heath, vine maple, Sitka alder, mountain alder, red-osier dogwood, Douglas spiraea, Douglas maple, devil's club, salmonberry, shrubby cinquefoil, Cascade azalea, and common snowberry series. Kovalchik presents these complex and dynamic systems in a manner that facilitates good stewardship of these riparian/wetland resources. He identifies the environmental matrix supporting the 13 series and the management concerns that span the environmental variation in this diverse group.

Herbaceous vegetation is described in the aquatic series, the meadow series, and the forb series. Unlike series within the previous life-form groups (conifers, deciduous trees, and shrubs), these three series of herbaceous vegetation do not have a singular climax dominant (for example, Pacific silver fir series). Rather, the series is named for recognizable habitat (aquatic and meadow) or life form (forb). A variety of climax herbaceous species can dominate sites within each of these three series. The aquatic series includes all herbaceous plant associations supporting rooted vascular or emergent vegetation that grows in deep water or in shallow water along the shoreline of permanently standing water. Graminoids dominate sites classified in the meadow series; this complex series includes 24 plant associations. These associations occur across a variety of habitats representing different environmental conditions of moisture, temperature, pH, aeration, and organic soil fraction. Five plant associations with perennial forb dominance are found in the forb series. The forb series includes all terrestrial riparian and wetland sites dominated by forbs; it does not include forb-dominated sites in the aquatic series. The author's treatment of herbaceous vegetation has provided a simplified description of the variation inherent in these diverse ecosystems and helps resource specialists become familiar with the distribution and management of these types.

The appendixes include information that both supplements and enhances the series descriptions. It has been a rewarding experience working with Bud Kovalchik to finish this aquatic, wetland, and riparian classification guide. The field sampling, synecological analyses, and draft document were his work; I have only assisted in the preparation of the final guide. Our hope is that the completed work is a valuable addition to the store of ecological information that will aid resource stewardship in northeastern Washington.

Rod Clausnitzer
July 2004

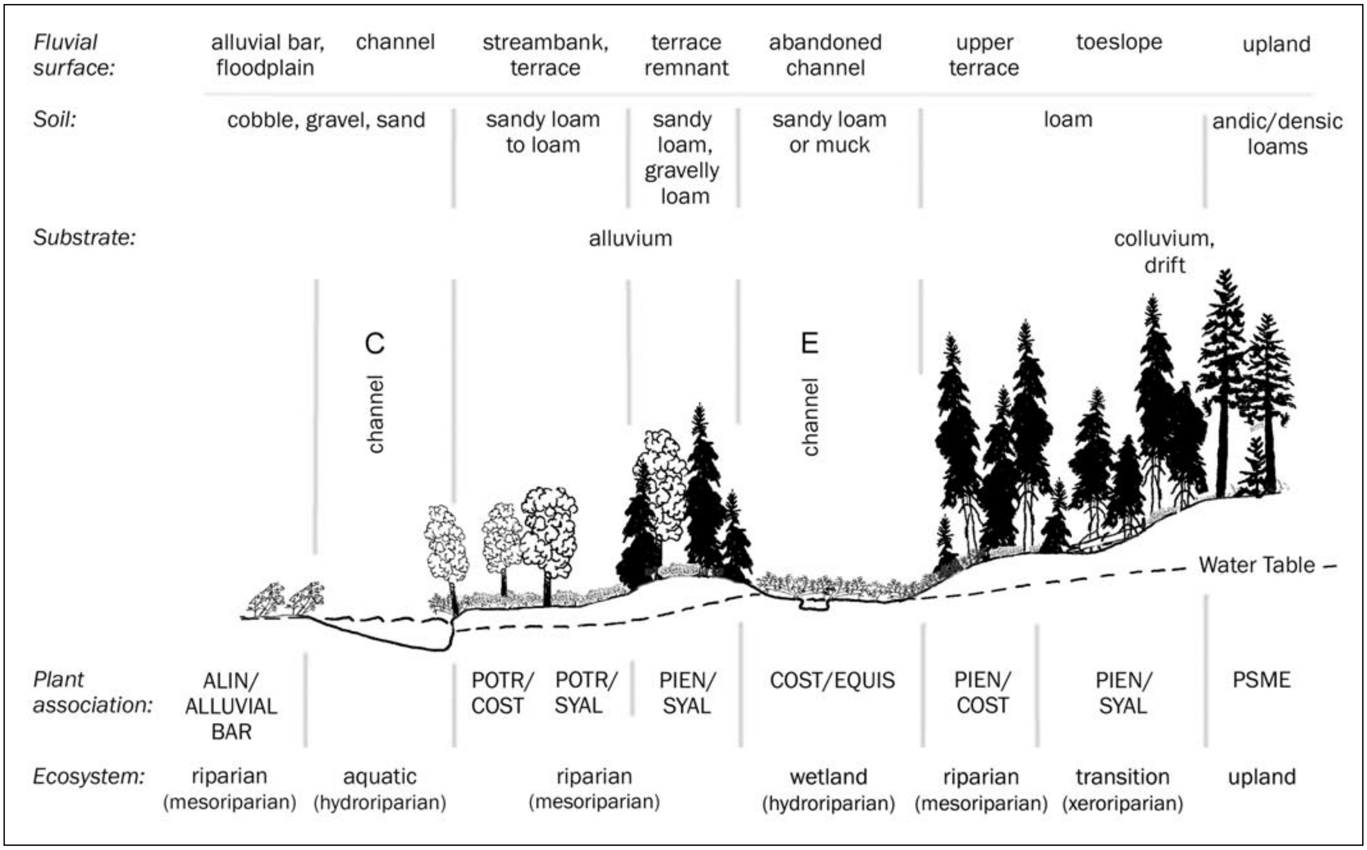

Figure 1—Riparian and wetland ecosystems form a narrow interface between aquatic and upland ecosystems.

INTRODUCTION

This study presents a classification of (and management options for) aquatic, wetland, and riparian series and plant associations occurring within the Colville, Okanogan, and Wenatchee National Forests (NF) (fig. 1). Aquatic, wetland and riparian ecosystems are only a small portion of the eastern Washington landscape. They are, however, disproportionately important as habitats for plants and as sources of food, water, cover, and nesting habitat for animals (Crowe and Clausnitzer 1997, Hansen et al. 1995, Kovalchik 1987). Vegetation production is generally higher in these ecosystems than in nearby uplands, and their cool, moist microclimate provides a contrasting habitat. These areas also are valued for human uses including recreation; livestock grazing; as a water supply for irrigation, mining operations, and crop production; and as transportation corridors. The structure and composition of riparian and wetland systems influence the rate, amount, and timing for water, nutrients, organic debris, and inorganic materials that enter lakes, ponds, streams, and rivers. The energy, and ultimate amount, timing, and erosive power of floodwaters are influenced by the soils, vegetation, and geomorphology of soil surfaces (fluvial surfaces) within valley bottoms. Decades of intensive use of riparian areas and other wetlands have caused substantial degradation of their ecological structure, composition, and function throughout most of the United States. Rehabilitation and restoration are currently high priorities for the U.S. Department of Agriculture (USDA) Forest Service (FS) and other agencies charged with managing public land. To improve conditions, an understanding of wetland and riparian ecosystems is necessary. Classification of aquatic, riparian, and wetland series and their plant associations provides a means of stratifying these ecosystems into recognizable and repeatable units that integrate potential natural vegetation, soil characteristics, fluvial geomorphology, hydrology, and climate. This classification is integral to ecosystem management providing a common framework for communicating about wetland ecosystems among various disciplines, and for planning management activities and analysis of their effects.

"Wetlands are areas that lie between terrestrial (upland) and aquatic systems and generally considered to be inundated or saturated by surface or groundwater at a frequency and duration sufficient, under normal circumstances, to support a prevalence of vegetation typically adapted for life in saturated soil conditions" (Federal Interagency Committee for Wetland Delineation 1989). The U.S. Fish and Wildlife Service (USFWS) wetlands classification (Cowardin et al. 1979) uses the term "wetland vegetation" to describe "vegetation within or adjacent to, and hydrologically influenced by, streams, rivers, lakes, meadows, and seeps." The term "riparian vegetation" is used specifically for vegetation located within the valley of, and hydrologically influenced by, a stream or river. "Aquatic vegetation" grows in deeper, permanently standing water in lakes and ponds (or in the sluggish backwaters of streams and rivers).

These riparian and wetland zones form a narrow interface between aquatic and terrestrial ecosystems. In the mountainous regions of the Pacific Northwest (Kovalchik 1987, Youngblood et al. 1985b), these water-oriented ecosystems are well defined by the presence of free, unbound water and are next to much drier upslope ecosystems. They occur on a variety of sites, such as floodplains, bogs, marshes, lakeshores, springs, and basins. Jurisdictional wetlands must (under current regulations) have three components: wetland hydrology, hydric soils, and hydrophytic vegetation. The Natural Resources Conservation Service (NRCS) has devised the list of soil types that qualify as hydric soils (USDA SCS 1987); the definitions of wetland hydrology are found in the Corps of Engineers Wetland Delineation Manual (Environmental Laboratory 1987); and the USFWS has prepared the list of hydrophytes and their degree of wetland affinity (USFWS 1996). Included are plant associations occurring on fluvial surfaces in valley bottoms that may not be classified as jurisdictional wetlands but that do function as "xeric" or "transitional" riparian or wetland areas (Crowe and Clausnitzer 1997, Kovalchik 1987). These fluvial surfaces usually are drier terraces and the adjacent toeslope. They also may include the transition to uplands that occurs at the margins of true wetlands.

Thus, typical riparian and wetland sites (as used in this report) are composed of three distinct ecosystems (fig. 1) (Kovalchik 1987):

- Aquatic—The permanently flooded portion of the riparian or wetland zone, which includes streams, rivers, ponds or lakes.
- Riparian and wetland—The land next to water where plants that are dependent on a perpetual source of water live.
- Transitional or xeroriparian—Subirrigated sites lying between riparian/wetland sites and upland. This ecosystem does not have true hydrophytic vegetation such as sedges and willows, yet is uniquely different from uplands.

The consistent occurrence of similar series and plant associations in these ecosystems can be used to stratify the landscape (Daubenmire 1976, Pfister et al. 1977). Although not all questions about a piece of land can be answered by a series/plant association classification (Hemstrom and Franklin 1982), vegetation, soil, water, and physical characteristics can usefully indicate plant responses to management, productivity potential, and future species composition. Such a classification allows us to:

- Plan management strategies—Evaluate resource condition, productivity, and responses to management.
- Communicate—Provide a common description of riparian conditions for various disciplines, record successes or failures of management actions, and repeat the successes.
- Apply research—Provide a direct link between research results and practical land management.

Recent classifications of series and plant associations integrate potential natural vegetation, soil characteristics, fluvial geomorphology, hydrology, and climate (Crowe and Clausnitzer 1997, Diaz and Mellen 1996, Hansen et al. 1995, Kovalchik 1987). This classification follows their lead as it classifies aquatic, wetland, and riparian series and plant associations (with some community types) occurring on the Colville, Okanogan, and Wenatchee NFs.

This classification covers all riparian and wetland sites within the Colville, Wenatchee, and Okanogan NFs, as well as a large tract of land on the west side of the Cascades between Washington Pass and the North Cascades National Park (fig. 2). It includes aquatic, riparian, wetland, and transitional series and plant associations that (1) occur repeatedly in eastern Washington, (2) are large enough to be mapped for project-level wildland management, and (3) have distinct management differences.

This classification supplements and expands information presented in upland forest plant association classifications in eastern Washington (Lillybridge et al. 1995, Williams et al. 1995). It focuses on riparian and wetland ecosystems but also includes aquatic ecosystems. Intermittent streams, dry draws, and other land features that may at times transport water are poorly represented in the classification, although they may support vegetation described by one of the series or plant associations. Seeps and springs support wetland or riparian vegetation but were not sampled often. Small portions of the NFs, such as parts of the eastern half of the Tonasket Ranger District (RD) of the Okanogan NF and the Table Mountain area of the Wenatchee NF, may have riparian zones in deteriorated condition. They are weakly represented in the database because of the lack of riparian and wetland ecosystems in late-seral to climax ecological status.

This study has been prepared to meet the following objectives of the Pacific Northwest Region Ecology Program:

- Provide a useful classification of water-defined ecosystems as a step toward completing the USDA Forest Service, Pacific Northwest Region classification program.

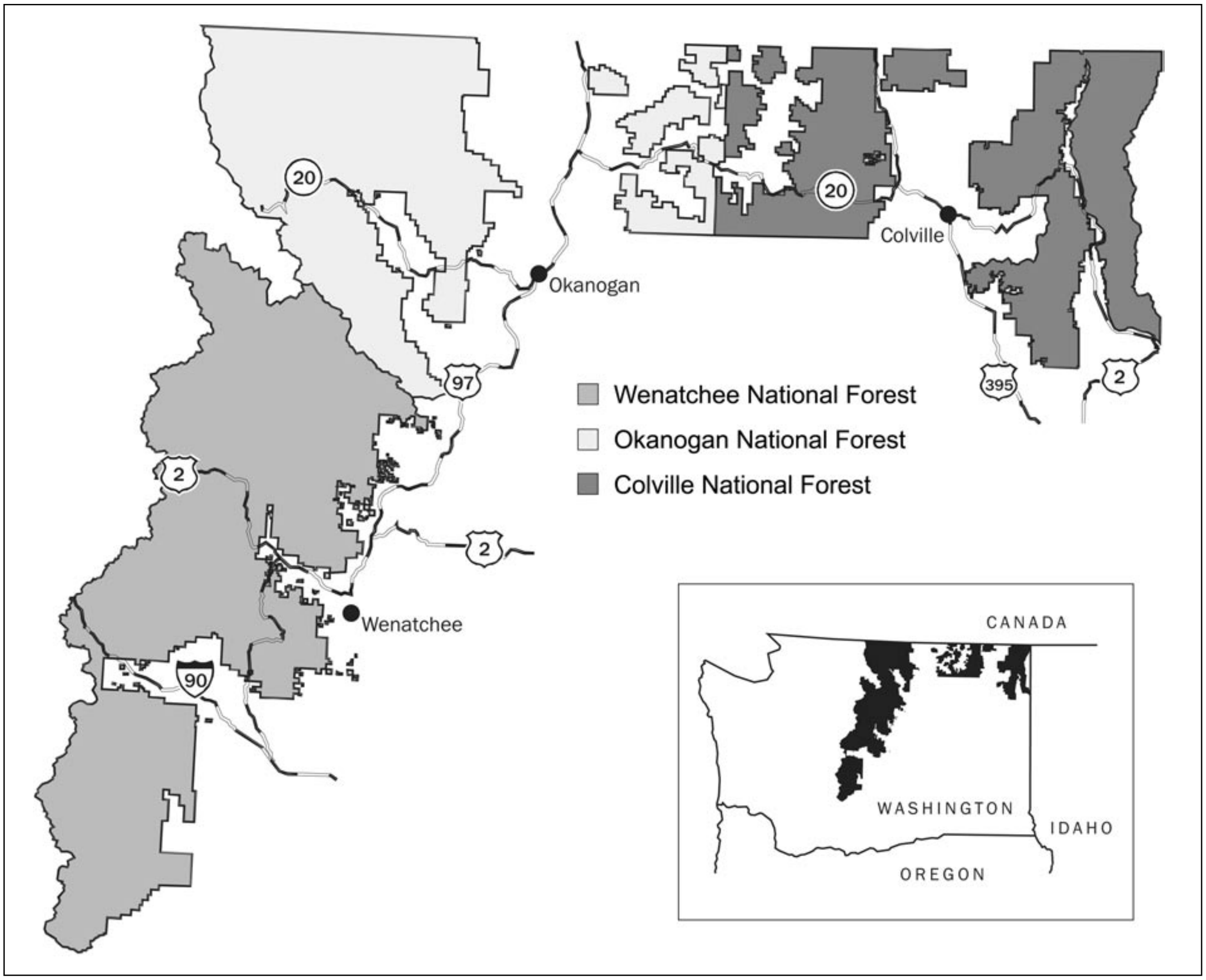

Figure 2—Location of the Colville, Okanogan, and Wenatchee National Forests.

- Describe the general geographic, topographic, edaphic, functional, and floristic features of aquatic, riparian, and wetland ecosystems.
- Describe successional trends and predict vegetative potential on disturbed aquatic, riparian, and wetland ecosystems.
- Present information on resource values and management opportunities.

METHODS

Field Methods—

Aquatic, riparian, and wetland ecosystems in north-central and northeastern Washington were first sampled from 1990 through 1992 and incorporated into a draft classification for the Colville NF and Tonasket RD of the Okanogan NF (Kovalchik 1992c). The database for that draft included about 700 sample plots that were selected to represent the best available environmental conditions. Field sampling continued on the Okanogan and Wenatchee NFs from 1993 through 1995 and provided an additional 950 plots for the final riparian/wetland classification for eastern Washington.

Stands in climax ecological status (good ecological condition) were sampled wherever available. In areas of consistently high levels of disturbance, climax stands were difficult to find, and late-seral stands in fair ecological condition were sampled. Exceptions included a few plots in naturalized community types such as the Kentucky bluegrass community type or obviously seral communities such as those dominated by lodgepole pine, quaking aspen, black cottonwood, red alder, bigleaf maple, or paper birch. The final classification thus provides a foundation of series and plant associations in fair to good ecological condition (late-seral to climax ecological status) against which stands of other condition stages can be compared in order to determine their potential.

A reconnaissance of drainages was made prior to plot selection. Sample sites representing best conditions were then chosen in distinct reaches (as defined by valley gradient, valley width, and elevation) of riparian/wetland zones. A stream reach might include several progressively drier, distinct series and plant associations on the succession of fluvial surfaces occurring between the aquatic and upland ecosystems. Sketches delineating the stream, fluvial surfaces, and each plant association across the valley reach were drawn. Each plant association became a plot site, and a cross section of the valley located clusters of plots. Actual sample plot size per site was usually one-tenth of an acre. For small sites (e.g., alluvial bars, floodplains, streambanks) that were less than one-tenth of an acre, the entire site became the plot. In either case, the plot had to represent the stand and not include ecotones.

A complete inventory of vascular plants and ocular estimates of canopy cover was taken on each plot. Generally, the ocular estimates were to the nearest percent up to 10-percent canopy coverage and to the nearest 5 percent thereafter. Plants not field identified to the species level were collected for later identification in the office. Although usually field identified, all willows (*Salix* spp.[1]) and most sedges (*Carex* spp. and their relatives) were collected for further study of these difficult genera.

Soil pits were described by using standard pedon descriptions (USDA SCS 1975). Thickness, moist color, texture, coarse fragments, rooting depth, and root abundance were recorded by horizon. Other soil data included water table levels, soil moisture, rooting depth, total soil depth, and parent material. A 3-inch soil auger proved most effective for digging pits in fine-textured mineral or organic soils, but auger penetration was often limited in cobbly soils. The hole was augered only to the depth of an impenetrable layer (such as cobbles).

Other data collected on each plot included elevation, aspect, slope, landform, microtopography, and ecological status. The percentages of cover of bare ground, gravel, rock, bedrock, and moss were estimated for the soil surface. Wildlife habitat was briefly described. Tree heights, tree ages (at 4.5 feet), basal area of live tree species, and snag data were measured on forested plots. Log information was collected on all plots. Stream channels were described by using Rosgen's stream classification (Rosgen 1994, 1996). Valley width, shape, and gradient were recorded for each plot.

Taxonomic Considerations—

Wetland plant identification is considered difficult by many of the potential users of this report. Thus, considerable collections were made of willows, sedges, other difficult genera, and unknown plant species. Joy Mastroguiseppe at the Washington State University Herbarium verified sedges and sedgelike graminoids during the first 2 years of the study. Similarly, Steven Brunsfeld at the University of Idaho verified willow collections in early years of the study. The author verified later collections of sedges and willows. Willow taxonomy follows Brunsfeld and Johnson (1985) and Hitchcock and Cronquist (1973). Monocot taxonomy and other flora generally follow Hitchcock and Cronquist (1973).

About 25 willow species and varieties have been identified on eastern Washington NFs. The author is very familiar with willow taxonomy, but identification of willows was difficult for summer field crews. Many willows bloom before or simultaneously with mature vegetation development, and the characteristics of female and male aments are used for identification. Later in the summer, aments are often lacking so that growth form, leaves, and twigs become important identifying criteria. Some species may hybridize, and a few species are very similar to one another. This has created considerable confusion in nomenclature. (A willow comparisons table is included in app. F).

Readers please note that a recent review of the willow collections for the study area and subsequent voucher verifications by George Argus (2004) have revealed some earlier misidentifications. Piper's willow (*Salix piperi*) collected in northeastern Washington is best considered Barclay's willow (*Salix barclayi*)—albeit, extremely large specimens of that taxon. In addition, most of the Farr's willow (*Salix farriae*) identified in the study area is likely *S. barclayi*. The remaining Farr's willow specimens were reexamined and identified as bog willow (*Salix pedicellaris*) by Argus and Kovalchik. Further, some of the *S. barclayi* collected in northeastern Washington has been verified as tea-leaved willow (*Salix planifolia* var. *monica*). Although Barclay's willow, bog willow, and tea-leaved willow are well distributed and quite common in the study area, apparently Farr's willow is more limited in its distribution. Consequently, the authors find it more appropriate to rename the short willow types (SAFA) after the more common taxon, *Salix planifolia* var. *monica* (SAPLM2).

Sedges, sedgelike plants, and wet-site grasses also were difficult species for summer crews. The taxonomy for sedges in Hitchcock and Cronquist (1973) required some clarification. Their keys to sedges are based on characteristics that are at times variable and overlapping. A comparisons table for sedges is provided in appendix E.

Aquatic plants presented a problem because of their slow development relative to riparian and wetland species. A site with the potential to support aquatics may not have aquatic growth in June, may have some vegetative development but no flower development in July, and flowering material may not be available until late August. Some of the most common aquatics, such as pondweed (*Potamogeton*), bur-reed (*Sparganium*), and bladderwort (*Utricularia*), were grouped into genera because of the difficulty identifying them to species without flowering parts.

[1] See appendix A for common and scientific names of plant, animal, and insect species and diseases mentioned in this classification.

The separation between individuals clearly recognizable as Oregon hollygrape and those clearly identifiable as creeping hollygrape was problematic. Most plants appeared to fit *Berberis aquifolium*, although there is considerable variation from plant to plant. Cascade hollygrape (*Berberis nervosa*) was recorded as such.

Big huckleberry (*Vaccinium membranaceum*) and globe huckleberry (*V. globulare*) are morphologically similar species that occur in the study area and are easily confused (Steele et al. 1981). Globe huckleberry is more common in the Rocky Mountains and big huckleberry in the Cascade Range. Most of the material seems to better fit big huckleberry so all plants of this group are arbitrarily referred to as big huckleberry.

Low huckleberry (*V. myrtillus*) appears at times to intergrade with both big (*V. membranaceum*) and grouse huckleberry (*V. scoparium*). However, the difference in indicator value of the species is most significant when low or grouse huckleberry or both are the only or the greatly predominant species. Species identification is normally readily apparent under these conditions.

Pfister et al. (1977) indicated that most spruces in northern Montana are hybrids of Engelmann (*Picea engelmannii*) and white spruce (*Picea glauca*). White spruce is prominent closer to the Montana-Canada border, especially in geologic areas with limestone parent material or at low elevations near the border. The same pattern seems true in eastern Washington, especially in strong continental climate near the Canadian border, but cone scales were not collected to prove or disprove hybridization. Most of the spruce found on the ecology plots readily keyed to Engelmann spruce, so that name was used for all spruces.

Paper birch and water birch often hybridize, and it is unclear what to call these hybrid forms. Paper birch has striking white bark and is a moderately large tree. Water birch is usually more shrublike, with many stems and brownish-reddish bark. Hybrids are small trees with pinkish bark that were lumped with paper birch because of their treelike stature.

Mountain alder can grow to more than 40 feet tall in the study area, which is much taller than described in the literature (Hitchcock and Cronquist 1973). Some persons have called these specimens red alder because of their unusual height, but a close look at cones and leaves of the species indicates they best fit mountain alder. This problem seemed to be especially prominent on the Colville NF, but mountain and red alder also intermix on the Wenatchee and Okanogan NFs. In the Colville NF data, all were called mountain alder. In Cascades data, red and mountain alder were named separately, even though hybridization may account for the large size of some mountain alder.

Classification Techniques—

Arriving at a vegetation classification involved reiterative interactions between data gathered in the field (the "real" world) and the more abstract, analytical activities in the office.

Manipulating data via various computer programs was important from the beginning of the study. Field data were entered and edited in a PARADOX[2] (later MS Access) database to analyze field data and aid classification development. Association tables were made to group stands with similar floristic characteristics. Pacific Northwest Region ecology programs (adapted for personal computers by Brad Smith in 1991[3]) such as TWINSPAN, DECORANA, and SIMILARITY (Hill 1979a, 1979b) provided more objective techniques for analyzing field data and developing the classification. For synthesis of the many tables and figures in the classification, data were queried in MS Access, transferred to MS Excel, assembled in workbooks by series, and further massaged and collated to various data subsets by series and plant association. The data subsets are displayed as tables, charts, and maps in this classification.

Data collected from 1990 through 1992 were used to write a preliminary draft of the riparian and wetland plant associations found on the Okanogan's Tonasket RD and the Colville NF (Kovalchik 1992c).

Later data were used in 1999 to write a draft manuscript for wetland and riparian series in all three NFs that was made available on the Colville NF intranet site (http://fsweb1.f21.r6.fs.fed.us). This rough draft was missing considerable management information.

Plant association keys and constancy/cover tables, production information, and additional management information were added to this report in 2000 and 2001. The current report focuses on riparian and wetland series classification for eastern Washington NFs but also includes keys and constancy/cover tables for the plant associations.

CLASSIFICATION CONCEPTS AND TERMINOLOGY

Series, Plant Association, and Community Type Concepts—

Series, plant association, and community type are the basic units of the classification. The series refers to all the plant associations and community types dominated by the same species at climax or in good ecological condition (for example, the willow series). Pfister et al. (1977) define a plant community as an assembly of plants living together, reflecting no particular ecological status. The community

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[2] The use of trade or firm names in this publication is for reader information and does not imply endorsement of any product or service by the U.S. Department of Agriculture.

[3] Brad Smith was the associate ecologist and acting area ecologist for the Area 2 Ecology Program from 1989 to 1994.

type is an aggregation of all plant communities distinguished by floristic and structural similarities in both overstory and undergrowth (Youngblood et al. 1985a). Pfister et al. (1977) define the plant association as a climax community type. This classification (and Crowe and Clausnitzer 1997) uses riparian and wetland plant association as an assemblage of native vegetation in equilibrium with the environment on specific fluvial surfaces (the vegetative potential on the fluvial surface). This potential may change in time as soil and water characteristics of the fluvial surface change through erosion or, more typically, flooding and silt deposition. The *Classification and Management of Montana's Riparian and Wetland Sites* (Hansen et al. 1995) follows this lead and defines a riparian or wetland plant association as a vegetation type representing the latest (most stable) successional stage attainable on a specific hydrologically influenced surface.

This study concentrated on sampling riparian associations in climax and late-seral ecological status (fair or better ecological condition) and avoided disturbed sites. The aquatic/riparian/wetland series and associations are often restricted to very specific fluvial surfaces within a valley segment. Together, plant associations and fluvial surfaces provide a meaningful way of integrating various environmental factors such as water regime and soils that affect vegetation. They represent a relatively narrow portion of the environmental variation found in riparian landforms and reflect certain potential for vegetation and fluvial surface development. Therefore, riparian association and community types are useful as an ecological basis for management guidelines related to ecological status, wildlife, fisheries, productivity, silviculture, succession, range management, hydrology, and mapping. The following four criteria must be met before a particular assemblage of plants can be classified as a riparian series or plant association (Hall 1973): The series or plant association (or community type) (1) differs from other associations in opportunities and limitations to land management, (2) can be recognized on the ground in any stage of disturbance, (3) has limited variation in species composition, and (4) has limited variability in productivity.

Nomenclature—

Each series is named after its tallest, most dominant life form (for example, the mountain alder series). Plant associations are named based on a combination of the dominant life form plus the characteristic or dominant plant species in the various plant layers (trees, shrubs, and herbs) (for example, the mountain alder–common snowberry (ALIN–SYAL) and Engelmann spruce/saw-leaved sedge (PIEN/CASCP2) associations). A slash (/) is used to separate the various life forms in a community name, and a dash (–) separates members of the same life form. The association may have only one species in its name (e.g., the herb layer in meadows), two where shrubs are superimposed over the herbaceous layer, or three where there are tree, shrub, and herb layers.

Shade tolerance is also a consideration in nomenclature (Williams and Lillybridge 1983). Thus, the name will be suggestive of plants most capable of growing on a site in more mature stands. For example, willows may be present in small amounts in the mountain alder–Douglas spiraea association (ALIN–SPDO), but mountain alder is used to name the association because it will dominate the willows as the plant composition and structure proceeds towards maturity. In the Engelmann spruce/saw-leaved sedge association (PIEN/CASCP2), the shrub undergrowth may contain both willows and saw-leaved sedge, but the sedge is used to name the association because it is more tolerant of conifer shade and is more dominant under mature forest canopies than willows. In the willow/saw-leaved sedge association (SALIX/CASCP2), however, trees are uncommon and willows are used to name the plant association. The dominant or most characteristic graminoid or herb is used to name the herbaceous layer. For instance, queencup beadlily is the most consistent species in a group of mesic forbs in the undergrowth of the relatively dry western redcedar/queencup beadlily association (THPL/CLUN), saw-leaved sedge forms a sward below trees in the wet Engelmann spruce/saw-leaved sedge association (PIEN/CASCP2) and the wet willow/saw-leaved sedge (SALIX/CASCP2) association. On the other hand, meadow series plant communities dominated by saw-leaved sedge alone are called the saw-leaved sedge (CASCP2) association.

Appendix A contains a list of the plant species codes, scientific names, and common names used in the text. Common names and Pacific Northwest (PNW) Region species codes are used in the constancy/cover tables. Series, plant associations, and community types are referred to in the text and tables by capital letter codes (for example, the PIEN series and PIEN/CASCP2 plant association). These codes are used instead of longhand species names to save space in some tables. The code is derived from the first two letters of each scientific name for a species. For example, the code for Geyer's willow (*Salix geyeriana*) is SAGE. The scientific code is better adapted to computer use and helps distinguish between series and plant associations in the text. All codes follow Garrison et al. (1976). The national plant species list codes (USDA SCS 1982) are included in appendix A. Scientific names largely follow Hitchcock and Cronquist (1973) except for a few exceptions. Common names follow Garrison et al. (1976) or Hitchcock and Cronquist (1973). Appendix A entries list the USDA FS PNW Region alpha code; newer national PLANTS database alpha code, scientific name, common name, the plant's indicator status, and each plant's hydrologic status.

THE PHYSICAL ENVIRONMENT

Climate—

The Cascade Range is a significant barrier to the movement of maritime and continental air masses. The study area has a climate with both maritime and continental climate because air masses from the continent and the Pacific Ocean cross this region. North-south trending mountain ranges and narrow valleys also create variation in climate. The central portion of the study area is under the influence of an intense rain shadow formed by the north Cascade Range. This effect is pronounced on the eastern half of the Wenatchee NF and occurs in areas just a few miles east of the Cascade crest on the Okanogan NF. This rain-shadow effect continues eastward through the Tonasket and Republic RDs. The far northeastern portion of the region has a moist inland maritime climate caused by westerly airflow being lifted over the 5,000- to 7,000-foot peaks of the Selkirk Mountains. Through most of the year, maritime air from the Pacific exerts a moderating influence on temperatures, whereas drier air from the interior can bring more extreme temperatures and drought.

Precipitation is greater in winter and spring. Most low-elevation valleys receive 10 to 25 inches of precipitation per year (fig. 3). The towns of Wenatchee, Okanogan, Republic, and Colville, Washington, receive about 9, 13, 20, and 18 inches of yearly precipitation, respectively. Precipitation increases in the mountains to 25 or more inches on the higher ridges of the Kettle River Range, 50 inches or more in the Selkirk Mountains, and over 80 inches along the Cascade crest. During the warmest summer months, maximum afternoon temperatures in the valleys range from the mid to upper 80s (degrees Fahrenheit), while minimums range from the 40s to the mid 50s (degrees Fahrenheit), (Phillips and Durkee 1972). During an average winter, afternoon temperatures are near freezing with minimums from 10 to 20 degrees Fahrenheit. In average years, summer temperatures exceed 100 degrees Fahrenheit for 1 to 5 days, and winter temperatures below 0 degrees Fahrenheit occur for 5 to 12 nights. Conditions are more severe in the mountains.

Climatic gradients between riparian and upland sites are sharp (Youngblood et al. 1985a). Cold air draining downhill into broad flats, basins, and valley bottoms can create severe summer frost problems in riparian and wetland zones. Summer droughts common in the uplands are largely moderated by moist to wet soils in riparian and wetland zones. Sites next to larger bodies of water, especially lakes, may have air temperatures moderated by the standing water.

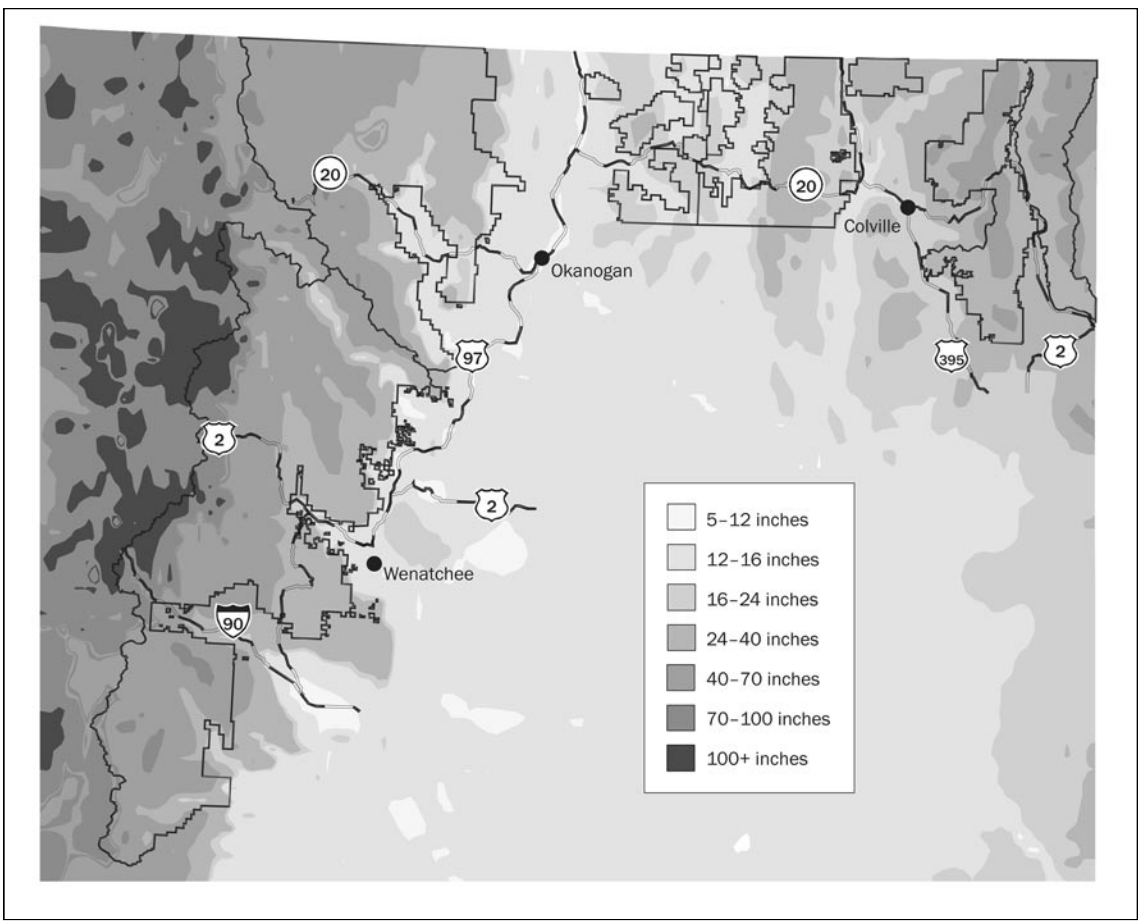


Figure 3—Annual precipitation zones for eastern Washington national forests.

Soils—

Soils in riparian and wetland ecosystems usually are much more complicated than those on adjacent uplands (Youngblood et al. 1985a). Soil texture, chemistry, and temperature, amount and kind of organic matter, and especially water tables, have a strong effect on plant species composition. Seasonally or permanently high water tables are necessary for a soil to support riparian and wetland vegetation. High water may be brief, with mid- to late-summer drought, as in the case of the timber oatgrass association (DAIN), or nearly season-long as in the bladder sedge association (CAUT). Fine-textured soils have stronger capillary action and remain wet longer than coarse soils. Organic matter also helps the soil draw water up from the water table and then retain it. Peat bogs are especially good "sponges;" their surfaces are often saturated even when the water table lies below the soil surface. Mineral soils that are saturated for long periods function in an anaerobic state and become gleyed, as evidenced by iron oxide spotting and a neutral gray to bluish-gray color.

Water levels also have a marked influence on accumulation of organic matter. Organic soil material is produced onsite in most riparian and wetland ecosystems, although water does move some organic material from site to site. Accumulation and decomposition proceed rapidly near the soil surface. Whether organic matter accumulates depends on the hydrology of the site. Under anaerobic conditions, less decomposition occurs, and thick layers of organic material accumulate with time. Organic material accumulation is accelerated if low soil and water fertility, low soil and water temperatures, and minimally fluctuating water tables accompany anaerobic conditions, such as in bogs. The reverse is true where water tables fluctuate and soils function aerobically.

Taxonomy of riparian soils is in its infancy, and soils were not identified beyond suborder. Even at this level, the taxonomy was of questionable value. For instance, a bog community with a peat surface horizon 4 to 14 inches thick and with the bulk of the root mass in this layer would not be considered an organic soil because soil taxonomy requires at least 16 inches of organic matter to key to a Histisol. Therefore, descriptions in the text use general soil texture within the rooting zone, instead of standard soil taxonomy terminology. Thus:

- Organic loam refers to very fine-textured, black soils judged to contain more than 12 percent organic matter. They are generally sapric Histisols. Saturated organic loam soils may be called ooze or muck.
- Sedge or moss peat soils are either fibric or hemic Histisols.
- Sedimentary peat refers to limnic Histisols on the bottom or margins of lakes and ponds.
- Ooze or muck refers to black semiliquid soils and are equivalent to sapric Histisols.
- Skeletal soils are medium- to coarse-textured mineral soils that occur on floodplains and streambanks, and are generally Entisols.
- Most fine-textured mineral soils on grass-dominated or the drier end of meadow associations such as the timber oatgrass association (DAIN) are Mollisols containing 2 to 12 percent organic matter in the surface horizons.
- Other mineral soils with no mollic epipedon occur mostly in transitional riparian associations (usually on terraces or toeslopes) such as subalpine fir/bunchberry dogwood (ABLA2/COCA) and are Inceptisols.

Geomorphology—

Geomorphology is best defined as the study of landforms (Ritter 1978, Thornbury 1969), and these concepts were used in developing this classification throughout the field and office stages. Geologic structure, modification process, and stage (time) of modification are the controlling factors in the evolution of landforms.

- Structure refers to rock orientations in space (i.e., joints, faults, bedding, and the variation of hardness or permeability of rocks)—the pattern in which the Earth's crust differs from location to location.
- Modification processes are the many chemical, biological, and physical ways in which the Earth's surface undergoes change.
- Stage is a description of the temporal progression of these modification processes and their consequent effects on landforms.

These factors are neither static nor uniformly directional. In most of eastern Washington, the wearing process from weathering has been periodically interrupted by extension of massive ice sheets during the ice ages (Pleistocene Epoch). The last advance of the Cordilleran ice sheet covered much of the study area until some 12,000 years ago. Although most of the Wenatchee NF escaped the continental ice advance, areas at higher elevation were influenced by extensive alpine glaciation.

The geomorphological aspects of this study are based on concepts from the classic text by Thornbury (1969). The formation of watersheds and both upland and riparian landforms is mostly determined by five interdependent factors: geology, climate, valley gradient, soils, and vegetation (Lotspeich 1980, Thornbury 1969). By using these factors, riparian classifications can be physically organized into four hierarchical levels (Kovalchik 1987, Kovalchik and Chitwood 1990) (fig. 4).

The broadest levels are the sections and subsections used in the national land mapping system (Maxwell et al. 1995).

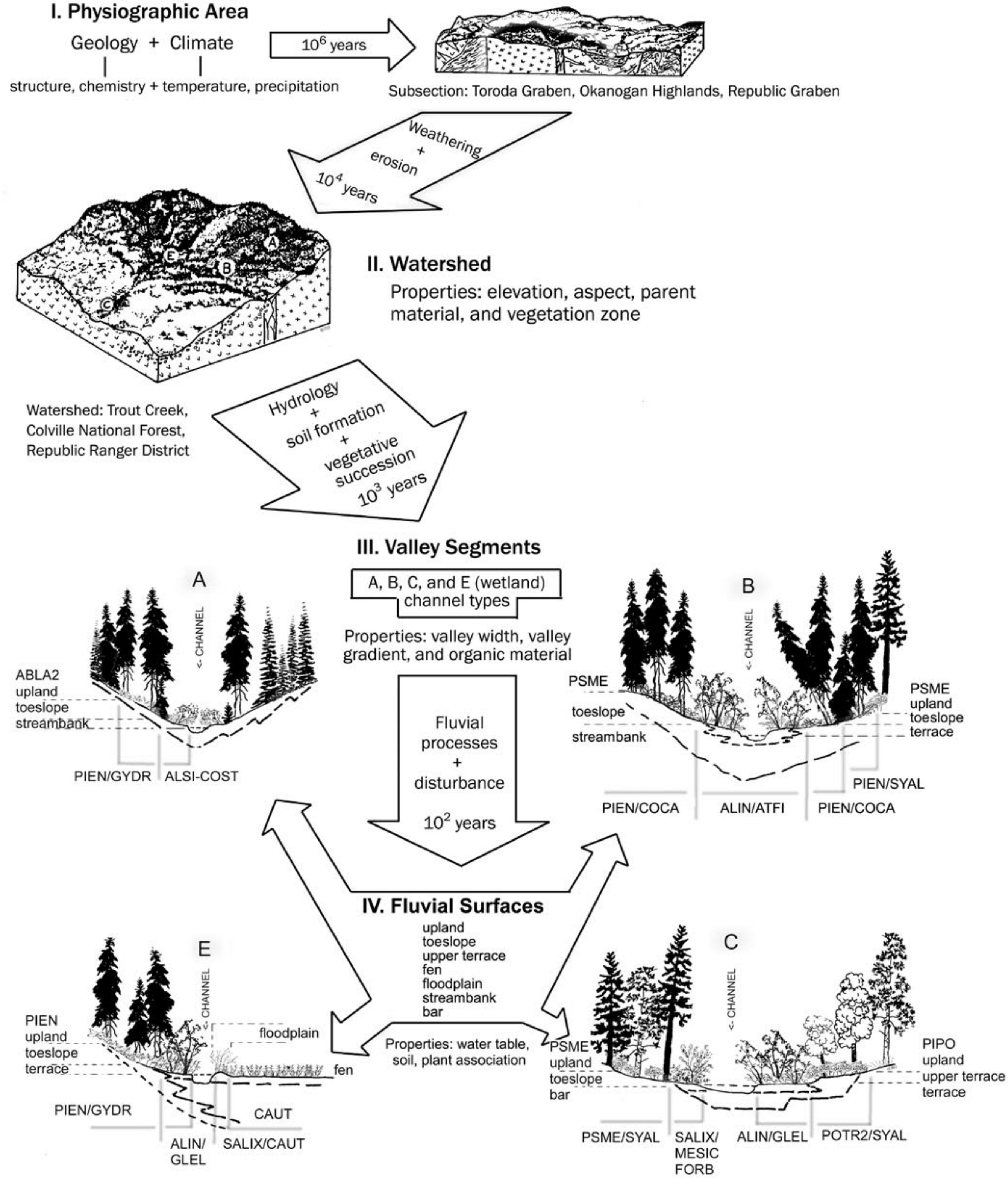


Figure 4—Valley geomorphology of the Trout Creek watershed, Republic Ranger District, Colville National Forest.

Sections and subsections are recognized based on broad uniformity in vegetation, geology, climate, and stage of modification in the evolution of landforms.

The second level is the watershed. Watersheds were not included in the riparian classification for central Oregon (Kovalchik 1987) but are proposed for this work. Lotspeich (1980) proposed the watershed as the conceptual framework for a natural geomorphic classification system. The effects of modification processes, such as weathering or erosion, on geologic formations result in the development of characteristic watersheds. These, in turn, ultimately determine the structure and function of associated riparian and wetland zones. Considering sections and watersheds allows a shift from a classification that focuses on the riparian and wetland zone only (i.e., the series and plant associations), to the zone's relationship to the larger geomorphic picture. Because of the interaction between uplands and lowlands, management activities in upland zones may change management potentials in riparian and wetland zones. Although watersheds may be relatively uniform within a section or subsection, differences exist in stream order, aspect, elevation, geology, soils, sediment supply, water regimes, timing and frequency of floods, and vegetation. Understanding these factors is critical for land management planning in riparian and wetland zones.

The third level is the valley segment. These smaller land units are equivalent to the land types defined in the national land classification system (Maxwell et al. 1995). They are segments of riparian and wetland zones characterized by distinctive relation to the upland, surface expression, internal structure, and vegetation. Valley segments reflect local uniformity in elevation, valley gradient and width, fluvial processes, water regime, and soils. Streams may occur in steep, narrow, V-shaped valleys in their headwaters (bedrock channels of Montgomery and Buffington 1993), but open downstream to flat-bottomed, wide, depositional valleys at lower elevations. Wide, flat valleys also may occur in high-elevation, glacial troughs or behind hard points such as rock outcrops or log debris jams in otherwise steep stream reaches.

The fourth basic level is the fluvial surface occurring within each valley segment and the riparian and wetland plant associations that grow there. Fluvial surface examples include alluvial bars, point bars, floodplains, streambanks, terraces, overflow channels, fens, carrs, and bogs. Fluvial surfaces are similar to land-type phases and represent response to patterns of stream erosion, overflow, and deposition. They also represent environmental variations found in a valley segment and reflect a specific potential for vegetation development. Riparian and wetland plant associations respond characteristically to differences in soil structure, soil texture, and water tables in fluvial surfaces. Together, fluvial surfaces and riparian plant associations provide a meaningful way of integrating various environmental factors, such as water regime and soils, which affect vegetation potentials in riparian landforms.

Four interdependent factors mostly determine the mosaic of riparian associations and fluvial surfaces in any one valley segment in eastern Washington: (1) Climate is mostly determined by the geographic setting. Annual precipitation, hydrologic regime, and temperature range determine factors such as soil formation rates, disturbance regime, and species composition. Climate varies with elevation and aspect such that similar climates can occur at different elevations or aspects in different areas. (2) Geology largely determines drainage pattern and the kind of soil deposited on fluvial surfaces. (3) Steep valley gradients (over 4 percent) tend to form narrow, downcutting valley cross sections. Intermediate gradients (1 to 3 percent) interact with biological factors, such as large wood and beaver dams to form infinitely varied habitats. Flat gradients (under 1 percent) form wide, depositional floodplains. (4) Vegetation filters and traps sediments and helps build and anchor fluvial surfaces. In steeper segments the roots of large trees can both stabilize banks or alter the course of the stream when the trees fall.

Stream action is a major factor in landscape formation. Valley deepening is often associated with relatively early stages of landscape formation and is a result of hydrologic, corrosive, abrasive, and weathering processes on the valley floor (Thornbury 1969). Valley widening is the result of lateral erosion, slumping, soil creep, and other hill-slope processes (Horton 1945). Valley lengthening is the result of headwall erosion, meander development, and the formation of fans and deltas. All these are indirectly tied to the effects of water and result in the formation of water-related landforms in the vicinity of streams and other bodies of water that form the riparian and wetland zone.

For the transportation of a stream's sediment load, changes in structure or process require change in gradient and channel characteristics (Leopold et al. 1964). The gradient or steepness of a valley is often related to the width of the valley floor. Narrow valleys, especially those in headwater or first-order drainages, often have V-shaped profiles, moderate to steep gradients, and narrow riparian zones. Streams in these valleys have high energy, relatively straight channels, and if they adjust to dissipate energy, they do so vertically, over steps or cascades. Steep channels cut downward by deepening the pools, and move relatively coarse material along the bed and in suspension. They build streambanks and terraces with moderate- to coarse-textured, well-aerated soils. At lower elevations, third- to fifth-order streams predominate (Strahler 1952); valley gradients are low, and most valleys are wide. These streams oscillate horizontally, forming meanders, and lateral erosion is predominant. These streams carry fine-grained sediment loads and form floodplains with finer textured soils. They may have numerous overflow and cutoff channels. Steep and shallowly graded sections are often present on the same stream.

Continent Physiography—

The study area lies within the Okanogan Highlands, Northern Cascades, and Southern Washington Cascades Provinces described by Franklin and Dryness (1973). In this study area, those provinces coincide with the eastern Cascades M242 and Okanogan Highlands M333 sections, which were delineated by Maxwell et al. (1995). Because the geologic and climatic diversity within a province is so great, more difference occurs among riparian habitats within the large units than among provinces or sections. To be definitive for riparian classification, we have chosen the hierarchical subsections of Maxwell et al. (1995) to subdivide the province for series descriptions.

Geologic Basis of the Sections—

The geology and geologic history of the study area are among the most complex on the North American continent (fig. 5). In brief, beginning with a sedimentary cover on an ancient, granite crust, the continent was rifted approximately 700 million years ago. The line of that rift lies, at depth, under the Okanogan Dome subsection, a few miles east of the Okanogan River. From the time of rifting until 55 million years before present, mixes of locally derived and far-traveled rock packages were added to the western edge of that foundation. During that interval, as the lithosphere below the old continent cooled and sank, collision with the Pacific plate pushed the added crust up and over (Alt and Hyndman 1984). The surface boundary between the old cover and the added crust is now along a line from the northeastern corner of Washington to near the mouth of the Spokane River. Building of the present mountain topography then began with faulting, volcanism, and the intrusion of large igneous rock masses. The mountain building progressed from east to west and continues just beyond the western edge of the study

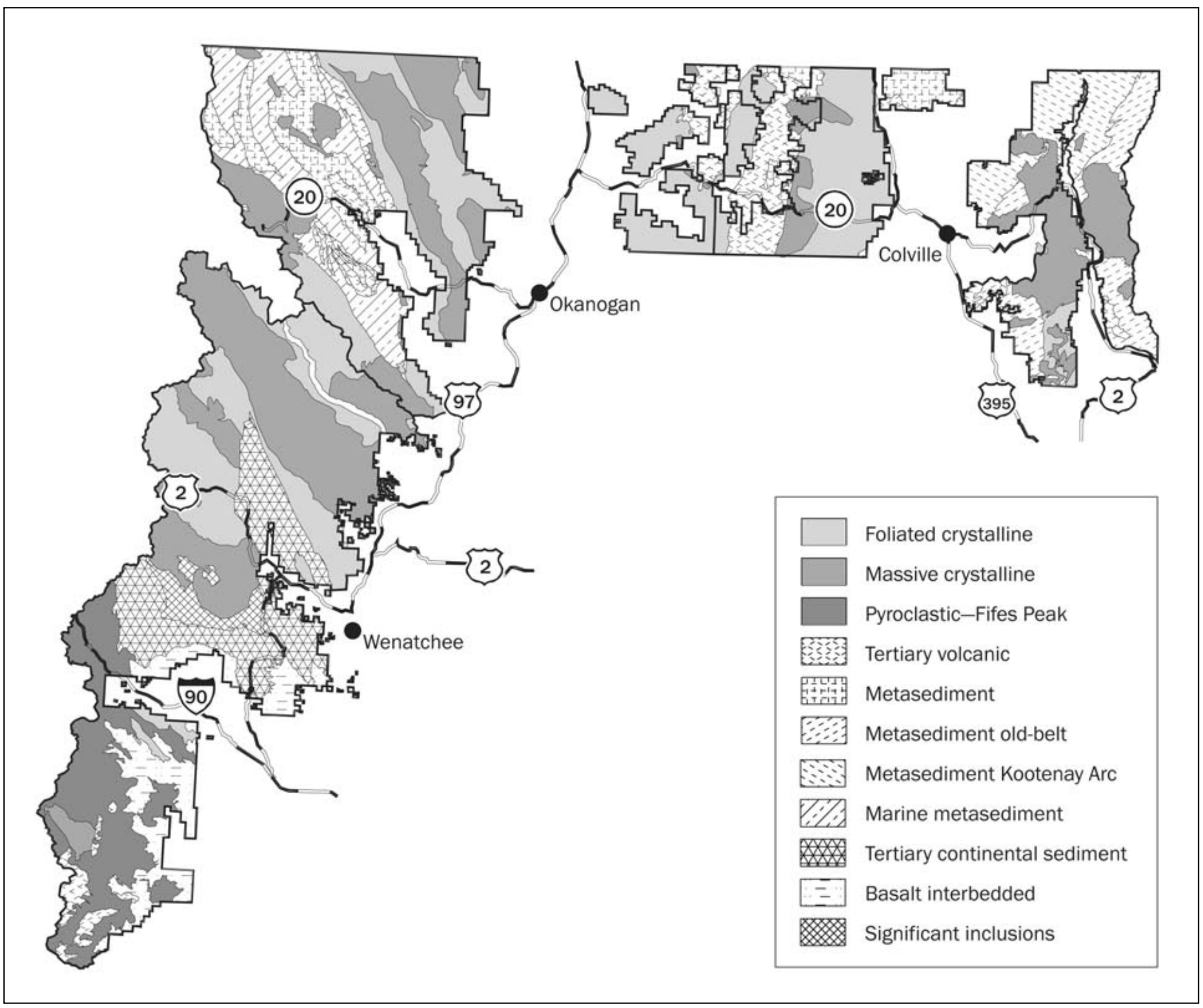


Figure 5—Bedrock geology for eastern Washington national forests.

area (Burchfiel et al. 1992). The mountain building exhumed large domes of gneiss in the eastern part of the study area. West of the Okanogan River, volcanic rocks were added to mountains that already consisted of metamorphic rock ridges and northwest trending basins full of sediment.

The most recent event to revise the topography was glaciation. The ice advanced and retreated in at least two and possibly four pulses during the last 800,000 years. The Cordilleran Continental Ice Sheet formed a continuous cover over most of the study area that is east of the Sinlahekin River. Alpine glaciers occupied most of the major valleys in the western part of the area (Richmond et al. 1965). The continental glacier stripped almost all the soil and weathered material from the area that it covered and left a discontinuous cover of less weathered material. As volcanic activity continued to the west, fine-grained tephra fell over the whole area. The addition of the volcanic ash hastened and altered soil development on the glaciated area.

The bedrock of the study area includes nearly the full range of possible chemistries, types, and textures. The varieties that are present in significant abundance and concentration can be grouped into eight functional complexes (Davis 2000):

Granular crystalline rocks are primarily granite rocks that are mostly high in silica, potash, and soda; and tend to weather to uniformly sand-size particles. Examples are the Cathedral Batholith, in the Pasayten Wilderness, and Starvation Flat quartz monzonite, east of Colville (Stoffel et al. 1991).

Structured crystalline rocks have undergone intense, repeated metamorphism and weather to very mixed-size debris that is often dominated by large, blocky fragments. They are of intermediate composition with more lime and alumina than the granular crystalline complex. Examples are Coryell intrusive rocks, near Northport, and the Tonasket gneiss, east of Tonasket.

Fractal metasedimentary rocks that are thinly layered occur in very steeply dipping, folded structures. With abundant silica and micas, they weather to soils that are rich in small, irregular fragments in a matrix of sand, silt, and clay. Ground water collects in deep and extensive aquifers in these rocks. Examples are the Entiat schist, southwest of Lake Chelan, and the Belt Supergroup, flanking the Pend Oreille River.

Euxinic metasedimentary rocks are very fine grain and rich in carbon and sulfur. They are often finely layered or sheared but have many massive lenses and layers. The carbon occurs as elemental carbon, hydrocarbons, and carbonate. Sulfur is present as sulfide and sulfate. The infiltration and storage of ground water is very irregular, and many of the springs yield sulfurous, corrosive, or acid water. They underlie mostly rounded and gentle topography, but where the structures are steep or the rock is massive, there are anomalous cliffs. Examples are the Ledbetter Slate, near Metaline Falls, and the Anarchist Group, west of Oroville.

Younger sedimentary rocks are frequently massive rocks derived from the debris of island arcs and volcanic ocean platforms. These are less altered by metamorphism and weather more readily than other metasedimentary complexes. Highly variable slopes gradually shed sandy debris into the riparian zones. Because their chemistry is rich in calcium and alumina, but poor in silica, they yield neutral and alkaline soils. Examples are the Virginian Ridge Formation between Twisp and Winthrop, and the Swauk Formation, at Blewett Pass (Walsh et al. 1987).

Cenozoic Continental Rocks combine volcanic flow rocks and sedimentary rocks derived from volcanic debris. The exposures of these rocks are mixed, by faulting and erosion, with outcrops of the conduit and magma chamber rocks that fed the volcanoes. Massive layers alternate with less resistant layers, all at moderate dip angles. The result is valleys that stairstep at amplitude of tens of meters to a few kilometers. Examples are the Columbia River basalt group around the forks of the Naches River and the Republic volcanic series along the Sanpoil-Curlew valley.

Ultramafic rocks are present in scattered areas and in a large area at the head of the North Fork Teanaway River. They are fragments of the lower crust that originated at ocean floor spreading centers. They have exotic chemistries, which include chromium and other heavy metals. The resulting iron-rich and nutrient-poor soils are related to narrowly endemic upland floras.

Glacial drift is distributed throughout the study area but is most abundant in the north-central and eastern parts. Although the drift is unconsolidated, it frequently functions as bedrock. Many areas have naturally compacted (densic) subsoils. Present stream and slope processes act differently on the drift than on the alluvium. The difference is greatest where the drift is compact or includes large boulders. The floor of the Yakima River valley, west of Ellensburg, is composed of alpine drift; moraines left by continental ice impound the Little Pend Oreille Lakes.

AQUATIC/RIPARIAN/WETLAND CLASSIFICATION

Relating riparian plant associations to physiographic areas, watersheds, valley segments, and fluvial surfaces enables the prediction of potential natural vegetation on degraded sites. Geomorphic concepts are used to help describe the series in this classification.

This classification recognizes 32 series and 163 aquatic, wetland, and riparian plant associations or community types. Nineteen of the series have two or more plant associations and are described in detail. Thirteen series have only one plant association or community type, are considered minor series, and are discussed briefly. One hundred plant associations are represented by five or more plots (major associations). An additional 63 plant associations and community types are represented by fewer than five plots (minor associations). The large number of associations and community types are the result of the remarkable climatic, geologic, and floristic diversity in eastern Washington.

First, a vegetative key provides an orderly process for determining the series. After determining the series, users should validate site characteristics against the series descriptions. The major associations and community types for each series are listed after the keys. Second, series descriptions give information for the distribution, vegetation characteristics, physical setting, and management for each series. Third, plant association keys and constancy/mean cover tables for plant associations are provided at the end of each series.

SERIES DESCRIPTION CRITERIA

Each series description begins with a figure showing a map of sample plot locations followed by a summary of the distribution of the dominant species and the series. Following this, the series description is divided into several descriptive sections: classification database, vegetation characteristics, physical setting, ecosystem management, adjacent series, and relation to other classifications.

The section entitled “Classification Database” defines the series, provides the number of plots in the series, and lists the major and minor plant associations within the series.

The “Vegetation Characteristics” section provides a brief description of the dominant or characteristic vegetation found on the sample plots of each series. Constancy and cover tables comparing plant species in each series are found in appendix G. Constancy and cover tables comparing plant species for plant associations are found at the end of each series description.

The “Physical Setting” section provides a brief description of the prevailing environment associated with each series and its plant associations. Tables display the number of plots by category under each of the subsections. It is important to note that the total number of plots may differ among the tables because of missing and/or incorrect data. This section includes the following:

- “Elevation” describes the general climatic environment associated with the series. Tables display elevation by NF and plant association.
- “Valley geomorphology” describes the character of the valleys where series plots occur. Tables display the distribution of valley width and valley gradient classes by both series and plant associations. Parameters for measured classes are:
- Valley width:
    - Very broad >984 feet (>300 meters)
    - Broad 328–984 feet (100.1–300 meters)
    - Moderate 99–327 feet (30.1–100 meters)
    - Narrow 33–98 feet (10.1–30 meters)
    - Very narrow <33 feet (<10 meters)
- Valley gradient:
    - Very low <1%
    - Low 1–3%
    - Moderate 4–5%
    - Steep 6–8%
    - Very steep >8%
- “Channel types” (classes) describes the character of stream channels that occur within valley landforms associated with series. The Rosgen stream classification system (Rosgen 1994, 1996) provides all disciplines with a standard method for describing and communicating about stream morphology, how streams fit the landscape, and how management actions affect them. Streams adjacent to sample transects were classified with this system to establish correlations between valley segments, Rosgen channel types, fluvial surfaces, and plant communities. Briefly, streams generally fit one of the following common classes (fig. 6):
- A channels—Steep, highly entrenched, step pool systems with high sediment transport potential.
- B channels—Gentle to moderately steep terrain, moderate-gradient streams that are moderately entrenched, have low sinuosity, and are riffle dominated.
- C channels—Low gradient, moderately high sinuosity, pool/riffle bedform with well-developed floodplains.
- D channels—Braided with moderate channel slope.
- E channels—Very low gradient, highly sinuous, with low width-to-depth ratios.
- F channels—Highly entrenched, high width-to-depth ratio streams.

Wetland sites without streams do not fit Rosgen’s classification; however, description of the water regime associated with their plant associations and valley configuration requires some classification. Categories used to describe these sites include:

- Lake or pond—Wetlands adjacent to lakes or ponds.
- Ephemeral or intermittent—Riparian zones within draws or valleys without perennial streamflow.
- Seep or spring—Wetlands associated with seeps or springs.

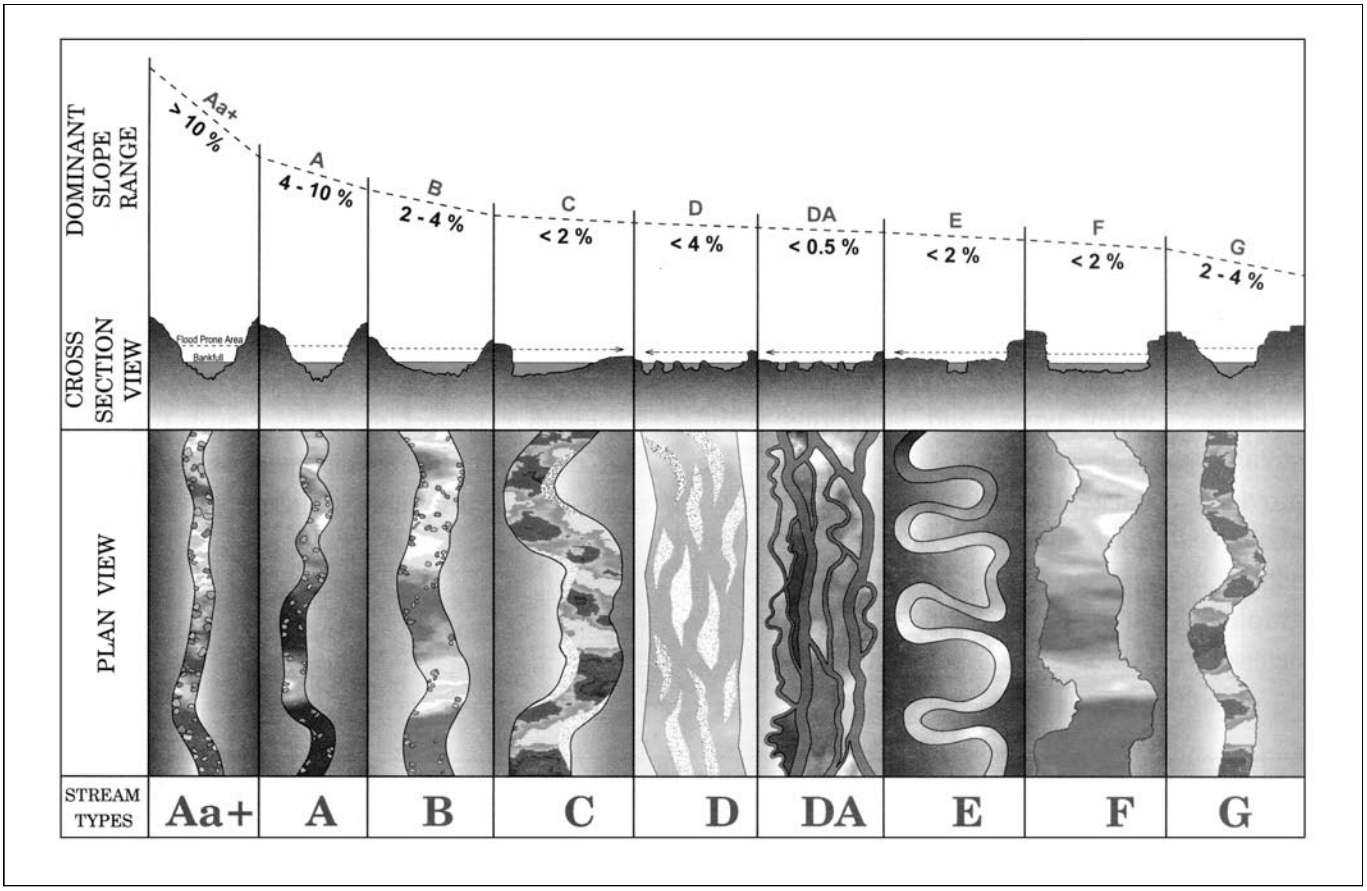


Figure 6—Longitudinal, cross-sectional and plan views of major Rosgen channel types (Rosgen 1996).

- Shrub wetland—Wetlands dominated by shrub plant associations.
- Forest wetlands—Wetlands dominated by coniferous or deciduous tree plant associations.

Within the descriptions for each series, a chart shows the distribution of Rosgen channel classes. A table relates these classes to the plant associations.

- "Fluvial surfaces" describes the character of the various land surfaces on which the series occurs such as point bars, alluvial bars, floodplains, streambanks, terraces, overflow channels, and wetlands. Definitions are found in the glossary. Within the series descriptions, a small chart shows the distribution of fluvial surfaces for each series. Another small table shows the distribution of fluvial surfaces for the plant associations.
- "Soils" describes the general texture of surface soils, depth of water tables, soil surface flooding, and soil temperature (degrees Fahrenheit). The distribution of soil texture classes for each series is shown in a chart. Another small table shows the distribution of plant associations by texture class. Other small tables relate plant associations to water table, surface flooding, and soil temperature where data are available.

ECOSYSTEM MANAGEMENT

The section provides detailed descriptions for the management of each series. Descriptions of the various categories that may be in a series discussion include the following:

- Natural regeneration—Describes the natural regeneration processes associated with the plant that names the series.
- Artificial establishment—Describes the means for artificially establishing vegetation on disturbed sites.
- Stand management—Helps managers develop management plans for the series.
- Growth and yield (labeled "Tree Growth and Yield" in the coniferous and deciduous tree series)—Provides productivity information for the series (if available). A table shows the site index (height in feet by base years) and basal area (square feet per acre) for the trees dominating the series. References for the site index equations used in determining site index are shown in the following tabulation:

Scientific name	Site index source
Abies amabilis	Hoyer and Herman 1989 (base 100)
Abies grandis	Cochran 1979 (base 50)
Abies lasiocarpa	Clendenen 1977 (based on Alexander 1987) (base 50)
Abies procera	Herman et al. 1978 (base 100)
Acer macrophyllum	Worthington et al. 1960 (base 50)
Alnus rubra	Worthington et al. 1960 (base 50)
Betula papyrifera	Edminster et al. 1985 (base 80)
Chamaecyparis nootkatensis	Barnes 1962 (base 100)
Larix lyallii	Schmidt et al. 1976 (base 50)
Larix occidentalis	Schmidt et al. 1976 (base 50)
Picea engelmannii	Clendenen 1977 (based on Alexander 1967) (base 50)
Pinus albicaulis	Alexander et al. 1987 (base 100)
Pinus contorta	Alexander et al. 1987 (base 100)
Pinus monticola	Brickell 1970 (based on Haig's 1932 curve) (base 50)
Pinus ponderosa	Meyer 1961 (base 100)
Populus tremuloides	Edminster et al. 1985 (base 80)
Populus tricocarpa	Edminster et al. 1985 (base 80)
Pseudotsuga menziesii	Monserud 1985 (base 50)
Thuja plicata	Hegyi et al. 1981 (base 100)
Tsuga heterophylla	Wiley 1978 (breast height age <150 years only) (base 50)
Tsuga mertensia	Hegyi et al. 1981 (base 100)

Much of the management information came from Crowe and Clausnitzer 1997; Fischer et al. (1996); Hansen et al. 1995; Kovalchik 1987, 1991a, 1992a, 1992c; Kovalchik and Chitwood 1990; and Kovalchik and Elmore 1991.

- "Down wood and snags"—Provides information on numbers, species, biomass, height, and class for snags and logs. Within each description, a table shows log attributes (tons per acre, cubic feet per acre, linear feet per acre, square feet per acre, and percentage of ground cover) for each series. Another table shows the snag attributes (snags per acre by condition class by diameter class in inches) for each series. Classes 1 through 5 for logs and snags are defined as:
  - Log decomposition classes:
    1. Bark intact, twigs present, texture intact, shape round, color original, elevated, retains original shape
    2. Bark intact, twigs absent, partly soft, shape round, color original, slightly sagging
    3. Bark largely gone, a few hard pieces, shape round, color faded, sagging
    4. Bark gone, soft blocky pieces, round to oval, light brown to yellowish, all of log on the ground
    5. Soft to powdery, flattened, light yellow to gray, all of log on ground
  - Snag condition classes:
    1. Recent dead
    2. Fine branches gone, bark intact
    3. Bark loose, large branch stubs
    4. Solid buckskin snag
    5. Broken and rotten
- Fire—Describes the sensitivity of important series indicator plants to fire. When possible, evidence for and discussion of stand age and fire regime is included.
- Animals—Describes the use of the series by various classes and includes:
  - Browsing—Describes the palatability of the series indicator species to various classes of browsers and some of their potential impacts on the species.
  - Livestock—Describes palatability of important plants and describes season of use and influences on sites by domestic livestock.
  - Wildlife—Describes the use of the association by various classes of wildlife.
  - Fish—Describes the utility of the association for streambank stabilization and fish habitat and cover.
- Recreation—Helps recreation managers to develop recreation management plans.
- Insects and disease—Describes some of the common insect and disease pests of the series indicator plant.
- Estimating vegetation potential on disturbed sites—Gives the user hints on how to recognize the vegetative potential for stands in poor ecological status.
- Sensitive species—Provides a description of sensitive plants or animals found. Each table displays the number of populations found in the described plant associations or series.

ADJACENT SERIES AND RELATIONSHIPS TO OTHER CLASSIFICATIONS

The section called "Adjacent Series" describes other series found on adjacent portions of the riparian/wetland zone as well as uplands.

Finally, the section "Relationships to Other Classifications" lists other classifications in adjacent states that describe the same series.

Attributes for the USFWS, which define very broad categories of wetlands that often contain several dissimilar plant associations or community types, also are given. The plant associations and community types complete Cowardin's classification (Cowardin et al. 1979) at the dominance level. Transitional or xeroriparian plant associations may not fit into any "type" in Cowardin's classification.

KEYS FOR FIELD IDENTIFICATION

(Plant association keys are found at the end of each series description)

INSTRUCTIONS FOR USING THE KEY

1. Use this key for riparian and wetland plant associations and community types located on or near lands of the Wenatchee, Okanogan, or Colville NFs.
2. Determine the boundaries of the various riparian stands that exist within the riparian or wetland zone being investigated. (As many as eight distinct riparian plant associations have been sampled along a single valley cross section and up to 25 plant associations within a single wetland basin.)
3. Locate an approximately 1/10-acre plot (37-foot radius in size is suggested) in a uniform and representative portion of each stand. Small or irregularly shaped stands may need smaller or irregularly shaped plots. Stay near the center of the stand and avoid ecotones or crossing stand boundaries.
4. Identify and record canopy coverages or cover classes for all key indicator species as well as the environmental information located on the field form provided in appendix H.
5. While on the plot, key to the appropriate life-form group. In general, a species or group of species will appear to dominate a community if the coverage is 25 percent or more.
6. Within the life-form group, key to the appropriate aquatic, riparian, or wetland plant association or community type. All conditions stipulated in the key must be satisfied in order to make a correct determination. Complete the selection by comparing the community composition and site characteristics with written descriptions and the appendixes. In addition, when classifying a site, be aware of and account for microsites. Microsites are small areas that are atypical for the stand or site as a whole. Examples include small depressions such as windthrow holes, raised hummocks within bogs, etc.
7. The key and written descriptions are based largely on samples of relatively undisturbed stands in late-seral to climax ecological status. On disturbed sites, evaluate each stand against the written descriptions for the associations. Use the landform and fluvial surface key to riparian associations for disturbed sites. In addition, extrapolating from the nearest nondisturbed condition occurring on a comparable site will assist in the correct determination of the type.
8. Depauperate undergrowth. In stands where the undergrowth is obviously reduced in cover by heavy grazing, shade, litter, and competition from conifers or shrubs, adjust keys downward to reflect the scant herbaceous cover. For instance, a few SALIX/CAUT ecology plots had only 1 or 2 percent canopy coverage for sedges because of dense willow shade and competition. In addition, extrapolation from the nearest nondepauperate condition occurring on a comparable site will assist in the correct determination of the type.

Caution: The potential of a site may change if there is a long-term change in the soil or water characteristics of the site.

Warning: The key is not the classification! Users should validate their determination by comparing the site characteristics with the written description of the type. Be aware that the environmental conditions described in the text are from both sampled sites and personal observations and may not include all the sites on the landscape in which the type is found.

Series-level constancy/cover tables are found in appendix G. They are a useful aid in determining whether the correct series has been keyed. Users should note that **the keys are tools and are not the classification**. Series and plant association descriptions portray modal riparian and wetland stands in late-seral and climax ecological status. Thus, highly disturbed stands will not key well and the user will have to refer to the series descriptions and to his or her personal experience and intuition. In any dynamic ecosystem (aquatic, riparian, and wetland included), variation can be expected in any series and plant association. The user is cautioned to validate the “keyed” determination by reading the written description, supporting tables, and appendixes before leaving the stand or plot.

VEGETATIVE KEY TO THE MAJOR VEGETATION LIFE FORMS

1. Potential vegetation dominated by conifers with at least 25 percent canopy coverage. Conifers reproducing successfully **and not** restricted to microsites; deciduous trees subordinate ....**Coniferous forest series**
2. Potential vegetation dominated by deciduous tree species with at least 25 percent canopy coverage. Deciduous tree species reproducing successfully; coniferous tree species subordinate or restricted to microsites ....**Deciduous forest series**
3. Potential vegetation dominated by shrubs with at least 25 percent canopy coverage ....**Shrub series**
4. Potential vegetation dominated by herbaceous plants with at least 25 percent canopy coverage ....**Herbaceous series**

KEY TO THE CONIFEROUS FOREST SERIES

(Coniferous trees present **and** reproducing successfully **and not** restricted to microsites)

1. Subalpine larch (*Larix lyallii*) present with ≥10 percent canopy coverage and reproducing ....**Miscellaneous conifer series** (p. 99)
2. Mountain hemlock (*Tsuga mertensiana*) present with ≥10 percent canopy coverage and reproducing ....**Mountain hemlock series** (p. 19)
3. Pacific silver fir (*Abies amabilis*) present with ≥10 percent canopy coverage and reproducing ....**Pacific silver fir series** (p. 29)
4. Western hemlock (*Tsuga heterophylla*) present with ≥10 percent canopy coverage and reproducing ....**Western hemlock series** (p. 39)
5. Western redcedar (*Thuja plicata*) present with ≥10 percent canopy coverage and reproducing ....**Western redcedar series** (p. 51)
6. Subalpine fir (*Abies lasiocarpa*) present with ≥10 percent canopy coverage and reproducing ....**Subalpine fir series** (p. 63)
7. Engelmann spruce (*Picea engelmannii*) present with ≥10 percent canopy coverage and reproducing ....**Engelmann spruce series** (p. 77)
8. Alaska yellow-cedar (*Chamaecyparis nootkatensis*) present with ≥10 percent canopy coverage and reproducing ....**Alaska yellow-cedar communities: return to No. 1 above and try another series**
9. Grand fir (*Abies grandis*) present with ≥10 percent canopy coverage and reproducing ....**Grand fir series** (p. 89)
10. Douglas-fir (*Pseudotsuga menziesii*) present with ≥10 percent canopy coverage and reproducing ....**Miscellaneous conifer series** (p. 99)
11. Lodgepole pine (*Pinus contorta*) dominates the stand, other conifers not reproducing; the successional sequence to climax is unknown ....**Miscellaneous conifer series** (p. 99)

KEY TO THE DECIDUOUS FOREST SERIES

1. Quaking aspen (*Populus tremuloides*) the dominant deciduous tree and reproducing .... **Quaking aspen series** (p. 109)
2. Black cottonwood (*Populus trichocarpa*) the dominant deciduous tree and reproducing .... **Black cottonwood series** (p 119)
3. Oregon white oak (*Quercus garryana*) present with ≥10 percent canopy coverage and reproducing .... **Miscellaneous deciduous tree series** (p. 129)
4. Red alder (*Alnus rubra*) the dominant deciduous tree and reproducing .... **Miscellaneous deciduous tree series** (p. 129)

5. Bigleaf maple (*Acer macrophyllum*) the dominant deciduous tree and reproducing .... **Miscellaneous deciduous tree series** (p. 129)
6. Paper birch (*Betula papyrifera*) the dominant deciduous tree and reproducing .... **Miscellaneous deciduous tree series** (p. 129)
7. Shrubs and small trees such as mountain alder, Saskatoon serviceberry, Douglas hawthorn, Douglas maple, and some willows may be more than 18 feet tall and may be considered trees but vegetation described as shrub life form .... **Go to shrub series key (below)**

KEY TO THE SHRUB SERIES

1. Tall or dwarf willows (*Salix* spp.) or bog birch (*Betula glandulosa*) ≥25 percent canopy coverage .... **Willow series** (p. 141)
2. Cascade huckleberry (*Vaccinium deliciosum*), moss-heathers (*Cassiope* spp.), mountain heaths (*Phyllodoce* spp.), and/or partridgefoot (*Luetkea pectinata*) ≥25 percent canopy coverage .... **Heath series** (p. 161)
3. Vine maple (*Acer circinatum*) ≥25 percent canopy coverage .... **Vine maple series** (p. 169)
4. Sitka alder (*Alnus sinuata*) ≥25 percent canopy coverage .... **Sitka alder series** (p. 177)
5. Mountain alder (*Alnus incana*) ≥25 percent canopy coverage .... **Mountain alder series** (p. 187)
6. Red-osier dogwood (*Cornus stolonifera*) ≥25 percent canopy coverage .... **Red-osier dogwood series** (p. 201)
7. Devil's club (*Oplopanax horridum*) ≥5 percent canopy coverage .... **Miscellaneous shrub series** (p. 219)
8. Salmonberry (*Rubus spectabilis*), stink currant (*Ribes bracteosum*), or Hudsonbay currant (*Ribes hudsonianum*) ≥25 percent canopy coverage .... **Miscellaneous shrub series** (p. 219)
9. Cascade azalea (*Rhododendron albiflorum*) or rusty menziesia (*Menziesia ferruginea*) ≥25 percent canopy coverage .... **Miscellaneous shrub series** (p. 219)
10. Douglas maple (*Acer glabrum* var. *douglasii*), common chokecherry (*Prunus virginiana*), or Saskatoon serviceberry (*Amelanchier alnifolia*) ≥25 percent canopy coverage .... **Miscellaneous shrub series** (p. 219)
11. Douglas spiraea (*Spiraea douglasii*)and/or pyramid spiraea (*Spiraea pyramidata*) ≥25 percent canopy coverage .... **Douglas spiraea series** (p. 211)
12. Common snowberry (*Symphoricarpos albus*) ≥25 percent canopy coverage .... **Miscellaneous shrub series** (p. 219)
13. Shrubby cinquefoil (*Potentilla fruticosa*) ≥25 percent canopy coverage .... **Miscellaneous shrub series** (p. 219)

KEY TO THE HERBACEOUS SERIES

1. Aquatic sites on the edges of lakes or ponds or in sluggish streams, usually with standing water for all or much of the growing season, potential vegetation dominated by species such as Indian water-lily (*Nuphar polysepalum*), cow-lily (*N. variegatum*), pondweed (*Potamogeton* spp.), bur-reed (*Sparganium* spp.), softstem bulrush (*Scirpus validus*), hardstem bulrush (*S. acutus*), northern mannagrass (*Glyceria borealis*) western mannagrass (*G. occidentalis*), water horsetail (*Equisetum fluviatile*), and/or creeping spike-rush (*Eleocharis palustris*) with a combined canopy coverage of at least 25 percent .... **Aquatic series** (p. 231)
2. Potential vegetation dominated by sedge (*Carex*) species and/or other wetland sedgelike species or graminoids with a combined canopy coverage of at least 25 percent .... **Meadow series** (p. 241)
3. Sedge and grasslike species with a combined canopy coverage of less than 25 percent, forbs the dominant vegetation .... **Forb series** (p. 263)

MOUNTAIN HEMLOCK SERIES

Tsuga mertensiana

TSME N = 25

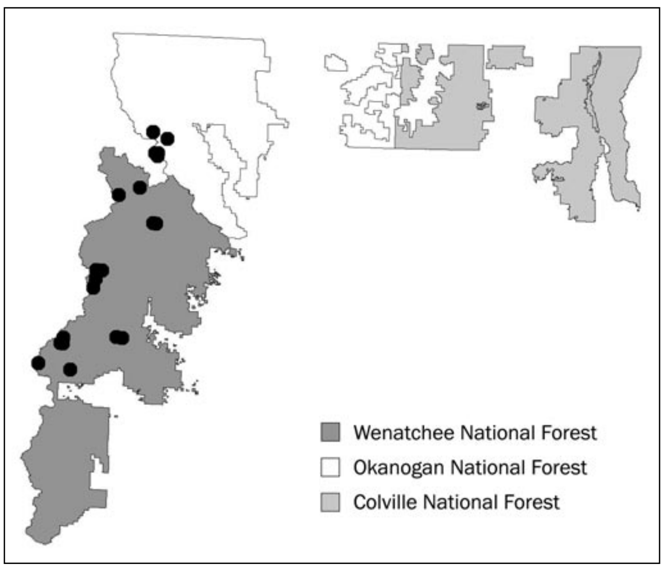


Figure 7—Plot locations for the mountain hemlock series.

THE PRIMARY RANGE of mountain hemlock[1] extends from northern British Columbia and southern Alaska through the Cascade Range and Olympic Mountains to northern California (Arno and Hammerly 1984, Hitchcock and Cronquist 1973). It also extends inland to southeastern British Columbia, northern Idaho, and northwestern Montana. Mountain hemlock is abundant along the Cascade crest in eastern Washington (Lillybridge et al. 1995). Mountain hemlock stands are quite extensive in the Rocky Mountains of northern Idaho and Montana but are limited to very snowy areas with a maritime climate (Pfister et al. 1977). A few outlying stands occur in the Blue Mountains of northeastern Oregon. Stands of mountain hemlock usually are associated with uplands but also are prominent in riparian zones, primarily on streambanks and terraces, and occasionally on the margin of wetlands.

Mountain hemlock is one of the most shade-tolerant and environmentally restricted conifers in eastern Washington (Lillybridge et al. 1995). It is the major upper subalpine and timberline conifer along the Cascade crest. Its presence indicates cold, snowy habitats where deep snow accumulations are typical. Average annual precipitation often exceeds 50 inches. At its highest elevations, mountain hemlock quickly grades into subalpine parklands variously dominated by open woodlands, tree islands, or krummholz of mountain hemlock, subalpine fir, and (occasionally) subalpine larch or whitebark pine (Lillybridge et al. 1995). Therefore, the TSME series is found only in areas of strong maritime influence, usually in climatic zones within 15 miles of the Cascade crest. This maritime influence is particularly strong on the western portions of the Wenatchee NF. The TSME series is also prominent on the west side of the Okanogan NF, generally west of a line formed by Washington Pass, Harts Pass, and Reynolds Peak. Most of this land lies west of the Cascade crest on lands once administered by the Mount Baker NF but are now administered by the Okanogan NF. The TSME series is absent on the Colville NF.

Mountain hemlock and Pacific silver fir broadly overlap in their ecological distribution so that distinguishing between the TSME and ABAM series can be difficult (Lillybridge et al. 1995). Where Pacific silver fir is present in the TSME series, it will likely never be totally excluded and is essentially a codominant, even in climax and near-climax stands. Only in colder, harsher, wetter sites is Pacific silver fir absent. Predicting mountain hemlock canopy coverage that exceeds 10 percent in older stands is the convention used in this guide for placing stands within the TSME series.

CLASSIFICATION DATABASE

The TSME series includes all closed-forest stands potentially dominated by mountain hemlock at climax. It occurs on all but the Tonasket RD on the Wenatchee and Okanogan NFs. Twenty-one riparian and wetland plots were sampled in the TSME series (fig. 7). Information from an additional four plots from other ecology samples was added to facilitate development of the classification and to augment species composition, distribution, and elevation data for the series. From this database, three major and one minor plant associations are recognized. Five other potential one-plot plant associations (TSME/ATFI, TSME/LEGL/ERPO2, TSME/MEFE-VAME, TSME/RULA, and TSME/VAME) are not used in the data for the TSME series nor described in this

[1] See appendix A for a cross reference for all species codes and common and scientific names used in this document.

Mountain hemlock plant associations

	Scientific name	Common name	Ecoclass code	Plots
Major associations:				
TSME/MEFE-VAAL	*Tsuga mertensiana/Menziesia ferruginea-Vaccinium alaskaense*	Mountain hemlock/rusty menziesia-Alaska huckleberry	CMS256	5
TSME/PHEM-VADE	*Tsuga mertensiana/Phyllodoce empetriformis-Vaccinium deliciosum*	Mountain hemlock/red mountain-heath–Cascade huckleberry	CMS354	5
TSME/RHAL-VAME	*Tsuga mertensiana/Rhododendron albiflorum-Vaccinium membranaceum*	Mountain hemlock/Cascade azalea-big huckleberry	CMS356	11
Minor associations:				
TSME/OPHO-VAAL	*Tsuga mertensiana/Oplopanax horridum-Vaccinium alaskaense*	Mountain hemlock/devil's club-Alaska huckleberry	CMS450	4

classification. Some of these associations are found in the classification by Lillybridge et al. (1995). These samples were mostly located in late-seral to climax mountain hemlock stands.

VEGETATION CHARACTERISTICS

The TSME series exhibits high species diversity owing partially to its inherent site variability but also, perhaps even more importantly, to its role in the transition from closed forest to parkland environments. Indeed, the TSME/RHAL-VAME and (especially) TSME/PHEM-VADE associations often occur within the upper several hundred feet of closed forest as well as in tree islands within parklands. Thus, species from both types of environments are present. Mature stands are generally dominated by large, long-lived mountain hemlock and, within its elevation range, Pacific silver fir. The understory of mature stands is usually dominated by mountain hemlock and Pacific silver fir with lesser amounts of western hemlock (low elevations), subalpine fir, and Engelmann spruce. The compositions of seral stands vary by association and stand history but usually include mountain hemlock, Pacific silver fir, whitebark pine, Alaska yellow-cedar, western hemlock, Engelmann spruce, or subalpine fir. Upper elevation stands (TSME/PHEM-VADE and TSME/RHAL-VAME associations) are typically dominated only by mountain hemlock, and seral tree species are limited to Engelmann spruce, Alaska yellow-cedar, whitebark pine, and subalpine fir. Subalpine larch appears to be absent in strong maritime environments but may be present in stands in more continental climates. Western redcedar and western hemlock are seral trees in the lower elevation associations (TSME/MEFE-VAAL and TSME/OPHO-VAAL) and occur as scattered large individuals in mature stands. The TSME series is usually too high in elevation to support ponderosa pine, grand fir, Douglas-fir, western white pine, or western larch.

Shrubs form a rich layer in the undergrowth. Composition and abundance vary by stand history and plant association. The primary association indicators are devil's club, rusty menziesia, Cascade azalea, Alaska huckleberry, Cascade huckleberry, big huckleberry, and red mountain-heath. Oval-leaf huckleberry was not present on any of the sample plots but can be used as an ecological equivalent of Alaska huckleberry when keying the TSME/MEFE-VAAL association. Other common medium and tall shrubs include Sitka alder, Hudsonbay currant, salmonberry, and Sitka mountain-ash. Low shrubs include dwarf and five-leaved bramble.

The herb composition is also rich and varied. It includes deerfoot vanilla-leaf, lady fern, oak fern, queencup beadlily, sidebells pyrola, arrowleaf groundsel, starry solomonplume, claspleaf twisted-stalk, coolwort foamflower, and Sitka valerian.

PHYSICAL SETTING

Elevation—

Elevations for the TSME series span a moderately broad elevation range, although 80 percent of the sites are between 3,500 and 5,500 feet. The 1,000-foot elevation difference between the Okanogan and Wenatchee NFs is caused by a rain-shadow effect in the Okanogan Cascade Range created by high mountains such as Bacon, Picket, Colonial, and Pilchuck Peaks to the west (Henderson 1998). Therefore, the TSME series occurs at higher elevations on the Okanogan NF to compensate for the lower precipitation.

Additional insight is gained by looking at the individual associations. TSME/PHEM-VADE and TSME/RHAL-VAME are high-elevation associations generally found well above 4,500 feet. TSME/PHEM-VADE is often found above continuous forest in parklands, occupying areas covered by snowfields until late summer. The TSME/RHAL-VAME association also tends to be high elevation but usually occurs in zones of closed forest that are transitional to continental climates. It also occurs as tree islands scattered within subalpine parklands. The remaining two associations (TSME/

	Elevation (feet)			
Forest	Minimum	Maximum	Average	N
Okanogan	5,075	5,980	5,398	6
Wenatchee	3,100	5,890	4,326	19
Series	3,100	5,980	4,583	25

OPHO-VAAL and TSME/MEFE-VAAL) are found at lower elevations, often following cold air drainage to unusually low elevations for the TSME series.

Plant association	Elevation (feet)			N
	Minimum	Maximum	Average	
TSME/PHEM-VADE	4,130	5,980	5,344	5
TSME/RHAL-VAME	4,140	5,775	5,085	11
TSME/OPHO-VAAL	3,125	4,150	3,584	4
TSME/MEFE-VAAL	3,100	4,200	3,518	5
Series	3,100	5,980	4,583	25

Valley Geomorphology—

Plot locations in the TSME series are found in a variety of valley width and gradient classes. Plots appear to occur in two clusters. The most common landform is moderate to very narrow valleys with moderate to very steep valley gradient. The other landform is moderate to broad valleys with moderate to low valley gradient, which is unusual, and more likely located in high-elevation cirque basins, lower elevation subalpine sites along narrow streams, or on the edge of wetland systems. Still, no patterns are clear for the TSME series overall, and data are limited.

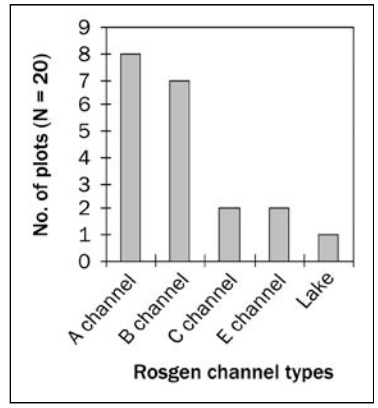
Valley width	Valley gradient					N
	Very low	Low	Moderate	Steep	Very steep	
Very broad	0	0	0	0	0	0
Broad	1	2	1	0	1	5
Moderate	0	0	2	0	2	4
Narrow	0	1	0	1	3	5
Very narrow	0	1	1	0	4	6
Series total	1	4	4	1	10	20

Looking at individual associations is not very helpful. TSME/OPHO-VAAL is the one exception, as it appears to be restricted to narrow riparian valleys as much as plant associations in other series that use devil's club to indicate the characteristic ground cover. TSME/PHEM-VADE appears to be largely associated with very steep valleys; however, this may be largely an artifact of small sample size and plot distribution. This association has been observed on many sites, including the margins of riparian and wetland zones. Unfortunately, no valley, Rosgen channel type, fluvial surface, or soils data are available for the TSME/MEFE-VAAL association (data used are from Lillybridge et al. 1995).

Plant association	Valley width					N
	Very broad	Broad	Moderate	Narrow	Very narrow	
TSME/OPHO-VAAL	0	0	0	2	2	4
TSME/PHEM-VADE	0	1	2	1	1	5
TSME/RHAL-VAME	0	4	2	2	3	11
Series total	0	5	4	5	6	20

Plant association	Valley gradient					N
	Very low	Low	Moderate	Steep	Very steep	
TSME/OPHO-VAAL	0	1	1	1	1	4
TSME/PHEM-VADE	1	0	0	0	4	5
TSME/RHAL-VAME	0	3	3	0	5	11
Series total	1	4	4	1	10	20

Channel Types—

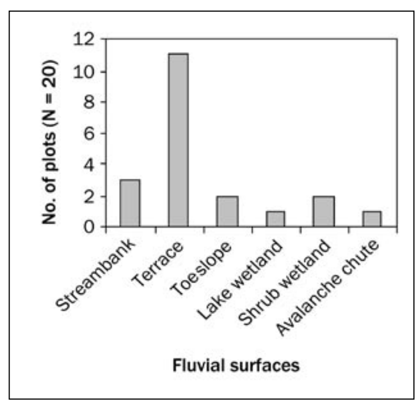


TSME series plots are located along a variety of channel types. Rosgen channel types A and B are prevalent as many sites lie within moderate to very steep gradient valleys. The Rosgen C channel, E channel, and the pond type are found in low to very low gradient valleys, usually in cirque basins or large, moderate-elevation valleys.

The data for individual associations support these observations as most stands are located along A and B channel types. However, the TSME/PHEM-VADE and TSME/RHAL-VAME associations are probably more common around lakes than shown.

Plant association	Rosgen channel types					N
	A	B	C	E	Lake	
TSME/OPHO-VAAL	3	1	0	0	0	4
TSME/PHEM-VADE	3	0	1	1	0	5
TSME/RHAL-VAME	2	6	1	1	1	11
Series total	8	7	2	2	1	20

Fluvial Surfaces—



Plots in the TSME series are predominantly located in riparian zones, with most plots (about 80 percent) on streambanks, terraces, and toeslopes. The rest of the plots are associated with wetlands, wet high-elevation cirque basins, or avalanche chutes. For the most part, the TSME series requires sites with good drainage; very wet or active fluvial surfaces do not support the TSME series. Some TSME/OPHO-VAAL sites are moderately wet and poorly drained, at least early in the growing season.

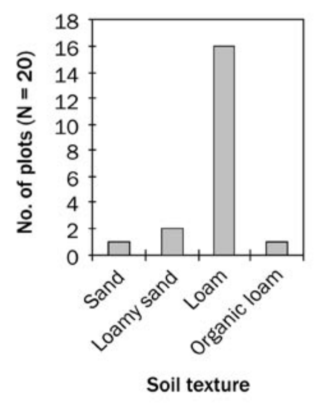
The individual plant associations are similar to the TSME series as a whole. Almost all plots in the TSME/OPHO-VAAL and TSME/RHAL-VAME associations are located in the riparian zone. TSME/PHEM-VADE is equally distributed between riparian zones and the dry margins of wetlands, although one plot was in an avalanche chute.

Plant association	Fluvial surfaces						N
	Stream-bank	Terrace	Toe-slope	Lake wetland	Shrub wetland	Avalanche chute	
TSME/OPHO-VAAL	1	2	1	0	0	0	4
TSME/PHEM-VADE	0	2	0	0	2	1	5
TSME/RHAL-VAME	2	7	1	1	0	0	11
Series total	3	11	2	1	2	1	20

Soils—

The TSME series is dominated by mineral soils with loam textures. Few plots are located on sand (indicates recent alluvial deposition) or organic loam (indicates wetland soils).

Little additional insight is gained by looking at individual associations, as all are strongly associated with loam soils.



Plant association	Soil texture				N
	Sand	Loamy sand	Loam	Organic loam	
TSME/OPHO-VAAL	0	1	3	0	4
TSME/PHEM-VADE	0	0	4	1	5
TSME/RHAL-VAME	1	1	9	0	11
Series total	1	2	16	1	20

Water tables were not measurable on most sites. The TSME/OPHO-VAAL association presumably has the highest water table as it is the wettest of the TSME plant associations. Appreciable differences in soil temperature do not appear to occur among the associations. Of the three shown, the TSME/OPHO-VAAL association reasonably represents the warmest soils owing to its lower elevations compared with the TSME/PHEM-VADE and TSME/RHAL-VAME associations.

Plant association	Soil temperature (°F)			N
	Minimum	Maximum	Average	
TSME/OPHO-VAAL	46	54	49	4
TSME/PHEM-VADE	43	53	47	5
TSME/RHAL-VAME	42	54	47	10
Series	42	54	47	19

ECOSYSTEM MANAGEMENT

Natural Regeneration of Mountain Hemlock—

Mountain hemlock reproduces from seed and vegetatively (Means 1990). Seed production begins at about 20 years of age. Mature trees produce moderate to very heavy crops of cones at about 3-year intervals, but crops may fail in other years. The winged seed is dispersed by the wind and may travel long distances across the snow. Seed germination occurs on mineral or organic soils if sufficient moisture is available. Seedlings are drought intolerant and grow best in partial shade. Initial growth is very slow, and small saplings are often 50 to 100 years of age under dense canopies but grow well when released by removal of overstory competition.

Mountain hemlock also reproduces vegetatively by layering (Means 1990). This is an effective way of reproducing at timberline as layered saplings are sheltered by the parent tree and initially receive their nutrients through the established root system of the parent tree.

Artificial Establishment of Mountain Hemlock and Associated Shrubs and Herbs—

If accessible, mountain hemlock is as valued a timber species as western hemlock. However, any timber harvest should be restricted to lower elevations for the TSME series. Natural regeneration is preferred over planted stock. Regeneration is suitable on a variety of sites ranging from mineral soils to well-decomposed organic material. Direct seeding is possible where bare mineral soil is available. It is probably better to rely on the release of natural seedlings and saplings when using selection-cutting methods in riparian zones.

Many of the shrubs that characterize the TSME series are well adapted to planting on disturbed sites. Sitka alder and devil's club can be established from nursery stock, seed, cuttings, or layering. Stink and Hudsonbay currant, salmonberry, and dwarf and five-leaved bramble can be easily grown from seed. Dwarf and five-leaved bramble, salmonberry, bunchberry dogwood, and other trailing plants can be easily propagated from root runners. Huckleberry cuttings root poorly; they can be established from seed but growth is slow. Oak fern, lady fern, and common horsetail can be easily propagated from rhizomes. (For more information on the short- and long-term revegetation potential of selected riparian/wetland plant species, see app. B-5.)

Stand Management—

Many sites in the TSME series are poorly suited for intensive timber management (Lillybridge et al. 1995). This is primarily due to the heavy snowpacks and short growing seasons that characterize most of these sites. These factors lead to slow growth of seedlings, and overall low productivity of mountain hemlock stands, and make it difficult to ensure reforestation within 5 years after harvest. Reliance on natural regeneration is probably the only way to ensure regeneration in 5 years (Atzet et al. 1984). In addition, many of the TSME sites are in inaccessible areas at high elevation or in wilderness. High water tables and the presence of seeps and springs associated with these riparian and wetland sites preclude many timber management activities. Loam soils predominate and are susceptible to compaction during most of the short growing season. Easily displaced organic soils are rare. Coarse-textured, compaction-resistant soils are unusual except on a few more fluvially active sites. Loam soils predominate and are subject to compaction. Therefore, machinery and livestock easily compact or otherwise damage the soil during periods of excessive soil moisture or high water tables (Hansen et al. 1995). For these reasons, any tree harvesting and associated management activities need to be carefully planned.

Many of the larger trees have extensive heart rot, shallow root systems, and are susceptible to windthrow. Snow damage to trees is also common. Timber harvesting in these sites or adjacent sites that are upslope may increase the risk of windthrow and rising water tables. Management options in riparian zones appear to be limited to single tree selection or small group selection to open the canopy and increase understory production. Activity during late summer/fall or during winter on snowpack to minimize soil disturbance is preferable. Only the lowest elevation sites (usually TSME/MEFE-VAAL) would be suitable for forestry, if appropriate techniques were used.

Tree Growth and Yield—

Short, cold growing seasons limit tree growth in the TSME series (Lillybridge et al. 1995). The lower elevation TSME/MEFE-VAAL and TSME/OPHO-VAAL associations are probably more productive than the high-elevation TSME/PHEM-VADE and TSME/RHAL-VAME associations. The TSME series is one of the least productive forested series in eastern Washington as indicated by low basal area and site index values. Basal area averages only 157 square feet per acre, one of the lowest for the forested tree series (apps. C-1a and C-1b). Only the LALY, BEPA, and ALRU series are lower. Similarly, site index (feet) for individual tree species is low compared with other tree series (app. C-2). Most methods for estimating tree productivity are poorly suited for use in the TSME series, as many of these sites are quite old and site index curves cannot be accurately applied (Henderson et al. 1992). Therefore, tree productivity data must be viewed with caution.

Site index			
Species	Base age	No. of trees	SI
ABAM	100	27	56
ABLA2	50	12	26
PIEN	50	12	38
TSHE	50	2	50
TSME	50	24	49

Basal area (sq. ft./ac)	
Species	BA
ABAM	58
ABLA2	27
CHNO	6
PIAL	3
PIEN	24
PSME	5
THPL	1
TSHE	9
TSME	26
Total	157

Down Wood—

The overall amount of down woody material is moderate compared with the other tree series (app. C-3). Logs cover only 7 percent of the ground surface. This is commensurate with the moderate stand basal area, tree diameters and height, and site indices associated with these stands.

Definitions of log decomposition classes are on page 15.

	Down log attributes				
Log decomposition	Tons/ acre	Cu. ft./ acre	Linear ft./ acre	Sq. ft./ acre	% ground cover
Class 1	1.18	100	188	149	0.34
Class 2	8.48	905	686	794	1.82
Class 3	3.71	475	1,023	677	1.55
Class 4	1.98	636	849	760	1.74
Class 5	1.43	459	760	603	1.38
Total	16.78	2,575	3,506	2,983	6.83

Snags—

The TSME series supports a moderate number of snags (37 snags per acre) in comparison with other tree series (app. C-4). Only the ABGR, POTR, POTR2, and TSHE series have lower snag values. This again reflects harsh habitats that take long periods to grow large-diameter trees. The lower-elevation TSME/MEFE-VAAL and TSME/OPHO-VAAL associations have a greater abundance of large down wood owing to their more productive environments and greater tree species diversity.

Definitions of snag condition classes are on page 15.

	Snags/acre by d.b.h. class (inches)				
Snag condition	5–9.9	10–15.5	15.6–21.5	21.6+	Total
Class 1	0	2.4	1.6	1.1	5.1
Class 2	14.3	5.7	2.6	1.2	23.8
Class 3	2.2	2.8	.4	.4	5.8
Class 4	0	.7	.3	.1	1.1
Class 5	0	0	.4	.8	1.2
Total	16.5	11.6	5.3	3.6	37.0

Fire—

Mountain hemlock is low to moderate in its adaptation to fire (Fischer and Bradley 1987). Its relatively thick bark provides some protection; however, its shallow roots, low-hanging branches, highly flammable foliage, and tendency to grow in dense stands make it very susceptible to fire injury. The lichen-covered branches further increase its susceptibility to fire (Franklin and Dyrness 1973). Even light ground fires are damaging because the shallow roots scorch. Additional mortality is caused by fungal infection of the fire wounds. Despite these disadvantages, TSME sites are typically moist, making fire occurrence low. Fires generally occur as infrequent stand-replacement fires at 400- to 800-year intervals (Atzet and Wheeler 1982).

In all, 81 trees were sampled for age in the TSME series. The average tree age (188 years breast height) is high compared with other forest series. Most stands appeared to be between 100 and 400 years old. Two trees were over 400 years old, 14 were 300 to 399 years old, 21 were 200 to 299 years old, 19 were 100 to 199 years old, and 25 were less than 100 years old. The two oldest trees were both mountain hemlocks at 410 and 579 years old. Both of these trees were measured in a TSME/RHAL-VAME association. The percentage (46 percent) of trees greater than 199 years old is the highest percentage of any forest series. These data suggest that fires usually are large, stand-replacing fires and that the average fire-return interval in the TSME series sites probably exceeds 200 years, and may be greater than 400 years on some sites. Although lightning strikes are common at higher elevations, fires started by lightning strikes appear to be infrequent or to burn small areas.

Animals—

Livestock. There are few grazing allotments within the TSME series in eastern Washington. In general, these cool, moist to wet sites have little utility for domestic livestock, with low forage value and relatively short growing seasons. Most areas are covered in snow and unavailable until early or mid summer. In addition, many areas are located at high elevations or in wilderness areas with very rugged topography, eliminating any potential livestock use. Forage potential may be fair in early successional stages but is generally poor in late-successional stages. Owing to the lack of suitable forage, these sites primarily represent sources of water and shade. In general, these sites are susceptible to trampling owing to moist, fine-textured soils.

Livestock grazing is not usually a problem, if present at all. However, if sites have been grazed too heavily, modifying the grazing system coupled with close monitoring of wildlife often allows the remnant shrub and herb population to sprout and reinvade the stand. The ability to easily reestablish desired shrubs and herbs may be lost when the vegetation has been eliminated because of overgrazing and when the water table has been lowered owing to streambed downcutting or lateral erosion. (For more information on forage palatability see app. B-1. For potential biomass production, see app. B-5.)

Wildlife. Riparian zones in the TSME series provide good hiding and thermal cover for wildlife species (Atzet et al. 1984, Lanner 1983). However, these sites are characterized by long, cold, wet winters with heavy snowpacks in steep, rugged terrain. Because of these characteristics, the TSME series is not as heavily used by wildlife as some of the other forest series. Most use by wildlife is limited to mid to late summer when conditions are more favorable, often in the subalpine parklands. These sites provide important summer and fall range for elk and mule deer (Pfister et al. 1977). Mountain goats may be observed in mountain hemlock stands and surrounding habitat during most seasons of the year. Black bears forage in these sites, especially on the many berry-producing shrubs that are used in late summer and fall. Grizzly bears, although rare, may select these areas for summer foraging and winter denning. Various small mammals such as bats, red tree vole, red squirrels, and American marten will use hollow trees, snags, and logs for feeding, dens, or rest sites (Hansen et al. 1995). Conifer cones are harvested and cached for winter use by squirrels and chipmunks.

Late-seral stand structures at many of these sites serve as important habitat for a variety of bird species. These include the northern spotted owl, great horned owl, great gray owl, pileated and hairy woodpeckers, chickadees, nuthatches, kinglets, and warblers. Blue grouse use these sites even in winter. Ptarmigan use surrounding heath meadows and alpine sites. Birds eat the seed of mountain hemlock and other conifers. (For more information on thermal or feeding cover values, see apps. B-2 and B-3. For information on food values or degree of use, see apps. B-2 and B-4.)

Fish. Riparian zones in the TSME series play important roles in watershed function and hydrologic regimes. Watershed values are high. Many of these sites are located in high-elevation cirque basins where winter snowpacks are the largest and most pronounced on the eastern slope of the Cascade Range. These areas serve an important function by acting as hydrologic reservoirs, helping maintain streamflows and runoff during the warm summer months. In addition, owing to windthrow and disease, many mountain hemlock sites have moderate amounts of large woody debris in and alongside the stream channels. This woody debris, primarily large-diameter logs, provides good stream channel stabilization particularly during peak flows associated with spring runoff (for more information see app. B-5, erosion control potential). Many of these locations are too high in elevation, and channels are too steep and small for good fisheries habitat. However, the large tree canopies provide shade for the small streams, helping to regulate stream water temperatures and promoting good fisheries habitat in downstream locations. Managers may wish to maintain healthy, vigorous stands of TSME and associated series on fluvially active locations. These buffer strips of erosion-resistant plant species help stabilize streambanks and nearby terraces and swales, provide a barrier to sedimentation from nearby slopes, and provide a source of large down wood for the stream and nearby fluvial surfaces.

Recreation—

Most of these sites are not well suited for recreation uses owing to often inaccessible locations, high water tables, and sensitive soils. Soils are susceptible to compaction, and vegetation is easily trampled. Many of the heaths, heathers, and huckleberries found on these sites are very sensitive to trampling damage. In addition, most of these sites are plagued by overabundant mosquito and fly populations during summer. Most recreation use is limited to wilderness areas where horseback riders, backpackers, and day hikers pass through riparian zones and uplands along established trails.

Insects and Disease—

The most common pathogens found on these sites are various species of decay fungi. Mountain hemlock is very susceptible to laminated root rot (Dickman and Cook 1989, Means 1990). This fungus spreads from centers of infection along tree roots so that all trees are killed in an expanding circle. Annosus root disease is another common decay, particularly in mature stands, that infects the root and butt of both Pacific silver fir and mountain hemlock as well as subalpine fir, Engelmann spruce, and western hemlock (Lillybridge et al. 1995). Other fungal and parasitic pests include Indian paint fungus and dwarf mistletoe.

Insect pests include mountain pine beetle, spruce beetle, western spruce budworm, and fir engraver (Lillybridge et al. 1995). Potential problems with insects usually are minimal at these sites. However, outbreaks of the silver fir beetle are possible on Pacific silver fir trees. Pacific silver fir also may be susceptible to the balsam woolly adelgid. Both mountain hemlock and Pacific silver fir may be affected by the western black-headed budworm.

Estimating Vegetation Potential on Disturbed Sites—

Estimating potential on disturbed sites is generally not needed on these conifer-dominated sites. Clearcutting in riparian areas is unusual, at least on FS lands. Wetter types in the SALIX, MEADOW, and ALSI series separate many mountain hemlock stands from active flood zones. Currently, FS riparian zones are buffered and not managed for timber management. For young stands, similar valley segments in nearby drainages can indicate the potential natural vegetation.

Sensitive Species—

Sensitive plants were not found on any of the ecology plots (app. D).

ADJACENT SERIES

The TSME series occupies some of the highest forested sites found in the stronger maritime climates of the Cascade Range. At its highest elevation it often grades quickly into a mountain hemlock-dominated subalpine parkland along the crest of the Cascade Range (Lillybridge et al. 1995). However, the LALY, ABLA2, or PIAL series can be found at the upper fringe of the TSME series on some sites (especially those transitional to continental climate). At lower elevations, the TSME series grades into the ABAM series.

RELATIONSHIPS TO OTHER CLASSIFICATIONS

This is the first riparian/wetland classification of the TSME series for eastern Washington. Many of the associations described in this classification also were recognized in the upland forest classification for the Wenatchee NF (Lillybridge et al. 1995). In the context of this study, they occur near water. Only TSME/OPHO-VAAL represents a newly classified association.

Plant associations belonging to the TSME series have been described by numerous authors, either as unique types or sometimes included in the ABAM series in the Cascade Range (Brockway et al. 1983, Diaz et al. 1997, Franklin et al. 1988, Hemstrom and Franklin 1982, Hemstrom et al. 1987, Henderson et al. 1992, John et al. 1988, Lillybridge et al. 1995, Williams and Lillybridge 1983); northeastern Washington, northern Idaho, and Montana (Cooper et al. 1991, Daubenmire and Daubenmire 1968, Pfister et al. 1977, Williams et al. 1995); and northeastern Oregon (Johnson and Simon 1987). Meidinger and Pojar (1991) described mountain hemlock-dominated sites for British Columbia.

U.S. DEPARTMENT OF THE INTERIOR, FISH AND WILDLIFE SERVICE WETLANDS CLASSIFICATION

System:	palustrine
Class:	forested wetland
Subclass:	needle-leaved evergreen
Water regime:	(nontidal) intermittently saturated

KEY TO THE MOUNTAIN HEMLOCK (*TSUGA MERTENSIANA*) PLANT ASSOCIATIONS

1. Devil's club (*Oplopanax horridum*) ≥5 percent canopy coverage .... **Mountain hemlock/devil's club (TSME/OPHO-VAAL) association**

2. Moss-heathers (*Cassiope* spp.), mountain-heaths (*Phyllodoce* spp.), and/or Cascade huckleberry (*Vaccinium deliciosum*) ≥5 percent canopy coverage .... **Mountain hemlock/red mountain-heath–Cascade huckleberry (TSME/PHEM-VADE) association**

3. Rusty menziesia (*Menziesia ferruginea*) ≥5 percent canopy coverage, Alaska (*Vaccinium alaskaense*) or oval-leaf huckleberry (*V. ovalifolium*) usually present .... **Mountain hemlock/rusty menziesia-Alaska huckleberry (TSME/MEFE-VAAL) association**

4. Cascade azalea (*Rhododendron albiflorum*) ≥5 percent canopy coverage, big huckleberry (*Vaccinium membranaceum*) usually present .... **Mountain hemlock/Cascade azalea-big huckleberry (TSME/RHAL-VAME) association**

Table 1—Constancy and mean cover of important plant species in the TSME plant associations

		TSME/MEFE-VAAL 5 plots		TSME/OPHO-VAAL 4 plots		TSME/PHEM-VADE 5 plots		TSME/RHAL-VAME 11 plots	
Species	**Code**	**CON[a]**	**COV[b]**	**CON**	**COV**	**CON**	**COV**	**CON**	**COV**
Tree overstory:									
Pacific silver fir	ABAM	100	30	75	20	40	15	100	23
subalpine fir	ABLA2	—	—	—	—	80	9	55	12
Alaska yellow-cedar	CHNO	—	—	—	—	20	5	9	30
Engelmann spruce	PIEN	—	—	—	—	—	—	82	9
whitebark pine	PIAL	—	—	—	—	20	3	18	8
western redcedar	THPL	40	9	25	5	—	—	—	—
western hemlock	TSHE	80	13	25	20	—	—	—	—
mountain hemlock	TSME	100	17	100	29	80	7	100	13
Tree understory:									
Pacific silver fir	ABAM	100	11	100	6	80	14	100	10
subalpine fir	ABLA2	—	—	—	—	80	21	64	5
Alaska yellow-cedar	CHNO	—	—	25	1	20	20	9	Tr[c]
Engelmann spruce	PIEN	—	—	—	—	40	7	27	1
western hemlock	TSHE	60	1	75	2	—	—	—	—
mountain hemlock	TSME	80	1	75	8	100	10	100	6
Shrubs:									
Sitka alder	ALSI	20	5	75	23	—	—	9	2
bearberry honeysuckle	LOIN	—	—	25	6	—	—	27	1
rusty menziesia	MEFE	100	17	50	14	20	33	9	5
devil's club	OPHO	80	1	100	15	—	—	—	—
Cascade azalea	RHAL	—	—	50	15	60	25	100	36
stink currant	RIBR	—	—	25	5	—	—	9	3
Hudsonbay currant	RIHU	—	—	50	5	20	15	9	Tr[c]
salmonberry	RUSP	60	3	100	16	—	—	9	3
undergreen willow	SACO2	—	—	—	—	20	5	—	—
Piper's willow	SAPI	—	—	—	—	20	35	—	—
scarlet elderberry	SARA	—	—	—	—	20	12	—	—
Cascade mountain-ash	SOSC2	60	2	50	5	60	13	18	8
Sitka mountain-ash	SOSI	—	—	25	10	40	3	27	3
Douglas spiraea	SPDO	—	—	—	—	20	15	—	—
Alaska huckleberry	VAAL	100	13	100	37	20	18	9	5
big huckleberry	VAME	80	9	75	4	80	13	100	33
Low shrubs and subshrubs:									
bunchberry dogwood	COCA	40	5	25	Tr	—	—	—	—
Labrador tea	LEGL	—	—	—	—	20	3	27	1
red mountain-heath	PHEM	—	—	—	—	100	16	64	2
dwarf bramble	RULA	100	3	50	1	20	8	45	7
five-leaved bramble	RUPE	100	6	75	3	40	3	55	5

Table 1—Constancy and mean cover of important plant species in the TSME plant associations (continued)

Species	Code	TSME/MEFE-VAAL 5 plots		TSME/OPHO-VAAL 4 plots		TSME/PHEM-VADE 5 plots		TSME/RHAL-VAME 11 plots	
		CON	COV	CON	COV	CON	COV	CON	COV
Cascade huckleberry	VADE	—	—	—	—	80	41	36	2
low huckleberry	VAMY	20	6	—	—	20	30	9	1
Perennial forbs:									
deerfoot vanilla-leaf	ACTR	—	—	50	3	—	—	—	—
sharptooth angelica	ANAR	—	—	75	2	20	Tr	27	1
mountain arnica	ARLA	20	2	25	Tr	40	3	82	2
queencup beadlily	CLUN	100	11	100	2	—	—	—	—
false saxafrage	LEPY	—	—	—	—	60	4	27	1
bigleaf lupine	LUPO	—	—	—	—	20	1	18	Tr
lupine species	LUPIN	—	—	—	—	—	—	9	Tr
northern bluebells	MEPAB	—	—	25	Tr	—	—	9	Tr
miterwort species	MITEL	—	—	50	1	60	1	9	1
sidebells pyrola	PYSE	20	1	75	2	20	Tr	73	1
arrowleaf groundsel	SETR	—	—	25	Tr	60	1	55	1
starry solomonplume	SMST	60	4	—	—	—	—	9	Tr
claspleaf twisted-stalk	STAM	—	—	100	2	20	2	45	Tr
rosy twisted-stalk	STRO	40	5	50	Tr	20	3	55	4
coolwort foamflower	TITRU	80	5	75	3	—	—	36	3
Sitka valerian	VASI	60	3	25	Tr	80	4	73	3
American false hellebore	VEVI	—	—	50	Tr	40	2	27	1
pioneer violet	VIGL	—	—	50	Tr	40	Tr	27	1
Ferns and fern allies:									
lady fern	ATFI	20	1	75	18	20	3	9	Tr
deer fern	BLSP	—	—	50	4	—	—	—	—
common horsetail	EQAR	—	—	25	Tr	60	1	9	Tr
oak fern	GYDR	60	10	50	5	—	—	9	Tr

[a] CON = percentage of plots in which the species occurred.
[b] COV = average canopy cover in plots in which the species occurred.
[c] Tr = trace cover, less than 1 percent canopy cover.

PACIFIC SILVER FIR SERIES

Abies amabilis

ABAM N = 62

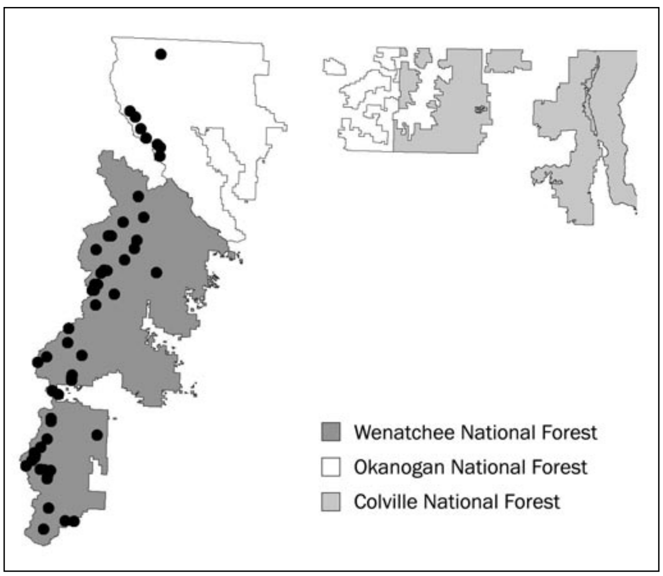


Figure 8—Plot locations for the Pacific silver fir series.

THE RANGE OF Pacific silver fir[1] extends from extreme southeastern Alaska south through western British Columbia and the Cascade Range of Washington and Oregon to northwestern California (Hitchcock and Cronquist 1973). Pacific silver fir is usually associated with uplands, but within its range, it is also prominent in riparian zones on fluvial surfaces such as streambanks and terraces.

Pacific silver fir is one of the most shade-tolerant and environmentally restricted conifers in eastern Washington. The ABAM series is found only in areas of strong maritime influence, usually in climatic zones within 10 miles of the Cascade crest (Lillybridge et al. 1995). This maritime influence is particularly strong and extensive in the mountain pass corridors on the Wenatchee NF. The ABAM series also is found on the western extreme of the Okanogan NF, generally west of a line formed by Washington Pass, Harts Pass, and Reynolds Peak. Most of this land lies west of the Cascade crest on lands once administered by the Mount Baker NF but now administered by the Okanogan NF. The ABAM series is not found on the Colville NF.

CLASSIFICATION DATABASE

The ABAM series includes all forest stands potentially dominated by silver fir at climax. The series was sampled on the Okanogan and Wenatchee NFs (fig. 8). Stands are common on all ranger districts of the Wenatchee NF and the extreme west end of the Methow Valley RD on the Okanogan NF. Thirty riparian and wetland plots were sampled in the ABAM series. Data from an additional 32 plots from other ecology samples were included to augment species composition, distribution, and elevation data for the series. From this database, seven major and two minor plant associations are described. For the most part, these samples were located in late-seral and climax Pacific silver fir stands.

[1] See appendix A for a cross reference for all species codes and common and scientific names used in this document.

Pacific silver fir plant associations

	Scientific name	Common name	Ecoclass code	Plots
Major associations:				
ABAM/ACTR-WEN	*Abies amabilis/Achlys triphylla*-Wenatchee	Pacific silver fir/deerfoot vanilla-leaf–Wenatchee	CFF254	6
ABAM/ATFI	*Abies amabilis/Athyrium filix-femina*	Pacific silver fir/lady fern	CFF621	7
ABAM/GYDR	*Abies amabilis/Gymnocarpium dryopteris*	Pacific silver fir/oak fern	CFF622	9
ABAM/MEFE-WEN	*Abies amabilis/Menziesia ferruginea*-Wenatchee	Pacific silver fir/rusty menziesia-Wenatchee	CFS542	8
ABAM/OPHO	*Abies amabilis/Oplopanax horridum*	Pacific silver fir/devil's club	CFS351	15
ABAM/TITRU	*Abies amabilis/Tiarella trifoliata* var. *unifoliata*	Pacific silver fir/coolwort foamflower	CFF162	6
ABAM/VAME/CLUN-WEN	*Abies amabilis/Vaccinium membranaceum*-Wenatchee	Pacific silver fir/big huckleberry-Wenatchee	CFS233	5
Minor associations:				
ABAM/ACCI	*Abies amabilis/Acer circinatum*	Pacific silver fir/vine maple	CFS621	2
ABAM/RHAL-VAME-WEN	*Abies amabilis/Rhododendron albiflorum-Vaccinium membranaceum*-Wenatchee	Pacific silver fir/Cascade azalea-big huckleberry-Wenatchee	CFS556	4

VEGETATION CHARACTERISTICS

Mature stands in the ABAM series characteristically have two or more tree canopies, with species such as Douglas-fir and Engelmann spruce forming a tall canopy above a layer of more shade-tolerant and slower growing species such as Pacific silver fir, western hemlock, and western redcedar (Lillybridge et al. 1995). Late-seral stands have an overstory dominated by Pacific silver fir, with some large, remnant western redcedar and western hemlock. Common seral tree species include Engelmann spruce, western hemlock, western redcedar, western white pine, and Douglas-fir. Subalpine fir and Alaska yellow-cedar are common seral species in the three high-elevation types (ABAM/RHAL-VAME-WEN, ABAM/TITRU, and ABAM/VAME/CLUN-WEN). Mountain hemlock may be scattered in cold, high-elevation stands on sites transitional to the TSME series. The tree understory is usually dominated by Pacific silver fir and western hemlock regeneration, with lesser amounts of western redcedar. Pacific silver fir is extremely shade tolerant and will survive for decades in sapling form, releasing rapidly when the overstory is opened by logging, disease, or windthrow.

Shrub and herb layers are floristically rich and varied. Heavily shaded stands often support little understory plant cover (depauperate). Very deep litter and low light levels at the forest floor appear to reduce the number and cover of shrubs and herbs. Inspection of adjacent stands or use of relative cover data may be needed to correctly identify the type. Shrubs dominate many types in open stands and include vine maple, big huckleberry, rusty menziesia, dwarf bramble, and Cascade azalea on relatively drier sites; devil's club, prickly currant, and salmonberry on wetter sites. Common herbs include queencup beadlily, deerfoot vanilla-leaf, sidebells pyrola, rosy twisted-stalk, and coolwort foamflower. Lady fern and oak fern are prominent on wetter sites.

PHYSICAL SETTING

Elevation—

The majority of ABAM series plots are between 3,000 and 5,000 feet. Okanogan NF plots are over 600 feet higher than Wenatchee NF plots. The Okanogan NF has a relatively weak maritime climate compared with the Wenatchee NF. Therefore, ABAM series sites are located at elevations high enough to provide the precipitation and snowpack needed to support the ABAM series. The highest plot on the Wenatchee NF is located at the extreme eastern extension of the range of Pacific silver fir and, like the Okanogan plots, occurs at higher elevation in zones of heavier precipitation and snowpack.

	Elevation (feet)			
Forest	Minimum	Maximum	Average	N
Okanogan	3,190	4,900	4,250	8
Wenatchee	2,380	5,520	3,623	54
Series	2,380	5,520	3,704	62

Additional insight is gained by looking at individual associations. The average elevations for ABAM/RHAL-VAME-WEN, ABAM/VAME/CLUN-WEN, and ABAM/TITRU associations are much higher compared with the other associations, but ranges still overlap for many associations. The limited data and the author's own observations suggest that ABAM/ACCI is the lowest elevation plant association.

	Elevation (feet)			
Plant association	Minimum	Maximum	Average	N
ABAM/RHAL-VAME-WEN	4,400	5,500	5,002	4
ABAM/VAME/CLUN-WEN	3,620	5,520	4,824	5
ABAM/TITRU	3,190	4,850	4,422	6
ABAM/ATFI	2,380	4,460	3,653	7
ABAM/GYDR	2,450	4,920	3,519	9
ABAM/MEFE-WEN	2,900	3,760	3,318	8
ABAM/ACTR-WEN	2,500	3,680	3,292	6
ABAM/OPHO	2,610	4,200	3,290	15
ABAM/ACCI	3,040	3,050	3,045	2
Series	2,380	5,520	3,704	62

Valley Geomorphology—

The ABAM series is found in various valley width and gradient classes. Approximately 65 percent of the plots are located in moderate to very narrow valleys (less than 330 feet) with moderate to very high gradients (greater than 4 percent). However, some sites also are located in very broad (greater than 990 feet), low gradient (less than 3 percent) valleys. In many cases these later plots are associated with lake basins or along cold air drainages in large valleys such as the Chiwawa River. The variety of valley width and gradient classes likely indicates that maritime climate is more important than valley geomorphology in determining the distribution of the ABAM series (with the exception of cold air drainages).

	Valley gradient					
Valley width	Very low	Low	Moderate	Steep	Very steep	N
Very broad	6	2	1	0	0	9
Broad	0	0	0	0	0	0
Moderate	0	2	2	1	1	6
Narrow	0	2	4	0	7	13
Very narrow	0	0	0	0	2	2
Series total	6	6	7	1	10	30

The limited valley data do not show a clear pattern for individual ABAM associations, as each association can be found across a variety of valley width and gradient classes. ABAM/ACCI, ABAM/ATFI, ABAM/MEFE-WEN, ABAM/OPHO, ABAM/RHAL-VAME-WEN, and ABAM/VAME/CLUN-WEN occur more often in moderate to very narrow valleys. Only ABAM/ACTR-WEN and ABAM/TITRU indicate a preference for broader valleys. ABAM/ACCI, ABAM/ACTR-WEN, ABAM/ATFI, and ABAM/GYDR appear to occur on very low to moderate gradient valleys, whereas the ABAM/OPHO, ABAM/RHAL-VAME-WEN, and ABAM/VAME/CLUN-WEN occur in steeper valleys.

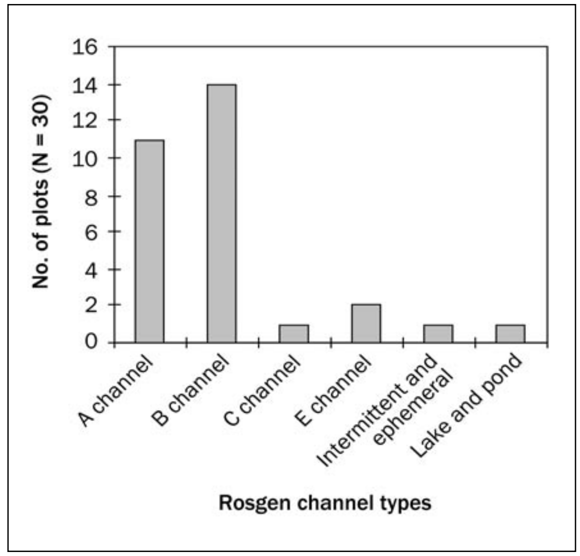
	Valley width					
Plant association	Very broad	Broad	Moderate	Narrow	Very narrow	N
ABAM/ACCI	0	0	0	1	0	1
ABAM/ACTR-WEN	2	0	1	0	0	3
ABAM/ATFI	0	0	3	2	0	5
ABAM/GYDR	2	0	0	2	0	4
ABAM/MEFE-WEN	0	0	1	1	1	3
ABAM/OPHO	1	0	0	3	0	4
ABAM/TITRU	2	0	1	0	0	3
ABAM/RHAL-VAME-WEN	1	0	0	2	0	3
ABAM/VAME/CLUN-WEN	1	0	0	2	1	4
Series total	9	0	6	13	2	30

	Valley gradient					
Plant association	Very low	Low	Moderate	Steep	Very steep	N
ABAM/ACCI	0	0	1	0	0	1
ABAM/ACTR-WEN	2	1	0	0	0	3
ABAM/ATFI	0	1	3	0	1	5
ABAM/GYDR	2	0	2	0	0	4
ABAM/MEFE-WEN	0	2	0	1	0	3
ABAM/OPHO	1	0	0	0	3	4
ABAM/TITRU	0	1	1	1	0	3
ABAM/RHAL-VAME-WEN	1	0	0	0	2	3
ABAM/VAME/CLUN-WEN	0	1	0	0	3	4
Series total	6	6	7	1	10	30

Channel Types—

The limited data suggest the moderate to narrow width, moderate to very steep gradient valleys associated with many plots in the ABAM series usually support A and B Rosgen channel types. Fewer plots are associated with C channels, E channels, and lakes or ponds in larger, lower gradient valleys. These sites tend to get too wet for Pacific silver fir; therefore, the ABAM series gives way to wetter riparian and wetland series and associations.

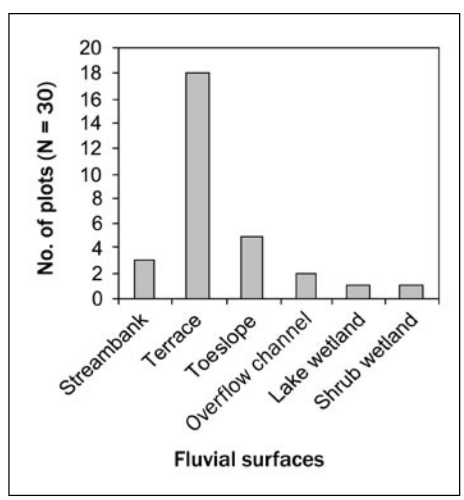
Data for individual associations support these observations, as most are located along A and B channels. Only ABAM/ACCI and ABAM/ACTR-WEN seem to have an affinity for other channel types (C and E channels), but data to support this observation are very limited.



	Rosgen channel types						
Plant association	A	B	C	E	Intermittent/ ephemeral	Lake/ pond	N
ABAM/ACCI	0	0	0	1	0	0	1
ABAM/ACTR-WEN	0	1	1	1	0	0	3
ABAM/ATFI	2	3	0	0	0	0	5
ABAM/GYDR	2	2	0	0	0	0	4
ABAM/MEFE-WEN	0	2	0	0	1	0	3
ABAM/OPHO	2	2	0	0	0	0	4
ABAM/TITRU	1	2	0	0	0	0	3
ABAM/RHAL-VAME-WEN	1	1	0	0	0	1	3
ABAM/VAME/CLUN-WEN	3	1	0	0	0	0	4
Series total	11	14	1	2	1	1	30

Fluvial Surfaces—

The ABAM series is most prominent in riparian zones on streambanks, overflow channels, terraces, and toeslopes. The vast majority of plots (76 percent) are on terraces and toeslopes. Only two plots are found on the dry margins (xeroriparian) of lakes and ponds associated with wetlands.

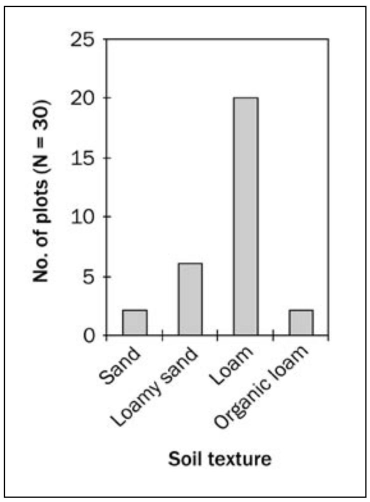


Little additional insight into fluvial location is gained by looking at individual plant associations. All eight associations are found primarily on riparian zone fluvial surfaces, especially terraces. ABAM/GYDR is the only plant association located in largely filled-in overflow channels. ABAM/ACTR-WEN and ABAM/RHAL-VAME-WEN are occasionally located on the dry margins of wetlands.

	Fluvial surfaces					
Plant association	Stream-bank	Terrace	Toe-slope	Overflow channel	Wetlands	N
ABAM/ACTR-WEN	0	2	0	0	1	3
ABAM/ATFI	1	3	1	0	0	5
ABAM/GYDR	0	3	0	2	0	5
ABAM/MEFE-WEN	0	1	2	0	0	3
ABAM/OPHO	2	2	0	0	0	4
ABAM/RHAL-VAME-WEN	0	2	0	0	1	3
ABAM/TITRU	0	3	0	0	0	3
ABAM/VAME/CLUN-WEN	0	2	2	0	0	4
Series total	3	18	5	2	2	30

Soils—

Mineral soils predominate in the ABAM series. Loamy sand and loam soils are the most common soil texture classes. Two plots with recent flood overflow and deposition have sandy soils. A few soils in the wettest types (ABAM/GYDR and ABAM/ATFI) were classified organic loam.



Little additional information about soil texture is gained by looking at individual plant associations. As with the ABAM series in general, most stands are associated with loam soils. ABAM/ACTR-WEN and ABAM/VAME/CLUN-WEN are the only associations with sandy (flood deposition) soils, whereas the wet ABAM/ATFI and ABAM/GYDR associations occasionally grow on organic soils.

	Soil texture				
Plant association	Sand	Loamy sand	Loam	Organic loam	N
ABAM/ACCI	0	0	1	0	1
ABAM/ACTR-WEN	1	1	1	0	3
ABAM/ATFI	0	1	3	1	5
ABAM/GYDR	0	0	3	1	4
ABAM/MEFE-WEN	0	1	2	0	3
ABAM/OPHO	0	0	4	0	4
ABAM/RHAL-VAME-WEN	0	1	2	0	3
ABAM/TITRU	0	1	2	0	3
ABAM/VAME/CLUN-WEN	1	1	2	0	4
Series total	2	6	20	2	30

Water tables were sampled on only seven plots, where they averaged 28 inches below the soil surface. There is no discernable pattern between plant associations and water tables, perhaps owing to the low sample size. Similarly, few plots had soil surface water present at the time of sampling. ABAM/OPHO, ABAM/ATFI, and ABAM/GYDR are the plant associations most likely to be partially flooded at snowmelt.

Soil temperature data are available for 29 plots. Generally, higher elevation plant associations had the coldest soil temperatures; however, data are limited and should be viewed with caution.

	Soil temperature (°F)			
Plant association	Minimum	Maximum	Average	N
ABAM/ACCI	55	55	55	1
ABAM/MEFE-WEN	47	55	53	3
ABAM/GYDR	45	58	52	4
ABAM/OPHO	48	54	49	4
ABAM/ATFI	43	51	47	4
ABAM/TITRU	43	47	46	3
ABAM/VAME/CLUN-WEN	43	47	46	4
ABAM/ACTR-WEN	42	48	45	3
ABAM/RHAL-VAME-WEN	40	46	43	3
Series	40	58	48	29

ECOSYSTEM MANAGEMENT

Natural Regeneration of Pacific Silver Fir—

Pacific silver fir reproduces only from seed (Lane 1959) and begins seed production at 20 to 30 years of age. Good seed crops are produced every 2 to 3 years, although intervals between good seed production may be as long as 6 years. The largeness of the seed limits the distance it can be dispersed by wind. Seed germination occurs in the spring on a variety of substrates, such as litter, rotten wood, moss, and both organic and mineral soils. Cool, moist sites are optimal for germination, whereas full sunlight is needed for maximum new growth. Under optimal conditions, Pacific silver fir saplings reach a height of 5 feet in 9 years, but under dense canopies, it may take 80 years or longer. Information about natural and artificial establishment of other tree species that may be found in ABAM series stands is found in descriptions for other tree series.

Artificial Establishment of Pacific Silver Fir and Associated Shrubs and Firs—

Nursery-grown bare-root and container stock of Pacific silver fir are widely planted in the Pacific Northwest. Both establish best on bare mineral soil, although broadcast slash burning has been shown to slow the success of regeneration. When using selection-harvest methods in riparian zones, it is probably better to rely on the release of natural seedlings and saplings for regeneration of Pacific silver fir.

Many of the shrubs used to characterize the ABAM series are well adapted to planting on disturbed sites. Devil's club can be established from seed or cuttings, or by layering, although establishment is slow. Prickly currant, salmonberry, and western thimbleberry can be easily grown from seed. Five-leaved bramble, dwarf bramble, twinflower, and other trailing plants can be easily propagated from root runners. Huckleberry species can be established from seed, but its growth from seed is slow. Huckleberry cuttings root poorly. Rusty menziesia and Cascade azalea, like all ericaceous plants, can propagate from seed or cuttings. However, the seed is small and the seedlings need two or three transplantings before being outplanted. Deerfoot vanilla-leaf, oak fern, and lady fern are easily propagated from rhizomes. (For more information on the short- and long-term revegetation potential of selected riparian wetland plant species, see app. B-5.)

Stand Management—

The ABAM series supports many tree species. Pacific silver fir, Engelmann spruce, western redcedar, and western hemlock are dominant, and six other eastern Washington trees are well represented. Only ponderosa pine, Oregon white oak, mountain hemlock, subalpine larch, and whitebark pine are not suited to ABAM series environments. Douglas-fir and, in some cases, western redcedar and western hemlock, are not well suited to higher, colder associations such as ABAM/VAME/CLUN-WEN and ABAM/RHAL-VAME-WEN.

Although tree productivity is quite high on these sites, tree harvesting and associated management activities need to be carefully planned in riparian zones. Some sites, such as those that occur in ABAM/OPHO and ABAM/ATFI associations, are swampy and, although tree growth is rapid, are difficult to manage for timber production (Lillybridge et al. 1995). Loam soils are prevalent and are susceptible to compaction during most of the growing season. Many larger trees have extensive heart rot and also are susceptible to blowdown. Timber harvesting in these sites or adjacent upslope sites may cause water tables to rise and increase the risk of blowdown. Regeneration may be particularly difficult on the wettest sites, such as ABAM/OPHO and ABAM/ATFI, where Pacific silver fir and western hemlock will only establish themselves on down logs or root wads.

Although overstory removal is a viable harvest option in uplands, riparian zones are best suited to single-tree or small-group selection to open the canopy and increase understory production, as well as to protect streams and other riparian-dependent resources. After release by logging or blowdown, suppressed Pacific silver fir will respond with substantial growth. Tree harvesting should occur during late summer/fall or during winter, over snow, to minimize soil disturbance. Commercial rotations are seldom longer than 110 years, but a period of 150 to 200 years is more suited to riparian sites. Wetland sites should be avoided entirely.

Provisions for future supplies of large down wood are essential for riparian sites.

Tree Growth and Yield—

Cool average annual temperatures and heavy snowpacks are the main limitations to tree growth in the ABAM series (Lillybridge et al. 1995). However, favorable summer growing conditions that include moist soils and occasional summer rains more than make up for the relatively short growing season. The ABAM series is one of the more productive series in eastern Washington, exhibiting high basal area (281 square feet per acre) and site index values. The high basal area value is one of the highest for any of the tree series (apps. C-1a and C-1b). Only the PSME, THPL, and TSHE series are comparable. Similarly, the average site index for individual species (feet) is generally high compared with other series (app. C-2). Tree productivity data are limited and should be viewed with caution.

Site index			
Species	Base age	No. of trees	SI
ABAM	100	63	97
ABGR	5	3	104
ABLA2	50	10	56
ABPR	100	3	118
CHNO	100	3	75
PIEN	50	39	78
PSME	50	6	86
THPL	100	11	85
TSHE	50	13	65
TSME	50	2	56

Basal area (sq. ft./ac)	
Species	BA
ABAM	100
ABGR	2
ABPR	1
ABLA2	28
CHNO	18
LAOC	2
PICO	1
PIEN	49
PIMO	1
POTR2	2
PSME	13
THPL	27
TSHE	35
TSME	2
Total	281

Down Wood—

Overall, the amount of down wood on ABAM sites is high compared to other tree series sites (app. C-3), with logs covering 12 percent of the ground. This reflects cool, moist, productive conditions that support large-diameter trees and, hence, large-diameter logs. These environmental conditions then slow the decomposition of the down wood. ABAM sites usually carry less down wood than the THPL series (e.g., 31.37 tons per acre compared with 66.32 tons per acre) probably because ABAM sites have far fewer decay-resistant western redcedar trees and logs.

	Down log attributes				
Log decomposition	Tons/ acre	Cu. ft./ acre	Linear ft./ acre	Sq. ft./ acre	% ground cover
Class 1	3.14	265	182	222	0.50
Class 2	4.30	724	605	534	1.20
Class 3	11.87	1,519	1,012	1,288	3.00
Class 4	5.00	1,604	1,487	1,585	3.60
Class 5	7.06	2,261	1,302	1,771	4.10
Total	31.37	6,373	4,588	5,400	12.40

Definitions of log decomposition classes are on page 15.

Snags—

Similarly, the ABAM series has more snags (53.5 snags per acre) than other forest series (app. C-4) except the ABLA2 series (54.3 snags per acre). It also has a greater number of snags in larger size classes (16.3 snags per acre larger than 15.5 inches diameter at breast height (d.b.h.) than other tree series. However, nearly 70 percent of snags are less than 15.5 inches in diameter, and nearly 60 percent are class 1 or 2. Most tree mortality is caused by overstory suppression or losses to insects and diseases in smaller diameter classes.

Definitions of snag condition classes are on page 15.

	Snags/acre by d.b.h. class (inches)				
Snag condition	5–9.9	10–15.5	15.6–21.5	21.6+	Total
Class 1	5.1	3.1	3.2	2.3	13.7
Class 2	9.2	4.4	2.0	1.0	16.6
Class 3	.7	5.0	1.2	.9	7.8
Class 4	1.0	4.3	1.0	1.5	7.8
Class 5	2.3	2.1	1.2	2.0	7.6
Total	18.3	18.9	8.6	7.7	53.5

Fire—

Fire in Pacific silver fir stands is infrequent owing to the relatively short summers, high humidity, and high precipitation associated with this zone (Houston and Scott 1992). Fire intervals are reported to be as long as 500 years. Pacific silver fir's distribution and dominance are directly dependent on long fire-return intervals because its thin bark and shallow roots are extremely fire sensitive. When they do occur, fires are extremely intense owing to the buildup of natural fuels. The intense fires replace the stands of Pacific silver fir.

A total of 179 site index trees were sampled for age data. These trees averaged 183 years in age at breast height. Four trees were at least 400 years old, 7 were 300 to 399 years old, 59 were 200 to 299 years old, and 66 were 100 to 199 years old. Sixty-three percent of the site index trees were found to be greater than 150 years old. These age data suggest that stand-replacing fire intervals in the ABAM series in riparian areas on the east side of the Cascade Range generally range from 150 to 400 years (Agee 1993).

Animals—

Livestock. There are few grazing allotments within the ABAM series in eastern Washington, and livestock grazing is not usually a problem. In general, these cold, wet sites have little utility for domestic livestock. Forage potential may be fair in early successional stages but becomes poor as stands mature. Because of the lack of suitable forage, these sites represent sources of water and shade. However, when grazed, trampling can damage the moist, fine-textured soils on these sites. As a result of limiting grazing and monitoring of wildlife, remnant shrub and herb populations will reoccupy the stand; however, the opportunity to quickly reestablish shrubs is lost when they are eliminated by overgrazing or when the water table is dramatically lowered by streambed downcutting. (For more information on forage palatability, see app. B-1. For potential biomass production, see app. B-5.)

Wildlife. Riparian zones in the ABAM series provide valuable habitat for a variety of wildlife species. Multiple shrub and tree layers associated with most stands provide considerable habitat diversity. In general, ABAM series sites offer cover, forage, and water. Late-seral and climax stand structures at many sites serve as important habitat for old-growth-dependent species. These more mature stands include old, large western hemlock and Pacific silver fir with extensive heart rot decay, which results in large trees, snags, and logs with hollow centers. In addition, many sites have abundant berry-producing shrubs, an important food source for many animals.

Large ungulates such as mule deer and elk forage in these sites during summer and fall. Elk do not usually browse on Pacific silver fir but are known to favor vine maple and devil's club as forage plants and also will eat deerfoot vanilla-leaf. ABAM sites also provide good habitat for mountain goats, as long as other critical habitat such as rocks and cliffs are nearby (Young 1989). Black bears forage in these sites during late summer and fall, especially on the abundant berry-producing shrubs. Grizzly bears, although rare, may select these sites for summer foraging and winter denning. Bears, squirrels, bats, and American marten will use hollow logs for dens and resting sites. Mammals that prefer old-growth stands include fisher and western red-backed vole. Squirrels and other rodents eat the seeds of Pacific silver fir and other conifers. Pacific silver fir stands provide little habitat for beavers.

Woodpeckers and Vaux's swift use hollow trees and snags for roosting. Woodpeckers forage them for ants. Mature stands are important habitat for the northern spotted owl and goshawks. Birds eat the seeds of Pacific silver fir and other conifers. (For more information on thermal or feeding cover values, see apps. B-2 and B-3. For information on food values or degree of use, see apps. B-2 and B-4.)

Fish. The ABAM series plays an important role in the maintenance of good fish habitat. The sites are very productive and provide ample amounts of large woody debris, primarily large-diameter logs that enhance stream structure. Most Pacific silver fir sites are located along A and B channels, which tend to be steeper in gradient. Thus, the contribution of large woody debris from ABAM stands helps maintain channel stability, particularly during peak flows. (For more information, see app. B-5, erosion control potential.) In addition, the large tree canopies provide shade for the stream and help regulate stream water temperatures. Maintaining healthy, vigorous stands of Pacific silver fir and associated series along riparian zones helps to stabilize streambanks and nearby terraces and swales, form barriers to sedimentation from nearby slopes, and provide large down wood for the stream and nearby fluvial surfaces.

Recreation—

Late-seral and old-growth stands of Pacific silver fir have high recreational value owing to the attractiveness of the big trees. Other than fishing opportunities in nearby streams, stands in the ABAM/TITRU, ABAM/ATFI, ABAM/GYDR, and ABAM/OPHO associations are not well suited for recreation owing to moist soils, high water tables, and seeps and springs. The prevalent loam soils are highly susceptible to compaction. The shrub layers of some associations, such as ABAM/ACCI, may be dense and tangled in open conifer stands and thus hard to access. The herbaceous vegetation in ABAM/ACCI is easily trampled if the shrub layer is opened. Construction and maintenance of campgrounds and trails is not recommended on wetter associations. If access is necessary, it may require boardwalks. Campsites can be constructed in associations such as ABAM/ACTR-WEN and ABAM/VAME/CLUN-WEN where they occur on well-drained terraces well away from flood zones. However, campground managers should be aware that these sites are prone to windthrow owing to seasonally wet soils, shallow rooting systems, and heart and root rot.

Insects and Disease—

The most common pathogens found on these sites are decay fungi (Henderson and Peter 1982). Annosus root disease is the most serious disease of the ABAM series, causing root, butt, and stem decay of Pacific silver fir and western hemlock. Armillaria root rot kills mostly suppressed and diseased trees. Laminated root rot also occurs in some stands. Other fungal diseases include yellow root rot, red ring rot, rust red stringy rot, and long pocket rot. Brown trunk rot and brown cubical rot are particular problems with Douglas-fir. Natural or human-caused wounds to trees often result in increased damage from decay fungi. Brown felt blight (snow mold) might occur on Pacific silver fir, especially at higher elevations. White pine blister rust may occur on western white pine.

Insect pests include the silver fir beetle, mountain pine beetle, spruce beetle, western spruce budworm, and fir engraver (Lillybridge et al. 1995). Of these, only the silver fir beetle and mountain pine beetle have the potential to reach epidemic populations in the ABAM series. The silver fir beetle can kill thousands of trees in areas with extensive, mature Pacific silver fir. The mountain pine beetle can cause extensive damage within limited areas dominated by lodgepole pine. The Douglas-fir tussock moth and western spruce budworm attack mainly Douglas-fir and grand fir.

Estimating Vegetation Potential on Disturbed Sites—

Because many ABAM stands are protected by wilderness status and all FS riparian zones are buffered, it is generally not necessary to estimate potential vegetation for this series. Conifers and the understory vegetation usually reestablished quickly on these sites where clearcut in the past. Additionally, many stands lie in wilderness areas and are separated from active flood zones by wetter associations belonging to the SALIX, MEADOW, and ALSI series. In young stands or in the event of recent wildfire, managers can look at nearby stands or in similar valley segments of nearby watersheds to help determine the potential natural vegetation.

Sensitive Species—

No sensitive species were found on ABAM series ecology plots. However, sensitive plants have been found in ABAM series environments on the Wenatchee NF and elsewhere in the Northwest (Lillybridge 1998). (See app. D.)

ADJACENT SERIES

The TSME series occurs on colder, harsher sites at higher elevations than the ABAM series. The TSHE series usually replaces ABAM on warmer and drier sites. Wetter sites in ALSI, SALIX, and MEADOW series often occur on more fluvially active surfaces and separate the ABAM series from the direct influence of streams except, perhaps, during very high floods.

RELATIONSHIPS TO OTHER CLASSIFICATIONS

This is the first riparian/wetland classification of the ABAM series in eastern Washington. Many of the riparian plant associations described in the ABAM series represent relatively wet stand conditions for Pacific silver fir plant associations previously described for uplands on the Wenatchee NF by Lillybridge et al. (1995). Only the ABAM/ATFI and ABAM/GYDR associations are newly classified. The ABAM/ATFI association represents a slightly warmer component of the ABAM/OPHO association described in Lillybridge et al. (1995). ABAM/GYDR represents a wetter component of several other associations described by Lillybridge et al. (1995). ABAM/VAME/CLUN-WEN is very similar to Lillybridge's ABAM/VAME/CLUN and ABAM/VAME-PYSE associations, but this study does not include sufficient plots to differentiate the two.

Plant associations belonging to the ABAM series have been described in the Cascade Range (Brockway et al. 1983, Franklin et al. 1988, Hemstrom et al. 1982, Hemstrom et al. 1987, Henderson et al. 1992, John et al. 1988, Williams and Lillybridge 1983). These are primarily upland classifications. Meidinger and Pojar (1991) described similar stands for British Columbia, although these are classified primarily in their "Mountain Hemlock Zone."

U.S. DEPARTMENT OF THE INTERIOR, FISH AND WILDLIFE SERVICE WETLANDS CLASSIFICATION

System:	palustrine
Class:	forested wetland
Subclass:	needle-leaved evergreen
Water regime:	(nontidal) temporarily saturated to intermittently flooded

KEY TO THE PACIFIC SILVER FIR (*ABIES AMABILIS*) PLANT ASSOCIATIONS

1. Devil's club (*Oplopanax horridum*) ≥5 percent canopy cover .... **Pacific silver fir/devil's club (ABAM/OPHO) association**
2. Lady fern (*Athyrium filix-femina*) ≥5 percent canopy coverage .... **Pacific silver fir/lady fern (ABAM/ATFI) association**
3. Vine maple (*Acer circinatum*) ≥5 percent canopy coverage .... **Pacific silver fir/vine maple (ABAM/ACCI) association**
4. Oak fern (*Gymnocarpium dryopteris*) ≥5 percent canopy coverage .... **Pacific silver fir/oak fern (ABAM/GYDR) association**
5. Rusty menziesia (*Menziesia ferruginea)* ≥5 percent canopy coverage .... **Pacific silver fir/rusty menziesia-Wenatchee (ABAM/MEFE-WEN) association**
6. Cascade azalea (*Rhododendron albiflorum*) ≥5 percent canopy coverage, big huckleberry (*Vaccinium membranaceum*) usually present .... **Pacific silver fir/Cascade azalea-big huckleberry-Wenatchee (ABAM/RHAL-VAME-WEN) association**
7. Deerfoot vanilla-leaf (*Achlys triphylla*) ≥2 percent canopy coverage .... **Pacific silver fir/deerfoot vanilla-leaf–Wenatchee (ABAM/ACTR-WEN) association**
8. Coolwort foamflower (*Tiarella trifoliata* var. *unifoliata*), rosy twisted-stalk (*Streptopus roseus*) and/or false bugbane (*Trautvetteria caroliniensis*) ≥5 percent canopy coverage .... **Pacific silver fir/coolwort foamflower (ABAM/TITRU) association**
9. Big huckleberry (*Vaccinium membranaceum*) ≥5 percent canopy coverage .... **Pacific silver fir/big huckleberry/queencup beadlily-Wenatchee (ABAM/VAME/CLUN-WEN) association**

Table 2—Constancy and mean cover of important plant species in the ABAM plant associations

Species	Code	ABAM/ ACCI 2 plots		ABAM/ ACTR-WEN 6 plots		ABAM/ ATFI 7 plots		ABAM/ GYDR 9 plots		ABAM/ MEFE-WEN 8 plots		ABAM/ OPHO 15 plots		ABAM/RHAL-VAME-WEN 4 plots		ABAM/ TITRU 6 plots		ABAM/VAME/ CLUN-WEN 5 plots	
		CON[a]	COV[b]	CON	COV	CON	COV	CON	COV	CON	COV	CON	COV	CON	COV	CON	COV	CON	COV
Tree overstory:																			
Pacific silver fir	ABAM	100	10	100	25	100	31	78	26	100	26	100	30	100	37	100	22	100	32
grand fir	ABGR	50	10	—	—	14	10	22	4	—	—	—	—	—	—	—	—	—	—
subalpine fir	ABLA2	50	10	50	23	29	7	33	20	25	3	—	—	25	8	67	13	40	23
Alaska yellow-cedar	CHNO	—	—	33	11	14	15	44	10	25	20	—	—	25	10	17	35	60	13
Engelmann spruce	PIEN	50	15	50	8	57	24	78	15	25	5	13	4	50	18	83	23	80	16
western white pine	PIMO	50	10	17	3	14	1	44	5	13	2	—	—	25	5	33	3	—	—
Douglas-fir	PSME	100	10	33	13	14	3	33	10	25	6	27	15	—	—	17	5	—	—
western redcedar	THPL	100	13	50	12	29	18	67	9	50	11	53	14	—	—	17	25	—	—
western hemlock	TSHE	100	18	67	17	43	13	100	15	88	29	93	25	—	—	33	11	40	23
mountain hemlock	TSME	—	—	—	—	14	Tr[c]	—	—	13	8	13	3	75	1	17	5	40	8
Tree understory:																			
Pacific silver fir	ABAM	50	5	100	12	100	6	89	13	100	12	100	9	100	16	100	17	100	13
grand fir	ABGR	50	6	—	—	14	1	—	—	—	—	—	—	—	—	—	—	—	—
subalpine fir	ABLA2	—	—	50	5	57	2	11	1	13	1	—	—	25	1	67	6	40	3
Alaska yellow-cedar	CHNO	—	—	50	12	14	5	56	6	25	12	—	—	25	Tr	17	5	60	4
Engelmann spruce	PIEN	50	2	17	1	14	1	11	1	—	—	7	1	25	1	67	4	40	1
western redcedar	THPL	100	6	33	5	14	1	44	4	38	3	53	2	—	—	17	8	—	—
western hemlock	TSHE	50	10	67	9	43	3	100	7	75	3	73	7	—	—	50	1	20	3
mountain hemlock	TSME	—	—	—	—	43	2	11	5	13	1	7	2	50	4	—	—	40	4
Shrubs:																			
vine maple	ACCI	100	55	—	—	14	2	—	—	—	—	27	11	—	—	—	—	—	—
Sitka alder	ALSI	—	—	17	2	29	10	11	2	13	20	20	7	25	10	17	8	—	—
California hazel	COCO	50	5	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
rusty menziesia	MEFE	—	—	17	1	43	6	44	5	100	19	47	7	—	—	33	1	20	2
devil's club	OPHO	—	—	17	1	43	1	56	2	—	—	100	34	—	—	17	1	—	—
Cascade azalea	RHAL	—	—	33	2	29	3	22	5	38	16	—	—	100	26	17	1	20	2
Hudsonbay currant	RIHU	—	—	—	—	29	4	22	Tr	—	—	13	8	—	—	—	—	—	—
prickly currant	RILA	—	—	50	3	57	2	67	2	—	—	33	1	—	—	50	7	60	2
western currant	RILA2	—	—	—	—	—	—	11	5	—	—	7	10	—	—	—	—	—	—
baldhip rose	ROGY	50	10	67	2	29	1	22	3	25	1	27	1	—	—	—	—	—	—
western thimbleberry	RUPA	50	1	50	5	29	3	44	1	—	—	60	5	—	—	17	4	—	—
salmonberry	RUSP	—	—	33	4	57	5	33	10	63	2	60	7	—	—	—	—	20	1
Alaska huckleberry	VAAL	—	—	67	5	—	—	22	4	38	9	53	4	25	5	—	—	40	3
big huckleberry	VAME	50	2	100	16	86	23	89	4	88	12	67	5	100	16	83	18	100	19
oval-leaf huckleberry	VAOV	—	—	—	—	14	Tr	33	17	—	—	—	—	—	—	—	—	—	—
Low shrubs and subshrubs:																			
Cascade hollygrape	BENE	50	35	17	6	—	—	11	3	25	3	—	—	—	—	17	1	—	—
western prince's-pine	CHUMO	50	10	—	—	—	—	33	2	50	1	—	—	—	—	17	2	—	—
bunchberry dogwood	COCA	50	20	83	14	29	1	67	10	38	10	20	26	—	—	17	2	—	—
Labrador tea	LEGL	—	—	17	30	—	—	22	19	—	—	—	—	—	—	—	—	—	—
twinflower	LIBOL	50	35	67	7	14	Tr	78	4	63	8	40	3	—	—	—	—	20	Tr
dwarf bramble	RULA	—	—	67	3	57	5	78	7	75	1	67	4	50	5	50	13	60	Tr
five-leaved bramble	RUPE	—	—	33	3	57	4	33	8	50	2	33	7	25	7	17	3	40	4
low huckleberry	VAMY	—	—	—	—	—	—	33	1	13	15	20	1	—	—	17	4	—	—
grouse huckleberry	VASC	—	—	17	5	—	—	22	2	13	2	—	—	—	—	—	—	40	3

Table 2—Constancy and mean cover of important plant species in the ABAM plant associations (continued)

		ABAM/ ACCI 2 plots		ABAM/ ACTR-WEN 6 plots		ABAM/ ATFI 7 plots		ABAM/ GYDR 9 plots		ABAM/ MEFE-WEN 8 plots		ABAM/ OPHO 15 plots		ABAM/RHAL-VAME-WEN 4 plots		ABAM/ TITRU 6 plots		ABAM/VAME/ CLUN-WEN 5 plots	
Species	Code	CON	COV	CON	COV	CON	COV	CON	COV	CON	COV	CON	COV	CON	COV	CON	COV	CON	COV
Perennial forbs:																			
deerfoot vanilla-leaf	ACTR	50	10	100	15	43	22	56	16	38	3	27	16	—	—	—	—	—	—
baneberry	ACRU	50	Tr	17	2	57	1	56	1	—	—	67	1	—	—	—	—	—	—
pathfinder	ADBI	100	1	—	—	14	2	22	3	—	—	40	3	—	—	—	—	—	—
Oregon anemone	ANOR	—	—	17	Tr	14	Tr	33	1	—	—	7	5	—	—	—	—	—	—
sharptooth angelica	ANAR	—	—	17	Tr	43	Tr	33	Tr	—	—	—	—	25	1	—	—	60	Tr
mountain arnica	ARLA	—	—	17	18	29	4	11	1	13	Tr	7	Tr	50	4	83	6	20	2
wild ginger	ASCA3	50	5	—	—	14	1	11	4	—	—	53	5	—	—	—	—	—	—
alpine leafybract aster	ASFO	—	—	—	—	—	—	—	—	—	—	—	—	—	—	17	5	—	—
queencup beadlily	CLUN	100	6	83	4	57	9	78	4	100	4	100	9	50	3	33	7	40	Tr
Hooker fairy-bells	DIHO	50	Tr	17	Tr	14	3	11	Tr	—	—	40	2	—	—	—	—	—	—
sweetscented bedstraw	GATR	—	—	17	Tr	43	2	56	1	—	—	73	2	—	—	17	3	—	—
western rattlesnake plantain	GOOB	50	2	33	2	43	1	33	2	38	1	20	2	—	—	17	2	20	Tr
bigleaf lupine	LUPO	—	—	17	3	—	—	—	—	—	—	—	—	—	—	17	5	—	—
fivestamen miterwort	MIPE	—	—	—	—	29	Tr	11	Tr	—	—	—	—	25	Tr	50	4	40	Tr
three-parted mitewort	MITR2	—	—	—	—	—	—	11	6	—	—	—	—	—	—	17	1	—	—
broadleaved montia	MOCO	—	—	17	Tr	14	2	—	—	13	1	—	—	—	—	50	2	20	Tr
purple sweet-root	OSPU	—	—	—	—	43	Tr	22	Tr	—	—	—	—	25	1	50	1	20	Tr
sidebells pyrola	PYSE	50	2	83	2	71	2	89	1	88	2	60	3	100	1	67	2	100	1
western solomonplume	SMRA	50	Tr	—	—	57	3	22	2	—	—	27	2	—	—	33	2	—	—
starry solomonplume	SMST	50	7	50	1	29	5	67	3	25	3	60	6	—	—	33	1	—	—
rosy twisted-stalk	STRO	—	—	50	2	71	3	44	3	25	2	60	6	50	1	17	2	60	Tr
western meadowrue	THOC	—	—	17	1	29	1	11	Tr	—	—	20	1	—	—	50	1	—	—
coolwort foamflower	TITRU	50	2	83	3	86	9	78	3	50	2	93	11	50	7	83	7	—	—
false bugbane	TRCA3	—	—	50	4	14	1	44	4	—	—	7	5	—	—	33	23	—	—
broadleaf starflower	TRLA2	—	—	—	—	14	Tr	22	2	13	1	20	5	—	—	—	—	—	—
white trillium	TROV	50	Tr	50	2	57	1	56	2	38	1	80	2	—	—	50	1	40	Tr
Sitka valerian	VASI	—	—	17	3	71	1	67	3	25	1	20	3	50	5	67	13	80	Tr
pioneer violet	VIGL	50	Tr	17	Tr	86	1	56	1	—	—	73	3	—	—	83	3	40	Tr
round-leaved violet	VIOR2	—	—	17	4	—	—	89	1	25	4	27	4	—	—	33	2	—	—
Ferns and fern allies:																			
lady fern	ATFI	50	3	33	4	100	11	44	1	—	—	93	6	—	—	33	1	—	—
common horsetail	EQAR	50	15	33	2	29	1	11	Tr	13	1	—	—	—	—	—	—	40	Tr
oak fern	GYDR	50	3	—	—	86	11	100	12	25	1	100	14	25	4	33	2	—	—
sword fern	POMU	50	Tr	—	—	14	1	33	1	13	Tr	—	—	—	—	—	—	—	—

[a] CON = percentage of plots in which the species occurred.
[b] COV = average canopy cover in plots in which the species occurred.
[c] Tr = trace cover, less than 1 percent canopy cover.

WESTERN HEMLOCK SERIES

Tsuga heterophylla

TSHE N = 117

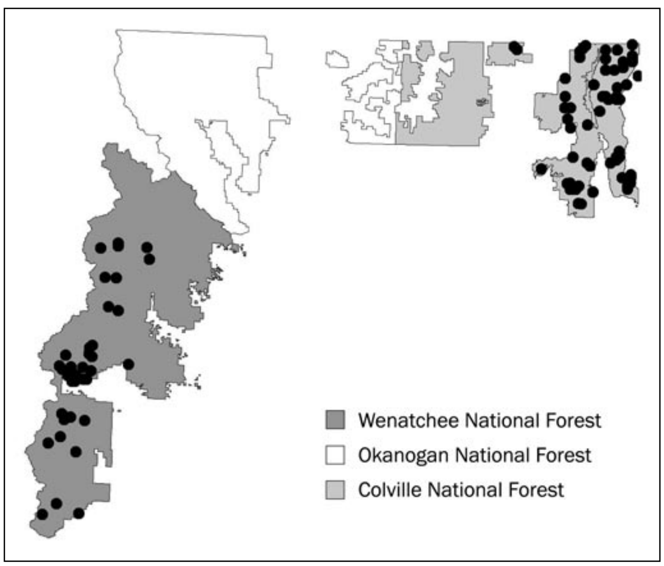


Figure 9—Plot locations for the western hemlock series.

THE DISTRIBUTION OF western hemlock[1] is similar to that of western redcedar, with disjunct coastal and interior populations (Williams et al. 1995). The interior distribution, which includes portions of the Colville NF, is closely correlated with the inland maritime climatic regime and extends from southeastern British Columbia to northeastern Washington, northern Idaho, and northwestern Montana (Hitchcock and Cronquist 1973, Parish et al. 1996). The coastal distribution, which includes portions of the Wenatchee and Okanogan NFs, extends from Alaska's Kenai Peninsula south into the coast ranges of northern California inland along the east side of the Cascade Range in Oregon and Washington. Within this range, western hemlock occurs on a variety of sites, including wetland, riparian, and upland sites.

Western hemlock is one of the most shade-tolerant and environmentally restricted conifers on the Colville, Wenatchee, and Okanogan NFs. The shade tolerance of western hemlock is outranked only by those of Pacific silver fir and mountain hemlock (Lillybridge et al. 1995). Like Pacific silver fir, mountain hemlock, and western redcedar, western hemlock develops in areas influenced by Pacific maritime and inland maritime climatic patterns. Average annual precipitation for the TSHE series is more than 25 inches, with highest averages along the Cascade crest and moderately high precipitation in northeastern Washington. Temperatures are moderate; summer drought is less severe than in areas of continental climate.

Therefore, the TSHE series occurs only on that part of the species' range beyond the environmental or geographic limits of the ABAM and TSME series, which prefer cooler, stronger maritime environments (Lillybridge et al. 1995). Riparian and wetland sites for the TSHE series are generally higher and presumably cooler, although not necessarily moister, than THPL series sites. The TSHE series occupies cooler maritime and inland maritime sites, whereas the THPL and ABGR series occupy slightly warmer and drier habitats (Williams et al. 1995). Under these restrictions, the TSHE series is limited to (but abundant in) the eastern half of the Colville NF (Williams et al. 1995), primarily east of a line formed by the Columbia and Kettle Rivers. It occurs only sporadically in isolated stands west of this line and is apparently absent on the Colville Indian Reservation (Clausnitzer and Zamora 1987). The best development of the TSHE series on the Wenatchee and Okanogan NFs is in areas within strong maritime climate but where Pacific silver fir and mountain hemlock are absent (Lillybridge et al. 1995). The TSHE series is most abundant south of the Entiat River on the west side of the Wenatchee NF (CleElum, Naches, Leavenworth, and Lake Wenatchee RDs). The TSHE series also is found in the western extremes of the Entiat and Lake Chelan RDs (Wenatchee NF). On the Okanogan NF, western hemlock sites are limited to areas west of Washington Pass near the North Cascades National Park.

CLASSIFICATION DATABASE

The TSHE series includes all closed-forest stands potentially dominated by western hemlock at climax. The series is found on all three NFs and to some extent on all but the Twisp and Republic RDs, where it is extremely rare. Fifty-five riparian and wetland plots were sampled on the

[1] See appendix A for a cross reference for all species codes and common and scientific names used in this document.

Western hemlock plant associations

	Scientific name	Common name	Ecoclass code	Plots
Major associations:				
TSHE/ACCI	*Tsuga heterophylla/Acer circinatum*	Western hemlock/vine maple	CHS226	19
TSHE/ACTR-WEN	*Tsuga heterophylla/Achlys triphylla*-Wenatchee	Western hemlock/deerfoot vanilla-leaf–Wenatchee	CHF223	14
TSHE/ARNU3	*Tsuga heterophylla/Aralia nudicaulis*	Western hemlock/wild sarsaparilla	CHF312	6
TSHE/ATFI	*Tsuga heterophylla/Athyrium filix-femina*	Western hemlock/lady fern	CHF421	15
TSHE/CLUN	*Tsuga heterophylla/Clintonia uniflora*	Western hemlock/queencup beadlily	CHF311	6
TSHE/GYDR	*Tsuga heterophylla/Gymnocarpium dryopteris*	Western hemlock/oak fern	CHF422	24
TSHE/OPHO	*Tsuga heterophylla/Oplopanax horridum*	Western hemlock/devil's club	CHS513	29
Minor associations:				
TSHE/ASCA3	*Tsuga heterophylla/Asarum caudatum*	Western hemlock/wild ginger	CHF313	2
TSHE/LYAM	*Tsuga heterophylla/Lysichiton americanus*	Western hemlock/skunk cabbage	CHM122	2

Colville and Wenatchee NFs (fig. 9). Data were added from an additional 62 plots from previous ecology sampling (Lillybridge et al. 1995, Williams et al. 1995) to help develop the classification, as well as to provide more data for species composition, distribution, and elevation. From this database, seven major and two minor plant associations are recognized. TSHE/ACCI, TSHE/ASCA3, TSHE/ACTR-WEN, and TSHE/LYAM associations are restricted to the Cascade Range. With the exception of a few plots, the TSHE/ARNU3, TSHE/ATFI, TSHE/CLUN, and TSHE/GYDR associations are restricted to northeastern Washington. The TSHE/OPHO association is found throughout the study area. The information presented for this series primarily represents mature stands in late-seral to climax conditions.

VEGETATION CHARACTERISTICS

Mature TSHE series stands are normally dominated by western hemlock and long-lived western redcedar, although a variety of other tree species may be present depending on plant association, past disturbance, and time since disturbance (Williams et al. 1995). Scattered large grand fir, Douglas-fir, western larch, and Engelmann spruce may be present. In the Cascade Range, mountain hemlock and Pacific silver fir, if present, are restricted to microsites or are clearly reproducing less successfully than western hemlock (Lillybridge et al. 1995). The understory of mature stands is also usually dominated by both western redcedar and western hemlock, with a few grand fir and Engelmann spruce. Stands usually are too shady to support Douglas-fir regeneration. Seral stands vary by association and stand history but usually include grand fir, Douglas-fir, and Engelmann spruce. Ponderosa pine occurs on warmer, drier sites, although it is very uncommon. Western larch may dominate stands that originated after stand replacement fire. Some dense, doghair western hemlock/western redcedar stands originated after the stand-replacement fires of the early 1900s.

The TSHE series exhibits high species diversity owing to its inherent site variability. One cause of community variety is that moister associations usually contain one set of plants, whereas drier ones have another. Primary indicator shrub species are vine maple and devil's club. Herbs characterize all other associations. Other medium and tall shrub species include Douglas maple, Utah honeysuckle, common snowberry, baldhip rose, big huckleberry, and western thimbleberry on mesic sites; and mountain alder, Sitka alder, and prickly currant on wetter sites. Low shrubs include Oregon and Cascade hollygrape, western prince's-pine, twinflower, myrtle pachistima, five-leaved bramble, and Pacific blackberry.

The herb composition is also rich and varied. Indicator herbs include deerfoot vanilla-leaf, wild sarsaparilla, wild ginger, lady fern, queencup beadlily, oak fern, and skunk cabbage. Other herbs include pathfinder, western rattlesnake plantain, sweetscented bedstraw, white trillium, sidebells pyrola, and starry solomonplume on mesic sites; and baneberry, claspleaf twisted-stalk, and coolwort foamflower on wet sites.

PHYSICAL SETTING

Elevation—

The TSHE series spans a moderate to moderately high range of elevations. Most plots are located between 2,500 and 4,500 feet. The average elevation for the plots on the Colville NF is about 850 feet higher than the Wenatchee NF. At the same elevations, Cascade Range sites receive higher precipitation compared with the Selkirk Mountains on the Colville NF. Therefore, in the Cascade Range, the ABAM and TSME series occupy mid to upper elevation sites, which (in the absence of TSME and ABAM) support TSHE on the Colville NF. For example, the TSHE/OPHO association averages about 2,700 feet in elevation on the Wenatchee NF but averages 3,350 feet on the Colville. The TSHE/CLUN and TSHE/GYDR associations also occur at lower levels on the Wenatchee NF compared with the Colville NF.

	Elevation (feet)			
Forest	Minimum	Maximum	Average	N
Colville	2,270	5,200	3,696	68
Wenatchee	2,080	4,720	2,854	49
Series	2,080	5,200	3,343	117

Additional insight is gained by looking at elevation distributions by plant association. The TSHE/ATFI, TSHE/GYDR, and TSHE/LYAM associations occur at higher elevations on average, although individual plot elevations overlap with plots in associations at lower elevations. TSHE/ARNU3, TSHE/ASCA3, and TSHE/ACCI are the lowest elevation associations.

	Elevation (feet)			
Plant association	Minimum	Maximum	Average	N
TSHE/ATFI	3,260	5,200	4,233	15
TSHE/GYDR	2,640	5,025	3,901	24
TSHE/LYAM	2,925	4,720	3,822	2
TSHE/CLUN	2,600	5,150	3,338	6
TSHE/ACTR-WEN	2,340	4,000	3,299	14
TSHE/OPHO	2,080	4,250	3,120	29
TSHE/ARNU3	2,270	3,150	2,817	6
TSHE/ASCA3	2,390	3,100	2,745	2
TSHE/ACCI	2,080	3,190	2,490	19
Series	2,080	5,200	3,343	117

Valley Geomorphology—

Plants in the TSHE series are located in a variety of valley width and gradient classes. Sixty-six percent of the plots occur in valleys of moderate, narrow, and very narrow width (less than 330 feet). Valley gradient is more variable, with most plots occurring in the low, moderate, and very steep classes (1 to more than 8 percent).

	Valley gradient					
Valley width	Very low	Low	Moderate	Steep	Very steep	N
Very broad	0	3	0	0	0	3
Broad	1	4	1	1	0	7
Moderate	0	3	3	3	0	9
Narrow	0	5	8	3	10	26
Very narrow	0	0	1	0	9	10
Series total	1	15	13	7	19	55

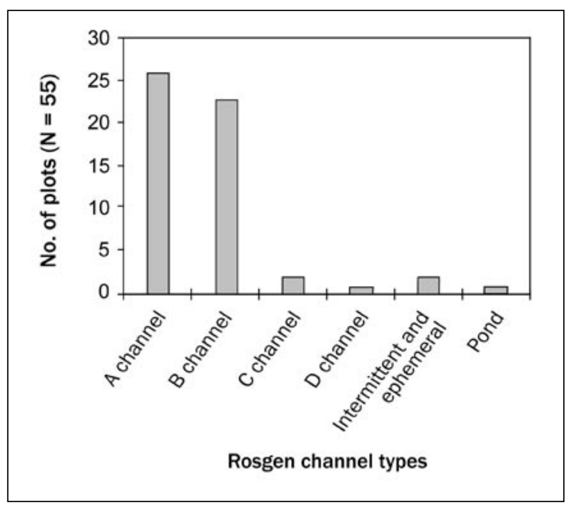
Little additional insight is gained by looking at the distribution of valley width and gradient classes according to associations. The trend follows that almost all associations are most common in moderate to very narrow width classes; and low, moderate, and very steep gradient classes. The TSHE/ATFI and TSHE/OPHO associations appear to favor narrower valleys but also occur over a wide range of valley gradients. The TSHE/GYDR association favors broad to narrow valley widths, but again, no particular valley gradient class. Other associations also occur in several valley configurations, but their sample size is too small for definitive conclusions. For the TSHE series, valley configuration seems less important for vegetation diversity than soil moisture and climate.

	Valley width					
Plant association	Very broad	Broad	Moderate	Narrow	Very narrow	N
TSHE/ACCI	0	1	0	3	0	4
TSHE/ACTR-WEN	0	1	1	1	0	3
TSHE/ARNU3	0	1	0	2	0	3
TSHE/ATFI	0	1	1	5	4	11
TSHE/CLUN	1	0	1	0	1	3
TSHE/GYDR	0	2	3	4	0	9
TSHE/OPHO	1	1	3	11	5	21
Series total	3	7	9	26	10	54

	Valley gradient					
Plant association	Very low	Low	Moderate	Steep	Very steep	N
TSHE/ACCI	0	1	0	2	1	4
TSHE/ACTR-WEN	0	1	2	0	0	3
TSHE/ARNU3	1	1	1	0	0	3
TSHE/ATFI	0	2	3	1	5	11
TSHE/CLUN	0	1	1	0	1	3
TSHE/GYDR	0	3	2	1	3	9
TSHE/OPHO	0	5	4	3	9	21
Series total	1	14	13	7	19	54

Channel Types—

The TSHE series plots are located along a variety of channel types. Given the lack of broad to very broad valley widths and very low valley gradient; primarily straight, well-entrenched Rosgen A and B channel types predominate (89 percent). Few plots are located along very low gradient C channels, intermittent streams, ephemeral draws, or lakes and ponds. E channels were not sampled.

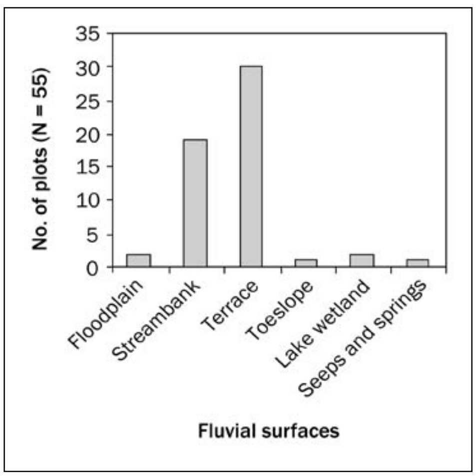


Little additional insight is gained by looking at the distribution of channel types by plant associations. All associations other than TSHE/ARNU3 show a preference for A or B channels. The TSHE/ARNU3 association is the only association found along intermittent streams, ephemeral draws, or the dry margins of a pond wetland. However, this association is also common on well-drained sites along A and B channels.

	Rosgen channel types						
Plant association	A	B	C	D	Intermittent and ephemeral	Pond	N
TSHE/ACCI	1	3	0	0	0	0	4
TSHE/ACTR-WEN	0	2	1	0	0	0	3
TSHE/ARNU3	0	0	0	0	2	1	3
TSHE/ATFI	8	3	0	0	0	0	11
TSHE/CLUN	2	1	0	0	0	0	3
TSHE/GYDR	4	4	1	0	0	0	9
TSHE/LYAM	0	1	0	0	0	0	1
TSHE/OPHO	11	9	0	1	0	0	21
Series total	26	23	2	1	2	1	55

Fluvial Surfaces—

Most TSHE series plots (89 percent) are located in riparian zones on well-drained streambanks and terraces. Smaller percentages are found on wet floodplains, the dry margins of wetlands, or near seeps and springs (11 percent).

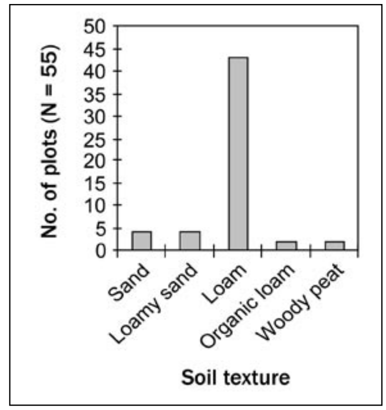


The same pattern holds for individual plant associations. No single association shows a preference for fluvial surfaces other than streambanks or terraces.

	Fluvial surfaces						
Plant association	Flood-plain	Stream-bank	Terrace	Toe-slope	Lake wetland	Seeps/ springs	N
TSHE/ACCI	0	1	3	0	0	0	4
TSHE/ACTR-WEN	0	0	3	0	0	0	3
TSHE/ARNU3	0	1	1	0	1	0	3
TSHE/ATFI	0	6	5	0	0	0	11
TSHE/CLUN	0	1	2	0	0	0	3
TSHE/GYDR	0	2	5	1	1	0	9
TSHE/LYAM	0	0	1	0	0	0	1
TSHE/OPHO	2	8	10	0	0	1	21
Series total	2	19	30	1	2	1	55

Soils—

The TSHE series plots are dominated by mineral soils with loam textures (78 percent). Sand and loamy sand textures are uncommon and presumably occur on more active fluvial surfaces such as streambanks and floodplains. In most plots the soil surface is covered with a thick layer of duff and logs.



Like the TSHE series, most individual plant associations grow on loam soil. Two soils in the wettest associations (TSHE/LYAM and TSHE/ATFI) were classified as organic loams. The two wood peat soils in TSHE/OPHO probably represent crew error where they placed the soil auger on a log with condition class 5. Loam soil likely occurred beneath the log.

	Soil texture					
Plant association	Sand	Loamy sand	Loam	Organic loam	Woody peat	N
TSHE/ACCI	1	0	3	0	0	4
TSHE/ACTR-WEN	0	0	3	0	0	3
TSHE/ARNU3	0	0	3	0	0	3
TSHE/ATFI	0	1	9	1	0	11
TSHE/CLUN	0	0	3	0	0	3
TSHE/GYDR	1	3	5	0	0	9
TSHE/LYAM	0	0	0	1	0	1
TSHE/OPHO	2	0	17	0	2	21
Series total	4	4	43	2	2	55

Water table depth at the time of sampling could only be measured on two associations: TSHE/OPHO and TSHE/ATFI. Measurements for TSHE/LYAM are not available, but it is easily as wet as TSHE/OPHO and TSHE/ATFI. The remaining associations are generally restricted to well-drained streambanks and terraces with water tables that were not often reached with a soil auger.

	Water table (inches)			
Plant association	Minimum	Maximum	Average	N
TSHE/OPHO	-35	-2	-15	15
TSHE/ATFI	-28	-5	-16	9
Series	-75	-3	-22	49

The TSHE/OPHO and TSHE/ATFI series also are the only sites that had surface water present at the time of sampling and they, along with TSHE/LYAM, are probably partially flooded at spring runoff. Data are limited and no table is shown. Soil temperature data are available for 52 plots. With some exceptions, higher elevation associations such as

TSHE/ATFI and TSHE/GYDR had cold soil temperatures, whereas low-elevation associations (TSHE/ACCI) had warm soil temperatures.

	Soil temperature (°F)			
Plant association	Minimum	Maximum	Average	N
TSHE/ACCI	50	62	56	4
TSHE/ACTR-WEN	46	52	49	3
TSHE/CLUN	42	56	48	3
TSHE/OPHO	36	62	47	19
TSHE/ARNU3	43	50	46	3
TSHE/ATFI	31	47	42	10
TSHE/GYDR	34	49	41	9
Series	31	62	46	52

ECOSYSTEM MANAGEMENT

Natural Regeneration of Western Hemlock—

Western hemlock reproduces from seed and vegetatively (Owens and Molder 1984, Packee 1990, Ruth 1974). Trees in open-grown stands can begin producing seeds at 20 years, but good cone crops do not usually occur until stands are 25 to 35 years old. Some cones are produced every year, but good crops occur every 3 or 4 years. Seeds are small and light, with large wings. They generally fall within 2,000 feet of the parent tree; however, strong winds can carry them as far as 4,000 feet, and in denser stands they fall much closer to the base of the parent. Western hemlock seeds require 3 to 4 weeks of cold stratification to improve germination. Seed remains viable only through the first growing season after it falls. Germination can occur on a variety of soils, including undisturbed duff and litter, rotten wood, or bare mineral soil (Williamson 1976). Most seedling mortality occurs in the first 2 years. Seedlings are shade tolerant but grow best in partial shade. However, germination may fail on heavily shaded sites owing to slow root penetration in drying duff. Western hemlock seedlings also are sensitive to heat, drought, frost, and wind (Owens and Molder 1984). Seedlings grow slowly; at 2 years a seedling may be only 8 inches tall. Once established, those in full sunlight may average 24 inches height growth annually. Suppressed seedlings and saplings release well following removal of competing overstory and understory vegetation.

Western hemlock can occasionally reproduce vegetatively by layering of live branches or rooting of broken branches (Packee 1990). Seedlings that die back to the soil surface may sprout from buds near the root collar.

Artificial Establishment of Western Hemlock—

Western hemlock is a valued timber species that is strong, even grained, and uniform in color. It is widely used for lumber, doors, windows, flooring, stairways, and molding (Parish et al. 1996). Although widely planted, it is difficult to grow in outdoor nurseries (Klinka et al. 1984) so natural regeneration is preferred over planting stock. Artificial regeneration is suitable on sites ranging from mineral soils to well-decomposed organic material. Nursery-grown container stock appears to perform better than bare rootstock. Direct seeding is possible where bare mineral soil is available. Western hemlock also grafts readily, and the growth of grafted material is often better than that of rooted material. When using selection-cutting methods in riparian zones, it is probably better to rely on natural seeding.

Many of the shrubs that characterize the TSHE series are well adapted to planting on disturbed sites. Red-osier dogwood, vine maple, Sitka alder, mountain alder, myrtle pachistima, and devil's club can be established from nursery stock or seed. Layering or cuttings can establish red-osier dogwood and vine maple. Prickly currant, western thimbleberry, salmonberry, dwarf bramble, five-leaved bramble, and Pacific blackberry can be easily grown from seed. These and other trailing plants can be easily propagated from root runners. Although growth is slow, huckleberries can be established from seed. Common snowberry can be established from stem or root cuttings, nursery stock, or seed. Oak fern, lady fern, and horsetail species can be easily propagated from rhizomes. (For more information on the short- and long-term revegetation potential of selected riparian wetland plant species, see app. B-5.)

Stand Management—

Western hemlock forests are among the most productive forests in the world, especially on the Pacific coast. The TSHE series supports a variety of seral tree species, including western redcedar, grand fir, Engelmann spruce, western larch, and Douglas-fir. Ponderosa pine does not perform well on TSHE sites. Except for western redcedar and Engelmann spruce, regeneration of these tree species will be difficult in the wettest sites owing to high water and competition from a rich variety of shrubs and herbs. Heavy browsing of western redcedar regeneration by snowshoe hares is a potential problem. Despite its high growth and yield, the TSHE series is vulnerable to a variety of perturbations, and management activities must be carefully planned.

The TSHE sites can be regenerated by using various harvest methods (Weetman and Vyse 1990). Overstory removal will favor seral species such as Douglas-fir and western larch. A common problem after overstory removal is overtopping vegetation, especially by shrubs such as vine maple, Sitka alder, and Scouler's willow, which tend to form dense thickets and exclude conifer regeneration. Shelterwood and single-tree cutting will reduce shrub competition, as well as favor shade-tolerant conifers such as western hemlock and western redcedar. Management options in riparian zones appear to be limited to single-tree selection or small-group selection with the objective of opening the canopy to increase understory production for other resources. Scheduling management activity during late summer and early fall or during winter on snowpack will minimize soil disturbance. High water tables and the presence of seeps and springs on wetter sites such as TSHE/ATFI and TSHE/OPHO preclude many timber management activities. Other associations also have seasonably high water tables. Many larger trees have extensive heart rot, and trees on wetter sites are often susceptible to blowdown. Timber harvest upslope of these or adjacent sites may raise water tables and increase the risks of blowdown. A clearcut within or adjacent to riparian zones could result in blowdown in the riparian zone.

Western hemlock, western redcedar, Engelmann spruce, and grand fir may require down logs or root wads to establish in mature stands, especially on wetter sites. Coarse, compaction-resistant soils are unusual in these sites, except on frequently flooded floodplains and streambanks. Loam soils predominate, with sensitive organic soils only in the wetter associations (TSHE/ATFI and TSHE/OPHO). Machinery and livestock easily compact or otherwise damage these soils, especially when water tables are high (Hansen et al. 1995). Roads and trails generally should be located on the adjacent upland. Poorly drained sites, streamside locations, or sites with organic soils warrant special concern.

Tree Growth and Yield—

The TSHE series is one of the most productive forested series in eastern Washington, as indicated by high basal area and site index values. Perhaps this is because of its moderate to moderately high elevations, cool temperatures, and high moisture levels (Williams et al. 1995). Another factor helping explain high productivity is the variability and the number of tree species on TSHE sites. Large, old-growth trees characterize some of the wetter associations, such as TSHE/ATFI, TSHE/LYAM, and TSHE/OPHO. Basal area averaged 263 square feet per acre (apps. C-1a and C-1b). Only the ABAM, PSME, and THPL series were higher. Similarly, average site index for individual species (feet) is high compared with other series (app. C-2). Note that tree productivity data are limited and should be used with caution.

Site index			
Species	Base age	No. of trees	SI
ABGR	50	32	77
ABLA2	50	14	65
CHNO	100	2	58
LAOC	50	37	75
PICO	100	3	109
PIEN	50	31	71
PIMO	50	6	69
PIPO	100	4	129
PSME	50	41	82
THPL	100	81	76
TSHE	50	45	60

Basal area (sq. ft./ac)	
Species	BA
ABAM	1
ABGR	25
ABLA2	6
BEPA	Tr
CHNO	Tr
LAOC	14
PICO	3
PIEN	19
PIMO	6
PIPO	Tr
POTR2	1
PSME	23
THPL	103
TSME	62
Total	263

Down Wood—

The overall amount of down woody material is generally high for forest series (app. C-3). Logs cover 13 percent of the ground surface, a measure second only to the THPL series. This reflects the cool, moist (to wet) environment of TSHE series sites, which tends to support large-diameter trees and logs.

Definitions of log decomposition classes are on page 15.

	Down log attributes				
Log decomposition	Tons/ acre	Cu. ft./ acre	Linear ft./ acre	Sq. ft./ acre	% ground cover
Class 1	2.33	213	456	304	0.7
Class 2	3.53	374	659	498	1.14
Class 3	15.22	1,931	3,473	1,803	4.14
Class 4	5.86	1,606	1,639	1,592	3.65
Class 5	5.54	1,776	1,352	1,584	3.64
Total	32.48	5,900	7,579	5,781	13.27

Snags—

The TSHE series supports a moderate number of snags (27.5 per acre) compared with other forest series (app. C-4). The POTR2 series is the only forest series with fewer snags (8.1 per acre). This is surprising, as the TSHE series is in other ways (site index, basal area, and logs) one of the most productive series. Possible explanations are (1) conditions for decomposition are ideal, and (2) high heart rot causes rapid snag fall. Approximately 74 percent of the snags were in the 5- to 15-inch diameter range, distributed fairly well through all condition classes.

Definitions of snag condition classes are on page 15.

	Snags/acre by d.b.h. class (inches)				
Snag condition	5–9.9	10–15.5	15.6–21.5	21.6+	Total
Class 1	5.5	1.9	1.1	0.4	8.9
Class 2	0	1.2	.3	1.0	2.5
Class 3	1.1	3.8	1.3	.2	6.4
Class 4	2.9	1.9	1.2	.1	6.1
Class 5	1.8	.2	1.0	.6	3.6
Total	11.3	9.0	4.9	2.3	27.5

Fire—

Fire-return intervals are infrequent, as all but the most severe wildfires do not take hold on the TSHE series' cool, moist sites (Davis et al. 1980, Ruth 1976). Fire frequencies are reported to be as long as 150 to 400 years in the Pacific Northwest (Parminter 1983). Intervals tend to be longer in riparian and wetland zones compared with adjacent uplands.

Western hemlock's thin bark, shallow roots, highly flammable foliage, and low branching habit make it vulnerable to fire (Davis et al. 1980, Parminter 1983). Lichen-covered branches further increase this susceptibility. Even light ground fires are damaging because of scorching of its shallow roots (Packee 1990). Additional mortality can be caused by fungal infection of fire wounds (Fischer and Bradley 1987). Although old stands support heavy fuel loads, much of this material is moist, deep duff, and rotting wood. Because this organic material does not burn easily, these sites may act as firebreaks. Fires in older stands tend to be slow moving and to do little damage (although western hemlock appears to be more vulnerable than western redcedar). Once ignited, however, such fuels could support long-lasting fires, especially during severe drought.

Three hundred sixty-six trees were measured for age in the TSHE series. They averaged 188 years old at breast height. One hundred and nine trees were less than 100 years old, 170 were 100 to 199, 54 were 200 to 299, 7 were 400 to 499, and 2 trees were 500 to 599 years old. Over half of the site index trees were over 100 years old, and nearly 17 percent were over 200 years old. Most stands appear to be between 75 and 250 years old based on site index trees. This seems to suggest that stand-replacing fire-return intervals in eastern Washington generally range from 100 to 250 years. Stands in the wetter TSHE/OPHO, TSHE/ATFI, and TSHE/GYDR associations contain older trees, and nearly all site index trees older than 200 years were located in these three associations. Fire-return intervals in wet associations may be greater than 200 years, whereas drier associations are probably characterized by shorter fire-return intervals of 100 to 200 years. Furthermore, most trees in the TSHE series over 200 years old were located on the Colville NF. This suggests that fire-free intervals in western hemlock sites in the inland maritime area are longer than on the east slope of the Cascade Range.

The fire regime of surrounding upland stands also affects how often riparian sites burn. In eastern Washington, riparian zones in the TSHE series are surrounded by drier Douglas-fir or grand fir uplands on southerly slopes, which historically burned more frequently during the late summer fire season. The ABLA2 associations on upper slopes of all aspects usually bound TSHE series sites in the vicinity of the Selkirk Mountains. Many of these burned in the early 1900s, and it is reasonable to presume that many adjacent western hemlock uplands and bottoms also burned during these intense fires. Such TSHE sites may reflect shorter fire-return intervals compared with riparian zones adjacent to moister western redcedar/western hemlock uplands. It is thought, therefore, that those vast, early 1900s fires influence present stand ages in the TSHE series.

Animals—

Livestock. In general, these cool, moist to wet sites have little forage for domestic livestock, except in early successional stages when forage production may be high (in the absence of shrubs). With forage potential generally poor, sites in mid- to late-successional stages primarily present sources of water and shade. Regeneration of conifers has been poor in some cattle grazing allotments that were clearcut (generally, the 1990s saw a moratorium on clearcutting). Where water tables are high and soils moist or wet, sites are vulnerable to trampling. In addition, where grazing is particularly heavy, shrub and herb composition may be altered over the years, with a trend toward dominance by increaser and invader species such as Kentucky bluegrass and white clover.

Because forage is poor for livestock, grazing is not usually a problem. However, the ability to easily reestablish desired shrubs and herbs may be lost when they have been eliminated owing to the combination of clearcutting, fire, or overgrazing, and if the water table has been lowered because of stream downcutting (rare on eastern Washington NFs) or lateral erosion. If sites have not been grazed too heavily, modification of the grazing system and close monitoring of wildlife often allow the remnant shrub and herb population to sprout and reestablish in the stand. (For more information on forage palatability, see app. B-1, and for potential biomass production, see app. B-5.)

Wildlife. The mosaic of riparian and wetland associations within and adjacent to the TSHE series provides valuable habitat for a variety of wildlife species. In general, these sites offer sources of cover, forage, and water. Late-seral stand structures on many sites serve as important habitat for old-growth-dependent species. These stands include older western hemlock and western redcedar trees with extensive heart rot, resulting in large trees, snags, and logs with hollow interiors. During summer and fall, large ungulates such as mule deer, white-tailed deer, and elk will forage in these sites on the rich variety of shrubs and herbs. They may browse western hemlock (Packee 1990). Elk are known to favor devil's club as forage. In the Selkirk Mountains, caribou forage in lower elevation western hemlock stands during summer and move into mature, high-elevation western hemlock and subalpine fir stands in winter and early spring to feed on lichens. Bears will use hollow logs for dens and rest sites. Black bears and grizzly bears are known to forage in these sites (Layser 1978). Various small mammals such as bats, flying squirrels, red tree voles, red squirrels, and American marten will use hollow trees, snags, and logs for feeding, dens, or rest sites (Anthony et al. 1987, Thomas 1979). Squirrels and chipmunks cache western hemlock and other conifer cones for winter feeding. Beaver are important only where stands are located along lower gradient channels. They may occasionally use conifer limbs for nearby dam construction, and they have been observed eating western redcedar and grand fir bark, probably as a food of last resort.

Various woodpeckers, yellow-bellied sapsuckers, and Vaux's swifts use hollow trees and snags on these sites for nesting, feeding, and roosting (McClelland 1980). Woodpeckers forage for ants. The northern spotted owl can be found in forest dominated by large western hemlock on the Wenatchee NF and near Ross Lake. These stands also serve as important habitat for barred owls and goshawks

(Allen 1987). (For more information on thermal or feeding cover values, see apps. B-2 and B-3. For information on food values or degree of use, see apps. B-2 and B-4.)

Fish. The TSHE series play important roles in maintaining good fisheries habitat. The high tree productivity associated with most of these sites provides ample amounts of large woody debris, primarily large-diameter logs, which provide good fish habitat (structure) in streams. Most TSHE sites are located along high-energy Rosgen A and B channels, and the contribution of large woody debris helps maintain channel and streambank stability, particularly during peak flows. (For more information, see app. B-5, erosion control potential.) In addition, the tree canopy provides shade for the streams, helping regulate water temperatures. If managers maintain healthy, vigorous stands of TSHE and associated series along streams, these buffer strips help stabilize streambanks, form a barrier to sedimentation from nearby slopes, and provide large down wood for the stream and nearby fluvial surfaces.

Recreation—

Old-growth stands of western hemlock and western redcedar are valued for their big trees and general attractiveness (Hansen et al. 1995). Despite this, many are not well suited for recreation owing to high water tables or seeps and springs. Loamy textures and low gravel content, and organic soils in some cases, make most sites highly susceptible to foot or vehicle compaction, especially when soil moisture is high. Wetter sites may require wood boardwalks to prevent trampling of vegetation and soils. Construction and maintenance of campgrounds, roads, and trails is not recommended except on well-drained terraces. TSHE sites also are prone to windthrow of western redcedar, western hemlock, grand fir, and Engelmann spruce owing to shallow rooting systems, wet soils, and root rot infestations.

Insects and Disease—

The most common pathogens found on TSHE sites are decay fungi. Large trees with root, butt, and trunk rot are common. Hessburg et al. (1994) noted four diseases as primary influences in both historical and current forests: laminated root rot, armillaria root rot, annosus root disease, and brown cubical rot. Laminated root rot was especially common in early- and mid-seral stands dominated by Douglas-fir and grand fir, where trees of all ages were killed. Western hemlock shows little effect until maturity, when butt defects develop. Dwarf mistletoe can be a major cause of mortality in western larch, particularly where western larch is a major component of the stand.

Potential problems with insects usually are minimal on TSHE sites, but they do exist. Western hemlock hosts a variety of insect pests, such as the Steremnius weevil, western larch borer, western black-headed budworm, western hemlock looper, green striped forest looper, saddleback looper, and hemlock sawfly (Packee 1990). The western hemlock looper, a potential defoliator, has caused more mortality of western hemlock than any other insect pest. Drier sites supporting Douglas-fir may be prone to attack by budworm and Douglas-fir beetle.

Estimating Vegetation Potential on Disturbed Sites—

Estimating vegetation potential on disturbed sites is generally not needed as these sites are seldom disturbed. Wetter associations in the SALIX, COST, ALSI, and ALIN series often isolate TSHE stands from active flood zones and associated disturbance. Past clearcutting in riparian areas has been unusual on FS lands in eastern Washington. Even when clearcut, western redcedar, western hemlock, grand fir, Douglas-fir, Engelmann spruce, and other conifers often rapidly regenerated on these productive sites. Riparian zones on NF lands are currently protected from management-created disturbances by buffers and not managed for timber. Estimation to help determine the potential in young stands can be gauged by comparison with similar valley segments in nearby drainages.

Sensitive Species—

Black snake-root was found on two TSHE/ASCA3 association plots on the Colville NF. No other sensitive species were found on TSHE series plots, although *Botrychium* species have been found on the dense duff below mature western hemlock/western redcedar stands. (For more information, see app. D.)

ADJACENT SERIES

The ABAM and TSME adjoin the TSHE series at higher elevations (colder, wetter sites) on the Wenatchee and Okanogan NFs, and ABLA2 series adjoins it on the Colville NF. The TSHE, ABGR, or PSME series usually adjoin it on warmer sites at lower elevations. The ALIN, ALSI, and SALIX series often separate the TSHE series from the nearby stream.

RELATIONSHIPS TO OTHER CLASSIFICATIONS

Kovalchik (1992c) described many of the riparian/wetland plant associations in the TSHE series in the draft classification for northeast Washington. Riparian plant associations described in the TSHE series represent relatively wet stand conditions for western hemlock plant associations previously described for uplands on the Wenatchee NF by Lillybridge et al. (1995) and the Colville NF by Williams et al. (1995). They focused on upland environments but included several plant associations located primarily in riparian and wetland zones. Some of the associations in this classification derived from Lillybridge et al. (1995) and Williams et al. (1995)

include: TSHE/ACTR-WEN, TSHE/ARNU3, TSHE/CLUN, and TSHE/GYDR. The TSHE/ACCI association represents parts of the Wenatchee NF's TSHE/ACCI/CLUN, TSHE/ACCI/ACTR, and TSHE/ACCI/ASCA3 associations. The TSHE/ATFI and TSHE/OPHO associations are both included within THPL/OPHO in the forest classifications by Lillybridge et al. (1995) and Williams et al. (1995). The TSHE/OPHO and THPL/OPHO series were separately classified in this document to discriminate between sites dominated at climax by both western redcedar and western hemlock and those supporting just western redcedar. The TSHE/ATFI series is very similar to the THPL/ATFI habitat type described by Cooper et al. (1991) for northern Idaho.

The TSHE series has been described in the Washington Cascade Range (Diaz and Mellen 1996, Henderson et al. 1989, Henderson et al. 1992, Lillybridge et al. 1995, and Topik et al. 1986); in northeastern Washington, northern Idaho, and Montana (Cooper et al. 1991, Daubenmire and Daubenmire 1968, Hansen et al. 1988, Hansen et al. 1995, Pfister et al. 1977, and Williams et al. 1995); and in British Columbia (Braumandl and Curran 1992, Lloyd et al. 1990, and Meidinger and Pojar 1991).

U.S. DEPARTMENT OF THE INTERIOR, FISH AND WILDLIFE SERVICE WETLANDS CLASSIFICATION

System:	palustrine
Class:	forested wetland
Subclass:	needle-leaved evergreen
Water regime:	(nontidal) intermittently saturated to intermittently flooded

KEY TO THE WESTERN HEMLOCK *(TSUGA HETEROPHYLLA)* PLANT ASSOCIATIONS

1. Skunk cabbage (*Lysichiton americanus*) ≥5 percent canopy coverage .... **Western hemlock/skunk cabbage (TSHE/LYAM) association**
2. Devil's club (*Oplopanax horridum*) ≥5 percent canopy coverage .... **Western hemlock/devil's club (TSHE/OPHO) association**
3. Lady fern (*Athyrium filix-femina)* ≥5 percent canopy coverage .... **Western hemlock/lady fern (TSHE/ATFI) association**
4. Oak fern (*Gymnocarpium dryopteris)* and/or five-leaved bramble (*Rubus pedatus*) ≥5 percent canopy coverage; sites located east of the Okanogan River .... **Western hemlock/oak fern (TSHE/GYDR) association**
5. Vine maple (*Acer circinatum*) ≥5 percent canopy coverage .... **Western hemlock/vine maple (TSHE/ACCI) association**
6. Wild ginger (*Asarum caudatum*) and lady fern (*Athyrium filix-femina*) ≥1 percent canopy coverage; site located west of the Okanogan River .... **Western hemlock/wild ginger (TSHE/ASCA3) association**
7. Deerfoot vanilla-leaf (*Achlys triphylla*) ≥2 percent canopy coverage .... **Western hemlock/deerfoot vanilla-leaf (TSHE/ACTR) association**
8. Wild sarsaparilla (*Aralia nudicaulis*) and/or wild ginger (*Asarum caudatum*) ≥2 percent canopy coverage; site located east of the Okanogan River .... **Western hemlock/wild sarsaparilla (TSHE/ARNU3) association**
9. Queencup beadlily (*Clintonia uniflora*), myrtle pachistima (*Pachistima myrsinites*) and/or round-leaved violet (*Viola orbiculata*) ≥1 percent canopy coverage .... **Western hemlock/queencup beadlily (TSHE/CLUN) association**

Table 3—Constancy and mean cover of important plant species in the TSHE plant associations

		TSHE/ACCI 19 plots		TSHE/ACTR-WEN 14 plots		TSHE/ARNU3 6 plots		TSHE/ASCA3 2 plots		TSHE/ATFI 15 plots		TSHE/CLUN 6 plots		TSHE/GYDR 24 plots		TSHE/LYAM 2 plots		TSHE/OPHO 29 plots	
Species	Code	CON[a]	COV[b]	CON	COV	CON	COV	CON	COV	CON	COV	CON	COV	CON	COV	CON	COV	CON	COV
Tree overstory:																			
Pacific silver fir	ABAM	—	—	—	—	—	—	50	5	7	1	—	—	—	—	50	3	—	—
grand fir	ABGR	63	19	79	21	67	24	50	10	33	16	50	22	50	12	—	—	62	10
subalpine fir	ABLA2	11	10	—	—	33	4	—	—	40	6	50	9	29	4	50	3	21	2
western larch	LAOC	21	11	50	8	17	25	—	—	13	2	33	23	25	11	50	2	7	5
Engelmann spruce	PIEN	11	1	36	14	33	1	—	—	73	10	33	9	54	11	100	17	24	9
lodgepole pine	PICO	16	8	21	6	17	1	—	—	—	—	17	5	4	30	—	—	7	2
western white pine	PIMO	37	5	43	5	17	20	—	—	13	5	83	2	33	3	50	2	10	2
Douglas-fir	PSME	89	19	93	21	33	13	50	35	13	4	67	8	25	8	—	—	45	9
western redcedar	THPL	74	21	71	18	100	38	100	43	87	28	83	24	92	32	100	21	93	32
western hemlock	TSHE	84	21	86	17	100	13	100	18	100	28	100	24	100	29	100	23	100	25
Tree understory:																			
Pacific silver fir	ABAM	16	1	21	2	—	—	50	3	—	—	—	—	—	—	50	1	7	1
grand fir	ABGR	68	6	86	7	83	4	50	1	33	2	50	4	50	4	50	Tr[c]	41	1
subalpine fir	ABLA2	16	4	14	8	—	—	—	—	40	1	33	3	17	3	100	2	10	1
Engelmann spruce	PIEN	16	2	21	5	—	—	—	—	33	2	—	—	25	2	50	Tr	14	Tr
western redcedar	THPL	89	4	71	8	100	12	50	1	87	4	83	14	88	7	100	6	83	6
western hemlock	TSHE	79	5	93	4	83	7	50	6	93	9	100	9	100	5	100	4	93	5
Shrubs:																			
vine maple	ACCI	100	23	21	1	—	—	50	2	—	—	—	—	—	—	—	—	28	18
Douglas maple	ACGLD	16	4	—	—	67	7	—	—	13	2	67	3	25	2	—	—	28	1
mountain alder	ALIN	—	—	—	—	17	3	—	—	7	5	17	Tr	4	1	50	6	17	3
Sitka alder	ALSI	5	1	7	10	—	—	—	—	27	9	17	4	4	3	—	—	7	1
red-osier dogwood	COST	16	13	7	Tr	33	2	—	—	20	1	—	—	4	2	—	—	24	2
Utah honeysuckle	LOUT	—	—	—	—	50	1	—	—	53	2	83	2	63	2	—	—	31	Tr
rusty menziesia	MEFE	—	—	7	1	—	—	50	1	40	6	—	—	33	6	50	7	10	1
devil's club	OPHO	16	2	—	—	33	1	100	1	13	2	17	Tr	25	1	50	Tr	100	15
Cascade azalea	RHAL	—	—	—	—	—	—	—	—	20	7	17	Tr	13	4	50	Tr	—	—
prickly currant	RILA	11	4	43	2	33	2	—	—	47	2	33	2	33	2	50	6	66	1
baldhip rose	ROGY	74	3	93	4	83	2	—	—	13	3	67	3	21	2	50	2	31	1
western thimbleberry	RUPA	42	2	50	1	83	2	—	—	60	3	83	2	42	4	50	1	41	1
salmonberry	RUSP	21	1	7	2	—	—	—	—	—	—	—	—	—	—	50	2	21	2
common snowberry	SYAL	—	—	36	2	67	2	—	—	7	Tr	17	4	13	1	—	—	14	2
big huckleberry	VAME	53	3	93	2	50	2	50	2	87	5	67	2	67	4	100	1	55	1
Low shrubs and subshrubs:																			
Oregon hollygrape	BEAQ	—	—	14	4	50	2	—	—	—	—	50	2	—	—	—	—	7	Tr
Cascade hollygrape	BENE	79	6	79	11	—	—	100	2	7	4	17	3	—	—	100	1	21	2
little prince's-pine	CHME	32	2	21	1	—	—	50	1	—	—	17	2	4	1	—	—	10	2
western prince's-pine	CHUMO	63	3	71	2	50	2	50	1	20	1	67	3	4	Tr	100	2	24	1
bunchberry dogwood	COCA	37	12	21	4	83	2	50	1	13	2	33	2	8	11	—	—	17	1
slender wintergreen	GAOV	37	1	29	3	—	—	100	2	—	—	17	Tr	—	—	100	3	3	5
twinflower	LIBOL	68	12	86	7	100	6	100	6	47	4	83	8	75	5	100	4	59	1
myrtle pachistima	PAMY	68	7	86	4	33	3	100	3	53	1	83	2	50	2	50	2	48	1
dwarf bramble	RULA	21	3	36	1	—	—	50	10	—	—	—	—	—	—	50	4	10	1
five-leaved bramble	RUPE	—	—	—	—	—	—	—	—	60	7	—	—	38	7	—	—	17	Tr
Pacific blackberry	RUUR	63	3	43	3	—	—	—	—	—	—	—	—	—	—	—	—	10	2

Table 3—Constancy and mean cover of important plant species in the TSHE plant associations (continued)

		TSHE/ACCI 19 plots		TSHE/ACTR-WEN 14 plots		TSHE/ARNU3 6 plots		TSHE/ASCA3 2 plots		TSHE/ATFI 15 plots		TSHE/CLUN 6 plots		TSHE/GYDR 24 plots		TSHE/LYAM 2 plots		TSHE/OPHO 29 plots	
Species	**Code**	**CON**	**COV**	**CON**	**COV**	**CON**	**COV**	**CON**	**COV**	**CON**	**COV**	**CON**	**COV**	**CON**	**COV**	**CON**	**COV**	**CON**	**COV**
Perennial forbs:																			
deerfoot vanilla-leaf	ACTR	63	8	100	22	—	—	—	—	7	45	—	—	—	—	—	—	14	6
baneberry	ACRU	11	1	21	1	50	1	—	—	40	1	50	Tr	25	1	100	1	55	1
pathfinder	ADBI	37	1	64	2	50	2	—	—	40	2	50	1	42	3	—	—	52	1
wild sarsaparilla	ARNU3	—	—	—	—	83	18	—	—	—	—	—	—	13	2	—	—	14	1
heartleaf arnica	ARCO	—	—	29	2	17	1	—	—	—	—	—	—	4	1	50	7	3	Tr
wild ginger	ASCA3	26	2	14	1	67	3	100	2	13	Tr	—	—	38	5	—	—	69	4
queencup beadlily	CLUN	74	5	79	6	83	3	50	3	100	2	83	3	92	5	50	Tr	93	3
Hooker's fairy-bells	DIHO	21	1	7	1	50	1	—	—	33	3	33	Tr	50	2	—	—	48	1
sweetscented bedstraw	GATR	32	1	21	2	83	2	—	—	67	1	67	Tr	67	1	50	Tr	83	1
western rattlesnake plantain	GOOB	84	2	86	2	33	2	50	2	33	2	83	1	58	2	—	—	45	1
skunk cabbage	LYAM	5	3	—	—	17	Tr	—	—	—	—	—	—	4	1	100	13	14	1
arctic butterbur	PEFR2	5	2	—	—	—	—	—	—	—	—	—	—	—	—	50	25	—	—
pink wintergreen	PYAS	42	2	29	1	33	2	50	1	20	4	—	—	17	3	50	1	28	1
sidebells pyrola	PYSE	47	1	79	2	—	—	50	2	33	3	67	2	42	2	50	2	34	1
arrowleaf groundsel	SETR	—	—	14	2	—	—	—	—	47	1	17	Tr	25	1	50	Tr	31	1
starry solomonplume	SMST	58	2	50	2	83	4	100	1	60	2	50	3	63	4	100	2	62	3
claspleaf twisted-stalk	STAM	11	Tr	7	6	33	Tr	—	—	87	1	33	1	58	2	50	Tr	76	1
rosy twisted-stalk	STRO	16	2	7	Tr	—	—	—	—	13	2	17	Tr	4	1	50	Tr	7	1
coolwort foamflower	TITRU	32	2	57	2	83	4	50	6	100	5	67	2	96	5	100	3	97	3
false bugbane	TRCA3	5	2	21	1	—	—	—	—	27	1	—	—	21	2	50	Tr	14	3
broadleaf starflower	TRLA2	53	4	21	4	—	—	—	—	—	—	—	—	—	—	—	—	7	8
white trillium	TROV	84	2	93	2	83	1	50	2	67	1	33	1	75	1	100	1	72	1
Sitka valerian	VASI	—	—	7	1	—	—	50	2	—	—	—	—	—	—	50	30	—	—
pioneer violet	VIGL	16	1	36	1	—	—	50	1	33	2	—	—	25	2	—	—	34	2
round-leaved violet	VIOR2	21	2	21	3	50	2	50	5	33	4	50	4	71	3	—	—	17	1
Grasses or grasslike:																			
brome species	BROMU	5	1	14	1	33	2	—	—	27	2	17	2	4	5	—	—	3	Tr
soft-leaved sedge	CADI	—	—	—	—	—	—	—	—	13	Tr	—	—	—	—	50	3	—	—
tall mannagrass	GLEL	—	—	—	—	—	—	—	—	—	—	—	—	—	—	50	1	7	1
Ferns and fern allies:																			
lady fern	ATFI	11	2	14	2	33	3	50	2	100	13	33	Tr	79	2	100	18	90	7
oak fern	GYDR	26	1	7	1	17	2	—	—	100	11	—	—	100	14	—	—	79	6
sword fern	POMU	21	1	7	5	17	1	—	—	13	Tr	17	Tr	17	1	—	—	34	1
western brackenfern	PTAQ	68	2	29	3	17	Tr	—	—	—	—	17	Tr	4	1	50	2	14	1

[a] CON = percentage of plots in which the species occurred.
[b] COV = average canopy cover in plots in which the species occurred.
[c] Tr = trace cover, less than 1 percent canopy cover.

WESTERN REDCEDAR SERIES

Thuja plicata

THPL N = 89

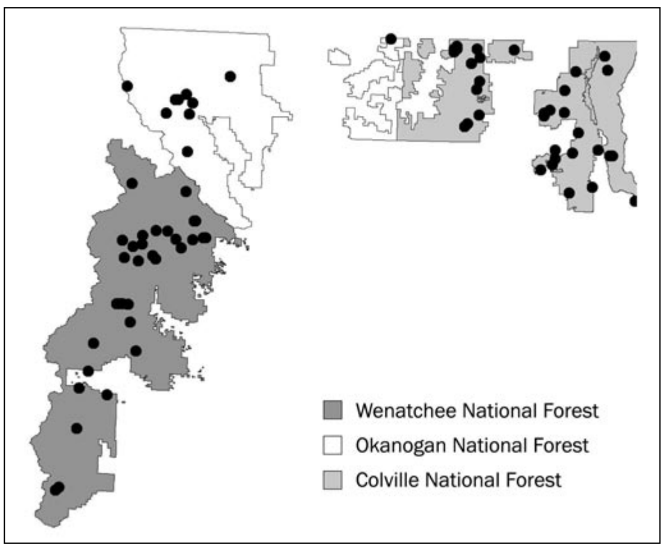


Figure 10—Plot locations for the western redcedar series.

WESTERN REDCEDAR[1] is a long-lived conifer that can reach 800 to 1,000 years in age (Williams et al. 1995). The species has two separate coastal and interior distributions. The coastal distribution occurs along the Pacific coast from the Alaska Panhandle south through British Columbia, western Washington, western Oregon, and the redwood forests of California. Inland areas extend in a continuous band along the east side of the Cascade Range from southern British Columbia to northern central Oregon (Arno and Hammerly 1984, Minore 1990). A disjunct population occurs much farther inland along the west slopes of the Rocky Mountains from Prince George, British Columbia, to northeast Washington, northern Idaho, and western Montana. Within this range, western redcedar occurs on a variety of sites, including wetland, riparian, and upland sites.

Western redcedar ranks second only to western hemlock as the most shade-tolerant conifer on the Colville NF (Williams et al. 1995). The shade tolerance of western redcedar is outranked by mountain hemlock, Pacific silver fir, and western hemlock on the Wenatchee NF (Lillybridge et al. 1995). Like mountain hemlock, Pacific silver fir, and western hemlock, the distribution of western redcedar is dependent on maritime and inland maritime climatic patterns. Average annual precipitation at western redcedar sites is generally greater than 25 inches per year.

Therefore, the THPL series (where redcedar is the indicated climax dominant) occurs only on that part of the species' range that is beyond the environmental or geographic range of mountain hemlock, Pacific silver fir, and western hemlock. Only minor amounts of mountain hemlock, Pacific silver fir, and western hemlock are acceptable in the THPL series. On the Colville NF, western redcedar tolerates warmer temperatures and both wetter and drier conditions compared with sites dominated by western hemlock (Minore 1979). The THPL series can be said to occupy sites that are marginal or beyond the environmental or geographic range of the TSHE series (Williams et al. 1995). The THPL series also has a bimodal moisture distribution on the Colville NF. At one end it characterizes sites too dry to support the TSHE series but which are somewhat moister than the ABGR series. Root penetration of western redcedar is better than that of western hemlock, perhaps allowing it to survive in somewhat warmer, drier locations (Burns and Honkala 1990). The THPL series also tolerates moderately wet sites where western hemlock is usually, but not always, a climax codominant. The upland forest classification for the Colville NF (Williams et al. 1995) follows Daubenmire and Daubenmire (1968) and Pfister et al. (1977) in assigning these wet habitats to the THPL/OPHO association, which is part of the THPL series. However, this study added additional plots to the database and elected to distinguish between sites clearly successional to western redcedar climax versus those successional to western hemlock (with western redcedar as a co-climax species). Thus associations such as THPL/OPHO (Williams et al. 1995) have been split into both THPL/OPHO and TSHE/OPHO associations based on the authors' interpretation of climax overstory potential.

The requirements for the THPL series are somewhat different on the Wenatchee and Okanogan NFs. Western redcedar is one of the most shade-tolerant yet environmentally restricted conifers on these NFs. Few plots attributable to western redcedar climax were available in the previous classifications for upland forests (Lillybridge et al. 1995); thus that guide collapsed the few plots dominated by western

[1] See appendix A for a cross reference for all species codes and common and scientific names used in this document.

Western redcedar plant associations

	Scientific name	Common name	Ecoclass code	Plots
Major associations:				
THPL/ACCI	*Thuja plicata/Acer circinatum*	Western redcedar/vine maple	CCS511	6
THPL/ARNU3	*Thuja plicata/Aralia nudicaulis*	Western redcedar/wild sarsaparilla	CCF222	14
THPL/ATFI	*Thuja plicata/Athyrium filix-femina*	Western redcedar/lady fern	CCF121	13
THPL/GYDR	*Thuja plicata/Gymnocarpium dryopteris*	Western redcedar/oak fern	CCF224	13
THPL/OPHO	*Thuja plicata/Oplopanax horridum*	Western redcedar/devil's club	CCS211	17
THPL/PAMY/CLUN	*Thuja plicata/Pachistima myrsinites/ Clintonia uniflora*	Western redcedar/myrtle pachistima/ queencup beadlily	CCS312	11
Minor associations:				
THPL/ACTR	*Thuja plicata/Achlys triphylla*	Western redcedar/deerfoot vanilla-leaf	CCF212	2
THPL/ALIN	*Thuja plicata/Alnus incana*	Western redcedar/mountain alder	CCS411	3
THPL/ASCA3	*Thuja plicata/Asarum caudatum*	Western redcedar/wild ginger	CCF223	3
THPL/CLUN	*Thuja plicata/Clintonia uniflora*	Western redcedar/queencup beadlily	CCF221	2
THPL/EQUIS	*Thuja plicata/Equisetum* species	Western redcedar/horsetail species	CCM411	3
THPL/VAME	*Thuja plicata/Vaccinium membranacium*	Western redcedar/big huckleberry	CCS311	2

redcedar into its closest relative, the TSHE series. However, additional data indicate the THPL series clearly exists and should be separately recognized for riparian and wetland zones on the Okanogan and Wenatchee NFs. The best development of the THPL series is in areas of maritime climate where Pacific silver fir, mountain hemlock, and western hemlock are poorly represented or absent. Here, just as on the Colville NF, the THPL series usually lies in an environmental position intermediate between the TSHE and ABGR series. The TSME and ABAM series prefer much stronger maritime environments. In addition, western hemlock, Pacific silver fir, and mountain hemlock are largely absent in the extensive continental climate zones found north of the Entiat River and east of the Cascade crest (to the Kettle Mountain crest). Within this zone, scattered stands belonging to the THPL series are found on a limited number of riparian sites, usually within uplands dominated by the PSME and ABLA2 series.

CLASSIFICATION DATABASE

The THPL series includes all closed-forest stands potentially dominated by western redcedar at climax. The THPL series was sampled on all three NFs and all RDs in eastern Washington (fig. 10). Sixty-four riparian and wetland plots were sampled in the THPL series. Data from an additional 25 plots from previous ecology sampling were included to increase the data set for the THPL series, help facilitate classification, and provide additional information for species composition, distribution, and elevation. From this database, six major and six minor plant associations are recognized. The THPL/ACCI, THPL/ASCA3, THPL/ACTR, and THPL/PAMY/CLUN associations are limited to the Cascade Range, whereas the THPL/CLUN and THPL/ARNU3 associations are only found well east of the Okanogan River. The remaining associations are found throughout the study area. Two potential one-plot associations (THPL/COST and THPL/MEFE) are not used in the data nor described in this classification. However, the THPL/MEFE association is described in the upland forest classification for the Colville NF (Williams et al. 1995). For the most part, the samples used in the THPL series represent mature stands in late-seral to climax conditions.

VEGETATION CHARACTERISTICS

The THPL series exhibits high species diversity owing to its inherent site amplitude. Mature stands are dominated by large, long-lived western redcedar. More shade-tolerant trees such as mountain hemlock, Pacific silver fir, or western hemlock are absent or accidental and, if present, are clearly reproducing less successfully than western redcedar. Grand fir, Douglas-fir, western larch, and Engelmann spruce may be present as scattered large individuals in old stands. The understory of mature stands is usually dominated by western redcedar, with lesser amounts of grand fir, Douglas-fir, and Engelmann spruce. The composition of seral stands varies by association and stand history (especially fire history) but usually includes grand fir, Douglas-fir, and Engelmann spruce. Ponderosa pine, although unusual, may be seral on warmer sites, whereas western larch often dominates stands originating after stand-replacement fire. Also, dog hair western redcedar stands originated after the fires of the early 1900s.

Shrubs are common. Their composition and abundance vary by association. The primary indicator species are vine maple, mountain alder, devil's club, myrtle pachistima, and big huckleberry. Other common shrubs include Saskatoon serviceberry, common snowberry, twinflower, Douglas maple, baldhip rose, and western thimbleberry on moist sites; Sitka alder and prickly currant on wetter sites.

Indicator herbs include deerfoot vanilla-leaf, wild sarsaparilla, wild ginger, lady fern, oak-fern, horsetails (especially common horsetail), and queencup beadlily. Other herbs include sweetscented bedstraw, sidebells pyrola, and starry solomonplume on moist sites; baneberry, claspleaf twistedstalk, and coolwort foamflower on wetter sites.

PHYSICAL SETTING

Elevation—

The THPL series occurs at moderately low to moderate elevations in eastern Washington. Elevation differences between NFs are insignificant and range from 1,760 to 4,650 feet (2,845 feet average), although the majority of riparian sites are below 3,000 feet. This contrasts with the TSHE series, where the majority of samples are above 3,000 feet. Thus, riparian sites in the THPL series are generally lower in elevation and presumably warmer, although not necessarily drier, than sites in the TSHE series. As mentioned before, the THPL series is associated with moderate maritime or inland maritime climates. Precipitation is moderately high, temperatures are moderate, and summer drought is less severe compared with areas of continental climate.

	Elevation (feet)			
Forest	Minimum	Maximum	Average	N
Colville	2,200	4,650	2,880	40
Okanogan	1,850	4,360	2,991	15
Wenatchee	1,760	4,120	2,740	34
Series	1,760	4,650	2,845	89

The major exceptions to the 3,000-foot rule are the THPL/ACTR, THPL/ATFI, THPL/GYDR, and THPL/VAME associations.

	Elevation (feet)			
Plant association	Minimum	Maximum	Average	N
THPL/VAME	3,630	4,360	3,995	2
THPL/GYDR	2,320	4,050	3,176	13
THPL/ACTR	2,200	4,140	3,170	2
THPL/ATFI	2,300	4,650	3,061	13
THPL/PAMY/CLUN	2,020	3,400	2,844	11
THPL/ASCA3	2,200	3,400	2,793	3
THPL/OPHO	1,850	3,630	2,775	17
THPL/EQUIS	2,550	2,950	2,767	3
THPL/ARNU3	2,200	3,300	2,592	14
THPL/ACCI	1,960	3,130	2,582	6
THPL/CLUN	2,240	2,500	2,370	2
THPL/ALIN	1,760	2,280	2,060	3
Series	1,760	4,650	2,859	89

Valley Geomorphology—

Plots in the THPL series are located in a variety of valley width and valley gradient classes. The most common valley landforms are broad to narrow valleys with low to moderate valley gradient. Still, no patterns are clear for the THPL series as a whole.

	Valley gradient					
Valley width	Very low	Low	Moderate	Steep	Very steep	N
Very broad	3	3	0	0	0	6
Broad	2	9	1	0	0	12
Moderate	1	9	5	5	3	23
Narrow	0	4	6	2	3	15
Very narrow	0	0	0	2	6	8
Series total	6	25	12	9	12	64

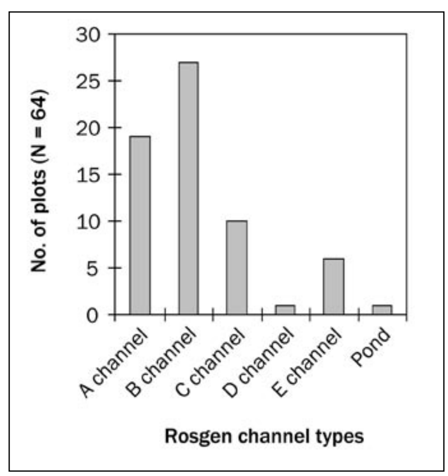
Looking at valley configuration by individual associations is not very helpful. The THPL/ACCI, THPL/ALIN, and THPL/EQUIS associations appear to favor relatively wide and gentle valleys. However, three plots per association is not a satisfactory sample size for making these conclusions. The other associations have more plots but still occur on a variety of valley landforms. Apparently valley configuration is less important than site location, climate, or hydrology.

	Valley width					
Plant association	Very broad	Broad	Moderate	Narrow	Very narrow	N
THPL/ACCI	2	0	1	0	0	3
THPL/ACTR	0	0	1	0	0	1
THPL/ALIN	1	1	0	1	0	3
THPL/ARNU3	1	1	3	1	0	6
THPL/ATFI	0	3	3	1	3	10
THPL/CLUN	0	0	1	0	1	2
THPL/EQUIS	0	2	0	1	0	3
THPL/GYDR	1	2	5	2	2	12
THPL/OPHO	1	2	5	5	0	13
THPL/PAMY/CLUN	0	0	4	4	2	10
THPL/VAME	0	1	0	0	0	1
Series total	6	12	23	15	8	64

	Valley gradient					
Plant association	Very low	Low	Moderate	Steep	Very steep	N
THPL/ACCI	1	1	1	0	0	3
THPL/ACTR	0	0	1	0	0	1
THPL/ALIN	0	2	1	0	0	3
THPL/ARNU3	1	2	2	0	1	6
THPL/ATFI	1	3	1	1	4	10
THPL/CLUN	0	0	0	2	0	2
THPL/EQUIS	2	1	0	0	0	3
THPL/GYDR	0	5	2	3	2	12
THPL/OPHO	1	5	4	1	2	13
THPL/PAMY/CLUN	0	5	0	2	3	10
THPL/VAME	0	1	0	0	0	1
Series total	6	25	12	9	12	64

Channel Types—

The THPL series plots are located along a variety of channel types. Rosgen A, B, and C channels predominate, which is typical for valleys with low to steep gradients. A few wetland plots are located in low-gradient valleys with E channels, lakes, and ponds.

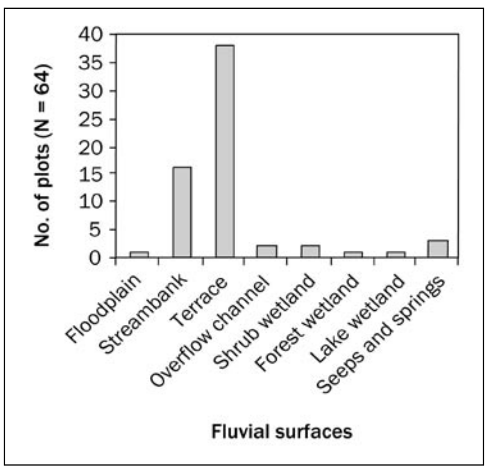


Additional insight can be gained by looking at the distribution of Rosgen channel types by plant association. With the exception of the THPL/EQUIS and THPL/OPHO associations, most associations are near Rosgen A, B, or C channels. Five of six E channels are associated with very low gradient valleys and wet associations (THPL/ATFI, THPL/OPHO, and THPL/EQUIS).

	Rosgen channel types						
Plant association	A	B	C	D	E	Pond	N
THPL/ACCI	0	2	1	0	0	0	3
THPL/ACTR	0	1	0	0	0	0	1
THPL/ALIN	1	1	1	0	0	0	3
THPL/ARNU3	1	3	1	0	1	0	6
THPL/ATFI	4	5	0	0	1	0	10
THPL/CLUN	2	0	0	0	0	0	2
THPL/EQUIS	0	0	1	0	1	1	3
THPL/GYDR	5	7	0	0	0	0	12
THPL/OPHO	2	6	1	1	3	0	13
THPL/PAMY/CLUN	4	2	4	0	0	0	10
THPL/VAME	0	0	1	0	0	0	1
Series total	19	27	10	1	6	1	64

Fluvial Surfaces—

Eighty percent of the THPL series plots are located in riparian zones on moist, well-drained streambanks and terraces. A small percentage of sites are located on wetter floodplains, overflow channels, wetlands, seeps, and springs.

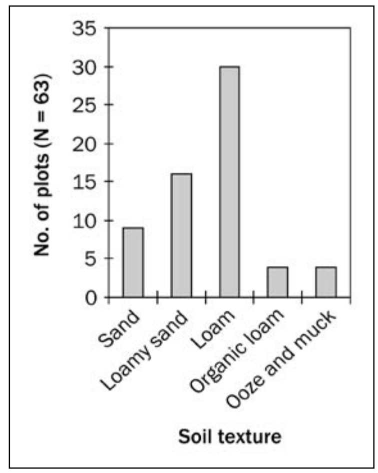


Additional insight can be gained by looking at the distribution of fluvial surfaces by plant associations. Most associations are best represented on streambanks and terraces. However, in the case of the THPL/ATFI, THPL/EQUIS, and THPL/OPHO associations, some sites are located on wetlands. The THPL/ALIN association occurs on active fluvial surfaces such as overflow channels, floodplains, and streambanks that are subject to periodic flooding.

	Fluvial surfaces					
Plant association	Stream-bank	Terrace	Overflow channel	Seeps/ springs	Other	N
THPL/ACCI	0	3	0	0	0	3
THPL/ACTR	0	1	0	0	0	1
THPL/ALIN	2	1	0	0	0	3
THPL/ARNU3	1	4	0	0	1	6
THPL/ATFI	4	4	0	1	1	10
THPL/CLUN	1	1	0	0	0	2
THPL/EQUIS	0	1	0	0	2	3
THPL/GYDR	4	8	0	0	0	12
THPL/OPHO	2	7	2	1	1	13
THPL/PAMY/CLUN	2	7	0	1	0	10
THPL/VAME	0	1	0	0	0	1
Series total	16	38	2	3	5	64

Soils—

The THPL series plots are dominated by mineral soils with loamy sand and loam textures. Sand textures are less common, presumably occurring on active fluvial surfaces such as streambanks, floodplains, and overflow channels. A few wet sites had organic loam and muck soils.



Additional insight is gained by looking at soil texture by plant association. Some soils in the wettest associations (THPL/OPHO, THPL/EQUIS, and THPL/ATFI) are classified as organic loams, ooze, or muck. However, most associations are found on loam and loamy sand-textured soils. The frequently flooded THPL/ALIN association is most common on sand-textured soils.

	Soil texture					
Plant association	Sand	Loamy sand	Loam	Organic loam	Ooze/ muck	N
THPL/ACCI	0	2	1	0	0	3
THPL/ACTR	0	1	0	0	0	1
THPL/ALIN	2	0	1	0	0	3
THPL/ARNU3	1	2	3	0	0	6
THPL/ATFI	0	1	6	2	1	10
THPL/CLUN	0	0	2	0	0	2
THPL/EQUIS	0	0	1	0	2	3
THPL/GYDR	2	3	6	1	0	12
THPL/OPHO	1	3	6	1	1	12
THPL/PAMY/CLUN	3	3	4	0	0	10
THPL/VAME	0	1	0	0	0	1
Series total	9	16	30	4	4	63

Water table measurements at the time of sampling were variable, depending on association. The THPL/EQUIS and THPL/ATFI associations are easily the wettest sites, with THPL/OPHO a close third. The data associated with THPL/ALIN are due to the sample season as these sites may be temporarily saturated or even flooded at peak runoff (before sampling). The rest of the associations are generally restricted to well-drained terraces and deeper water tables. Water table depths are not available for the THPL/CLUN, THPL/ACCI, and THPL/VAME associations.

	Water table (inches)			
Plant association	Minimum	Maximum	Average	N
THPL/EQUIS	-20	-3	-9	3
THPL/ATFI	-28	0	-11	10
THPL/OPHO	-35	-9	-17	10
THPL/GYDR	-35	-12	-23	7
THPL/ARNU3	-35	-20	-26	3
THPL/PAMY/CLUN	-77	-7	-33	5
THPL/ALIN	-47	-22	-35	2
Series	-77	0	-20	40

Soil temperature at the time of sampling (degrees Fahrenheit) also varies by association. The THPL/ALIN sites are warm because the young, open stands of alder allow the sun to directly strike sand, gravel, and cobble soil surfaces. The causal effects creating the other average soil temperatures are unknown. The higher elevation associations appear to be cooler.

	Soil temperature (°F)			
Plant association	Minimum	Maximum	Average	N
THPL/ALIN	58	67	62	3
THPL/ACCI	52	60	56	3
THPL/PAMY/CLUN	47	65	55	10
THPL/EQUIS	53	56	54	3
THPL/OPHO	43	57	51	11
THPL/GYDR	44	55	51	10
THPL/ATFI	36	63	48	9
THPL/ARNU3	42	52	47	3
Series	36	67	52	52

ECOSYSTEM MANAGEMENT

Natural Regeneration of Western Redcedar—

Western redcedar reproduces from seed and vegetatively (Arno and Hammerly 1984, Edwards and Leadem 1988, Habeck and Mutch 1973). Vegetative regeneration may occur by layering; rooting of live, fallen branches that have been torn off by wind or snow; and rooting along the trunks of fallen, living trees. Seed production begins at about 10 years of age in open stands and 20 to 30 years in closed stands (Turner 1985). Poor cone crops are rare, and large seed crops are produced every 3 to 4 years. The seeds are small, light, and wind dispersed, but generally fall within 400 feet of the parent tree. The seed germinates well without stratification and, with proper warehouse storage, remains viable for at least 7 years (Minore 1990). Germination occurs on a variety of sites, including heavily shaded duff seedbeds, rotten wood, and burned surfaces (Graham et al. 1988).

Seedling survival is low because of various factors such as fungi, birds, insects, and smothering by fallen leaves (Arno and Hammerly 1984, Krasowski and Owens 1991, Minore 1990). Drought and high soil temperatures will damage seedlings in full sunlight. Seedlings grow best in partial shade, although they may fail on heavily shaded sites because of slow root penetration. Seedlings grow very slowly; early annual height growth ranges from less than 1 inch in dense stands to more than 7 inches in partially shaded stands (Graham et al. 1988). They release well following removal of competing vegetation. Vegetative reproduction by layering is favored by closed stands, especially old-growth stands where the soil or rotten wood substrate is moist throughout the growing season (Fischer and Bradley 1987, Habeck 1963, Habeck and Mutch 1973).

Artificial Establishment of Western Redcedar and Associated Shrubs and Herbs—

Western redcedar is a valued timber species (Parish et al. 1996) and can be planted on disturbed sites within its range. It is suitable for planting on a variety of sites, ranging from mineral soils in mesic uplands to well-decomposed organic material on lowland sites (Hawkes et al. 1990). Nursery-grown container stock appears to perform better than bare rootstock (Graham et al. 1988). Direct seeding is possible where bare mineral soil is available. It is probably better to rely on the release of natural seedlings and saplings when using selection-cutting methods in riparian zones.

Many of the shrubs that characterize the THPL series are well adapted to planting on disturbed sites. Red-osier dogwood, mountain alder, myrtle pachistima, vine maple, and devil's club can be established from nursery stock, seed, cuttings, or layering. Prickly currants, Nootka and baldhip rose, and western thimbleberry can be easily grown from seed. Five-leaved bramble, bunchberry dogwood, and other trailing plants can be propagated from root runners. Huckleberry cuttings root poorly but can be established from seed although growth is slow. Common snowberry can be established from stem or root cuttings, nursery stock, or seed. Oak fern, lady fern, and horsetail species can be easily propagated from rhizomes. (For more information on the short- and long-term revegetation potential of selected riparian wetland plant species, see app. B-5.)

Stand Management—

Although tree productivity is high on these sites, tree harvesting and associated management activities need to be carefully planned. The high water tables and the presence of seeps and springs on wetter sites such as THPL/ATFI and THPL/OPHO preclude many timber management activities. Periodic flooding and scouring is a problem on THPL/ALIN sites or other associations that lie on active fluvial surfaces. Loam soils are very susceptible to compaction during most of the growing season. Many large western redcedar have extensive heart rot. Wetter sites also are susceptible to windthrow. Timber harvesting on these sites or adjacent sites that are upslope may increase the risk of windthrow and rising water tables. A clearcut adjacent to a small riparian zone could result in blowdown in the riparian zone.

The THPL series supports a variety of seral tree species including grand fir, Engelmann spruce, western larch, and Douglas-fir. Ponderosa pine may perform well on warmer associations such as THPL/CLUN, THPL/ARNU3, THPL/ASCA3, and THPL/ACTR. With the exception of Engelmann spruce, regeneration of these tree species will be difficult on the wettest sites owing to seasonally high water and competition from a variety of shrubs and herbs. Also, heavy browsing of western redcedar regeneration by snowshoe hares is a potential problem. Management options appear to be limited to single-tree or small-group selection with the objective of opening the canopy to increase understory production for other resources. It is preferable to schedule any management activity during late summer, early fall, or winter (on snowpack) to minimize soil disturbance.

Coarse-textured, compaction-resistant soils are unusual, except on more active fluvial sites such as THPL/ALIN. Loam soils predominate and are subject to compaction. Very sensitive organic soils are occasionally associated with the wetter associations. Machinery and livestock easily displace or otherwise damage these soils during periods of excessive soil moisture (Hansen et al. 1995). Poorly drained sites, streamside locations, or sites with organic soils should warrant special concern. Roads and trails generally should be located on the adjacent upland.

Tree Growth and Yield—

Moderate elevation, mild temperatures, and moderately high precipitation characterize the THPL series (Williams et al. 1995). Large, old-growth trees characterize some of the wetter associations. The THPL series is one of the most productive forested series in eastern Washington as indicated by high basal area (square feet per acre) and site index values. Basal area averages 286 square feet per acre, which is the highest value for any of the tree series (apps. C-1a and C-1b). Only the ABAM, PSME, and TSHE series are comparable. Similarly, average site index (feet) is high compared with other series (app. C-2). Tree productivity data are limited and should be viewed with caution.

Site index			
Species	Base age	No. of trees	SI
ABGR	50	22	75
ABLA2	50	4	65
LAOC	20	12	76
PIEN	20	51	78
PIPO	100	3	122
POTR2	80	2	142
PSME	50	53	77
THPL	100	86	87

Basal area (sq. ft./ac)	
Species	BA
ABGR	20
ABLA2	6
ACMA	Tr
ALRU	1
BEPA	1
LAOC	5
PICO	1
PIEN	48
PIMO	Tr
PIPO	4
POTR	1
POTR2	7
PSME	31
THPL	162
TSHE	1
Total	288

Down Wood—

The overall amount of down woody material on THPL sites is the highest of any forested tree series (app. C-3). Logs cover 14 percent of the ground surface. This reflects both the warm, moist (to wet) environment, which tends to support large-diameter trees and logs, and the prevalence of heart rot in western redcedar trees.

Definitions of log decomposition classes are on page 15.

	Down log attributes				
Log decomposition	Tons/ acre	Cu. ft./ acre	Linear ft./ acre	Sq. ft./ acre	% ground cover
Class 1	1.21	109	301	182	0.42
Class 2	7.62	837	1,018	850	1.95
Class 3	20.82	2,735	2,862	2,697	6.19
Class 4	3.15	799	1,033	938	2.15
Class 5	33.52	1,753	916	1,269	2.91
Total	66.32	6,233	6,130	5,936	13.62

Snags—

Similarly, the THPL series supports a high number of snags (40.9 snags per acre) compared with other tree series (app. C-4). Only the ABAM, ABLA2, and PIEN series, with 53.5, 54.3, and 41.3 snags per acre, respectively, exceed it. Most snags are between 5 and 15.5 inches in diameter and in condition classes 1 and 2.

Definitions of snag condition classes are on page 15.

	Snags/acre by d.b.h. class (inches)				
Snag condition	5–9.9	10–15.5	15.6–21.5	21.6+	Total
Class 1	4.4	2.6	1.2	0.5	8.7
Class 2	13.3	1.8	.5	.2	15.8
Class 3	.1	.8	1.4	.4	2.7
Class 4	3.8	4.5	0	1.1	9.4
Class 5	1.6	2.3	0	.4	4.3
Total	23.2	12.0	3.1	2.6	40.9

Fire—

Western redcedar has low to moderate resistance to fire (Fischer and Bradley 1987). Its susceptibility comes from its thin bark, shallow root system, low branching habit, and highly flammable foliage. Yet the frequency of fire in western redcedar stands tends to be low, especially in river bottoms (Boggs et al. 1990, Turner 1985). In riparian and wetland zones, the mean fire interval is generally considered greater than 200 years. Trees in younger stands are easily damaged by fire, whereas the large trees associated with mature stands tolerate it quite well as evidenced by deep multiple fire scars on cedar trees in older stands.

Although old-age stands support heavy fuel loads, much of this material is in the form of moist, deep duff and rotting wood. Riparian stringers may often act as firebreaks because the moist duff does not easily burn. Therefore, fires in older stands tend to be slow moving and do little damage to the cedars. However, once ignited, such fuels could support long-lasting fires, especially during severe drought periods.

Fire-return intervals on THPL riparian sites in eastern Washington are not well documented. However, western redcedar stands appear to be younger than stands in the TSHE, ABAM, and TSME series. Two hundred fifty-three site index trees were measured for age in the THPL series. These trees averaged 123 years in age at breast height. One hundred four trees were less than 100 years old, 117 were 100 to 199 years old, 20 were 200 to 299 years old, 9 were 300 to 399 years old, 2 were 500 to 599 years old, and 1 western redcedar was 600 years old. Of the 32 trees that were older than 199 years, 18 trees were western redcedar. Most stands appear to be less than 200 years old based on ages of site index trees. These data suggest that stand-replacing fire-return intervals in eastern Washington generally range from 100 to 199 years. Return intervals are likely longer for THPL stands in stronger maritime and inland maritime climates or in the wetter THPL associations. However, these data and interpretations may be misleading owing to the large number of stands that originated after the huge stand-replacing fires of the early 1900s. Natural fire-return intervals may actually be longer. In general, it is reasonable to expect that the present stand ages associated with the THPL series are more a reflection of the vast acres associated with the early 1900s fires. This is supported by the large numbers of large logs observed in these stands as well as the size of trees in stands that escaped the fires (and logging).

The fire regime of surrounding upland forests also may affect how often these riparian sites burn. In eastern Washington, riparian zones in the THPL series are quite often surrounded by drier Douglas-fir or grand fir uplands, at least on southerly aspects. These sites historically burned more frequently during the late-summer fire season. In the vicinity of the Kettle River Range, the THPL series is usually bound by the ABLA2 series on mid and upper north slopes. Most of these subalpine fir stands burned in the early 1900s and are presently dominated by lodgepole pine. It is reasonable to expect that these fires burned into adjacent western redcedar uplands and bottoms. These western redcedar sites may reflect shorter fire-return intervals than riparian zones that are adjacent to moister western redcedar/western hemlock uplands in maritime and inland maritime zones.

Animals—

Livestock. Both cattle and sheep browse western redcedar and can cause considerable damage to western redcedar regeneration (Minore 1983). However, in most cases, these cool, wet sites have little utility for domestic livestock except for shade or where forage production is high in early successional stages. Regeneration of conifers in clearcuts (before 1990) in riparian areas with cattle grazing allotments has been poor. In addition, shrub and herb composition has been highly altered, with a trend toward dominance by increaser and invader species such as Kentucky bluegrass and white clover. Cattle also graze and damage the streamside areas within the clearcuts. Sites are susceptible to trampling owing to high water tables and moist or wet soils. If grazed, modification of the grazing system, coupled with close monitoring of wildlife, often allows the remnant shrub and herb population to sprout and reinvade the stand. The ability to easily reestablish desired shrubs and herbs may be lost when they have been eliminated owing to overgrazing and the water table has been lowered because of streambed downcutting or lateral erosion. (For more information on forage palatability, see app. B-1. For potential biomass production, see app. B-5.)

Wildlife. Riparian zones in the THPL series provide valuable habitat for a variety of wildlife species. In general, these sites offer sources of cover, forage, and water. Multiple shrub and tree layers provide structural diversity for wildlife. Late-seral stand structures serve as important habitat for old-growth-dependent species. These stands include older western redcedar, grand fir, and Engelmann spruce trees with extensive heart rot decay, resulting in large trees, snags, and logs with hollow interiors.

Western redcedar is a major winter food for big game in the northern Rocky Mountains (Minore 1983). Some sites may have an abundance of berry-producing shrubs, providing food for wildlife. Large ungulates such as mule deer and elk will forage in these sites during summer and fall. Elk are known to favor devil's club as a forage plant and also will eat deerfoot vanilla-leaf. Black bears may remove cedar bark and feed on the exposed sapwood (Minore 1990). Black bears use hollow logs for dens and rest sites. Grizzly bears also are known to use heavily timbered western redcedar forests (Layser 1978). Flying squirrels, bats, skunks, raccoons, and red squirrels use western redcedar stands for hiding and thermal cover and cedar cavities for dens (Arno and Hammerly 1984). American marten use hollow logs and snags for dens and rest sites. Beaver have been observed eating cedar bark, probably as a food of last resort. They also may use conifer limbs for dam construction.

Western redcedar is used as a nest tree by cavity-nesting birds such as woodpeckers, yellow-belied sapsuckers, tree swallows, chestnut-backed chickadees, and Vaux's swift (McClelland 1980). These sites also may serve as important habitat for the northern spotted owl, barred owl, and goshawk. Woodpeckers also forage these trees for bark beetles and ants, especially Engelmann spruce. (For more information on thermal or feeding cover values, see apps. B-2 and B-3. For information on food values or degree of use, see apps. B-2 and B-4.)

Fish. Riparian associations in the THPL series play important roles in the maintenance of good fish habitat. The high tree productivity associated with most of these sites provides ample amounts of large woody debris, primarily large-diameter logs, which provide good fish habitat (structure). In addition, most THPL sites are located along A and B channels with steep gradients. The contribution of large woody debris helps to maintain channel and streambank stability, particularly during peak flows. (For more information, see app. B-5, erosion control potential.) The large tree canopies provide shade for the stream, which helps to regulate stream water temperatures.

Maintaining healthy, vigorous stands of THPL and associated series along streams will create buffer strips of erosion-resistant plant species to help stabilize streambanks, nearby terraces, and swales; form barriers to sedimentation from nearby slopes; and provide a source of large down wood for the stream and nearby fluvial surfaces.

Recreation—

Old-growth stands of western redcedar have high recreational value owing to their attractiveness, scarcity, and big trees (Hansen et al. 1995). However, many riparian and wetland sites are not well suited for recreation purposes on account of high water tables or seeps and springs. Low gravel content and loamy textures (in some cases organic soils) make most sites highly susceptible to compaction and trampling when soil moisture conditions are high. Many wetter sites would require boardwalks so forest visitors would not trample vegetation and soils. Construction and maintenance of campgrounds, trails, and roads are not recommended except on well-drained terraces. The THPL sites also are prone to windthrow of western redcedar, grand fir, and Engelmann spruce owing to wet soil, these species' shallow rooting system, and weakness from root rot.

Insects and Disease—

Western redcedar is relatively free of major problems associated with insects and disease (Hessburg et al. 1994, Williams et al. 1995), although more than 200 fungi are found on it (Minore 1990). Trees with trunk, butt, and root rots are common. Laminated root rot caused by *Phellinus* (*Poria*) *weirii* is the most important trunk rot in eastern Washington. Trunk, butt, and root rots also affect other trees in the THPL series, such as Douglas-fir, grand fir, and Engelmann spruce. Armillaria root rot is very common throughout the series and is found in most stands (McDonald et al. 1987b). Annosus root disease is a common decay in western redcedar and grand fir, particularly in old-growth stands. Indian paint fungus is very common in old grand fir. Natural or human-caused wounding of trees will generally increase damage from decay fungi.

Although, western redcedar is a host for a variety of insect species, it seems to suffer little damage from them. The cedar gall midge reduces cedar seed crops (Minore 1990). Weevils damage seedlings and the western cedar borer causes degradation resulting in cull of lumber. Drier THPL associations that support seral Douglas-fir and grand fir are prone to some activity by Douglas-fir beetle, western spruce budworm, or fir engraver.

Estimating Vegetation Potential on Disturbed Sites—

Estimating vegetation potential on disturbed sites is generally not needed on these conifer-dominated sites, as they are seldom greatly disturbed. Clearcutting in riparian areas is unusual, at least on FS land. Wetter associations in the SALIX, COST, MEADOW, and ALIN series often separate THPL stands from active flood zones. Currently, the FS places buffer strips along riparian and wetland zones and does not manage them for wood production. Even where clearcut in the past, western redcedar, grand fir, Engelmann spruce, and other conifers regenerate rapidly on these productive sites. Similar valley segments in nearby drainages can help determine the potential natural vegetation for young stands.

Sensitive Species—

No sensitive plants were found on THPL series plots. However, old western redcedar stands often contain various *Botrychium* species on the thick accumulation of duff (Lillybridge 1998). (See app. D for more information.)

ADJACENT SERIES

In maritime and inland maritime zones, the TSHE series and the ABGR series normally bound the THPL series on cooler and warmer sites, respectively. Within continental climates, the THPL series is replaced by the ABLA2 series on colder sites and PSME series on warmer sites.

RELATIONSHIPS TO OTHER CLASSIFICATIONS

Kovalchik (1992c) described many of the plant associations in the THPL series in the draft classification for northeastern Washington. The THPL/ARNU3 and THPL/OPHO associations are described in the upland classifications by Lillybridge et al. (1995) and Williams et al. (1995). The THPL/ACCI and THPL/PAMY/CLUN associations have not been previously described.

Daubenmire and Daubenmire (1968) incorporated climax western redcedar stands into the TSHE series and did not explicitly recognize a THPL series. Plant associations belonging to the THPL series are similarly lumped into the TSHE series in other classifications for the Washington Cascade Range (e.g., Henderson et al. 1992, Lillybridge et al. 1995). The THPL plant associations (THPL/OPHO, THPL/ATFI, and THPL/GYDR) have been described for northeastern Washington, northern Idaho, and Montana (Cooper et al. 1991, Hansen et al. 1995, Pfister et al. 1977, and Williams et al. 1995). The western redcedar series also occurs in the southern interior of British Columbia (Braumandl and Curran 1992).

U.S. DEPARTMENT OF THE INTERIOR, FISH AND WILDLIFE SERVICE WETLANDS CLASSIFICATION

System:	palustrine
Class:	forested wetland
Subclass:	needle-leaved evergreen
Water regime:	(nontidal) temporarily flooded to saturated

KEY TO THE WESTERN REDCEDAR (*THUJA PLICATA*) PLANT ASSOCIATIONS

1. Devil's club (*Oplopanax horridum*) ≥5 percent canopy coverage .... **Western redcedar/devil's club (THPL/OPHO) association**
2. Lady fern (*Athyrium filix-femina*) ≥5 percent canopy coverage .... **Western redcedar/lady fern (THPL/ATFI) association**
3. Oak fern (*Gymnocarpium dryopteris*) ≥5 percent canopy coverage .... **Western redcedar/oak fern (THPL/GYDR) association**
4. Common horsetail (*Equisetum arvense*) and/or soft-leaved sedge (*Carex disperma*) ≥10 percent canopy coverage .... **Western redcedar/common horsetail (THPL/EQUIS) association**
5. Vine maple (*Acer circinatum*) ≥5 percent canopy coverage .... **Western redcedar/vine maple (THPL/ACCI) association**
6. Mountain alder (*Alnus incana*) ≥25 percent canopy coverage .... **Western redcedar/mountain alder (THPL/ALIN) association**
7. Deerfoot vanilla-leaf (*Achlys triphylla*) ≥2 percent canopy coverage .... **Western redcedar/deerfoot vanilla-leaf (THPL/ACTR) association**
8. Wild ginger (*Asarum caudatum*) ≥2 percent canopy coverage; site west of Okanogan River .... **Western redcedar/wild ginger (THPL/ASCA3) association**
9. Myrtle pachistima (*Pachistima myrsinites*) ≥5 percent canopy coverage; site west of the Okanogan River .... **Western redcedar/myrtle pachistima/queencup beadlily (THPL/PAMY/CLUN) association**
10. Wild sarsaparilla (*Aralia nudicaulis*), wild ginger (*Asarum caudatum*) or baneberry (*Actaea rubra*) ≥2 percent canopy coverage; sites east of the Okanogan River .... **Western redcedar/wild sarsaparilla (THPL/ARNU3) association**
11. Big huckleberry (*Vaccinium membranaceum*) ≥5 percent canopy coverage; sites east of the Okanogan River .... **Western redcedar/big huckleberry (THPL/VAME) association**
12. Queencup beadlily (*Clintonia uniflora*) ≥1 percent canopy coverage; sites east of the Okanogan River.......... **Western redcedar/queencup beadlily (THPL/CLUN) association**

Table 4—Constancy and mean cover of important plant species in the THPL plant associations

Species	Code	THPL/ ACCI 6 plots		THPL/ ACTR 2 plots		THPL/ ALIN 3 plots		THPL/ ARNU3 14 plots		THPL/ ASCA3 3 plots		THPL/ AFTI 13 plots		THPL/ CLUN 2 plots		THPL/ EQUIS 3 plots		THPL/ GYDR 13 plots		THPL/ OPHO 17 plots		THPL/ PAMY/CLUN 12 plots		THPL/ VAME 2 plots	
		CON[a]	COV[b]	CON	COV	CON	COV	CON	COV	CON	COV	CON	COV	CON	COV	CON	COV	CON	COV	CON	COV	CON	COV	CON	COV
Tree overstory:																									
grand fir	ABGR	83	15	100	8	67	4	64	21	100	20	46	11	100	6	—	—	23	2	41	23	17	4	—	—
subalpine fir	ABLA2	—	—	—	—	—	—	—	—	—	—	23	3	—	—	33	5	23	3	12	23	8	Tr[c]	100	3
red alder	ALRU	17	2	—	—	33	10	—	—	—	—	8	25	—	—	—	—	—	—	12	18	—	—	—	—
western larch	LAOC	17	10	50	5	—	—	57	8	67	8	31	4	—	—	—	—	31	4	6	Tr	—	—	—	—
Engelmann spruce	PIEN	33	8	—	—	33	20	79	17	67	11	77	14	50	Tr	100	35	69	19	41	17	58	16	100	45
western white pine	PIMO	50	5	—	—	—	—	14	3	33	7	15	3	—	—	—	—	8	Tr	—	—	8	8	—	—
ponderosa pine	PIPO	—	—	50	5	33	55	7	35	33	10	—	—	50	5	—	—	8	Tr	—	—	—	—	—	—
black cottonwood	POTR2	—	—	100	5	—	—	14	1	—	—	31	3	—	—	33	3	8	10	35	8	25	13	—	—
Douglas-fir	PSME	50	15	100	24	33	Tr	93	15	100	19	38	12	50	35	67	8	38	8	47	18	67	21	50	5
western redcedar	THPL	100	44	100	19	100	25	93	30	100	30	100	43	100	90	100	22	100	58	94	38	100	50	100	12
Tree understory:																									
grand fir	ABGR	50	3	100	4	67	1	50	6	67	1	62	3	100	4	—	—	38	2	24	3	25	4	—	—
Engelmann spruce	PIEN	17	5	—	—	—	—	43	3	—	—	38	4	—	—	67	13	54	2	18	2	25	2	—	—
Douglas-fir	PSME	17	1	50	1	33	Tr	43	2	—	—	8	Tr	50	1	—	—	8	Tr	12	1	50	1	—	—
western redcedar	THPL	67	9	50	7	100	4	93	9	100	12	100	9	100	14	67	23	100	12	100	8	92	9	100	24
western hemlock	TSHE	17	1	—	—	33	2	7	2	67	1	23	1	—	—	—	—	—	—	18	2	—	—	—	—
Shrubs:																									
vine maple	ACCI	100	41	—	—	33	2	—	—	—	—	15	5	—	—	—	—	—	—	41	16	—	—	—	—
Douglas maple	ACGLD	—	—	100	4	—	—	100	3	33	1	38	7	50	1	—	—	54	9	35	4	50	6	—	—
mountain alder	ALIN	17	1	50	5	100	35	—	—	—	—	46	12	—	—	100	3	38	3	18	3	50	4	—	—
Sitka alder	ALSI	—	—	100	4	33	1	14	3	33	2	23	4	—	—	—	—	23	1	18	4	25	3	—	—
Saskatoon serviceberry	AMAL	33	1	50	2	—	—	71	1	33	1	23	1	100	1	—	—	38	1	24	Tr	50	Tr	50	1
red-osier dogwood	COST	—	—	50	10	33	17	29	1	—	—	54	4	50	3	100	4	54	3	41	8	50	2	50	2
bearberry honeysuckle	LOIN	17	Tr	—	—	—	—	—	—	—	—	8	Tr	—	—	33	Tr	8	3	6	1	—	—	50	1
rusty menziesia	MEFE	—	—	—	—	—	—	—	—	33	1	15	2	—	—	—	—	8	2	24	5	8	Tr	50	1
devil's club	OPHO	—	—	—	—	—	—	—	—	—	—	23	1	—	—	33	Tr	38	2	100	22	—	—	50	1
prickly currant	RILA	17	2	—	—	—	—	36	2	33	1	69	1	50	1	33	2	92	3	59	2	67	1	100	3
baldhip rose	ROGY	50	2	100	3	67	3	100	3	67	2	54	1	100	1	33	3	54	1	29	1	50	1	50	Tr
Nootka rose	RONU	—	—	50	1	67	2	7	1	—	—	8	1	—	—	—	—	8	Tr	—	—	—	—	—	—
western thimbleberry	RUPA	50	4	100	2	—	—	71	5	67	1	62	4	50	2	33	Tr	62	7	82	9	67	3	100	2
Scouler's willow	SASC	—	—	50	2	33	3	—	—	—	—	—	—	—	—	—	—	8	2	—	—	25	2	—	—
Cascade mountain-ash	SOSC2	—	—	50	Tr	—	—	7	Tr	—	—	—	—	—	—	33	Tr	—	—	6	2	67	1	—	—
shiny-leaf spiraea	SPBEL	17	Tr	50	3	67	1	7	5	33	1	—	—	—	—	—	—	8	Tr	—	—	42	1	—	—
common snowberry	SYAL	—	—	50	2	33	3	64	3	33	2	54	2	50	Tr	33	2	46	4	12	5	33	1	—	—
big huckleberry	VAME	17	Tr	—	—	33	40	14	1	—	—	15	1	—	—	—	—	31	1	24	1	25	Tr	100	13
Low shrubs and subshrubs:																									
Oregon hollygrape	BEAQ	—	—	50	Tr	33	5	71	2	33	1	8	2	50	Tr	33	Tr	23	Tr	12	Tr	50	1	—	—
Cascade hollygrape	BENE	50	4	100	3	33	10	—	—	100	2	23	1	—	—	—	—	—	—	12	4	—	—	50	1
western prince's-pine	CHUMO	33	3	100	1	33	2	21	1	100	1	31	Tr	50	Tr	33	Tr	54	Tr	29	1	75	1	100	2
bunchberry dogwood	COCA	33	12	—	—	—	—	71	5	33	4	31	2	50	Tr	67	2	31	2	—	—	—	—	—	—
twinflower	LIBOL	50	7	50	2	—	—	93	10	33	4	77	2	100	2	33	15	77	7	35	6	—	—	100	11

Table 4—Constancy and mean cover of important plant species in the THPL plant associations (continued)

Species	Code	THPL/ ACCI 6 plots		THPL/ ACTR 2 plots		THPL/ ALIN 3 plots		THPL/ ARNU3 14 plots		THPL/ ASCA3 3 plots		THPL/ AFTI 13 plots		THPL/ CLUN 2 plots		THPL/ EQUIS 3 plots		THPL/ GYDR 13 plots		THPL/ OPHO 17 plots		THPL/ PAMY/CLUN 12 plots		THPL/ VAME 2 plots	
		CON	COV	CON	COV	CON	COV	CON	COV	CON	COV	CON	COV	CON	COV	CON	COV	CON	COV	CON	COV	CON	COV	CON	COV
myrtle pachistima	PAMY	67	4	50	7	67	2	50	1	67	2	38	1	—	—	33	Tr	31	1	29	1	100	12	50	2
five-leaved bramble	RUPE	—	—	—	—	—	—	—	—	—	—	15	6	—	—	33	5	—	—	6	Tr	—	—	—	—
low huckleberry	VAMY	—	—	—	—	33	3	7	2	33	1	8	Tr	—	—	—	—	23	1	—	—	17	1	—	—
Perennial forbs:																									
deerfoot vanilla-leaf	ACTR	17	1	100	18	—	—	—	—	33	2	—	—	—	—	—	—	—	—	12	4	—	—	—	—
baneberry	ACRU	—	—	50	2	—	—	71	1	33	2	69	1	100	Tr	—	—	54	1	65	3	8	Tr	—	—
pathfinder	ADBI	17	1	50	4	—	—	71	1	33	1	46	1	50	Tr	33	1	23	1	47	1	17	2	50	Tr
wild sarsaparilla	ARNU3	—	—	—	—	—	—	79	13	—	—	23	2	—	—	33	5	31	6	12	1	—	—	—	—
mountain arnica	ARLA	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	8	Tr	—	—	8	Tr	50	Tr
wild ginger	ASCA3	33	13	—	—	—	—	43	2	100	6	46	12	—	—	33	1	15	2	65	5	—	—	—	—
enchanter’s nightshade	CIAL	—	—	—	—	—	—	29	2	—	—	46	2	100	1	67	3	31	3	53	1	—	—	—	—
queencup beadlily	CLUN	50	11	50	1	—	—	86	4	100	2	100	2	100	3	—	—	77	2	41	2	—	—	50	2
Hooker’s fairy-bells	DIHO	50	Tr	100	3	—	—	29	2	—	—	23	1	—	—	—	—	8	Tr	47	1	17	2	—	—
roughfruit fairy-bells	DITR	—	—	—	—	—	—	50	2	—	—	—	—	50	Tr	—	—	15	1	6	Tr	17	3	—	—
sweetscented bedstraw	GATR	33	1	50	1	—	—	79	2	33	1	92	1	100	1	67	2	38	1	53	2	17	Tr	50	Tr
western rattlesnake plantain	GOOB	67	1	50	Tr	33	2	43	1	100	1	31	1	50	1	33	Tr	46	Tr	41	1	50	1	100	1
fivestamen miterwort	MIPE	—	—	—	—	—	—	7	1	—	—	15	1	—	—	33	5	23	1	6	3	—	—	—	—
miterwort species	MITEL	—	—	—	—	—	—	21	1	—	—	23	1	100	Tr	33	2	31	2	12	1	—	—	—	—
smallflower miterwort	MIST2	—	—	—	—	—	—	—	—	—	—	8	5	—	—	—	—	—	—	—	—	—	—	—	—
mountain sweet-root	OSCH	—	—	50	1	—	—	57	2	—	—	23	2	50	Tr	—	—	23	1	24	1	25	1	50	Tr
western sweet-root	OSOC	—	—	50	2	—	—	—	—	—	—	—	—	—	—	—	—	8	Tr	6	2	—	—	—	—
purple sweet-root	OSPU	—	—	—	—	—	—	14	1	—	—	15	1	50	1	33	Tr	15	1	12	1	—	—	—	—
arctic butterbur	PEFR2	—	—	50	20	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
pink wintergreen	PYAS	33	2	50	1	—	—	—	—	67	2	31	2	50	Tr	33	2	46	Tr	24	3	17	3	100	14
sidebells pyrola	PYSE	17	1	50	Tr	33	Tr	36	2	67	1	46	1	50	Tr	33	Tr	46	1	35	1	92	1	100	3
arrowleaf groundsel	SETR	—	—	50	1	—	—	7	1	—	—	38	1	—	—	—	—	23	Tr	12	1	8	Tr	—	—
western solomonplume	SMRA	33	Tr	100	1	—	—	21	1	33	1	23	1	50	Tr	—	—	—	—	53	1	58	1	—	—
starry solomonplume	SMST	83	4	50	1	67	1	86	3	100	2	85	3	100	1	33	2	38	2	71	7	8	Tr	50	1
claspleaf twisted-stalk	STAM	—	—	—	—	—	—	50	1	—	—	85	1	50	1	—	—	77	2	65	2	25	1	50	Tr
rosy twisted-stalk	STRO	17	1	—	—	—	—	—	—	—	—	8	7	—	—	—	—	8	Tr	12	2		—	50	5
coolwort foamflower	TITRU	17	Tr	—	—	—	—	71	5	—	—	69	4	—	—	33	5	92	3	71	5	—	—	50	2
false bugbane	TRCA3	17	1	—	—	—	—	29	6	—	—	15	4	—	—	—	—	15	5	18	4	—	—	—	—
broadleaf starflower	TRLA2	17	1	50	1	—	—	—	—	100	1	15	2	—	—	—	—	—	—	29	3	—	—	—	—
white trillium	TROV	67	1	50	1	—	—	50	2	100	1	46	2	—	—	—	—	15	1	65	1	—	—	—	—
Canadian violet	VICA	—	—	50	2	—	—	14	3	—	—	8	1	—	—	—	—	8	2	—	—		—	—	—
pioneer violet	VIGL	—	—	50	1	—	—	29	2	33	1	62	3	100	2	33	Tr	54	1	76	2	25	1	50	Tr
round-leaved violet	VIOR2	33	1	—	—	—	—	29	2	—	—	—	—	—	—	—	—	8	Tr	6	2	25	2	—	—
Grass or grasslike:																									
soft-leaved sedge	CADI	—	—	—	—	—	—	7	3	—	—	46	1	50	Tr	67	14	15	Tr	6	5	8	Tr	—	—
smooth sedge	CALA	—	—	—	—	—	—	7	3	—	—	23	Tr	50	3	33	2	23	1	12	1	—	—	—	—
wood reed-grass	CILA2	—	—	—	—	—	—	—	—	—	—	38	1	50	Tr	67	2	46	1	41	1	17	Tr	—	—
western fescue	FEOC	—	—	50	Tr	—	—	29	1	—	—	—	—	—	—	—	—	8	Tr	—	—	—	—	—	—
tall mannagrass	GLEL	—	—	—	—	—	—	14	Tr	—	—	23	5	—	—	67	2	8	Tr	12	3	—	—	—	—

Table 4—Constancy and mean cover of important plant species in the THPL plant associations (continued)

Species	Code	THPL/ ACCI 6 plots		THPL/ ACTR 2 plots		THPL/ ALIN 3 plots		THPL/ ARNU3 14 plots		THPL/ ASCA3 3 plots		THPL/ AFTI 13 plots		THPL/ CLUN 2 plots		THPL/ EQUIS 3 plots		THPL/ GYDR 13 plots		THPL/ OPHO 17 plots		THPL/ PAMY/CLUN 12 plots		THPL/ VAME 2 plots	
		CON	COV	CON	COV	CON	COV	CON	COV	CON	COV	CON	COV	CON	COV	CON	COV	CON	COV	CON	COV	CON	COV	CON	COV
Ferns and fern allies:																									
alpine lady fern	ATDI	—	—	—	—	—	—	—	—	—	—	8	7	—	—	—	—	—	—	—	—	—	—	—	—
lady fern	ATFI	17	Tr	—	—	—	—	43	1	—	—	92	13	50	3	33	1	77	2	82	21	17	Tr	—	—
common horsetail	EQAR	33	1	50	3	—	—	14	1	—	—	54	6	—	—	67	26	69	2	29	3	25	2	—	—
oak fern	GYDR	—	—	—	—	—	—	21	1	—	—	54	2	—	—	—	—	100	9	76	9	—	—	—	—
stiff clubmoss	LYAN	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	8	Tr	—	—	—	—	—	—
western brackenfern	PTAQ	17	2	—	—	33	1	14	3	33	1	8	1	—	—	—	—	—	—	29	3	17	13	—	—

[a] CON = percentage of plots in which the species occurred.
[b] COV = average canopy cover in plots in which the species occurred.
[c] Tr = trace cover, less than 1 percent canopy cover.

SUBALPINE FIR SERIES

Abies lasiocarpa

ABLA2 N = 141

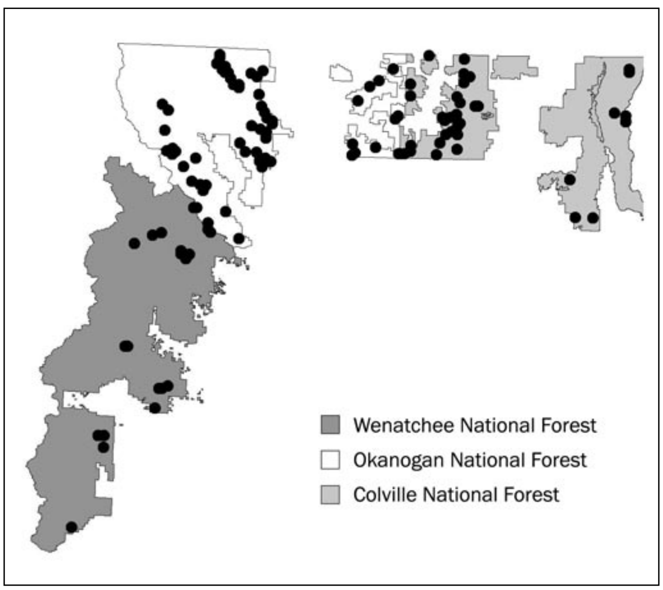


Figure 11—Plot locations for the subalpine fir series.

SUBALPINE FIR[1] is the most widely distributed true fir in North America (Alexander et al. 1984). The range of subalpine fir extends from near the northern tree line in the Yukon interior along the coast of southeastern Alaska, then south through western Alberta and British Columbia, to southern Colorado and the scattered mountain ranges of Arizona and New Mexico (Henderson and Peter 1982, Hitchcock and Cronquist 1973). It does not occur along the Coast Ranges of British Columbia, Washington, or Oregon; however, it does occur in the Olympic Mountains and on Vancouver Island. It occurs along both sides of the Cascade Range in Washington and is very prominent to the east, through the mountainous areas of north central and northeastern Washington into Idaho and Montana.

Subalpine fir is quite shade tolerant compared with Douglas-fir and ponderosa pine, but less so than grand fir, western redcedar, western hemlock, mountain hemlock, and Pacific silver fir. Therefore the ABLA2 series is best represented in areas characterized by relatively dry and cold continental climates where the more shade-tolerant species do not grow well. Although subalpine fir stands are less abundant in moister inland maritime and maritime climates, subalpine fir is found on sites too harsh (cold and dry) for the species listed above. The ABLA2 series is most abundant and widespread in the strong continental climate west of the Columbia River, east of the Okanogan Cascade crest, and north of the Entiat River. It is also prominent on high-elevation, relatively dry ridges in locations that usually are too dry for mountain hemlock and Pacific silver fir. These areas extend east from the Cascade crest and south of the Entiat River and include the Wenatchee Mountains, Table Mountain, and Manastash Ridge. Within its range, the ABLA2 series is present on a variety of sites, including riparian and upland sites, but is limited in wetlands owing to subalpine fir's intolerance to saturated soils and flooding.

CLASSIFICATION DATABASE

The ABLA2 series includes all stands potentially dominated by subalpine fir at climax and is found on all three NFs covered in this guide (fig. 11). Stands are common on all RDs. Ninety-six riparian and wetland sampling plots were measured in the ABLA2 series. Data from an additional 45 plots in other ecology databases were added to facilitate classification and provide additional data only for descriptions of species composition, distribution, and elevation. From this database, nine major and seven minor associations are recognized. Five of these associations (ABLA2/ARLA-POPU, ABLA2/LEGL-VASC, ABLA2/PAMY, ABLA2/RULA, and ABLA2/TRLA4) are limited to the Cascade Range. The remaining 11 associations are found throughout the study area. Two potential one-plot associations (ABLA2/VACA and ABLA2/VASC), occasionally found on drier terraces and benches, are not used in the data nor described in this classification. They are, however, found in upland forest classifications for eastern Washington (Lillybridge et al. 1995, Williams et al. 1995). For the most part, these samples represent late-seral to climax conditions. However, some mid-seral plots were located in extensive, mature lodgepole pine stands that originated in the widespread stand-replacing fires of the early 1900s.

[1] See appendix A for a cross reference for all species codes and common and scientific names used in this document.

Subalpine fir plant associations

	Scientific name	Common name	Ecoclass code	Plots
Major associations:				
ABLA2/ATFI	*Abies lasiocarpa/Athyrium filix-femina*	Subalpine fir/lady fern	CEF332	10
ABLA2/COCA	*Abies lasiocarpa/Cornus canadensis*	Subalpine fir/bunchberry dogwood	CEF423	21
ABLA2/GYDR	*Abies lasiocarpa/Gymnocarpium dryopteris*	Subalpine fir/oak fern	CEF342	19
ABLA2/LEGL-VASC	*Abies lasiocarpa/Ledum glandulosum-Vaccinium scoparium*	Subalpine fir/Labrador tea-grouse huckleberry	CES632	16
ABLA2/PAMY	*Abies lasiocarpa/Pachistima myrsinites*	Subalpine fir/myrtle pachistima	CES113	7
ABLA2/RHAL/SETR	*Abies lasiocarpa/Rhododendron albiflorum/Seniceo triangularis*	Subalpine fir/Cascade azalea/arrowleaf groundsel	CES214	10
ABLA2/STAMC	*Abies lasiocarpa/Streptopus amplexifolius* var. *chalazatus*	Subalpine fir/claspleaf twisted-stalk	CEF311	6
ABLA2/TRCA3	*Abies lasiocarpa/Trautvetteria caroliniensis*	Subalpine fir/false bugbane	CEF422	19
ABLA2/TRLA4	*Abies lasiocarpa/Trollius laxus*	Subalpine fir/globeflower	CEF425	12
Minor associations:				
ABLA2/ALSI	*Abies lasiocarpa/Alnus sinuata*	Subalpine fir/Sitka alder	CES142	3
ABLA2/ARLA-POPU	*Abies lasiocarpa/Arnica latifolia-Polemonium pulcherrimum*	Subalpine fir/mountain arnica-skunkleaf polemonium	CEF424	3
ABLA2/LIBOL	*Abies lasiocarpa/Linnaea borealis* var. *longiflora*	Subalpine fir/twinflower	CEF211	4
ABLA2/OPHO	*Abies lasiocarpa/Oplopanax horridum*	Subalpine fir/devil's club	CES711	3
ABLA2/RHAL/LUHI	*Abies lasiocarpa/Rhododendron albiflorum/Luzula hitchcockii*	Subalpine fir/Cascade azalea/smooth woodrush	CES213	2
ABLA2/RULA	*Abies lasiocarpa/Rubus lasiococcus*	Subalpine fir/dwarf bramble	CES423	2
ABLA2/VAME	*Abies lasiocarpa/Vaccinium membranaceum*	Subalpine fir/big huckleberry	CES342	2

VEGETATION CHARACTERISTICS

Mature stands in the ABLA2 series have a tree overstory that contains both subalpine fir and Engelmann spruce. In many stands they are codominant. Engelmann spruce is a larger, longer-lived species than subalpine fir. In some older stands it tends to dominate the overstory, with subalpine fir forming multiaged canopies in the understory. Engelmann spruce also tolerates both wetter and drier conditions and extends to lower elevations or wetter sites than subalpine fir. These sites lie outside the ecological amplitude of subalpine fir and are described in the PIEN series. The tree understory is usually characterized by a combination of subalpine fir and Engelmann spruce regeneration, with smaller amounts of Douglas-fir on drier associations. Other tree species, such as western hemlock, mountain hemlock, and subalpine larch, are generally not well represented except on sites transitional to series characterized by these species. Lodgepole pine is a common seral species in moderate to high-elevation associations such as ABLA2/LEGL-VASC and ABLA2/TRLA4, as well as young- to moderate-aged, fire-regenerated stands. Douglas-fir and western larch (east of the Okanogan River) are common seral species on lower elevation, warmer associations.

Because of the extreme environmental variation in the many associations represented in the ABLA2 series, understory vegetation is diverse. Species composition and cover varies from very rich in the wetter associations, such as ABLA2/ATFI, to little diversity in drier associations, such as ABLA2/LEGL-VASC. Common shrub species on drier associations include Labrador tea, bearberry, Utah honeysuckle, baldhip rose, western thimbleberry, grouse huckleberry, dwarf huckleberry, bunchberry dogwood, twinflower, and myrtle pachistima. Sitka alder, devil's club, and prickly currant are common on wetter associations. Common herbs include mountain arnica, skunkleaf polemonium, queencup beadlily, sweetscented bedstraw, and starry solomonplume. Lady fern, oak fern, claspleaf twisted-stalk, false bugbane, globeflower, coolwort foamflower, and arrowleaf groundsel are common on wetter sites. Smooth woodrush is found at high elevations.

PHYSICAL SETTING

Elevation—

The ABLA2 series spans a broad range of elevations, but the majority of sites are above 4,000 feet, with lower elevation sites usually in cold air drainages. Elevation differences of ABLA2 sites between NFs probably result from differences in climate and physical settings. The lower elevation boundary of the ABLA2 series is higher in continental climate zones and restricted to absent within strong maritime climates. Therefore, elevations in the ABLA2 series are generally higher on the Wenatchee and Okanogan NFs. The lower elevation ranges shown for the three NFs occur as the series extends down cold air drainages within continental climate zones.

	Elevation (feet)			
Forest	Minimum	Maximum	Average	N
Colville	3,000	6,250	4,402	40
Okanogan	2,875	6,900	4,883	73
Wenatchee	2,550	6,620	5,031	28
Series	2,550	6,900	4,775	141

Additional insight is gained by looking at the individual associations. The ABLA2/TRLA4, ABLA2/RHAL/SETR, ABLA2/LEGL-VASC, ABLA2/STAMC, ABLA2/TRCA3, ABLA2/ATFI, ABLA2/ARLA-POPU, ABLA2/ALSI, and ABLA2/RHAL/LUHI associations are the highest, usually located above 4,500 feet. However, all ABLA2 associations are at high elevations compared with the PIEN, TSHE, THPL, ABGR, and PSME series except where the ABLA2 series extends to lower elevations along cold air drainages.

Plant association	Elevation (feet)			N
	Minimum	Maximum	Average	
ABLA2/TRLA4	5,075	6,900	6,195	12
ABLA2/RHAL/LUHI	5,800	6,500	6,150	2
ABLA2/RHAL/SETR	4,950	6,620	5,878	10
ABLA2/LEGL-VASC	4,621	6,620	5,696	16
ABLA2/STAMC	4,500	4,500	5,450	6
ABLA2/ARLA-POPU	4,640	5,640	5,155	3
ABLA2/TRCA3	4,000	5,440	4,747	19
ABLA2/ATFI	4,225	5,225	4,608	10
ABLA2/ALSI	4,430	4,750	4,567	3
ABLA2/LIBOL	3,860	4,760	4,355	4
ABLA2/OPHO	3,460	5,475	4,212	3
ABLA2/GYDR	3,160	5,225	4,105	19
ABLA2/VAME	3,500	4,675	4,088	2
ABLA2/PAMY	2,875	4,520	3,912	7
ABLA2/COCA	3,000	4,570	3,852	21
ABLA2/RULA	2,550	4,600	3,575	2
Series	2,550	6,900	4,775	139

Valley Geomorphology—

The ABLA2 series is found in a variety of valley width and gradient classes, but most sample plots are in valleys of moderate to very narrow width (less than 330 feet) and moderate to very steep valley gradient (4 percent to greater than 8 percent). A smaller number of sample plots are in broader valleys with low to very low valley gradient (less than 4 percent).

Valley width	Valley gradient					N
	Very low	Low	Moderate	Steep	Very steep	
Very broad	3	1	0	0	0	4
Broad	2	6	0	2	1	11
Moderate	0	6	7	5	11	29
Narrow	0	4	2	5	18	29
Very narrow	0	0	3	5	15	23
Series total	5	17	12	17	45	96

The valley data for individual plant associations generally follow that for the ABLA2 series. The trend is that no single ABLA2 association is common on very low gradient, very broad valley bottoms. The ABLA2/COCA association shows a relatively strong tendency toward broad, low gradient valleys, whereas the ABLA2/TRCA3 association is more common in low-gradient as well as steeper valley bottoms.

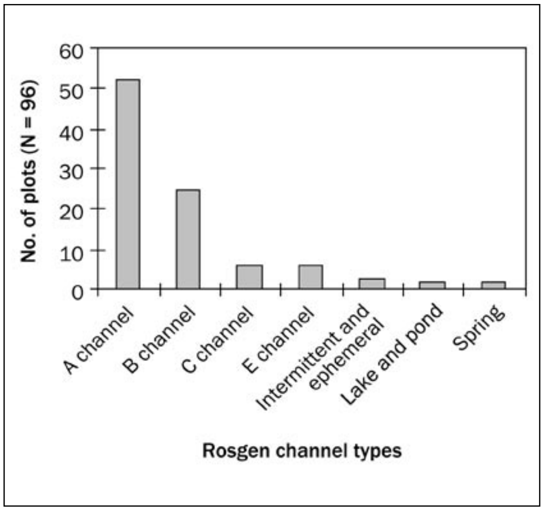
Plant association	Valley width					N
	Very broad	Broad	Moderate	Narrow	Very narrow	
ABLA2/ALSI	0	0	1	2	0	3
ABLA2/ARLA-POPU	0	0	2	0	0	2
ABLA2/ATFI	0	1	3	2	0	6
ABLA2/COCA	0	2	4	0	0	6
ABLA2/GYDR	1	1	4	7	3	16
ABLA2/LEGL-VASC	1	3	1	5	3	13
ABLA2/OPHO	0	0	2	0	0	2
ABLA2/PAMY	0	0	5	1	0	6
ABLA2/RHAL/LUHI	0	1	0	0	1	2
ABLA2/RHAL/SETR	0	1	0	2	6	9
ABLA2/RULA	1	0	0	1	0	2
ABLA2/STAMC	0	0	0	2	4	6
ABLA2/TRCA3	0	1	2	4	4	11
ABLA2/TRLA4	1	0	4	3	2	10
ABLA2/VAME	0	1	1	0	0	2
Series total	4	11	29	29	23	96

Plant association	Valley gradient					N
	Very low	Low	Moderate	Steep	Very steep	
ABLA2/ALSI	0	0	1	1	1	3
ABLA2/ARLA-POPU	0	0	0	1	1	2
ABLA2/ATFI	0	0	1	2	3	6
ABLA2/COCA	0	4	0	1	1	6
ABLA2/GYDR	1	4	2	4	5	16
ABLA2/LEGL-VASC	3	2	0	1	7	13
ABLA2/OPHO	0	0	0	2	0	2
ABLA2/PAMY	0	0	3	1	2	6
ABLA2/RHAL/LUHI	0	1	0	0	1	2
ABLA2/RHAL/SETR	0	1	1	0	7	9
ABLA2/RULA	1	0	0	0	1	2
ABLA2/STAMC	0	0	0	1	5	6
ABLA2/TRCA3	0	4	2	2	3	11
ABLA2/TRLA4	0	1	2	1	6	10
ABLA2/VAME	0	0	0	0	2	2
Series total	5	17	12	17	45	96

Channel Types—

The majority of ABLA2 series plots are located adjacent to Rosgen A and B channel types. A smaller number of plots (20 percent) are located along Rosgen C and E channels. Most of the low gradient, meandering C and E channel types are located in high-elevation basins or wide, low-gradient, riparian wetlands dominated by fens, bogs, and carrs.

The data for individual associations follow observations for the ABLA2 series as most associations are located along A and B channels. Few plots are associated with other channel types. However, the ABLA2/TRLA4 association is probably much more common around springs than indicated by only two plots.

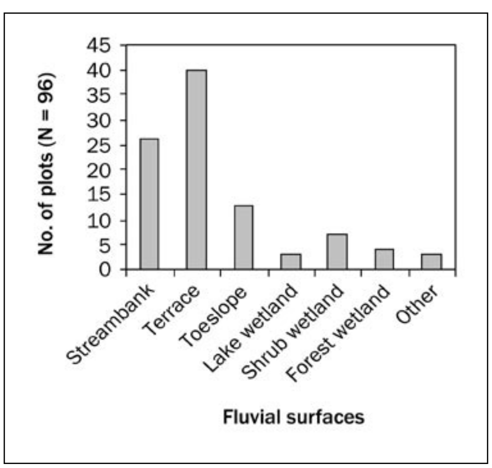


Plant association	Fluvial surfaces							N
	Stream-bank	Terrace	Toe-slope	Lake wetland	Shrub wetland	Forest wetland	Other	
ABLA2/ALSI	2	1	0	0	0	0	0	3
ABLA2/ARLA-POPU	0	2	0	0	0	0	0	2
ABLA2/ATFI	2	2	2	0	0	0	0	6
ABLA2/COCA	0	3	1	0	1	1	0	6
ABLA2/GYDR	6	8	1	0	1	0	0	16
ABLA2/LEGL-VASC	2	2	2	2	3	2	0	13
ABLA2/OPHO	1	1	0	0	0	0	0	2
ABLA2/PAMY	0	5	1	0	0	0	0	6
ABLA2/RHAL/LUHI	0	1	1	0	0	0	0	2
ABLA2/RHAL/SETR	4	3	2	0	0	0	0	9
ABLA2/RULA	0	2	0	0	0	0	0	2
ABLA2/STAMC	4	2	0	0	0	0	0	6
ABLA2/TRCA3	3	6	0	1	0	0	1	11
ABLA2/TRLA4	2	2	2	0	2	1	1	10
ABLA2/VAME	0	0	1	0	0	0	1	2
Series total	26	40	13	3	7	4	3	96

Plant association	Rosgen channel types							N
	A	B	C	E	Intermittent/ ephemeral	Lake/ pond	Spring	
ABLA2/ALSI	2	1	0	0	0	0	0	3
ABLA2/ARLA-POPU	1	1	0	0	0	0	0	2
ABLA2/ATFI	3	3	0	0	0	0	0	6
ABLA2/COCA	0	4	2	0	0	0	0	6
ABLA2/GYDR	10	4	1	1	0	0	0	16
ABLA2/LEGL-VASC	7	1	1	2	1	1	0	13
ABLA2/OPHO	1	1	0	0	0	0	0	2
ABLA2/PAMY	2	3	1	0	0	0	0	6
ABLA2/RHAL/LUHI	1	0	0	1	0	0	0	2
ABLA2/RHAL/SETR	6	2	0	0	1	0	0	9
ABLA2/RULA	1	0	1	0	0	0	0	2
ABLA2/STAMC	6	0	0	0	0	0	0	6
ABLA2/TRCA3	5	3	0	1	1	1	0	11
ABLA2/TRLA4	5	2	0	1	0	0	2	10
ABLA2/VAME	2	0	0	0	0	0	0	2
Series total	52	25	6	6	3	2	2	96

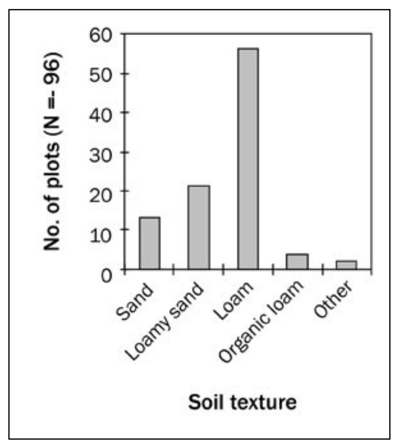
Fluvial Surfaces—

The majority of plots in the ABLA2 series are located in riparian zones on streambanks, terraces, and toeslopes, with relatively few in or on the margin of wetland sites.



Little additional information is gained by looking at the distribution of fluvial surfaces by association. A small number of plots located on wetter sites, such as the ABLA2/TRLA4 or ABLA2/TRCA3 associations, are located along the margins of high-elevation wetlands and basins (some with lakes) and along seeps and springs. In general, subalpine fir is only moderately tolerant of high water tables; riparian sites are the norm, and true wetland associations such as those mentioned above are less common.

Soils—



Mineral soils are the dominant soil types (94 percent) for plots in the ABLA2 series. Loam soils are the most common soil texture. Other mineral soil texture types were not as common. Only a few plots on wetter sites are classified as organic soils (including wood, peat, and muck listed as "other" in the soil texture table).

Few differences are apparent when looking at individual plant associations. As with the entire ABLA2 series, sand, loamy sand, and loam textures predominate. Whatever the association, very few plots occur on organic soils.

Average water tables at the time of sampling ranged from 3 to 75 inches below the soil surface and averaged 22 inches for the ABLA2 series as a whole. The higher water tables correlated well with species that are obligate to wetland soils such as globeflower, false bugbane, claspleaf twisted-stalk, and lady fern. The 29-inch average for ABLA2/ALSI is somewhat misleading as these sites are flooded at spring runoff, which occurred before the sample season. Few plots had surface flooding at the time of sampling, so no table is shown. Flooding is most common on the ABLA2/TRLA4 association at snowmelt.

Plant association	Soil texture					N
	Sand	Loamy sand	Loam	Organic loam	Other	
ABLA2/ALSI	0	1	2	0	0	3
ABLA2/ARLA-POPU	0	0	2	0	0	2
ABLA2/ATFI	0	0	5	0	1	6
ABLA2/COCA	0	0	6	0	0	6
ABLA2/GYDR	3	5	8	0	0	16
ABLA2/LEGL-VASC	0	3	9	0	1	13
ABLA2/LIBOL	0	0	0	0	0	0
ABLA2/OPHO	1	0	1	0	0	2
ABLA2/PAMY	2	1	3	0	0	6
ABLA2/RHAL/LUHI	0	0	2	0	0	2
ABLA2/RHAL/SETR	1	1	5	2	0	9
ABLA2/RULA	0	0	2	0	0	2
ABLA2/STAMC	3	1	1	1	0	6
ABLA2/TRCA3	3	8	0	0	0	11
ABLA2/TRLA4	0	0	9	1	0	10
ABLA2/VAME	0	1	1	0	0	2
Series total	13	21	56	4	2	96

Plant association	Water table (inches)			N
	Minimum	Maximum	Average	
ABLA2/TRLA4	-26	-3	-12	6
ABLA2/TRCA3	-24	-8	-14	3
ABLA2/STAMC	-31	-7	-18	6
ABLA2/ATFI	-28	-16	-22	4
ABLA2/GYDR	-75	-8	-23	11
ABLA2/RHAL/SETR	-39	-12	-25	4
ABLA2/ALSI	-35	-22	-29	2
ABLA2/COCA	-31	-24	-29	3
Series	-75	-3	-22	39

Soil temperature data are available for 78 plots. With a few exceptions, the higher elevation, wetter associations have lower soil temperatures. The high average temperature for the ABLA2/OPHO association is an aberration from the one-plot sample. These sites should be much colder.

Plant association	Soil temperature (°F)			N
	Minimum	Maximum	Average	
ABLA2/OPHO	61	61	61	1
ABLA2/VAME	47	56	52	2
ABLA2/RULA	45	56	51	2
ABLA2/LEGL-VASC	42	62	50	9
ABLA2/COCA	41	53	49	5
ABLA2/RHAL/SETR	44	58	49	5
ABLA2/PAMY	46	50	48	3
ABLA2/ALSI	45	58	47	3
ABLA2/STAMC	43	55	47	6
ABLA2/TRLA4	45	58	47	8
ABLA2/ATFI	34	54	46	4
ABLA2/GYDR	33	53	46	15
ABLA2/TRCA3	35	57	46	11
ABLA2/ARLA-POPU	39	53	41	2
ABLA2/RHAL/LUHI	32	47	39	2
Series	32	62	48	78

ECOSYSTEM MANAGEMENT

Natural Regeneration of Subalpine Fir—

Subalpine fir reproduces from seed as well as layering (Alexander 1987, Arno and Hammerly 1984). Seed production can begin at 20 years of age when trees are 4 or 5 feet tall, but under closed-forest conditions, seed production is not significant until trees are older and taller. Maximum seed production is by vigorous, dominant trees between 150 and 200 years old. Good seed crops are erratic, occurring every 3 to 5 years. The large wing seeds are dispersed by the wind in the fall as the cones disintegrate. Most seed falls within one or two tree heights of the tree. Red squirrels harvest large quantities of cones, storing them in caches. Seeds germinating from these middens may form dense thickets. Seed germination occurs in the spring a few days after snowmelt. Seedlings establish best on mineral soils but will establish on litter and decaying wood. Subalpine fir is very shade tolerant and will establish under closed canopies. Therefore, subalpine fir seedlings often outnumber Engelmann spruce under mature canopies, even where Engelmann spruce dominates the overstory. At high elevations, seedling survival is often better on duff as the duff protects the seedlings from summer rainstorms and frost heaving. Seedling densities are often greater on mineral soils at lower elevations (Fiedler et al. 1985). At higher elevations, especially near or above timberline, subalpine fir reproduces by layering as heavy snow, wind, and cold temperatures result in growth along the ground. This often results in cloned clusters of subalpine fir. Layering is negligible at lower elevations under closed-forest canopies. (See the other tree series for descriptions of natural and artificial establishment of other tree species that may be found in ABLA2 series stands.)

Artificial Establishment of Subalpine Fir—

Subalpine fir is an undervalued timber species in eastern Washington, but where it occurs naturally, it can be planted on disturbed sites. A local plant association classification should be used to determine appropriate sites. Because subalpine fir exhibits a large degree of genetic variability, seed or nursery stock should come from a local source. Transplanting nursery-grown, bare root and container stock is usually more dependable than direct seeding. Seedlings grow very slowly so 2- to 3-year-old seedlings work best. Plantings usually do best on bare mineral soil. It is probably better to rely on the release of natural seedlings and saplings when using selection-cutting methods in riparian zones.

Many of the shrubs used to characterize the ABLA2 series are well adapted to planting on disturbed sites. Sitka alder can be established with container stock but usually reproduces faster and better from its abundant seed. Devil's club can be established from seed or cuttings or by layering although establishment is slow. Prickly currant, Hudsonbay currant, baldhip rose, dwarf bramble, bunchberry dogwood, and western thimbleberry can be easily grown from seed. Five-leaved bramble, twinflower, bunchberry dogwood, mountain arnica, dwarf bramble, and many other trailing plants can be easily propagated from root runners. Huckleberry cuttings root poorly but can be established from seed (growth is slow). Cascade azalea, like all ericaceous plants, can be propagated from seed or cuttings. However, the seed is small and the seedlings need two or three transplantings before being set out. Oak fern and lady fern are easily propagated from rhizomes. (For more information on the short- and long-term revegetation potential of selected riparian wetland plant species, see app. B-5.)

Stand Management—

Although tree productivity is fairly high in these sites, tree harvesting and associated management activities need to be carefully planned in riparian zones and especially within wetlands. Cold temperature regimes, including frost, are factors that limit tree growth. Loam soils are prevalent and are very susceptible to compaction during most of the growing season. Many of the larger trees have extensive heart rot and are "cull" trees. Subalpine fir and Engelmann spruce are both very susceptible to windthrow. Timber harvesting in these sites or adjacent sites that are upslope may increase the risk of windthrow and rising water tables. A clearcut adjacent to a small riparian zone could result in near total blowdown in the riparian zone.

Some sites (such as the ABLA2/TRLA4, ABLA2/TRCA3, ABLA2/ATFI, and ABLA2/OPHO associations) are somewhat swampy and, although tree growth is rapid, are difficult to manage for timber production (Lillybridge et al. 1995). Regeneration also may be difficult on these sites. Dense Sitka alder and Scouler's willow thickets can develop after tree removal on many ABLA2 sites. Management options in riparian zones appear to be limited to single-tree or small-group selection to open the canopy and increase understory production. Shelterwood and individual tree selection cuts will favor subalpine fir and Engelmann spruce, whereas group selection and clearcuts will favor seral species such as Douglas-fir and lodgepole pine. Scheduling any management activity during late summer/fall or during winter on snowpack will minimize soil disturbance.

Coarse, compaction-resistant soils are unusual except perhaps in some of the wetter associations. Loam soils, found on most of these sites, may predominate on account of silt and ash deposition on relatively fluvially inactive terraces. They are subject to compaction, especially when wet or moist. Heavy equipment should not be used on these sites in spring or summer when water tables are high. Wetter sites should be avoided at all seasons of the year (Hansen et al. 1995). Roads and trails should be located on adjacent uplands. Protection of water resources should be a major concern in the ABLA2 series.

Tree Growth and Yield—

Cold temperatures and heavy snowpacks are the main limitations to tree growth in the ABLA2 series (Lillybridge et al. 1995). Tree productivity is variable depending on elevation, temperature, and available moisture. In general, growth and yield is moderate or higher within this series. Many sites have favorable environments for producing large Engelmann spruce on account of the longevity of this species. The more productive associations are those located at moderate elevations where growing conditions are more favorable. These sites appear to have higher basal area and site index values. The associations found at high elevations generally have lower productivity, owing to the harsh environment and short growing season characteristic of these sites. Despite high elevations, the ABLA2/TRLA4 often have excellent individual tree growth, but stand production is low to moderate owing to stocking limitations caused by high water tables. Basal area averages 203 square feet per acre, which is moderate (apps. C-1a and C-1b). Subalpine fir and Engelmann spruce are the dominant species, accounting for more than 85 percent of the total basal area. In comparison, the LALY, PICO, TSME, BEPA, ACMA, ALRU, POTR2, and QUGA series have lower average basal areas. Similarly, average site index for individual species (feet) is moderate compared with other series (app. C-2). Tree productivity data are limited and should therefore be considered with caution.

Site index			
Species	Base age	No. of trees	SI
ABLA2	50	115	55
LAOC	50	38	64
PIAL	100	2	44
PICO	100	43	66
PIEN	50	194	63
PSME	50	22	60

Basal area (sq. ft./ac)	
Species	BA
ABAM	Tr
ABGR	2
ABLA2	51
ALIN	Tr
LAOC	6
PIAL	Tr
PICO	14
PIEN	109
PIMO	Tr
PIPO	Tr
POTR	Tr
POTR2	2
PSME	15
TSHE	Tr
Total	203

Down Wood—

The overall amount of down woody material is moderate compared with other tree series (app. C-3). Logs cover 10 percent of the ground surface. Smaller material is largely composed of lodgepole pine and subalpine fir. Larger logs usually are longer lived Engelmann spruce. However, ABLA2 sites are generally not capable of producing trees and logs as big as those seen in the ABAM, TSHE, or THPL series. This is primarily due to the prevalence of lodgepole pine and subalpine fir in younger stands.

Definitions of log decomposition classes are on page 15.

	Down log attributes				
Log decomposition	Tons/ acre	Cu. ft./ acre	Linear ft./ acre	Sq. ft./ acre	% ground cover
Class 1	2.57	216	321	252	0.58
Class 2	5.23	552	1,109	777	1.78
Class 3	6.94	889	2,095	1,308	3.00
Class 4	3.18	1,020	1,433	1,182	2.71
Class 5	2.67	857	912	897	2.06
Total	20.59	3,534	5,870	4,416	10.13

Snags—

The ABLA2 series has the most snags (54.3 snags per acre) of the tree series (app. C-4). Sixty-seven percent of the snags are less than 10 inches in diameter. Only 10 percent of the snags are larger than 15.5 inches in diameter. This is due primarily to the prevalence of smaller size trees, especially lodgepole pine, found in the younger stands.

Definitions of snag condition classes are on page 15.

	Snags/acre by d.b.h. class (inches)				
Snag condition	5–9.9	10–15.5	15.6–21.5	21.6+	Total
Class 1	23.5	4.1	1.2	1.0	29.8
Class 2	7.0	3.1	.8	.4	11.3
Class 3	3.1	.8	.1	.1	4.1
Class 4	1.2	2.7	.8	.3	5.0
Class 5	2.1	1.3	.5	.2	4.1
Total	36.9	12.0	3.4	2.0	54.3

Fire—

Subalpine fir is one of the least fire-resistant western conifers (Starker 1934). It is very susceptible to fire because of its thin flammable bark, shallow roots, low-growing branches, dense stands, highly flammable foliage, and moderate to heavy lichen growth. Engelmann spruce also is susceptible to fire although less so than subalpine fir.

The ABLA2 series varies from cold and wet at higher elevations and in riparian zones, to cool and dry at lower elevations. Lower elevation associations often have more frequent, less intense fires. Fires at this frequency have a tendency to kill subalpine fir and keep forests dominated by seral conifers such as Douglas-fir, lodgepole pine, or western larch (Arno and Hammerly 1984). Forests at higher elevations generally experience high-intensity stand-replacing fires at intervals of 100 years or more. These longer lived stands often have the opportunity to be dominated by subalpine fir and Engelmann spruce. The ABLA2 stands in high subalpine habitats often escape fires because of discontinuous fuels; broken, rocky terrain; and moist, cold environments in adjacent uplands (Pfister et al. 1977).

A total of 471 site index trees were sampled for age in the ABLA2 series. These trees averaged 127 years in age at breast height. One tree was over 400 years old, 9 were 300 to 399 years old, 48 were 200 to 299 years old, 206 were 100 to 199 years old, and 207 were less than 100 years old. Only 13 percent of the site index trees were more than 200 years old. Most of these older trees were Engelmann spruce, which are generally considered fire intolerant. Other old trees included western larch and Douglas-fir, which have high fire tolerance. Of 116 subalpine fir trees sampled, only 8 were older than 200 years. These data suggest that fires usually are large, stand-replacing fires. Average fire-return intervals in the ABLA2 series may be less than 150 years, perhaps closer to 100 years. However, the fire interval appears to be much longer (greater than 200 years) on wetter sites such as the ABLA2/ATFI and ABLA2/TRLA4 associations.

The fire regime of surrounding forests on uplands also may affect how often ABLA2 sites burn. Upland forests of lodgepole pine that are prone to high-intensity stand-replacement fire regimes often surround riparian and wetland zones in the ABLA2 series. The riparian zones most likely burn when the adjacent uplands experience stand-replacing fires.

Animals—

Livestock. The palatability of subalpine fir to domestic livestock is low (Dittberner and Olson 1983). In general, most ABLA2 stands have little utility for domestic livestock. Forage potential may be fair in early successional stages or on some of the wetter, open associations, but is generally poor in late-successional stages. Without suitable forage, these sites primarily represent sources of water and shade. In any case, sites are susceptible to trampling on account of high water tables and moist or wet soils.

If grazed, improving the grazing system and close monitoring of wildlife use often allows the remnant shrub and herb population to sprout and reestablish the stand. The ability to easily reestablish shrubs is lost, however, when the shrubs have been eliminated on account of overgrazing, when the soil has been compacted, or the water tables lowered because of stream downcutting. (For more information on forage palatability, see app. B-1. For potential biomass production, see app. B-5.)

Wildlife. The multiple shrub and tree layers associated with most stands provide considerable habitat diversity for wildlife. In general, these sites offer sources of cover, forage, and water. Most wildlife species use these sites in the summer as winters are cold and harsh. Many sites have large subalpine fir and Engelmann spruce trees with extensive heart rot decay that results in large trees, snags, and logs with hollow interiors.

Caribou are found in the Selkirk Mountains where they are very dependent on mature subalpine fir, Engelmann spruce, and western hemlock forests for the abundant arboreal lichens that are their staple winter food source. Some sites have an abundance of berry-producing shrubs, such as huckleberries, that provide food for a variety of birds and mammals. Large ungulates such as mule deer and elk will forage in subalpine fir stands during summer and fall. Deer, elk, moose, bighorn sheep, and snowshoe hares sometimes eat young subalpine fir, but it is not an important food item. Subalpine fir is an important food source for mountain goats and moose in winter and spring (Peek 1974, Saunders 1955). Black bears and American martens may use hollow logs for dens and rest sites. Black bears and grizzly bears also will forage on the abundant berries found in many subalpine fir stands. Grizzly bears sometimes strip off the bark of subalpine fir to eat the cambium (Blanchard 1980). Brooms formed by rusts are common, and martens use these brooms as platforms for resting. Red squirrels eat seeds from cached conifer cones (Lanner 1983). Chipmunks and mice also eat conifer seed.

Woodpeckers will forage large snags and logs, especially Engelmann spruce, for bark beetles and ants. Some common seed-eating birds include crossbills, nuthatches, pine siskin, chickadees, and Clark's nutcrackers. Blue grouse and Franklin's grouse make extensive use of fir buds, especially in winter. Other avian species include varied thrush, golden-crowned kinglet, Steller's jay, warblers, and flycatchers. Harlequin ducks and American dippers may be observed on nearby streams. (For more information on thermal or feeding cover values, see apps. B-2 and B-3. For information on food values or degree of use, see apps. B-2 and B-4.)

Fish. Riparian zones in the ABLA2 series play important roles in watershed function and hydrology. Many of these sites are located near small first- and second-order streams or basins high in the watershed where winter snowpacks are long and deep. In addition, in continental climate zones, the ABLA2 series follows cold air drainage to lower elevations into larger order drainages with larger fish-bearing streams. These areas serve as hydrologic reservoirs that help maintain streamflows during summer. Owing to windthrow and disease, many sites have an abundance of large woody debris in and along the stream channels. This woody debris, primarily large-diameter logs (especially spruce), provides good stream structure for fish and channel stabilization during peak flows associated with spring runoff or summer storms (for more information, see app. B-5, erosion control potential). The large tree canopies provide shade for the stream, helping to regulate stream water temperatures and promoting good fisheries habitat in downstream locations.

Managers may choose to maintain or manage for stands of larger conifers as future sources of woody debris. They may also manage for stable wetland series such as SALIX or ALSI along streambanks and floodplains. These buffer strips help stabilize streambanks, nearby terraces, and swales; provide a barrier to sedimentation from nearby slopes; and provide a source of large down wood for the stream and nearby fluvial surfaces.

Recreation—

Some sites are not suited for recreation uses owing to inaccessible locations or high water tables. Most recreation use on ABLA2 sites is limited to fishermen, backpackers, and day hikers passing through riparian zones along the streambank or established trails. However, the shrub layers in a few associations (such as ABLA2/RHAL/SETR) may be dense and tangled in open stands, thus resistant to access. Late-seral and old-growth stands may have high recreational value owing to their attractiveness and big trees (especially stands dominated by large Engelmann spruce). Other than fishing opportunities in nearby streams, stands in wetter associations such as ABLA2/ATFI, ABLA2/TRLA4, and ABLA2/TRCA3 are not well suited for recreation purposes owing to moist soils, high water tables, and seeps and springs.

The prevalent loam soils may be highly susceptible to compaction. Wetter sites may require wood boardwalks so that forest visitors do not trample sensitive vegetation and soils. Construction and maintenance of campgrounds and trails is not recommended on wetter associations, but others (such as ABLA2/LEGL-VASC and ABLA2/COCA) often occur on well-drained terraces well away from flood zones, providing favorable camps and trail sites. However, these sites, as well as old-growth stands, also are prone to windthrow of subalpine fir and Engelmann spruce owing to stem and root rot as well as shallow rooting systems.

Insects and Disease—

Root diseases are common in the ABLA2 series and include annosus root disease, armillaria root rot, Tomentosus root disease, brown cubical rot, rust red stringy rot, laminated root rot, and Schweinitzii butt rot (Hessburg et al. 1994). Schweinitzii butt rot is particularly common in older Engelmann spruce trees (Lillybridge et al. 1995). Some common stem rots include brown crumbly rot, brown stringy rot, red heart rot, white pocket rot, armillaria root rot, red belt fungus, and white spongy root rot. Natural or human-caused wounding of trees generally will increase damage from decay fungi in subalpine fir, whereas Engelmann spruce is more resistant. Fungal pathogens also increase, especially in subalpine fir as a result of infecting stumps from past timber harvesting.

Subalpine fir can be damaged or killed by various insects (Alexander et al. 1984, Carlson et al. 1983). Insects also attack many trees infected by fungal agents. Potential bark beetles include spruce beetle, western balsam bark beetle, fir engraver, and mountain pine beetle. The mountain pine beetle primarily infests lodgepole pine; large stands of fire-regenerated lodgepole pine are most susceptible. Other insect pests include Douglas-fir tussock moth, western black-headed budworm, balsam woolly adelgid, and fir engraver.

Estimating Vegetation Potential on Disturbed Sites—
This process is generally not needed on these conifer-dominated sites, as they are seldom heavily disturbed. Clearcutting in riparian areas is unusual on FS land, and many stands lie in wilderness. In addition, other vegetation in the SALIX, MEADOW, and ALSI series often separate the ABLA2 series from active flood zones. Currently, all FS riparian zones are buffered and not managed for timber management. If clearcut or burned in the past, subalpine fir and other conifers (especially lodgepole pine) have usually rapidly reestablished on these sites. Nearby stands or similar valley segments in nearby watersheds can help determine the potential natural vegetation in young stands or in the event of recent wildfire.

Sensitive Species—
Tweedy's willow was located on two plots in the ABLA2/LEGL-VASC and ABLA2/RHAL/SETR associations. It appears from these data that sensitive species are uncommon in the ABLA2 series (app. D).

ADJACENT SERIES

The ABLA2 series is bound below by the TSHE series in maritime climate zones. The TSHE, PIEN, or PSME series occur on lower elevation sites within inland maritime climates. The PSME series also occurs on lower elevation sites within strong continental climates. The parkland and alpine zones lie above the ABLA2 series throughout its distribution. Whitebark pine parkland (Lillybridge et al. 1995, Williams et al. 1995) usually occurs at higher elevations in both continental and inland maritime climates.

RELATIONSHIPS TO OTHER CLASSIFICATIONS

Kovalchik (1992c) described many of the plant associations in the ABLA2 series in the draft classification for northeastern Washington. Riparian plant associations described in the ABLA2 series represent relatively wet stand conditions for subalpine fir plant associations previously described for uplands on the Wenatchee NF by Lillybridge et al. (1995) and the Colville NF by Williams et al. (1995). They focused on upland environments but included several plant associations exclusive to riparian and wetland zones. Some of the associations in this classification that were derived from Lillybridge et al. (1995) and Williams et al. (1995) include ABLA2/ARLA-POPU, ABLA2/COCA, ABLA2/LIBOL, ABLA2/PAMY, ABLA2/RHAL/LUHI, ABLA2/RULA, ABLA2/TRCA3, and ABLA2/VAME. The ABLA2/ALSI, ABLA2/ATFI, ABLA2/GYDR, ABLA2/LEGL-VASC, ABLA2/OPHO, ABLA2/RHAL/SETR, ABLA2/STAMC, and ABLA2/TRLA4 associations were not previously described in published classifications for the study area except for some in the Kovalchik (1992c) draft.

Plant associations belonging to the ABLA2 series have been described in the Washington Cascade Range (Lillybridge et al. 1995, Williams and Lillybridge 1983); Colville, Spokane, and Yakima Indian reservations (Clausnitzer and Zamora 1987, John et al. 1988, Zamora 1983,); eastern Washington, northern Idaho, and Montana (Cooper et al. 1991, Daubenmire and Daubenmire 1968, Hansen et al. 1988, Hansen et al. 1995, Pfister et al. 1977, Williams et al. 1995); and central and northeastern Oregon (Crowe and Clausnitzer 1997, Hall 1973, Johnson and Clausnitzer 1992, Johnson and Simon 1987). Crowe and Clausnitzer (1997) and Hansen et al. (1998, 1995) are strictly riparian/wetland classifications. A similar "Engelmann spruce-subalpine fir zone" has been described for British Columbia (Braumandl and Curran 1992, Lloyd et al. 1990, and Meidinger and Pojar 1991). The ABLA2 series has very limited distribution west of the Cascade crest (Henderson et al. 1989, 1992).

U.S. DEPARTMENT OF THE INTERIOR, FISH AND WILDLIFE SERVICE WETLANDS CLASSIFICATION

System:	palustrine
Class:	forested wetland
Subclass:	needle-leaved evergreen
Water regime:	(nontidal) intermittently saturated to seasonally saturated

KEY TO THE SUBALPINE FIR (*ABIES LASIOCARPA*) PLANT ASSOCIATIONS

1. Saw-leaved sedge (*Carex scopulorum* var. *prionophylla*) ≥10 percent canopy coverage .... **Engelmann spruce/saw-leaved sedge (PIEN/CASCP2) association**

2. Common horsetail (*Equisetum arvense*), wood horsetail (*Equisetum sylvaticum*), and/or soft-leaved sedge (*Carex disperma*) ≥10 percent canopy coverage .... **Engelmann spruce/horsetail (PIEN/EQUIS) association**

3. Devil's club (*Oplopanax horridum*) ≥5 percent canopy coverage .... **Subalpine fir/devil's club (ABLA2/OPHO) association**

4. Lady fern (*Athyrium filix-femina*) ≥5 percent canopy coverage .... **Subalpine fir/lady fern (ABLA2/ATFI) association**

5. Oak fern (*Gymnocarpium dryopteris*) ≥5 percent canopy coverage .... **Subalpine fir/oak fern (ABLA2/GYDR) association**

6. Sitka alder (*Alnus sinuata*) ≥25 percent canopy coverage .... **Subalpine fir/Sitka alder (ABLA2/ALSI) association**

7. False bugbane (*Trautvetteria caroliniensis*) ≥5 percent canopy coverage .... **Subalpine fir/false bugbane (ABLA2/TRCA3) association**

8. Globeflower (*Trollius laxus*) ≥2 percent canopy coverage .... **Subalpine fir/globeflower (ABLA2/TRLA4) association**

9. Labrador tea (*Ledum glandulosum*) ≥5 percent canopy coverage .... **Subalpine fir/Labrador tea-grouse huckleberry (ABLA2/LEGL-VASC) association**

10. Cascade azalea (*Rhododendron albiflorum*) ≥5 percent canopy coverage:

    10a. Smooth woodrush (*Luzula hitchcockii*) ≥1 percent canopy coverage .... **Subalpine fir/Cascade azalea/smooth woodrush (ABLA2/RHAL/LUHI) association**

    10b. Smooth woodrush (*Luzula hitchcockii*) <1 percent canopy coverage (sites generally wetter) .... **Subalpine fir/Cascade azalea/arrow-leaf groundsel (ABLA2/RHAL/SETR) association**

11. Claspleaf twisted-stalk (*Streptopus amplexifolius*) ≥1 percent canopy coverage .... **Subalpine fir/claspleaf twisted-stalk (ABLA2/STAMC) association**

12. Dwarf bramble (*Rubus lasiococcus*) ≥2 percent canopy coverage .... **Subalpine fir/dwarf bramble (ABLA2/RULA) association**

13. Bunchberry dogwood (*Cornus canadensis*) ≥2 percent canopy coverage .... **Subalpine fir/bunchberry dogwood (ABLA2/COCA) association**

14. Myrtle pachistima (*Pachistima myrsinites*) ≥5 percent canopy coverage .... **Subalpine fir/myrtle pachistima (ABLA2/PAMY) association**

15. Dwarf huckleberry (*Vaccinium caespitosum*) or bearberry (*Arctostaphylos uva-ursi*) ≥5 percent canopy coverage; cold-air drainage sites .... **Subalpine fir/dwarf huckleberry (ABLA2/VACA) association** (not described here—see Williams et al. 1995)

16. Twinflower (*Linnaea borealis* var. *longiflora*) ≥5 percent canopy coverage .... **Subalpine fir/twinflower (ABLA2/LIBOL) association**

17. Mountain arnica (*Arnica latifolia*), skunkleaf polemonium (*Polemonium pulcherrimum*) or Sitka valerian (*Valeriana sitchensis*) ≥2 percent canopy coverage .... **Subalpine fir/mountain arnica-skunkleaf polemonium (ABLA2/ARLA-POPU) association**

18. Big huckleberry (*Vaccinium membranaceum*) ≥5 percent canopy coverage .... **Subalpine fir/big huckleberry (ABLA2/VAME) association**

19. Grouse huckleberry (*Vaccinium scoparium*) ≥5 percent canopy coverage .... **Subalpine fir/grouse huckleberry (ABLA2/VASC) association** (not described here—see Williams et al. 1995)

Table 5—Constancy and mean cover of important plant species in the ABLA2 plant associations—Part 1

Species	Code	ABLA2/ALSI 3 plots		ABLA2/ARLA-POPU 3 plots		ABLA2/ATFI 10 plots		ABLA2/COCA 21 plots		ABLA2/GYDR 19 plots		ABLA2/LEGL-VASC 16 plots		ABLA2/LIBOL 4 plots		ABLA2/OPHO 3 plots	
		CON[a]	COV[b]	CON	COV	CON	COV	CON	COV	CON	COV	CON	COV	CON	COV	CON	COV
Tree overstory:																	
subalpine fir	ABLA2	100	6	100	28	90	23	86	11	100	16	88	14	100	5	100	27
western larch	LAOC	—	—	—	—	10	3	52	13	32	3	—	—	75	15	—	—
Engelmann spruce	PIEN	100	42	100	33	100	32	95	37	100	34	88	29	100	11	100	30
lodgepole pine	PICO	—	—	33	10	10	Tr[c]	38	6	21	1	63	18	100	26	—	—
Douglas-fir	PSME	—	—	—	—	20	5	81	15	42	12	—	—	75	15	33	5
Tree understory:																	
subalpine fir	ABLA2	67	2	100	19	90	3	81	7	100	7	100	8	100	6	100	7
Engelmann spruce	PIEN	67	3	100	8	100	2	95	5	95	4	88	6	100	6	100	1
Douglas-fir	PSME	—	—	—	—	—	—	52	5	26	2	—	—	75	4	—	—
Shrubs:																	
Douglas maple	ACGLD	—	—	—	—	20	15	24	6	26	9	—	—	—	—	33	2
mountain alder	ALIN	—	—	—	—	40	5	14	2	53	3	13	4	—	—	—	—
Sitka alder	ALSI	100	58	33	5	30	Tr	24	2	42	3	13	3	—	—	67	30
Saskatoon serviceberry	AMAL	—	—	—	—	—	—	67	2	47	1	6	Tr	25	1	—	—
red-osier dogwood	COST	—	—	—	—	20	2	29	7	58	3	—	—	—	—	—	—
bearberry honeysuckle	LOIN	67	2	67	5	40	1	62	2	37	2	63	2	50	1	33	2
Utah honeysuckle	LOUT	—	—	—	—	40	2	62	3	47	2	6	Tr	50	3	—	—
rusty menziesia	MEFE	—	—	—	—	30	22	5	Tr	11	11	—	—	—	—	33	70
devil's club	OPHO	—	—	—	—	—	—	—	—	11	3	—	—	—	—	100	13
Cascade azalea	RHAL	—	—	—	—	20	7	5	1	16	11	38	6	—	—	33	10
Hudsonbay currant	RIHU	33	20	—	—	20	1	—	—	16	1	—	—	—	—	33	5
prickly currant	RILA	67	5	33	10	100	6	76	3	95	2	38	2	25	1	100	7
baldhip rose	ROGY	—	—	—	—	10	Tr	57	3	16	2	—	—	—	—	—	—
western thimbleberry	RUPA	33	Tr	33	Tr	70	2	57	3	79	4	—	—	—	—	33	50
Scouler's willow	SASC	33	3	—	—	—	—	—	—	11	3	6	2	—	—	33	8
Cascade mountain-ash	SOSC2	33	Tr	33	2	30	1	19	2	26	Tr	13	Tr	—	—	—	—
shiny-leaf spiraea	SPBEL	—	—	—	—	10	Tr	33	3	37	1	13	1	—	—	—	—
common snowberry	SYAL	33	Tr	—	—	40	1	48	3	37	2	—	—	—	—	—	—
big huckleberry	VAME	—	—	33	13	40	14	38	3	37	4	25	6	25	4	33	5
Low shrubs and subshrubs:																	
western prince's-pine	CHUM	—	—	—	—	10	4	71	2	26	2	6	Tr	75	2	33	Tr
bunchberry dogwood	COCA	—	—	—	—	30	Tr	100	11	68	6	19	3	25	1	—	—
Labrador tea	LEGL	—	—	33	6	—	—	10	1	5	12	100	24	—	—	—	—
twinflower	LIBOL	—	—	—	—	—	—	95	11	79	7	44	6	100	6	—	—
myrtle pachistima	PAMY	—	—	67	18	20	Tr	76	4	21	1	19	10	100	3	67	2
red mountain-heath	PHEM	—	—	33	3	—	—	—	—	—	—	38	7	—	—	—	—
dwarf bramble	RULA	—	—	—	—	—	—	—	—	11	4	—	—	—	—	—	—
five-leaved bramble	RUPE	—	—	—	—	60	6	14	4	53	8	—	—	—	—	—	—
dwarf huckleberry	VACA	—	—	33	2	—	—	24	5	—	—	6	Tr	—	—	—	—
low huckleberry	VAMY	—	—	67	1	—	—	29	6	21	4	31	9	50	3	—	—
grouse huckleberry	VASC	—	—	33	1	20	1	38	6	5	3	81	43	50	38	—	—
Perennial forbs:																	
deerfoot vanilla-leaf	ACTR	—	—	—	—	10	10	—	—	—	—	—	—	—	—	—	—
baneberry	ACRU	33	Tr	—	—	40	1	38	2	74	1	—	—	—	—	67	1
pathfinder	ADBI	—	—	—	—	10	Tr	10	2	26	1	—	—	—	—	33	Tr
sharptooth angelica	ANAR	67	1	67	4	10	Tr	—	—	26	1	19	1	—	—	33	Tr

Table 5—Constancy and mean cover of important plant species in the ABLA2 plant associations—Part 1 (continued)

		ABLA2/ALSI 3 plots		ABLA2/ARLA-POPU 3 plots		ABLA2/ATFI 10 plots		ABLA2/COCA 21 plots		ABLA2/GYDR 19 plots		ABLA2/LEGL-VASC 16 plots		ABLA2/LIBOL 4 plots		ABLA2/OPHO 3 plots	
Species	**Code**	CON	COV	CON	COV	CON	COV	CON	COV	CON	COV	CON	COV	CON	COV	CON	COV
wild sarsaparilla	ARNU3	—	—	—	—	—	—	10	18	—	—	—	—	—	—	—	—
heartleaf arnica	ARCO	33	Tr	33	1	20	4	38	2	26	2	44	2	—	—	—	—
mountain arnica	ARLA	33	Tr	67	4	—	—	5	1	—	—	38	6	—	—	67	Tr
queencup beadlily	CLUN	—	—	—	—	50	3	43	2	42	2	—	—	25	1	33	Tr
Hooker's fairy-bells	DIHO	—	—	—	—	30	1	5	5	5	1	—	—	—	—	33	Tr
dentate shooting-star	DODE	—	—	—	—	10	1	5	Tr	16	1	—	—	—	—	—	—
sweetscented bedstraw	GATR	67	Tr	33	Tr	90	2	57	2	95	1	—	—	—	—	—	—
western rattlesnake plantain	GOOB	—	—	—	—	60	1	52	1	37	1	—	—	25	4	33	Tr
common cow-parsnip	HELA	67	1	33	5	30	1	10	1	21	Tr	—	—	—	—	—	—
partridgefoot	LUPE	—	—	—	—	—	—	—	—	—	—	6	1	—	—	—	—
broadleaf lupine	LULA	—	—	33	1	—	—	—	—	—	—	19	Tr	25	35	—	—
fivestamen miterwort	MIPE	—	—	—	—	30	3	—	—	5	5	—	—	—	—	—	—
mountain sweet-root	OSCH	—	—	33	Tr	30	2	52	2	26	1	13	4	25	1	33	2
purple sweet-root	OSPU	67	Tr	33	Tr	20	1	24	1	21	2	6	Tr	—	—	33	Tr
skunkleaf polemonium	POPU	—	—	67	1	—	—	—	—	5	Tr	19	Tr	—	—	—	—
pink wintergreen	PYAS	—	—	—	—	50	2	14	Tr	42	1	13	1	—	—	33	Tr
sidebells pyrola	PYSE	33	1	100	1	70	2	76	2	58	1	50	1	75	2	33	1
brook saxifrage	SAAR	—	—	—	—	10	4	—	—	5	2	—	—	—	—	—	—
dotted saxifrage	SAPU	67	1	—	—	10	1	—	—	11	Tr	13	Tr	—	—	—	—
arrowleaf groundsel	SETR	67	1	33	1	50	3	10	Tr	37	1	31	1	—	—	33	Tr
starry solomonplume	SMST	—	—	—	—	50	1	62	1	42	1	6	2	—	—	—	—
claspleaf twisted-stalk	STAM	33	1	—	—	70	2	33	1	84	2	44	1	—	—	67	Tr
western meadowrue	THOC	67	Tr	33	25	30	1	38	2	21	Tr	13	9	25	3	33	Tr
coolwort foamflower	TITRU	33	Tr	—	—	90	8	29	2	79	7	—	—	25	1	33	Tr
false bugbane	TRCA3	—	—	—	—	30	2	14	1	37	3	6	5	—	—	—	—
globeflower	TRLA4	67	Tr	33	Tr	10	Tr	—	—	5	Tr	25	1	—	—	—	—
Sitka valerian	VASI	33	1	100	22	20	2	5	1	21	1	75	3	—	—	—	—
American false hellebore	VEVI	—	—	—	—	30	2	—	—	11	3	13	Tr	—	—	—	—
Canadian violet	VICA	—	—	—	—	10	10	5	Tr	5	Tr	—	—	—	—	—	—
pioneer violet	VIGL	67	Tr	33	1	30	1	24	2	42	1	6	Tr	—	—	33	Tr
Grasses or grasslike:																	
pinegrass	CARU	—	—	—	—	—	—	62	6	5	5	13	Tr	50	18	—	—
northwestern sedge	CACO	—	—	—	—	—	—	38	3	5	2	6	2	75	2	—	—
soft-leaved sedge	CADI	—	—	—	—	10	3	5	Tr	42	2	—	—	—	—	—	—
saw-leaved sedge	CASCP2	—	—	—	—	—	—	—	—	5	4	44	3	—	—	—	—
wood reed-grass	CILA2	33	Tr	—	—	40	1	14	Tr	58	1	13	Tr	—	—	—	—
blue wildrye	ELGL	—	—	33	5	10	Tr	10	1	5	Tr	—	—	—	—	—	—
smooth woodrush	LUHI	—	—	33	1	10	2	—	—	—	—	13	Tr	—	—	—	—
smallflowered woodrush	LUPA	—	—	—	—	—	—	—	—	21	Tr	13	Tr	—	—	—	—
Ferns and fern allies:																	
lady fern	ATFI	33	Tr	—	—	100	12	10	Tr	68	1	—	—	—	—	100	4
wood-fern	DREX	—	—	—	—	20	10	—	—	5	Tr	—	—	—	—	—	—
wood-fern species	DRYOP	—	—	—	—	—	—	—	—	—	—	—	—	—	—	33	25
common horsetail	EQAR	33	3	—	—	40	2	19	1	68	2	19	1	—	—	—	—
oak fern	GYDR	—	—	—	—	70	15	10	1	100	19	—	—	—	—	—	—

Table 5—Constancy and mean cover of important plant species in the ABLA2 plant associations—Part 2

Species	Code	ABLA2/PAMY 7 plots		ABLA2/RHAL/ LUHI 2 plots		ABLA2/RHAL/ SETR 10 plots		ABLA2/ABLA2/ RULA 2 plots		ABLA2/STAMC 6 plots		ABLA2/TRCA3 19 plots		ABLA2/TRLA4 12 plots		ABLA2/VAME 2 plots	
		CON[a]	COV[b]	CON	COV	CON	COV	CON	COV	CON	COV	CON	COV	CON	COV	CON	COV
Tree overstory:																	
subalpine fir	ABLA2	100	22	100	23	100	12	100	19	100	18	89	22	83	11	100	14
western larch	LAOC	—	—	—	—	—	—	50	3	—	—	42	19	—	—	—	—
Engelmann spruce	PIEN	100	33	100	18	90	18	100	13	100	36	89	25	100	32	100	23
lodgepole pine	PICO	29	1	—	—	30	13	—	—	50	2	42	19	33	7	—	—
Douglas-fir	PSME	86	22	—	—	10	5	100	18	50	2	37	5	—	—	50	28
Tree understory:																	
subalpine fir	ABLA2	100	7	100	10	100	7	100	4	100	3	74	10	83	7	100	4
Engelmann spruce	PIEN	100	7	100	3	90	2	100	Tr	83	3	74	5	75	3	100	5
Douglas-fir	PSME	14	Tr[c]	—	—	—	—	50	3	—	—	5	Tr	—	—	—	—
Shrubs:																	
Douglas maple	ACGLD	43	1	—	—	—	—	50	Tr	17	Tr	—	—	—	—	—	—
mountain alder	ALIN	43	7	—	—	—	—	—	—	67	13	42	7	—	—	—	—
Sitka alder	ALSI	43	3	—	—	30	3	—	—	33	7	32	7	—	—	50	18
Saskatoon serviceberry	AMAL	57	4	—	—	—	—	50	Tr	—	—	16	1	—	—	—	—
red-osier dogwood	COST	29	3	—	—	—	—	—	—	—	—	5	1	—	—	—	—
bearberry honeysuckle	LOIN	86	1	—	—	40	4	50	Tr	100	1	42	1	25	2	100	1
Utah honeysuckle	LOUT	—	—	—	—	10	Tr	—	—	33	Tr	42	2	—	—	—	—
rusty menziesia	MEFE	—	—	—	—	10	1	—	—	—	—	11	3	—	—	—	—
devil's club	OPHO	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Cascade azalea	RHAL	—	—	100	36	100	52	—	—	17	Tr	16	1	17	6	—	—
Hudsonbay currant	RIHU	—	—	—	—	—	—	—	—	33	1	32	1	—	—	—	—
prickly currant	RILA	100	4	—	—	40	2	100	1	100	3	89	5	17	4	100	3
baldhip rose	ROGY	29	4	—	—	—	—	50	Tr	—	—	5	2	—	—	50	30
western thimbleberry	RUPA	57	2	—	—	—	—	50	2	33	2	32	3	—	—	50	4
Scouler's willow	SASC	14	3	—	—	10	10	—	—	33	5	11	2	—	—	—	—
Cascade mountain-ash	SOSC2	43	1	—	—	20	2	—	—	33	Tr	11	2	8	Tr	50	5
shiny-leaf spiraea	SPBEL	43	3	—	—	10	Tr	—	—	33	Tr	5	1	—	—	50	1
common snowberry	SYAL	14	1	—	—	—	—	50	12	—	—	16	1	—	—	100	21
big huckleberry	VAME	43	2	50	12	80	10	50	Tr	17	Tr	37	11	8	5	100	35
Low shrubs and subshrubs:																	
western prince's-pine	CHUM	57	1	—	—	20	1	—	—	17	Tr	32	1	8	1	50	3
bunchberry dogwood	COCA	—	—	—	—	—	—	—	—	17	Tr	21	2	8	1	—	—
Labrador tea	LEGL	14	3	50	2	50	4	—	—	33	Tr	—	—	50	2	—	—
twinflower	LIBOL	—	—	—	—	—	—	50	Tr	50	Tr	47	4	—	—	50	15
myrtle pachistima	PAMY	100	23	—	—	20	Tr	100	Tr	17	Tr	37	1	8	Tr	100	44
red mountain-heath	PHEM	—	—	100	7	50	1	—	—	—	—	—	—	33	4	—	—
dwarf bramble	RULA	—	—	—	—	—	—	100	4	—	—	11	17	—	—	—	—
five-leaved bramble	RUPE	14	1	—	—	10	Tr	—	—	17	Tr	11	10	8	5	—	—
dwarf huckleberry	VACA	—	—	—	—	—	—	—	—	—	—	—	—	25	3	—	—
low huckleberry	VAMY	43	1	50	60	40	12	—	—	67	Tr	26	3	—	—	—	—
grouse huckleberry	VASC	43	1	50	8	50	11	50	Tr	33	4	16	3	100	5	—	—
Perennial forbs:																	
deerfoot vanilla-leaf	ACTR	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
baneberry	ACRU	29	Tr	—	—	10	Tr	50	Tr	50	1	16	5	—	—	—	—
pathfinder	ADBI	14	Tr	—	—	—	—	50	20	—	—	—	—	—	—	—	—
sharptooth angelica	ANAR	14	Tr	—	—	—	—	50	Tr	50	Tr	32	2	—	—	50	3
wild sarsaparilla	ARNU3	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

Table 5—Constancy and mean cover of important plant species in the ABLA2 plant associations—Part 2 (continued)

Species	Code	ABLA2/PAMY 7 plots		ABLA2/RHAL/LUHI 2 plots		ABLA2/RHAL/SETR 10 plots		ABLA2/ABLA2/RULA 2 plots		ABLA2/STAMC 6 plots		ABLA2/TRCA3 19 plots		ABLA2/TRLA4 12 plots		ABLA2/VAME 2 plots	
		CON	COV	CON	COV	CON	COV	CON	COV	CON	COV	CON	COV	CON	COV	CON	COV
mountain arnica	ARLA	—	—	100	3	50	6	—	—	—	—	16	26	67	3	—	—
queencup beadlily	CLUN	29	16	—	—	—	—	50	2	—	—	42	4	—	—	50	55
Hooker's fairy-bells	DIHO	29	Tr	—	—	—	—	50	1	—	—	11	1	8	Tr	—	—
dentate shooting-star	DODE	—	—	—	—	10	Tr	—	—	50	1	5	Tr	25	4	—	—
sweetscented bedstraw	GATR	43	Tr	—	—	—	—	—	—	83	Tr	58	2	—	—	50	1
western rattlesnake plantain	GOOB	57	Tr	—	—	20	Tr	50	Tr	17	Tr	42	1	—	—	50	1
common cow-parsnip	HELA	—	—	—	—	10	Tr	50	Tr	33	Tr	16	1	—	—	50	Tr
partridgefoot	LUPE	—	—	50	50	20	2	—	—	—	—	—	—	—	—	—	—
broadleaf lupine	LULA	—	—	—	—	10	Tr	—	—	—	—	11	26	33	Tr	—	—
fivestamen miterwort	MIPE	—	—	—	—	40	1	50	Tr	33	1	5	2	58	7	—	—
mountain sweet-root	OSCH	14	Tr	—	—	10	Tr	50	3	—	—	32	2	17	3	—	—
purple sweet-root	OSPU	43	Tr	—	—	10	Tr	—	—	—	—	16	5	33	1	100	1
skunkleaf polemonium	POPU	—	—	—	—	—	—	—	—	—	—	5	3	42	1	—	—
pink wintergreen	PYAS	14	Tr	—	—	—	—	—	—	33	Tr	16	6	25	1	50	3
sidebells pyrola	PYSE	100	1	50	1	50	1	100	1	100	1	95	2	50	1	50	2
brook saxifrage	SAAR	—	—	—	—	10	1	—	—	100	1	—	—	—	—	—	—
dotted saxifrage	SAPU	14	Tr	—	—	20	1	50	Tr	—	—	16	5	25	17	—	—
arrowleaf groundsel	SETR	—	—	100	Tr	50	1	50	Tr	83	Tr	47	1	100	3	—	—
starry solomonplume	SMST	29	Tr	—	—	—	—	50	15	—	—	42	1	—	—	50	30
claspleaf twisted-stalk	STAM	29	Tr	—	—	60	1	50	Tr	100	1	42	2	50	1	—	—
western meadowrue	THOC	43	Tr	50	Tr	—	—	100	Tr	50	1	53	3	67	2	100	2
coolwort foamflower	TITRU	43	Tr	—	—	10	Tr	—	—	—	—	53	3	8	20	50	4
false bugbane	TRCA3	—	—	—	—	20	3	50	Tr	—	—	95	19	—	—	—	—
globeflower	TRLA4	—	—	—	—	20	2	—	—	17	Tr	5	Tr	100	7	—	—
Sitka valerian	VASI	14	Tr	100	4	60	6	—	—	17	Tr	16	3	83	14	50	25
American false hellebore	VEVI	—	—	50	1	50	2	—	—	—	—	11	2	58	2	—	—
Canadian violet	VICA	—	—	—	—	—	—	—	—	—	—	5	2	—	—	—	—
pioneer violet	VIGL	29	Tr	—	—	—	—	—	—	33	Tr	37	4	17	1	100	2
Grasses or grasslike:																	
pinegrass	CARU	—	—	—	—	—	—	—	—	17	Tr	11	2	—	—	50	3
northwestern sedge	CACO	—	—	—	—	—	—	—	—	—	—	5	3	—	—	—	—
soft-leaved sedge	CADI	—	—	—	—	—	—	—	—	50	Tr	11	2	8	3	—	—
saw-leaved sedge	CASCP2	14	Tr	—	—	70	1	—	—	50	1	11	Tr	42	2	—	—
wood reed-grass	CILA2	—	—	—	—	—	—	50	Tr	50	Tr	11	1	—	—	—	—
blue wildrye	ELGL	—	—	—	—	—	—	50	2	—	—	—	—	—	—	50	2
smooth woodrush	LUHI	—	—	100	1	30	Tr	—	—	—	—	—	—	50	3	—	—
smallflowered woodrush	LUPA	14	Tr	—	—	—	—	—	—	67	Tr	16	Tr	33	Tr	—	—
Ferns and fern allies:																	
lady fern	ATFI	—	—	—	—	—	—	—	—	17	Tr	21	2	—	—	—	—
wood-fern	DREX	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
wood-fern species	DRYOP	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
common horsetail	EQAR	43	1	—	—	—	—	—	—	50	Tr	32	1	—	—	—	—
oak fern	GYDR	14	Tr	—	—	—	—	—	—	—	—	11	Tr	—	—	50	3

[a] CON = percentage of plots in which the species occurred.
[b] COV = average canopy cover in plots in which the species occurred.
[c] Tr = trace cover, less than 1 percent canopy cover.

ENGELMANN SPRUCE SERIES

Picea engelmannii

PIEN N = 100

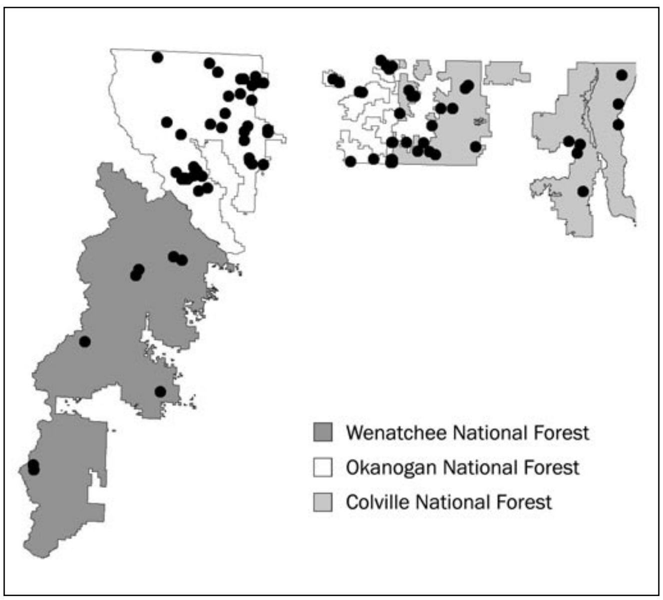


Figure 12—Plot locations for the Engelmann spruce series.

THE RANGE OF Engelmann spruce[1] extends from central British Columbia east to southwestern Alberta, south on the eastern slopes of the Cascade Range, and southeast and south through the Rocky Mountain states to New Mexico and Arizona (Hitchcock and Cronquist 1973). It is a minor component of forests on the west side of the Cascade Range (Alexander and Shepperd 1984).

Engelmann spruce is often thought of as a high-elevation upland species, but in eastern Washington it is found at various elevations on well-drained soils in riparian zones as well as on semipermanently saturated soils in wetlands (Kovalchik 1992c). It is also a very common species at timberline, where it often depends on subalpine larch or whitebark pine "mother tree" microsites for regeneration (Lillybridge et al. 1995). It eventually assumes a surprisingly large, erect form on these sites. Engelmann spruce is commonly codominant with subalpine fir in ABLA2 series upland stands (Lillybridge et al. 1995, Williams et al. 1995) and is also a seral component of the tree canopy in other upland series.

The literature generally considers climax stands of Engelmann spruce as widely scattered and characterized by the absence or scant representation of subalpine fir (Alexander 1987, Pfister et al. 1977, Steele et al. 1983). The PIEN series is generally restricted to wet or cold habitats.

Three conditions lead to a relatively widespread occurrence of the PIEN series in eastern Oregon and eastern Washington (Kovalchik 1987, 1992c). First, Engelmann spruce's shallow, widespread root system allows it to tolerate wetter soil conditions than subalpine fir and other conifers in eastern Washington. The PIEN series dominates many forested wetlands over a wide range of elevations. Secondly, Engelmann spruce also tolerates warmer temperatures than subalpine fir in eastern Washington. This tolerance is aided by the apparent hybridization of Engelmann spruce with white spruce near the Canadian border. Therefore many PIEN sites lie at elevations below the ecological extent of subalpine fir. Finally, extensive areas of continental climate provide an abundance of moist, warm PIEN sites that other series (ABGR, THPL, and TSHE) would occupy within maritime and inland maritime climates.

Engelmann spruce is quite shade tolerant compared with Douglas-fir and ponderosa pine, and it is roughly equivalent to subalpine fir. It is less shade tolerant than mountain hemlock, Pacific silver fir, western redcedar, western hemlock, and (perhaps) grand fir. Like subalpine fir, the PIEN series is most common in areas characterized by continental climates such as those in the northern Cascade Range and the Okanogan Highlands east of the Okanogan Cascade crest, north of the Entiat River, and west of the Kettle Range. In maritime climatic zones the PIEN series is generally replaced by conifers with greater shade tolerance in riparian zones and is largely restricted to wetland sites where other conifers have difficulty growing on waterlogged soils. The PIEN series (other than the PIEN/EQUIS association) was not described in the forested upland classifications for eastern Washington (Lillybridge et al. 1995, Williams et al. 1995).

[1] See appendix A for a cross reference for all species codes and common and scientific names used in this document.

Engelmann spruce plant associations

	Scientific name	Common name	Ecoclass code	Plots
Major associations:				
PIEN/CASCP2	*Picea engelmannii/Carex scopulorum* var. *prionophylla*	Engelmann spruce/saw-leaved sedge	CEM131	31
PIEN/COCA	*Picea engelmannii/Cornus canadensis*	Engelmann spruce/bunchberry dogwood	CEM321	18
PIEN/COST	*Picea engelmannii/Cornus stolonifera*	Engelmann spruce/red-osier dogwood	CES511	16
PIEN/EQUIS	*Picea engelmannii/Equisetum* species	Engelmann spruce/horsetail species	CEM211	19
PIEN/SYAL	*Picea engelmannii/Symphoricarpos albus*	Engelmann spruce/common snowberry	CES521	8
Minor associations:				
PIEN/ARNU3	*Picea engelmannii/Aralia nudicaulis*	Engelmann spruce/wild sarsaparilla	CEM214	4
PIEN/GYDR	*Picea engelmannii/Gymnocarpium dryopteris*	Engelmann spruce/oak fern	CEM21	4

CLASSIFICATION DATABASE

The presence of Engelmann spruce as the most successful conifer is characteristic of the series. The series was sampled on all three NFs and all RDs in eastern Washington (fig. 12). Seventy-seven riparian and wetland sample plots were measured in the PIEN series. Data from an additional 23 plots from other ecology data were included to facilitate classification and to provide additional data for species composition, distribution, and elevation. From this database, five major and two minor plant associations are recognized. Three other potential one-plot associations (PIEN/ALLUVIAL BAR, PIEN/BEGL-SCMI, and PIEN/PAMY) are not used in the database or described in this classification. For the most part, the information in the PIEN series represents mature stands in late-seral to climax conditions. However, some mid-seral plots were located in zones of extensive, mature lodgepole pine stands that originated in the widespread stand-replacing fires of the early 1900s.

VEGETATION CHARACTERISTICS

Late-seral and climax stands are dominated by large, long-lived Engelmann spruce. Engelmann spruce is the most common tree in the understory. Although relatively intolerant of high water tables, subalpine fir overstory and understory is common on dry, raised hummocks in the wetter PIEN/CASCP2 and PIEN/EQUIS associations. Even though subalpine fir may have 10 percent or more canopy coverage in some stands in these two associations, the stands are keyed to the PIEN series on account of the dominance of Engelmann spruce and the greater tolerance of spruce to wet soil conditions. Seral conifer tree species differ greatly by association but include lodgepole pine, Douglas-fir, western larch, and ponderosa pine. Seral deciduous trees include quaking aspen, black cottonwood, and paper birch. Lodgepole pine is a common seral species in some of the moderate- to high-elevation associations such as PIEN/CASCP2 and PIEN/COCA, as well as in fire-regenerated stands. Lodgepole pine is also relatively tolerant of high water tables (Kovalchik 1987) and is occasionally common in wetter associations such as PIEN/CASCP2. Douglas-fir and western larch are more common on drier, well-drained associations such as PIEN/COCA, PIEN/COST, PIEN/GYDR, and PIEN/SYAL.

Shrub species are common to abundant, and their composition differs by association. Primary indicators include red-osier dogwood, common snowberry, and bunchberry dogwood. Other common shrubs include bearberry honeysuckle, western thimbleberry, myrtle pachistima, and twinflower on drier sites; mountain alder, Sitka alder, prickly currant, and willow species on wetter sites.

Indicator herbs include saw-leaved sedge, wild sarsaparilla, oak fern, and various horsetails, especially common horsetail. Common dry site herbs include sweetscented bedstraw, starry solomonplume, and western meadowrue. Arrowleaf groundsel, claspleaf twisted-stalk, and false bugbane are found on wetter sites.

PHYSICAL SETTING

Elevation—

The PIEN series occurs over a wide elevation range compared with most forested series. Most plots lie between 2,200 and 6,300 feet, which reflects the great ecological amplitude of the PIEN series. The upper elevation range is about 1,000 feet higher on the Okanogan NF owing to higher elevation timberlines associated with strong continental climate.

	Elevation (feet)			
Forest	Minimum	Maximum	Average	N
Colville	2,210	6,250	3,999	26
Okanogan	2,170	7,200	3,862	65
Wenatchee	2,380	5,920	3,996	9
Series	2,170	7,200	3,910	100

Additional insight is gained by comparing elevation by plant association. Most plots represent a zone that is low to moderate in elevation and warmer than that of subalpine fir. The one major exception is the PIEN/CASCP2 association, which occurs at moderate to high elevations. Stands in the other six associations are generally found below 4,500 feet. The PIEN/COST and PIEN/SYAL associations represent warmer, lower elevation sites.

Plant association	Elevation (feet)			N
	Minimum	Maximum	Average	
PIEN/CASCP2	4,060	7,200	5,217	31
PIEN/EQUIS	2,600	4,880	3,859	19
PIEN/GYDR	2,980	4,200	3,390	4
PIEN/ARNU3	2,190	4,400	3,348	4
PIEN/COCA	2,210	4,850	3,307	18
PIEN/SYAL	2,190	4,280	3,055	8
PIEN/COST	2,250	3,700	2,815	16
Series	2,170	7,200	3,910	100

Valley Geomorphology—

Plots in the Engelmann spruce series are located in a variety of valley width and valley gradient classes. Over 80 percent of sampled plots are located in moderate to very broad (99 to greater than 990 feet) valleys. These wider valleys are largely characterized by very low to moderate (less than 1 to 5 percent) valley gradient and include both riparian and wetland zones. A smaller number of sites are found in narrower (less than 99 feet), steeper (greater than 5 percent) riparian valleys.

Valley width	Valley gradient					N
	Very low	Low	Moderate	Steep	Very steep	
Very broad	17	8	0	0	0	25
Broad	7	10	2	0	0	19
Moderate	2	6	7	1	1	17
Narrow	0	2	3	1	3	9
Very narrow	0	0	1	2	4	7
Series total	26	26	13	4	8	77

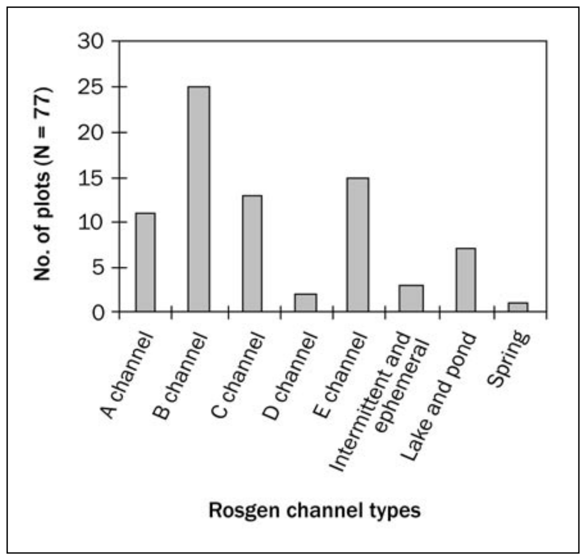
Little additional insight is gained by looking at individual plant associations. The PIEN/CASCP2 and PIEN/EQUIS associations prefer gentle gradient valleys of moderate or greater width, reflecting the need for high water tables in these wet associations. The PIEN/ARNU3 association appears to prefer steeper, narrower valleys. The relations of other associations to valley geomorphology were not quite as clear, perhaps owing to small sample sizes.

Plant association	Valley width					N
	Very broad	Broad	Moderate	Narrow	Very narrow	
PIEN/ARNU3	0	0	0	1	2	3
PIEN/CASCP2	14	5	4	1	5	29
PIEN/COCA	1	4	2	2	0	9
PIEN/COST	3	4	4	3	0	14
PIEN/EQUIS	6	3	3	1	0	13
PIEN/GYDR	0	0	3	0	0	3
PIEN/SYAL	1	3	1	1	0	6
Series total	25	19	17	9	7	77

Plant association	Valley gradient					N
	Very low	Low	Moderate	Steep	Very steep	
PIEN/ARNU3	0	0	1	0	2	3
PIEN/CASCP2	15	7	2	2	3	29
PIEN/COCA	3	4	1	0	1	9
PIEN/COST	0	6	4	2	2	14
PIEN/EQUIS	8	4	1	0	0	13
PIEN/GYDR	0	2	1	0	0	3
PIEN/SYAL	0	3	3	0	0	6
Series total	26	26	13	4	8	77

Channel Types—

Because of the range of valley width and gradient classes, the PIEN series occurs along a variety of channel types. The many wide, low gradient valleys associated with the PIEN series are characterized by Rosgen C or E channels, ponds, or lakes. On low and moderate gradient valley bottoms of moderate width, B channels increase. On narrower, steeper gradient valleys, A channels are prominent. A small number of PIEN series plots are located along D, intermittent, and ephemeral channels or springs.



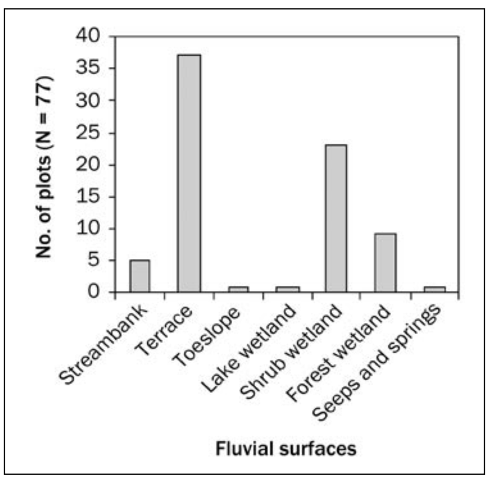
The data for individual associations add additional insight to the observations for the PIEN series. A, B, and intermittent channels are consistent with the relatively narrow, steep valleys associated with the PIEN/ARNU3 association. The PIEN/CASCP2 association is found in a variety of valley configurations supporting various channel types; however, gentler, wider valleys with C and E channels or lakes and ponds predominate. The PIEN/EQUIS wetlands are mostly along relatively wide, gentle valleys with B, C, and E channels. Both PIEN/CASCP2 and PIEN/EQUIS sites are wet for most of the year. The PIEN/GYDR, PIEN/COCA, PIEN/COST, and PIEN/SYAL associations are found mostly along B channels, possibly reflecting their need for better drained soils.

Plant association	Rosgen channel types							N
	A	B	C	E	Intermittent/ ephemeral	Lake/ pond	Other*	
PIEN/ARNU3	1	1	0	0	1	0	0	3
PIEN/CASCP2	5	5	2	11	1	4	1	29
PIEN/COCA	1	4	1	1	0	2	0	9
PIEN/COST	3	4	6	0	0	0	1	14
PIEN/EQUIS	0	5	3	3	1	1	0	13
PIEN/GYDR	0	3	0	0	0	0	0	3
PIEN/SYAL	1	3	1	0	0	0	1	6
Series total	11	25	13	15	3	7	3	77

* "Other" includes both D channel and springs.

Fluvial Surfaces—

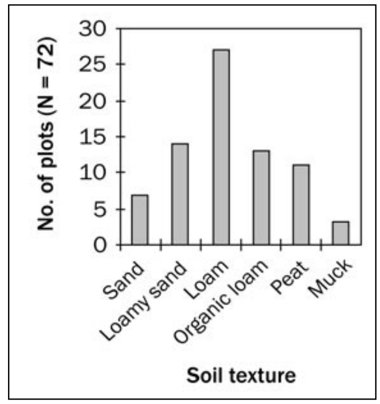
The PIEN series plots are common on both riparian and wetland sites. Sites found in riparian zones usually are located on terraces, with a few sites on well-drained streambanks. Toeslopes are underrepresented in the database. Small areas such as seeps and springs supporting the PIEN series are common but small in size, thus difficult to sample independently from bordering uplands. Alluvial bar, point bar, floodplain, and streambank sites are generally flooded too frequently to support the PIEN series. Rather they are occupied more often by series such as SALIX, COST, or ALIN.



Additional insight is gained by comparing fluvial surfaces to individual plant associations. Virtually all the plots located in wetlands belong to either the PIEN/CASCP2 or PIEN/EQUIS plant associations because of the need for free, unbound water. The other associations are occasionally located on the dry margins of wetlands but are more often found on well-drained terraces.

Plant association	Fluvial surfaces							N
	Stream-bank	Terrace	Toe-slope	Lake wetland	Shrub wetland	Forest wetland	Seeps/ springs	
PIEN/ARNU3	1	1	1	0	0	0	0	3
PIEN/CASCP2	4	4	0	1	14	5	1	29
PIEN/COCA	0	5	0	0	3	1	0	9
PIEN/COST	0	14	0	0	0	0	0	14
PIEN/EQUIS	0	4	0	0	6	3	0	13
PIEN/GYDR	0	3	0	0	0	0	0	3
PIEN/SYAL	0	6	0	0	0	0	0	6
Series total	5	37	1	1	23	9	1	77

Soils—



Mineral soils are most common in riparian zones, whereas organic soils dominate wetlands. Mineral soils account for about 60 percent of the plots, with variations of loam soils being the most common soil texture. Loamy sands and sands account for the remaining mineral textures. Organic soils are found on the wettest sites and include organic loam and peat textures.

Additional insight is gained by looking at soil textures by plant association. All sites with organic texture belong to the wet PIEN/CASCP2 and PIEN/EQUIS plant associations. The other associations usually are associated with well-drained loam soils.

Plant association	Soil texture						N
	Sand	Loamy sand	Loam	Organic loam	Peat	Muck	
PIEN/ARNU3	0	1	2	0	0	0	3
PIEN/CASCP2	0	7	7	6	8	1	29
PIEN/COCA	0	3	5	0	0	0	8
PIEN/COST	4	1	9	0	0	0	14
PIEN/EQUIS	0	1	0	7	3	2	13
PIEN/GYDR	0	1	1	0	0	0	2
PIEN/SYAL	3	0	3	0	0	0	6
Series total	7	14	27	13	11	3	75

Water tables were accessible on 59 plots. The PIEN/CASCP2 and PIEN/EQUIS associations have the highest water tables. The PIEN/ARNU3 is indicated as nearly as wet as PIEN/EQUIS. However, data are limited for PIEN/ARNU3, and its mineral soils indicate a soil/water relationship much drier than PIEN/EQUIS. PIEN/COST appears to be the driest association. However, the water table could not be reached on the drier PIEN/SYAL association. Flooded soil surfaces were uncommon during the sampling season except on the PIEN/CASCP2 and PIEN/EQUIS plant associations, which averaged 2.4 and 8.9 percent submerged, respectively.

With the exception of PIEN/EQUIS, lower elevation associations (PIEN/COST through PIEN/COCA) generally have higher average soil temperatures. The wet PIEN/EQUIS and PIEN/CASCP2 associations have colder soil temperatures.

Plant association	Water table (inches) Minimum	Maximum	Average	N
PIEN/CASCP2	-26	0	-11	27
PIEN/EQUIS	-24	-4	-12	13
PIEN/ARNU3	-18	-12	-15	3
PIEN/GYDR	-35	-18	-28	3
PIEN/COCA	-44	-16	-30	3
PIEN/COST	-51	-20	-37	10
Series	-51	0	-18	59

Plant association	Soil temperature (°F) Minimum	Maximum	Average	N
PIEN/COST	47	62	54	12
PIEN/SYAL	48	57	52	5
PIEN/ARNU3	47	55	51	2
PIEN/GYDR	44	54	49	3
PIEN/COCA	40	55	49	8
PIEN/CASCP2	33	58	48	28
PIEN/EQUIS	44	55	48	12
Series	33	62	50	70

ECOSYSTEM MANAGEMENT

Natural Regeneration of Engelmann Spruce—

Engelmann spruce reproduces well from seed (Alexander and Shepperd 1990). Seed production begins at 15 to 20 years of age when trees are typically 4 or 5 feet tall. Under closed-forest conditions, seed production is generally poor until trees are older and taller. Generally, trees greater than 15 inches in diameter produce the most seed. Although seed crops are erratic, Engelmann spruce is considered a good seed producer; good seed crops are produced every 2 to 5 years. The winged seeds are relatively light and generally are dispersed within 300 feet of the parent tree. Seed viability (averaging 69 percent) is good compared with many conifers. Most seeds overwinter under snow and germinate within 3 weeks of snowmelt (Alexander and Shepperd 1984, 1990). Seed germination is best on mineral soil. Seedlings that establish on organic matter (duff) more than 2 inches deep soon die because the shallow roots cannot penetrate to mineral soil before the organic material dries out (Alexander 1987). At higher elevations, survival may be greater on duff because the duff is more likely to remain moist through the growing season (Fiedler et al. 1985). Seedlings survive best under conditions of shade, cool temperatures, and consistent moisture. Under the best conditions, Engelmann spruce seedlings grow very slowly (Alexander and Shepperd 1990). Seedlings may be very suppressed under dense tree canopies. First-year seedlings are seldom taller than 1 inch, fifth-year seedlings are seldom over 5 inches tall, and 3- to 5-foot saplings may be 100 years old. In light shade, the 5-foot trees may be only 20 years old.

Like subalpine fir, Engelmann spruce may reproduce by layering on harsh, high-elevation sites, where it assumes a dwarf, prostrate form (Alexander and Shepperd 1990). Layering is negligible in closed forest stands.

Artificial Establishment of Engelmann Spruce and Associated Shrubs and Herbs—

Engelmann spruce is a valued timber species. Its light, uniform, and strong wood is used for lumber, plywood, poles, ties, and mine timbers. It is an excellent source of pulp (Parish et al. 1996). Nursery-grown bare-root and container stock is widely planted on disturbed sites in the Pacific Northwest and does best on cool, moist sites. Two- to three-year-old bare-root or container-grown stock is planted following snowmelt (Alexander 1987). Because seedlings are sensitive to direct sunlight, they should be planted in the protective shade of stumps, logs, or vegetation. It is probably better to rely on the release of natural seedlings and saplings when using selection cutting methods in riparian zones.

Many of the shrubs used to characterize the PIEN series are well adapted to planting on disturbed sites. Red-osier dogwood can be established from nursery stock, seed, and cuttings, or by layering. Prickly currant, dwarf red blackberry, red raspberry, and western thimbleberry can be easily grown from seed. Five-leaved bramble, bunchberry dogwood, and other trailing plants can be easily propagated from root runners. Huckleberry cuttings root poorly; they can be established from seed, but growth is slow. Common snowberry can be established from stem or root cuttings, nursery stock, or seed. Oak fern, saw-leaved sedge, and horsetails can be easily propagated from rhizomes. (For more information on the short- and long-term revegetation potential of selected riparian wetland plant species, see app. B-5.)

Stand Management—

Although tree productivity is fairly high on these sites, tree harvesting and associated management activities should be carefully planned and monitored. Cold temperature regimes, including cold-air drainage and frost, are factors that limit tree regeneration. Plant associations such as PIEN/CASCP2 and PIEN/EQUIS are swampy and difficult to manage for timber production. Wet, organic soils limit any kind of mechanical activity on wetter associations. Loam soils are prevalent on riparian sites and are susceptible to compaction during much of the growing season. Engelmann spruce and other trees may have extensive heart rot. Engelmann spruce is very susceptible to windthrow on account of shallow root systems and soft, saturated soils. Timber harvesting on these sites or adjacent upslope sites may increase the risk of windthrow and rising water tables. A clearcut adjacent to or in a riparian zone could result in near-total blowdown in the riparian zone.

The PIEN series supports a variety of seral tree species including western larch and Douglas-fir. Ponderosa pine will normally do well on warmer associations such as PIEN/SYAL. Regeneration of any tree species will be difficult on the wetter sites, where there is usually advanced regeneration of Engelmann spruce or lodgepole pine on raised hummocks. These seedlings should be protected during any harvest operation. Direct exposure to sunlight, combined with cold temperatures and problems with frost, further limit the success of conifer regeneration.

Although regeneration harvests may be a viable option in upland Engelmann spruce stands, management options in riparian zones might best be limited to single-tree or small-group selection. These options can be used to open the canopy to increase shrub and herb production for wildlife resources as well as increase shrub root biomass for streambank stability and other riparian-dependent resources. After release by logging or windfall, suppressed Engelmann spruce will usually respond with immediate release and growth. Management activities would have less impact if scheduled during late summer or early fall, or on snowpack to minimize soil disturbance. Commercial rotations in uplands are seldom longer than 110 years, but a period of 150 to 200 years is more suited to riparian zones, especially for the provision of future supplies of large wood. Managers may choose to avoid arvesting on wetland sites (PIEN/EQUIS and PIEN/CASCP2)..

Coarse-textured, compaction-resistant soils are unusual, except on some of the more fluvially active sites. Loam soils, found on most of the drier associations, may predominate owing to silt and ash deposition on fluvially inactive terraces. Very sensitive organic soils are associated with the wetter associations. Machinery and livestock easily displace or otherwise damage the associated organic soils during periods of high water tables (Hansen et al. 1995). Poorly drained sites, streamside locations, or sites with organic soils warrant special consideration, for example, by locating roads and trails on the adjacent upland.

Tree Growth and Yield—

Environmental conditions usually range from cool and moist to cold and wet in the PIEN series. The more productive associations are those located at mid to lower elevations where growing conditions are more favorable. Sites with moist, well-drained soils produce large Engelmann spruce, western larch, and Douglas-fir. More productive associations in these riparian zones include PIEN/COCA, PIEN/COST, and PIEN/SYAL. Contrary to the other PIEN associations, the wet PIEN/CASCP2 and PIEN/EQUIS associations have lower growth potential owing to soil conditions. Diameter and height of individual tree growth may be good on these wet sites, especially for Engelmann spruce, but saturated soils limit tree stocking. Tree productivity in the PIEN series is moderate to above average, exhibiting relatively high basal area and site index values. The average basal area of 212 square feet per acre was moderate compared with other tree series (apps. C-1a and C-1b). The ABAM, ABGR, PSME, THPL, and TSHE series were all higher. Similarly, average site index for individual species (feet) was moderate compared with other tree series (app. C-2). Tree production data are limited and should be viewed with caution.

Site index			
Species	Base age	No. of trees	SI
ABLA2	50	23	43
LAOC	50	27	68
PICO	100	18	68
PIEN	50	127	63
PIPO	100	5	109
POTR2	80	3	122
PSME	50	50	68

Basal area (sq. ft./ac)	
Species	BA
ABLA2	13
BEPA	1
CHNO	2
LAOC	11
PICO	18
PIEN	125
PIPO	3
POTR	2
POTR2	5
PSME	32
THPL	1
TSHE	>1
Total	212

Down Wood—

The overall amount of down wood was surprisingly low given the size of some of the individual Engelmann spruce trees in these stands (app. C-3). These sites are capable of growing high stand volume and large Engelmann spruce, western larch, and Douglas-fir trees, but logs covered less than 8 percent of the ground surface. Many stands in the drier associations appear to be susceptible to relatively frequent stand-replacement fires, possibly owing to being near drier upland sites, thus limiting the size of down wood. Relatively rapid decomposition rates for Engelmann spruce also may contribute to the lack of logs. Wetter sites (PIEN/EQUIS and PIEN/CASCP2) are generally fire resistant and usually have larger individuals of live Engelmann spruce and larger down logs. However, stand stocking restrictions limit the number of live trees, snags, and logs compared with closed stands.

Definitions of log decomposition classes are on page 15.

	Down log attributes				
Log decomposition	Tons/ acre	Cu. ft./ acre	Linear ft./ acre	Sq. ft./ acre	% ground cover
Class 1	0.74	62	205	113	0.26
Class 2	3.29	353	843	509	1.17
Class 3	6.73	853	1,965	1,279	2.94
Class 4	2.56	812	1,094	960	2.20
Class 5	1.91	612	429	531	1.22
Total	15.23	2,692	4,536	3,392	7.79

Snags—

Conversely, at 41.3 snags per acre, the PIEN series is above average compared with other tree series (app. C-4). Only the ABAM and ABLA2 series exceed it, with 53.5 and 54.3 snags per acre, respectively. Over 85 percent of the snags are in the 5 to 15.5 inch diameter classes, with about 75 percent in condition classes 1 or 2.

Definitions of snag condition classes are on page 15.

	Snags/acre by d.b.h. class (inches)				
Snag condition	5–9.9	10–15.5	15.6–21.5	21.6+	Total
Class 1	18.4	3.6	2.1	0.5	24.6
Class 2	0	5.1	1.3	0	6.4
Class 3	1.3	1.5	.9	0	3.7
Class 4	0	2.8	.2	.3	3.3
Class 5	1.9	.6	.3	.5	3.3
Total	21.6	13.6	4.8	1.3	41.3

Fire—

Engelmann spruce is fire sensitive on account of its thin bark and is usually killed by low-intensity fires (Fischer and Bradley 1987). The multicanopy fuel structure found in mature Engelmann spruce stands might promote highly destructive fires in severe drought years, at least in the drier associations. Fuel loads are high, and the fuel beds tend to be irregular and have large amounts of deep litter under the narrow-crowned trees. The needles form a compact fuel bed in which the fire spreads slowly yet provides flames high enough to reach the medium to high herb and shrub layer and lichen-draped branches, which starts crown fires (Crane 1982, Taylor and Fonda 1990). Postfire establishment is via wind-dispersed seeds from occasional mature trees and those that escaped in small dispersed pockets, which then germinate on fire-prepared seedbeds. Caches of cones by red squirrels also may provide seed for regeneration (Alexander and Shepperd 1984).

The literature indicates riparian and wetland Engelmann spruce forests usually develop in relatively cool, moist locations and experience fire-free intervals averaging 150 years or more (Arno 1980). Some stands, especially those dominated by seral lodgepole pine, are even aged, suggesting they developed after a fire (Loope and Gruell 1973). Although these observations are generally related to uplands, the interpretations can easily be applied to riparian sites. Fire-free intervals in wet PIEN associations appear to be even longer.

A total of 263 site index trees were sampled for age data. These trees averaged 131 years in age at breast height. Only five trees were more than 299 years old, 33 trees were 200 to 299 years old, 135 trees were 100 to 199 years old, and 90 trees were less than 100 years old. Only 32 percent of the site index trees were greater than 149 years in age. These data seem to suggest that stand-replacing fire-return intervals in the PIEN series in eastern Washington range from 80 years in drier stands to well over 200 years in wet stands. The fire-return interval in the PIEN series appears to be shorter than forest series common in more maritime climate zones such as the TSME, ABAM, THPL, or TSHE series. The data also seem to indicate that many of the sampled stands experienced average fire-return intervals that were less than the 150 years mentioned above (Arno 1980). The widespread stand-replacing fires of the late 1800s and early 1900s might be a factor in this apparent disagreement.

The PIEN associations found at lower elevations may be exposed to fire more frequently than series found at higher elevations or where the maritime climate occurs. The drier PIEN/COCA and PIEN/SYAL associations appear to be the youngest stands, based on ages of trees sampled for productivity estimates. The wet, low-elevation PIEN/EQUIS and wet, high-elevation PIEN/CASCP2 associations had the oldest stands. In these associations, many site index trees were more than 170 years old, which indicates that these wet associations probably burn less frequently than the lower elevation, warmer associations.

The fire regime of surrounding upland forests also may affect how often these riparian and wetland sites burn. Where the PIEN series is found at low to moderate elevations, it is often adjoined by drier Douglas-fir upland forests that are prone to more frequent low- to moderate-intensity fire events. These ground fire events may burn into the PIEN bottomlands in drought years. The PIEN associations at higher elevations usually are found only in wetlands, whereas surrounding drier riparian or upland sites host members of the ABLA2 series. Lodgepole pine forests that are prone to moderately frequent stand-replacement fires often dominate these drier upland sites. In these environments, hot stand-replacement fires in the upland lodgepole pine forests may threaten the PIEN associations. The wetter sites, however, probably burn only in extreme drought years.

Animals—

Livestock. Many of the plant associations lack suitable forage and thus primarily represent sources of water and shade. Forage potential on the drier associations may be fair in early-successional stages, but is generally poor in later successional stages. Wetter sites, such as PIEN/CASCP2 and PIEN/EQUIS, may provide an abundant supply of forage but are susceptible to trampling owing to high water tables and wet soils. Overuse is possible as livestock seek shelter from the heat during hot summer months. Usually, livestock avoid these wet sites until they can walk on the soil surface in late August or September (Kovalchik 1987). At this time, most plants are physiologically mature and can withstand light to moderate grazing pressure.

Few sample stands were highly impacted by livestock grazing. However, if overgrazed, elimination of grazing coupled with close monitoring of wildlife often allows the remnant shrub and herb populations to sprout and reestablish the stand. The ability of shrubs to easily reestablish may be lost when they have been eliminated owing to overgrazing and the water table has been lowered on account of stream downcutting or lateral erosion. (For more information on forage palatability, see app. B-1. For potential biomass production, see app. B-5.)

Wildlife. Riparian and wetland zones in the PIEN series provide valuable habitat for a variety of wildlife species (Alexander 1987, Alexander and Shepperd 1984, Mauk and Henderson 1984, McCaughey et al. 1986). This value is common to riparian and wetland sites in general, not just to the PIEN series. In general, these sites offer good sources of hiding and thermal cover, forage, or water. Multiple shrub and tree layers associated with most stands provide considerable habitat diversity for wildlife. The mosaic of PIEN and other riparian and wetland plant associations at lower elevations is often key habitat that is located in a matrix of fairly dry forest. Higher elevation sites often provide a source of diversity in otherwise extensive monotypic stands of lodgepole pine. The majority of wildlife species use these sites during summer and fall as winters are snowy and cold, but lower elevation sites also may be used in winter too. Owing to the moist, productive environments, some of these stands have late-seral or old-growth stand structures that serve as important habitat for old-growth-dependent species. Some sites have large Engelmann spruce with extensive heart rot decay, resulting in large trees, snags, and logs with hollow interiors. The seeds of spruce and other conifers are eaten by a variety of birds, squirrels, and other rodents. In addition, many sites have an abundance of berry-producing shrubs in the understory.

Large ungulates such as mule deer and elk will forage in these sites during summer and fall. Deer also may use these sites as fawning areas in early summer. Engelmann spruce needles and twigs are low in protein and fair in energy value (Dittberner and Olson 1983). The new growth of Engelmann spruce may be eaten by ungulates but is not an important food item except as a last resort. Other species associated with Engelmann spruce stands, such as red-osier dogwood and various huckleberries, provide more valuable forage for ungulates. Brooms formed by rusts in Engelmann spruce are common, and American marten use these brooms as rest sites. Marten also use hollow logs for dens and rest sites. Squirrels and chipmunks cache spruce seeds for winter food and sometimes clip and eat twigs and buds (Safford 1974). The seeds also are taken off the ground by squirrels, chipmunks, and voles. Black bears use hollow logs for dens and rest sites. Black bears and grizzly bears also will forage in these sites. Bear also use Engelmann spruce stands for hiding and thermal cover as well as bedding sites and protection from storms. The wetter associations may provide beneficial herbaceous forage for bears. Many associations support berry-producing shrubs that provide forage for bears. Beavers have been observed to feed on the shrubs of some of the associations, especially those with willows and red-osier dogwood, but other shrubs may be used for emergency food or dam building.

Woodpeckers use snags and logs for foraging for bark beetles and ants. Spruce grouse and blue grouse feed extensively on buds and needles of Engelmann spruce (Martin et al. 1951, Schroeder 1984). Many species of small birds such as chickadees, nuthatches, crossbills, and pine siskin eat the seed from Engelmann spruce cones (Hall 1973). Other birds that nest and feed in Engelmann spruce trees include Williamson's sapsucker, red-breasted nuthatch, brown creeper, and owls. Harlequin ducks and American dippers may be observed on nearby streams. (For more information on thermal or feeding cover values, see apps. B-2 and B-3. For information on food values or degree of use, see apps. B-2 and B-4.)

Fish. Riparian and wetland zones in the PIEN series play important roles in watershed function and hydrologic regimes. Many sites, such as those of PIEN/CASCP2, are located in high-elevation basins where winter snowpacks are heavy. At lower elevations, PIEN/EQUIS stands are equally important in acting as hydrologic reservoirs and helping maintain streamflows and runoff during summer. In addition, owing to windthrow and disease, many PIEN sites have moderate amounts of large woody debris in and alongside the stream channels. This woody debris, especially large-diameter logs, provides good fish habitat and stream channel stabilization, particularly during peak flows associated with spring runoff or following summer storms. The large tree canopies also provide shade for the stream, helping to regulate water temperatures and promote good fisheries habitat downstream. Maintaining healthy, vigorous stands of Engelmann spruce and other series such as SALIX, ALIN, and ALSI along streams and rivers creates buffer strips of erosion-resistant plant communities that help stabilize streambanks and floodplains as well as nearby terraces and swales, provide a barrier to sedimentation from nearby slopes, and provide a source of down wood for the stream and nearby fluvial surfaces. (For more information, see app. B-5, erosion control potential.)

Recreation—

Higher elevation associations are not well suited for recreation owing to inaccessible locations, high water tables, and wet soils. Sites at lower elevations may be impacted by recreation activities where they are accessed from nearby roads most often for fishing and dispersed camping. The predominant loam soils are highly susceptible to compaction, and vegetation is easily trampled. Whether wet or dry, construction and maintenance of roads, campgrounds, and trails is not recommended on PIEN sites. These sites are highly prone to windthrow of Engelmann spruce owing to their shallow rooting system and weakness from fungal disease.

Insects and Disease—

Wood-rotting fungi that result in root rot or butt decay are the most common tree diseases in the PIEN series. The primary diseases include rust red stringy rot, brown cubical rot, armillaria root rot, and Tomentose root disease (Hessburg et al. 1994). Schweinitzii butt rot is particularly common in older Engelmann spruce trees. Many of these fungal pathogens also infect western larch and Douglas-fir. Annosus root disease may be common in the subalpine fir found in the wet PIEN/CASCP2 and PIEN/EQUIS associations. These rots were scattered before the era of intensive resource management but have increased dramatically by attacking through stumps and other wounds associated with logging. Spruce broom rust is also common in spruce-fir forests and causes bole deformation, spike tops, wind breakage, and an entry point for decay fungi (Alexander and Shepperd 1990). Dwarf mistletoe infestations may be common in lodgepole pine, western larch, and Douglas-fir (Hadfield 1995).

Occasional insect outbreaks occur in the PIEN series (Alexander and Shepperd 1990, Flanagan 1995, Hessburg et al. 1994). The spruce beetle is the most serious insect pest of Engelmann spruce. Outbreaks are associated with extensive windthrow, untreated logging slash, or wildfire, as dead and down trees provide a good food supply, causing a rapid expansion of the beetle population. Other bark beetles infecting Engelmann spruce, Douglas-fir, and lodgepole pine include the spruce beetle, Douglas-fir beetle, and mountain pine beetle, respectively. Potential defoliators include the western spruce budworm and the Douglas-fir tussock moth.

Estimating Vegetation Potential on Disturbed Sites—

Estimating vegetation potential on disturbed sites, therefore, is generally not needed on these conifer-dominated sites. Clearcutting in riparian areas is unusual, at least on FS land. Wetter associations in the SALIX, MEADOW, ALIN, and ALSI series often separate PIEN stands from active flood zones. Currently, all FS riparian and wetland zones are buffered and not managed for timber production. Where clearcut in the past, Engelmann spruce and other conifers rapidly regenerated these productive sites. Similar valley landforms can help determine the potential of young stands.

Sensitive Species—

Only three sensitive plants were found under PIEN series stands. Moxieplum, glaucous willow, and tall agoseris were found on PIEN/CASCP2 association plots. Tall agoseris also was found on a PIEN/COCA site (app. D). (See app. A for a cross reference to scientific names.)

ADJACENT SERIES

The PIEN series is generally bound by the ABLA2 series at higher elevations. The PSME series usually replaces the PIEN series on warmer sites at low elevation. Wetter series such as the COST, ALIN, ALSI, SALIX, and MEADOW series often occur on more fluvially active surfaces or in adjacent wetlands, thus separating the PIEN series from the direct influence of streams except during very high flows.

RELATIONSHIPS TO OTHER CLASSIFICATIONS

Traditionally, the PIEN series has been considered an inclusion in the subalpine fir series in Washington. This has proved adequate in describing upland habitats but is not well suited for riparian and wetland zones. Engelmann spruce is quite tolerant of high water tables, extends to lower elevations than subalpine fir, and therefore displays wider ecological amplitude in riparian zones and wetlands compared with subalpine fir.

Kovalchik (1992c) described many of the plant associations in the PIEN series in the draft classification for northeastern Washington. Riparian plant associations described in the PIEN series represent relatively wet stand conditions for some plant associations in the ABLA2 plant associations previously described for uplands on the Wenatchee NF by Lillybridge et al. (1995) and the Colville NF by Williams et al. (1995). The PIEN/EQUIS association was the only association described in these eastern Washington upland classifications. Other climax Engelmann spruce stands are lumped into the ABLA2 series by these authors. Crowe and Clausnitzer (1997) describe PIEN/EQUIS and PIEN/COST associations in northeastern Oregon that are very similar to the ones described here. Hansen et al. (1995) also describe similar PIEN/EQUIS and PIEN/COST associations for western Montana.

Plant associations belonging to the PIEN series have been previously described for nearby areas in the Pacific Northwest. These include central and northeastern Oregon (Crowe and Clausnitzer 1997, Kovalchik 1987) and Montana (Hansen et al. 1988, 1995). Strangely, no Engelmann spruce associations are described for northern Idaho (Cooper et al. 1991). Braumandl and Curran (1992) and Lloyd et al. (1990) describe similar communities in British Columbia.

U.S. DEPARTMENT OF THE INTERIOR, FISH AND WILDLIFE SERVICE WETLANDS CLASSIFICATION

System:	palustrine
Class:	forested wetland
Subclass:	needle-leaved evergreen
Water regime:	(nontidal) intermittently saturated to temporarily flooded

KEY TO THE ENGELMANN SPRUCE (*PICEA ENGELMANNII*) PLANT ASSOCIATIONS

1. Holm's and/or saw-leaved sedge (*Carex scopulorum* var. *bracteosa* and/or *prionophylla*) ≥10 percent canopy coverage .... **Engelmann spruce/saw-leaved sedge (PIEN/CASCP2) association**
2. Common horsetail (*Equisetum arvense*), wood horsetail (*Equisetum sylvaticum*), and/or soft-leaved sedge (*Carex disperma*) ≥10 percent canopy coverage .... **Engelmann spruce/horsetail (PIEN/EQUIS) association**
3. Lady fern (*Athyrium filix-femina*) ≥5 percent canopy coverage ....**Subalpine fir/lady fern (ABLA2/ATFI) association**[2]
4. Oak fern (*Gymnocarpium dryopteris*) ≥5 percent canopy coverage ....**Engelmann spruce/oak fern (PIEN/GYDR) association**
5. Labrador tea (*Ledum glandulosum*) ≥5 percent canopy coverage .... **Subalpine fir/Labrador tea-grouse huckleberry (ABLA2/LEGAL-VASC) association**[2]
6. Globeflower (*Trollius laxus*) ≥2 percent canopy coverage .... **Subalpine fir/globeflower (ABLA2/TRLA4) association**[2]
7. Red-osier dogwood (*Cornus stolonifera*) ≥10 percent canopy coverage ....**Engelmann spruce/red-osier dogwood (PIEN/COST) association**
8. Wild sarsaparilla (*Aralia nudicaulis*) ≥2 percent canopy coverage .... **Engelmann spruce/wild sarsaparilla (PIEN/ARNU3) association**
9. Bunchberry dogwood (*Cornus canadensis*) ≥2 percent canopy coverage ....**Engelmann spruce/bunchberry dogwood (PIEN/COCA) association**
10. Common snowberry (*Symphoricarpos albus*) ≥5 percent canopy coverage .... **Engelmann spruce/common snowberry (PIEN/SYAL) association**

[2] These ABLA2 associations occasionally key to the PIEN series because subalpine fir is less than 10 percent canopy coverage in some plots otherwise dominated by Engelmann spruce. Detailed analysis of data indicates Engelmann spruce communities with lady fern or globeflower characterizing the understory will eventually be dominated by subalpine fir.

Table 6—Constancy and mean cover of important plant species in the PIEN plant associations

Species	Code	PIEN/ARNU3 4 plots		PIEN/CASCP2 31 plots		PIEN/COCA 18 plots		PIEN/COST 16 plots		PIEN/EQUIS 19 plots		PIEN/GYDR 4 plots		PIEN/SYAL 8 plots	
		CON[a]	COV[b]	CON	COV	CON	COV	CON	COV	CON	COV	CON	COV	CON	COV
Tree overstory:															
subalpine fir	ABLA2	25	Tr[c]	77	9	11	6	25	6	63	13	—	—	38	Tr
western larch	LAOC	100	13	—	—	56	19	13	4	5	5	100	10	13	10
Engelmann spruce	PIEN	100	30	100	30	89	26	88	42	100	43	100	54	88	35
lodgepole pine	PICO	—	—	39	15	61	24	—	—	21	3	—	—	13	4
ponderosa pine	PIPO	—	—	—	—	11	6	13	4	—	—	—	—	38	18
quaking aspen	POTR	—	—	—	—	17	15	6	1	16	10	25	2	25	14
black cottonwood	POTR2	—	—	—	—	—	—	31	10	5	1	—	—	25	15
Douglas-fir	PSME	75	12	6	2	50	28	88	22	16	10	75	6	75	29
Tree understory:															
subalpine fir	ABLA2	—	—	87	7	6	Tr	13	3	74	5	—	—	50	2
Engelmann spruce	PIEN	75	1	97	5	89	5	69	6	89	5	75	6	75	6
lodgepole pine	PICO	—	—	26	4	17	6	—	—	5	8	—	—	—	—
Douglas-fir	PSME	75	2	3	1	67	5	50	4	—	—	25	2	75	1
Shrubs:															
Douglas maple	ACGLD	100	17	—	—	39	10	63	3	5	3	25	Tr	88	4
mountain alder	ALIN	25	Tr	23	11	28	2	63	6	63	13	75	9	25	5
Sitka alder	ALSI	—	—	6	2	—	—	19	3	16	14	—	—	25	3
Saskatoon serviceberry	AMAL	100	1	3	2	78	2	44	4	26	2	100	1	88	2
red-osier dogwood	COST	75	2	6	5	44	2	100	47	53	5	75	13	50	3
bearberry honeysuckle	LOIN	25	Tr	42	3	28	1	50	1	42	1	—	—	38	1
Utah honeysuckle	LOUT	50	1	13	2	50	2	6	2	5	Tr	50	1	13	Tr
prickly currant	RILA	75	4	32	2	61	2	63	3	68	3	100	2	88	1
baldhip rose	ROGY	75	2	3	3	44	3	19	5	16	2	100	3	38	3
red raspberry	RUID	25	Tr	3	1	17	Tr	19	1	11	1	50	1	25	1
western thimbleberry	RUPA	100	5	—	—	50	5	75	2	32	2	75	4	100	4
dwarf red blackberry	RUPU2	50	1	—	—	11	3	6	5	21	3	25	7	—	—
Drummond's willow	SADR	—	—	16	5	—	—	—	—	5	10	—	—	—	—
Farr's willow	SAFA	—	—	26	8	—	—	—	—	5	3	—	—	—	—
Scouler's willow	SASC	—	—	10	Tr	6	1	13	8	5	2	—	—	13	2
russet buffaloberry	SHCA	50	2	6	1	28	3	13	2	11	1	25	Tr	13	1
shiny-leaf spiraea	SPBEL	75	2	—	—	33	6	19	5	—	—	—	—	63	6
common snowberry	SYAL	100	7	3	4	89	7	94	10	32	6	75	20	100	12
Low shrubs and subshrubs:															
Oregon hollygrape	BEAQ	75	2	—	—	72	4	50	1	11	Tr	25	Tr	50	1
western prince's-pine	CHUMO	100	2	6	Tr	50	3	13	Tr	16	1	25	Tr	50	1
bunchberry dogwood	COCA	100	7	42	4	100	10	13	5	74	5	100	5	13	Tr
Labrador tea	LEGL	—	—	58	15	—	—	—	—	21	6	—	—	—	—
twinflower	LIBOL	100	10	52	4	94	18	13	6	68	4	100	7	25	8
myrtle pachistima	PAMY	—	—	—	—	33	2	56	7	5	Tr	—	—	63	16
five-leaved bramble	RUPE	—	—	19	7	—	—	6	Tr	21	3	25	Tr	—	—
dwarf huckleberry	VACA	25	1	35	3	28	7	—	—	—	—	—	—	—	—
low huckleberry	VAMY	—	—	35	3	11	7	—	—	26	2	—	—	—	—
grouse huckleberry	VASC	—	—	55	12	6	10	—	—	—	—	25	1	—	—
Perennial forbs:															
baneberry	ACRU	75	Tr	3	3	28	1	25	1	32	3	75	1	25	Tr
wild sarsaparilla	ARNU3	100	7	—	—	—	—	—	—	5	7	25	Tr	—	—
heartleaf arnica	ARCO	50	1	19	1	50	3	19	1	16	1	25	Tr	63	1
showy aster	ASCO	50	3	3	Tr	33	2	19	1	—	—	25	Tr	25	1

Table 6—Constancy and mean cover of important plant species in the PIEN plant associations (continued)

		PIEN/ARNU3 4 plots		PIEN/CASCP2 31 plots		PIEN/COCA 18 plots		PIEN/COST 16 plots		PIEN/EQUIS 19 plots		PIEN/GYDR 4 plots		PIEN/SYAL 8 plots	
Species	Code	CON	COV	CON	COV	CON	COV	CON	COV	CON	COV	CON	COV	CON	COV
enchanter's nightshade	CIAL	25	Tr	—	—	—	—	13	1	16	2	50	2	—	—
queencup beadlily	CLUN	50	8	6	2	56	5	13	1	21	1	25	1	13	Tr
roughfruit fairy-bells	DITR	50	Tr	—	—	39	1	25	Tr	5	2	50	2	25	10
woods strawberry	FRVEB	50	Tr	—	—	22	Tr	13	1	5	2	75	1	25	Tr
sweetscented bedstraw	GATR	75	1	13	1	78	2	50	1	58	2	75	2	50	1
western rattlesnake plantain	GOOB	50	1	3	Tr	67	1	25	Tr	11	1	25	Tr	75	1
fivestamen miterwort	MIPE	—	—	26	2	6	5	—	—	16	7	—	—	—	—
miterwort species	MITEL	50	Tr	42	2	17	1	13	2	42	5	100	3	13	1
mountain sweet-root	OSCH	25	2	10	1	61	2	31	1	26	2	75	4	38	2
purple sweet-root	OSPU	75	1	10	1	—	—	38	1	11	1	25	Tr	38	1
pink wintergreen	PYAS	25	Tr	13	2	11	1	19	1	58	2	—	—	25	4
sidebells pyrola	PYSE	25	7	32	1	61	1	44	1	58	2	100	1	50	1
arrowleaf groundsel	SETR	—	—	58	2	11	Tr	—	—	58	1	—	—	—	—
western solomonplume	SMRA	25	1	—	—	39	1	38	2	11	1	—	—	50	1
starry solomonplume	SMST	100	2	13	2	67	2	56	2	79	2	100	2	88	1
claspleaf twisted-stalk	STAM	75	1	58	1	28	Tr	38	1	79	1	100	2	13	1
western meadowrue	THOC	75	1	23	1	61	2	63	2	32	2	25	Tr	75	2
coolwort foamflower	TITRU	25	Tr	13	1	6	Tr	13	1	53	3	50	4	13	Tr
false bugbane	TRCA3	—	—	10	2	11	1	13	4	42	8	75	19	—	—
Canadian violet	VICA	50	Tr	—	—	17	3	19	1	5	3	25	3	13	1
pioneer violet	VIGL	—	—	3	2	28	5	38	1	26	3	—	—	63	Tr
Grasses or grasslike:															
Columbia brome	BRVU	75	1	—	—	6	2	19	1	5	Tr	25	1	63	1
bluejoint reedgrass	CACA	25	Tr	65	7	11	3	—	—	53	5	50	2	13	Tr
pinegrass	CARU	25	2	10	1	67	9	—	—	—	—	—	—	38	2
Sitka sedge	CAAQS	—	—	—	—	—	—	—	—	11	5	—	—	—	—
soft-leaved sedge	CADI	25	4	29	3	6	Tr	6	1	47	20	25	2	—	—
black alpine sedge	CANI2	—	—	3	15	—	—	—	—	—	—	—	—	—	—
Holm's sedge	CASCB	—	—	6	45	—	—	—	—	—	—	—	—	—	—
saw-leaved sedge	CASCP2	—	—	94	31	—	—	—	—	11	8	—	—	—	—
bladder sedge	CAUT	—	—	16	5	—	—	—	—	16	2	—	—	—	—
wood reed-grass	CILA2	25	1	13	3	17	1	6	2	26	2	50	2	—	—
blue wildrye	ELGL	25	4	10	14	44	3	19	1	16	1	25	Tr	38	1
Ferns and fern allies:															
wood-fern species	DRYOP	—	—	—	—	—	—	—	—	5	20	—	—	—	—
common horsetail	EQAR	25	2	55	2	33	2	38	1	95	36	100	1	38	1
common scouring-rush	EQHY	25	Tr	—	—	11	8	25	Tr	5	Tr	—	—	38	Tr
wood horsetail	EQSY	—	—	6	17	—	—	—	—	5	5	50	4	—	—
oak fern	GYDR	50	1	—	—	—	—	6	Tr	26	6	100	17	—	—

[a] CON = percentage of plots in which the species occurred.
[b] COV = average canopy cover in plots in which the species occurred.
[c] Tr = trace cover, less than 1 percent canopy cover.

GRAND FIR SERIES

Abies grandis

ABGR N = 36

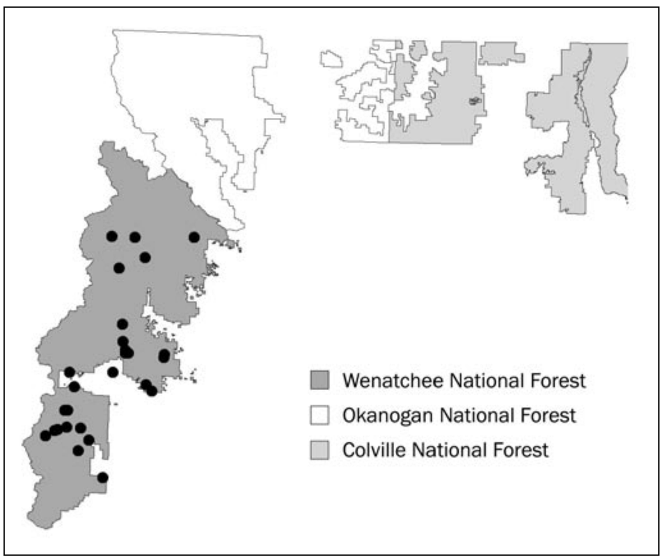


Figure 13—Plot locations for the grand fir series.

GRAND FIR[1] ranges from southern British Columbia south through the Coast and Cascade Ranges to central Oregon, where it hybridizes with white fir (Hitchcock and Cronquist 1973). In the continental interior it extends from the Okanogan and Kootenay Lakes area of British Columbia south and southeast through eastern Washington, northern and central Idaho, and into Montana west of the Continental Divide and the Blue and Ochoco Mountains of northeastern Oregon (Foiles et al. 1990, Steinhoff 1978). Grand fir reaches its northern limit as an important forest species in the Cascade Range on the Wenatchee NF (Lillybridge et al. 1995). Except for a few outlying stands, the northern boundary follows the Entiat River. Grand fir is again common east of the Kettle Mountains on the Colville NF, extending into Montana. This distribution suggests that grand fir has an affinity for maritime climates and does not tolerate dry, cold climates. It does, however, tolerate warmer, drier conditions than western redcedar or western hemlock, which share similar geographic distribution across the Northwest.

The above information on grand fir distribution shows the ABGR series only occurs where the climate is moderated by Pacific maritime influence (Cooper et al. 1991, Pfister et al. 1977). The ABGR series is extremely limited within the continental climate of the central interior of the study area (Lillybridge et al. 1995, Williams et al. 1995). Although common in uplands, the ABGR series does not exist in riparian areas in the Colville NF. It is rare on the Okanogan NF, except west of the Cascade crest. It is common in both uplands and riparian areas on the Wenatchee NF.

CLASSIFICATION DATABASE

The ABGR series includes all forest stands potentially dominated by grand fir at climax. Stands are common on the southern two-thirds of the Wenatchee NF on the Naches, Cle Elum, Leavenworth, and Lake Wenatchee RDs (fig. 13). It also can be found in limited areas of the western portions of the Entiat and Chelan RDs. One stand was observed but not sampled on the Twisp RD of the Okanogan NF. Riparian plots of the ABGR series have not been observed on the Colville NF, although they might be found on the Colville Indian Reservation and other nonfederal lands to the south of the Colville NF. A total of 24 riparian and wetland sampling plots were measured in the ABGR series. Data from an additional 12 plots from other ecology databases were included to increase the data for this series to aid classification and provide additional data for species composition, distribution, and elevation. From this database, three major plant associations are recognized. One potential one-plot community (ABGR/ARCO) was found on a drier site but is not used in the data or described in this classification. For the most part, these samples represent late-seral to climax conditions.

[1] See appendix A for a cross reference for all species codes and common and scientific names used in this document.

Grand fir plant associations

	Scientific name	Common name	Ecoclass code	Plots
Major associations:				
ABGR/ACCI-WEN	*Abies grandis/Acer circinatum*-Wenatchee	Grand fir/vine maple-Wenatchee	CWS551	9
ABGR/ACTR-WEN	*Abies grandis/Achlys triphylla*-Wenatchee	Grand fir/dearleaf vanilla-leaf–Wenatchee	CWF524	18
ABGR/SYAL-FLOODPLAIN	*Abies grandis/Symphoricarpos albus*-floodplain	Grand fir/common snowberry-floodplain	CWS314	9

VEGETATION CHARACTERISTICS

Mature stands characteristically have an overstory co-dominated by Douglas-fir and grand fir. Engelmann spruce is a common seral species in the moist ABGR/ACCI-WEN and ABGR/ACTR-WEN associations. However, stands where Engelmann spruce is reproducing more successfully than grand fir will key to the PIEN series. Bigleaf maple is often present in the drier ABGR/SYAL-FLOODPLAIN association, mostly in stands where ocean-spray is well represented. The tree understory of mature stands is composed primarily of grand fir regeneration, with lesser amounts of Engelmann spruce and subalpine fir in the ABGR/ACCI-WEN and ABGR/ACTR-WEN associations.

The shrub and herb layer are floristically rich and varied. Shrub species with high constancy or cover include vine maple, twinflower, western thimbleberry, myrtle pachistima, and Oregon hollygrape on ABGR/ACCI and ABGR/ACTR associations and Douglas maple, ocean-spray, baldhip rose, Lewis' mock orange, western thimbleberry, common snowberry, and myrtle pachistima on the ABGR/SYAL association. Understory plant cover is commonly depauperate in heavily shaded stands.

Some common herbs found in the moist associations include deerfoot vanilla-leaf, queencup beadlily, pioneer violet, and white trillium. Drier associations support herbs such as sidebells pyrola, purple sweet-root, elk sedge, and western and starry solomonplume.

PHYSICAL SETTING

Elevation—

The ABGR series occurs at low to moderate elevations. The majority of sites are below 3,500 feet. One unusual 4,100-foot plot in the ABGR/ACCI-WEN association was located over 1,000 feet higher than other plots in the ABGR series and could have easily keyed to the ABLA2 series. However, it seemed to better fit the ABGR series, as vine maple is not a common plant in most subalpine fir plant associations (Lillybridge et al. 1995).

	Elevation (feet)			
Forest	Minimum	Maximum	Average	N
Wenatchee only	2,160	4,100	2,495	36

Additional insight is gained by looking at individual associations. The ABGR/ACTR-WEN association is found at the highest elevations in the series, and most plots are above 3,000 feet. The ABGR/ACCI-WEN and ABGR/SYAL-FLOODPLAIN associations usually are found at lower elevations, quite often below 3,000 feet. The ABGR/ACCI-WEN and ABGR/ACTR-WEN associations are found within the relatively moist fringes of maritime climate zones on the Wenatchee NF. The ABGR/SYAL-FLOODPLAIN association is found in the eastern half of the Wenatchee NF on the transition to a continental climate with less precipitation and warmer temperatures.

	Elevation (feet)			
Plant association	Minimum	Maximum	Average	N
ABGR/ACTR-WEN	2,550	3,675	3,269	18
ABGR/SYAL-FP	2,180	3,700	2,633	9
ABGR/ACCI-WEN	2,160	4,100	2,574	9
Series	2,160	4,100	2,945	36

Valley Geomorphology—

The ABGR series is found in the whole range of valley width and gradient classes. Most plots are in moderate or broad valleys (330 to 990 feet). Broad valleys more than 990 feet wide are more common in private lands at elevations below FS ownership. Valley gradient classes are more defined, with the two most common being low (1 to 3 percent) and, at the other extreme, very steep (greater than 8 percent). This likely reflects a relatively quick change in gradient from wider, gentler river valley bottoms (such as those of the Taneum, Teanaway, Naches, and Wenatchee Valleys) to the narrower, steeper profiles of their tributaries.

	Valley gradient					
Valley width	Very low	Low	Moderate	Steep	Very steep	N
Very broad	1	1	0	0	0	2
Broad	0	6	0	0	1	7
Moderate	0	4	2	1	3	10
Narrow	0	1	0	1	1	3
Very narrow	0	0	0	0	2	2
Series total	1	12	2	2	7	24

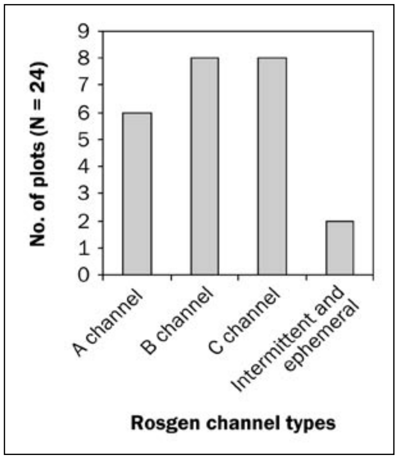
Valley geomorphology is most clear when considering the individual ABGR plant associations. The ABGR/ACCI-WEN and ABGR/ACTR-WEN associations are more common in broad, low gradient valleys. The tree plots located in narrower, steeper valleys are found in side drainages and ephemeral draws. The ABGR/SYAL-FLOODPLAIN association is found in similar valleys but is more prominent in steeper drainages, perhaps because the drainages are warmer and better drained.

	Valley width					
Plant association	Very broad	Broad	Moderate	Narrow	Very narrow	N
ABGR/ACCI-WEN	1	1	1	0	0	3
ABGR/ACTR-WEN	0	6	3	2	1	12
ABGR/SYAL-FP	1	0	6	1	1	9
Series total	2	7	10	3	2	24

Plant association	Valley gradient					N
	Very low	Low	Moderate	Steep	Very steep	
ABGR/ACCI-WEN	1	1	0	0	1	3
ABGR/ACTR-WEN	0	9	0	2	1	12
ABGR/SYAL-FP	0	2	2	0	5	9
Series total	1	12	2	2	7	24

Channel Types—

The ABGR series plots are equally common on fluvial surfaces associated with Rosgen A, B, and C channel types. The B and C channels usually are found within wider, lower gradient valley bottoms, whereas A channels are characteristic of narrower, steeper tributaries. Intermittent and ephemeral stream channels were infrequently sampled during the study, so these channel types are likely underrepresented in the data.

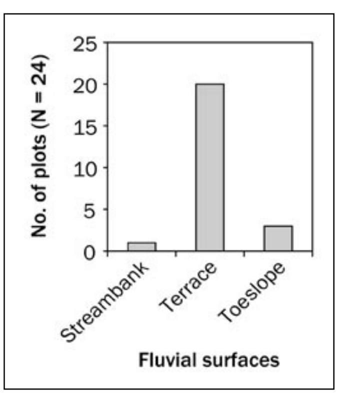


Additional insight is gained by looking at individual ABGR plant associations. For instance, ABGR/SYAL-FLOODPLAIN is found along A and B channels, whereas the other two associations are more frequent along B and C channels.

Plant association	Rosgen channel types				N
	A	B	C	Intermittent and ephemeral	
ABGR/ACCI-WEN	1	1	1	0	3
ABGR/ACTR-WEN	1	4	6	1	12
ABGR/SYAL-FP	4	3	1	1	9
Series total	6	8	8	2	24

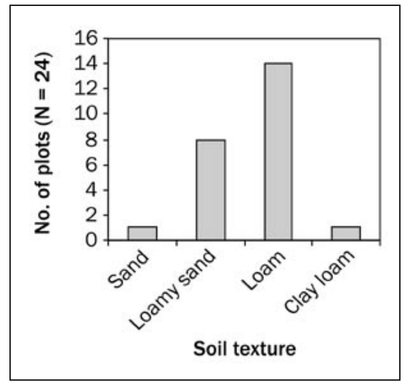
Fluvial Surfaces—

The ABGR series plots are located in riparian zones, especially on drier, well-drained fluvial terraces. Only one plot is on a well-drained streambank, and only three plots are on toeslope positions. No plots are located on wet fluvial surfaces owing to the low tolerance of grand fir to high water tables. Other series (such as ALIN, COST, PIEN, SALIX, or POTR2) occupy wetter sites such as alluvial bars, floodplains, and overflow channels that often separate ABGR series sites from the active stream channel.



Plant association	Fluvial surfaces			N
	Streambank	Terrace	Toeslope	
ABGR/ACCI-WEN	0	2	1	3
ABGR/ACTR-WEN	1	10	1	12
ABGR/SYAL-FP	0	8	1	9
Series total	1	20	3	24

As with the entire ABGR series, all three ABGR plant associations are more likely to occur on terraces.



Soils—

All the ABGR series plots have mineral soils in their rooting zones, reflecting drier fluvial surfaces and relatively infrequent flood deposition. Loamy sand and loam are the most common soil textures, with only one plot having sand texture and one plot having clay loam. Terraces farther from flooding may have significant deposits of ash.

Plant association	Soil texture				N
	Sand	Loamy sand	Loam	Clay loam	
ABGR/ACCI-WEN	1	2	0	0	3
ABGR/ACTR-WEN	0	1	10	1	12
ABGR/SYAL-FP	0	5	4	0	9
Series total	1	8	14	1	24

As with the ABGR series, the three ABGR associations are most common on loam and loamy sand soils.

Water tables measured during the growing season were well below the soil surface, and the soil auger could reach the water table on only a few plots, which averaged 27 inches below the soil surface. Similarly, no plots were flooded during the growing season. Therefore, no tables are shown.

The ABGR/SYAL association has the warmest soil temperatures due to its low elevation and location in the transition zone from maritime to continental climate. ABGR/ACTR-WEN has the coldest soil temperatures owing to its higher elevation and maritime climate. Data are limited and should be read with caution.

Plant association	Soil temperature (°F)			N
	Minimum	Maximum	Average	
ABGR/SYAL-FP	49	60	55	9
ABGR/ACCI-WEN	48	58	52	3
ABGR/ACTR-WEN	45	54	49	12
Series	45	60	52	24

ECOSYSTEM MANAGEMENT

Natural Regeneration of Grand Fir—

Grand fir reproduces only from seed. Flowering occurs between late March and June; cones ripen in August and September. One month later, seeds from disintegrating cones are dispersed by wind and rodents. Cone and seed production begins at 20 years of age, increasing with age and vigor. There may be as many as 200 seeds per cone (Franklin 1968). Good seed crops are frequent; they are reported every 2 to 3 years on Vancouver Island, where there is good correlation between weather and cone crops (Tanaka 1982). Wind dispersal of seed is usually restricted to within a few hundred feet of the tree owing to the medium weight of the seed (Arno and Hammerly 1984). Seed germination occurs in spring and is most successful when the seed falls on mineral soil, although grand fir germinates almost as well on duff under shade (Foiles et al. 1990, Schmidt 1957). Cool, moist sites are optimal for germination and growth of seedlings, although grand fir seeds are relatively drought resistant compared with other true firs. Seedlings establish readily in small openings in mature forests (Antos and Shearer 1980), and initial root penetration growth is relatively rapid on sites with full sunlight. However, root penetration is relatively slow on shaded sites, and desiccation is the major cause of seedling mortality (Foiles et al. 1990).

Artificial Establishment of Grand Fir and Associated Shrubs and Herbs—

Because grand fir grows well on a variety of sites, including riparian sites, it is a good candidate for management (Hall 1983). Cones must be collected before they ripen, as they disintegrate at maturity. Nursery-grown bare-root and container-stock fir are both planted in the Pacific Northwest and do best on bare, mineral soil; although broadcast burning has been shown to decrease the success of regeneration. When using selection cutting in riparian zones, it is probably better to rely on the release of natural seedlings and saplings.

Many shrubs and herbs that characterize the ABGR series are well adapted to planting on disturbed sites. Vine maple and myrtle pachistima can be established from nursery stock or cuttings, depending on the species. Prickly currant and western thimbleberry can be easily grown from seed. Common snowberry, Saskatoon serviceberry, Douglas maple, baldhip and woods rose, and ocean-spray can be established from stem or root cuttings, nursery stock, or seed. Deerfoot vanilla-leaf, solomonplume, sweetscented bedstraw, pioneer violet, and other trailing herbs can be easily propagated from root runners and rhizomes. (For more information on the short- and long-term revegetation potential of selected riparian wetland plant species, see app. B-5.)

Stand Management—

The ABGR series supports a variety of tree species. The dominant trees are grand fir, Douglas-fir, and Engelmann spruce. Other common trees may include bigleaf maple, lodgepole pine, western white pine, and black cottonwood. Subalpine fir, western redcedar, and western hemlock are occasionally present but are not suited to these environments.

Although the wood of grand fir is light in weight and weak compared with many other conifers, it is commercially valuable as timber. Timber harvesting in these sites may increase the risks of windthrow and of rising water tables. Engelmann spruce is particularly susceptible to windthrow. Many larger grand firs have extensive heart rot. In riparian zones, management options appear to be limited to single-tree or small-group selection to open the canopy and increase understory production. During any management activity, care is needed to prevent scarring of the bole of grand fir and subsequent entry of decay organisms. Although tree productivity is high in these relatively warm, moist environments, any management activities need to be planned carefully.

Coarse-textured, compaction-resistant soils are unusual, except on more fluvially active sites. Most sites have loam soils, which are subject to compaction much of the year, especially when moist. During periods of excessive soil moisture or high water tables, machinery and livestock easily compact or otherwise damage the soil. Moist sites and streamside locations should warrant special concern. Roads and trails generally should be located on drier terraces or adjacent upland. To minimize soil disturbance, management activity should be confined to late summer or fall, or during winter on snowpack.

Tree Growth and Yield—

The ABGR series riparian sites are characterized by ample soil moisture, plus relatively warm and mild growing conditions (Lillybridge et al. 1995). The ABGR series has fair to good productivity compared with other forested series, exhibiting high basal areas and site index values. Basal area averages 240 square feet per acre, a moderately high value for the forested tree series (apps. C-1a and C-1b). Only the ABAM, PSME, THPL, and TSHE series are higher. Similarly, average site index for individual species (height in feet) is high compared with many other series (app. C-2). The two moist associations (ABGR/ACCI-WEN and ABGR/ACTR-WEN) are found in areas with higher levels of precipitation and cooler temperatures, allowing better growth compared with the ABGR/SYAL-FLOODPLAIN association. The ABGR/ACCI-WEN is probably the most productive association, followed by ABGR/ACTR-WEN. The ABGR/SYAL-FLOODPLAIN is less productive owing to its warmer, drier environments. This is supported by comparable productivity values for similar types described in Lillybridge et al. (1995). Tree production data are limited and should be used with caution.

Site index			
Species	Base age	No. of trees	SI
ABGR	50	24	82
ACMA	80	2	55
LAOC	50	5	74
PIEN	50	4	78
PIPO	100	5	107
POTR	80	2	80
PSME	50	20	82

Basal area (sq. ft./ac)	
Species	BA
ABGR	83
ACMA	2
CHNO	1
LAOC	13
PICO	4
PIEN	19
PIPO	5
POTR2	23
PSME	91
Total	240

Down Wood—

The overall amount of down woody material is moderate compared with other forested tree series (app. C-3), with logs covering about 8 percent of the ground surface in the ABGR series. This reflects lower elevations, warmer temperatures, and perhaps relatively frequent, log-destroying ground fire. The two moist associations, ABGR/ACCI-WEN and ABGR/ACTR-WEN, have higher amounts of down wood than the drier ABGR/SYAL-FLOODPLAIN association. Log ground cover is lower in the ABGR series than in the moister ABAM, ABLA2, THPL, and TSHE series.

Definitions of log decomposition classes are on page 15.

	Down log attributes				
Log decomposition	Tons/ acre	Cu. ft./ acre	Linear ft./ acre	Sq. ft./ acre	% ground cover
Class 1	1.01	84	210	109	0.25
Class 2	5.24	552	700	561	1.29
Class 3	2.17	271	682	421	0.97
Class 4	1.06	341	611	456	1.05
Class 5	7.88	2,526	1,098	1,742	4.00
Total	17.36	3,774	3,301	3,289	7.56

Snags—

Similarly, the ABGR series has moderate snag production (35.6 snags per acre) compared with other series (app. C-4). Only the TSHE and POTR2 series have fewer numbers of snags. More than half the snags are 5 to 9.9 inches in diameter and only 10 percent are larger than 21.5 inches in diameter.

Definitions of snag condition classes are on page 15.

	Snags/acre by d.b.h. class (inches)				
Snag condition	5–9.9	10–15.5	15.6–21.5	21.6+	Total
Class 1	17.0	5.7	3.3	2.8	28.8
Class 2	2.4	.4	2.1	0	4.9
Class 3	0	0	0	0	0
Class 4	0	0	.5	.2	.7
Class 5	0	0	.5	.7	1.2
Total	19.4	6.1	6.4	3.7	35.6

Fire—

Young grand fir has thin bark and is killed easily by light ground fires until it is at least 4 inches in diameter. Mature trees have 2-inch bark, which protects them against low to moderately severe fires (Crane and Fischer 1986); however, if the bark is injured, the tree bole becomes readily susceptible to Indian paint fungus. Other characteristics that make grand fir susceptible to fire include dense, low branches, flammable foliage, heavy fruticose lichen growth hanging from branches, and relatively shallow roots (Crowe and Clausnitzer 1997, Davis et al. 1980, Fischer and Bradley 1987). In general, grand fir is more resistant to fire than subalpine fir, Engelmann spruce, and lodgepole pine, but less resistant than Douglas-fir and ponderosa pine.

Return intervals of stand-replacing fires on moist ABGR habitat types in the northern Rocky Mountains (ABGR/ACCI-WEN and ABGR/ACTR-WEN are likely similar) probably ranged from 70 to 250 years (Arno 1980). Light ground fires were probably infrequent. Mature stands were dominated by grand fir with lesser amounts of Douglas-fir. Drier sites in continental climate areas (ABGR/SYAL-FLOODPLAIN) probably experienced frequent ground fire return intervals of 16 to 47 years (Agee 1994). Before fire control, mature stands on drier sites and some moist sites were probably composed of large, widely spaced grand fir, Douglas-fir, and ponderosa pine, with relatively dense understory of low and tall shrubs. Ground fires thinned the smaller trees. The advent of intensive fire control encouraged development of multistoried tree canopies in all associations, and many grand fir stands are now at risk to stand-replacing wildfire.

Many ecology plot stands are relatively young compared with other conifer tree series; most are less than 175 years old. Seventy site index trees were sampled for age data. They averaged 118 years in age at breast height. Forty-three trees were less than 100 years old; 18 were 100 to 199, 2 were 200 to 299, and 5 were 300 to 399 years old. One western larch was 500 years old. Most trees older than 199 years were in the moister ABGR/ACTR association. These data seem to suggest that stand-replacing fire-return intervals on the east side of the Cascade Range generally ranged from 100 to 175 years, which is similar to the 100- to 200-year interval reported above. The stand composition regime of neighboring forests also may affect how often these sites burn. Relatively dry grand fir or Douglas-fir upland forests, for example, often adjoin riparian ABGR series sites, and they are prone to more frequent fire, particularly in late summer and during drought periods.

Grand fir seeds can regenerate burned areas but have a short period of viability. Regeneration can be delayed for years if conditions for regeneration are not met at the time of seed fall or planting. In that event, grand fir sites may turn into shrub fields.

Animals—

Livestock. Domestic animals seldom use grand fir as browse (Johnson and Simon 1987). Browse and forage in the shrub and herb layers are greatly reduced in late-successional stands; however, early-seral stands may produce moderate amounts of palatable browse and forage, and use by domestic livestock can be high. However, most use of these sites by livestock (and elk and deer) depends on the availability of cover, shade, and water.

Grazing allotments in the grand fir zone are common, especially on the Cle Elum and Naches RDs, but livestock grazing is not usually a serious problem. However, since many sites have moist, fine-textured soils, managers need to make sure that such sites are not overused. Overuse can result in muddy, trampled areas in early summer or in compaction. Both lead to a significant decline in vegetative cover. If grazed too heavily, eliminating grazing or changing the grazing system, coupled with close monitoring of wildlife, often will allow the remnant shrub and herb populations to sprout and reestablish the stand. This ability to easily reestablish desired shrubs and herbs may be lost when they have been eliminated by overgrazing or when the water table has been lowered by stream downcutting (rare in eastern Washington NFs) or lateral erosion. (For more information on forage palatability, see app. B-1, and for potential biomass production, see app. B-5.)

Wildlife. The ABGR series is good wildlife habitat owing to its structural diversity, closeness to water, mild conditions, and low elevations (Johnson and Simon 1987). Many sites can be used in summer, winter, or both seasons. Wild ungulates, particularly elk, will use them extensively for forage, water, and thermal and hiding cover. Deer and elk trails and beds were common in the vicinity of many sample sites. Deer and elk may eat grand fir needles in winter (Crowe and Clausnitzer 1997). Elk will forage on deerfoot vanilla-leaf when available. Sites are probably used for calving or fawning as well. Older stands often contain ample amounts of snags and logs, which are important for various wildlife species. Black bears may hibernate in large logs and in the base of snags. Old, rotten snags provide dens, nests, and feeding sites for cavity nesters such as martens, fishers, squirrels, weasels, bushy-tailed wood rats, skunks, flying squirrels, and deer mice. Hollowed trunks and logs are used as dens by many small mammals, and the thick grand fir boughs provide temporary shelter from rain (Arno and Hammerly 1984). Beavers have been observed eating the bark of young grand fir trunks and stems, and they occasionally use branches and stems for dam-building material.

Sapsuckers, chickadees, and nuthatches will forage and nest in snags (Crane 1991, Crowe and Clausnitzer 1997, Foiles et al. 1990). Many woodpeckers prefer grand fir and subalpine fir as nesting trees (Agee 1982, Thomas 1979). Pileated woodpeckers and Vaux's swifts roost in snags. Spotted owls are known to use dwarf mistletoe brooms as nest sites. Prey is abundant owing to the frequent logs and snags found on grand fir sites. Grand fir needles are a major part of the diet of grouse. Many species of birds eat the seeds. (For more information on thermal or feeding cover values, see apps. B-2 and B-3. For information on food values or degree of use, see apps. B-2 and B-4.)

Fish. Owing to windthrow and disease, many ABGR sites have moderate amounts of large woody debris in and along adjacent stream channels. This debris provides good channel stabilization, particularly during peak flows associated with spring runoff, and modifies stream structure to provide good fish habitat. (For more information, see app. B-5, erosion control potential.) In addition, older stands with large tree canopies provide shade for smaller streams, which helps regulate water temperatures, a benefit for fish directly in the shade as well as for fish downstream.

Healthy, vigorous stands of ABGR series conifers in riparian zones act as barriers to sedimentation from nearby slopes, and provide a source of large down wood for the stream and nearby fluvial surfaces. Shrub series (such as ALIN) on fluvially active surfaces provide strips of erosion-resistant plants to help stabilize streambanks.

Recreation—

Older stands of grand fir have high value owing to opportunities for undeveloped recreation activities such as hunting, bird watching, and fishing in nearby streams. These sites are not well suited for recreation such as campsites owing to occasional flooding, high water tables, or soils susceptible to compaction much of the year. In addition, shrub layers in open stands, especially the ABGR/ACCI-WEN association, may be dense and tangled, hindering site access and use. Care needs to be taken when selecting such sites for developed recreation purposes. Stands on drier terraces well away from flood zones may provide favorable camps and road sites. However, owing to the number of trees with root rot and decay, these sites are susceptible to windthrow and are hazardous enough that they are not recommended for campsites.

Insects and Disease—

The ABGR series may be the most disease-ridden tree series in eastern Washington (Lillybridge et al. 1995, McDonald et al. 1987a, 1987b). Fungal pathogens, especially various species of decay fungi, are common. Armillaria, annosus, and laminated root rots are particularly common in the ABGR series on the Wenatchee NF (Flanagan 1995).

Laminated and armillaria root rots commonly infect both Douglas-fir and grand fir. Annosus root disease may infect virtually any conifer species on these sites except western larch but is most common in grand fir trees. Schweinitzii butt rot also may infect most conifer species found on these sites. Indian paint fungus also is common in the ABGR series. Dwarf mistletoe infestations affect Douglas-fir, grand fir, and western larch on ABGR sites (Hessburg et al. 1994).

Various insect pests also are possible, most notably western pine beetle, mountain pine beetle, pine engraver beetle, Douglas-fir beetle, fir engraver, western spruce budworm, fir cone moth, fir cone maggot, seed chalcids, and the Douglas-fir tussock moth (Crowe and Clausnitzer 1997).

Estimating Vegetation Potential on Disturbed Sites—

Generally, riparian ABGR sites are not disturbed, so estimating potential vegetation is usually not needed. Clearcutting in riparian areas is unusual, at least on FS land, and currently all FS riparian zones are buffered and not managed for timber production. Also, many stands are located on dry terraces and are infrequently flooded. The ABGR stands usually are separated from active flood zones by wetter plant associations in the SALIX, MEADOW, and ALSI series. In addition, grand fir and other conifers have rapidly reestablished on past clearcut sites. However, to help determine the potential of young stands, or in the event of recent wildfire, sites in similar, nearby watersheds, should be examined.

Sensitive Species—

No sensitive species were located on the ecology plots (app. D).

ADJACENT SERIES

The ABGR series usually transitions into the PSME series (rarely, the PIPO series) on warmer or drier sites. The upper boundaries of the ABGR series are transitional to the THPL or TSHE series on wetter or cooler sites. It changes into the ABLA2 series on colder sites in continental areas of the forests.

RELATIONSHIPS TO OTHER CLASSIFICATIONS

Kovalchik (1992c) described some of the plant associations in the ABGR series in the draft classification for northeastern Washington. Riparian plant associations described in the ABGR series represent relatively wet stand conditions for grand fir associations previously described for the uplands on the Wenatchee NF by Lillybridge et al. (1995). They focused primarily on upland environments but included several plant associations that occur in or in the vicinity of riparian/wetland zones. The ABGR/ACCI-WEN and ABGR/ACTR-WEN associations in this classification are very similar to those described in Lillybridge's Wenatchee classification. The ABGR/SYAL-FLOODPLAIN association is newly classified and similar to the ABGR/SYAL/CARU and ABGR/HODI/CARU associations described by Lillybridge et al. (1995), but the data are from plots only in riparian zones.

Many authors in the Pacific Northwest have described the ABGR series. A partial list of the areas and authors includes the Cascade Range (Diaz and Mellen 1996, John et al. 1988, Topik 1989, Topik et al. 1988); Colville Indian Reservation (Clausnitzer and Zamora 1987); northeastern Washington, northern Idaho, and Montana (Cooper et al. 1991, Daubenmire and Daubenmire 1968, Hansen et al. 1988, 1995, Pfister et al. 1977, Williams et al. 1995); and central and northeast Oregon (Crowe and Clausnitzer 1997, Hall 1973, Johnson and Clausnitzer 1992, Johnson and Simon 1987, Kovalchik 1987). Crowe and Clausnitzer (1997), Diaz and Mellen (1996), and Hansen et al. (1995) are strictly riparian/wetland classifications. Lloyd et al. (1990) and Meidinger and Pojar (1991) described grand fir types in British Columbia.

U.S. DEPARTMENT OF THE INTERIOR, FISH AND WILDLIFE SERVICE WETLANDS CLASSIFICATION

System:	palustrine
Class:	forested wetland
Subclass:	needle-leaved evergreen
Water regime:	(nontidal) intermittently saturated

KEY TO THE GRAND FIR (*ABIES GRANDIS*) PLANT ASSOCIATIONS

1. Vine maple (*Acer circinatum*) ≥5 percent canopy coverage .... **Grand fir/vine maple (ABGR/ACCI) association**

2. Deerfoot vanilla-leaf (*Achlys triphylla*) ≥2 percent canopy coverage .... **Grand fir/deerfoot vanilla-leaf (ABGR/ACTR) association**

3. Dwarf huckleberry (*Vaccinium caespitosum*) or bearberry (*Arctostaphylos uva-ursi*) ≥5 percent canopy coverage; cold-air drainage sites east of the Okanogan River .... **Grand fir/dwarf huckleberry (ABGR/VACA) association** (refer to Williams et al. 1995)

4. Common snowberry (*Symphoricarpos albus*) or ocean-spray (*Holodiscus discolor*) ≥5 percent canopy coverage .... **Grand fir/common snowberry-floodplain (ABGR/SYAL-FLOODPLAIN) association**

Table 7—Constancy and mean cover of important plant species in the ABGR plant associations

		ABGR/ACCI-WEN 9 plots		ABGR/ACTR-WEN 18 plots		ABGR/SYAL-FLOODPLAIN 9 plots	
Species	Code	CON[a]	COV[b]	CON	COV	CON	COV
Tree overstory:							
grand fir	ABGR	89	36	100	42	78	27
subalpine fir	ABLA2	11	15	6	5	—	—
bigleaf maple	ACMA	22	2	—	—	44	9
Alaska yellow-cedar	CHNO	—	—	11	3	—	—
Engelmann spruce	PIEN	22	26	50	8	—	—
lodgepole pine	PICO	—	—	6	35	—	—
western white pine	PIMO	44	2	11	5	—	—
black cottonwood	POTR2	11	10	33	15	11	3
Douglas-fir	PSME	89	31	61	16	89	31
western redcedar	THPL	11	5	—	—	—	—
Tree understory:							
grand fir	ABGR	56	9	100	7	89	4
subalpine fir	ABLA2	11	5	6	Tr[c]	—	—
Engelmann spruce	PIEN	33	3	50	2	11	Tr
western white pine	PIMO	11	8	—	—	—	—
Douglas-fir	PSME	22	1	17	1	56	1
western hemlock	TSHE	—	—	11	2	—	—
Shrubs:							
vine maple	ACCI	100	39	—	—	—	—
Douglas maple	ACGLD	—	—	44	4	89	25
mountain alder	ALIN	—	—	33	9	22	1
Saskatoon serviceberry	AMAL	22	1	44	1	67	1
California hazel	COCO	11	4	—	—	11	20
ocean-spray	HODI	—	—	11	1	67	18
Lewis' mock orange	PHLE2	—	—	—	—	56	22
prickly currant	RILA	11	5	83	3	33	3
baldhip rose	ROGY	78	3	72	2	56	8
woods rose	ROWO	11	5	22	1	11	3
western thimbleberry	RUPA	67	13	72	3	56	2
Scouler's willow	SASC	11	3	—	—	11	7
Sitka mountain-ash	SOSI	11	5	6	Tr	11	Tr
shiny-leaf spiraea	SPBEL	22	8	6	Tr	78	10
common snowberry	SYAL	22	5	83	4	100	26
big huckleberry	VAME	33	12	17	Tr	—	—
Low shrubs/subshrubs:							
Oregon hollygrape	BEAQ	11	Tr	28	1	67	1
Cascade hollygrape	BENE	67	4	61	2	—	—
western prince's-pine	CHUMO	56	2	44	1	22	Tr
twinflower	LIBOL	56	5	39	10	—	—
myrtle pachistima	PAMY	89	6	67	1	89	2
Perennial forbs:							
deerfoot vanilla-leaf	ACTR	22	2	100	27	—	—
baneberry	ACRU	22	2	50	1	—	—
largeleaf sandwort	ARMA3	11	1	33	2	56	2
heartleaf arnica	ARCO	—	—	33	1	22	Tr

Table 7—Constancy and mean cover of important plant species in the ABGR plant associations (continued)

		ABGR/ACCI-WEN 9 plots		ABGR/ACTR-WEN 18 plots		ABGR/SYAL-FLOODPLAIN 9 plots	
Species	**Code**	**CON**	**COV**	**CON**	**COV**	**CON**	**COV**
wild ginger	ASCA3	44	9	—	—	—	—
queencup beadlily	CLUN	78	8	28	1	—	—
Hooker's fairy-bells	DIHO	44	1	17	Tr	44	Tr
broadpetal strawberry	FRVIP	—	—	11	Tr	—	—
sweetscented bedstraw	GATR	22	3	61	1	33	1
western rattlesnake plantain	GOOB	56	1	44	1	33	Tr
white hawkweed	HIAL	11	Tr	17	Tr	56	Tr
peavine species	LATHY	—	—	6	Tr	—	—
purple sweet-root	OSPU	11	Tr	61	1	56	1
pink wintergreen	PYAS	11	40	17	3	11	Tr
sidebells pyrola	PYSE	33	2	72	1	22	3
western solomonplume	SMRA	78	3	67	1	56	Tr
starry solomonplume	SMST	89	6	67	1	22	15
claspleaf twisted-stalk	STAM	—	—	17	Tr	11	Tr
western meadowrue	THOC	22	3	67	6	11	Tr
broadleaf starflower	TRLA2	22	2	50	1	11	Tr
white trillium	TROV	78	2	78	1	—	—
pioneer violet	VIGL	44	2	67	1	22	1
Grass or grasslike:							
elk sedge	CAGE	—	—	28	1	67	5

[a] CON = percentage of plots in which the species occurred.
[b] COV = average canopy cover in plots in which the species occurred.
[c] Tr = trace cover, less than 1 percent canopy cover.

MISCELLANEOUS CONIFER TREE SERIES AND PLANT ASSOCIATIONS N = 19

THIS SECTION IS composed of three coniferous tree series, each with one plant association or community type. The LALY, PICO, and PSME[1] series have 6, 3, and 10 plots, respectively. The PSME series (PSME/SYAL-FLOODPLAIN association) is somewhat uncommon at very low elevations on eastern Washington NFs but very common at lower elevations on lands of other ownership. The LALY series (LALY/CAME-PHEM association) is very common at timberline on the Okanogan NF and northern half of the Wenatchee NF. The PICO series (PICO community type) is a catchall for three very different (vegetation and site) lodgepole pine-dominated plots. Descriptions for these series are short compared with series with more plots and plant associations. Because there is only one association in each series, the following writeups also substitute for plant association writeups.

PHYSICAL SETTING

The three miscellaneous conifer series are first combined into a common set of environmental tables, and then the individual series/plant associations are described. The locations of the sample plots are shown in figures 14, 15, and 16.

[1] See appendix A for a cross reference for all species codes and common and scientific names used in this document.

Elevation—

	Elevation (feet)			
Series	Minimum	Maximum	Average	N
LALY	6,860	7,320	7,058	6
PICO	4,300	4,400	4,367	3
PSME	1,320	2,550	2,118	10

Valley Geomorphology—

	Valley width					
Series	Very broad	Broad	Moderate	Narrow	Very narrow	N
LALY	1	4	1	0	0	6
PICO	0	1	2	0	0	3
PSME	3	1	3	2	0	9

	Valley gradient					
Series	Very low	Low	Moderate	Steep	Very steep	N
LALY	5	1	0	0	0	6
PICO	1	2	0	0	0	3
PSME	1	5	2	1	0	9

Channel Types—

	Rosgen channel types					
Series	B	C	E	Intermittent and ephemeral	Lake/pond	N
LALY	0	0	2	0	4	6
PICO	0	0	3	0	0	3
PSME	6	3	0	1	0	10

Fluvial Surfaces—

	Fluvial surfaces				
Series	Terrace	Toeslope	Shrub wetland	Forest wetland	N
LALY	0	0	4	2	6
PICO	0	0	2	1	3
PSME	6	3	0	0	9

Soils—

	Soil texture				
Series	Sand	Loamy sand	Loam	Clay loam	N
LALY	0	3	3	0	6
PICO	0	0	1	2	3
PSME	1	1	7	0	9

Miscellaneous conifer plant associations

	Scientific name	Common name	Ecoclass code	Plots
Major associations:				
LALY/CAME-PHEM	*Larix layallii/Cassiope mertensiana-Phyllodoce empetriformis*	Subalpine larch/Merten's moss-heather–red mountain-heath	CAC116	6
PSME/SYAL-FLOODPLAIN	*Pseudotsuga menziesii/Symphoricarpos albus*-floodplain	Douglas-fir/common snowberry-floodplain	CDS628	10
Minor associations:				
PICO	*Pinus contorta*	Lodgepole pine community type	CLMO	3

KEY TO THE MISCELLANEOUS CONIFER TREE SERIES

1. Moss-heathers (*Cassiope* spp.), mountain-heaths (*Phyllodoce* spp.), and/or partridgefoot (*Luetkea pectinata*) ≥10 percent canopy coverage .... **Subalpine larch series and subalpine larch/Merten's moss-heather–red mountain-heath (LALY/CAME-PHEM) association**

2. Douglas-fir (*Pseudotsuga menziesii*) present with ≥10 percent canopy coverage and reproducing successfully .... **Douglas-fir series and Douglas-fir/common snowberry-floodplain (PSME/SYAL-FLOODPLAIN) association**

3. Lodgepole pine (*Pinus contorta*) dominates the stand, other conifers are not reproducing successfully .... **Lodgepole pine series and lodgepole pine (PICO) community type**

DOUGLAS-FIR SERIES

Pseudotsuga menziesii

PSME/SYAL-FLOODPLAIN Plant Association DS628

N = 10

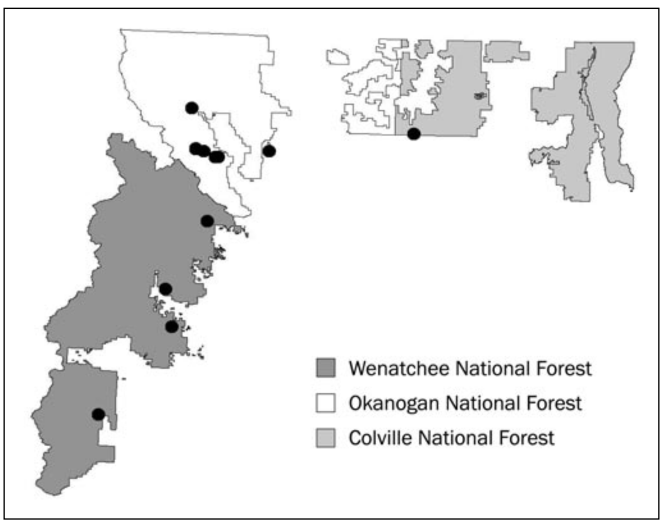


Figure 14—Plot locations for the Douglas-fir series.

VEGETATION CHARACTERISTICS

Mature PSME/SYAL-FLOODPLAIN[1] stands are characterized by an abundance of Douglas-fir and common snowberry. Other trees are seral opportunists and include bigleaf maple, western larch, lodgepole pine, ponderosa pine, quaking aspen, and black cottonwood. Shrubs, especially common snowberry, dominate the ground cover. Other shrubs with high constancy or cover include Douglas maple, Saskatoon serviceberry, Oregon hollygrape, red-osier dogwood, myrtle pachistima, western thimbleberry, and shinyleaf spiraea. These shrubs may form a rich thicket on some of the moister sites in the PSME/SYAL-FLOODPLAIN association. Herbs are generally scarce, especially under dense shrub canopies, and include broadpetal strawberry and starry solomonplume.

PHYSICAL SETTING

The PSME series (PSME/SYAL-FLOODPLAIN association) is somewhat common on the Okanogan and Wenatchee NFs but is rare on the Colville NF, where it was sampled only on the Republic RD. This is the warmest and driest riparian conifer series; although, it is relatively moist compared with PSME associations described in upland classifications (Lillybridge et al. 1995, Williams et al. 1995). Two potential one-plot associations (PSME/ALLUVIAL BAR and PSME/VACA) were sampled but not described in this classification (PSME/VACA is found in the classifications mentioned above).

The PSME/SYAL-FLOODPLAIN sites are generally near the lower elevation distribution of forest zones and occasionally adjacent to shrub-steppe. Ecology plot elevations range from 1,320 to 2,550 feet and average 2,118 feet. Most stands are associated with terraces and gentle toeslopes in broad, low gradient valleys. Valley side slopes usually are quite steep. Only 2 of 10 sample plots are located in narrower, moderate to steep gradient valleys. The streams associated with the PSME series are classified as Rosgen B and C channel types. Most soils are well-developed loam except for one plot with sandy soil deposited during a recent flood. With a few exceptions, these sites are elevated well above the stream and are flooded only by 50- to 100-year flood events. Water tables may be located within a few feet of the soil surface in May and June and lower to more than 5 feet below the soil surface in July and August.

ECOSYSTEM MANAGEMENT

Natural Regeneration of Douglas-Fir

Douglas-fir has winged seeds that are dispersed primarily by wind and gravity (Fowells 1965). Seed is produced annually; good crops are produced about every 6 to 10 years. The seeds are capable of traveling a distance of about 265 feet from the parent tree. Seedlings establish best on mineral seedbeds or on organic seedbeds less than 2 inches thick (Ryker 1975). Seedling survival is higher on undisturbed litter on exposed surfaces in clearcuts (Schmidt 1969); however, it is best under partial shade (Ryker 1975).

Artificial Establishment of Douglas-Fir—

Douglas-fir is a valued timber species. Nursery-grown container and bare-root stock is widely planted on disturbed sites in the Pacific Northwest and does best on warm, mesic sites. Trees can usually be established from seed or advanced, natural regeneration with proper regeneration strategies. Seedlings are somewhat sensitive to direct sunlight and

[1] See appendix A for a cross reference for all species codes and common and scientific names used in this document.

should be planted in the protective shade of stumps, logs, or vegetation. (For more information on the short- and long-term revegetation potential of selected riparian wetland plant species, see app. B-5.)

Stand Management—

Clearcutting was often the method of choice before the 1990s (even in riparian zones), and the success of regeneration using stand regeneration harvest methods has been variable. Overstory removal may result in a long-term conversion of site potential to nonforest communities, especially shrubs, in the PSME/SYAL association (Lillybridge et al. 1995, Pfister et al. 1977). This is especially true on moister sites. Partial overstory removal (selection or group selection) is more appropriate for riparian sites. This is probably not a problem on sites with drier, better drained soils. Most riparian sites on FS lands are presently managed as buffer zones.

Growth and Yield, Down Wood, and Snags—

Wood fiber production is moderately high compared with upland Douglas-fir plant associations (Lillybridge et al. 1995, Williams et al. 1995). Site index averaged 155 (100-year base) for ponderosa pine and 83 (50-year base) for Douglas-fir. Basal area averaged 249 square feet per acre for Douglas-fir and 282 square feet for all species. Down wood averaged 12 tons per acre, 1,824 cubic feet per acre, 2,400 linear feet per acre, 1,878 square feet per acre, and 8 percent ground cover. (For more information, see apps. C-1a through C-4.)

Fire—

Vegetation occurring in this association has a moderate to high resistance to fire. Pole and sawlog ponderosa pine and Douglas-fir will tolerate moderate to hot ground fire. Common snowberry and many of the shrubs will sprout from the stem base or underground rhizomes following cool and moderate ground fire.

Animals—

Livestock. These low-elevation sites have often received a century or more of intensive use (roads, season-long grazing, logging, flooding) because of easy access. Therefore, the majority of stands are highly altered. Past disturbance has lowered the competitive ability of native trees, shrubs, and herbs, thus allowing increasers and invaders to become dominant. Some stands are presently orchards or pastures (for example, Swaukane Creek). (For more information on forage palatability, see app. B-1, and for potential biomass production, see app. B-5.)

Wildlife and fish. The fish habitats on most streams within PSME/SYAL-FLOODPLAIN sites are degraded. Degraded Rosgen B and C channels have wide, shallow, dished profiles, and streambanks (supporting different series) are at least partially denuded of shrubs, especially red-osier dogwood and mountain alder. Depending on the condition of the watershed upstream, the hydrology of these sites may be altered to abnormally high peak flows and low summer flows (for more information, see app. B-5, erosion control potential). Establishing natural plant communities, such as the ALIN/SYAL or COST/SYAL associations, on floodplains and streambanks will influence the development of normal channels with good vegetation control. Ponderosa pine and Douglas-fir should be reestablished on degraded PSME/SYAL-FLOODPLAIN terraces to provide a long-term presence of woody debris for the stream channel. Valleys supporting these associations provide important habitat for a variety of wildlife. Passerines, deer, elk, grouse, woodpeckers, squirrels, chipmunks, and quail use this habitat. (For more information on thermal or feeding cover values, see apps. B-2 and B-3. For information on food values or degree of use, see apps. B-2 and B-4.)

Estimating Vegetation Potential on Disturbed Sites—

Most forested valley bottoms below the elevation distribution of Engelmann spruce belong to the PSME series and PSME/SYAL-FLOODPLAIN association. Forest stands on lower elevation sites on other land ownerships may belong to the PIPO or POTR2 series.

RELATIONSHIPS TO OTHER CLASSIFICATIONS

The PSME series was sampled but not described in the draft classification for northeastern Washington (Kovalchik 1992c). The PSME/SYAL-FLOODPLAIN association is similar to the PSME/SYAL-FLOODPLAIN association described by Crowe and Clausnitzer (1997). The PSME/SYAL-FLOODPLAIN stands with red-osier dogwood are similar to the PSME/COST4 habitat type in Montana (Hansen et al. 1995). This association was sampled but not described on the Ochoco NF in central Oregon (Kovalchik 1987). It is also somewhat similar (in vegetation composition) to the upland PSME/SYAL associations described for eastern Washington (Lillybridge et al. 1995, Williams et al. 1995).

U.S. DEPARTMENT OF THE INTERIOR, FISH AND WILDLIFE SERVICE WETLANDS CLASSIFICATION

System:	palustrine
Class:	forested wetland
Subclass:	needle-leaved evergreen
Water regime:	(nontidal) intermittently flooded

SUBALPINE LARCH SERIES

Larix lyallii

LALY/CAME-PHEM plant association CAC116

N = 6

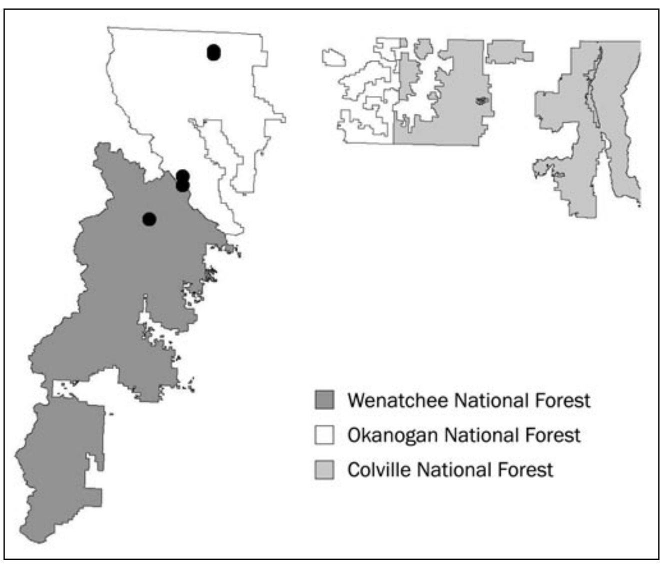


Figure 15—Plot locations for the subalpine larch series.

VEGETATION CHARACTERISTICS

Stands of LALY/CAME-PHEM[1] usually are open and relatively dwarfed compared with adjacent upland stands of subalpine larch (usually the LALY/CAME-LUPE and LALY/VADE-CAME associations, Lillybridge et al. 1995). Individual trees may be centuries old, yet only 3 to 5 inches in diameter. Subalpine larch has at least 10 percent canopy coverage and is usually dominant. Subalpine fir or Engelmann spruce are codominant in some stands. Ericaceous shrubs, especially moss-heathers or mountain-heaths, are characteristic of the ground cover. Other shrubs with high constancy or cover include alpine laurel, Labrador tea, dwarf huckleberry, and grouse huckleberry. The herb layer is often richer relative to adjacent uplands. Partridgefoot was well represented on one-third of the plots and can be used to help key the sites to LALY/CAME-PHEM. Other herbs with high constancy or cover may include woolly pussytoes, hairy arnica, twinflower marsh-marigold, slender hawkweed, fanleaf cinquefoil, black alpine sedge, and smooth woodrush.

[1] See appendix A for a cross reference for all species codes and common and scientific names used in this document.

PHYSICAL SETTING

The LALY series (LALY/CAME-PHEM association) is very common on the Okanogan and Wenatchee NFs (Lillybridge et al. 1995) but is absent on the Colville NF (Williams et al. 1995). This is one of the harshest, coldest associations in the various conifer series. It generally occurs at very high elevations at the upper margin of forest development. Ecology plot elevations range from 6,860 to 7,320 feet and average 7,058 feet. Sites are generally adjacent to high-elevation fens or carrs (such as the CAME-PHEM, CANI2, CASCB, or SAFA/CASCB associations) on wetter sites or alpine meadows, and adjacent to cliffs or talus slopes on uplands. Stands lie in the transition (xeroriparian) zone that occurs between wetland or riparian zones and uplands. Most sites seem to fall in valleys that are moderate to very broad in width and low to moderate in gradient. Valley side slopes range from gentle to extremely steep. The LALY series usually occurs next to E channels, lakes, or ponds. It also occurs next to A channels. Soil textures within the rooting zone are sandy loam and loam. The soil surface is often very hummocky owing to frost heaving of the moist, loam soils. The LALY/CAME-PHEM sites usually are elevated well above the stream or body of water and are saturated at snowmelt but rarely flooded in the traditional sense.

ECOSYSTEM MANAGEMENT

Natural Regeneration of Subalpine Larch—

Subalpine larch begins to produce cones when it is about 100 years old but generally does not produce significant numbers of seed until it is 200 years old (Arno 1970). Cone production is generally low, presumably owing to late-season frost damage. Large seed crops are infrequent, averaging perhaps 1 out of 10 years. The small, winged seeds are wind disseminated in September. Gravity and snow slides may transport seeds to lower elevations. The seed germinates in July, soon after snowmelt. Seedlings establish best on mineral seedbeds on north slopes. Dry, warm winds contribute to less regeneration on south-facing slopes; however, vigorous stands of subalpine larch are found on gentle, south-facing slopes with deep, moist soils.

Stand Management—

Subalpine larch is not a valued timber species. These harsh sites lie at high elevations in climates with deep snowpack and short growing seasons, often in roadless areas, and regeneration cannot be assured. Management should concentrate on limiting any kind of disturbance on these harsh, sensitive sites.

Growth and Yield, Down Wood, and Snags—

Tree production data are limited in the LALY series. Basal area averaged a surprising 111 square feet per acre on six sample plots, probably on account of stand selection bias. Subalpine fir, subalpine larch, and Engelmann spruce each averaged 24, 45, and 42 square feet per acre, respectively. However, wood fiber production was low. Site index averaged only 18, 17, and 34 feet (50-year base) for subalpine fir, subalpine larch, and Engelmann spruce, respectively. The site index numbers are probably too high for the growing conditions as western larch site index curves were used. The western larch curves assume the tree reached breast height at 5 years of age, but it may take subalpine larch 50 or more years to reach breast height on these harsh sites. (For more information, see apps. C-1a through C-4.)

Fire—

Subalpine larch stands lie in zones of very frequent lightning strikes. However, stand-replacement fires are rare because areas of cliff, talus, and rock often interrupt LALY stands. Fires usually are restricted to the immediate vicinity of the lightning-struck tree (Lillybridge et al. 1995). Very little evidence of fire was observed in subalpine larch stands in eastern Washington.

Animals—

Livestock. Large numbers of sheep and cattle were grazed on LALY/CAME-PHEM sites in the late 1800s and early 1900s. Modern-day grazing is limited to an occasional allotment. Still, the damage to vegetation cover of the late 1800s and early 1900s may have initiated erosion that continues to present day (Lillybridge et al. 1995). Examination of areas lying within the LALY series that were used as sheep bedding grounds reveal that erosion is still common, even though the sites have not had sheep on them for many decades. (For more information on forage palatability, see app. B-1. For potential biomass production, see app. B-5.)

Wildlife and fish. Timberline and alpine sites are extremely important for a variety of wildlife. Pikas, ptarmigan, and mountain goats represent a few of the unique animals that inhabit this zone (Lillybridge et al. 1995). (For more information on thermal or feeding cover values, see apps. B-2 and B-3. For information on food values or degree of use, see apps. B-2 and B-4.) These sites usually are located away from streambanks. (For more information, see app. B-5, erosion control potential.)

Recreation—

Subalpine larch forms a distinctive zone of open forests at upper treeline. Heavy, late-melting snowpacks form the headwaters of many streams. Summer recreational use is often high because of the rugged beauty of this country, with subalpine larch being an attractive feature of these landscapes (Lillybridge et al. 1995). Watershed and recreation values are extremely high, but these fragile and valuable habitats need to be carefully managed to protect their soils and vegetation. Excessive horse use is one of the biggest modern-day threats to LALY/CAME-PHEM and other timberline and alpine plant associations. Horses have caused major trail damage and vegetation obliteration on many campsites, and managing this activity is one of the biggest challenges to managing the wilderness.

Insects and Disease—

Subalpine larch is relatively disease free compared with other trees (Lillybridge et al. 1995). No known threats exist for subalpine larch stands.

Estimating Vegetation Potential on Disturbed Sites—

Most LALY stands are in fair or better ecological condition, and it is rare to find stands that cannot be identified to the proper series and plant association.

RELATIONSHIPS TO OTHER CLASSIFICATIONS

Except for the proximity to riparian and wetland ecosystems, the LALY/CAME-PHEM association is similar to the LALY/CAME-LUPE and LALY/VADE-CAME associations described by Lillybridge et al. (1995). Upland plant associations belonging to the LALY series have been described in the Washington Cascade Range (Lillybridge et al. 1995, Williams and Lillybridge 1983), northern Idaho, and Montana (Cooper et al. 1991, Pfister et al. 1977).

U.S. FISH AND WILDLIFE SERVICE WETLANDS CLASSIFICATION

System:	palustrine
Class:	forested wetlands
Subclass:	needle-leaved evergreen
Water regime:	(nontidal) intermittently saturated

LODGEPOLE PINE SERIES

Pinus contorta

PICO N = 3

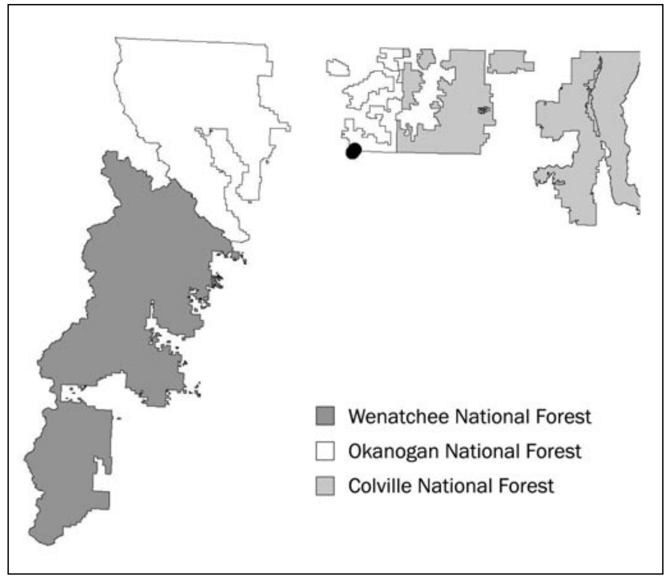


Figure 16—Plot locations for the lodgepole pine series.

ALL THREE PLOTS were sampled in the headwaters of Lost Creek on the Tonasket RD, Okanogan NF. Elevations of these plots range from 4,300 to 4,400 feet. Lodgepole pine[1] dominates the overstory of all three plots. Other conifers are uncommon, and the climax cannot be determined. Two plots are located in wetlands and would have keyed to PICO/CACA and PICO/CAUT associations if there had been more than one plot in each type. Bluejoint reedgrass dominates the undergrowth of the first plot with 80 percent canopy coverage. No other herb is well represented. Sedges dominate the undergrowth of the second plot. Bladder sedge is most abundant with 20 percent canopy coverage. Gray, northern clustered, Buxbaum's, and inflated sedges, as well as weak alkaligrass, are well represented. It is likely that both plots are early-seral stages of PIEN/CACA and PIEN/CAUT associations. The driest plot is located on the transition zone between the above wetlands and the adjacent upland. Shrubby cinquefoil dominates the undergrowth. Dwarf huckleberry, timber oatgrass, Kentucky bluegrass, cutting wheatgrass, spike trisetum, broadpetal strawberry, white clover, and Sitka valerian are well represented. This plot is likely an early-seral, disturbance phase of the ABLA2/VACA plant association found in Lillybridge et al. (1995). (For more information, see apps. B-1 through B-5 and C-1a through C-4.)

[1] See appendix A for a cross reference for all species codes and common and scientific names used in this document.

Table 8—Constancy and mean cover of important plant species in the miscellaneous conifer associations

Species	Code	LALY/CAME-PHEM 6 plots		PICO 3 plots		PSME/SYAL-FLOODPLAIN 11 plots	
		CON[a]	COV[b]	CON	COV	CON	COV
Tree overstory:							
subalpine fir	ABLA2	33	9	—	—	—	—
bigleaf maple	ACMA	—	—	—	—	9	20
subalpine larch	LALY	67	5	—	—	—	—
western larch	LAOC	—	—	—	—	9	15
Engelmann spruce	PIEN	33	13	33	Tr[c]	9	Tr
lodgepole pine	PICO	—	—	100	55	9	10
ponderosa pine	PIPO	—	—	—	—	27	16
quaking aspen	POTR	—	—	—	—	18	7
black cottonwood	POTR2	—	—	—	—	18	7
Douglas-fir	PSME	—	—	—	—	100	56
Tree understory:							
subalpine fir	ABLA2	50	3	33	1	9	Tr
subalpine larch	LALY	100	18	—	—	—	—
Engelmann spruce	PIEN	67	5	67	2	18	1
lodgepole pine	PICO	—	—	100	5	—	—
Douglas-fir	PSME	—	—	—	—	82	3
Shrubs:							
Douglas maple	ACGLD	—	—	—	—	73	16
mountain alder	ALIN	—	—	—	—	27	6
Saskatoon serviceberry	AMAL	—	—	—	—	82	8
red-osier dogwood	COST	—	—	—	—	36	9
Lewis' mock orange	PHLE2	—	—	—	—	27	20
rose species	ROSA	—	—	—	—	9	15
red raspberry	RUID	—	—	—	—	27	10
western thimbleberry	RUPA	—	—	—	—	55	8
shiny-leaf spiraea	SPBEL	—	—	—	—	55	3
common snowberry	SYAL	—	—	—	—	100	50
Low shrubs and subshrubs:							
Oregon hollygrape	BEAQ	—	—	—	—	82	2
Merten's moss-heather	CAME	50	35	—	—	—	—
four-angled moss-heather	CATE2	50	63	—	—	—	—
western wintergreen	GAHU	33	8	—	—	—	—
alpine laurel	KAMI	83	2	—	—	—	—
Labrador tea	LEGL	83	8	—	—	—	—
twinflower	LIBOL	—	—	33	3	9	25
myrtle pachistima	PAMY	—	—	—	—	73	3
red mountain-heath	PHEM	100	13	—	—	—	—
cream mountain-heath	PHGL	17	5	—	—	—	—
shrubby cinquefoil	POFR	—	—	100	14	—	—
dwarf huckleberry	VACA	83	6	67	12	—	—
grouse huckleberry	VASC	50	13	—	—	—	—
Perennial forbs:							
woolly pussytoes	ANLA	67	3	—	—	—	—
rose pussytoes	ANMI	—	—	67	3	—	—
Chamisso arnica	ARCH	—	—	67	3	—	—
hairy arnica	ARMO	50	2	—	—	—	—
western aster	ASOC	—	—	67	3	—	—
twinflower marshmarigold	CABI	50	3	—	—	—	—
Hooker's fairy-bells	DIHO	—	—	—	—	55	4
broadpetal strawberry	FRVIP	—	—	100	5	—	—
largeleaf avens	GEMA	—	—	100	3	—	—
slender hawkweed	HIGR	67	1	—	—	—	—
Canby's licoriceroot	LICA2	17	Tr	67	2	—	—
partridgefoot	LUPE	67	10	—	—	—	—
fanleaf cinquefoil	POFL2	50	1	—	—	—	—
northwest cinquefoil	POGR	—	—	67	3	—	—
hooked buttercup	RAUN2	—	—	100	1	9	Tr
starry solomonplume	SMST	—	—	—	—	64	1
common dandelion	TAOF	—	—	100	1	18	Tr
western meadowrue	THOC	—	—	67	3	36	2
white clover	TRRE	—	—	67	5	—	—
Sitka valerian	VASI	33	5	—	—	—	—
Grass or grasslike:							
cutting wheatgrass	AGCA	—	—	67	4	—	—
bluejoint reedgrass	CACA	—	—	100	30	—	—

Table 8—Constancy and mean cover of important plant species in the miscellaneous conifer associations (continued)

		LALY/CAME-PHEM 6 plots		PICO 3 plots		PSME/SYAL-FLOODPLAIN 11 plots	
Species	**Code**	**CON**	**COV**	**CON**	**COV**	**CON**	**COV**
slimstem reedgrass	CANE3	—	—	67	3	—	—
northern clustered sedge	CAAR2	—	—	33	10	—	—
Buxbaum's sedge	CABU2	—	—	33	5	—	—
gray sedge	CACA4	—	—	33	5	—	—
black alpine sedge	CANI2	83	4	—	—	—	—
bladder sedge	CAUT	—	—	33	20	—	—
inflated sedge	CAVE	—	—	33	5	—	—
timber oatgrass	DAIN	—	—	67	9	—	—
tufted hairgrass	DECE	—	—	67	4	—	—
smooth woodrush	LUHI	83	3	—	—	—	—
timothy	PHPR	—	—	67	2	—	—
Kentucky bluegrass	POPR	—	—	67	4	9	2
weak alkaligrass	PUPAH	—	—	33	10	—	—
Ferns and fern allies:							
common horsetail	EQAR	—	—	67	2	—	—

[a] CON = percentage of plots in which the species occurred.
[b] COV = average canopy cover in plots in which the species occurred.
[c] Tr = trace cover, less than 1 percent canopy cover.

Go to Part 2

Return to Part 1 Go to Part 3

QUAKING ASPEN SERIES

Populus tremuloides

POTR N = 33

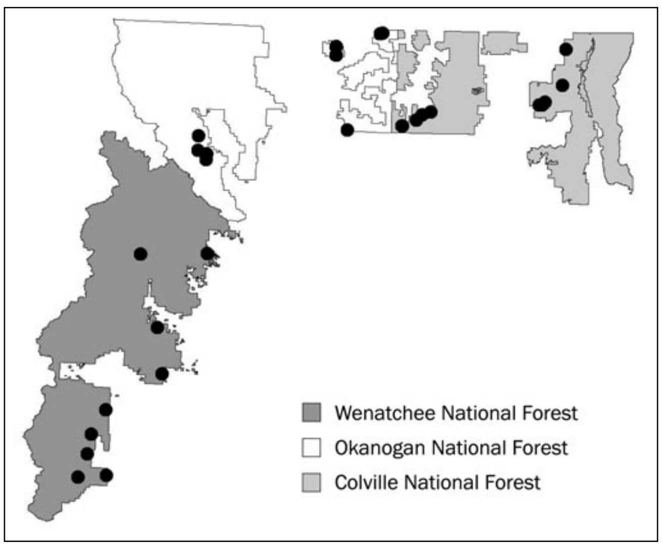


Figure 17—Plot locations for the quaking aspen series.

QUAKING ASPEN[1] is the most widespread tree in North America. It occurs from Alaska to Newfoundland, south to northern Mexico and east to Nebraska, Tennessee, Virginia, and New Jersey (Hitchcock and Cronquist 1973, Little 1971, Parish et al. 1996). Quaking aspen is distributed fairly uniformly in the Eastern United States but is patchy in the West, where trees are confined to suitable sites.

[1] See appendix A for a cross reference for all species codes and common and scientific names used in this document.

Quaking aspen has wide ecological amplitude in the Northwest, and aspen communities may be found from low-elevation shrub-steppe environments up to subalpine areas. Quaking aspen is most common in areas with a continental climate, with few plots in areas with strong maritime climate. However, it is rarely the major landscape component in eastern Washington as it is in certain locations within the northern and central Rocky Mountains. Instead, aspen clones usually occur in small clumps of a few acres or less in size. Most upland aspen stands have ample conifer regeneration and are successional to conifer forest. The situation in riparian and wetland zones is more complex. Some stands are climax. This appears to be particularly true of aspen communities found in poorly drained depressions, wetlands, springs, and seeps. Stands in the POTR/CALA3 association occur on such sites and are obviously climax. Some stands in the POTR/COST and POTR/SYAL also are climax, whereas other sites are drier and show a trend toward conifer climax. As these stands are better managed for aspen, both situations are included within these associations.

CLASSIFICATION DATABASE

The POTR series includes all closed-forest stands potentially dominated by quaking aspen. The POTR series occurs on all three NFs in eastern Washington (fig. 17). It was sampled on all RDs except the Kettle, Newport, Sullivan, Methow Valley, and Chelan RD, although it likely occurs on these RDs as well. Thirty-three riparian and wetland sampling plots were measured in the POTR series. Data from a single plot from previous ecology sampling were used to increase the data for the POTR series to facilitate classification as well as provide additional data for species composition, distribution, and elevation. From this database, two major associations and one minor association are recognized as shown in the table below. Two one-plot associations (POTR/CACA and POTR/SCMI) were found on wetland sites but are not used in the data nor used to describe the POTR series. For the most part, the information presented in the POTR series represents mature stands in late-seral to climax conditions, although some stands are obviously seral to conifers as described in the previous section.

Quaking aspen plant associations

	Scientific name	Common name	Ecoclass code	Plots
Major associations:				
POTR/COST	*Populus tremuloides/Cornus stolonifera*	Quaking aspen/red-osier dogwood	HQS311	14
POTR/SYAL	*Populus tremuloides/Symphoricarpos albus*	Quaking aspen/common snowberry	HQS221	16
Minor associations:				
POTR/CALA3	*Populus tremuloides/Carex lanuginosa*	Quaking aspen/woolly sedge	HQM211	3

VEGETATION CHARACTERISTICS

Despite the small number of plots and associations, the POTR series exhibited high species diversity owing to its inherent site variability. Moderately large quaking aspen generally dominate mature stands. Paper birch and lodgepole pine variously occur as scattered individuals in the POTR/CALA3, POTR/COST, and POTR/SYAL associations. Drier sites support scattered Douglas-fir, lodgepole pine, ponderosa pine, paper birch, and black cottonwood. The tree understory is usually dominated by quaking aspen, with occasional paper birch, black cottonwood, Douglas-fir, or Engelmann spruce.

Shrubs form a diverse understory in all three associations. The primary indicator species are red-osier dogwood and common snowberry. Other common shrub species include Douglas maple, mountain alder, Saskatoon serviceberry, prickly currant, Nootka and baldhip rose, western thimbleberry, and various species of willows.

The herbaceous layer is also varied, although herbs are often sparse under denser stands of red-osier dogwood, common snowberry, and other shrubs. The sole indicator for the POTR/CALA3 association is woolly sedge. Bluejoint reedgrass, tufted hairgrass, sharptooth angelica, broadpetal strawberry, arrowleaf coltsfoot, starry solomonplume, and common horsetail are common herbs on the POTR/CALA3 association. Herbs on the two drier associations include purple and mountain sweet-root, starry solomonplume, western meadowrue, blue wildrye, and common horsetail.

PHYSICAL SETTING

Elevation—

The POTR series occurs at low to moderate elevations in eastern Washington. Elevations range from 1,980 to 4,520 feet in riparian and wetland zones, although the majority of sites are below 4,000 feet.

Forest	Elevation (feet)			N
	Minimum	Maximum	Average	
Colville	2,420	4,000	3,046	10
Okanogan	2,400	4,520	3,321	11
Wenatchee	1,980	4,210	2,775	12
Series	1,980	4,520	3,039	33

The POTR/CALA3 association is located at the highest elevations in the POTR series, generally above 3,500 feet. The remaining associations are generally found at elevations lower than 3,500 feet.

Plant association	Elevation (feet)			N
	Minimum	Maximum	Average	
POTR/CALA3	3,100	4,520	3,973	3
POTR/COST	2,000	4,000	2,965	14
POTR/SYAL	1,980	4,210	2,928	16
Series	1,980	4,520	3,039	33

Valley Geomorphology—

Plot locations in the POTR series are in a variety of valley width and gradient classes. The most common valley landforms are moderate to very broad valleys with low or very low gradients. The remaining stands are largely located in narrow valleys with steep gradients.

Valley width	Valley gradient					N
	Very low	Low	Moderate	Steep	Very steep	
Very broad	2	3	0	0	0	5
Broad	6	5	0	0	0	11
Moderate	5	4	0	0	0	9
Narrow	0	0	1	3	3	7
Very narrow	0	0	0	0	0	0
Series total	13	12	1	3	3	32

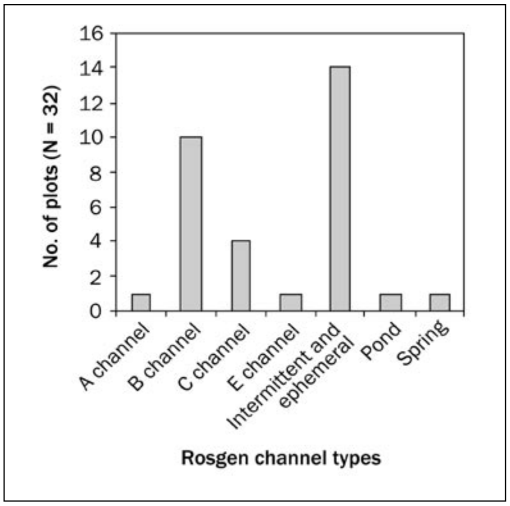
The differences between these two landform clusters justify examining individual associations in more detail. The wet POTR/CALA3 association favors broader valleys and flat, wet sites. The POTR/COST association generally favors moderately wide valleys and low valley gradients. The POTR/SYAL association, on the other hand, is equally at home on well-drained terraces in wide, low gradient valleys or in narrow draws or along springs with a steep gradient.

Plant association	Valley width					N
	Very broad	Broad	Moderate	Narrow	Very narrow	
POTR/CALA3	1	1	1	0	0	3
POTR/COST	1	5	6	2	0	14
POTR/SYAL	3	5	2	5	0	15
Series total	5	11	9	7	0	32

Plant association	Valley gradient					N
	Very low	Low	Moderate	Steep	Very steep	
POTR/CALA3	3	0	0	0	0	3
POTR/COST	8	4	1	0	1	14
POTR/SYAL	2	8	0	3	2	15
Series total	13	12	1	3	3	32

Channel Types—

The POTR series stands are located along a variety of Rosgen channel types. Most of the plots are located in sites that were ephemeral in nature, such as ephemeral draws or ephemeral depressions containing meadow-, shrub-, or aspen-dominated wetlands. Quaking aspen stands also are located in riparian zones along low to moderate gradient Rosgen C and B channel types. Very few plots are associated with Rosgen A and E channel types.

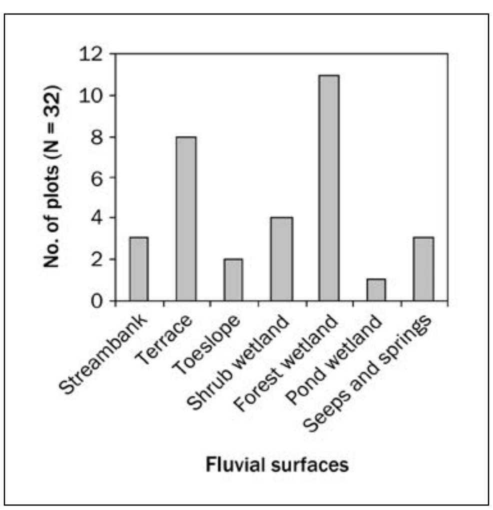


Additional insight can be gained by looking at individual associations as shown in the table below. The POTR/CALA3 associaton occurs only in ephemeral depressions, but the other two associations also are common on these sites. The POTR/COST and POTR/SYAL associations also are common on terraces next to B channels.

	Rosgen channel types							
Plant association	A	B	C	E	Intermittent and ephemeral	Pond	Spring	N
POTR/CALA3	0	0	0	0	3	0	0	3
POTR/COST	0	4	2	0	8	0	0	14
POTR/SYAL	1	6	2	1	3	1	1	15
Series total	1	10	4	1	14	1	1	32

Fluvial Surfaces—

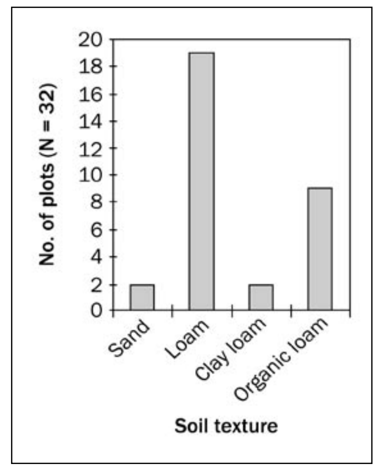
The POTR series plots are located on a variety of fluvial surfaces. Relatively few plots (38 percent) are found in riparian zones. The majority of plots (62 percent) are located in wetlands associated with ephemeral depressions, lakes, or springs.



Additional insight is gained by looking at individual plant associations according to fluvial surfaces. The POTR/CALA3 association is located strictly within wetlands, whereas POTR/SYAL is equally distributed between riparian and wetland fluvial surfaces. The POTR/COST association can be found on both wetland and riparian fluvial surfaces, the former being more common.

	Fluvial surfaces							
Plant association	Stream-bank	Terrace	Toe-slope	Shrub wetland	Forest wetland	Pond wetland	Seeps/springs	N
POTR/CALA3	0	0	0	1	2	0	0	3
POTR/COST	1	3	1	2	6	0	1	14
POTR/SYAL	2	5	1	1	3	1	2	15
Series total	3	8	2	4	11	1	3	32

Soils—



Mineral soils are the dominant soil types in the POTR series. Loam and organic loam textures predominated. Sand and clay loam textures are rare. Whatever the soil texture, quaking aspen stands produce deep leaf litter that contains an abundance of nitrogen, phosphorus, potash, and calcium. The litter decays rapidly and may amount to 25 tons per acre on an oven-dry basis. This humus reduces runoff, aids in percolation and recharge of ground water, reduces evapotranspiration, and supports an abundant and varied flora (Brinkman and Roe 1975).

Differences are more apparent when comparing the three associations. All POTR/CALA3 plots had organic soils, whereas organic soils are scattered in the other two types. Organic soils also are common on POTR/COST where there are deep accumulations of leaf litter within ephemeral depression shrub wetlands. The two organic soils in POTR/SYAL are located by a spring and on the edge of a pond. Most POTR/COST and POTR/SYAL soils are loams associated with streambanks, terraces, and ephemeral draws.

	Soil texture				
Plant association	Sand	Loam	Clay loam	Organic loam	N
POTR/CALA3	0	0	0	3	3
POTR/COST	1	8	1	4	14
POTR/SYAL	1	11	1	2	15
Series total	2	19	2	9	32

Water table depths at time of sampling are variable. The POTR/CALA3 is the wettest association, with organic soils that often remained moist season long. The other associations usually are better drained, except where associated with the organic soils. Few plots had soil surface flooding at the time of sampling so no table is shown. However, stands located on wetland sites are frequently flooded at snowmelt.

	Water table (inches)			
Plant association	Minimum	Maximum	Average	N
POTR/CALA3	-20	-12	-17	3
POTR/SYAL	-49	-12	-26	3
POTR/COST	-60	-10	-31	6
Series	-60	-10	-26	12

Soil temperatures are available for 32 plots. In general, the drier plant associations had warmer season-long soil temperatures. The POTR/CALA3 association occurs at higher elevations and has wetter soils that contribute to cooler soil temperatures throughout the growing season.

	Soil temperature (°F)			
Plant association	Minimum	Maximum	Average	N
POTR/SYAL	46	62	54	15
POTR/COST	42	60	51	14
POTR/CALA3	42	55	49	3
Series	42	60	52	32

ECOSYSTEM MANAGEMENT

Natural Regeneration of Quaking Aspen—

Quaking aspen regenerate from seed and, primarily, by sprouting from the roots (Schier et al. 1985b). Root suckers originate from thousands of shoot primordia buried in the root's cork cambium and can develop anytime during the growth of a tree (Schier 1973). Root sprouting is known to occur in 1-year-old saplings. Such sprouting is usually suppressed by apical dominance (Schier et al. 1985a). Closed stands produce a few sprouts each growing season, but the sprouts usually die unless they occur in a gap in the canopy. When overstory removal occurs because of cutting, fire, or defoliation, suppressed primordia resume growth and thousands of seedlings per acre can suddenly appear. The numbers of stems that emerge depends on various factors. Some clones produce more saplings than others. Older clones or those stressed by insect and disease infestations usually produce relatively few root sprouts following overstory removal. Where sprouting is successful, natural thinning is heavy in the first years owing to competition with quaking aspen neighbors, insects, diseases, browsing, and snow damage. Growth of the surviving saplings is very rapid compared with those produced from seed owing to the already established root system.

Contrary to popular opinion, quaking aspen clones alternate between staminate and pistillate forms in different years, or may even produce combinations of pistillate and staminate aments (Einspahr and Winton 1976). The first flowers are generally produced at 2 or 3 years, and maximum seed production occurs at about 50 years. There are 3- to 5-year intervals between heavy seed crops. Each clone produces millions of seed (Fechner and Barrows 1976). The plumose seeds are dispersed for several miles by winds. Seeds also disperse by water and can germinate while floating or submerged (Faust 1936). Initial seed viability is good but remains so only a few weeks under the best conditions.

Optimum conditions for germination and seedling survival include a moist, well-drained mineral seedbed, moderate temperature, and freedom from competition (McDonough 1979). Seedling survival is generally poor as initial root growth is very slow and minor disturbances can uproot seedlings. Drying of the seedbed will desiccate them. For those that survive the critical first days, root growth exceeds stem growth. Some seedlings show little top growth until their third year (Brinkman and Roe 1975). After fires, many aspen seedlings may appear. These seedlings tend to concentrate in moist depressions, seeps, springs, lake margins, and burnt-out riparian zones (Kay 1993). Browsing has a tremendous impact on seedling height growth, and long-term survival of most seedlings is low. For those rare survivors that reach heights above the reach of browsing ungulates, further stand expansion is primarily due to the development of new seedlings from root primordia.

Artificial Establishment of Quaking Aspen—

Quaking aspens are unique in their ability to stabilize soils and watersheds. Fire-killed stands of young, vigorous aspen normally regenerate rapidly by root sprouting, whereas old, diseased or overgrazed stands that are low in vigor may not successfully regenerate from sprouts, thus requiring artificial means of regeneration. The wide adaptability of aspen makes it desirable for restoration of a variety of sites. Moist mineral soils and freedom from competition are critical. Nursery-grown seedlings establish readily on disturbed sites and have advantages over vegetative cuttings (Chan and Wong 1989). Seedlings grow a taproot and secondary roots, whereas cuttings may not develop an adequate root system (Schier et al. 1985b). Seedlings have greater genetic diversity than cuttings that may be selected from only one or two clones. The primary advantage of cuttings is that clones with desirable genetic traits can be selected as parent stock. However, aspen cuttings are difficult to root (Perala 1990). Root cuttings taken from young sprouts are generally more successful than those from older trees.

Many of the shrubs that characterize the quaking aspen series are well adapted to planting on disturbed sites.

Red-osier dogwood, willows, mountain alder, and Nootka or baldhip rose can variously be established from nursery stock, seed, cuttings, or layering. Prickly currant can be easily grown from seed. Common snowberry can be established from stem or root cuttings, nursery stock, or seed. Woolly sedge can be easily established from rhizomes or plugs. (For more information on the short- and long-term revegetation potential of selected riparian wetland plant species, see app. B-5.)

Stand Management—

Quaking aspen is not an important wood product in eastern Washington. Most aspen is harvested mainly for firewood (Hansen et al. 1995). In addition, the small size of most stands in eastern Washington precludes any type of profitable commercial harvesting. In general, any management decisions would likely include retaining or increasing aspen clones for their importance for other resources. In seral POTR series stands, removal of existing conifer stock may be desirable to maintain the aspen for resources other than timber production. However, extreme care is necessary to avoid injury to residual aspen stems while harvesting the conifers owing to the high susceptibility of injured aspen to fungal agents. Aspen can best be regenerated asexually by root suckering. Overstory removal by cutting or fire tends to result in vigorous aspen suckering in healthy, vigorous stands.

Sometimes, it may be required to establish quaking aspen on new sites or where old clones are diseased or have died or been destroyed. Artificial regeneration using seedlings or root and stem cuttings is necessary in such cases. Clone differences need to be considered when selecting genotypes for propagation.

Coarse-textured, compaction-resistant soils are unusual in the quaking aspen series. The loam soils in riparian zones are subject to compaction and displacement. Very sensitive organic soils are associated with the wetter POTR/CALA3 association and wetter sites in POTR/COST and POTR/SYAL. Machinery and livestock easily compact or otherwise damage these soils during periods of excessive soil moisture or high water tables (Hansen et al. 1995). Poorly drained sites, streamside locations, or sites with organic soils should warrant special concern. Managers may choose to locate campgrounds, roads, and trails on the adjacent upland.

Maintaining healthy, vigorous stands of quaking aspen as well as members of other series that may lie between the aspen stands and the stream creates buffer strips of erosion-resistant plants to help stabilize streambanks and nearby terraces and swales, provide a barrier to sedimentation from nearby slopes, and provide a source of large down wood for the stream and nearby fluvial surfaces.

Tree Growth and Yield—

Basal area averages 205 square feet per acre, which is moderate for the conifer and deciduous series as a whole (apps. C-1a and C-1b). Quaking aspen is the dominant species and accounted for more than 75 percent of the average basal area. In comparison, the LALY, PICO, TSME, BEPA, ACMA, ALRU, POTR2, and QUGA series has lower average basal areas. Similarly, average site index for individual species (feet) is generally moderate compared with other series (app. C-2). Tree productivity data are limited and should therefore be viewed with caution.

Site index				Basal area (sq. ft./ac)	
Species	Base age	No. of trees	SI	Species	BA
BEPA	80	2	65	ABGR	1
PIPO	100	3	88	BEPA	4
POTR	80	38	67	PIPO	3
POTR2	80	3	122	POTR	181
PSME	50	4	72	POTR2	9
				PSME	6
				THPL	1
				Total	205

Down Wood—

The overall amount of down woody material is moderately low compared with other tree series (app. C-3). Logs cover only 6 percent of the ground surface. Most material is largely composed of small to moderate-size quaking aspen. Other softwood species, such as paper birch, Scouler's willow, and mountain alder are present on some plots. Large conifer logs are unusual.

Definitions of log decomposition classes are on page 15.

	Down log attributes				
Log decomposition	Tons/ acre	Cu. ft./ acre	Linear ft./ acre	Sq. ft./ acre	% ground cover
Class 1	0.84	77	168	124	0.28
Class 2	.96	109	488	232	.53
Class 3	8.56	1,097	2,697	1,647	3.78
Class 4	1.71	368	967	621	1.43
Class 5	.05	18	85	41	.09
Total	12.12	1,669	4,405	2,665	6.11

Snags—

The POTR series has a moderate number of snags (33.9 snags per acre) compared with other tree series (app. C-4). Seventy-five percent of the snags were less than 10 inches in diameter. Only 11 percent of the snags were larger than 15.5 inches in diameter. This was primarily due to the prevalence of smaller trees, especially quaking aspen, found in the stands.

Definitions of snag condition classes are on page 15.

	Snags/acre by d.b.h. class (inches)				
Snag condition	5–9.9	10–15.5	15.6–21.5	21.6+	Total
Class 1	10.6	2.3	0.9	0	13.8
Class 2	8.9	.6	0	0	9.5
Class 3	1.3	0	0	0	1.3
Class 4	2.3	.9	0	.4	3.6
Class 5	2.3	.9	1.6	.9	5.7
Total	25.4	4.7	2.5	1.3	33.9

Fire—

Quaking aspen is variable in its response to fire. Young, small-diameter aspen is usually top-killed by low-severity surface fires (Jones and DeByle 1985). As diameter at breast height increases beyond 6 inches, aspen becomes increasingly resistant to fire mortality (Brown and DeByle 1987). Large trees may survive low-intensity surface fire but usually show some fire damage. Moderate- to severe-intensity surface fire top-kills most aspen, although those that survive may die within 4 years because of infection by fungal disease.

Light- to moderate-intensity fire usually does not damage aspen roots insulated by the deep humus layer. Severe fires may kill the roots near the surface, but deeper roots will maintain the ability to sucker (Gruell and Loope 1974). In general, fuels in aspen stands are moister than those in surrounding conifer stands, and aspen stands may act as natural fuel breaks during wildfire so that crown fires in adjacent coniferous forests drop to the surface in aspen stands or may be extinguished after penetrating only a few feet (Bevins 1984, Fechner and Barrows 1976).

On account of intensive fire control by land management agencies, fires in quaking aspen stands have dramatically decreased since the 1900s. In response, young aspen stands are now uncommon in the West (Jourdonnais and Bedunah 1990). In addition, cattle and wildlife browsing of aspen sprouts have been severe in many areas, further contributing to the decline of aspen clones.

The fire regime of surrounding upland forests also may affect how often these riparian sites burn. Quaking aspen stands are generally small in eastern Washington compared with the extensive stands found in the Rocky Mountains of the United States and Canada. They usually are only a few acres in extent and are often surrounded by drier, upland conifer forests. Many of these upland forests have relatively short fire-return intervals and are prone to fire, particularly during late summer. Small aspen stands are undoubtedly more susceptible to fire than the large aspen stands mentioned above.

The POTR series contains some of the youngest forested stands sampled for this classification. Most aspen stands were less than 100 years old (avg. 92 years). Although individual trees do not often live beyond 150 years, the clone itself may exist for many hundreds of years. A total of 46 site index trees were sampled for age in the POTR series. Only two trees were older than 150 years: a 310-year-old Douglas-fir and a 255-year-old ponderosa pine. Fifteen trees were between 100 and 150 years old, and 29 trees (63 percent) were less than 100 years old. The oldest quaking aspen was a 136-year-old tree sampled in a POTR/SYAL association. This seems to confirm the literature, which suggests that many of our stands are aging owing to recent fire control.

Animals—

Livestock. Livestock use of quaking aspen communities differs with species composition of the understory and relative age of the quaking aspen stand. Aspen is highly palatable to all browsing ungulates. It is especially valuable in fall and winter, when protein levels are high relative to other browse species and herbs. Young stands generally provide the most browse as aspen crowns can grow out of reach of ungulates in 6 to 8 years. Some of these sites produce moderate to high amounts of palatable forage, and use by domestic livestock can be high. This is especially true of POTR/CALA3, with its relatively dense ground cover of the palatable woolly sedge and other herbs. The other two associations, especially POTR/COST, can have a rather dense layer of shrubs that both suppresses the herbs and restricts access to livestock.

The aspen overstory is not a static resource, and aspen groves in riparian locations are perhaps the hardest to retain under the usual impacts of livestock grazing. Livestock concentrate in these areas and use them for forage, shade, and bedding areas. If the aspen suckers are repeatedly grazed and eaten, the aspen clone will eventually be lost. Modifying the grazing systems, coupled with close monitoring of wildlife, often allows the aspen to sprout from root runners, and allows remnant shrub and herb populations to sprout or reestablish in the stand. Fencing or otherwise blocking livestock from declining groves for an 8- to 10-year period should allow adequate sucker regeneration to establish, at least for younger stands. The ability to easily reestablish aspen, shrubs, and herbs may be lost when they have been extremely stressed or eliminated by long periods of overgrazing and soil compaction. In this situation, disking and planting may be the only effective means to regenerate the aspen stand and its understory associates. Owing to their limited abundance in eastern Washington forests, aspen stands might best be managed for their aesthetic and wildlife potential rather than as a grazing resource. (For more information on forage palatability, see app. B-1. For potential biomass production, see app. B-5.)

Wildlife. Quaking aspen forests provide important breeding, foraging, and resting habitat for a variety of wildlife in eastern Washington. Aspen stands are heavily used by wildlife compared with conifer habitat and other deciduous tree series. Aspen is important forage for moose, elk, mule deer, and white-tailed deer. They feed on the bark, branch tips, and sprouts and, if physically available, will often do so throughout the year (Brinkman and Roe 1975, DeByle 1985). In winter, they also may feed on partially decomposed leaves. Deer, and occasionally elk, have been observed bedding in aspen stands. It also appears aspen stands are favorite fawning grounds (Kovalchik 1987). Black and grizzly bears feed on herbs and berry-producing shrubs (DeByle 1985), and they also will feed on aspen buds, leaves, and catkins. Rabbits, hares, and pikas feed on aspen buds, twigs, and bark the entire year (DeByle 1985, Tew 1970). Porcupines use the bark in winter and twigs in spring. Small rodents such as squirrels, pocket gophers, field mice, red-backed vole, deer mice, and white-footed mice are abundant (DeByle 1985). Mice and voles frequently eat aspen bark below the snow level and can girdle suckers and small trees. Rabbits may girdle suckers or even mature trees. Beavers use aspen stems for building dams and lodges and eat the leaves, bark, and twigs (Crowe and Clausnitzer 1997). It is not true that beaver are almost entirely dependent on aspen and other members of the plant family Salicaceae (primarily willows) for food and building materials. In many areas where quaking aspen and willows are scarce, beaver form viable, stable populations, depending more on palatable herbs such as the rhizomes of sedges and common cattail or aquatic species such as Indian water-lily for food. Other shrubs such as mountain alder or red-osier dogwood along with mud and herbs (such as sedge) make very adequate building materials in low-gradient valleys.

Quaking aspen stands provide structural diversity for a variety of birds. Songbirds use aspen stands for nesting in the canopy, shrub layers, or the ground. Some of the birds that frequently use aspen stands include grouse, wood ducks, red-breasted nuthatches, red-naped sapsuckers, mourning doves, crossbills, wild turkeys, chipping and song sparrows, lazuli bunting, and grosbeaks (Crowe and Clausnitzer 1997, DeByle 1985). Ruffed grouse use aspen stands for breeding, brooding, overwintering, nesting cover, and winter food. Bluebirds, tree swallows, pine siskins, yellow-bellied sapsuckers, and black-headed grosbeaks favor aspen edges (DeByle 1981). A variety of primary and secondary cavity-nesting birds use aspen forests. This is largely due to the high rate of heart rot disease in older stands, which makes excavation easier for cavity nesters. Sapsuckers, woodpeckers, and flickers are all primary excavators of aspen. Although small in area, aspen stands provide a critical source of diversity within the landscape and should be managed with emphasis on providing habitat for wildlife (Kovalchik 1987). (For more information on thermal or feeding cover values, see apps. B-2 and B-3. For information on food values or degree of use, see apps. B-2 and B-4.)

Fish. In general, quaking aspen stands do not play important roles in stream and fish habitat in eastern Washington owing to their general lack of abundance and their location on fluvial surfaces away from streambanks. (For more information, see app. B-5, erosion control potential.) However, where locally abundant, aspen may play important roles in beaver dam complexes and subsequent positive effects on fisheries habitat and downstream water quality.

Recreation—

Quaking aspen stands have a high degree of aesthetic and scenic quality, and are quite noticeable in the conifer-dominated forests of eastern Washington. Many people enjoy simply resting and relaxing in cool, shady aspen stands while listening to the aspen leaves trembling overhead. Aspen stands make attractive campgrounds. However, successful aspen regeneration is likely to be reduced or eliminated by trampling and compacted soils (Hansen et al. 1995).

Insects and Disease—

Quaking aspen is very susceptible to fungal attacks, and decays are quite common in this species. Many are a primary factor in tree mortality and cycling of stands in a clone (Crowe and Clausnitzer 1997, Schmitt 1996). Perhaps the most obvious disease of aspen is black canker. Other cankers are cytospora canker, hypoxylon canker, sooty-bark canker, and shepherd's crook. The most common trunk rot appears to be the result of false tinder fungus, which is the major cause of aspen volume loss in the West. Other very common diseases include melampsora rust and mottled rot. Heart and trunk rots appear to be highly correlated with fire scars and trunk wounds.

A variety of insects use quaking aspen as a food source (Crowe and Clausnitzer 1997, Schmitt 1996). Insects that cause defoliation include fall webworm, western tent caterpillar, forest tent caterpillar, large aspen tortrix, aspen leaf-tier, and satin moth. Insects that cause stem girdling, stem breakage, crown dieback, and predisposition to disease include blue alder agrilus, poplar borer, and the bronze poplar borer.

Estimating Vegetation Potential of Disturbed Sites—

Clearcutting in aspen stands is unusual, at least on FS land. Therefore, estimating vegetation potential of disturbed aspen-dominated sites is generally not needed. Wetter sites in the SALIX, COST, MEADOW, ALSI, and ALIN series usually separate POTR stands from active flood zones. Currently, all FS riparian zones, including moist aspen depressions well away from the normal riparian zone, are buffered and not managed for wood fiber. Even where clearcut or burned in the past, the aspen usually regenerate rapidly on these productive sites. In young stands or in the event of recent wildfire, comparison with nearby drainages can help determine the potential. A potential problem exists where aspen stands have become old and decadent and lack vigorous sprouting. Eventually these stands will disappear and it will be necessary to look for evidence such as rotted logs or fragments of bark to tell if the site has POTR series potential.

Sensitive Species—

Black snake-root (*Sanicula marilandica*) was located on two POTR series plots. Both were in the POTR/SYAL association. It appears from these data that sensitive species are uncommon in the POTR series compared with wetter series such as SALIX, MEADOW, and ALIN (app. D).

ADJACENT SERIES

Many other series can occur on adjacent sites owing to the wide ecological amplitude of the POTR series. The most common adjacent stands in continental climate zones belong to the PSME and ABLA2 series. In maritime climates, aspen stands usually are adjacent to stands in the TSHE or THPL series. In very dry areas, the POTR series may be surrounded by shrub-steppe.

RELATIONSHIPS TO OTHER CLASSIFICATIONS

Most of the plant associations in the POTR series are described in the draft classification for northeastern Washington (Kovalchik 1992c). Two quaking aspen plant associations are described for the Okanogan NF (Williams and Lillybridge 1983), and their POTR/SYAL association is similar to the POTR/SYAL described in this publication, except that all but one of their plots are restricted to uplands.

Quaking aspen plant associations have been described for uplands throughout the northern latitudes and are too numerous to name. Plant associations in the POTR series are described in riparian/wetland classifications for eastern Washington (Crawford 2003), Kovalchik 1992c), central Oregon (Kovalchik 1987), northeastern Oregon (Crowe and Clausnitzer 1997), and Montana (Hansen et al. 1995).

U.S. DEPARTMENT OF THE INTERIOR, FISH AND WILDLIFE SERVICE WETLANDS CLASSIFICATION

System: palustrine
Class: forested wetland
Subclass: broad-leaved deciduous
Water regime: (nontidal) temporarily saturated to temporarily flooded

KEY TO THE QUAKING ASPEN (*POPULUS TREMULOIDES*) PLANT ASSOCIATIONS

1. Woolly sedge (*Carex lanuginosa*) ≥25 percent canopy coverage .... **Quaking aspen/woolly sedge (POTR/CALA3) association**
2. Red-osier dogwood (*Cornus stolonifera*) ≥10 percent canopy coverage .... **Quaking aspen/red-osier dogwood (POTR/COST) association**
3. Common snowberry (*Symphoricarpos albus*) ≥5 percent canopy coverage .... **Quaking aspen/common snowberry (POTR/SYAL) association**

Table 9—Constancy and mean cover of important plant species in the POTR plant associations

Species	Code	POTR/CALA3 3 plots		POTR/COST 14 plots		POTR/SYAL 16 plots	
		CON[a]	COV[b]	CON	COV	CON	COV
Tree overstory:							
paper birch	BEPA	33	3	7	7	25	19
lodgepole pine	PICO	67	3	14	2	13	4
ponderosa pine	PIPO	—	—	7	20	19	6
quaking aspen	POTR	100	64	100	55	100	51
black cottonwood	POTR2	—	—	29	6	25	13
Douglas-fir	PSME	—	—	21	12	44	3
Tree understory:							
paper birch	BEPA	33	5	14	5	13	4
Engelmann spruce	PIEN	33	2	14	1	6	5
quaking aspen	POTR	100	12	86	16	56	15
black cottonwood	POTR2	—	—	14	8	13	1
Douglas-fir	PSME	33	2	21	6	38	4
Shrubs:							
vine maple	ACCI	—	—	7	50	—	—
Douglas maple	ACGLD	—	—	14	9	44	30
mountain alder	ALIN	33	7	64	16	44	11
Saskatoon serviceberry	AMAL	33	5	71	3	56	2
red-osier dogwood	COST	67	15	100	51	38	7
Lewis' mock orange	PHLE2	—	—	14	10	38	4

Table 9—Constancy and mean cover of important plant species in the POTR plant associations (continued)

Species	Code	POTR/CALA3 3 plots		POTR/COST 14 plots		POTR/SYAL 16 plots	
		CON	COV	CON	COV	CON	COV
bittercherry	PREM	—	—	—	—	6	40
common chokecherry	PRVI	—	—	14	29	13	6
alder buckthorn	RHAL2	—	—	7	60	—	—
prickly currant	RILA	67	2	29	8	38	5
baldhip rose	ROGY	67	19	21	7	19	2
Nootka rose	RONU	33	7	57	8	50	26
woods rose	ROWO	—	—	14	2	25	5
western thimbleberry	RUPA	—	—	36	2	56	4
dwarf red blackberry	RUPU2	33	3	14	4	6	3
Bebb's willow	SABE	100	2	7	12	—	—
Scouler's willow	SASC	33	3	36	8	31	7
common snowberry	SYAL	33	7	86	30	100	53
Low shrubs and subshrubs:							
twinflower	LIBOL	33	7	29	2	19	4
myrtle pachistima	PAMY	—	—	36	22	25	2
Perennial forbs:							
Columbia monkshood	ACCO	33	Tr[c]	21	1	25	1
sharptooth angelica	ANAR	67	1	14	4	19	2
wild sarsaparilla	ARNU3	—	—	—	—	25	9
broadpetal strawberry	FRVIP	67	1	—	—	—	—
northern bedstraw	GABO	33	5	—	—	6	Tr
sweetscented bedstraw	GATR	—	—	29	2	19	1
largeleaf avens	GEMA	33	2	29	1	25	1
northern bluebells	MEPAB	—	—	—	—	6	25
mountain sweet-root	OSCH	—	—	7	Tr	31	1
purple sweet-root	OSPU	—	—	21	1	56	2
arrowleaf coltsfoot	PESA	67	7	—	—	—	—
alkali-marsh butterweed	SEHY	33	3	—	—	6	Tr
starry solomonplume	SMST	100	8	79	2	56	3
common dandelion	TAOF	67	Tr	43	Tr	31	1
western meadowrue	THOC	—	—	29	3	25	7
Canadian violet	VICA	—	—	21	7	6	2
Grasses or grasslike:							
redtop	AGAL	33	5	21	1	6	Tr
spike bentgrass	AGEX	33	7	7	5	—	—
winter bentgrass	AGSC	33	10	7	2	—	—
bluejoint reedgrass	CACA	100	17	14	4	—	—
woolly sedge	CALA3	100	28	14	2	—	—
thick-headed sedge	CAPA	—	—	21	Tr	13	Tr
bladder sedge	CAUT	33	12	7	2	—	—
tufted hairgrass	DECE	67	1	—	—	—	—
blue wildrye	ELGL	—	—	7	1	56	2
tall mannagrass	GLEL	33	Tr	14	Tr	6	Tr
fowl mannagrass	GLST	33	20	7	3	6	5
Kentucky bluegrass	POPR	33	3	7	1	19	3
Ferns and fern allies:							
common horsetail	EQAR	100	2	29	1	38	1

[a] CON = percentage of plots in which the species occurred.
[b] COV = average canopy cover in plots in which the species occurred.
[c] Tr = trace cover, less than 1 percent canopy cover.

BLACK COTTONWOOD SERIES

Populus trichocarpa

POTR2 N = 50

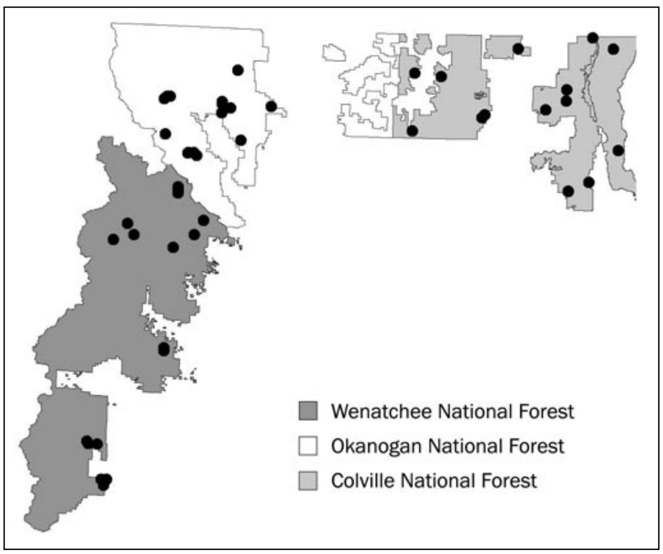


Figure 18—Plot locations for the black cottonwood series.

THE RANGE OF black cottonwood[1] extends from Kodiak Island in Alaska south through southeastern Alaska and British Columbia to Washington and Oregon, Montana, California, Wyoming, and Utah (Hitchcock and Cronquist 1973).

It occurs along both sides of the Cascade Range in Washington and is very prominent through eastern Washington into Idaho and western Montana. Scattered occurrences reported for Utah, Nevada, Wyoming, and North Dakota represent the extreme eastern reaches for black cottonwood (Lanner 1983). Black cottonwood communities usually are associated with low- to moderate-elevation rivers and streams, but stands also may be found on wetland sites such as broad moist depressions, slump zones, and the shores of lakes and ponds. Black cottonwood grows in various climates ranging from relatively arid to humid (Crowe and Clausnitzer 1997). Annual precipitation across its range averages from 10 to 120 inches. Maximum temperatures range from 60 to 117 degrees Fahrenheit, and minimum temperatures range from 32 to -53 degrees Fahrenheit.

Black cottonwood requires abundant, well-oxygenated water for good growth (Smith 1957). It is very tolerant of flooding but cannot tolerate the water that collects in stagnant pools after flooding. It also has low drought tolerance. Therefore, the POTR2 series is most abundant on active fluvial surfaces such as point bars, floodplains, streambanks, and nearby terraces throughout eastern Washington. The POTR2 series is often abundant along larger rivers, especially on lands below FS ownership, such as along the Yakima, Naches, Wenatchee, Okanogan, Columbia, Kettle, Pend Oreille, and Methow Rivers. Plot distribution may indicate some tendency for the series to be more common in areas characterized by continental climate. However, there are extensive stands of cottonwood along the Interstate 90 corridor to Snoqualmie Pass, a zone of rapidly increasing maritime climate. Apparently large streams and rivers with extensive actively meandering channels and alluvial bar development are likely more responsible than climate for large cottonwood stand development. Black cottonwood communities were much more common in the past than today. Recent alterations to rivers and associated floodplains such as agriculture, dam building, and channelization have caused drastic declines in black cottonwood habitat and communities (especially at low elevations).

CLASSIFICATION DATABASE

The POTR2 series includes all closed-forest stands potentially dominated by black cottonwood. Some stands appear to be climax, whereas others are obviously seral to conifers. The POTR2 series occurs on all three NFs (fig. 18) and was sampled on all but the Cle Elum RD, where it is common along the major rivers or in scattered stands within NF ownership. Fifty plots were sampled in the series. From this database, four major associations and two minor associations are recognized. Two potential one-plot associations (POTR2/ALSI and POTR2/EQUIS) are not used in the database nor described in this classification. For the most part, these samples were located in late-seral or climax black cottonwood stands, at least for the present soil and water conditions. As soils depths increase with sediment deposition, the vegetation potential on riparian sites will change to drier POTR2 associations (often with the initial invasion of conifers) and eventually to one of the conifer series. In other words, the

[1] See appendix A for a cross reference for all species codes and common and scientific names used in this document.

Black cottonwood plant associations

	Scientific name	Common name	Ecoclass code	Plots
Major associations:				
POTR2/ALIN	*Populus trichocarpa/Alnus incana*	Black cottonwood/mountain alder	HCS115	13
POTR2/ALIN-COST	*Populus trichocarpa/Alnus incana-Cornus stolonifera*	Black cottonwood/mountain alder-red-osier dogwood	HCS113	7
POTR2/COST	*Populus trichocarpa/Cornus stolonifera*	Black cottonwood/red-osier dogwood	HCS114	17
POTR2/SYAL	*Populus trichocarpa/Symphoricarpos albus*	Black cottonwood/common snowberry	HCS311	7
Minor asociations:				
POTR2/ALLUVIAL BAR	*Populus trichocarpa/*alluvial bar	Black cottonwood/alluvial bar	HCGR	4
POTR2/OPHO	*Populus trichocarpa/Oplopanax horridum*	Black cottonwood/devil's club	HCS441	2

soil/water characteristics must change (through deposition) to allow the change to another climax series.

VEGETATION CHARACTERISTICS

Mature stands in the POTR2 series have an overstory that is dominated by mid-size to large black cottonwood with average canopy cover that ranges from a low of 22 percent on young POTR2/ALLUVIAL BAR sites to a high of 67 percent on POTR2/SYAL. Conifers are often present on these sites. On terraces, conifers indicate transition to the eventual climax with increased sediment deposition and accompanying lowered water tables. Douglas-fir, ponderosa pine, and Engelmann spruce are the most common conifers on these sites, especially within continental climate zones. Western redcedar or western hemlock may be common on maritime sites. Tree understory is usually composed of small amounts of black cottonwood. Small numbers of conifers may be present. If well represented, they may indicate the site is transitional to conifer climax. In true black cottonwood wetlands such as with internally drained depressions or on the margins of springs, ponds, and lakes, conifers are generally relegated to microsites. On active riparian fluvial surfaces, conifer regeneration may not survive past the seedling/sapling stage owing to flood disturbance.

Ground cover is usually dominated by a variety of shrubs, depending on the association. The POTR2/ALLUVIAL BAR association occurs on relatively young, frequently disturbed sites that support scattered shrubs and herbs. This association occurs throughout the elevation range of the POTR2 series, and primary succession on these sites is rather opportunistic, depending on the timing of flood events and seed availability from nearby seed sources. Therefore, no one species tends to dominate the ground layer. The most constant and abundant shrubs are Scouler's willow and ocean-spray. Other shrubs include Douglas maple, mountain alder, Saskatoon serviceberry, red-osier dogwood, and western thimbleberry.

The other five POTR2 associations occur on more developed soils (i.e., sediment deposition, finer textured soils, and deeper water tables). The characteristic shrub dominants on these associations include Douglas maple, mountain alder, red-osier dogwood, devil's club, California hazel, and common snowberry. Other shrubs include prickly currant, Saskatoon serviceberry, and western thimbleberry.

Herbs are relatively scarce under the dense shrubs. Baneberry, wild sarsaparilla (Colville NF only), wild ginger, queencup beadlily, starry solomonplume, western solomonplume, and western meadowrue are the most constant and abundant species. The POTR2/OPHO association supports a wetter, richer variety of herbs, with lady fern, enchanter's nightshade, Hooker's fairy-bells, claspleaf twisted-stalk, pioneer violet, and common horsetail being the most common.

PHYSICAL SETTING

Elevation—

The POTR2 series occurs at low to moderate elevations in eastern Washington. Plots range from 1,700 to 4,200 feet, although the majority of sites are below 3,700 feet. The elevation of the POTR2 series extends well below the boundaries of the NFs in eastern Washington, and the series is found on suitable sites along many of the major rivers. Within NF ownership, plots tend to indicate that stands average about 400 feet lower in elevation in the increasingly more maritime zones within the Cascade Range compared with drier continental zones to the east. However, this may be misleading, as the base elevation of the Wenatchee NF is lower compared with the other two forests.

	Elevation (feet)			
Forest	Minimum	Maximum	Average	N
Colville	1,900	4,030	2,895	14
Okanogan	2,150	3,500	2,821	16
Wenatchee	1,700	3,680	2,395	20
Series	1,700	4,030	2,703	50

Additional insight is gained by looking at elevations for the individual associations. Of the major associations, the POTR2/ALIN has the highest average elevation, followed by POTR2/COST, POTR2/ALIN-COST, and POTR2/SYAL. The lower elevation associations usually are located in warmer, drier climatic regions.

Plant association	Elevation (feet) Minimum	Maximum	Average	N
POTR2/OPHO	2,600	3,680	3,140	2
POTR2/ALIN	2,190	3,800	3,123	13
POTR2/ALLUVIAL BAR	2,320	3,250	2,828	4
POTR2/COST	1,720	4,030	2,604	17
POTR2/ALIN-COST	1,700	3,075	2,299	7
POTR2/SYAL	1,900	3,480	2,274	7
Series	1,700	4,030	2,703	50

Valley Geomorphology—

Plots in the POTR2 series are located in a variety of valley width and gradient classes. Most black cottonwood plots are located in valleys of moderate to very broad width and moderate to very low valley gradient. These sites represent environments conducive to the development of Rosgen B and C channels, which are the channel types most likely to create point bars and other seral fluvial surfaces needed for cottonwood seedbeds. The black cottonwood stands on these sites may be quite large. A second, smaller cluster of plots is located in narrow, steeper valley landforms. These sites generally support small, discontinuous stands of black cottonwood located along small, upper elevation streams with small pockets of suitable habitat created by localized flooding disturbance.

Valley width	Valley gradient Very low	Low	Moderate	Steep	Very steep	N
Very broad	5	3	0	0	0	8
Broad	3	8	0	1	0	12
Moderate	3	8	7	0	3	21
Narrow	0	2	0	1	4	7
Very narrow	0	0	0	0	2	2
Series total	11	21	7	2	9	50

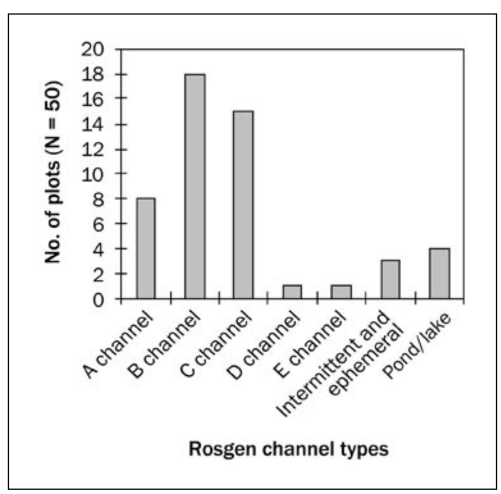
Plant association	Valley width Very broad	Broad	Moderate	Narrow	Very narrow	N
POTR2/ALIN	0	5	8	0	0	13
POTR2/ALIN-COST	1	2	2	2	0	7
POTR2/ALLUVIAL BAR	0	0	2	2	0	4
POTR2/COST	5	3	7	2	0	17
POTR2/OPHO	0	0	0	0	2	2
POTR/SYAL	2	2	2	1	0	7
Series total	8	12	21	7	2	50

The differences between the two clusters of plots in the above table justify examining individual associations in more detail. Only the POTR2/ ALLUVIAL BAR and POTR2/OPHO associations appear to have an affinity for narrow, steep valley bottoms. This may be true of POTR2/OPHO, as devil's club prefers the cold, moist habitat found in steep narrow valleys, but is misleading for POTR2/ALLUVIAL BAR. The POTR2/ALLUVIAL BAR is prominent on extensive alluvial bars associated with large, meandering, low-elevation streams and rivers. However, most of these sites lie below FS ownership and are not included in the samples. In general, most black cottonwood communities in eastern Washington are more abundant in lower elevation valleys outside the NFs. Here, streams and their associated floodplains are larger and have more energy to produce the alluvial bars and floodplains on which cottonwood is so dependent for successful regeneration.

Plant association	Valley gradient Very low	Low	Moderate	Steep	Very steep	N
POTR2/ALIN	3	5	3	0	2	13
POTR2/ALIN-COST	1	3	1	1	1	7
POTR2/ALLUVIAL BAR	0	0	1	0	3	4
POTR2/COST	7	7	2	0	1	17
POTR2/OPHO	0	0	0	0	2	2
POTR/SYAL	0	6	0	1	0	7
Series total	11	21	7	2	9	50

Channel Types

Two-thirds of POTR2 series sites are located along B and C Rosgen channel types, which often meander in wider, lower gradient valleys, forming the gravel and point bars so important to the development of seedbeds for cottonwood. The single Rosgen D channel developed below a large logjam on a river that would otherwise have been classified as a Rosgen C channel. Ephemeral and intermittent channels are found in 6 percent of the plots. The black cottonwood stands that normally establish in the narrow valleys associated with these channel types are generally small (often just several trees) and isolated due to a general lack of gravel and point bar development. This situation is similar along Rosgen A channels (16 percent of the plots). A smaller number of plots are associated with Rosgen E channels, the channel type most often associated with wetlands. These flat valley bottoms often support herb and shrub meadows that separate the cottonwood stands from the stream. Four plots were located on the shores of lakes and ponds.

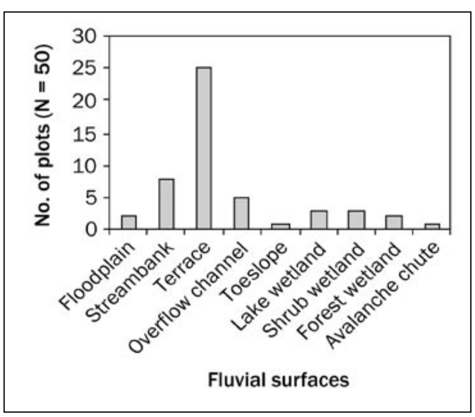


Additional insight is gained by looking at individual associations. All six associations are variably located along Rosgen A, B, and C channels in riparian zones. The POTR2/ALIN-COST and POTR2 ALLUVIAL BAR are the most frequent associations along A channels. In addition, POTR2/ALIN and POTR2/COST are associated with intermittent and ephemeral channels or pond and lake wetlands.

Plant association	Rosgen channel types							N
	A	B	C	D	E	Intermittent/ ephemeral	Pond/ lake	
POTR2/ALIN	1	6	3	0	0	2	1	13
POTR2/ALIN-COST	2	1	4	0	0	0	0	7
POTR2/ALLUVIAL BAR	2	2	0	0	0	0	0	4
POTR2/COST	1	4	7	1	1	0	3	17
POTR2/OPHO	1	0	0	0	0	1	0	2
POTR/SYAL	1	5	1	0	0	0	0	7
Series total	8	18	15	1	1	3	4	50

Fluvial Surfaces—

The POTR2 series is located on a variety of fluvial surfaces. Eighty percent of the plots are in riparian zones on floodplains, streambanks, and terraces (including the associated overflow channels). These sites are indicative of periodic flood events that create raw, moist, mineral seedbeds suitable for cottonwood establishment (POTR2/ALLUVIAL BAR) and subsequent soil deposition and vegetation succession to drier POTR2 associations. The remaining plots are located within wetlands such as herb or shrub wetlands, forested depressions, or the edges of lakes and ponds.

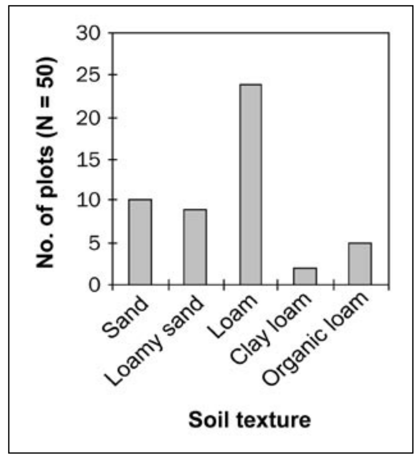


Additional insight is gained by looking at the distribution of POTR2 associations by fluvial surface. All plots in the POTR2/ALLUVIAL BAR, POTR2/COST, POTR2/SYAL, and POTR2/OPHO associations are located in riparian zones. The POTR2/ALIN and POTR2/COST associations are mostly riparian but also include a few wetland plots in which black cottonwood may be acting as climax. None of the other associations are located on wetland sites.

Plant association	Fluvial surfaces									N
	Flood-plain	Stream-bank	Terrace	Overflow channel	Toe-slope	Lake wetland	Shrub wetland	Forest wetland	Avalanche chute	
POTR2/ALIN	0	2	5	2	0	1	2	1	0	13
POTR2/ALIN-COST	0	1	4	2	0	0	0	0	0	7
POTR2/ALLUVIAL BAR	0	2	2	0	0	0	0	0	0	4
POTR2/COST	1	0	10	1	0	2	1	1	1	17
POTR2/OPHO	0	2	0	0	0	0	0	0	0	2
POTR/SYAL	1	1	4	0	1	0	0	0	0	7
Series total	2	8	25	5	1	3	3	2	1	50

Soils—

The majority (73 percent) of sampled POTR2 stands grow on mineral soils. This is because POTR2 appears to like riparian zones where sediment deposition favors successional processes on frequently flooded point bars with skeletal, cobbly textures (POTR2/ALLUVIAL BAR) to older black cottonwood terraces with loam soils (POTR2/SYAL). Dark organic soils (mollic and sapric Histisols) are recorded on six sites and are often associated with E channels, low gradient valleys, wetlands, and the margins of ponds and lakes. Optimum growth occurs on soils that have abundant moisture, oxygen, and nutrients and where the pH is neutral (between 6.0 and 7.0) (Crowe and Clausnitzer 1997).



Little additional information is gained when looking at individual plant associations. All six associations are found on a variety of soil textures and mineral soils are prominent. Again, POTR2/ALLUVIAL BAR was the only association found predominantly on freshly deposited alluvium with sandy, cobbly soils. The other five associations usually are found on loamy sand and loam soils. A few plots are located in wetland sites on clay loam and organic loam textures.

Plant association	Soil texture					N
	Sand	Loamy sand	Loam	Clay loam	Organic loam	
POTR2/ALIN	2	4	5	0	2	13
POTR2/ALIN-COST	2	2	2	1	0	7
POTR2/ALLUVIAL BAR	3	0	1	0	0	4
POTR2/COST	2	2	11	0	2	17
POTR2/OPHO	1	0	0	1	0	2
POTR/SYAL	0	1	5	0	1	7
Series total	10	9	24	2	5	50

Water table depths (inches) were measured on 23 plots. The POTR2/COST and POTR2/ALIN associations grow on the wettest sites. Although data are lacking, POTR2/OPHO is equally as wet. Water tables were not reachable in the cobble soils associated with the POTR2/ALLUVIAL BAR association. However, plots were established well into the summer, after the spring flood.

	Water table (inches)			
Plant association	Minimum	Maximum	Average	N
POTR2/COST	-39	-2	-19	6
POTR2/ALIN	-39	-4	-21	8
POTR2/SYAL	-47	-14	-32	4
POTR2/ALIN-COST	-55	-17	-32	5
Series	-55	-2	-24	23

Soil temperatures were measured on 48 plots. The POTR2/COST, POTR2/ALIN, and POTR2/OPHO associations had the coldest soil temperatures as well as the highest water tables.

	Soil temperature (°F)			
Plant association	Minimum	Maximum	Average	N
POTR2/ALIN-COST	49	68	56	7
POTR2/ALLUVIAL BAR	52	73	56	4
POTR2/SYAL	44	60	54	7
POTR2/COST	42	62	53	17
POTR2/ALIN	44	57	50	11
POTR/OPHO	42	55	49	2
Series	42	73	54	48

ECOSYSTEM MANAGEMENT

Natural Regeneration of Black Cottonwood—

Black cottonwood seed falls at about the time that spring flows are declining and favorable seedbeds are becoming available along streams (Crowe and Clausnitzer 1997). Abundant crops of minute seed are produced every year. The seed bears long, light, cottony hair, which make them buoyant and transportable long distances by wind and water (Haeussler et al. 1990). Seed viability is 1 to 4 weeks. Once the seed is wet, viability will be lost in 2 to 3 days if an appropriate germination site is not encountered. Subsequent germination is rapid but requires moist soil for 1 to 2 weeks. Special root hairs for anchoring the seedling and absorbing water and nutrients are quickly produced.

Full sunlight is required for seed germination. There is little endosperm in the seeds; thus, seedlings are highly dependent upon photosynthate from the cotyledons and juvenile leaves. Black cottonwood seeds readily germinate on a variety of sites, especially where mineral soil has been exposed or recently deposited by a flood (Beals 1966). Moist seedbeds are essential for high regeneration rates (Roe 1958), and seedling survival depends on continuously favorable conditions (moist soils) during at least the first month (Schreiner 1974). Fine sand and silt substrates allow higher rates of root growth and seedling establishment than coarse, gravelly substrates (Crowe and Clausnitzer 1997). Energy is initially allocated to the developing root system. Once the roots are well established, rapid height growth follows. If the rate of water table decline exceeds the rate of root growth (approximately ½-inch per day), seedling mortality can be very high.

Black cottonwood is tolerant of flooding throughout its lifespan, including the seedling stage (Crowe and Clausnitzer 1997). Flood tolerance, along with the rapid growth of seedlings, gives black cottonwood a competitive advantage over many other alluvial bar colonizers. Thus riparian populations of cottonwood often are composed of even-aged stands or galleries, especially along larger rivers and valleys. These galleries correspond to the movement of the stream channel and development of fluvial surfaces that correspond to this movement. New stands of cottonwood usually are established on fresh alluvial bar deposits or on heavily scoured sections of floodplains, where unvegetated mineral sediment has been deposited or exposed.

On more mature alluvial bars or floodplains, layers of finer textured sediments often overlie the original coarse-textured bar deposits. As sediment accumulates, the POTR2/ALLUVIAL BAR association succeeds to drier associations such as POTR2/COST, POTR2/ALIN-COST, and POTR2/ALIN, often in this order. Finally, POTR2/SYAL occurs on terraces that are infrequently flooded and composed of deeper fine-textured alluvial deposits that have visible pedogenic soil horizons. This cycle of stand development will continue across the valley as the stream meanders and changes pattern over time. Managers should look for opportunities for new stand development on fresh scour and deposition sites rather than on older, heavily vegetated terraces where the water table is too deep or vegetative competition and shade are too high for abundant seedling establishment.

The most common methods of asexual reproduction in this species are (Crowe and Clausnitzer 1997) (1) the burial (in place) and subsequent rooting of branches that have broken and fallen from mature trees; (2) the abscission, falling, transport, and rooting of branchlets on favorable sites, such as alluvial bars; and (3) the sprouting of basal stems or roots that have been scoured by flooding.

Artificial Establishment of Black Cottonwood—

The roots of established cottonwood are effective soil stabilizers and provide valuable streambank and erosion protection. Black cottonwood has been used successfully to restore damaged riparian sites (Carson and Edgerton 1989, Hansen

1989, Radwan et al. 1987). Nursery-grown seedlings and rooted or unrooted cuttings can be planted. The site must include moist, well-drained soils that are free from overstory shade and herb competition. Cuttings should be taken during the dormant season. Best establishment and growth is achieved when cuttings have healthy auxillary buds at the time of planting. On moist sites, cottonwood cuttings should range from 0.4 to 1.2 inches in diameter and 16 to 25 inches in length. Cuttings may grow to heights exceeding 5 feet in the first year and 20 feet after 4 years. Long, thick pole cuttings also have been used to restore black cottonwoods where water tables have been lowered well below the soil surface by streambed downcutting. Many of the recommendations for willow establishment also are appropriate for black cottonwood.

The following guidelines can be used when planting sites with cuttings from black cottonwood (Swenson 1988):

- Do not plant cuttings in saline or alkaline soils.
- Select sites with substrates of sand, gravel, or cobbles (avoid clay soils).
- Make cuttings from stands of young, open-growing trees using cuttings that are less than 5 years old.
- Take cuttings from trees that are dormant.
- Soak the cuttings for 10 to 14 days.
- Plant the cuttings to a depth of the anticipated growing season water table.
- Put the cuttings in the planting holes the same day they are removed from the soak and allow for a ratio of at least 66 percent belowground to 33 percent aboveground stem, respectively (this allows for the energy of the cutting to be put into root rather than stem growth).
- Fill the holes carefully to avoid air pockets.
- Place tree guards around the base of the cuttings if rodent damage is anticipated.
- As buds begin to swell, wipe them off the lower portion of the cutting.
- Exclude livestock grazing and big game browsing for at least 3 years (some beaver control may be necessary).

Many of the shrubs used to characterize the POTR2 series are well adapted to planting on disturbed sites. Red-osier dogwood and appropriate willow species can be established with bare cuttings. Mountain alder can be established from seed or nursery-grown seedlings. These and other important shrubs can be established with rooted cuttings and nursery-grown seedlings on moist, well-drained soil. If the water table has been lowered through streambed downcutting, the success will be low. (For more information on the short- and long-term revegetation potential of selected riparian wetland plant species, see app. B-5.)

Stand Management—

Black cottonwood is a valuable timber species in parts of the West (Kennedy 1985) and is the largest American poplar. Wood production is moderately high (except in POTR2/ALLUVIAL BAR) owing to favorable soil texture and moisture. Complete stand removal may result in a shrub-dominated community with limited black cottonwood regeneration except for occasional sprouting from stumps or roots. Coarser textured soils, such as those associated with the POTR2/ALLUVIAL BAR association, are resistant to compaction problems. This is not necessarily true with other associations where loam or organic loam soils predominate.

Tree Growth and Yield—

Favorable growing conditions include moist loam soils and a long growing season. However, the POTR2 series is moderate in production compared with other tree series, likely because typical stands are composed of big, widely scattered black cottonwood. Basal area averaged 169 square feet per acre, 80 percent of which is cottonwood (apps. C-1a and C-1b). Site index values for individual species (feet) is generally high compared with other tree series (app. C-2). Tree production data are limited and should be used with caution.

Site index

Species	Base age	No. of trees	SI
BEPA	80	2	79
PICO	100	2	105
PIEN	50	4	81
PIPO	100	4	88
POTR2	80	32	106
PSME	50	12	72
THPL	100	2	79

Basal area (sq. ft./ac)

Species	BA
ABGR	1
ALIN	3
BEPA	4
LAOC	1
PICO	1
PIEN	6
PIPO	3
POTR	2
POTR2	135
PSME	9
THPL	2
Total	167

Down Wood—

Overall, the amount of down wood is low compared with other tree series (app. C-3). Logs cover only 4.5 percent of the ground surface. This is probably due to the rapid decomposition of cottonwood snags and logs.

Definitions of log decomposition classes are on page 15.

	Down log attributes				
Log decomposition	Tons/ acre	Cubic ft./ acre	Linear ft./ acre	Square ft./ acre	% ground cover
Class 1	0.50	49	79	59	0.14
Class 2	1.87	248	420	252	.58
Class 3	4.48	604	1,219	777	1.78
Class 4	2.75	831	737	700	1.61
Class 5	.47	153	171	166	.38
Total	12.05	1,885	2,626	1,954	4.49

Snags—

The POTR2 series has few snags (app. C-4). Snags averaged only 8.1 per acre in the sample stands. Live cottonwoods are often in an advanced stage of stem rot and trees quickly fall following death.

Definitions of snag condition classes are on page 15.

	Snags/acre by d.b.h. class (inches)				
Snag condition	5–9.9	10–15.5	15.6–21.5	21.6+	Total
Class 1	0	1.3	0.3	0.5	2.1
Class 2	1.7	0	.2	.1	2.0
Class 3	0	0	0	0	0
Class 4	0	0	.3	.1	.4
Class 5	0	2.1	.8	.7	3.6
Total	1.7	3.4	1.6	1.4	8.1

Fire—

The thin bark and relatively shallow root systems of black cottonwood seedlings and saplings make them highly susceptible to fires of any intensity (Myers and Buchman 1984). After 10 to 20 years, trees may have bark with enough thickness to withstand low-intensity surface fires, but fire wounds may facilitate the onset of heartwood decay (Roe 1958). Trees can sprout from the stump or root suckers following top-kill by fire (Dickmann and Stuart 1983, Haeussler and Coates 1986). The ability of black cottonwood to sprout following fire is dependent on two criteria (Hansen et al. 1995): (1) the age of the trees in the stand (sprouting potential decreases proportional to the age) and (2) the location of the water table (the higher the water table through the growing season, the greater the ability to sprout). Therefore, to extend the lifespan of a cottonwood stand, managers must use fire only in early- to mid-seral stages of development. Livestock should be excluded for at least 5 years following prescribed fire, and wildlife should be closely monitored. Fires could potentially create favorable conditions for seedling establishment by thinning the overstory and exposing bare ground, but soil moisture must be adequate for germination.

Fire-return intervals in these cottonwood stands are not well documented. Fire is probably not very common in these annually flooded, moist valley bottoms. However, these sites do burn on occasion and are probably most susceptible to fire in late summer or early fall, especially during severe drought years. For example, cottonwood stands burned just as hot as the surrounding uplands during the Tyee Fire in 1994. Many of the plant species found in these communities have mechanisms for surviving fire, such as sprouting. For instance, red-osier dogwood and common snowberry often resprout after fire.

The POTR2 series contains some of the youngest forested stands sampled for this classification. A total of 64 site index trees were measured for age in the POTR2 series. Sample trees averaged 88 years in age. Only three trees were 200 years or older: one 200-year-old and one 224-year-old black cottonwood and one 433-year-old ponderosa pine. All other site index trees were less than 151 years old. Thirty-seven trees (58 percent) were less than 100 years old; 24 trees were 100 to 151 years old.

Animals—

Livestock. Species associated with drier black cottonwood associations and community types may provide abundant forage for livestock, depending on the density of the overstory, composition of the herb layer, and the seral stage of the stand (Crowe and Clausnitzer 1997). However, forage production usually ranges from low to moderate owing to the dense nature of the shrub layers in most stands (Hansen et al. 1995). Stands in good to excellent ecological condition often support dense thickets of shrubs, limiting the amount of available forage. Red-osier dogwood is very palatable to both livestock and wildlife and can be used to indicate past and current levels of browsing.

Most sites are at low to mid elevation and, except for dense shrub layers, are accessible to livestock. Overuse of black cottonwood (especially regeneration) by livestock can be a common problem in livestock allotments where cattle congregate in the riparian zone. With moderate to heavy prolonged grazing pressures, most shrubs will be eliminated from the understory, converting the stand to nonpalatable herbs and shrubs such as Kentucky bluegrass and woods rose. Severe browsing and trampling by livestock and wild ungulates can prevent new stands from establishing on fresh scour or depositional surfaces, which can lead to an unbalanced age structure in the population and eventual loss of cottonwood from the site. Where grazing is a problem, modification of the livestock grazing system coupled with close monitoring of wildlife often allows the remnant shrub population to sprout and re-invade or increase in the stand. The ability to easily reestablish the shrubs is lost when the shrubs have been eliminated due to overgrazing and when the water table has been dramatically lowered due to streambed downcutting. (For more information on forage palatability, see app. B-1. For potential biomass production, see app. B-5.)

Wildlife. Black cottonwood stands provide food, cover, and shade for many wildlife species (Crowe and Clausnitzer 1997). Black cottonwood stands provide habitat for deer, elk, and moose. Bears feed on the buds and new growth of cottonwood. The author once observed a bear feeding on spring cottonwood buds in the extreme top of a 125-foot-tall black cottonwood. Bears also use rotten logs or excavate under the roots of living trees or snags for denning. Meadow voles and mice feed on roots and the bark of young trees. Rabbits and hares clip branches and also feed on bark. Squirrels, flying squirrels, and raccoons use the cavities of rotten trees. Beavers use both black cottonwood and red-osier dogwood for food and building materials. Shrubs such as mountain alder may be used for building materials and emergency food supplies.

The spreading crown provides sites for huge platform-like stick nests for bald eagles, ospreys, and blue herons. Woodpeckers, great horned owls, wood ducks, and songbirds use black cottonwood cavities (Crowe and Clausnitzer 1997). (For more information on thermal or feeding cover values, see apps. B-2 and B-3. For information on food values or degree of use, see apps. B-2 and B-4.)

Fish. Black cottonwood stands enhance fish habitat in adjacent streams by stabilizing streambanks, reducing sediment, and maintaining low water temperatures through shading (Crowe and Clausnitzer 1997). (For more information, see app. B-5, erosion control potential.) Large woody debris adds to the structure of fish habitat. Managers may maintain a strip of cottonwood-dominated communities along streams and rivers where feasible and consider the importance of understory shrubs (Hansen et al. 1995). These buffer strips stabilize streambanks, reduce sedimentation, and slow flood waters.

Recreation—

Because of the proximity to streams, rivers, ponds, lakes, and often flat topography, recreational developments, and transportation corridors are common on black cottonwood sites (Hansen et al. 1995). Recreation opportunities are excellent for fishing, big game and waterfowl hunting, and observing a variety of bird species. However, the loam soils are subject to compaction and trampling and seasonal flooding. High water tables typically make these sites unsuitable for road construction and campgrounds.

Insects and Disease—

Unseasonably early or late frosts can injure or kill seedlings and young saplings (Crowe and Clausnitzer 1997). However, dormant individuals are among the most frost-tolerant trees in North America (Minore 1979). Frost cracks provide an entrance for decay fungi. Ice storms, heavy snowfall, and high winds can cause breakage and permanent bending of branches (Roe 1958).

As with other species of poplar, black cottonwood is susceptible to a number of fungal pathogens (Schmitt 1996). Diseases that affect black cottonwood include the cytospora canker and sooty-bark canker, which lead to stem breakage and vulnerability to decay and mortality; melampsora rust, which causes defoliation; mottled rot, which can lead to windthrow and mortality; and shepherd's crook, which causes shoot dieback and defoliation in seedlings and saplings.

Black cottonwood is highly susceptible to damage from several insects (Schmitt 1996). Particularly troublesome defoliating insects include the fall webworm, western tent caterpillar, forest tent caterpillar, and satin moth. Trunk-boring insects such as the bronze poplar borer, blue alder agrilus, and poplar borer cause crown dieback, stem girdling, stem breakage, and predisposition to other diseases. Other insects that occasionally feed on cottonwood include the large aspen tortrix and aspen leaf-tier.

Estimating Vegetation Potential on Disturbed Sites—

Because clearcutting in black cottonwood-dominated stands is unusual, at least on FS land, estimating vegetation potential on disturbed sites is generally not needed. Wetter associations in the SALIX, COST, MEADOW and ALIN series often separate the POTR2 series from active flood zones. Currently all FS riparian zones and wetlands, including moist cottonwood depressions well away from the normal riparian zone, are not managed for wood production. Where mature cottonwood stands are clearcut or burned, removal of the cottonwood overstory may hasten the transition to coniferous forest. Similar landforms in nearby drainages can help to determine the potential natural vegetation in young stands. A potential problem lies where cottonwood stands have become old and decadent and are not regenerating owing to the lack of suitable seedbeds or overuse by large ungulates. Eventually these stands will be highly deteriorated or will have disappeared, and it will become necessary to look for evidence such as rotted logs or fragments of bark to know if the site has cottonwood potential.

Sensitive Species—

There were no sensitive species found on POTR2 series plots (app. D).

ADJACENT SERIES

Because of wide ecological amplitude, the POTR2 series may be found next to one of several different series. Adjacent upland sites are often climax PSME or ABLA2 series forests, especially within strong continental climates. The THPL or TSHE series often bound the black cottonwood series in more maritime areas. The PIPO series and steppe or shrub-steppe vegetation may surround the POTR2 series in hot, dry climate regions.

RELATIONSHIPS TO OTHER CLASSIFICATIONS

Plant associations belonging to the POTR2 series are described in the draft riparian and wetland classification for northeastern Washington (Kovalchik 1992c). The POTR2 series has not been published in previous upland classifications for eastern Washington NFs (Lillybridge et al. 1995, Williams et al. 1995).

Plant communities dominated by various cottonwoods are described throughout the West but are too numerous to list. Plant associations belonging to the POTR series are described in riparian/wetland classifications for eastern Washington (Crawford 2003, Kovalchik 1992c); central and northeastern Oregon (Crowe and Clausnitzer 1997, Kovalchik 1987); northwestern Oregon and southwestern Washington (Diaz and Mellen 1996); as well as Montana (Hansen et al. 1995). Similar associations described in these classifications include POTR2/ALIN-COST (Montana), POTR2/SYAL/POPR (central Oregon), POTR2/SYAL (northeastern Oregon), and POTR2/SYOC (Montana). The POTR2/RECENT ALLUVIAL BAR (Montana), POTR (northwestern Oregon and southwestern Washington), and POTR2/SYAL (northeastern Oregon) associations are comparable to the POTR2/ALLUVIAL BAR association described in this guide.

U.S. DEPARTMENT OF THE INTERIOR, FISH AND WILDLIFE SERVICE WETLANDS CLASSIFICATION

System:	palustrine
Class:	forested wetland
Subclass:	broad-leaved deciduous
Water regime:	(nontidal) temporarily flooded to intermittently flooded

KEY TO THE BLACK COTTONWOOD (*POPULUS TRICHOCARPA*) PLANT ASSOCIATIONS

1. Site on gravel or cobble bars .... **Black cottonwood/alluvial bar (POTR2/ALLUVIAL BAR) association**
2. Devil's club (*Oplopanax horridum*) ≥5 percent canopy coverage .... **Black cottonwood/devil's club (POTR2/OPHO) association**
3. Mountain alder (*Alnus incana*) ≥25 percent canopy coverage:
   - 3a. Red-osier dogwood (*Cornus stolonifera*) ≥10 percent canopy coverage .... **Black cottonwood/mountain alder–red-osier dogwood (POTR2/ALIN-COST) association**
   - 3b. Red-osier dogwood (*Cornus stolonifera*) <10 percent canopy coverage .... **Black cottonwood/mountain alder (POTR2/ALIN) association**
4. Red-osier dogwood (*Cornus stolonifera*) ≥10 percent canopy coverage .... **Black cottonwood/red-osier dogwood (POTR2/COST) association**
5. Common snowberry (*Symphoricarpos albus*) ≥5 percent canopy coverage, Douglas maple (*Acer glabrum douglasii*) often codominant .... **Black cottonwood/common snowberry (POTR2/SYAL) association**

Table 10—Constancy and mean cover of important plant species in the POTR2 plant associations

		POTR2/ ALIN 13 plots		POTR2/ ALIN-COST 7 plots		POTR2/ ALLUVIAL BAR 4 plots		POTR2/ COST 17 plots		POTR2/ OPHO 2 plots		POTR2/ SYAL 7 plots	
Species	**Code**	**CON[a]**	**COV[b]**	**CON**	**COV**	**CON**	**COV**	**CON**	**COV**	**CON**	**COV**	**CON**	**COV**
Tree overstory:													
paper birch	BEPA	23	6	—	—	—	—	24	23	50	4	43	18
Engelmann spruce	PIEN	38	8	29	10	50	5	18	10	—	—	—	—
lodgepole pine	PICO	8	1	—	—	25	5	—	—	—	—	29	4
ponderosa pine	PIPO	23	3	—	—	50	11	24	1	—	—	57	5
quaking aspen	POTR	38	10	—	—	25	3	29	6	50	10	29	3
black cottonwood	POTR2	100	43	100	48	100	22	100	48	100	26	100	59
Douglas-fir	PSME	38	2	43	1	50	9	53	4	50	3	57	15
western redcedar	THPL	15	6	14	7	25	20	24	2	50	6	—	—
Tree understory:													
paper birch	BEPA	23	4	—	—	—	—	6	2	—	—	43	5
Engelmann spruce	PIEN	62	3	—	—	25	2	24	Tr	—	—	—	—
quaking aspen	POTR	31	3	—	—	—	—	18	4	—	—	43	24
black cottonwood	POTR2	77	5	57	1	25	10	65	2	—	—	71	4
Douglas-fir	PSME	62	4	—	—	100	3	18	3	—	—	43	6
Oregon white oak	QUGA	—	—	14	Tr[c]	—	—	6	5	—	—	43	2
western redcedar	THPL	8	1	29	5	25	5	29	2	50	2	—	—

Table 10—Constancy and mean cover of important plant species in the POTR2 plant associations (continued)

		POTR2/ ALIN 13 plots		POTR2/ ALIN-COST 7 plots		POTR2/ ALLUVIAL BAR 4 plots		POTR2/ COST 17 plots		POTR2/ OPHO 2 plots		POTR2/ SYAL 7 plots	
Species	Code	CON	COV	CON	COV	CON	COV	CON	COV	CON	COV	CON	COV
Shrubs:													
vine maple	ACCI	—	—	29	2	—	—	6	80	—	—	—	—
Douglas maple	ACGLD	38	1	29	3	50	1	41	8	100	20	86	20
mountain alder	ALIN	100	36	100	43	25	10	41	9	100	7	43	2
Sitka alder	ALSI	23	22	—	—	—	—	12	11	50	3	14	5
Saskatoon serviceberry	AMAL	46	3	14	3	50	1	41	2	—	—	86	2
red-osier dogwood	COST	92	4	100	59	50	3	100	48	50	10	43	3
California hazel	COCO	—	—	14	10	—	—	12	12	—	—	71	24
black hawthorn	CRDOD	8	3	—	—	—	—	18	28	—	—	14	7
ocean-spray	HODI	15	1	—	—	50	16	12	12	—	—	14	1
devil’s club	OPHO	—	—	—	—	—	—	6	3	100	39	—	—
Lewis’ mock orange	PHLE2	—	—	29	11	—	—	24	9	—	—	71	11
prickly currant	RILA	69	3	43	6	—	—	47	8	100	2	14	1
Nootka rose	RONU	38	2	14	1	25	3	41	8	—	—	86	14
woods rose	ROWO	8	1	43	3	—	—	18	8	—	—	—	—
red raspberry	RUID	62	2	14	Tr	25	Tr	12	1	—	—	14	5
western thimbleberry	RUPA	62	1	86	2	50	1	53	2	100	1	71	16
Scouler’s willow	SASC	23	3	14	3	50	8	29	5	50	4	43	1
Douglas spiraea	SPDO	15	3	—	—	—	—	12	30	—	—	—	—
common snowberry	SYAL	69	39	71	17	—	—	65	18	50	Tr	86	48
Low shrubs and subshrubs:													
Oregon hollygrape	BEAQ	31	Tr	29	Tr	—	—	29	1	—	—	43	3
Cascade hollygrape	BENE	—	—	—	—	—	—	—	—	50	Tr	—	—
western prince’s-pine	CHUMO	23	1	14	Tr	50	10	—	—	—	—	14	Tr
myrtle pachistima	PAMY	46	1	29	2	25	1	35	1	50	2	14	15
Perennial forbs:													
baneberry	ACRU	46	Tr	43	3	—	—	24	Tr	100	1	—	—
pathfinder	ADBI	—	—	14	1	—	—	6	Tr	50	Tr	14	2
sharptooth angelica	ANAR	46	Tr	—	—	—	—	18	Tr	—	—	43	1
wild sarsaparilla	ARNU3	8	2	—	—	—	—	6	7	50	Tr	29	4
heartleaf arnica	ARCO	8	Tr	—	—	—	—	—	—	50	2	—	—
wild ginger	ASCA3	23	3	—	—	—	—	6	3	50	Tr	14	1
enchanter’s nightshade	CIAL	31	2	43	Tr	—	—	12	1	100	Tr	29	Tr
western white clematis	CLLI	—	—	—	—	—	—	6	Tr	—	—	57	1
queencup beadlily	CLUN	8	Tr	—	—	—	—	12	10	50	Tr	29	2
Hooker’s fairy-bells	DIHO	23	1	43	1	—	—	6	1	100	4	—	—
shootingstar species	DODEC	—	—	—	—	—	—	—	—	50	3	—	—
fireweed	EPAN	8	Tr	14	Tr	75	1	24	1	—	—	14	Tr
sweetscented bedstraw	GATR	54	1	57	Tr	—	—	47	1	50	Tr	43	2
northwestern twayblade	LICA3	—	—	—	—	—	—	—	—	50	5	—	—
pink wintergreen	PYAS	54	4	14	Tr	—	—	18	1	—	—	14	2
western solomonplume	SMRA	23	1	14	1	—	—	24	Tr	50	Tr	57	1
starry solomonplume	SMST	38	2	71	4	—	—	65	6	—	—	57	1
claspleaf twisted-stalk	STAM	8	Tr	—	—	—	—	6	Tr	100	4	—	—
western meadowrue	THOC	8	Tr	29	2	—	—	24	2	50	Tr	29	1
coolwort foamflower	TITRU	8	Tr	—	—	—	—	—	—	50	3	—	—
white trillium	TROV	8	Tr	29	Tr	—	—	12	Tr	50	Tr	—	—
pioneer violet	VIGL	23	2	57	1	—	—	6	2	100	3	14	Tr
Grasses or grasslike:													
smooth sedge	CALA	15	3	—	—	—	—	—	—	50	Tr	14	2
wood reed-grass	CILA2	23	Tr	14	Tr	—	—	6	2	100	1	—	—
blue wildrye	ELGL	62	2	—	—	50	Tr	41	3	—	—	57	1
tall mannagrass	GLEL	15	2	29	1	—	—	24	1	—	—	—	—
Kentucky bluegrass	POPR	8	1	—	—	25	2	18	1	—	—	—	—
Ferns and fern allies:													
lady fern	ATFI	31	1	14	3	—	—	6	1	100	5	14	Tr
coastal shield fern	DRAR	—	—	—	—	—	—	6	1	50	Tr	—	—
common horsetail	EQAR	69	2	43	1	25	Tr	35	1	50	Tr	57	1
common scouring-rush	EQHY	46	5	57	Tr	25	1	41	2	—	—	29	2
oak fern	GYDR	8	Tr	—	—	—	—	6	Tr	50	Tr	—	—
sword fern	POMU	—	—	—	—	—	—	—	—	50	Tr	—	—

[a] CON = percentage of plots in which the species occurred.
[b] COV = average canopy cover in plots in which the species occurred.
[c] Tr = trace cover, less than 1 percent canopy cover.

MISCELLANEOUS DECIDUOUS TREE SERIES AND PLANT ASSOCIATIONS

N = 30

THIS SECTION IS composed of four deciduous tree series, each with one plant association or community type. Data are so limited that it is not possible to classify multiple associations in each series. Four, 13, 7, and 6 plots support the ACMA, ALRU, BEPA, and QUGA[1] series, respectively. These series are somewhat uncommon in eastern Washington, although some may be locally common. The ALRU series (ALRU community type) is found on a variety of riparian fluvial surfaces in maritime climate zones on both the Wenatchee and Okanogan NFs. The BEPA series (BEPA community type) is found primarily in riparian zones on old burn areas on the Colville NF (one plot on the Tonasket RD, Okanogan NF). The QUGA series is common on terraces and alluvial fans in dry foothills in the southeastern corner of the Naches RD (mainly in the Oak Creek and Tieton River watersheds). It is not known to occur elsewhere on the NFs of eastern Washington. The descriptions for these series are short compared with series with more plots and plant associations and the writeups have been structured more like plant association descriptions. Because only one plant association or community type is in each series, the following descriptions also substitute for plant association descriptions. The approach in these series is to first present the data for the various series in a common set of physical setting tables, then describe each series individually. The ACMA series (ACMA community type) has only four plots and is described in just a few paragraphs.

[1] See appendix A for a cross reference for all species codes and common and scientific names used in this document.

PHYSICAL SETTING

The data for the four miscellaneous deciduous series are combined into a common set of environmental tables. The individual series/plant associations are described following the tables. The locations of the sample plots are shown in figures 19, 20, 21, and 22.

Elevation—

	Elevation (feet)			
Series	Minimum	Maximum	Average	N
BEPA	1,700	4,300	3,079	7
ALRU	1,340	3,800	2,375	13
ACMA	1,340	2,370	2,038	4
QUGA	1,700	2,200	1,963	6

Valley Geomorphology—

	Valley width					
Series	Very broad	Broad	Moderate	Narrow	Very narrow	N
ACMA	0	0	1	2	1	4
ALRU	1	2	6	3	1	13
BEPA	1	2	2	2	0	7
QUGA	2	2	1	0	0	5

	Valley gradient					
Series	Very low	Low	Moderate	Steep	Very steep	N
ACMA	0	0	0	2	2	4
ALRU	1	4	4	2	2	13
BEPA	1	0	3	2	1	7
QUGA	0	4	1	0	0	5

Channel Types—

	Rosgen channel types					
Series	A	B	C	E	Intermittent and ephemeral	N
ACMA	2	1	0	0	1	4
ALRU	3	7	1	2	0	13
BEPA	4	1	0	0	2	7
QUGA	0	5	1	0	0	6

Fluvial Surfaces—

	Fluvial surfaces							
Series	Alluvial bar	Flood-plain	Stream-bank	Terrace	Toe-slope	Forest wetland	Spring	N
ACMA	0	0	0	3	0	1	0	4
ALRU	1	2	4	4	2	0	0	13
BEPA	0	0	2	3	1	0	1	7
QUGA	0	0	0	6	0	0	0	6

Soils—

	Soil texture				
Series	Sand	Loamy sand	Loam	Organic loam	N
ACMA	1	2	1	0	4
ALRU	4	4	5	0	13
BEPA	0	0	7	0	7
QUGA	0	1	3	0	4

Miscellaneous deciduous plant associations

	Scientific name	Common name	Ecoclass code	Plots
Major associations:				
POTR2/ALIN	*Populus trichocarpa/Alnus incana*	Black cottonwood/mountain alder	HCS115	13
ALRU	*Alnus rubra*	Red alder community type	HAM1	13
BEPA	*Betula papyrifera*	Paper birch community type	HP	7
QUGA/COCO2-SYAL	*Quercus garryana/Corylus cornuta-Symphoricarpos albus*	Oregon white oak/california hazel-common snowberry	HOS311	6
Minor associations:				
ACMA	*Acer macrophyllum*	Bigleaf maple community type	HBM1	4

KEY TO THE MISCELLANEOUS DECIDUOUS TREE SERIES

1. Oregon white oak (*Quercus garryana*) present with ≥10 percent canopy coverage and reproducing successfully .... **Oregon white oak series and Oregon white oak/California hazel-common snowberry (QUGA/COCO2-SYAL) association**
2. Red alder (*Alnus rubra*) the dominant deciduous tree and reproducing successfully .... **Red alder series and red alder (ALRU) community type**
3. Bigleaf maple (*Acer macrophyllum*) the dominant deciduous tree and reproducing successfully .... **Bigleaf maple series and bigleaf maple (ACMA) community type**
4. Paper birch (*Betula papyrifera*) the dominant deciduous tree and reproducing successfully .... **Paper birch series and paper birch (BEPA) community type**

RED ALDER SERIES

ALRU community type HAM1

Alnus rubra

ALRU N = 13

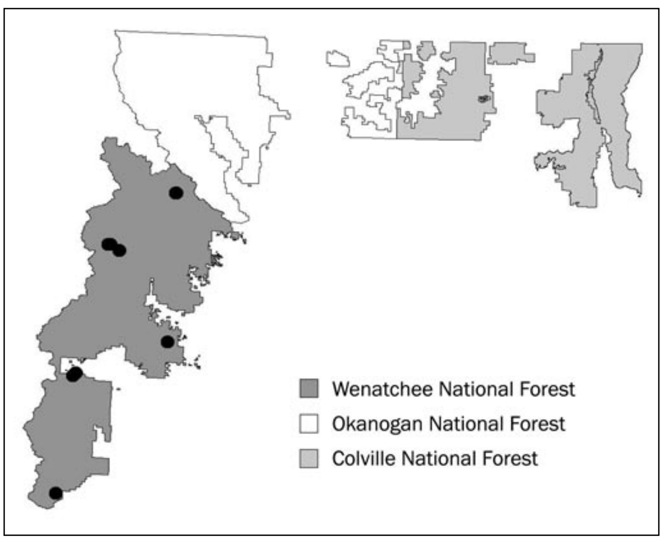


Figure 19—Plot locations for the red alder series.

VEGETATION CHARACTERISTICS

Mature stands are characterized by the dominance of seral stands of red alder.[1] Soil and water relationships will change over time through channel overflow and sediment deposition. As the fluvial surfaces stabilize and aggrade over time, changes in substrate condition will often allow conifer species such as Douglas-fir, grand fir, and western redcedar to encroach and eventually replace red alder.

Shrub and herb layers on ALRU series sites differ greatly. Shrubs with high constancy or cover include vine maple, mountain alder, Sitka alder, red-osier dogwood, ocean-spray, devil's club, prickly currant, and western thimbleberry. Common herbs include deerfoot vanilla-leaf, lady fern, enchanter's nightshade, purple sweet-root, arctic butterbur, starry solomonplume, white trillium, and pioneer violet.

Analysis of the limited data suggested four possible community types in this series:

- ALRU/ACCI (red alder/vine maple).
- ALRU/ACTR (red alder/deerfoot vanilla-leaf).
- ALRU/ALSI (red alder/Sitka alder).
- ALRU/OPHO/ATFI (red alder/devil's club/lady fern).

However, only two or three plots are found in each of these potential community types, and the classification is simplified by assigning the data to a single red alder community type.

PHYSICAL SETTING

Red alder grows in humid maritime climates characterized by cool, wet winters and warm, dry summers (Crowe and Clausnitzer 1997). The ALRU series was sampled only on the Wenatchee NF. Photographs suggest a few of the mountain alder-dominated plots established by summer crews on the west side of the Twisp RD (Okanogan NF) may actually be red alder. The ALRU series is probably common on FS lands on the west side of the Okanogan NF near Ross Lake.

Ecology plot elevations range from 1,340 to 3,800 (average 2,375) feet. Most stands in eastern Washington are found in riparian zones on floodplains, streambanks, and frequently flooded terraces. Valley width and gradient classes are variable, primarily narrow to broad, low to steep gradient valleys. Only a few plots are located in very broad, low gradient or very narrow, very steep valleys. Most streams associated with the ALRU series are classified as Rosgen A and B channel types. A few plots are located along Rosgen C or E channels. Soil texture within the rooting zone ranged from cobbly sand on floodplains and streambanks to loam on better developed terraces. Red alder can tolerate poor drainage and short periods of flooding (Crowe and Clausnitzer 1997) and, with few exceptions, most plots were located on sites that are frequently to intermittently flooded. Floodplain and streambank sites would usually be inundated during normal peak flows. Water tables would usually lower to several feet below the soil surface in July and August.

ECOSYSTEM MANAGEMENT

Natural Regeneration of Red Alder—

Red alder is a consistent and prolific seed producer (Crowe and Clausnitzer 1997). Seed dispersal occurs in late fall and winter. Most seeds are disseminated by wind and water, and seeds germinate best on moist, freshly deposited alluvium. Red alder requires full sunlight for best growth.

[1] See appendix A for a cross reference for all species codes and common and scientific names used in this document.

Roots develop rapidly into an extensive fibrous system that develops ectomycorrhizal relationships with a few fungal species. The roots develop nitrogen-fixing nodules soon after germination. Height growth of seedlings is exceptionally fast—3 feet or more the first year and 1.5 feet the second year. Two- to five-year-old seedlings can be 9 or more feet tall. On very productive sites, mature trees can attain heights of 30 feet in 5 years, 50 feet in 10 years, 80 feet in 20 years, and 100 feet at maturity. Red alder is relatively short-lived, maturing in 60 to 70 years and reaching maximum age in 100 years. Competition among saplings causes rapid self-thinning. Trees also self-prune well, and live crown ratios in crowded stands are low (crowns are characteristically narrow and domelike).

Artificial Establishment of Red Alder—

Red alder can be regenerated by any method that provides full sunlight and exposed mineral soil. Fire can probably substitute for mechanical disturbance of soil. (For more information on the short- and long-term revegetation potential of selected riparian wetland plant species, see app. B-5.)

Fire—

Fire rarely occurs in red alder stands because of the moist soils and scarcity of flammable fuels (Crowe and Clausnitzer 1997). Red alder bark is thin but resistant enough to prevent damage to the trees during light surface fires. Trees can sprout at the root collar after cutting and perhaps after fire.

Animals—

Livestock. Young red alder leaves and twigs are considered fair browse for sheep and cattle (Crowe and Clausnitzer 1997). Trees generally grow beyond the limits of browsing within 5 years. (For more information on forage palatability, see app. B-1. For potential biomass production, see app. B-5.)

Wildlife and fish. Deer, elk, and moose eat the leaves, twigs, and buds of young red alder from fall through early spring (Crowe and Clausnitzer 1997). Young red alder stands provide good cover for elk and mule deer. (For more information on thermal or feeding cover values, see apps. B-1 and B-2.) Beavers build dams and lodges with the trunks and stems and eat the bark. Goldfinches, siskins, and deer mice eat the seeds. (For information on food values or degree of use, see apps. B-3 and B-4.)

Insects and Disease—

Red alder is relatively free of insect and disease pests when young and uninjured (Schmitt 1996). White heart rot is the major cause of rotting in older trees. Canker-causing stem diseases are not serious. Insects found on red alder are the alder woolly sawfly, striped alder sawfly, alder flea beetle, and wooly alder aphid. Ice storms or unseasonable frost can cause mortality or top damage. Windthrow is not common because of the relatively deep, tangled root system and the absence of winter leaves.

Estimating Vegetation Potential on Disturbed Sites—

Red alder occurs only as a seral community type on sites that with time become dominated by conifers. It is found only at low to moderate elevations in strong maritime zones on relatively recently flooded sites and fresh alluvial deposits.

RELATIONSHIPS TO OTHER CLASSIFICATIONS

An ALRU series is described for riparian/wetland zones in northeastern Oregon (Crowe and Clausnitzer 1997). None of their associations are similar to the ALRU series described in this classification. Dissimilar ALRU plant associations also are described for riparian zones on the Gifford Pinchot and Mount Hood NFs (Diaz and Mellen 1996).

U.S. DEPARTMENT OF THE INTERIOR, FISH AND WILDLIFE SERVICE WETLANDS CLASSIFICATION

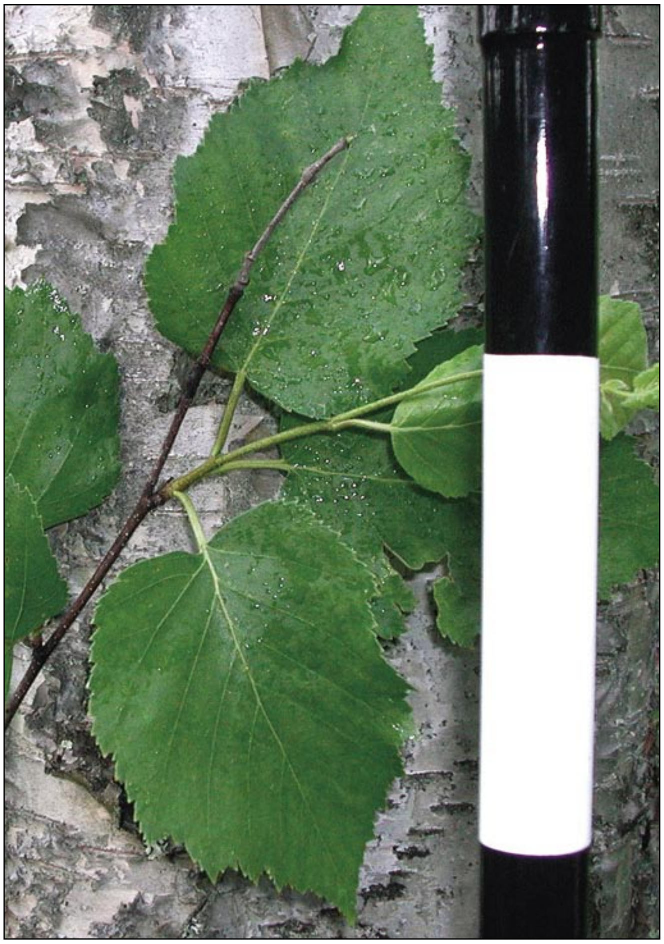
System:	palustrine
Class:	forested wetland
Subclass:	broad-leaved deciduous
Water regime:	(nontidal) intermittently to frequently flooded

PAPER BIRCH SERIES

BEPA community type HP

Betula papyrifera

BEPA N = 7



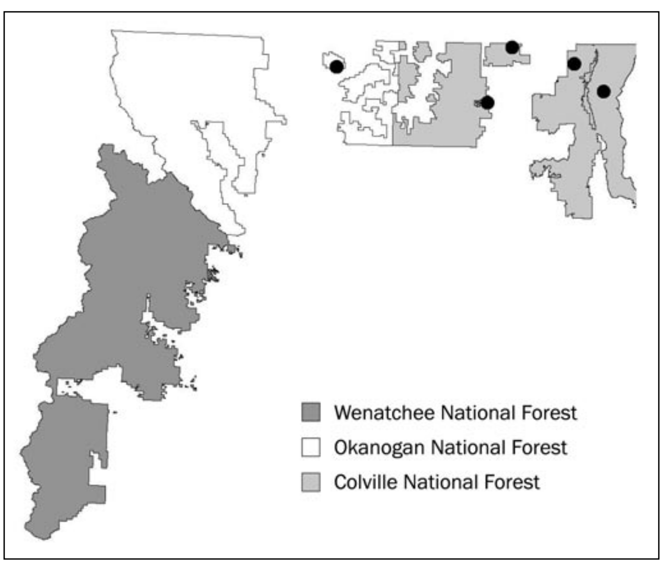


Figure 20—Plot locations for the paper birch series.

VEGETATION CHARACTERISTICS

Mature BEPA series stands are characterized by the dominance of paper birch,[1] which appears to be a seral species (after fire), thus a community type. Species composition will change over time even without changes in soil and water table characteristics caused by channel overflow and sediment deposition. The presence of western larch, lodgepole pine, and quaking aspen adds additional support for seral status. The presence of grand fir, western redcedar, or western hemlock may indicate the eventual vegetation potential for the site.

The shrub and herb layers in BEPA stands differ greatly. Common shrubs include Douglas maple, mountain alder, red-osier dogwood, prickly currant, baldhip rose, western thimbleberry, Oregon hollygrape, common snowberry, and twinflower. Common herbs include pathfinder, sharptooth angelica, wild sarsaparilla, queencup beadlily, sweetscented bedstraw, purple sweet-root, starry solomonplume, claspleaf twisted-stalk, and common horsetail.

Analysis of the limited data suggested four possible community types in this series:

- BEPA/ALIN (paper birch/mountain alder).
- BEPA/ARNU3 (paper birch/wild sarsaparilla).
- BEPA/COCA (paper birch/bunchberry dogwood).
- BEPA/COST (paper birch/red-osier dogwood).

However, only one to three plots are found in each of these potential community types, and the classification was simplified by assigning the data to a single paper birch community type.

PHYSICAL SETTING

Paper birch grows in humid climates characterized by inland maritime climate. Thus the BEPA series was largely sampled on the Colville NF. One plot is located on the eastern half of the Tonasket RD, Okanogan NF.

Ecology plot elevations range from 1,700 to 4,300 (avg. 3,079) feet. Most stands in this classification are found in riparian zones on well-drained streambanks and terraces. A few plots are located on the margins of wetlands or springs. Valley width and gradient classes are variable. Moderate to broad valley width and moderate valley gradient were predominant, although a few plots are in very broad or narrow valleys and very low, low, or very steep gradient valleys. Four streams sampled along the BEPA series are classified as Rosgen A channel types, and two are ephemeral channels. Only one plot is by a B channel. Stands developed best on deep, well-drained loam soils. Most sites are infrequently flooded, although streambank and seep sites may be briefly inundated during peak flows or at snowmelt. Water tables

[1] See appendix A for a cross reference for all species codes and common and scientific names used in this document.

usually lower to 2 or more feet below the soil surface in July and August.

ECOSYSTEM MANAGEMENT

Natural Regeneration of Paper Birch—

Good seed crops occur every 2 years (Haeussler and Coates 1986). The small, double-winged seeds are dispersed primarily by wind, most falling within 200 feet of the parent tree. Seeds germinate best on disturbed mineral or mixed mineral-organic seedbeds such as those produced by tree harvest or fire. The small seeds and seedlings are sensitive to soil moisture and temperature. Thus light shade and moist soil favor seedling survival. Growth is slow, and first-year seedlings are only 2 to 5 inches tall (Perala and Alm 1990b). Paper birch sprouts from the stump base or root collar after cutting or fire (Zasada et al. 1978). Younger trees may produce up to 100 sprouts. Sprout growth is rapid, sometimes up to 24 inches in the first growing season. Sprouting decreases with age.

Artificial Establishment of Paper Birch—

Paper birch is useful for long-term revegetation and soil stabilization of severely disturbed sites (Perala and Alm 1990a). Paper birch can be regenerated by any method that provides partial shade and exposed mineral or organic-mineral soil. Best results are obtained by planting 2-year-old or older bare-root or container stock. Where paper birch is present, stump or root crown sprouting will regenerate the species. Rooted stock can be planted, but silviculture practices (for example, overstory removal) favoring paper birch are now unusual on FS lands. Fire can probably substitute for mechanical disturbance of soil as a site-preparation method. (For more information on the short- and long-term revegetation potential of selected riparian wetland plant species, see app. B-5.)

Fire—

Paper birch is well adapted to fire, recovering quickly by means of seedling establishment and resprouting to form root collars (A.D. Revill Assoc. 1978, Lutz 1956, Viereck and Schandelmeier 1980). Seedling establishment is by far the most significant means of regeneration of new paper birch stands following fires.

Animals—

Livestock. Young paper birch leaves and twigs are probably fair browse for sheep and cattle. Trees should grow beyond the limits of browsing within 5 years. (For more information on forage palatability, see app. B-1. For potential biomass production, see app. B-5.)

Wildlife. Paper birch is an important moose browse throughout its range. Its nutritional value is poor in winter, but it is important to wintering moose because of its sheer abundance in young stands (Safford et al. 1990). Paper birch is also an important dietary component for white-tailed deer (Jordan and Rushmore 1969). Snowshoe hares browse paper birch seedlings and saplings, and porcupine feed on the inner bark. Beaver also eat paper birch (Haeussler and Coates 1986). Numerous birds, including redpolls, siskins, chickadees, and ruffed grouse eat paper birch buds, catkins, and seeds (Perala and Alm 1990b, Safford et al. 1990). Paper birch is also a favorite feeding tree of yellow-bellied sapsuckers, which peck holes in the bark to feed on the sap (Jordan and Rushmore 1969). Hummingbirds and red squirrels also feed at these sap wells (Perala and Alm 1990b). (For more information on thermal or feeding cover values, see apps. B-2 and B-3. For information on food values or degree of use, see apps. B-2 and B-4.)

Estimating Vegetation Potential on Disturbed Sites—

Paper birch is a seral community type on sites that with time become dominated by conifers. It is usually found on well-drained terraces at moderate elevations in inland maritime climate zones on the Colville NF. Most BEPA stands originated after forest fires on sites in the THPL and TSHE series.

RELATIONSHIPS TO OTHER CLASSIFICATIONS

The paper birch series has not been described in other riparian/wetland classifications.

U.S. DEPARTMENT OF THE INTERIOR, FISH AND WILDLIFE SERVICE WETLANDS CLASSIFICATION

System:	palustrine
Class:	forested wetland
Subclass:	broad-leaved deciduous
Water regime:	(nontidal) intermittently saturated

OREGON WHITE OAK SERIES
QUGA/COCO2-SYAL association HOS311
Quercus garryana
QUGA N = 6

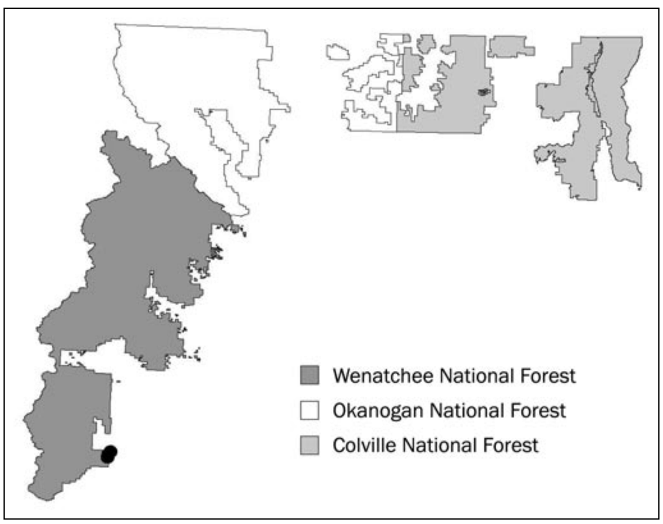


Figure 21—Plot locations for the Oregon white oak series.

VEGETATION CHARACTERISTICS

The composition and patterns of abundance of the flora have been considerably affected by disturbance, including fire, grazing, homesteading, and logging. Mature stands in fair or better ecological condition are characterized by the dominance of climax Oregon white oak.[1] Old white oak, Douglas-fir, and ponderosa pine mixed with younger trees is a common stand structure. However, white oak is always reproducing more successfully than Douglas-fir or ponderosa pine. Douglas-fir and ponderosa pine do reproduce and establish in these stands, but this may require long periods and special conditions. Both black cottonwood and quaking aspen were well represented in a few stands. Douglas-fir dominated one plot in which none of the oak regeneration was greater than 5 inches diameter at breast height. However, white oak was clearly regenerating more successfully than Douglas-fir.

The undergrowth is a rich mixture of medium and tall shrubs. California hazel dominates two plots, is absent on one plot, and is subordinate to common snowberry on the others. Common snowberry is usually abundant, except where unusually dense California hazel and other tall shrubs suppress it. Other shrubs include Douglas maple, bittercherry, common chokecherry, baldhip rose, wax currant, and ocean-spray. Elk sedge and blue wildrye are common on a few plots. Herbs are inconspicuous on most plots owing to shrub shade.

PHYSICAL SETTING

Oregon white oak is one of the tree species in the Northwest most tolerant of heat and drought (Franklin and Dyrness 1973, Minore 1979). Although widely distributed on the west side of the Cascade Range, Oregon white oak is limited on the east slope to a relatively small area north and south of the Columbia Gorge (Hitchcock and Cronquist 1973, Topik et al. 1988). The northernmost disjunct stand occurs along Swauk Creek between Cle Elum and Ellensburg. Cold temperatures seem to be the limiting factor in the northward distribution of Oregon white oak east of the Cascade Range. The Oregon white oak series is generally limited to the lower reaches of the Oak Creek/Tieton River watershed on the Naches RD, Wenatchee NF. A few stands have been observed on tributaries of the lower Naches River.

This is the hottest, most droughty forest series, and where it occurs, it marks the lower boundary of woodland and forest. As such, the QUGA series is transitional between conifer-dominated forests at higher elevations and shrub-steppe zones at lower elevations and to the east. The QUGA series is more extensive on the Yakama Indian Reservation (John et al. 1988).

Ecology plot elevations range from 1,700 to 2,200 (avg. 1,963) feet. Most stands in this classification are found in riparian zones on terraces. Stands also have been observed on relatively moist alluvial fans. Most streams flowing through Oregon white oak stands are classified as Rosgen B channel types. One stand is next to a large Rosgen C channel. The QUGA/COCO2-SYAL association typically occurs on basalt alluvium. Stands develop best on deep, well-drained loam and sandy loam soils. These sites are located on sites that are infrequently flooded. Water tables are rarely near the surface except during extreme flood events. The water table usually lies well below the soil surface by midsummer.

[1] See appendix A for a cross reference for all species codes and common and scientific names used in this document.

ECOSYSTEM MANAGEMENT

Natural Regeneration of Oregon White Oak—

Fresh acorns germinate as soon as they fall on warm, moist sites. Otherwise they wait until conditions are suitable. Initial growth is concentrated in the taproot to ensure the seedling maintains an adequate supply of moisture. Shoot development is slow, and it may take as long as 10 years for saplings to attain 3.3 feet in height (Burns and Honkala 1990, Sugihara and Reed 1987). Seedling survival is low when acorns germinate on sod or heavy duff. Browsing ungulates or rodents easily kill many seedlings. Pocket gophers destroy young roots. Oregon white oak also may sprout from the trunk and root crown following cutting or burning. Sprouts grow rapidly due to the already developed root system, and 3-year-old sprouts may average 9 feet in height (McDonald et al. 1983). Very old white oaks usually are weak sprouters or fail to sprout altogether (Griffin 1980).

Artificial Establishment of Oregon White Oak—

Oregon white oak can be regenerated by any method that provides full sunlight and exposed mineral soil. Fire can probably substitute for mechanical disturbance of soil. Sprouting can regenerate established stands of white oak. (For more information on the short- and long-term revegetation potential of selected riparian wetland plant species, see app. B-5.)

Stand Management—

Intensive tree production data are not available for the QUGA series. These sites are presumed to have moderate timber productivity owing to summer drought, low stocking, and slow growth rates (Lillybridge et al. 1995). However, the riparian plots are surprisingly dense and productive compared with adjacent Oregon white oak and ponderosa pine upland associations. Many riparian stands have been cleared for homesteads, grazing, or wood products. Oregon white oak makes excellent firewood. Opportunity exists to use these woodlands for the production of firewood through a coppice silviculture system. The ability of Oregon white oak to resprout after fire or cutting allows it to readily regenerate disturbed sites. Watershed, recreation, and wildlife values likely exceed the value for timber production.

Fire—

Historical fire frequency in these areas is judged to be in the 5- to 30-year range, with most fires being of low intensity (Lillybridge et al. 1995). Fire helped maintain the open woodland structure of these stands and the composition and dominance of shrubs. Oregon white oak is very fire tolerant because its foliage is relatively nonflammable and it will resprout should the aboveground stem be killed. Lack of fire or altered fire cycles in recent times have led to changes in floristic composition. Fire-sensitive species are more common and fuel ladders have developed, thus stands are more susceptible to stand-replacement fires.

Animals—

Livestock. Although clipped plots are not available, the QUGA series should provide moderate herbage for livestock, except where shrubs are especially dense (Lillybridge et al. 1995). Invasion of noxious weeds is a serious problem after heavy grazing or other ground-disturbing activity. Heavy grazing reduces shrub cover through trampling and browsing, and introduced grasses and forbs may persist for many years. (For more information on forage palatability, see app. B-1. For potential biomass production, see app. B-5.)

Wildlife and fish. These sites are important wildlife areas and are heavily used, especially as winter and early spring range (Lillybridge et al. 1995). Elk and deer sign is often abundant and these animals may have a significant impact on the relative abundance and composition of the undergrowth. The proximity to water makes these sites very important for a wide variety of small mammals and birds. They also produce forage from oak mast (fallen acorns) and are important thermal and hiding cover in winter. Natural stands probably produced little herbage below the dense shrub layer. Early spring green-up helps sustain wildlife until other forage becomes available at higher elevations. Snags and logs provide valuable habitat and perches and are especially critical because tree density is low, and therefore snag and log recruitment also will be slow or episodic on these sites. (For more information on thermal or feeding cover values, see apps. B-2 and B-3. For information on food values or degree of use, see apps. B-2 and B-4.)

The QUGA/COCA-SYAL stands are located on terraces adjacent to important fish-bearing streams. Woody debris and fallen leaves are important factors in stream processes and the fish food cycle. (For more information, see app. B-5, erosion control potential.)

Insects and Disease—

The primary root and trunk rot diseases of Oregon white oak include armillaria root rot (*A. sinapina*) and oak anthracnose (Hessburg 1995). Insects of note on white oak include the western oak looper, western tent caterpillar, and Pacific tent caterpillar. The primary root diseases affecting associated ponderosa pine and Douglas-fir are discussed in Lillybridge et al. (1995).

Estimating Vegetation Potential on Disturbed Sites—

Riparian Oregon white oak stands occur only at very low elevations on river terraces and alluvial fans along the lower Tieton River and its tributaries. Homesteading and logging have eliminated many stands. The classification user should look for Oregon white oak stands on similar sites at other locations in the watershed or scattered oak in the vicinity of the project area.

RELATIONSHIPS TO OTHER CLASSIFICATIONS

The QUGA/COCO2-SYAL association is described for the Wenatchee NF (Lillybridge et al. 1995). Upland plant associations belonging to the QUGA series also are described for the Yakama Indian Reservation (John et al. 1988) and Mount Hood NF (Topik et al. 1988).

U.S. DEPARTMENT OF THE INTERIOR, FISH AND WILDLIFE SERVICE WETLANDS CLASSIFICATION

System:	palustrine
Class:	forested wetland
Subclass:	broad-leaved deciduous
Water regime:	(nontidal) intermittently saturated to intermittently flooded

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BIGLEAF MAPLE SERIES

ACMA community type HBM1

Acer macrophyllum

ACMA N = 4

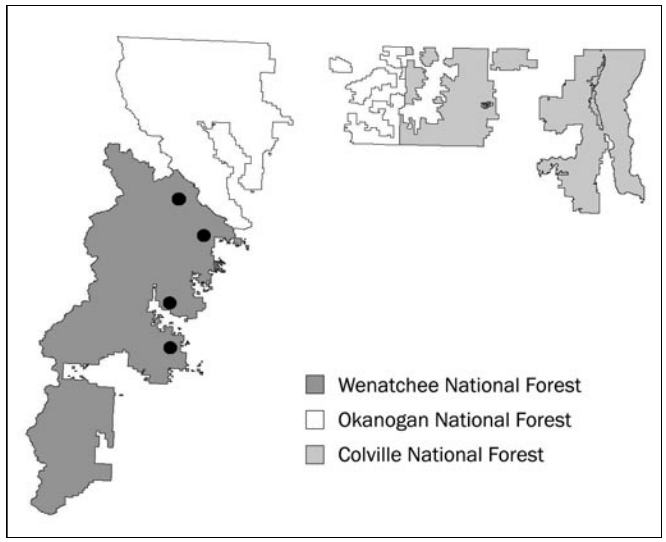


Figure 22—Plot locations for the bigleaf maple series.

BIGLEAF MAPLE[1] grows in humid, maritime climates. Two sample plots are located along Darby Creek and Devil's Gulch Creek on the Leavenworth RD, Wenatchee NF. The other two plots are located along Derby and Prince Creek on the Lake Chelan RD, Wenatchee NF. Elevations of these sample plots range from 1,340 to 2,370 (avg. 2,038) feet. The plots are located on moist, well-drained terraces and toe-slopes in generally narrow, steep to very steep valleys. The ACMA stands also occur in broader, low gradient valleys. It is likely that these stands originated after stand-replacing wildfire and are early seral successional stages on PSME, ABGR, or THPL series sites. Bigleaf maple is the dominant tree. Red alder, Douglas-fir, black cottonwood, and western redcedar are common in some sample stands. Grand fir has been observed in other stands. Red-osier dogwood and mountain alder dominate the undergrowth of one stand. Red-osier dogwood and ocean-spray dominate another. A third stand is dominated by ocean-spray, and the fourth is dominated by common snowberry. Various community types could have been designated by these undergrowths but are not recognized on account of limited plot data. (For more information, see apps. B-1 through B-5 and C-1a through C-4.)

[1] See appendix A for a cross reference for all species codes and common and scientific names used in this document.

Table 11—Constancy and mean cover of important plant species in the miscellaneous deciduous plant associations

Species	Code	ACMA 4 plots CON[a]	COV[b]	ALRU 13 plots CON	COV	BEPA 7 plots CON	COV	QUGA/COC2-SYAL 6 plots CON	COV
Tree overstory:									
grand fir	ABGR	—	—	23	5	43	2	—	—
bigleaf maple	ACMA	100	49	8	8	—	—	—	—
red alder	ALRU	25	20	100	66	—	—	—	—
paper birch	BEPA	—	—	—	—	100	36	—	—
western larch	LAOC	—	—	—	—	57	11	—	—
lodgepole pine	PICO	—	—	—	—	57	4	—	—
ponderosa pine	PIPO	25	Tr[c]	8	5	—	—	67	20
quaking aspen	POTR	—	—	—	—	43	7	17	20
black cottonwood	POTR2	25	5	8	2	14	Tr	17	2
Douglas-fir	PSME	25	1	31	8	71	2	67	17
Oregon white oak	QUGA	—	—	—	—	—	—	83	50
western redcedar	THPL	—	—	15	5	57	5	—	—
western hemlock	TSHE	—	—	15	2	57	3	—	—
Tree understory:									
grand fir	ABGR	50	Tr	62	6	57	Tr	—	—
subalpine fir	ABLA2	—	—	8	5	—	—	—	—
bigleaf maple	ACMA	75	2	15	Tr	—	—	—	—
red alder	ALRU	25	10	15	13	—	—	—	—
paper birch	BEPA	—	—	—	—	57	12	—	—
Douglas-fir	PSME	50	4	46	5	71	2	17	5
Oregon white oak	QUGA	—	—	—	—	—	—	83	13
western redcedar	THPL	25	5	31	5	71	2	—	—
western hemlock	TSHE	—	—	8	1	57	2	—	—
Shrubs:									
vine maple	ACCI	—	—	54	36	—	—	—	—
Douglas maple	ACGLD	75	2	31	6	71	4	50	4
mountain alder	ALIN	25	47	15	27	71	10	—	—
Sitka alder	ALSI	—	—	46	15	29	2	—	—
Saskatoon serviceberry	AMAL	100	1	31	Tr	71	2	33	3
red-osier dogwood	COST	75	44	38	19	71	10	—	—
California hazel	COCO	—	—	15	14	29	5	83	17
ocean-spray	HODI	100	15	54	3	29	Tr	50	3
devil's club	OPHO	—	—	31	22	29	2	—	—
Lewis' mock orange	PHLE2	75	4	23	1	29	2	33	3
bittercherry	PREM	—	—	—	—	—	—	83	6
common chokecherry	PRVI	—	—	—	—	14	Tr	67	8
Hudsonbay currant	RIHU	—	—	15	27	—	—	—	—
prickly currant	RILA	25	Tr	54	2	86	2	—	—
baldhip rose	ROGY	50	1	38	3	71	2	17	10
Nootka rose	RONU	—	—	—	—	29	4	50	13
red raspberry	RUID	50	1	23	Tr	43	1	—	—
western thimbleberry	RUPA	25	Tr	62	9	86	3	—	—
dwarf red blackberry	RUPU2	—	—	—	—	14	7	—	—
salmonberry	RUSP	—	—	38	15	—	—	—	—
scarlet elderberry	SARA	—	—	8	25	14	Tr	—	—
shiny-leaf spiraea	SPBEL	50	2	—	—	29	Tr	17	5
Douglas spiraea	SPDO	—	—	—	—	29	11	17	Tr
common snowberry	SYAL	75	22	23	14	100	4	83	47
Low shrubs and subshrubs:									
Oregon hollygrape	BEAQ	25	Tr	15	Tr	71	2	33	1
bunchberry dogwood	COCA	—	—	—	—	43	7	—	—
twinflower	LIBOL	—	—	8	Tr	57	17	—	—
myrtle pachistima	PAMY	100	1	38	4	43	2	33	1
Perennial forbs:									
deerfoot vanilla-leaf	ACTR	—	—	38	7	—	—	—	—
pathfinder	ADBI	25	Tr	46	2	57	3	—	—
wild onion species	ALLIU	—	—	—	—	—	—	50	Tr
sharptooth angelica	ANAR	25	Tr	15	3	57	1	—	—
raceme pussytoes	ANRA	—	—	8	5	—	—	—	—
wild sarsaparilla	ARNU3	—	—	—	—	57	3	—	—
wild ginger	ASCA3	—	—	46	1	14	15	—	—
western aster	ASOC	—	—	—	—	14	7	—	—
enchanter's nightshade	CIAL	50	Tr	54	21	29	2	—	—
western white clematis	CLLI	—	—	—	—	—	—	50	2
queencup beadlily	CLUN	—	—	15	3	86	2	—	—

Table 11—Constancy and mean cover of important plant species in the miscellaneous deciduous plant associations (continued)

		ACMA 4 plots		ALRU 13 plots		BEPA 7 plots		QUGA/COC2-SYAL 6 plots	
Species	**Code**	**CON**	**COV**	**CON**	**COV**	**CON**	**COV**	**CON**	**COV**
sweetscented bedstraw	GATR	25	Tr	38	Tr	57	1	—	—
fewflower peavine	LAPA2	—	—	—	—	—	—	17	8
purple sweet-root	OSPU	50	1	62	3	71	1	17	1
arctic butterbur	PEFR2	—	—	62	8	—	—	—	—
western solomonplume	SMRA	75	1	62	1	29	1	—	—
starry solomonplume	SMST	75	1	15	Tr	57	1	17	10
claspleaf twisted-stalk	STAM	—	—	38	Tr	71	1	—	—
white trillium	TROV	—	—	54	Tr	29	1	—	—
American vetch	VIAM	—	—	—	—	—	—	17	10
pioneer violet	VIGL	50	Tr	62	1	—	—	—	—
Grass or grasslike:									
winter bentgrass	AGSC	—	—	—	—	14	10	—	—
elk sedge	CAGE	—	—	—	—	—	—	67	4
smooth sedge	CALA	—	—	—	—	57	Tr	—	—
blue wildrye	ELGL	50	Tr	23	Tr	43	3	83	1
fowl mannagrass	GLST	—	—	—	—	14	10	—	—
Ferns and fern allies:									
lady fern	ATFI	—	—	46	24	29	1	—	—
common horsetail	EQAR	—	—	38	1	57	1	—	—

[a] CON = percentage of plots in which the species occurred.
[b] COV = average canopy cover in plots in which the species occurred.
[c] Tr = trace cover, less than 1 percent canopy cover.

WILLOW SERIES

Salix species

SALIX N = 152

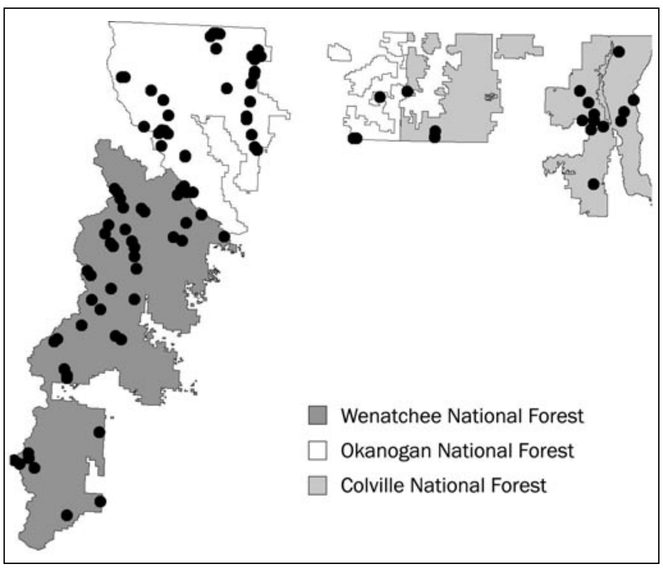


Figure 23—Plot locations for the willow series.

THERE ARE SOME 300 species of willows[1] in the world, most of which occur in the temperate Northern Hemisphere (Chmelar 1974, Hathaway 1987). Willows occur throughout North America and form one of the most widespread and complex groups of riparian and wetland species in the United States (Platts et al. 1987). Dorn (1976) recognizes some 80 species of willow for the United States and Canada. At least 25 species occur on eastern Washington NFs (see app. F). (For a complete list of the common names, species codes, and scientific names of these willows and the other species discussed in this section, refer to app. A.) These many willow species, with their associated high genetic variability and subsequent ecological amplitude, are well suited to a variety of sites in eastern Washington.

Variation in geology, climate, elevation, valley gradient, and slope, stream geomorphology, water tables, and soil and water chemistry produces a wide range of riparian and wetland habitats suitable for the growth of willow communities, each with unique vegetation structure and composition (Brunsfeld and Johnson 1985). Although willows are not capable of growing on every riparian and wetland site, the sheer number of willow species provides ample opportunity for the establishment of a variety of SALIX plant associations in eastern Washington (app. F).

Contrary to popular opinion that willows are pioneer species on disturbed or unstable sites, Brunsfeld and Johnson (1985) and Kovalchik (1987) found that most willow communities occur in relatively stable successional stages maintained by the nature of the habitat (high water tables, flooding, etc.). They found that flooding is not sufficient, by itself, to cause rapid changes in site characteristics except in the immediate vicinity of the stream. Floods charge the soil with moisture, nutrients, and sediments, and in some habitats prevent the establishment of willows. Willow communities occur not only along streams (point bars, alluvial bars, and floodplains), but also well away from the stream in willow bogs, swamps, and carrs where fluvial processes are minimal, if present at all. Flood disturbances may be required to establish some species of willow on floodplains, but other processes must act to establish other willows on nonriparian (wetland) sites. Once willows are established on wetland sites, succession to site conditions more favorable to conifers or deciduous trees proceeds slowly, if at all.

The climatic variation within the SALIX series is extreme owing to the wide variation in willow species' individual site requirements. Therefore, the SALIX series is found from the Columbia River to subalpine and alpine sites all across eastern Washington. Annual precipitation varies from under 10 inches at low elevations in the dry continental climate in the interior of the study area to well over 80 inches along the Cascade crest and over 25 inches in the inland maritime climate in northeastern Washington. However, such climate generalities need to be interpreted carefully when considering the effects of cold air drainage, the flow of cold water from upper reaches of the watershed, and the existence of elevated water tables in willow-dominated wetlands.

CLASSIFICATION DATABASE

The SALIX series includes all nonforest stands potentially dominated by at least 25 percent canopy coverage of willow species. The SALIX series is common throughout eastern Washington (fig. 23), primarily in broad, low gradient valleys where soils are wet and poorly drained. It was sampled on all three NFs and all RDs except the Kettle RD

[1] See appendix A for a cross reference for all species codes and common and scientific names used in this document.

Willow plant associations

	Scientific name	Common name	Ecoclass code	Plots
Major associations:				
SACO2/CASCB-CASP	*Salix commutata/Carex scopulorum* var. *bracteosa-Carex spectabilis*	Undergreen willow/Holm's sedge-showy sedge	SW1211	5
SACO2/MESIC FORB	*Salix commutata/*mesic forb	Undergreen willow/mesic forb	SW1212	5
SAFA/CASCB-CASP	*Salix farriae/Carex scopulorum* var. *bracteosa-Carex spectabilis*	Farr's willow/Holm's sedge-showy sedge	SW1214	10
SAFA/CASCP2	*Salix farriae/Carex scopulorum* var. *prionophylla*	Farr's willow/saw-leaved sedge	SW1215	14
SAFA/CAUT	*Salix farriae/Carex utriculata*	Farr's willow/bladder sedge	SW1216	10
SAFA/ELPA2-ERPO2	*Salix farriae/Eleocharis pauciflora-Eriophorum polystachion*	Farr's willow/few-flowered spike-rush–many-spiked cotton-grass	SW1218	6
SALIX/ALLUVIAL BAR	*Salix/*alluvial bar	Willow/alluvial bar	SWGR	16
SALIX/CACA	*Salix/Calamagrostis canadensis*	Willow/bluejoint reedgrass	SW1141	8
SALIX/CASCP2	*Salix/Carex scopulorum* var. *prionophylla*	Willow/saw-leaved sedge	SW1143	14
SALIX/CAUT	*Salix/Carex utriculata*	Willow/bladder sedge	SW1123	26
SALIX/MESIC FORB	*Salix/*mesic forb	Willow/mesic forb	SW1146	16
Minor associations:				
SAFA/CANI2	*Salix farriae/Carex nigricans*	Farr's willow/black alpine sedge	SW1213	2
SAFA/DAIN	*Salix farriae/Danthonia intermedia*	Farr's willow/timber oatgrass	SW1217	2
SALIX/CALA4	*Salix/Carex lasiocarpa*	Willow/slender sedge	SW1142	2
SALIX/EQUIS	*Salix/Equisetum* species	Willow/horsetail species	SW1144	3
SALIX/GLEL	*Salix/Glyceria elata*	Willow/tall managrass	SW1145	4
SALIX-SPDO	*Salix/Spiraea douglasii*	Willow/douglas spiraea	SW1147	3
SASC-PAMY	*Salix scouleriana-Pachistima myrsinites*	Scouler's willow-myrtle pachistima	SM2111	6

(where it has been observed in limited quantities). One hundred fifty-two riparian and wetland plots were measured in the SALIX series. From this database, 11 major and 7 minor SALIX plant associations are recognized. The SASC-PAMY association has six plots but is described as a minor association because it occurs principally on drier sites such as toeslopes, drier terraces, avalanche chutes, or the margins of springs and could arguably be considered upland. Four potential, one-plot associations (SACO2-PHEM-VADE, SAFA/CASA2, SAFA/TRLA4, and SAFA/CADI2) are not used in the SALIX series data or described in this classification. All the information presented in the SALIX series represents mature, stable communities in good ecological condition. Conditions on some sites may be shifting toward dominance by black cottonwood or conifers owing to sediment accumulations and subsequent lowering of the effective water table.

VEGETATION CHARACTERISTICS

The most significant local reports interpreting the taxonomy of willows of the study area are (1) Brunsfeld and Johnson's (1985) *Field Guide to the Willows of East-Central Idaho* and (2) Cronquist's approach in *Vascular Plants of the Pacific Northwest* (Hitchcock and Cronquist 1973). This classification principally follows the taxonomic work of Hitchcock and Cronquist (1973) but includes improvements from the more recent work by Brunsfeld and Johnson (1985). The distributions of willows in eastern Washington as described by Hitchcock and Cronquist (1973) are inaccurate, and there are a few errors in their key, which were corrected for this study. Some new willow occurrences in eastern Washington also are discussed.

The SALIX series is very complex owing to the merging of climates and willow species from the Rocky Mountains, western Washington, Columbia basin, and British Columbia. The SALIX series is further complicated by the many willow species that can dominate SALIX plant associations, as well as by the many sedges and other wet-site graminoids or forbs in the understory below the willows. As with the willows, the composition of the understory species depends on climatic factors such as growing season and elevation as well as soil characteristics such as texture, aeration, temperature, water chemistry, and water tables. Twenty-five willow species and 18 additional shrub and herb species are used to characterize 18 SALIX plant associations. Willow identification is made easier by classifying them into two general categories, "tall" and "short" (table 12). Tall willows grow more than 5 feet tall and occur at low to moderate elevations. Short willows usually are less than 5 feet tall and are restricted to bogs (all elevations) or to timberline and alpine elevations.

The ground cover under the willows on most SALIX series sites is dominated by graminoids, although shrubs or forbs dominate a few associations. Species such as mud sedge, few-flowered spike-rush, and the various species of cotton-grass are characteristic of poor shrub fens and shrub bogs in the SALIX/CALA4 and SAFA/ELPA2-ERPO2 associations. Shrub fen associations (examples = SAFA/CASCB-CASP and SALIX/CAUT) are dominated by tall, robust graminoids such as bladder sedge, Holm's sedge, saw-leaved sedge, showy sedge, water sedge, and bluejoint reedgrass. The SACO2/MESIC FORB and SALIX/MESIC FORB associations lack significant cover of graminoids, and the

Table 12—Height classes for 29 willows found on the national forests of eastern Washington

Tall willows (>5 feet tall)			Short willows (<5 feet tall)		
R6 code	Scientific name	Common name	R6 code	Scientific name	Common name
SABEP	*Salix bebbiana* var. *perrostrata*	Bebb's willow	SACA6	*Salix cascadensis*	Cascade willow
SABO2	*S. boothii*	Booth's willow	SACO2	*S. commutata*	undergreen willow
SABR2	*S. brachycarpa*	short-fruited willow	SAFA	*S. farriae*	Farr's willow
SACA9	*S. candida*	hoary willow	SANI	*S. nivalis*	snow willow
SADR	*S. drummondiana*	Drummond's willow	SANIN	*S. nivalis nivalis*	snow willow
SAEX	*S. exigua*	coyote willow	SAPE3	*S. pedicellaris*	bog willow
SAEXE	*S. exigua* var. *exigua*	coyote willow	SAPLM2	*S. planifolia* var. *monica*	tea-leaved willow
SAGEG	*S. geyeriana* var. *geyeriana*	Geyer's willow			
SAGEM	*S. geyeriana* var. *meleiana*	Geyer's willow			
SAGL	*S. glauca*	glaucous willow			
SALAC	*S. lasiandra* var. *caudata*	whiplash willow			
SALAL	*S. lasiandra* var. *lasiandra*	Pacific willow			
SALE	*S. lemmonii*	Lemmon's willow			
SAMA	*S. maccalliana*	McCalla's willow			
SAME2	*S. melanopsis*	dusky willow			
SAPI	*S. piperi*	Piper's willow			
SAPS2	*S. pseudomonticola*	false mountain willow			
SARIM2	*S. rigida* var. *mackenzieana*	Mackenzie's willow			
SASC	*S. scouleriana*	Scouler's willow			
SASI2	*S. sitchensis*	Sitka willow			
SATW	*S. tweedyi*	Tweedy's willow			

Note: SACO2 occasionally slightly exceeds 5 feet.

understory is characterized by forbs. The SALIX/MESIC FORB association often has a very dense tall willow overstory, and the forb understory is depauperate in response to shade and competition from the willows. This situation is less common under the short willows of the SACO2/MESIC FORB association. SALIX/EQUIS association sites are wetter than the two "mesic forb" associations, and horsetail species, especially common horsetail, and other wet-site shrubs and herbs are abundant in the understory. The SALIX/GLEL association sites are similar to the SALIX/EQUIS association, but the understory is characterized by mannagrass species rather than an abundance of horsetails. The SALIX/ALLUVIAL BAR and SACO2/ALLUVIAL BAR associations are found on new fluvial surfaces such as point bars, alluvial bars, and floodplains. Shrub and herb layers are generally sparse on these relatively young sites. The SALIX/SPDO association is characterized by a dense understory of Douglas spiraea; other plants are often sparse. The SAFA/DAIN association occurs at the dry margin of high-elevation wetlands and has an understory composed of a variety of dry-site herbs characterized by timber oatgrass. The SASC/PAMY association occurs on the margin of riparian zones, and its species composition (characterized by myrtle pachistima) has much in common with adjacent uplands dominated by conifers (often ABLA2/PAMY).

PHYSICAL SETTING

Elevation—

The SALIX series extends from the lower elevation boundaries of the NFs to above timberline. The relatively low maximum elevation reported for the Colville NF reflects that high-elevation, short willow associations are unusual east of the Okanogan River. Only three short willow stands with elevations ranging from 4,100 to 4,980 feet were sampled in this climatic zone. The high average elevation (5,415 feet) on the Okanogan NF reflects the abundance of short willow associations in the high-elevation mountains of the Pasayten and Chelan-Sawtooth Wilderness Areas. Although the Wenatchee NF had some of the highest elevation willow plots (over 7,300 feet in the Enchantment Basin), plots above 5,000 feet are uncommon, occurring only in the more continental climate mountain ranges such as the Enchantment and Chelan Sawtooth Ranges. Elevations on the Wenatchee NF might have averaged higher except that difficult access resulted in fewer sample plots in higher elevation willow stands in the wilderness areas.

	Elevation (feet)			
Forest	Minimum	Maximum	Average	N
Colville	2,800	4,980	3,664	26
Okanogan	2,350	7,380	5,415	55
Wenatchee	1,840	7,530	3,813	71
Series	1,840	7,530	4,367	152

Additional insight is gained by examining elevations for the individual associations. Most of the short willow group (various SAFA and SACO2 associations) occurred at high elevations, whereas tall willow associations occurred at low to moderate elevations. The notable exceptions are SAFA/CAUT and SAFA/ELPA2-ERPO2, which occurred on bogs and adjacent poor fens at uncharacteristically low elevations.

Plant association	Elevation (feet) Minimum	Maximum	Average	N
SAFA/CANI2	7,350	7,350	7,350	2
SAFA/CASCB-CASP	5,150	7,380	6,740	6
SAFA/DAIN	5,850	6,590	6,220	2
SAFA/CASCP2	4,700	6,150	5,692	14
SACO2/CASCB-CASP	5,000	6,970	5,689	5
SACO2/MESIC FORB	4,600	6,340	5,647	5
SALIX/CASCP2	4,100	6,300	5,069	14
SASC-PAMY	3,280	4,900	4,206	6
SALIX/GLEL	3,470	4,300	4,070	4
SALIX/CACA	2,800	5,360	4,068	7
SALIX/CAUT	2,380	5,500	3,777	26
SAFA/CAUT	2,600	5,600	3,720	10
SALIX/MESIC FORB	1,980	5,280	3,694	16
SAFA/ELPA2-ERPO2	1,940	4,980	3,423	6
SALIX-SPDO	2,960	3,950	3,370	3
SALIX/EQUIS	3,150	3,150	3,150	3
SALIX/ALLUVIAL BAR	1,840	5,075	2,952	16
SALIX/CALA4	2,950	2,950	2,950	2
Series	1,840	7,530	4,367	152

Valley Geomorphology—

Valley geomorphology probably has the most profound effect on distribution of the SALIX series. Only 11 percent (17 of 148) of the ecology plots are located in valleys less than 99 feet wide. Conversely, the frequency of willow-dominated stands increases greatly as valleys and wetlands exceed 99 feet in width. Seventy-four percent of the plots (100 of 148) were sampled in broad or very broad valleys (greater than 330 feet wide). Similarly, the frequency of willow stands decreases dramatically with increasing valley gradient. Only 18 (12 percent) of the willow-dominated plots are found where valley gradients exceeded 5 percent. These critical wide, low-gradient sites include wetlands (including wetlands adjacent to beaver ponds) and riparian zones.

Valley width	Valley gradient Very low	Low	Moderate	Steep	Very steep	N
Very broad	42	10	1	1	0	54
Broad	21	21	3	0	1	46
Moderate	8	11	6	0	6	31
Narrow	1	1	4	3	4	13
Very narrow	0	0	1	0	3	4
Series total	72	43	15	4	14	148

Although willows obviously predominate in broader, very low to low gradient valleys, it is helpful to look at individual plant association distribution by valley width and gradient class. Willow plant associations such as SAFA/CAUT, SAFA/ELPA2-ERPO2, SALIX/CAUT, and SALIX/CACA, with understories dominated by wet site sedges and herbs, are prominent only on wider, lower gradient valleys, and wetlands where conditions are more favorable to the development of wet, imperfectly drained soils. Some willow associations, such as SACO2/MESIC FORB and SALIX/MESIC FORB, are relatively dry compared with others but are temporarily saturated for at least part of the growing season. They still had a strong tendency to occur on wider, gentler valleys. High-elevation associations, such as SAFA/CASCP2 and SALIX/CASCP2, occur on broad to low gradient valleys as well as very low gradient to steep valleys, but the trend is not clear. Late snowmelt and summer rains allow many high-elevation associations to grow on steeper sites that at lower elevations would normally be too dry. Only the SASC-PAMY association has a strong affinity for valleys with steep gradients and narrow widths.

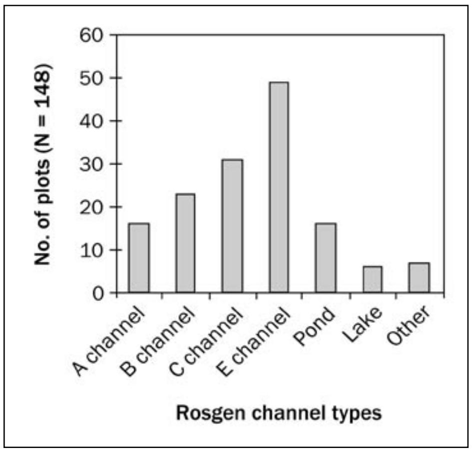
Plant association	Valley gradient Very low	Low	Moderate	Steep	Very steep	N
SACO2/CASCB-CASP	1	2	1	0	1	5
SACO2/MESIC FORB	0	1	1	1	2	5
SAFA/CANI2	0	2	0	0	0	2
SAFA/CASCB-CASP	5	1	0	0	0	6
SAFA/CASCP2	1	9	2	1	1	14
SAFA/CAUT	10	0	0	0	0	10
SAFA/DAIN	0	2	0	0	0	2
SAFA/ELPA2-ERPO2	6	0	0	0	0	6
SALIX/ALLUVIAL BAR	2	9	2	0	3	16
SALIX/CACA	8	0	0	0	0	7
SALIX/CALA4	2	0	0	0	0	2
SALIX/CASCP2	7	3	2	1	1	14
SALIX/CAUT	23	3	0	0	0	26
SALIX/EQUIS	0	3	0	0	0	3
SALIX/GLEL	1	3	0	0	0	4
SALIX/MESIC FORB	3	5	6	0	2	16
SALIX-SPDO	3	0	0	0	0	3
SASC-PAMY	0	0	1	1	4	6
Series total	72	43	15	4	14	147

Plant association	Valley width Very broad	Broad	Moderate	Narrow	Very narrow	N
SACO2/CASCB-CASP	0	4	0	1	0	5
SACO2/MESIC FORB	1	2	0	0	2	5
SAFA/CANI2	0	0	2	0	0	2
SAFA/CASCB-CASP	0	3	3	0	0	6
SAFA/CASCP2	1	6	5	2	0	14
SAFA/CAUT	8	2	0	0	0	10
SAFA/DAIN	0	1	1	0	0	2
SAFA/ELPA2-ERPO2	6	0	0	0	0	6
SALIX/ALLUVIAL BAR	7	4	4	0	1	16
SALIX/CACA	5	0	2	1	0	7
SALIX/CALA4	0	2	0	0	0	2
SALIX/CASCP2	6	3	3	2	0	14
SALIX/CAUT	12	10	4	0	0	26
SALIX/EQUIS	0	3	0	0	0	3
SALIX/GLEL	1	1	1	1	0	4
SALIX/MESIC FORB	5	3	4	4	0	16
SALIX-SPDO	2	1	0	0	0	3
SASC-PAMY	0	1	2	2	1	6
Series total	54	46	31	13	4	147

In summary, the chances of finding willow-dominated stands increases with decreasing valley gradient and increasing valley width because these sites are more likely to be imperfectly drained and thus wetter.

Channel Types—

A variety of Rosgen channel types are associated with the SALIX series. Most plots are associated with Rosgen B, C, and E channels or are located in wetlands adjacent to lakes and ponds. Most broad to very broad, low to very low gradient valleys (sites conducive to low gradient, meandering streams) support Rosgen E and C channel types. A and B channel types are more common in steeper, narrower valleys. D channel types (located in the "other" column) occur in locally degraded C channels or below glaciers. "Other" also includes a few ephemeral streams and springs.

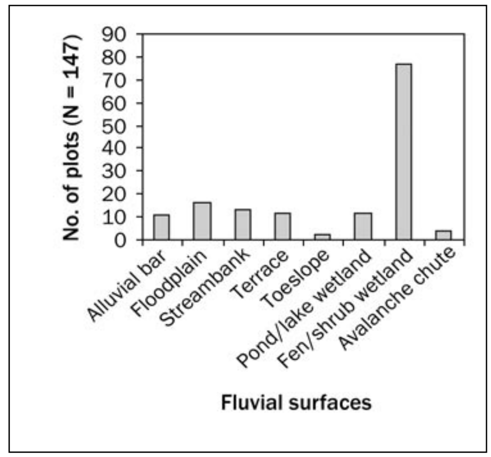


As with valley width and gradient classes, additional insight can be gained by looking at the distribution of channel classes for each plant association. With some exceptions, the first seven associations in the following table largely occur on riparian sites where A, B, and C channels predominate. The next 11 usually are found on riparian wetland and wetland sites where E channels, lakes, and ponds predominate. The major exception is SALIX/CAUT, which is also prominent on riparian wetlands adjacent to C channels.

	Rosgen channel types							
Plant association	A	B	C	E	Pond	Lake	Other	N
SACO2/CASCB-CASP	1	2	0	0	0	1	1	5
SACO2/MESIC FORB	3	1	0	1	0	0	0	5
SALIX/ALLUVIAL BAR	3	3	9	0	0	0	1	16
SALIX/EQUIS	0	0	3	0	0	0	0	3
SALIX/GLEL	0	3	0	0	1	0	0	4
SALIX/MESIC FORB	3	8	4	1	0	0	0	16
SASC-PAMY	5	1	0	0	0	0	0	6
SAFA/CANI2	0	0	0	1	1	0	0	2
SAFA/CASCB-CASP	1	0	1	3	1	0	0	6
SAFA/CASCP2	0	2	0	11	0	0	1	14
SAFA/CAUT	0	0	3	7	0	0	0	10
SAFA/DAIN	0	0	1	1	0	0	0	2
SAFA/ELPA2-ERPO2	0	0	0	4	0	2	0	6
SALIX/CACA	0	0	1	2	3	0	2	8
SALIX/CALA4	0	0	0	2	0	0	0	2
SALIX/CASCP2	0	3	0	7	2	1	1	14
SALIX/CAUT	0	0	8	8	7	2	1	26
SALIX-SPDO	0	0	1	1	1	0	0	3
Series total	16	23	31	49	16	6	7	148

Fluvial Surfaces—

Most people believe that SALIX stands are most often found in riparian zones on point bars, floodplains, and streambanks. They believe that flooding and deposition are required to prepare seedbeds for willow regeneration. The ecology plots indicate this presumption is not always true. In actuality, most willow stands in eastern Washington showed the strongest affinity for fen/shrub wetlands. These data are somewhat misleading, however, as willow wetlands on river terraces as well as those beside beaver dams were often coded as shrub wetlands even though they were technically part of a riparian valley bottom.

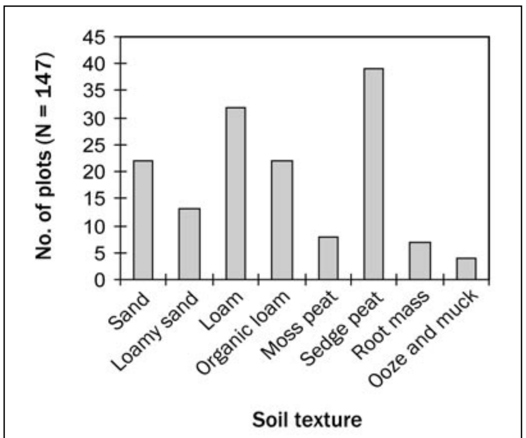


The distribution of the SALIX series by fluvial surface is clearer when looking at individual plant associations that may have strong affinities for riparian versus wetland zones. The first seven plant associations occur largely in riparian zones on alluvial bars (which include point bars), floodplains, streambanks, and subirrigated terraces, whereas the remaining eleven associations are found mostly in riparian wetlands or other wetlands. Only 54 of 147 plots (37 percent) occur on active riparian fluvial surfaces (alluvial bars, floodplains, streambanks, and the immediate adjacent terrace). The plots coded as wet terraces include some wetland sites such as old channel beds and overflow channels. Two plots occur on subirrigated toeslopes. True wetland sites (93 plots, 63 percent) include shrub wetlands and bogs, as well as willow sites associated with riparian wetlands, lakeside wetlands, and beaver activity. Beaver wetlands also are riparian, at least from the standpoint that they occur on valley bottoms with streams. Although not often sampled, willow associations also are found on seeps, springs, and wet portions of avalanche chutes.

Plant association	Riparian fluvial surfaces: Alluvial bar	Flood-plain	Stream-bank	Wet terrace	Toe-slope	N	Wetland fluvial surfaces: Pond/lake wetland	Fen/shrub wetland	Avalanche chute	N
SACO2/MESIC FORB	1	1	2	0	0	4	0	1	0	1
SACO2/CASCB-CASP	0	2	1	0	0	3	1	1	0	2
SALIX/EQUIS	0	3	0	0	0	3	0	0	0	0
SALIX/GLEL	0	1	1	1	0	3	1	0	0	1
SALIX/ALLUVIAL BAR	10	3	3	0	0	16	0	0	0	0
SALIX/MESIC FORB	0	6	3	3	0	12	0	2	2	4
SASC-PAMY	0	0	1	1	2	4	0	0	2	2
SAFA/CANI2	0	0	0	0	0	0	0	2	0	2
SAFA/CASCB-CASP	0	0	0	1	0	1	2	3	0	5
SAFA/CASCP2	0	0	1	1	0	2	0	12	0	12
SAFA/CAUT	0	0	0	0	0	0	0	10	0	10
SAFA/DAIN	0	0	0	1	0	1	0	1	0	1
SAFA/ELPA2-ERPO2	0	0	0	0	0	0	2	4	0	6
SALIX/CACA	0	1	0	0	0	1	1	6	0	7
SALIX/CALA4	0	0	0	0	0	0	0	2	0	2
SALIX/CASCP2	0	0	1	2	0	3	2	9	0	11
SALIX/CAUT	0	0	0	1	0	1	3	22	0	25
SALIX-SPDO	0	0	0	1	0	1	0	2	0	2
Series total	11	16	13	12	2	54	12	77	4	93

Soils—

Soils also are variable. Organic soils are present on 54 percent (80 of 143) of the SALIX series plots. Organic loam and sedge peat are the predominant organic soils (Histisols) and are present on many wetland sites such as shrub fens (carrs) and bogs. Mineral soils are present on 45 percent (67 of 147) of the plots, nearly all of which occur on riparian zone fluvial surfaces (point bars, floodplains, streambanks, and terraces). In addition, soil conditions may influence the presence of particular willow species. For example, hoary and McCalla's willows apparently occur only on calcareous soils, whereas whiplash, dusky, Mackenzie's and coyote willow usually occurred on mineral soils (and thus are riparian zone willows).



Many SALIX series associations show preference toward either mineral or organic soils. The first seven associations shown in the following table usually are found in riparian zones. Ninety percent (47 of 53) of their plots have mineral soil. None of these riparian zone willow associations had a preponderance of organic soil. The two organic loam soils associated with the SASC-PAMY association may be an error on the part of the field crew (probably deep humus). The last 11 associations usually occur on wetland sites. Seventy-eight percent (74 of 94) of the plots have organic soil. Of these 11 associations, only the SACO2/CASCB-CASP and SAFA/DAIN associations have more plots with mineral than with organic soils. The SAFA/DAIN association occurs at the transitional margin of wetlands, mostly on mineral soil. The SACO2/CASCB-CASP association usually occurs within fluvially active riparian wetlands, on predominantly freshly deposited (mineral) alluvium.

Plant association	Soil texture: Sand	Loamy sand	Loam	Organic loam	Moss peat	Sedge peat	Root mass	Ooze/muck	N
SACO2/MESIC FORB	0	0	4	0	0	1	0	0	5
SALIX/ALLUV. BAR	13	1	2	0	0	0	0	0	16
SALIX/EQUIS	0	1	2	0	0	0	0	0	3
SALIX/GLEL	1	0	2	0	0	0	0	1	4
SALIX/MESIC FORB	4	3	8	0	0	0	0	1	16
SALIX-SPDO	0	0	2	1	0	0	0	0	3
SASC-PAMY	1	1	2	2	0	0	0	0	6
SACO2/CASCB-CASP	1	0	2	1	0	0	0	0	4
SAFA/CANI2	0	0	1	1	0	0	0	0	2
SAFA/CASCB-CASP	1	1	0	2	1	0	0	1	6
SAFA/CASCP2	0	2	2	5	3	2	0	0	14
SAFA/CAUT	0	0	0	0	2	8	0	0	10
SAFA/DAIN	0	1	1	0	0	0	0	0	2
SAFA/ELPA2-ERPO2	0	0	0	0	2	3	1	0	6
SALIX/CACA	1	0	1	4	0	1	0	1	8
SALIX/CALA4	0	0	0	0	0	0	2	0	2
SALIX/CASCP2	0	1	1	1	0	10	1	0	14
SALIX/CAUT	0	2	2	5	0	14	3	0	26
Series total	22	13	32	22	8	39	7	4	147

Water tables were accessible on 104 plots and varied by association. The first five associations listed in the following table were the wettest, based on water tables. The SAFA/ELPA2-ERPO2 association is a bog site that is wetter than the average indicates. This association has deep moss-peat soils that act like a sponge, wicking water from the water table to the soil surface most of the year. The higher water tables listed in the table correspond with species and associations that are obligate to organic, wetland soils. The -16-inch average found on the SACO2/CASCB-CASP association is probably an artifact of low sample size and time of year. The -13-inch average associated with SALIX/ALLUVIAL BAR is an artifact of the sample season as these sites are flooded during spring runoff (before the sample season). The SALIX/MESIC FORB and SACO2/MESIC FORB associations are similar as they may be flooded during normal to above normal peak streamflow events. The SALIX-SPDO association appears to be the driest association, although two measurements make this conclusion weak. The water table was so deep it could not be reached on SASC-PAMY, the driest association.

	Water table (inches)			
Plant association	Minimum	Maximum	Average	N
SALIX/CALA4	-1	0	0	2
SALIX/CASCP2	-24	2	-4	13
SAFA/CAUT	-12	0	-6	10
SAFA/CASCP2	-18	0	-6	14
SALIX/CAUT	-28	3	-7	23
SAFA/ELPA2-ERPO2	-20	0	-8	6
SALIX/EQUIS	-10	-8	-9	3
SALIX/GLEL	-24	-1	-9	3
SAFA/CASCB-CASP	-39	-1	-12	6
SALIX/ALLUVIAL BAR	-33	7	-13	5
SALIX/CACA	-35	-1	-13	7
SACO2/CASCB-CASP	-18	-14	-16	2
SACO2/MESIC FORB	-31	-1	-16	4
SALIX/MESIC FORB	-31	-1	-16	4
SAFA/DAIN	-20	-14	-17	2
SALIX-SPDO	-39	-20	-30	2
Series	-39	7	-8	104

The amount of soil surface flooded at the time of sampling is also an indicator of the relative wetness of the various plant associations. This information corresponds fairly well with the water table rankings displayed above and together they indicate general trends. The first six associations appear to be the wettest sites based on the amount of surface flooding, which is somewhat different than associations based on water tables. Based on data in both tables, SAFA/CAUT, SAFA/CASCP2, SAFA/ELPA2-ERPO2, SAFA/CASCB-CASP, SALIX/CASCP2, and SALIX/CALA4 appear to have the wettest sites.

	Submerged (percent)			
Plant association	Minimum	Maximum	Average	N
SALIX/CALA4	5	50	28	2
SALIX/CAUT	0	60	20	26
SALIX/CASCP2	0	65	19	14
SAFA/CASCB-CASP	0	30	12	6
SAFA/CAUT	0	60	11	10
SAFA/CASCP2	0	35	10	14
SALIX/ALLUVIAL BAR	0	95	6	16
SALIX/CACA	0	35	5	8
SAFA/ELPA2-ERPO2	0	20	4	6
SACO2/CASCB-CASP	0	10	3	5
SALIX/GLEL	0	10	3	4
SACO2/MESIC FORB	0	10	2	5
SAFA/CANI2	0	5	2	2
SALIX/MESIC FORB	0	0	0	16
SAFA/DAIN	0	0	0	2
SASC-PAMY	0	0	0	6
SALIX/EQUIS	0	0	0	3
SALIX-SPDO	0	0	0	3
Series	0	95	9	146

There is also a wide range in soil temperatures within the first 5 inches of the soil profile. The SACO2/MESIC FORB, SALIX/ALLUVIAL BAR, and SALIX/MESIC FORB associations generally have open stands of willows that allow sunlight to directly strike the mineral soil, thus warming the first few inches. The SALIX/CALA4, SALIX/EQUIS, and SAFA/ELPA2-ERPO2 associations have warm soils on account of the flat terrain and open willow canopies that allow solar insulation to warm the exposed, wet (often shallowly flooded) substrates. Other soils are generally cooler owing to either site or dense willow canopy cover. As with water table and flooding information, the data need to be used with caution owing to low plot numbers in many of the plant associations.

	Soil temperature (°F)			
Plant association	Minimum	Maximum	Average	N
SALIX/EQUIS	64	72	66	3
SALIX/ALLUVIAL BAR	47	77	58	12
SALIX/CALA4	57	59	58	2
SAFA/ELPA2-ERPO2	53	65	57	6
SACO2/MESIC FORB	43	66	54	5
SAFA/CANI2	52	52	52	2
SACO2/CASCB-CASP	46	55	51	3
SAFA/CAUT	47	56	51	9
SAFA/DAIN	50	52	51	2
SALIX/MESIC FORB	38	62	51	15
SALIX-SPDO	47	54	50	3
SAFA/CASCP2	44	59	49	14
SALIX/CASCP2	44	56	49	14
SALIX/CAUT	42	62	49	25
SASC-PAMY	46	55	49	6
SAFA/CASCB-CASP	45	57	48	5
SALIX/CACA	42	53	47	7
SALIX/GLEL	40	50	45	4
Series	38	77	51	140

ECOSYSTEM MANAGEMENT

Natural Regeneration of Willows—

Colonization by willows is aided by the production of abundant, lightweight, wind- and water-disseminated seeds (Kovalchik 1992a). The vigor of dispersed seeds declines rapidly, and abnormal seedlings may be produced after just a few days. Therefore, the timing of seed dispersal and exposure to moist seedbeds is critical. On wet mineral seedbeds, willow seeds are fully saturated with water within a few hours and germinate in less than 24 hours. Root elongation initially is rapid, ranging from 0.4 to 0.6 inch in just the first 48 hours. However, the soil must remain moist for at least several weeks to promote good root establishment. Total root elongation during the first growing season averages only 6 inches; therefore, it is important that the soil remains moist in the lower rooting zone through the first growing season to ensure seedling survival into the second growing season.

The majority of willow seedlings do not survive through their first year. Factors that may contribute to low survival rate for willow seedlings include summer drought, summer floods, winter scouring, ice flows, herbaceous competition, shade from other shrubs or trees, and browsing by ungulates, hares, rodents, or beaver. In the second growing season, willow seedlings develop longer, well-established root systems that often remain in contact with a permanent water supply.

Traditional thinking is that willows depend on floods and mineral seedbeds for successful establishment. Although this is generally true for willows found in riparian zones, other willows successfully regenerate in wetlands from seed falling on organic soils (Kovalchik 1992a). For instance, domestic or wild ungulates sometimes expose bare organic soil through trampling, thus providing a seedbed and reducing competing vegetation long enough to establish willow seedlings. Wildfire may function similarly, producing new willow stands on exposed mineral and organic soils as well as temporarily reducing shrub and herbaceous competition.

Natural vegetative propagation is as important as establishment from seed. All eastern Washington willow species (except Scouler's willow, which produces roots only at the cut surface) appear to be able to propagate vegetatively through the rooting of broken stem and root pieces that are partially buried by flood deposition or beaver activity. Willows also root vegetatively by layering when their branches or stems are forced into contact with moist ground (organic or mineral soil) by snow loading. Vegetative propagation is from preformed root primordia along the stem that initiate growth after being buried in the ground. The majority of eastern Washington willows root readily, but there is a range from poor to good (table 13). In addition, two species (coyote and dusky willow) reproduce by sprouting from underground runners, thus forming dense thickets of clones (much like quaking aspen).

Artificial Establishment of Willows—

On account of willow stem root primordia, freshly cut willow stems can be used as planting stock (table 13). Again, it is critical to determine that natural and human-induced conditions on possible sites are favorable for establishment and survival. Managers planning to regenerate willows should consult a wetland and riparian classification to determine if willows are natural to the site, as well as which species are appropriate to plant. Site evaluation also may indicate which sites will probably regenerate naturally. Many managers have planted willow cuttings only to find that natural regeneration from seed, broken twigs, or release of existing willows occurred after eliminating or improving an improper grazing system. In addition, some degraded willow sites may no longer be able to support willows at all on account of altered soil; these soil conditions include a lowered water table as a result of streambed cutting.

Several causative factors (limiting factors) may be responsible for the degraded condition of a riparian zone; although many factors may contribute, at any one time, only one factor may dominate the recovery of riparian processes. Removal of the dominant limiting factor will result in an upward trend in vegetation and soil condition until the next limiting factor becomes dominant. In a degraded riparian or wetland zone, willow establishment will fail unless the site is sufficiently restored to support it. Often it is better to establish graminoids such as sedges first, and then wait for natural events to establish the willows.

Appropriate willow species should be selected for each site by using a riparian and wetland classification or by gathering willow cuttings from similar sites as near to the project area as possible (Kovalchik 1992a). Scouler's willow does not have root primordia along its stems, which makes it difficult to root except in commercial nurseries. Recommendations on the size of willow cuttings are summarized by three general methods:

1. Short pegs 12 to 20 inches in length can be planted on ideal sites that still retain their original, shallow water table.
2. Long poles 10 to 20 feet in length can be planted on more xeric sites or sites with water tables lowered by gully cutting.
3. Willow bundles made by binding together several stems can be buried horizontally in moist soil.

Older willow cuttings may not root as well as 2- or 3-year-old material cut from near the tip of the stem. Cuttings should be harvested when the willows are dormant (fall to early spring). They should be kept moist and stored at temperatures slightly above freezing. The top of cuttings should be marked so they can be planted top up. Cuttings can be planted in spring or fall, but results usually are better in

Table 13—Common native willows recommended for planting on disturbed riparian and wetland sites in eastern Washington (after Platts et al. 1987)

Species	Elevation	Habitat	Origin of roots	Number of roots	Days required for formation of: Roots	Shoots	Comments
Salix bebbiana Bebb's willow	Moderate elevation	Mostly wetlands, moist to wet soils	Callus and upper third of the stem	Moderate	10	10 to 20	Erratic rooting
Salix boothii Booth's willow	Moderate-low elevation to subalpine	Floodplains, basins moist to wet soils	Entire stem, mostly lower third	Abundant	10 to 15	10 to 15	Roots freely
Salix commutata Undergreen willow	Moderate-high elevation to subalpine	Riparian and wetland, mineral and organic soil	Roots through the length of the stem	Abundant	10	10	Roots freely
Salix drummondiana Drummond's willow	Moderate elevation	Riparian and wetland, moist to wet soil	Roots through the length of the stem	Abundant	10	10	Roots freely
Salix exigua Coyote willow	Low to moderate-low elevation	Mostly riparian, well-drained soils	Roots through the length of the stem	Moderate	10 to 15	10	Roots freely, runners
Salix farriae Farr's willow	Moderate-high elevation to subalpine	Bogs and basins organic soils, peat	Roots through the length of the stem	Abundant	10	10	Roots freely
Salix geyeriana Geyer's willow	Moderate-low to moderate elevation	Floodplains and basins moist to wet soils	Roots through the length of the stem	Moderate	10	10 to 15	Roots freely
Salix lasiandra Pacific and whiplash	Low to moderate elevation	Mostly riparian, well-drained soils	Roots through the length of the stem	Abundant	10	10 to 15	Roots freely
Salix lemmonii Lemmon's willow	Low to moderate-high elevation	Floodplains and basins moist to wet soils	Roots through the length of the stem	Moderate	10	10 to 15	Roots freely
Salix melanopsis Dusky willow	Low to moderate-low elevation	Mostly uplands, well-drained soils	Roots through the length of the stem	Moderate	10 to 15	10	Roots freely, runners
Salix planifolia monica Tea-leaved willow	Moderate-high elevation to subalpine	Bogs and basins organic soils, peat	Roots through the length of the stem	Abundant	10	10	Roots freely
Salix rigida mackenzieanna Mackenzie's willow	Low to moderate elevation	Mostly riparian, well-drained soils	Entire stem, mostly lower third	Moderate	10	10	Roots freely
Salix scouleriana Scouler's willow	Moderate elevation	Mostly uplands, well-drained soils	Callus cut only	Low	10 to 15	10 to 15	Poor success
Salix sitchensis Sitka willow	Moderate to moderate-high elevation	Streambanks and basins mineral and organic soil	Roots through the length of the stem	Abundant	10	10	Roots freely

spring. They should be planted when the buds are dormant and planted deep to attain high root-to-shoot ratio that will prevent water stress. To avoid their drying out, make sure their bases contact the late summer water table. Willow cuttings need at least 3 years without browsing to become vigorously established. (For more information on the short- and long-term revegetation potential of selected riparian wetland plant species, see app. B-5.)

Stand Management—

Scattered trees, especially Engelmann spruce and lodgepole pine, may occur on microsites within SALIX plant associations. These trees (and down woody debris and snags) provide for added structural diversity, future use by cavity nesters, and as a future supply of down woody debris. Managers may consider establishing conifers on appropriate microsites within SALIX series sites.

All observed willow stands were in fair or better ecological condition so that little is known about retrogression or successional pathways. The wet nature of most of the sites makes them highly susceptible to damage by livestock and heavy machinery (Hansen et al. 1995). These disturbances often lead to soil compaction, streambank sloughing, damage to vegetation, and premature drying of the soil surface. Hansen et al. (1995) stated that woody vegetation provides the greatest amount of soil surface protection, whereas herbaceous species rarely afford sufficient streambank protection. However, this interpretation of the role of willows is overstated (Kovalchik and Elmore 1991). Graminoids, especially sedges and sedgelike herbs, play an equal if not greater role in protecting streambanks and other active fluvial surface from erosion. Where SALIX stands still have moderate covers of willows, but the graminoid understory has been largely converted to forbs and increaser grasses, willows may not be able to hold streambanks during above-average floods, and bank erosion may be significant. Many wetlands are too wet to support willows, and, in these areas, sedges and sedgelike plants are adequate to protect associated Rosgen E and C channels. However, willows and sedges growing together protect streambanks better than either one alone. Managers often focus on willow regeneration (cuttings and plantings), which often fail, when trying to rehabilitate highly disturbed riparian areas. If they were to focus rehabilitation efforts on herbaceous recovery (especially sedges and their relatives) and then allow willows to regenerate naturally, they likely would have greater success.

Growth and Yield—

Because willows were rarely destructively sampled during this study, the following is generalized from other studies (Kovalchik 1992a). In general, short willows such as Farr and tea-leaved willow occur at high elevation or in bogs and grow to maximum heights of about 1 to less than 5 feet, with basal stem diameters less than one-half inch. Individual stem ages are not likely to exceed 10 years on account of attacks by insects or disease. Dead stems resprout from adventitious buds near the base of the stem.

Tall, rounded, many-stemmed willows such as Drummond's, Sitka, and Geyer's willows grow on well-drained peat or moist, well-aerated mineral soil and attain maximum heights of 10 to 20 feet with maximum basal stem diameters of usually 1 to 2 inches. They average less than 1.5 feet annual height growth in most natural stands. Individual stems may attain 20 years in age, eventually dying back on account of attacks by insects and diseases. Height and age growth for the common willows in eastern Washington are unknown but may be comparable to data reported for central Oregon willows (Kovalchik 1991a; fig. 24). Short willows will have height growth similar to Eastwood's willow and most tall willows have growths similar to Booth's and Lemmon's willows.

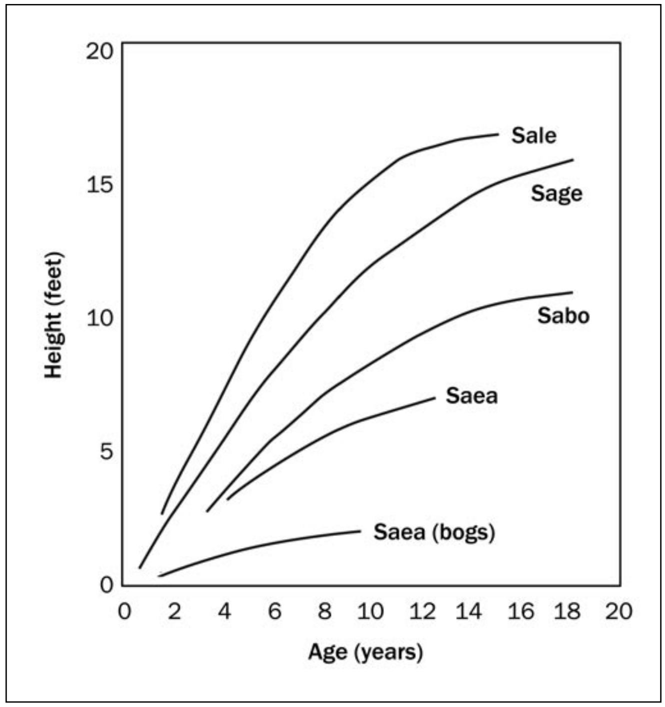


Figure 24—Height/age comparisons for some important willows in central Oregon (Kovalchik 1991a).

Total shrub biomass in eastern Washington may be similar to that reported for Alaska and Minnesota (Connolly-McCarthy and Grigal 1985, Reader and Stewart 1972). If so, willow stands may accumulate a total of 5,000 to 10,000 pounds dry weight per acre for short willows on bogs and 10,000 to 30,000 pounds per acre for tall, vigorous willows on well-drained peat and mineral soils. The general distribution of aboveground biomass should approximate 25 to 30 percent in leaves and 70 to 75 percent in the stems on tall willow sites (fig. 25).

Figure 25—Biomass distribution on shrubby willows (Kovalchik 1991b).

Roots should make up about 30 percent of the total shrub biomass on tall willow sites and 75 percent on short willow sites.

Eastern Washington plots were not clipped for herbage production estimates. Crowe and Clausnitzer (1997) reported the following estimates of air-dry herbage production for clipped northeastern Oregon willow stands (pounds per acre dry weight): (1) a range of 1,059 to 3,400 (average 2,069) for SALIX/CAUT stands and (2) a range of 938 to 3,223 (average 1,712) for SALIX/CAAQ stands. Eastern Washington averages are probably similar for comparable associations. However, herbage production is often much lower under dense willow thickets.

Down Wood—

The overall amount of down wood is low compared with that of the forest series (app. C-3). Logs cover less than 3 percent of the ground surface. This reflects wet sites where trees grow only on dry microsites such as hummocks (if at all). Most logs fall onto SALIX series sites from adjacent, forested fluvial surfaces or are transported to the site by floodwaters.

Log condition	Tons/ acre	Cu. ft./ acre	Linear ft./ acre	Sq. ft./ acre	% ground cover
	Down log attributes				
Class 1	0.06	4	9	7	0
Class 2	.94	218	155	184	.4
Class 3	4.11	595	456	472	1.1
Class 4	.94	301	219	248	.6
Class 5	.08	26	67	45	.1
Total	6.13	1,144	906	956	2.2

Fire—

All species of willows are well adapted to fire. When a light to moderate fire kills aboveground parts, willows resprout from roots, root crowns, or basal stems (Kovalchik 1992a). More sprouts occur after quick, hot fires than after slow fires (Hansen et al. 1995). Fires that burn the upper layers of soil can destroy or expose roots and root crowns and kill the plants. This is especially true of deep, lingering peat fires. Light and moderate fires will reduce the cover of willow stems, followed by a temporary increase in the cover and biomass of the herbaceous layer and then rapid regrowth of the willows. Exclusion of livestock may be needed to increase herb biomass (fuel) prior to the year of burning. After burning, a site should remain free of livestock grazing for 2 or 3 years to avoid livestock damage to young, palatable willow stems and regenerating herbs. Extra care should be taken when burning willow-dominated streambanks because of the excellent erosion protection provided by willows, sedges, and other herbaceous plants. Temporary removal of the aboveground biomass risks accelerated streambank erosion. All the willow species produce abundant seeds that germinate on exposed mineral or organic soil following fire.

Animals—

Browsing. Most willows appear to be at least moderately palatable to livestock and wild ungulates (app. B-5, potential biomass production). For example, Geyer's and Bebb's willows are more palatable to livestock than Booth's willow, but the latter is still highly palatable to deer, elk, and beaver (Crowe and Clausnitzer 1997, Kovalchik 1987). Willows lose vigor and density with heavy browsing. Older age classes become dominant, and plants begin to show high-lining, dead stems, or severe hedging. Heavy browsing for consecutive years will eventually kill individual shrubs and result in open stands (fair ecological condition). Continuous heavy overuse eventually eliminates entire stands of willows (poor ecological condition). Excessive browsing of willows in winter can reduce seed production by removing flower buds developed in fall and by stimulating the plant to vigorous vegetative growth instead of reproductive growth. Decadent willow stands need at least 5 to 6 years rest from browsing to reestablish or recover their vigor. Recovery takes even longer on severely compacted soils.

Livestock. Forage value of willow stands varies by plant association, season of use, soil wetness, previous grazing use, condition of upland forage, and the extent of the site (Hansen et al. 1995). Estimated herbage production is generally moderate to high for open willow stands, although dense willow stands and willow stands on point bars or alluvial bars may support little herbaceous growth. Short growing seasons and saturated soils associated with many willow associations may limit livestock use until August or September. The palatability of the herbs dominating the undergrowth of willow stands is variable but, in general, is moderate to high for many species during at least part of the growing season. Sedge palatability and protein content is especially high in fall (August and September) compared with forage in the adjacent uplands (Kovalchik and Elmore 1991).

Improper cattle grazing systems have severely affected the stability of willow-dominated riparian and wetland zones throughout the West (Kovalchik and Elmore 1991). Fortunately, most willow stands in eastern Washington NFs are still in fair or better ecological condition, primarily owing to wet soils and a favorable climate. However, willow stands have been almost totally eliminated on agricultural lands in the Columbia basin. (For more information on forage palatability of key species, see app. B-1. For potential biomass production, see app. B-5.)

There is considerable variation in the effects of common grazing systems on the stability of willow stands (Kovalchik and Elmore 1991). In general, grazing systems that encourage late-season grazing of willow stands are potentially incompatible with willow management. Late-season use often results in a switch from grazing to browsing, which happens when herb stubble heights decrease below 4 inches. Willows then become vulnerable to late-season pruning damage, which results in little regrowth before the end of the growing season. For a grazing system to be successful, it must meet the basic biological requirements of the plants, such as photosynthesis, food storage, reproduction, and seedling establishment. To meet these requirements, willows need long periods of rest. The impact of late-season grazing is probably greater for plant associations dominated by short willows compared with tall willows, as the entire plant is vulnerable to browsing. Under this scenario, grazing systems can be ranked by their suitability for willow stands (table 14) (Kovalchik and Elmore 1991):

- Highly compatible systems—holding pasture, corridor fencing, riparian pasture, and early season (spring).
- Moderately compatible systems—winter, three-pasture rest rotation, and three-pasture deferred rotation.
- Incompatible systems—two-pasture rotation, fall, deferred, late season, and season long.

Table 14—Value ratings for livestock grazing on willow stands (Kovalchik and Elmore 1991)

Grazing system	Willow trend	Sedge trend	Remarks
Early season	Good	Good	Livestock are attracted to palatable, available upland forage while they avoid the wet riparian/wetland soils and immature riparian vegetation. Light willow use and good sedge regrowth through the summer provides for good channel morphology and streambank protection.
Season long	Poor	Poor	Livestock begin to congregate in the riparian zone by midsummer. As the herbaceous forage is depleted, livestock use switches to browsing of willows, and the sedges never have a chance for regrowth. This ultimately results in poor channel morphology and streambank protection.
Late season	Poor	Fair	Livestock tend to congregate in the riparian/wetland zone in late summer. As soon as the herb forage is depleted, use switches to browsing of willows. Grazing of sedges is acceptable if site is in good condition. If not, this system results in poor channel morphology and streambank protection.
Winter	Poor	Good	Livestock are grazing dormant herbaceous forage on frozen ground. Use of willow stems and buds may be high. Livestock also browse any young willows, and regeneration of willow seedlings is difficult. This system results in fair or better channel morphology and streambank stability (sedges).
Holding pasture	Good	Good	System is effective with strict forage utilization and stocking control. The sedges regrow after spring grazing, with abundant late-season forage. Willow growth is good if the livestock are removed before the switch from grazing to browsing. Good channel morphology and streambank stability.
Deferred	Poor	Fair	System is effective for sedges in dormant condition on good-condition sites. Willow use becomes heavy as the use switches from grazing to browsing. Fair channel morphology and streambank stability on fair-to-good-condition sites but poor on poor-condition sites where sedges have been eliminated.
Rotation	Poor to fair	Fair	The high intensity of grazing associated with this system may counteract any expected benefits. Willow vigor often decreases because of 2 or 3 years of heavy grazing. Channel morphology is good and streambanks are stable if sites are in good condition but degrades on sites in poor or fair condition.
Rest rotation	Fair	Fair	This high-intensity grazing may counteract benefits of rest. Heavily used willows will require 2 or more years of rest to maintain their vigor or regenerate. This system should provide a sedge mat on streambanks in most years, thus providing for fair channel morphology and streambank stability.
Corridor fencing	Good	Good	This system is expensive but provides rapid permanent recovery of riparian/wetland zones. Willow recovery is rapid if protected from wild ungulates. Rapid recovery of channel morphology and streambank stability.
Riparian pasture	Good	Good	This system provides control of livestock distribution, intensity, and timing. Willows are protected by removing livestock before they switch from grazing to browsing. Good channel morphology and streambank stability.

Wildlife. Tall willow stands such as SALIX/CAUT provide excellent cover and foraging habitat for mule deer, white-tailed deer, elk, and moose (Crowe and Clausnitzer 1997, Hansen et al. 1995, Kovalchik 1987). Stands of shorter willows such as SAFA/CAUT may not provide good cover for these ungulates, but still may provide an abundance of palatable herbage. No matter their height, willow stands provide excellent cover and forage for a variety of small mammals. Snowshoe hares feed heavily on willows in some areas (Platts et al. 1987). Small mammals eat willow shoots, buds, leaves, and catkins. Willows provide good nesting, foraging, and cover for small mammals. Bog lemmings have been trapped in willow stands on the Colville NF. All the willow species are preferred food and building material for beavers. Beaver perform a vital role in the health and maintenance of riparian ecosystems (Hansen et al. 1995). Beaver dams assist in controlling the downcutting of channels, bank cutting, and the movement of sediments downstream (Gordon et al. 1992). Beaver dams raise the water table in the surrounding area, which provides water for hydrophytic plants such as willows and sedges. In addition, this water is then slowly released from storage during the dry summer. Dams also slow down water velocity in the channel, which allows suspended sediments to be deposited behind the dam. When coupled with plant production, this creates wetland environments that are excellent for waterfowl and fish. Therefore, any removal of beaver from wetland habitat should be closely evaluated. For stands that show long periods of coexistence between beaver and their forage, maintenance of current beaver populations is critical to ecosystem health. Beaver also should be considered for reintroduction into suitable habitat. Grouse, ducks, pine siskins, chickadees, kinglets, and other birds eat willow buds, catkins, leaves, and seeds (Crowe and Clausnitzer 1997). (For more information on thermal or feeding cover values, see apps. B-2 and B-3. For information on food values or degree of use, see apps. B-2 and B-4.)

Fish. Willows and their associated herb understory (especially species such as bladder, water, Holm's, and saw-leaved sedge) form a thick sod that is highly resistant to erosion and thus critical to streambank stabilization and stream channel maintenance (Crowe and Clausnitzer 1997, Hansen et al. 1995, Kovalchik 1987). The dense network of roots is very effective in stabilizing streambanks and creating deep, narrow channels. (For more information, see app. B-5, erosion control potential.) Immediately next to a stream the graminoid sod may be undercut and even sag into the water to provide excellent cover for fish. The various species of willow provide excellent overhanging cover and shade for the stream channel. Further, the willow stems and herb understory help filter out sediments during high flows and thereby contribute to the overall building of streambanks and adjacent terraces. Willows and their associated herbs provide critical substrates for insects, with subsequent effects as fish and aquatic insect food. Nutrients derived from fallen, decomposing leaves are important in maintaining a healthy stream ecosystem. Where sites have been highly altered, management alternatives include restoring willows and sedges for their excellent streambank stability values: planting and seeding bare streambanks and eliminating the factor that caused the willows and sedges to decline.

Recreation—

SALIX associations provide excellent opportunities for viewing moose, and to a lesser extent elk, deer, songbirds, and waterfowl (Crowe and Clausnitzer 1997, Hansen et al. 1995, Kovalchik 1987). Willow stands provide access points for fishing. Some stands are so dense they discourage or hinder most forms of recreational use. Where they are open, heavy human use in spring and summer can result in damaged soils, bank sloughing, and exposed soils along streambanks. On account of their wet soils and seasonal flooding, willow sites are unsuitable for the development of campsites, trails, and roads.

Insects and Disease—

There are no known studies of willow insects or disease in the Pacific Northwest. The following summary reflects probable insect pests of willows in the Northwest (Kovalchik 1990):

1. Defoliating insects include grasshoppers, spanworms, the larvae of moths and butterflies, as well as the larvae and adults of beetles. Defoliation of plants reduces their photosynthetic capacity. However, the effect of normal infestations on willow growth may be negligible. Severe infestations may limit growth. The key factor in defoliation is the timing of the attack. Defoliation in the spring reduces the growth of summerwood, whereas late summer defoliation causes little loss in growth. In addition, defoliation during late summer may occur after carbohydrate reserves are replenished, and the willows will maintain plant vigor for the next season's growth.
2. Mining insects include a diverse group of insects such as flea beetles, leaf miners, and casebearers. The tiny larvae of these insects live in the leaf epidermis, causing irregular blotches and tunnels as they consume the leaf tissue. Damage is generally minor.
3. Wood and stem borers cause damage by slowing growth or killing portions of the willow. Attacks often stimulate the growth of lateral branches, thus compensating for the destruction of shoots. However, larvae tunnels usually weaken willow stems so wind or snow may break them, and they provide entry for secondary pests such as fungus and bacteria. Birds also may cause more damage by digging larvae out of the wood.
4. Leaf and stem galling insects cause immature leaf and stem tissues (that would normally develop into normal leaves and wood) to form atypical structures that provide the insect larvae with food and shelter at the expense of the plant. Damage from leaf galling insects is minimal. However, attacks by stem galling insects may result in the direct death of the stem or loss of growth. Damage also occurs when wind or snow breaks weakened stems. Stem galling may encourage the development of lateral shoots, thus compensating for the destruction of stems and branches.
5. Sap-sucking insects include psyllids, aphids, scale insects, and mites. Sap-sucking reduces the carbohydrate reserves of the willow. Injury is usually minor, although certain insects may cause partial or entire plant death in severe outbreaks. Many sap-sucking insects are vectors for the introduction of secondary pests such as rust.

Estimating Vegetation Potential on Disturbed Sites—

Estimating vegetation potential on disturbed sites is not usually necessary because livestock and people avoid these sites owing to their wet, mucky soils. Most willow stands on NFs in eastern Washington appear to be, and all sampled stands were, in fair to good ecological condition; study of disturbed stands is needed. Where stands have been degraded, a riparian and wetland classification, personal experience, or similar sites in adjacent drainages should be used to determine the vegetation potential.

Sensitive Species—

Thirty sensitive plant species are found on SALIX series sites. Only the MEADOW series (61 sensitive species) has more sensitive plants than the SALIX series. The SALIX/CALA4 association has the highest number (nine). Sensitive plants also are common in the SAFA/CASCP2, SAFA/CAUT, SALIX/CAUT, and SALIX/MESIC FORB associations. None of these plants occur in enough numbers in the SALIX series to justify their removal from the USDA FS

Pacific Northwest Region sensitive plants list. However, russet sedge and green-keeled cotton-grass have been recommended for removal from sensitive listing in the MEADOW series. (For more information, see app. D.)

Plant association	Sensitive species															
	pale agoseris	arctic aster	Crawford's sedge	yellow sedge	inland sedge	russet sedge	crested shield fern	green-keeled cotton-grass	water avens	hoary willow	glaucous willow	McCalla's willow	bog willow	false mountain willow	black snake-root	N
SAFA/CASA2	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1
SAFA/CASCB-CASP	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	2
SAFA/CASCP2	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3
SAFA/CAUT	0	0	0	0	0	0	0	1	0	0	0	0	0	3	0	4
SAFA/DAIN	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
SAFA/ELPA2-ERPO2	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1
SALIX/CACA	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1
SALIX/CADI2	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1
SALIX/CALA4	0	0	0	1	2	0	0	1	2	2	0	0	0	0	1	9
SALIX/CASCP2	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1
SALIX/CAUT	0	0	0	0	0	0	1	0	0	0	0	1	1	0	0	3
SALIX/MESIC FORB	0	0	0	0	0	0	0	0	0	1	0	0	0	0	2	3
Series total	4	1	1	1	2	1	1	4	2	3	1	1	2	3	3	30

ADJACENT SERIES

Owing to the complexity of the SALIX series (i.e., many different willow species and willow plant associations that are found from above upper timberline to below lower timberline), willow stands may be found adjacent to all series listed in this and other riparian and wetland classifications. Furthermore, every series listed in forest upland classifications (Lillybridge et al. 1995, Williams et al. 1995) can be found on uplands adjacent to willow sites.

RELATIONSHIPS TO OTHER CLASSIFICATIONS

Kovalchik (1992c) describes many of the plant associations in the SALIX series in the draft classification for northeast Washington. Plant associations belonging to the SALIX series are described in eastern Washington by Crawford (2003); the Mount Hood and Gifford Pinchot NFs (Diaz and Mellen 1996); central and northeastern Oregon (Crowe and Clausnitzer 1997, Kovalchik 1987); Idaho, Utah, and Nevada (Manning and Padgett 1995, Padgett et al. 1989, Youngblood et al. 1985a, Youngblood et al. 1985b); and Montana (Hansen et al. 1988, 1995).

U.S. DEPARTMENT OF THE INTERIOR, FISH AND WILDLIFE SERVICE WETLANDS CLASSIFICATION

System:	palustrine
Class:	scrub-shrub
Subclass:	broad-leaved deciduous
Water regime:	(nontidal) saturated to seasonally flooded

KEY TO THE WILLOW (*SALIX*) PLANT ASSOCIATIONS

Use of Willows in the Classification—

Owing to the complexity of willow distribution, the number of willow species, and the difficulty of keying willow species for most laypeople, this classification makes it easy for the users to key individual plant associations. In most cases, the user simply needs to recognize that the dominant willows are taller or shorter than 5 feet tall (i.e., tall versus short willows). This also greatly minimizes the number of potential willow plant associations compared to a classification with willow associations identified by the particular willow species dominating the shrub stand (such as Hansen et al. 1995). Instead of having a multitude of associations that share a common understory layer (SABE/CAUT, SABO/CAUT, SAGE/CAUT, SADR/CAUT, and SASI2/CAUT are all possible willow communities with bladder sedge understory), all possible permutations are replaced by a single plant association (in this case, SALIX/CAUT). The user only needs to be able to identify undergreen willow to key the SACO2 plant associations. For those interested in identifying the various species of willows, a taxonomic comparisons table is found in appendix F.

Potential natural vegetation dominated by tall willows or bog birch (generally 5 or more feet tall):

1. Undergreen willow (*Salix commutata*) (usually less than 5 feet tall) ≥25 percent canopy coverage **3**
2. Undergreen willow (*Salix commutata*) absent or <25 percent canopy coverage, other willows dominant **5**
3. Showy sedge (*Carex spectabilis*), Holm's sedge (*C. scopulorum* var. *bracteosa*) and/or saw-leaved sedge (*C. scopulorum* var. *prionophylla*) ≥25 percent canopy coverage .... **Undergreen willow/Holm's sedge-showy sedge (SACO2/CASCB-CASP) association**
4. Moist site forbs combined ≥25 percent canopy coverage .... **Undergreen willow/mesic forb (SACO2/MESIC FORB) association**
5. Young, active, fluvial surfaces with recently worked alluvium the dominant feature of the ground layer, riparian vegetation scattered .... **Willow/alluvial bar (SALIX/ALLUVIAL BAR) association**

6. Saw-leaved sedge (*Carex scopulorum* var. *prionophylla*) ≥10 percent canopy coverage ....**Willow/saw-leaved sedge (SALIX/CASCP2) association**
7. Slender sedge (*Carex lasiocarpa*) and/or Buxbaum's sedge (*C. buxbaumii*) ≥25 percent canopy coverage .... **Willow/slender sedge (SALIX/CALA4) association**
8. Bladder sedge (*Carex utriculata*), inflated sedge (*C. vesicaria*), and/or water sedge (*C. aquatilis*) ≥25 percent canopy coverage ....**Willow/bladder sedge (SALIX/CAUT) association**
9. Bluejoint reedgrass (*Calamagrostis canadensis*) ≥25 percent canopy coverage ....**Willow/bluejoint reedgrass (SALIX/CACA) association**
10. Horsetail species (*Equisetum* species) ≥10 percent canopy coverage .... **Willow/horsetail species (SALIX/EQUIS) association**
11. Douglas (*Spiraea douglasii*) and/or pyramid spiraea (*S. pyramidata*) ≥10 percent canopy coverage .... **Willow/Douglas spiraea (SALIX/SPDO) association**
12. Mannagrass species (*Glyceria* spp.) and/or wood reed-grass (*Cinna latifolia*) ≥5 percent canopy coverage ....**Willow/tall mannagrass (SALIX/GLEL) association**
13. Scouler's willow (*Salix scouleriana*) ≥25 percent canopy coverage and myrtle pachistima (*Pachistima myrsinites*) ≥5 percent canopy coverage ....**Scouler's willow-myrtle pachistima (SASC-PAMY) association**
14. Moist site forbs ≥5 percent canopy coverage ....**Willow/mesic forb (SALIX/MESIC FORB) association**

Potential natural vegetation dominated by short willows or bog birch (usually less than 5 feet tall):

1. Undergreen willow (*Salix commutata*) ≥25 percent canopy coverage **3**
2. Undergreen willow (*Salix commutata*) absent or <25 percent canopy coverage, other short willows ≥25 percent canopy coverage **5**
3. Showy sedge (*Carex spectabilis*), Holm's sedge (*C. scopulorum* var. *bracteosa*), and/or saw-leaved sedge (*C. scopulorum* var. *prionophylla*) ≥25 percent canopy coverage ....**Undergreen willow/Holm's sedge-showy sedge (SACO2/CASCB-CASP) association**
4. Mesic forbs ≥25 percent canopy coverage ....**Undergreen willow/mesic forb (SACO2/MESIC FORB) association**
5. Few-flowered spike-rush (*Eleocharis pauciflora*), cotton-grass species (*Eriophorum* species), mud sedge (*Carex limosa*), poor sedge (*C. paupercula*), and/or lesser panicled sedge (*C. diandra*) ≥10 percent canopy coverage ....**Farr's willow/few-flowered spike-rush-cotton-grass (SAFA/ELPA2-ERPO2) association**
6. Holm's sedge (*Carex scopulorum* var. *bracteosa*) and/or showy sedge (*C. spectabilis*) ≥10 percent canopy coverage .... **Farr's willow/Holm's sedge (SAFA/CASCB-CASP) association**
7. Saw-leaved sedge (*Carex scopulorum* var. *prionophylla*) ≥10 percent canopy coverage ....**Farr's willow/saw-leaved sedge (SAFA/CASCP2) association**
8. Bladder sedge (*Carex utriculata*) and/or water sedge (*C. aquatilis*) ≥10 percent canopy coverage ....**Farr's willow/bladder sedge (SAFA/CAUT) association**
9. Black alpine sedge (*Carex nigricans*) ≥10 percent canopy coverage, the dominant graminoid .... **Farr's willow/black alpine sedge (SAFA/CANI2) association**
10. Timber oatgrass (*Danthonia intermedia*) and/or sheep fescue (*Festuca ovina* var. *rydbergii*) ≥10 percent canopy coverage .... **Farr's willow/timber oatgrass (SAFA/DAIN) association**

Table 15—Constancy and mean cover of important plant species in the SALIX plant associations—Part 1

		SACO2/ CASCB-CASP 5 plots		SACO2/ MESIC FORB 5 plots		SAFA/ CANI2 2 plots		SAFA/ CASCB-CASP 10 plots		SAFA/ CASCP2 14 plots		SAFA/ CAUT 10 plots	
Species	Code	CON[a]	COV[b]	CON	COV	CON	COV	CON	COV	CON	COV	CON	COV
Tree overstory:													
Engelmann spruce	PIEN	20	3	—	—	—	—	10	4	36	2	50	2
Tree understory:													
Engelmann spruce	PIEN	20	10	40	5	50	Tr[c]	40	1	36	2	70	2
Shrubs:													
mountain alder	ALIN	—	—	—	—	—	—	—	—	—	—	50	17
Sitka alder	ALSI	20	2	20	7	—	—	—	—	—	—	—	—
bog birch	BEGLG	—	—	—	—	—	—	—	—	43	15	20	33
red-osier dogwood	COST	—	—	—	—	—	—	—	—	—	—	10	15
prickly currant	RILA	—	—	20	1	—	—	—	—	—	—	—	—
western thimbleberry	RUPA	—	—	—	—	—	—	—	—	—	—	—	—
Bebb's willow	SABE	—	—	—	—	—	—	—	—	—	—	—	—
Booth's willow	SABO2	—	—	—	—	—	—	—	—	—	—	—	—
hoary willow	SACA9	—	—	—	—	—	—	—	—	—	—	—	—
Cascade willow	SACA6	—	—	—	—	100	18	10	10	—	—	—	—
undergreen willow	SACO2	100	71	100	37	—	—	—	—	7	1	20	5
Drummond's willow	SADR	—	—	—	—	—	—	—	—	14	4	10	1
coyote willow	SAEX	—	—	—	—	—	—	—	—	—	—	—	—
Farr's willow	SAFA	—	—	20	1	50	10	50	58	50	44	70	33
Geyer's willow	SAGEG	—	—	—	—	—	—	—	—	—	—	—	—
Geyer's willow	SAGEM	—	—	—	—	—	—	—	—	—	—	30	9
glaucous willow	SAGL	—	—	—	—	—	—	—	—	—	—	—	—
whiplash willow	SALAC	—	—	—	—	—	—	—	—	—	—	—	—
Pacific willow	SALAL	—	—	—	—	—	—	—	—	—	—	—	—
dusky willow	SAME2	—	—	—	—	—	—	—	—	—	—	—	—
Piper's willow	SAPI	—	—	—	—	—	—	—	—	—	—	10	40
tea-leaved willow	SAPLM2	—	—	—	—	50	5	30	47	43	53	20	25
Mackenzie's willow	SARIM	—	—	—	—	—	—	—	—	—	—	—	—
Scouler's willow	SASC	—	—	—	—	—	—	—	—	—	—	—	—
Sitka willow	SASI2	40	3	20	4	—	—	—	—	—	—	10	3
willow species	SALIX	—	—	—	—	—	—	20	33	7	30	—	—
Douglas spiraea	SPDO	—	—	—	—	—	—	—	—	7	15	40	14
Low shrubs and subshrubs:													
Merten's moss-heather	CAME	—	—	—	—	50	7	—	—	—	—	—	—
myrtle pachistima	PAMY	—	—	20	5	—	—	—	—	—	—	—	—
red mountain-heath	PHEM	60	1	40	1	50	1	30	1	7	1	—	—
cream mountain-heath	PHGL	—	—	—	—	50	3	—	—	—	—	—	—
dwarf huckleberry	VACA	—	—	20	1	100	4	30	10	43	5	10	Tr
Cascade huckleberry	VADE	40	3	20	1	—	—	20	2	7	6	—	—
grouse huckleberry	VASC	—	—	40	6	—	—	20	3	14	8	—	—
Perennial forbs:													
sharptooth angelica	ANAR	20	Tr	80	8	—	—	—	—	7	4	—	—
alpine leafybract aster	ASFO	20	Tr	—	—	—	—	10	3	43	4	10	Tr
fewflower aster	ASMO	40	3	—	—	—	—	20	4	21	5	10	3
twinflower marshmarigold	CABI	—	—	—	—	50	7	—	—	7	3	—	—
elkslip	CALE2	20	5	—	—	—	—	20	15	—	—	—	—
peregrine fleabane	ERPE	20	1	40	2	—	—	20	6	14	Tr	—	—
northern bluebells	MEPAB	20	1	20	2	—	—	—	—	—	—	—	—
broadleaved montia	MOCO	20	Tr	—	—	—	—	—	—	7	2	—	—
fanleaf cinquefoil	POFL2	80	8	20	6	100	1	60	5	14	2	—	—
marsh cinquefoil	POPA3	—	—	—	—	—	—	—	—	—	—	70	7
dotted saxifrage	SAPU	80	3	60	4	—	—	10	2	21	3	—	—
cleftleaf groundsel	SECY	20	7	—	—	50	2	50	4	7	Tr	—	—
arrowleaf groundsel	SETR	40	3	80	4	—	—	50	3	50	1	10	1
globeflower	TRLA4	—	—	20	15	50	1	60	10	21	4	—	—
Sitka valerian	VASI	60	7	40	4	—	—	30	1	14	10	—	—
American false hellebore	VEVI	20	5	40	2	—	—	20	Tr	—	—	—	—
thyme-leaved speedwell	VESE	—	—	—	—	50	1	10	Tr	7	Tr	—	—
Wormskjold's speedwell	VEWO	60	1	40	Tr	—	—	40	3	29	1	—	—
pioneer violet	VIGL	—	—	20	1	—	—	—	—	7	Tr	—	—
Macloskey's violet	VIMA	40	8	40	1	—	—	—	—	29	1	20	5
marsh violet	VIPA2	—	—	20	1	—	—	—	—	—	—	10	Tr
Grasses or grasslike:													
bluejoint reedgrass	CACA	40	5	20	7	—	—	40	5	71	3	70	7
Columbia sedge	CAAP3	—	—	—	—	—	—	—	—	—	—	20	33
water sedge	CAAQA	—	—	—	—	—	—	—	—	—	—	—	—

Table 15—Constancy and mean cover of important plant species in the SALIX plant associations—Part 1 (continued)

Species	Code	SACO2/ CASCB-CASP 5 plots CON	COV	SACO2/ MESIC FORB 5 plots CON	COV	SAFA/ CANI2 2 plots CON	COV	SAFA/ CASCB-CASP 10 plots CON	COV	SAFA/ CASCP2 14 plots CON	COV	SAFA/ CAUT 10 plots CON	COV
Sitka sedge	CAAQS	—	—	—	—	—	—	—	—	—	—	60	31
Buxbaum's sedge	CABU2	—	—	—	—	—	—	—	—	—	—	10	5
Cusick's sedge	CACU2	—	—	—	—	—	—	—	—	—	—	—	—
lesser panicled sedge	CADI2	—	—	—	—	—	—	—	—	—	—	—	—
woolly sedge	CALA3	—	—	—	—	—	—	—	—	—	—	—	—
slender sedge	CALA4	—	—	—	—	—	—	—	—	—	—	10	2
lenticular sedge	CALE5	—	—	—	—	—	—	10	13	—	—	10	80
mud sedge	CALI	—	—	—	—	—	—	—	—	—	—	10	3
black alpine sedge	CANI2	40	9	60	2	100	25	70	13	7	5	—	—
poor sedge	CAPA9	—	—	—	—	—	—	—	—	—	—	10	3
russet sedge	CASA2	—	—	—	—	—	—	—	—	—	—	—	—
Holm's sedge	CASCB	60	8	—	—	100	3	80	27	—	—	—	—
saw-leaved sedge	CASCP2	—	—	20	2	—	—	—	—	100	30	—	—
showy sedge	CASP	60	13	60	1	—	—	30	20	—	—	—	—
bladder sedge	CAUT	—	—	—	—	—	—	—	—	57	8	90	18
inflated sedge	CAVE	—	—	—	—	—	—	—	—	—	—	—	—
timber oatgrass	DAIN	—	—	—	—	—	—	10	Tr	29	1	—	—
few-flowered spike-rush	ELPA2	—	—	—	—	—	—	—	—	—	—	—	—
many-spiked cotton-grass	ERPO2	—	—	—	—	50	Tr	10	1	—	—	—	—
green-keeled cotton-grass	ERVI	—	—	—	—	—	—	10	2	—	—	10	1
tall mannagrass	GLEL	—	—	—	—	—	—	—	—	—	—	10	1
reed mannagrass	GLGR	—	—	—	—	—	—	—	—	—	—	—	—
Drummond's rush	JUDR	—	—	60	1	100	1	30	3	—	—	—	—
small-fruited bulrush	SCMI	—	—	—	—	—	—	—	—	—	—	10	15
Ferns and fern allies:													
common horsetail	EQAR	—	—	40	10	—	—	—	—	14	Tr	30	1

[a] CON = percentage of plots in which the species occurred.
[b] COV = average canopy cover in plots in which the species occurred.
[c] Tr = trace cover, less than 1 percent canopy cover.

Table 15—Constancy and mean cover of important plant species in the SALIX plant associations—Part 2

Species	Code	SAFA/ DAIN 2 plots CON[a]	COV[b]	SAFA/ ELPA2-ERPO2 6 plots CON	COV	SALIX/ ALLUVIAL BAR 16 plots CON	COV	SALIX/ EQUIS 3 plots CON	COV	SALIX/ GLEL 4 plots CON	COV	SALIX/ MESIC FORB 16 plots CON	COV
Tree overstory:													
Engelmann spruce	PIEN	—	—	—	—	6	Tr[c]	—	—	25	5	25	1
Tree understory:													
Engelmann spruce	PIEN	—	—	50	2	31	Tr	—	—	25	1	38	3
Shrubs:													
mountain alder	ALIN	—	—	17	5	19	10	100	2	25	3	13	33
Sitka alder	ALSI	—	—	—	—	38	7	—	—	25	15	56	16
bog birch	BEGLG	50	7	33	18	—	—	—	—	—	—	6	20
red-osier dogwood	COST	—	—	—	—	38	3	—	—	—	—	38	13
prickly currant	RILA	—	—	—	—	13	4	—	—	25	1	13	5
western thimbleberry	RUPA	—	—	—	—	13	1	—	—	—	—	31	8
Bebb's willow	SABE	—	—	—	—	—	—	—	—	25	Tr	6	15
Booth's willow	SABO2	—	—	—	—	—	—	—	—	25	40	—	—
hoary willow	SACA9	—	—	—	—	—	—	—	—	—	—	6	2
Cascade willow	SACA6	—	—	—	—	—	—	—	—	—	—	—	—
undergreen willow	SACO2	—	—	—	—	6	7	—	—	—	—	13	13
Drummond's willow	SADR	—	—	—	—	—	—	33	3	25	70	6	7
coyote willow	SAEX	—	—	—	—	6	50	—	—	—	—	6	10
Farr's willow	SAFA	50	25	50	28	—	—	—	—	—	—	6	Tr
Geyer's willow	SAGEG	—	—	—	—	—	—	—	—	—	—	—	—
Geyer's willow	SAGEM	—	—	—	—	—	—	—	—	—	—	—	—
glaucous willow	SAGL	—	—	—	—	—	—	—	—	—	—	—	—
whiplash willow	SALAC	—	—	—	—	13	3	100	4	25	25	6	10
Pacific willow	SALAL	—	—	—	—	6	2	—	—	—	—	6	Tr
dusky willow	SAME2	—	—	—	—	56	29	33	65	—	—	6	65
Piper's willow	SAPI	—	—	—	—	—	—	—	—	—	—	—	—
tea-leaved willow	SAPLM2	50	30	33	23	—	—	—	—	—	—	—	—
Mackenzie's willow	SARIM	—	—	—	—	6	3	100	42	—	—	19	12
Scouler's willow	SASC	—	—	—	—	13	4	—	—	—	—	6	99

Table 15—Constancy and mean cover of important plant species in the SALIX plant associations—Part 2 (continued)

		SAFA/ DAIN 2 plots		SAFA/ ELPA2-ERPO2 6 plots		SALIX/ ALLUVIAL BAR 16 plots		SALIX/ EQUIS 3 plots		SALIX/ GLEL 4 plots		SALIX/ MESIC FORB 16 plots	
Species	Code	CON	COV	CON	COV	CON	COV	CON	COV	CON	COV	CON	COV
Sitka willow	SASI2	—	—	—	—	94	38	33	3	75	47	81	71
willow species	SALIX	—	—	—	—	—	—	—	—	—	—	—	—
Douglas spiraea	SPDO	—	—	17	2	—	—	—	—	25	1	6	Tr
Low shrubs and subshrubs:													
Merten's moss-heather	CAME	—	—	—	—	—	—	—	—	—	—	—	—
myrtle pachistima	PAMY	—	—	—	—	13	Tr	—	—	—	—	—	—
red mountain-heath	PHEM	—	—	—	—	—	—	—	—	—	—	—	—
cream mountain-heath	PHGL	—	—	—	—	—	—	—	—	—	—	—	—
dwarf huckleberry	VACA	100	23	17	25	—	—	—	—	—	—	—	—
Cascade huckleberry	VADE	—	—	—	—	—	—	—	—	—	—	—	—
grouse huckleberry	VASC	—	—	—	—	6	5	—	—	—	—	—	—
Perennial forbs:													
sharptooth angelica	ANAR	—	—	17	Tr	31	1	—	—	25	1	81	2
alpine leafybract aster	ASFO	50	5	—	—	6	Tr	—	—	25	1	19	5
fewflower aster	ASMO	50	5	—	—	13	5	—	—	25	Tr	31	9
twinflower marshmarigold	CABI	—	—	—	—	—	—	—	—	—	—	—	—
elkslip	CALE2	50	3	—	—	—	—	—	—	—	—	—	—
peregrine fleabane	ERPE	—	—	—	—	—	—	67	Tr	50	25	—	—
northern bluebells	MEPAB	—	—	—	—	13	Tr	—	—	50	3	38	10
broadleaved montia	MOCO	—	—	—	—	13	1	—	—	25	15	19	5
fanleaf cinquefoil	POFL2	—	—	—	—	13	Tr	—	—	—	—	19	Tr
marsh cinquefoil	POPA3	—	—	67	10	—	—	—	—	—	—	—	—
dotted saxifrage	SAPU	—	—	—	—	6	Tr	—	—	50	3	31	3
cleftleaf groundsel	SECY	50	2	—	—	—	—	—	—	—	—	—	—
arrowleaf groundsel	SETR	—	—	—	—	19	1	—	—	50	4	56	3
globeflower	TRLA4	50	3	—	—	6	Tr	—	—	—	—	—	—
Sitka valerian	VASI	—	—	—	—	6	1	—	—	25	15	25	15
American false hellebore	VEVI	—	—	—	—	—	—	—	—	50	2	13	7
thyme-leaved speedwell	VESE	—	—	—	—	6	Tr	—	—	—	—	6	Tr
Wormskjold's speedwell	VEWO	50	Tr	—	—	—	—	—	—	—	—	6	1
pioneer violet	VIGL	—	—	—	—	19	1	—	—	50	14	69	6
Macloskey's violet	VIMA	—	—	33	2	—	—	—	—	—	—	—	—
marsh violet	VIPA2	—	—	—	—	—	—	—	—	—	—	—	—
Grasses or grasslike:													
bluejoint reedgrass	CACA	100	2	33	10	19	3	—	—	25	15	25	1
Columbia sedge	CAAP3	—	—	—	—	—	—	—	—	—	—	—	—
water sedge	CAAQA	—	—	17	3	—	—	—	—	—	—	—	—
Sitka sedge	CAAQS	—	—	17	5	—	—	—	—	—	—	—	—
Buxbaum's sedge	CABU2	—	—	—	—	—	—	—	—	—	—	—	—
Cusick's sedge	CACU2	—	—	—	—	—	—	—	—	—	—	—	—
lesser panicled sedge	CADI2	—	—	33	20	—	—	—	—	—	—	—	—
woolly sedge	CALA3	—	—	—	—	—	—	—	Tr	—	—	—	—
slender sedge	CALA4	—	—	—	—	—	—	—	—	—	—	—	—
lenticular sedge	CALE5	—	—	—	—	38	Tr	—	Tr	—	—	19	Tr
mud sedge	CALI	—	—	50	11	—	—	—	—	—	—	—	—
black alpine sedge	CANI2	50	5	—	—	—	—	—	—	—	—	—	—
poor sedge	CAPA9	—	—	17	7	—	—	—	—	—	—	—	—
russet sedge	CASA2	—	—	—	—	—	—	—	—	—	—	—	—
Holm's sedge	CASCB	50	3	—	—	—	—	—	—	—	—	—	—
saw-leaved sedge	CASCP2	50	1	17	5	6	Tr	—	—	25	1	6	3
showy sedge	CASP	—	—	—	—	6	Tr	—	—	—	—	13	1
bladder sedge	CAUT	—	—	67	13	—	—	—	—	50	4	6	2
inflated sedge	CAVE	—	—	17	1	—	—	—	—	—	—	—	—
timber oatgrass	DAIN	100	24	—	—	—	—	—	—	—	—	—	—
few-flowered spike-rush	ELPA2	—	—	50	16	—	—	—	—	—	—	—	—
many-spiked cotton-grass	ERPO2	50	Tr	33	33	—	—	—	—	—	—	—	—
green-keeled cotton-grass	ERVI	—	—	17	7	—	—	—	—	—	—	—	—
tall mannagrass	GLEL	—	—	—	—	6	Tr	—	—	75	10	19	1
reed mannagrass	GLGR	—	—	—	—	—	—	—	—	25	65	—	—
Drummond's rush	JUDR	—	—	—	—	6	Tr	—	—	—	—	6	1
small-fruited bulrush	SCMI	—	—	—	—	13	Tr	100	1	25	Tr	13	3
Ferns and fern allies:													
common horsetail	EQAR	—	—	33	2	50	1	100	55	50	1	56	2

[a] CON = percentage of plots in which the species occurred.
[b] COV = average canopy cover in plots in which the species occurred.
[c] Tr = trace cover, less than 1 percent canopy cover.

Table 15—Constancy and mean cover of important plant species in the SALIX plant associations—Part 3

		SALIX/SPDO 3 plots		SALIX/CACA 8 plots		SALIX/CALA4 2 plots		SALIX/CASCP2 14 plots		SALIX/CAUT 26 plots		SASC-PAMY 6 plots	
Species	**Code**	**CON[a]**	**COV[b]**	**CON**	**COV**	**CON**	**COV**	**CON**	**COV**	**CON**	**COV**	**CON**	**COV**
Tree overstory:													
Engelmann spruce	PIEN	—	—	50	7	50	2	50	9	19	1	17	3
Tree understory:													
Engelmann spruce	PIEN	—	—	50	4	50	2	71	1	23	2	33	2
Shrubs:													
mountain alder	ALIN	33	12	75	5	—	—	14	25	50	7	50	7
Sitka alder	ALSI	—	—	13	1	—	—	7	10	4	3	33	7
bog birch	BEGLG	—	—	25	23	100	40	29	24	19	13	—	—
red-osier dogwood	COST	33	Tr[c]	—	—	50	1	—	—	15	2	—	—
prickly currant	RILA	—	—	50	2	—	—	14	3	8	1	67	7
western thimbleberry	RUPA	—	—	—	—	—	—	—	—	—	—	67	7
Bebb's willow	SABE	—	—	—	—	100	1	—	—	23	22	—	—
Booth's willow	SABO2	—	—	25	3	—	—	29	36	27	26	—	—
hoary willow	SACA9	—	—	—	—	100	8	—	—	—	—	—	—
Cascade willow	SACA6	—	—	—	—	—	—	—	—	—	—	—	—
undergreen willow	SACO2	—	—	13	40	50	5	—	—	12	8	—	—
Drummond's willow	SADR	33	60	75	55	—	—	71	43	54	47	—	—
coyote willow	SAEX	—	—	—	—	—	—	—	—	—	—	—	—
Farr's willow	SAFA	—	—	—	—	—	—	36	22	8	23	—	—
Geyer's willow	SAGEG	—	—	—	—	—	—	—	—	4	60	—	—
Geyer's willow	SAGEM	—	—	13	30	—	—	7	Tr	19	33	—	—
glaucous willow	SAGL	—	—	—	—	—	—	7	5	—	—	—	—
whiplash willow	SALAC	—	—	13	Tr	—	—	—	—	—	—	—	—
Pacific willow	SALAL	—	—	—	—	—	—	—	—	8	23	—	—
dusky willow	SAME2	—	—	—	—	—	—	—	—	—	—	—	—
Piper's willow	SAPI	—	—	25	55	—	—	—	—	8	44	—	—
tea-leaved willow	SAPLM2	—	—	—	—	—	—	7	7	—	—	—	—
Mackenzie's willow	SARIM	—	—	—	—	—	—	—	—	—	—	—	—
Scouler's willow	SASC	—	—	—	—	—	—	—	—	—	—	100	69
Sitka willow	SASI2	67	95	25	5	—	—	14	23	15	61	—	—
willow species	SALIX	—	—	—	—	—	—	—	—	—	—	—	—
Douglas spiraea	SPDO	100	48	38	52	—	—	14	1	38	27	—	—
Low shrubs and subshrubs:													
Merten's moss-heather	CAME	—	—	—	—	—	—	—	—	—	—	—	—
myrtle pachistima	PAMY	—	—	—	—	—	—	—	—	—	—	100	27
red mountain-heath	PHEM	—	—	—	—	—	—	—	—	4	2	—	—
cream mountain-heath	PHGL	—	—	—	—	—	—	—	—	—	—	—	—
dwarf huckleberry	VACA	—	—	—	—	—	—	14	1	12	2	—	—
Cascade huckleberry	VADE	—	—	—	—	—	—	—	—	4	1	—	—
grouse huckleberry	VASC	—	—	—	—	—	—	7	2	—	—	—	—
Perennial forbs:													
sharptooth angelica	ANAR	—	—	13	2	50	Tr	14	2	12	1	50	2
alpine leafybract aster	ASFO	67	Tr	13	20	—	—	21	3	4	7	—	—
fewflower aster	ASMO	33	Tr	25	14	—	—	21	1	12	1	—	—
twinflower marshmarigold	CABI	—	—	—	—	—	—	7	1	—	—	—	—
elkslip	CALE2	—	—	—	—	—	—	—	—	—	—	—	—
peregrine fleabane	ERPE	—	—	—	—	—	—	7	15	—	—	—	—
northern bluebells	MEPAB	—	—	—	—	—	—	7	5	—	—	—	—
broadleaved montia	MOCO	—	—	—	—	—	—	—	—	—	—	—	—
fanleaf cinquefoil	POFL2	—	—	13	1	—	—	—	—	—	—	—	—
marsh cinquefoil	POPA3	—	—	13	3	—	—	21	3	23	4	—	—
dotted saxifrage	SAPU	33	Tr	13	2	—	—	—	—	—	—	—	—
cleftleaf groundsel	SECY	—	—	—	—	—	—	—	—	—	—	—	—
arrowleaf groundsel	SETR	67	9	25	3	50	Tr	36	4	—	—	17	Tr
globeflower	TRLA4	—	—	—	—	—	—	14	4	—	—	—	—
Sitka valerian	VASI	33	Tr	13	60	—	—	14	5	—	—	17	20
American false hellebore	VEVI	—	—	—	—	—	—	7	1	—	—	—	—
thyme-leaved speedwell	VESE	—	—	—	—	—	—	—	—	—	—	—	—
Wormskjold's speedwell	VEWO	—	—	—	—	—	—	14	Tr	—	—	—	—
pioneer violet	VIGL	67	5	—	—	—	—	—	—	15	2	50	1
Macloskey's violet	VIMA	—	—	13	1	—	—	14	1	8	1	—	—
marsh violet	VIPA2	—	—	13	2	100	4	—	—	—	—	—	—
Grasses or grasslike:													
bluejoint reedgrass	CACA	33	1	100	44	—	—	71	9	77	8	17	Tr
Columbia sedge	CAAP3	—	—	—	—	—	—	7	2	—	—	—	—
water sedge	CAAQA	—	—	—	—	—	—	14	16	15	11	—	—
Sitka sedge	CAAQS	—	—	—	—	—	—	—	—	15	9	—	—

Table 15—Constancy and mean cover of important plant species in the SALIX plant associations—Part 3 (continued)

		SALIX/SPDO 3 plots		SALIX/CACA 8 plots		SALIX/CALA4 2 plots		SALIX/CASCP2 14 plots		SALIX/CAUT 26 plots		SASC-PAMY 6 plots	
Species	Code	CON	COV	CON	COV	CON	COV	CON	COV	CON	COV	CON	COV
Buxbaum's sedge	CABU2	—	—	—	—	50	15	—	—	—	—	—	—
Cusick's sedge	CACU2	—	—	—	—	50	15	—	—	4	2	—	—
lesser panicled sedge	CADI2	—	—	—	—	—	—	—	—	—	—	—	—
woolly sedge	CALA3	—	—	—	—	—	—	—	—	—	—	—	—
slender sedge	CALA4	—	—	—	—	100	38	—	—	4	5	—	—
lenticular sedge	CALE5	—	—	—	—	—	—	—	—	4	2	—	—
mud sedge	CALI	—	—	—	—	—	—	—	—	—	—	—	—
black alpine sedge	CANI2	—	—	—	—	—	—	—	—	—	—	—	—
poor sedge	CAPA9	—	—	—	—	—	—	7	Tr	—	—	—	—
russet sedge	CASA2	—	—	—	—	—	—	—	—	—	—	—	—
Holm's sedge	CASCB	—	—	—	—	—	—	—	—	—	—	—	—
saw-leaved sedge	CASCP2	—	—	50	5	—	—	100	49	8	1	—	—
showy sedge	CASP	—	—	—	—	—	—	—	—	—	—	—	—
bladder sedge	CAUT	—	—	63	5	100	5	36	27	77	37	—	—
inflated sedge	CAVE	—	—	—	—	—	—	—	—	23	10	—	—
timber oatgrass	DAIN	—	—	—	—	—	—	—	—	4	2	—	—
few-flowered spike-rush	ELPA2	—	—	—	—	—	—	—	—	—	—	—	—
many-spiked cotton-grass	ERPO2	—	—	—	—	—	—	—	—	4	3	—	—
green-keeled cotton-grass	ERVI	—	—	—	—	50	Tr	—	—	—	—	—	—
tall mannagrass	GLEL	—	—	25	13	—	—	7	7	15	3	—	—
reed mannagrass	GLGR	—	—	13	10	—	—	—	—	4	5	—	—
Drummond's rush	JUDR	—	—	—	—	—	—	—	—	—	—	—	—
small-fruited bulrush	SCMI	—	—	25	10	—	—	—	—	23	7	—	—
Ferns and fern allies:													
common horsetail	EQAR	33	Tr	63	4	—	—	50	1	23	1	—	—

[a] CON = percentage of plots in which the species occurred.
[b] COV = average canopy cover in plots in which the species occurred.
[c] Tr = trace cover, less than 1 percent canopy cover.

HEATH SERIES

HEATH N = 18

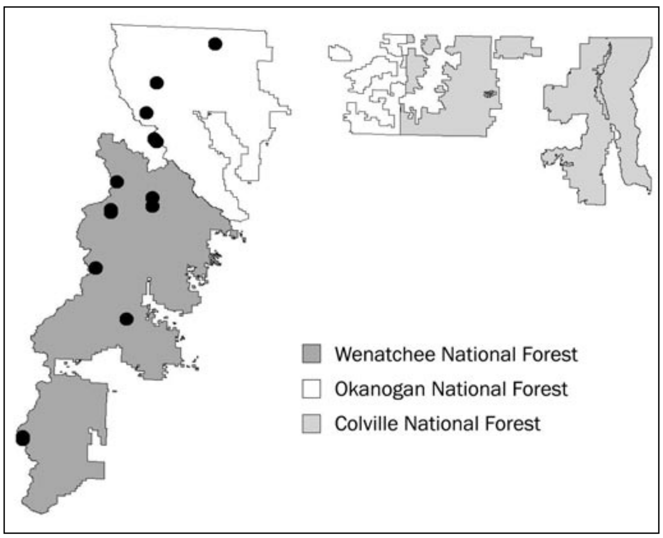


Figure 26—Plot locations for the HEATH series.

MANY OF THE HEATH series indicator plant species, and their plant communities in the broad sense, are circumpolar. Mountain-heaths, moss-heathers, Cascade huckleberry, and partridgefoot[1] as a whole are widespread in timberline and alpine zones in Canada and northwestern America. They occur from Alaska and the Yukon Territory through British Columbia and Alberta into the Cascade Range of Washington and Oregon, and east through the Rocky Mountains of northern Idaho and Montana. Alaska and four-angled moss-heathers also are circumboreal (Hitchcock and Cronquist 1973). Mountain-heaths, moss-heathers, and partridgefoot usually are found throughout the range of the HEATH series in eastern Washington. Cascade huckleberry, as part of the red mountain-heath–Cascade huckleberry association, is usually found only in strong maritime climates close to the Cascade crest.

Plant associations in the HEATH series are a major component of many subalpine parklands and alpine meadows (Franklin and Dyrness 1969). The climate associated with HEATH series indicator plants is harsh compared with that of other series. Deep, late-lying snowpacks and timberline are the major factors determining the distribution of HEATH series indicator plants (Franklin and Dyrness 1969). Winter temperatures are very cold, and wind desiccation limits the distribution of forests. Growing seasons are cool and short, and in normal years, sites remain relatively moist following snowmelt owing to occasional summer rain showers and cloud fog. The HEATH series is abundant at high elevations along the Cascade crest and the high-elevation ridges that extend to the east. However, the HEATH series is apparently absent on the Colville NF owing to the lack of timberline and subalpine sites, as well as the lack of an appropriate climate.

HEATH indicator species usually are considered components of upland communities that do not tolerate long periods of soil saturation or flooding and are incidental species (usually on dry microsites) on wetland soils. They are often the dominant vegetation in transition (xeroriparian) areas that are situated between riparian or wetland zones and true upland. Therefore, for use in this classification, the slope position of the HEATH series must be located between wetland or riparian zones and upland.

CLASSIFICATION DATABASE

The HEATH series is composed of all nonforest plant communities dominated by low shrubs such as mountain-heaths, moss-heathers, and Cascade huckleberry, or the semishrub partridgefoot. The HEATH series was sampled on all but the Tonasket and Cle Elum RDs on the Okanogan and Wenatchee NFs and was not found east of the Okanogan River (fig. 26). The low numbers of sample plots for the HEATH series is an artifact of plot selection owing to difficult access to these isolated, high-elevation sites. Eighteen plots were sampled in the HEATH series. From this database, two major plant associations are recognized. The Merten's moss-heather–red mountain heath association occurs in areas influenced by the continental climate zone to the east of the Cascade crest. The PHEM-VADE association is associated with maritime climates close to the Cascade crest. One potential one-plot association (SPDE-VAAL) is not used in the database or described in this classification. For the most part, the samples represent mature plant communities in good ecological condition.

[1] See appendix A for a cross reference for all species codes and common and scientific names used in this document.

HEATH series plant associations

	Scientific name	Common name	Ecoclass code	Plots
Major associations:				
CAME-PHEM	*Cassiope mertensiana-Phyllodoce empetriformis*	Merten's moss-heather–red mountain-heath	SS1921	7
PHEM-VADE	*Phyllodoce empetriformis-Vaccinium deliciosum*	Red mountain-heath–Cascade huckleberry	SS1922	11

VEGETATION CHARACTERISTICS

The HEATH series includes all nonforest stands in the timberline and alpine zones potentially dominated by at least 25 percent canopy coverage of mountain-heaths, moss-heathers, Cascade huckleberry, and/or partridgefoot. Mountain-heaths are well represented to abundant on 80 percent of the samples. Moss-heathers and Cascade huckleberry are well represented and abundant on 50 to 60 percent of the plots, respectively. Partridgefoot is common on 50 percent of the plots and, although usually not abundant, was used to help key some plots. It also increases in abundance with site disturbance, thus it is an important indicator when keying disturbed sites. Dwarf, alpine willows such as Cascade willow are common on a few sites but are generally inconspicuous relative to the abundance of indicator plants.

Franklin and Dyrness (1969) suspected that Cascade huckleberry may play an important succession role on some HEATH series sites such as (1) a pioneer community dominant on burned sites where it may be followed by a forest community later in the sere or (2) a pioneer community dominant with mountain-heaths and moss-heathers in a true alpine meadow habitat (see the "Fire" section on page 163).

A number of other relatively constant high-elevation plant species are in the HEATH series, such as Canby's licoriceroot, elephanthead pedicularis, fanleaf cinquefoil, Sitka valerian, black alpine sedge, showy sedge, and smooth woodrush. Small conifers are common on some sample stands but are considered incidental, having little potential to dominate the site.

PHYSICAL SETTING

Elevation—

The majority of HEATH series plots are between 5,200 and 7,100 feet in elevation. The upper range is probably low owing to restricted access to higher elevation sites. The HEATH series has been observed but not sampled above 7,500 feet in the Enchantment Wilderness Area. HEATH sites occur at lower elevations within wetter maritime zones close to the Cascade crest compared with drier zones along the high continental climate ridges that extend to the east. Elevations also decrease with increasing latitude. The tendency is for timberline to decrease about 330 feet per 1-degree increase in latitude under a given climatic regime (Daubenmire 1954). In addition, timberline varies with exposure, dropping about 450 feet on cool, northerly exposures compared with warm, southerly exposures on the same ridge (Arno 1966).

	Elevation (feet)			
Forest	Minimum	Maximum	Average	N
Okanogan	5,275	6,605	5,845	6
Wenatchee	4,975	7,100	5,955	12
Series	4,975	7,100	5,925	18

This trend is reflected in the elevation ranges for the two associations, where the average elevation of PHEM-VADE (maritime climate) is about 1,000 feet lower than CAME-PHEM (continental climate).

	Elevation (feet)			
Plant association	Minimum	Maximum	Average	N
CAME-PHEM	5,660	7,100	6,511	7
PHEM-VADE	4,975	6,300	5,552	11
Series	4,975	7,100	5,925	18

Valley Geomorphology—

The HEATH series is found in a variety of valley width and gradient classes. Thirteen of the 18 sample plots are located in two valley configuration clusters: (1) low gradient (1 to 3 percent), moderate to very broad valleys (99 to greater than 990 feet) and (2) very steep (greater than 8 percent), broad to very narrow (less than 99 to 990 feet) valleys. This pattern is likely an artifact of sampling and differences between associations. No correlation is clear for the HEATH series as a whole.

	Valley gradient					
Valley width	Very low	Low	Moderate	Steep	Very steep	N
Very broad	1	1	0	0	0	2
Broad	1	3	2	0	2	8
Moderate	0	2	0	0	1	3
Narrow	0	0	0	0	2	2
Very narrow	0	0	0	1	2	3
Series total	2	6	2	1	7	18

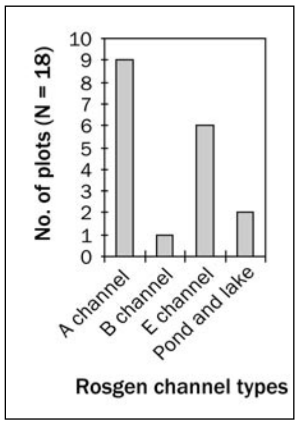
Differences between the two plant associations are more apparent. CAME-PHEM appears to be more common in low to very low gradient valleys, whereas PHEM-VADE is most common in very steep valleys. However, they are still present in other valley gradient classes. Site variation is probably due to the high elevation of the sites where deep, lingering snow pack, temporary soil saturation at snowmelt, summer showers, and short growing seasons are more important than valley characteristics in determining the composition of the community. Therefore, the HEATH series occurs on narrow, well-drained streambanks and terraces in steep narrow valleys as well as in transition zones next to gentle, broad, high-elevation valleys dominated by carrs, fens, and bogs.

Plant association	Valley width					
	Very broad	Broad	Moderate	Narrow	Very narrow	N
CAME-PHEM	2	2	2	0	1	7
PHEM-VADE	0	6	1	2	2	11
Series total	2	8	3	2	3	18

Plant association	Valley gradient					
	Very low	Low	Moderate	Steep	Very steep	N
CAME-PHEM	2	3	1	0	1	7
PHEM-VADE	0	3	1	1	6	11
Series total	2	6	2	1	7	18

Channel Types—

The HEATH series is associated with a rather limited variety of channel types. Most plots occur in valleys with Rosgen A and E channel types. One plot is along a B channel, and two plots are by lakes.



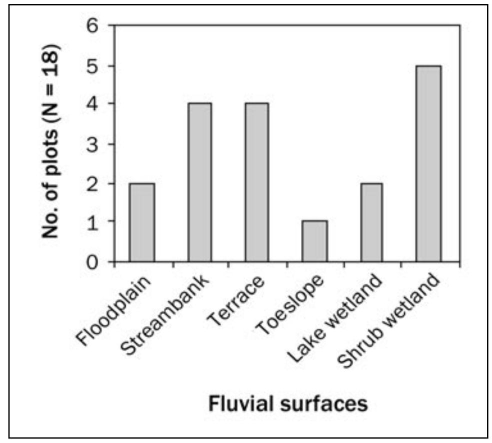
This apparent dichotomy for the HEATH series can be explained by looking at the distribution of the plant associations across channel classes. Five of the seven plots in the CAME-PHEM association occur along E channels, and one occurs by a lake. These channel classes are indicative of relatively broad, low gradient valleys. One CAME-PHEM plot occurs along an A channel, indicating the CAME-PHEM association may occasionally occur in narrow, steep valleys. The PHEM-VADE association on the other hand, occurs mostly along A channels in narrow, steeper valleys.

Plant association	Rosgen channel types				
	A	B	E	Pond/lake	N
CAME-PHEM	1	0	5	1	7
PHEM-VADE	8	1	1	1	11
Series total	9	1	6	2	18

Fluvial Surfaces—

Similarly, the HEATH series is found on a variety of fluvial surfaces. Sites include streambanks, terraces, the shores of lakes, and transition slopes surrounding riparian or wetland zones. The two sites coded as floodplains may reflect sample error and are more likely streambanks or terraces. The distinguishing characteristics are that all these sites are temporarily saturated at snowmelt, experience a very short, cold but moist growing season, and are well drained.

Fluvial surfaces also are variable within associations. Seventy-three percent of the PHEM-VADE plots are associated with riparian zones. Fifty-seven percent of the CAME-PHEM plots occur on transitional sites along wetlands, and

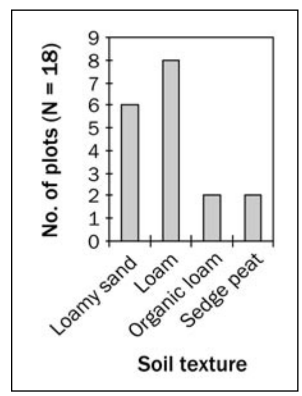


three plots (43 percent) occur within well-drained portions of riparian zones. The previous information on valley configuration and fluvial surfaces support the fact that the HEATH series occurs on a variety of transitional fluvial surfaces along high-elevation streams, lakes, and wetlands. Differences only occur when comparing the associations.

Plant association	Fluvial surfaces						
	Flood-plain	Stream-bank	Terrace	Toe-slope	Lake wetland	Shrub wetland	N
CAME-PHEM	1	0	1	1	1	3	7
PHEM-VADE	1	4	3	0	1	2	11
Series total	2	4	4	1	2	5	18

Soils—

The soil surface of most sampled sites could be characterized as a complex mosaic of broad rounded hummocks, possibly as a result of frost heaving. These hummocks, which are more evident in these transitional settings than in uplands, are perhaps owing to an accumulation of fine-textured soils, especially ash.



Soils are predominantly loamy sand or loam. Two plots coded as organic loam are likely a result of sampling error. Another two plots were coded as peat. One peat plot was marginally bog-like in character, whereas the other was probably a decomposed log on an otherwise normal mineral soil. Both plots had the highest measured water tables in the HEATH series and are transitional to sedge-dominated associations in the MEADOW series.

Plant association	Soil texture				
	Loamy sand	Loam	Organic loam	Sedge peat	N
CAME-PHEM	3	4	0	0	7
PHEM-VADE	3	4	2	2	11
Series total	6	8	2	2	18

In general, the HEATH series is indicative of seasonally saturated mineral soils (snowmelt) that are moist yet well drained during the growing season. The species that characterize the HEATH series do not survive well on sites with more than a few days of soil saturation.

Average water table depths (14 inches) at the time of sampling were identical for the two associations. However, only one CAME-PHEM plot was measured; one plot is not meaningful for distinguishing the CAME-PHEM association from the PHEM-VADE association. Both associations are intermittently saturated at snowmelt, and their water table lowers to more than 28 inches below the soil surface by September.

	Water table (inches)			
Plant association	Minimum	Maximum	Average	N
CAME-PHEM	-14	-14	-14	1
PHEM-VADE	-28	-3	-14	6
Series	-28	-3	-14	7

Soil temperatures (degrees Fahrenheit) in the first 5 inches of the soil profile were measured on 16 plots.

	Soil temperature (°F)			
Plant association	Minimum	Maximum	Average	N
CAME-PHEM	39	53	44	5
PHEM-VADE	44	60	49	11
Series	39	60	48	16

The colder soil temperatures associated with the CAME-PHEM association are probably a reflection of its location at higher elevations within the continental climate zone.

ECOSYSTEM MANAGEMENT

Natural Regeneration of HEATH Indicator Species—

Research on the regeneration of Cascade huckleberry is lacking. Huckleberries in general reproduce both sexually and vegetatively (Hitchcock and Cronquist 1973). Like other huckleberries, Cascade huckleberry has a complex system of rhizomes that occurs primarily in the duff layer or in the transition between the duff and the underlying mineral soil. Most rhizomes lie within 5 inches of the soil surface. Some lie deeper in the soil, allowing the species to survive more catastrophic disturbances. Dormant buds are scattered along the rhizomes and are generally inhibited until soil disturbance or removal of the aerial stems, such as by fire. Vegetative reproduction from rhizome extension and sprouting is the primary method of reproduction for all huckleberries. Huckleberries contain numerous seeds that are widely dispersed by passing through the digestive tracks of birds and mammals. Seed viability is high and requires no pretreatment. Some seed is probably stored in the soil seed bank.

Likewise little information is available for mountain-heaths and moss-heathers. They reproduce sexually and vegetatively (Hitchcock and Cronquist 1973) and have creeping stems rather than true rhizomes. New aerial shoots and roots arise from buds scattered along these stems. As they lie at the surface, these stems are very susceptible to disturbance such as trampling and fire. The fruits are many seeded, but the primary form of reproduction is probably by vegetative extension of rooting, creeping stems.

Similarly, little information is available for partridgefoot. It reproduces sexually from seed and produces new aerial stems along rhizomes as well as stolons (Hitchcock and Cronquist 1973). These root structures appear to lie very near or on the soil surface and, like mountain-heaths and moss-heathers, should be very sensitive to disturbance. However, partridgefoot appears to be one of the first plants to colonize sites released by the disturbing influence. The fruit is a several-seeded follicle, but vegetative reproduction from rhizome and stolon extension is presumed to be the primary means of reproduction on disturbed sites.

Artificial Establishment of HEATH Indicator Species—

The presence of rhizomes or stolons has implications on recommending plugs or cut sod as a means of establishing these species on disturbed sites. Merten's moss-heather is easily propagated by layering or from cuttings (Parish et al. 1996). Red mountain-heath is probably similar. Partridgefoot is extremely easy to propagate. Although it takes readily from seed, it is most easily propagated from a small section of stem and rhizome rooted in moist sand.

Whatever the source, transplants will fail on sites that do not have the potential to support these species. Therefore it is critical to determine that natural and human-induced conditions are favorable for their establishment and survival. Managers should use a wetland/riparian plant association classification to determine if the plants are natural to the site. Site evaluation may indicate these species will be restocked by plants already on the site or by natural regeneration by rhizome and stolon extension rather than requiring expensive transplants. Reducing soil trampling and compaction is critical. (For more information on the short- and long-term revegetation potential of selected riparian wetland plant species, see app. B-5.)

Stand Management—

Scattered, small, slow-growing trees, tree "islands," open woodlands, or krummholz may occur within HEATH series stands. Dwarfed trees may be 50 to more than 100 years of age and probably began invading HEATH stands as a result of milder climate following the end of the ice age. Silviculture opportunities are not appropriate on these sites, as no techniques are known to assure reforestation.

All sample plots were in good ecological condition so that little can be gleaned from plot data about successional pathways following disturbance. Fortunately we have the study by Cole (1989) described in the "Recreation" section. Continued study of other disturbed sites is needed. Because most sites are transitional to uplands, the primary concern is maintaining natural plant cover and its resistance to overland waterflow. Therefore, where a site has been highly altered, management could consider restoring native mountain-heaths, moss-heathers, partridgefoot, and huckleberries for their soil stability values. At the same time, establishing a good cover of organic material on the soil surface will speed vegetation recovery on severely damaged sites.

Growth and Yield—

Height growth for the indicator species appears to be extremely slow on these harsh sites. However, none of the mountain-heath and moss-heather species were sampled for height growth analysis.

Down Wood—

The overall amount of down logs is negligible as many of the plots in the HEATH series are above the elevation limits of tree growth. Logs covered less than 1 percent of the ground surface (app. C-3).

Definitions of log decomposition classes are on page 15.

	Down log attributes				
Log decomposition	Tons/ acre	Cu. ft./ acre	Linear ft./ acre	Sq. ft./ acre	% ground cover
Classes 1–5	0.22	67	407	174	0.04

Fire—

The HEATH series lies within zones of frequent lightning strikes. However, fires are rare on these sites and adjacent timberline stands because of the open nature of the adjacent forests (if any), frequent areas of rock and wetlands, the short growing season, low stature of the plants, moist soils, and relatively cold temperatures associated with these high-elevation sites. Most stands show no evidence of fire. However, during periods of very severe drought, HEATH stands may be burned along with the adjacent alpine or forest communities. Fire intervals appear to be at least several hundred years, as evidenced by the extreme age of snags and logs in nearby forested sample plots.

The rhizomes of Cascade huckleberry and other huckleberries lie deeply enough below the soil surface that they usually survive all but the most severe fires. The stolons and trailing stems of the various mountain-heaths, moss-heathers, and partridgefoot are shallow and can be eliminated by light- to moderate-intensity fire. Henderson (1973) felt that fires in heather-heath-huckleberry communities have little effect on Cascade huckleberry but greatly reduce the mountain-heaths and moss-heathers. Fire destroys the shallow rhizomes of the heaths and heathers, but Cascade huckleberry resprouts from underground rhizomes following the fire. In addition, Cascade huckleberry seed is well suited to animal dispersal and can be transported long distances to disturbed sites.

Animals—

Browsing. Cattle do not use red mountain-heath; sheep use it only in seriously overgrazed areas, such as around bedding grounds or along driveways (USDA FS 1937). It may even be poisonous to livestock as it belongs to the heath family and is closely related to plants that are known to be poisonous such as the alpine laurel. It is presumed that other moss-heathers and mountain-heath are similar in palatability and response to browsing.

Huckleberries in general are of negligible value for cattle, although caribou, deer, and elk use them extensively (USDA FS 1937). Elk, in particular, use them intensively and browse the stems and twigs on winter range. The taller huckleberry species, as a rule, are more palatable than the low, sprawling species such as grouse huckleberry, low huckleberry, dwarf huckleberry, and Cascade huckleberry. Cascade huckleberry is moderately palatable to sheep.

In general, browsing of older stems of moss-heathers, mountain-heaths, and Cascade huckleberry is probably low. Use of young twigs and sprouts may be heavier, especially where livestock grazing has heavily reduced other forage resources. Overall, little is known about the effect of overuse on the appearance, shape, and vigor of these species. The protein content of the indicator species is unknown but presumed low. Dwarf huckleberry (often associated with the HEATH series) is considered almost worthless forage (USDA FS 1937). Given the generally low palatability of HEATH series plants, it is likely that trampling and soil compaction have a greater impact on plant abundance and vigor than browsing itself (app. B-5).

Livestock. Hikers, horses, and livestock have caused extensive damage to timberline and alpine environments throughout the world (Arno and Hammerly 1984). Fortunately, in the Pacific Northwest damage appears less extensive than elsewhere in the world. Still, the degradation has begun and the risks are great, as once these HEATH communities are destroyed they take decades, if not centuries, to recover.

Although grazing of HEATH associations has been locally heavy in the past, poor access or protection by either high elevation or wilderness status generally limits most modern livestock grazing in eastern Washington. Domestic grazing is unusual except for occasional "grandfather" cattle and sheep allotments in some of the wilderness areas. Where grazing occurs, these shrub stands do not physically limit grazing; rather the generally poor palatability of the species causes livestock to graze elsewhere, perhaps on more palatable sedge or grass meadows.

Total shrub and herb forage production is unknown but appears very low. Two clipped red mountain-heath communities in Montana had a mean shrub and herb productivity of only 166 and 237 pounds per acre, per year dry weight, respectively (Cooper et al. 1997). A Merten's moss-heather stand was more productive, with 267 and 979 pounds per acre shrub and herb productivity, respectively. HEATH stands in eastern Washington appear equally variable, depending on species composition, soil texture, moisture, and snowpack duration. Plots within the maritime areas of the Cascade crest are likely more productive compared with those farther to the east. In most stands, shrubs generally dominate and there is low cover of herbs except in stands that are transitional to sedge or grass meadows. Browse production is low owing to the low stature of the shrubs.

The use of HEATH series stands varies greatly by stand accessibility, the palatability of other browse and forage species, the availability and condition of forage in nearby plant communities, and grazing intensity. In reality, most stands in the HEATH series are too remote and unpalatable to be grazed, even in existing allotments. Other than trampling, historical livestock grazing may have had minimal impact on HEATH stands on the Okanogan and Wenatchee NFs. (For more information on forage palatability, see app. B-1. For potential biomass production, see app. B-5.)

Wildlife. The HEATH series is located in terrain that provides valuable summer cover and forage for mountain goats, elk, and mule deer. In general, deer and elk use huckleberries extensively (USDA FS 1937). Structural diversity of HEATH stands is low unless within the timberline zone. Here tree "islands," woodlands, or krummholz stands of mountain hemlock, subalpine fir, Engelmann spruce, whitebark pine, or subalpine larch provide thermal and hiding cover for large ungulates. Huckleberry foliage in general is relatively high in carotene and energy content, with fair protein content (Dahlgren and Frylestam 1984). The value of mountain-heaths and moss-heathers is presumed low although the author has observed mountain goats eating them in the Enchantment Mountains. The berries of Cascade huckleberry are an important food source for bears. Other huckleberries found in HEATH series stands also are important, especially east of the range of Cascade huckleberry. Low berry production years have been associated with low cub survival (Rogers 1976), and crop failures increase the likelihood of bear-human encounters as hungry bears come into contact with high-country recreationists. Despite the low growth form, HEATH stands provide cover for many small mammals such as chipmunks, shrews, and voles. Seeds, flowers, and berries provide food for small mammals. These sites are situated well above the elevation limits of beavers.

Although short in stature, the dense shrubs in the HEATH series provide hiding and thermal cover for many species of birds. Spruce grouse, blue grouse, ptarmigan, bluebirds, and thrushes are typical of birds feeding on huckleberry fruits in high-elevation stands. Ground-nesting birds such as Oregon juncos use these low shrub stands for nesting and brood rearing. (For more information on thermal or feeding cover values, see apps. B-2 and B-3. For information on food values or degree of use, see apps. B-2 and B-4.)

Fish. Wetter communities in the SALIX and MEADOW series often separate stands in the HEATH series from streams and lakes. The dense shrub cover, as well as the herbs, litter, and mosses associated with the HEATH series provide considerable protection from sediment transport by overland flow to nearby streams, wetlands, and lakes (for more information, see app. B-5, erosion control potential).

Recreation—

The variety and richness of meadow flora and communities make the timberline and alpine zone very attractive to scientists and recreationists (Franklin and Dyrness 1969). These communities provide an excellent opportunity for viewing wildflowers and many species of wildlife. Nearby lakes and streams provide attractive fishing opportunities. Although remote, these sites are often served by an extensive network of trails, providing more access to adventurous hikers and horsemen. Trails, campsites, and cross-country travel have had severe trampling impacts locally in eastern Washington (Cole 1993). Trampling associated with horse camps especially impact these areas.

Fortunately, a scientific study demonstrates the impacts of trampling on red mountain-heath communities in the Okanogan Cascades (Cole 1993). This study recorded the impacts on various plant communities from passes of a loaded backpacker. Changes in vegetation cover were significant after only 25 passes, and the cover did not improve after 1 year of recovery. Two hundred passes started to change species composition and richness, with dead shrubs and stems still evident after 1 year of recovery. After 500 passes, total vegetation coverage was only 6 percent compared with cover at the beginning of the study, and an evident trail was still visible after 1 year of recovery. At this point, the trail is reflective of conditions along main trails. Main trails often have multiple pathways as hikers and horseriders go off the main course during wet, muddy conditions. Frequently used cross-country trails, campsites, and paths around lakeshores are often in very degraded condition, and recovery is nearly impossible under these conditions of repeated use, trampling, and soil compaction. Even with protection, transplanted plugs may survive but not spread on degraded HEATH sites (Cole 1986). Recovery can probably be measured in decades, if not centuries.

Recreation managers may manage low-impact campsites differently from high-impact sites (Cole 1989). Poor management can result in rapid deterioration of low-impact campsites, whereas proper management can lead to rapid recovery. The keys to managing low-use areas include:

- Maintain low levels of use.
- Avoid consistent use of the campsites.
- Discourage high-impact types of use.

High-use campsites are not likely to either deteriorate any further or improve in a short period. The keys to managing them include:

- Concentrate use on resistant, well-impacted sites.
- Discourage user behavior that contributes to long-term deterioration.
- Close and rehabilitate poorly located or unneeded sites.
- Implement sound trail management practices that include:
  - Discourage travel on closed trails and "user"-created trails.
  - Encourage hikers and horseback riders to travel single file and keep to the main tread.
  - Discourage shortcuts on switchbacks.
  - Encourage trailside breaks on durable sites.
  - Encourage hikers to spread out when walking off a trail.
  - Do not mark cross-country routes with rock cairns.

Managers should expect slow recovery for revegetation efforts in HEATH communities. Increaser species such as partridgefoot, alpine timothy, mountain hairgrass, black alpine sedge, other sedges, alpine bluegrass, arnica, aster, lupine, and pussytoe species are native herbs, which may be helpful in revegetation efforts (Lillybridge et al. 1995).

Estimating Vegetation Potential on Disturbed Sites—

Estimating vegetation potential on disturbed sites is not usually necessary (except on localized sites such as trails and campsites) because human or domesticated animals minimally impact these sites. The vegetation adjacent to the disturbed site is almost always in a condition that allows recognition of the vegetation potential within the disturbed areas.

Sensitive Species—

No sensitive species were found on the ecology plots (app. D).

ADJACENT SERIES

Rock lands; alpine meadows; or "islands" of forest in the LALY, PIAL, ABLA2, or TSME series occur on adjacent upland slopes. The SALIX and MEADOW series usually dominate adjacent riparian/wetland zones.

RELATIONSHIPS TO OTHER CLASSIFICATIONS

The HEATH series is newly described for eastern Washington. The HEATH series occurs around the world, and Franklin and Dyrness (1969, 1973) describe similar communities in the Cascade Range. Similar HEATH associations are abundant in the northern Rocky Mountains. The HEATH series and a similar PHEM association are described in the classification for central Oregon (Kovalchik 1987). Cole (1985, 1993) conducted trampling studies on mountain-heath and moss-heather dominated communities in the Rocky Mountains in Montana and Cascade Range in Washington.

U.S. DEPARTMENT OF THE INTERIOR, FISH AND WILDLIFE SERVICE WETLANDS CLASSIFICATION

System:	palustrine
Class:	scrub-shrub
Subclass:	needle-leaved evergreen
Water regime:	(nontidal) intermittently to seasonally saturated

KEY TO THE HEATH PLANT ASSOCIATIONS

1. Mountain-heaths (*Phyllodoce* spp.) and moss-heathers (*Cassiope* spp.) are inconspicuous, hidden under a dense layer of graminoids .... **Go to the MEADOW series key (page 252)**
2. Subalpine larch (*Larix lyallii*) ≥25 percent canopy coverage .... **Subalpine larch/Merten's moss-heather–red mountain-heath (LALY/CAME-PHEM) association**
3. Cascade huckleberry (*Vaccinium deliciosum*) ≥5 percent canopy coverage, sites maritime .... **Red mountain-heath–Cascade huckleberry (PHEM-VADE) association**
4. Moss-heathers (*Cassiope* spp.), mountain-heaths (*Phyllodoce* spp.), or partridgefoot (*Luetkea pectinata*) ≥25 percent canopy coverage, sites continental .... **Merten's moss-heather–red mountain-heath (CAME-PHEM) association**

Table 16—Constancy and mean cover of important plant species in the HEATH plant associations

Species	Code	CAME-PHEM 7 plots		PHEM-VADE 11 plots	
		CON[a]	COV[b]	CON	COV
Tree understory:					
Pacific silver fir	ABAM	—	—	18	3
subalpine fir	ABLA2	43	1	73	9
subalpine larch	LALY	57	3	9	1
Engelmann spruce	PIEN	14	10	27	1
mountain hemlock	TSME	—	—	45	4
Low shrubs and subshrubs:					
Merten's moss-heather	CAME	86	23	55	11
four-angled moss-heather	CATE2	14	35	—	—
western wintergreen	GAHU	14	12	—	—
alpine laurel	KAMI	71	11	27	1
Labrador tea	LEGL	14	2	27	19
red mountain-heath	PHEM	100	15	100	35
Cascade willow	SACA6	29	6	—	—
dwarf huckleberry	VACA	57	23	—	—
Cascade huckleberry	VADE	29	1	100	21
Perennial forbs:					
alpine pussytoes	ANAL	29	23	—	—
mountain arnica	ARLA	14	2	55	1
twinflower marshmarigold	CABI	14	15	27	3
slimpod shooting-star	DOCO	43	7	—	—
Jeffrey's shooting-star	DOJE	14	1	18	3
golden fleabane	ERAU	14	28	—	—
peregrine fleabane	ERPES	—	—	9	5
Rainier pleated gentian	GECA	57	2	36	1
false saxafrage	LEPY	—	—	55	5
Canby's licorice-root	LICA2	14	2	82	2
partridgefoot	LUPE	86	4	55	2
fivestamen miterwort	MIPE	—	—	27	1
elephanthead pedicularis	PEGR	57	4	55	1
fanleaf cinquefoil	POFL2	71	8	82	2
dotted saxifrage	SAPU	14	2	36	6
cleftleaf groundsel	SECY	57	7	—	—
arrowleaf groundsel	SETR	—	—	73	1
globeflower	TRLA4	14	1	18	8
Sitka valerian	VASI	14	1	82	3
American false hellebore	VEVI	—	—	73	1
Grass or grasslike:					
Merten's sedge	CAME2	—	—	9	5
black alpine sedge	CANI2	100	12	73	9
saw-leaved sedge	CASCP2	—	—	36	1
showy sedge	CASP	29	5	64	2
timber oatgrass	DAIN	14	3	18	8
Drummond's rush	JUDR	71	2	9	Tr[c]
smooth woodrush	LUHI	57	8	55	1

[a]CON = percentage of plots in which the species occurred.
[b]COV = average canopy cover in plots in which the species occurred.
[c]Tr = trace cover, less than 1 percent canopy cover.

VINE MAPLE SERIES

Acer circinatum

ACCI N = 12

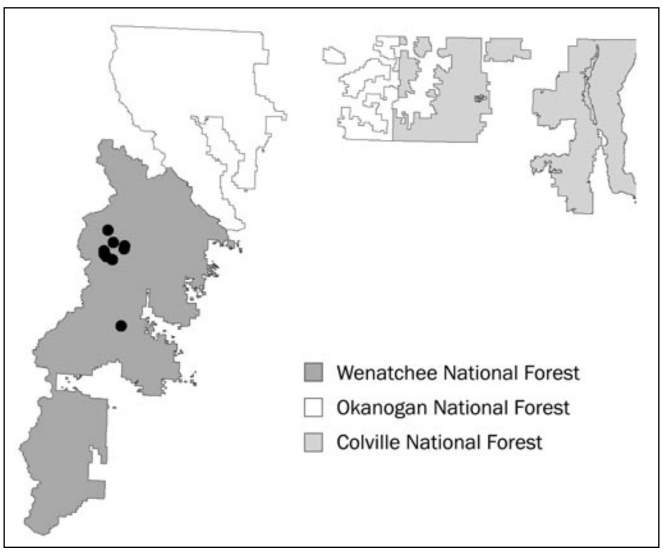


Figure 27—Plot locations for the vine maple series.

VINE MAPLE[1] is found only in the Pacific Northwest. It occurs from the Cascade Range of southwestern British Columbia to the coast and extends south to northern California (Hitchcock and Cronquist 1973). It occasionally extends a short distance across the crest of the Cascade Range into eastern California, Oregon, and Washington in areas influenced by maritime climates.

Vine maple is generally characterized as an understory shrub that grows in moist, maritime forests. Annual precipitation varies from more than 50 inches at the eastern edge of the species' distribution to more than 100 inches near the Cascade crest. Given the low elevation of vine maple plots, a relatively warm climate also may be an important factor in vine maple distribution. Vine maple does not tolerate permanently high water tables, and it does not inhabit wetlands such as carrs and swamps. Most plots are located in riparian zones on mineral soils associated with moist, well-drained fluvial surfaces such as sharply elevated streambanks and terraces. Several plots are located in well-drained ephemeral channels, as well as on the margins of wetlands along ponds and lakes. Vine maple is also locally extensive in uplands, both under conifers and in lower elevation avalanche chutes (Lillybridge et al. 1995).

Therefore, the ACCI series is restricted to strong maritime climates in eastern Washington. The ACCI series also is found on lands administered by the Okanogan NF that lay west of the Cascade crest near Ross Lake. In summary, the ACCI series appears to require warm valley temperatures associated with low to moderate elevation and high precipitation relative to the rest of eastern Washington. The series is limited in acreage as most vine maple stands are found as an understory below conifers, and it is unusual to find vine maple-dominated stands without conifer overstory.

CLASSIFICATION DATABASE

The ACCI series includes all nonforest stands potentially dominated by at least 25 percent canopy coverage of vine maple. The series was sampled only on the Wenatchee NF (fig. 27). Sample stands are common on the Lake Wenatchee RD, and one plot is located on the Leavenworth RD. This limited distribution is in part an artifact of sample plot distribution, and ACCI stands are probably also common within maritime areas on the Cle Elum, Lake Chelan, (perhaps) Entiat RDs, and west of the Cascade crest on lands administered by the Okanogan NF. Twelve riparian sampling plots were measured in the ACCI series. From this database, two major associations are described. These samples are mostly located in late-seral to climax stands in good ecological condition, although species composition on some sites may be shifting toward conifers owing to sediment accumulation and consequent lowering of the water table.

[1] See appendix A for a cross reference for all species codes and common and scientific names used in this document.

Vine maple plant associations

	Scientific name	Common name	Ecoclass code	Plots
Major associations:				
ACCI	*Acer circinatum*	Vine maple	SW70	6
ACCI-OPHO/ATFI	*Acer circinatum-Oplopanax horridum/Athyrium filix-femina*	Vine maple-devil's club/lady fern	SW7121	6

VEGETATION CHARACTERISTICS

The currently accepted name of vine maple is *Acer circinatum*. Little obvious variation has been observed in the species in eastern Washington. Vine maple is used early in the key to the various shrub series, as it is so indicative of maritime climates. The ACCI association is quite variable in species composition. Mountain alder and red-osier dogwood are codominant with vine maple on three of the plots and would have keyed to the ALIN or COST series if ACCI had occurred later in the shrub series key. The ACCI-OPHO/ATFI association is less variable, but Sitka alder or mountain alder dominate three plots that would have keyed to ALSI/OPHO or ALIN/OPHO if ACCI were keyed later.

Vine maple is generally abundant to nearly a pure dominant, averaging 66 percent canopy coverage for the ACCI series as a whole. Vine maple ranges from a low of 49 percent average canopy coverage in ACCI-OPHO/ATFI to 82 percent in the ACCI association. Vine maple is generally considered shade tolerant, but its cover can be reduced significantly under dense conifer canopies (Lillybridge et al. 1995). The relatively low vine maple canopy coverage on the ACCI-OPHO/ATFI association is the likely response to deep shade from conifers on adjacent fluvial surfaces as well as competition from other tall shrubs. Here, dense Sitka alder occasionally combines with vine maple to create thickets on some sites, especially those without adjacent conifer cover. The ACCI association, on the other hand, occurs in larger valley bottoms. The large streams and rivers associated with these bottoms not only produce relatively wide, conifer-free sites for vine maple abundance, but they also ensure that plenty of sunlight reaches the stands. Under these conditions, vine maple branches intermingle with those of other shrubs such as red-osier dogwood and mountain alder to create impenetrable thickets.

A relatively short herb list is associated with the ACCI series because of the dense shrub overstory, the limited elevation range and climate, and the limited number of associations. Few herbs survive under the thick canopy of the ACCI association. Red-osier dogwood and Sitka or mountain alder can be codominant on these sites. Other shrubs occasionally well represented include bittercherry, Sitka mountain-ash, and myrtle pachistima. Even though it may have more open shrub canopies, the ACCI-OPHO/ATFI association still has very few understory herbs. Only lady fern is well represented. The shrub layer is somewhat richer. Mountain alder, Sitka alder, and devil's club are codominant on some sites. Other common shrubs include prickly currant and salmonberry.

It is common for trees to be scattered in the overstory and understory on ACCI series plots. Tree cover approaching 25 percent conifer coverage may indicate a site changing toward forest potential on account of flooding and sediment accumulation.

PHYSICAL SETTING

Elevation—

The majority of ACCI series plots are between 2,000 and 3,200 feet; only one plot is higher than 3,225 feet.

	Elevation (feet)			
Forest	Minimum	Maximum	Average	N
Wenatchee	1,960	4,100	2,729	12

Little elevation difference was observed between associations except for one 4,100-foot ACCI-OPHO/ATFI plot. The ACCI association may extend to lower elevations in larger valleys and on warmer sites.

	Elevation (feet)			
Plant association	Minimum	Maximum	Average	N
ACCI	1,960	3,075	2,678	6
ACCI-OPHO/ATFI	2,300	4,100	2,779	6
Series	1,960	4,100	2,729	12

Valley Geomorphology—

The ACCI series is found in a variety of valley width and gradient classes. No single pattern is apparent for the ACCI series as a whole. Most plots are located in two very divergent landforms, either broad, very low gradient valleys or narrow, very high gradient valleys.

	Valley gradient					
Valley width	Very low	Low	Moderate	Steep	Very steep	N
Very broad	4	1	0	0	0	5
Broad	0	0	0	0	3	3
Moderate	0	0	0	0	0	0
Narrow	0	0	0	1	3	4
Very narrow	0	0	0	0	0	0
Series total	4	1	0	1	6	12

Differences are more apparent when comparing the associations. Most ACCI-OPHO/ATFI plots (four of six plots) are located in cold, steep, narrow drainages, sites more favorable for devil's club dominance. The two plots located in broad valleys lack significant cover of devil's club, but lady fern (a species more tolerant of wet, warm sites) is well represented. All of the ACCI association plots are located in broader valleys (wider than 330 feet). Four of six plots occur in low to very low valley gradients (0 to 3 percent). The two steep ACCI plots are on alluvial fans next to lakes. These plots were coded as steep valleys, but perhaps very low gradient would have been more representative of the open, sunny lakeside conditions.

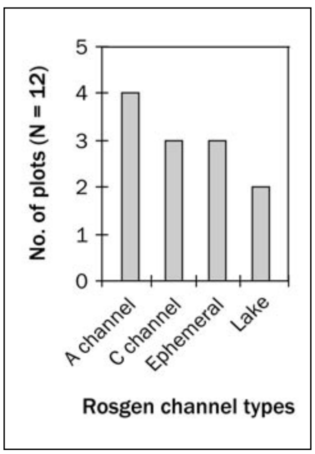
Plant association	Valley width: Very broad	Broad	Moderate	Narrow	Very narrow	N
ACCI	4	2	0	0	0	6
ACCI-OPHO/ATFI	1	1	0	4	0	6
Series total	5	3	0	4	0	12

Plant association	Valley gradient: Very low	Low	Moderate	Steep	Very steep	N
ACCI	3	1	0	0	2	6
ACCI-OPHO/ATFI	1	0	0	1	4	6
Series total	4	1	0	1	6	12

In summary, the ACCI-OPHO/ATFI association occurs in narrow, steep drainages except for an occasional stand keyed by lady fern (wide, low gradient valleys). The ACCI association is found in wide, low gradient valleys where large streams, through flooding and deposition, have had the chance to create open fluvial surfaces on point bars and streambanks for establishment of vine maple seedlings. ACCI also may occur on toeslopes, alluvial fans, and lakeshores.

Channel Types—

The ACCI series is found along a variety of channel types in the Rosgen A and C, ephemeral, and lake classes.

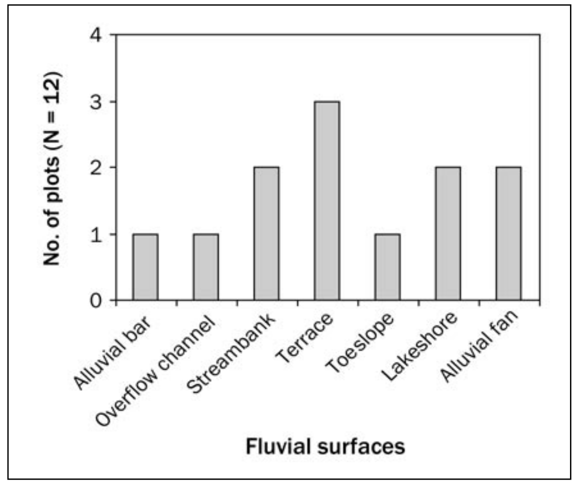


The distribution of stream types varies by plant association. The narrow, steep valleys most prominent in the ACCI-OPHO/ATFI association support high-energy A channels, although one lady fern dominated plot is along a C channel and another along an ephemeral channel (again, dominated by lady fern). The ACCI association plots usually are found along C channels, ephemeral channels, and on the margins of ponds and lakes. The two ephemeral ACCI plots are actually located on an alluvial fan beside a lake. Both plant associations also have been observed within old overflow channels and other depressions on terraces that are intermittently flooded and thus too wet for conifer establishment.

Plant association	Rosgen channel types: A	C	Ephemeral	Lake	N
ACCI	0	2	2	2	6
ACCI-OPHO/ATFI	4	1	1	0	6
Series total	4	3	3	2	12

Fluvial Surfaces—

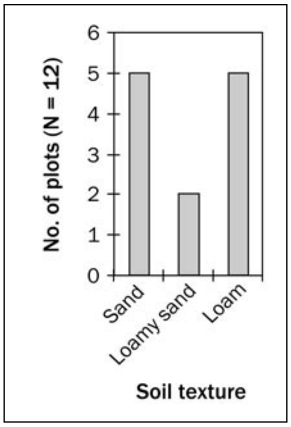
For so few plots, the ACCI series is found on a surprising variety of fluvial surfaces. Stands occasionally occur on intermittently saturated or intermittently flooded point bars, floodplains, streambanks, and overflow channels. Stands are more common on drier sites such as filled-in overflow channels, ephemeral draws, terraces, and alluvial fans as well as on well-drained banks and toeslopes surrounding ponds and lakes.



Some differences are apparent when looking at individual associations. Two ACCI association plots are located on an alluvial fan where an ephemeral stream is entering a lake. Two are on relatively similar toeslope sites that are transitional to lakeshores. The other two ACCI association plots are found on a well-drained alluvial bar and on an overflow channel. The ACCI-OPHO/ATFI plots are largely associated with riparian fluvial surfaces such as streambanks and terraces. All these sites are similar in that they are subjected to occasional floods or soil saturation but are moist and well drained rather early in the growing season. The one ACCI-OPHO/ATFI toeslope site is located on wet soils by a lake and is possibly a seral community type. Fire, insects, or disease may have eliminated the conifer overstory, and the dense vine maple stand may have prevented the regeneration of conifers.

Plant association	Fluvial surfaces: Alluvial bar	Overflow channel	Streambank	Terrace	Toeslope	Lakeshore	Alluvial fan	N
ACCI	1	1	0	0	0	2	2	6
ACCI-OPHO/ATFI	0	0	2	3	1	0	0	6
Series total	1	1	2	3	1	2	2	12

Soils—



Mineral soils with sand, loamy sand, and loam textures dominate the ACCI series. Early-seral sites (recent flooding) have sand to sandy loam textures and may contain considerable coarse fragments. Sand textures are especially prominent on alluvial bars, streambanks, and overflow channels. Fine-textured soils occur along lakeshores, elevated streambanks, and terraces and are especially common in denser ACCI stands.

Little additional information is gained by looking at soil texture according to individual association. Both plant associations support similar soil texture classes; the absence of loamy sand soils in the ACCI association is probably an artifact of the small sample size.

	Soil texture			
Plant association	Sand	Loamy sand	Loam	N
ACCI	3	0	3	6
ACCI-OPHO/ATFI	2	2	2	6
Series total	5	2	5	12

Water tables were measured on only three plots (no table is shown), where they ranged from 1 to 59 inches below the soil surface. The ACCI-OPHO/ATFI association may have higher water tables than the ACCI association and remain moist through the growing season. Plots were sampled in summer, following the flood season, and a few plots may have been saturated or temporarily flooded during earlier peak flows. Therefore, water tables reflect only those measured during summer. None of the plots had surface flooding when they were sampled.

Soil temperature (degrees Fahrenheit) was measured on all 12 plots. ACCI-OPHO/ATFI soils were colder than those associated with the ACCI association, which is consistent with their location in narrower, steeper valleys than the more open valleys of the ACCI association.

	Soil temperature (°F)			
Plant association	Minimum	Maximum	Average	N
ACCI	52	65	59	6
ACCI-OPHO/ATFI	48	55	52	6
Series	48	65	55	12

In general, the ACCI series is indicative of sites with temporarily saturated mineral soils that are moist but well drained during the growing season. Vine maple as a species does not survive well on soils with long periods of soil saturation.

ECOSYSTEM MANAGEMENT

Natural Regeneration of Vine Maple—

Vine maple is a poor seed producer and relies primarily on vegetative means of reproduction (Anderson 1969). It begins to produce seed at an early age, usually within 10 years (Olson and Gabriel 1974). The flowers appear in spring when leaves are half grown, and the winged seeds are dispersed by wind in fall. Seeds probably do not disperse very far in the quiet air under dense shrub and forest canopies, but wind may be an important factor in open ACCI series stands, especially those at the base of avalanche chutes or along the edge of rivers.

Vine maple forms dense thickets through layering of branches. Like red-osier dogwood and most willow species, vine maple has root primordia capable of producing new plants from branches in contact with moist ground. Plants also produce new shoots from the bases of burned, dying, or girdled branches.

Artificial Establishment of Vine Maple—

Little is known about the use of vine maple for rehabilitation, probably because foresters and researchers are so concerned about its ability to compete with conifers after logging and following wildfire (Bailey 1966, Dyrness 1973, Leininger and Sharrow 1987). The focus has usually been on controlling vine maple rather than encouraging it. The presence of root primordia may have some implication on recommending cuttings as a means of establishing vine maple on disturbed riparian sites. However, nursery-grown rooted cuttings and seedlings may show better results.

Whatever the source, plantings will fail on sites that do not have the potential to support vine maple. It is therefore critical to determine that natural and human-induced conditions are favorable for its establishment and survival. Managers can use a wetland/riparian plant association classification to determine if vine maple is natural to the site. Site evaluation also may indicate if vine maple will be stocked by natural regeneration. A stocking survey may show that plants are already established on the site, and small, suppressed shrubs will quickly respond to open grown conditions. Given the overwhelming evidence that vine maple will proliferate on cleared forest sites, artificial regeneration may be unnecessary on ACCI series sites. (For more information on the short- and long-term revegetation potential of selected riparian wetland plant species, see app. B-5.)

Stand Management—

All sample plots were in fair or better ecological condition so that little is known about rehabilitating disturbed stands, except for studies of logged upland stands. A study of disturbed riparian vine maple stands is needed. Where on active fluvial surfaces, the ACCI series is subject to recurring scouring and deposition by floods. If the site has been disturbed, managers should consider restoring vine maple and associated species such as Sitka or mountain alder and red-osier dogwood for their excellent streambank stability values. Bare streambanks and floodplains could be planted or seeded and protected from the limiting factor that caused the cover and condition to be altered to a degraded stage.

Where the ACCI series occurs on frequently flooded fluvial surfaces, the high coarse-fragment content minimizes most soil compaction problems. Where deposition has been significant, the deeper loam soils of both the ACCI and ACCI-OPHO/ATFI associations are subject to compaction and trampling, especially on wet soils. In some cases, deposition may be deep enough for the sites to be transitional to conifer or cottonwood potential. Where conifer or cottonwood encroachment is dense enough to shade the vine maple, reducing tree cover through selection cutting or prescribed fire will help create open stand conditions. This will increase shrub cover, thus delaying the transition to forest. When scattered trees are present, wood production opportunities are not appropriate on plots located close to lakes, ponds, and streams.

Growth and Yield—

The initial height growth of vine maple is rapid but tapers off as stem heights exceed 10 feet. The age of 2- to 2.7-inch-diameter stems ranged from 17 to 45 years and averaged 32 years. Heights ranged from 15 to 20 feet and averaged 18 feet. The stem heights are somewhat misleading as they often state the total length of recumbent stems that swoop up on their ends. Height above ground is often less. Heights are much shorter under dense conifer stands or where narrow bands of ACCI series sites are overtopped by adjacent conifer stands.

Growth attributes	Minimum	Maximum	Average	N
Age (years)	17	45	32	4
Height (feet)	15	20	18	4
Basal diameter (inches)	2	2.7	2.5	4

Down Wood—

The overall amount of wood is moderate compared with other shrub series (app. C-3). Logs covered 4.5 percent of the ground surface. This indicates that many ACCI sites occur within one tree height of forest communities or that logs may be transported to riparian sites during flood events. Snags and logs may play an important role in the structure and function of the ACCI series and provide diverse habitat for both plants and animals. Future supplies of down woody material should be considered in the management of adjacent and upstream forest.

	Down log attributes				
Log decomposition	Tons/ acre	Cu. ft./ acre	Linear ft./ acre	Sq. ft./ acre	% ground cover
Classes 1–5	13.16	1,842	1,983	1,947	4.47

Fire—

Fire is somewhat infrequent in riparian and lakeside ACCI stands owing to the high moisture content of the soils and vegetation as well as the relatively high rainfall and cool temperatures found on these maritime sites. However, during severe drought, ACCI series stands may be burned just as severely as the adjacent forest. Stands in narrow valleys may burn even in moderate fire years owing to the proximity of coniferous overstory in the adjacent uplands. Vine maple is well adapted to fire; its crown may be killed, but the root crown then produces numerous sprouts (Hubbard 1950, Russel 1974). Shrub canopy may be reduced where severe fires remove the duff and heat the upper soil for extended periods (Landis and Simonich 1984). Vine maple cover and frequency may drop dramatically following the fire, but preburn levels may be reached as quickly as 2 to 5 years after the fire (Dyrness 1973, Kovalchik et al. 1988).

Animals—

Browsing. Vine maple is grazed by both domestic and wild ungulates (USDA FS 1937). Browsing of older stems is probably low, whereas use of young twigs and sprouts is higher. This is especially true during late-season grazing where other forage resources have been heavily reduced by livestock on winter ranges, or in cases of unusual buildups of wild ungulate populations. Overall, little is known about the effect or overuse on the appearance, shape, and vigor of vine maple and ACCI stands (app. B-5).

Livestock. Vine maple is rated moderately to highly palatable for sheep and cattle and poor for horses (USDA FS 1937). Although not estimated in this study, total browse production must be quite high. Twigs are low in protein in winter (4.5 to 5 percent), but high in fat. Crude fiber is 43 to 50 percent by dry weight (Brown 1961, Einarsen 1946, Hines and Land 1974). Vine maple is much more palatable in summer when crude protein averages 9 to 13 percent and crude fiber 15 to 20 percent by dry weight. Sheep have been successfully used to control vine maple cover in cutover lands in western Oregon and Washington (Ingram 1931, Leininger and Sharrow 1987). Total herbaceous forage production appears to be low in vine maple stands as shrubs predominate and there is low cover of herbs.

The use of ACCI associations varies greatly by stand density, stand accessibility, the palatability of other browse species, the availability and condition of other forage, and grazing intensity. Wetter sites (ACCI-OPHO/ATFI) may receive lower grazing pressure owing to seasonally wet soils.

Livestock use is delayed until midsummer after the annual reproductive and energy requirements of the vegetation have been completed. In reality, many ACCI series stands are too dense to be grazed at all except along their margins. Livestock grazing probably has little impact on ACCI stands on the Wenatchee NF. (For more information on forage palatability, see app. B-1. For potential biomass production, see app. B-5.)

Wildlife. The high structural diversity of the ACCI series provides food, thermal cover, and hiding cover for many large ungulates. Vine maple is a preferred food of elk and deer (Bailey 1966, Mitchell 1950, Schwartz and Mitchell 1945). Browsing is especially high in summer owing to the high palatability and protein content of young twigs. Deer seldom use vine maple twigs in winter on account of high crude fiber content. However, elk use vine maple at all times of the year and use can be heavy, especially on winter ranges (Brown 1961, Hines and Land 1974, Hubbard 1950). Dense thickets of red-osier dogwood provide good fawning and rearing areas for deer and elk. The importance of vine maple stands for bears is unknown, but abundant sign was observed in and near the sample plots, especially those within avalanche chutes.

Vine maple stands also provide excellent cover for a variety of small mammals. The seeds, flowers, and buds provide food for numerous small mammals. For instance, squirrels eat the seeds and store them in caches after removing the hull and wing (Martin et al. 1951). Stands with an abundance of vine maple also may contain high concentrations of mountain beaver (Aller 1956, Hubbard 1950). There is little evidence of beaver colonies; they are probably present but likely rely mostly on streambanks and lake banks for denning sites and do not find conditions appropriate for dam building owing to large streams with high peak flows. Because vine maple is highly palatable, it is food for bank-dwelling beavers. (For more information on thermal or feeding cover values, see apps. B-2 and B-3. For information on food values or degree of use, see apps. B-2 and B-4.)

The dense shrubs provide hiding and thermal cover for many species of birds (Martin et al. 1951). Many bird species use vine maple stands for nesting, brood rearing, and foraging. Birds also eat vine maple seeds.

Fish. Land managers may have the perception that ACCI stands are nonriparian and occur only on mesic, well-drained terraces, toeslopes, and lower slopes that are too far from the stream to be considered important for streambank protection, fish cover, and stream thermal protection. However, plot data reflect sites located in both riparian and lacustrine zones. Where along streams, vine maple is often mixed with species such as Sitka alder, mountain alder, and red-osier dogwood. Together, these shrubs provide a dense network of roots and stems that are very effective in stabilizing streambanks and other active fluvial surfaces to withstand flooding or wave action. The dense multiple stems aid in filtering out sediments during high flows, thereby contributing to the overall building of streambanks and floodplains, channel maintenance, and stabilization of the stream. (For more information, see app. B-5, erosion control potential.) Streams lined with these shrubs develop stable channels that provide cover, food, spawning sites, and cool temperatures for trout and other salmonids. Where located away from permanent streams, such as overflow channels, ephemeral draws, and alluvial fans, the dense multiple stems aid in filtering out sediments during floods or overland flow.

Recreation—

The ACCI series provides an excellent opportunity for viewing elk, deer, and songbirds. Owing to low elevations, many sites are close to roads or trails. Easy access may provide for day hiking or fishing. However, owing to seasonal flooding, campsites and structures should be located elsewhere. Heavy human use in spring and summer can result in compacted soils, bank sloughing, and exposed soils along streambanks, but it is usually not a problem in these dense thickets.

Estimating Vegetation Potential on Disturbed Sites—

The need to determine the vegetation potential of disturbed ACCI series is unusual as these sites are minimally impacted by human activities on FS lands in eastern Washington. This is because of the use of buffer zones (logging excluded) and the density of the shrub stands, which limit human-caused disturbance. The major disturbance factor is flooding. Most stands are in fair to excellent ecological condition, and classification users can consistently find sufficient cover of vine maple to key to the ACCI series. Where the understory vegetation is depauperate, users can lower the cover criteria for the understory indicators one class to key the ACCI series. For the rare stand where the vegetation is largely gone, users of this guide can use experience or look at similar sites in nearby undisturbed valleys to key the site to the ACCI series.

Sensitive Species

Sensitive plants were not found on ACCI series sample plots (app. D).

ADJACENT SERIES

Adjacent terraces and upland slopes usually are dominated by coniferous forest in ABGR, THPL, TSHE, and ABAM series. The ACCI series does not occur at higher elevation in TSME, ABLA2, and LALY zones.

RELATIONSHIPS TO OTHER CLASSIFICATIONS

The ACCI series and plant associations are newly classified for eastern Washington. A vine maple plant community is described on the Mount Hood and Gifford Pinchot NFs (Diaz and Mellen 1996).

U.S. DEPARTMENT OF THE INTERIOR, FISH AND WILDLIFE SERVICE WETLANDS CLASSIFICATION

System:	palustrine
Class:	scrub-shrub
Subclass:	broad-leaved deciduous
Water regime:	(nontidal) temporarily saturated to intermittently flooded

KEY TO THE VINE MAPLE (*ACER CIRCINATUM*) PLANT ASSOCIATIONS

1. Devil's club (*Oplopanax horridum*) and/or lady fern (*Athyrium filix-femina*) ≥5 percent canopy coverage .... **Vine maple-devil's club/lady fern (ACCI-OPHO/ATFI) association**
2. Devil's club (*Oplopanax horridum*) and/or lady fern (*Athyrium* species) <5 percent canopy coverage .... **Vine maple (ACCI) association**

Table 17—Constancy and mean cover of important plant species in the ACCI plant associations

		ACCI 6 plots		ACCI-OPHO/ATFI 6 plots	
Species	Code	CON[a]	COV[b]	CON	COV
Tree overstory:					
grand fir	ABGR	17	1	67	1
bigleaf maple	ACMA	—	—	17	5
western redcedar	THPL	17	25	67	1
western hemlock	TSHE	—	—	50	1
Tree understory:					
grand fir	ABGR	—	—	50	3
western redcedar	THPL	—	—	67	2
Shrubs:					
vine maple	ACCI	100	82	100	49
mountain alder	ALIN	50	55	17	99
Sitka alder	ALSI	—	—	50	47
red-osier dogwood	COST	67	50	17	Tr[c]
bearberry honeysuckle	LOIN	—	—	17	5
devil's club	OPHO	—	—	100	20
bittercherry	PREM	50	20	—	—
Hudsonbay currant	RIHU	—	—	33	5
prickly currant	RILA	17	Tr	17	5
western thimbleberry	RUPA	50	1	50	2
salmonberry	RUSP	17	Tr	83	12
Scouler's willow	SASC	—	—	17	10
Sitka mountain-ash	SOSI	33	6	17	Tr
moosewood viburnum	VIED	—	—	17	5
Low shrubs and subshrubs:					
western prince's-pine	CHUMO	—	—	50	Tr
myrtle pachistima	PAMY	67	26	33	1
Perennial forbs:					
baneberry	ACRU	—	—	83	Tr
queencup beadlily	CLUN	—	—	83	Tr
Hooker's fairy-bells	DIHO	—	—	100	Tr
sweetscented bedstraw	GATR	17	Tr	50	Tr
pink wintergreen	PYAS	—	—	50	Tr
western solomonplume	SMRA	83	Tr	67	Tr
starry solomonplume	SMST	100	5	67	Tr
coolwort foamflower	TITRU	—	—	67	Tr
broadleaf starflower	TRLA2	33	Tr	50	Tr
white trillium	TROV	33	Tr	67	Tr
pioneer violet	VIGL	33	Tr	83	Tr
Ferns and fern allies:					
lady fern	ATFI	—	—	100	11
oak fern	GYDR	—	—	50	2

[a]CON = percentage of plots in which the species occurred.
[b]COV = average canopy cover in plots in which the species occurred.
[c]Tr = trace cover, less than 1 percent canopy cover.

SITKA ALDER SERIES

Alnus sinuata

ALSI N = 121

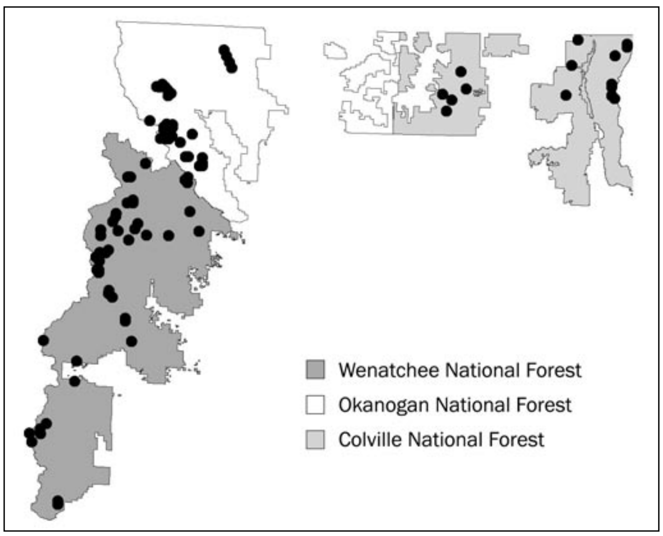


Figure 28—Plot locations for the Sitka alder series.

THE RANGE OF Sitka alder[1] extends from Alaska, British Columbia, and western Alberta south through the Olympic and Cascade Range of Washington and Oregon to northern California, then east through Washington and Oregon to much of Idaho and Montana (Hitchcock and Cronquist 1973). Central and eastern Washington appears to be a center of distribution for Sitka alder, as the ALSI series is weakly represented in other riparian/wetland classifications for the Northwestern United States (Crowe and Clausnitzer 1997, Hansen et al. 1995, Kovalchik 1987). In the literature, Sitka alder is typically thought of as a pioneer or early-seral shrub of cool, moist uplands where it colonizes disturbed or seral soils and often appears on avalanche chutes, recent burns, and fresh alluvium (Haeussler and Coates 1986, Hayes and Garrison 1960, Johnson 1968, Lawrence 1958, Oliver et al. 1985). In northeastern Oregon and eastern Washington, however, Sitka alder also may dominate well-drained sites along mountain streams as well as the margins of wetlands. In general, Sitka alder likes cold, moist climates at moderate to high elevations. Annual precipitation on sites averages from roughly 20 inches in the dry interior of the study area to well over 50 inches in the maritime climate along the Cascade crest, and more than 30 inches in the weaker inland maritime climate in northeastern Washington.

In this classification, the ALSI series is restricted to the riparian zone and sites associated with seeps, slumps, and the streamside locations in Sitka alder-dominated avalanche chutes. The ALSI series is common throughout most of the mountains of eastern Washington and is found on all three NFs and most RDs. It is less abundant in stronger continental climate zones, such as on the eastern half of the Tonasket RD and the Republic RD, where it is restricted to higher elevations where higher precipitation and shorter growing seasons compensate for the relatively dry, warm climate. Although not sampled during this study, the ALSI series is common at higher elevations in the "Meadows" area on the Tonasket RD and in the Kettle Range on the Republic RD. It also has been observed, although not sampled, near Calispell Mountain in the Selkirk Mountains.

CLASSIFICATION DATABASE

The ALSI series includes all nonforest stands potentially dominated by at least 25 percent canopy coverage of Sitka alder. The ALSI series was sampled on all three NFs and most RDs. It was not sampled on the Tonasket, Republic,

[1] See appendix A for a cross reference for all species codes and common and scientific names used in this document.

Sitka alder plant associations

	Scientific name	Common name	Ecoclass code	Plots
Major associations:				
ALSI-COST	*Alnus sinuata-Cornus stolonifera*	Sitka alder–red-osier dogwood	SW2222	9
ALSI-OPHO	*Alnus sinuata-Oplopanax horridum*	Sitka alder-devil's club	SW2223	14
ALSI-RILA	*Alnus sinuata-Ribes lacustre*	Sitka alder-prickly currant	SW2224	17
ALSI-RUSP	*Alnus sinuata-Rubus spectabilis*	Sitka alder-salmonberry	SW2225	8
ALSI/ALLUVIAL BAR	*Alnus sinuata*/alluvial bar	Sitka alder/alluvial bar	SWGR12	7
ALSI/ATFI	*Alnus sinuata/Athyrium filix-femina*	Sitka alder/lady fern	SW2111	18
ALSI/GYDR	*Alnus sinuata/Gymnocarpium dryopteris*	Sitka alder/oak fern	W2130	12
ALSI/MESIC FORB	*Alnus sinuata*/mesic forb	Sitka alder/mesic forb	SW2113	13
ALSI/SETR	*Alnus sinuata/Senecio triangularis*	Sitka alder/arrowleaf groundsel	SW2133	23

or Newport RDs or on the south half of the Colville RD, although it was observed there (fig. 28). One hundred twenty-one riparian plots were measured in the ALSI series; from this database, nine major ALSI plant associations are described. One potential one-plot association (ALSI/CACA) is not used in the ALSI series database nor described in this classification.

VEGETATION CHARACTERISTICS

Compared with mountain alder, there appears to be little variation in botanical characteristics in Sitka alder in eastern Washington. The taxon is accepted as *Alnus sinuata* (Sitka alder) throughout the Northwestern United States (Hitchcock and Cronquist 1973).

Sitka alder is abundant on all plots and ranges from a low 53 percent canopy coverage in the ALSI/ALLUVIAL BAR association to 80 percent in ALSI/GYDR, with an average of 67 percent for the ALSI series as a whole. There is a tendency for the cover of most associates to decrease dramatically with increasing Sitka alder cover. However, some species such as red-osier dogwood, various currants, salmonberry, red raspberry, Devil's club, lady fern, oak fern, and Fendler's waterleaf appear quite tolerant of Sitka alder competition and may be well represented or abundant even where Sitka alder exceeds 70 percent canopy coverage. The constancy and cover of these and other species vary according to the plant association.

Of the other indicator species in the ALSI series, red-osier dogwood is often codominant with Sitka alder at lower elevations in the ALSI-COST association, whereas salmonberry, devil's club, and lady fern characterize the wettest sites in the series. Salmonberry is also strongly associated with maritime climate. Forbs such as oak fern, arrowleaf groundsel, and coolwort foamflower are associated with moist plant associations, as is prickly currant.

It is common for both overstory and understory trees to be scattered on many ALSI series plots, especially along streambanks and on the adjacent terrace. Tree cover approaching 25 percent may indicate the soil and water relationships of the site are transitional toward forest potential.

PHYSICAL SETTING

Elevation—

The majority of ALSI series plots are between 2,500 and 5,500 feet. Only six plots are above 5,500 feet and four plots are below 2,500 feet. This is somewhat misleading owing to maritime climate influence along the Cascade crest and extreme northeastern Washington. Plot elevations on the Colville NF range from about 4,000 to over 5,500 feet, but the lower elevation ranges of plots are higher in the drier continental climate portions of the Colville NF compared with those located in the inland maritime climate. The ALSI series extends to much lower elevations (less than 3,000 feet) on the Wenatchee and Okanogan NFs owing to maritime-influenced climate close to the Cascade crest (deep snowpack and shorter growing seasons). These lower elevation sites allow a significant overlap with sites potentially dominated by mountain alder. It is not uncommon to find Sitka alder dominant on streambanks at lower elevations in strong maritime zones, whereas mountain alder dominates adjacent wetlands, which are sites that Sitka alder cannot tolerate.

	Elevation (feet)			
Forest	Minimum	Maximum	Average	N
Colville	3,840	5,700	4,826	15
Okanogan	2,600	5,850	4,253	46
Wenatchee	2,050	6,360	3,672	60
Series	2,050	6,360	4,036	121

Additional insight is gained by comparing elevations between ALSI plant associations. ALSI/SETR has the highest average elevation, yet all other associations have elevations that extend well into its range. The range of ALSI-COST is understandably low as red-osier dogwood is a low-elevation species. Any correlations with elevation in other associations are not apparent in this data, probably because of major differences in plot elevations within plant associations between forests. For instance, ALSI/SETR averages 4,968, 4,514, and 4,214 feet on the Colville, Okanogan, and Wenatchee NFs, respectively, yet the elevation ranges overlap greatly.

	Elevation (feet)			
Plant association	Minimum	Maximum	Average	N
ALSI/SETR	2,050	5,700	4,594	23
ALSI/MESIC FORB	2,540	6,360	4,301	13
ALSI-RILA	2,150	5,500	4,277	17
ALSI/ATFI	3,350	5,160	4,170	18
ALSI/GYDR	3,400	4,800	4,046	12
ALSI/ALLUVIAL BAR	2,600	5,370	3,955	7
ALSI-RUSP	2,880	5,730	3,734	8
ALSI-OPHO	2,900	4,520	3,324	14
ALSI-COST	2,325	3,760	2,931	9
Series	2,050	6,360	4,036	121

Valley Geomorphology—

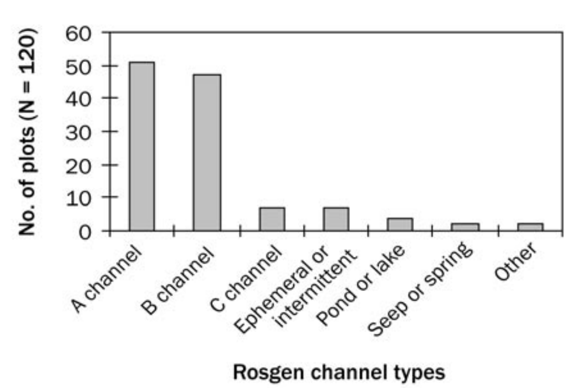
The Sitka alder series is found on a variety of valley width and gradient classes. Over half the plots are in moderate or narrow valleys with moderate to very steep gradients. About 13 percent are in valleys both very steep and narrow. There are few plots in wetlands or low gradient valleys. About two-thirds of ALSI plots are in moderate to steep valleys of narrow to moderate width. Only 26 of 121 plots (about 22 percent) are in valleys more than 330 feet wide. Ninety-five plots are located in valleys from less than 33 to 330 feet in width. The incidence of the ALSI series generally increases as valleys narrow. The 18 plots in very narrow valleys, however, may reflect a reduction in Sitka alder potential owing to shade from overtopping conifers and terrain. Similarly, the frequency of Sitka alder stands generally increases with increasing valley gradient. Only 32 plots were found where valley gradients were 3 percent or less, whereas 91 plots were found where valley gradients were greater than or equal to 4 percent. Most of these (58) occur where valley gradient was greater than 8 percent.

Valley width	Valley gradient					
	Very low	Low	Moderate	Steep	Very steep	N
Very broad	3	11	0	0	1	15
Broad	3	4	0	1	3	11
Moderate	0	7	12	4	9	32
Narrow	0	4	8	5	28	45
Very narrow	0	0	1	1	16	18
Series total	6	26	21	11	57	121

The distribution of the ALSI series by valley configuration may become clearer when considering individual plant associations. ALSI/OPHO, ALSI-RILA, ALSI/ATFI, ALSI/GYDR, and ALSI/SETR appear to favor narrower, steeper valleys. However, most associations occur in a variety of valley configurations, and other factors may better explain the distribution of the various ALSI associations.

Channel Types—

Channel types associated with the ALSI series reflect the above valley widths and gradients. Ninety-eight of 120 plots (82 percent) are associated with the well-drained margins of Rosgen A and B channels. Another 14 plots are associated with Rosgen C and intermittent channels or are in ephemeral draws. Few plots (7 percent) are associated with what would normally be perceived as wetland sites along E channels, seeps and springs, or the margins of lakes and ponds. Even in these sites, the soil must be at least moderately well drained for Sitka alder to dominate. For instance, lake and pond sites are actually well-drained banks at the edge of water or located at the abrupt transition from the adjacent wetlands to upland sites.



Plant association	Valley width					
	Very broad	Broad	Moderate	Narrow	Very narrow	N
ALSI-RUSP	2	0	3	3	0	8
ALSI-OPHO	1	0	5	4	4	14
ALSI/ATFI	2	2	4	6	4	18
ALSI/SETR	4	1	5	8	4	22
ALSI/ALLUVIAL BAR	0	1	2	2	2	7
ALSI-COST	3	2	2	2	0	9
ALSI/GYDR	1	0	3	7	1	12
ALSI-RILA	0	1	6	8	2	17
ALSI/MESIC FORB	2	3	2	5	1	13
Series total	15	10	32	45	18	120

Plant association	Valley gradient					
	Very low	Low	Moderate	Steep	Very steep	N
ALSI-RUSP	1	3	1	1	2	8
ALSI-OPHO	0	2	3	2	7	14
ALSI/ATFI	0	2	4	0	12	18
ALSI/SETR	1	4	3	2	12	22
ALSI/ALLUVIAL BAR	0	1	1	3	2	7
ALSI-COST	0	5	1	1	2	9
ALSI/GYDR	0	2	3	0	7	12
ALSI-RILA	0	3	3	2	9	17
ALSI/MESIC FORB	3	4	2	0	4	13
Series total	5	26	21	11	57	120

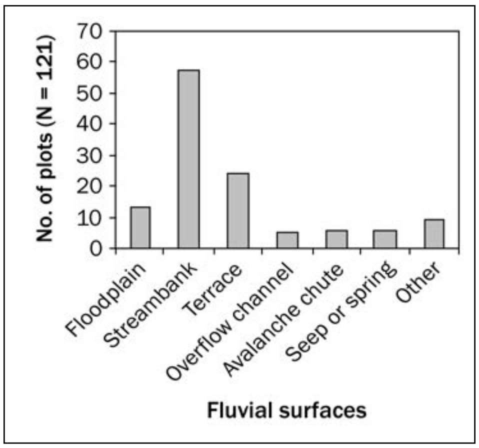
The same pattern holds with the individual ALSI plant associations. Only the ALSI/ATFI and ALSI/COST associations break the pattern of dominance by Rosgen A and B channels by perhaps being located on wetter sites along ephemeral or C channel types.

Plant association	Rosgen channel types							
	A	B	C	Ephemeral/ intermittent	Pond/ lake	Seep/ spring	Other	N
ALSI-RUSP	2	4	0	0	1	1	0	8
ALSI-OPHO	6	7	0	0	0	0	1	14
ALSI/ATFI	8	5	0	5	0	0	0	18
ALSI/SETR	9	9	1	1	1	1	0	22
ALSI/ALLUVIAL BAR	3	3	1	0	0	0	0	7
ALSI-COST	2	3	4	0	0	0	0	9
ALSI/GYDR	8	4	0	0	0	0	0	12
ALSI-RILA	9	8	0	0	0	0	0	17
ALSI/MESIC FORB	4	4	1	1	2	0	1	13
Series total	51	47	7	7	4	2	2	120

Fluvial Surfaces—

The ALSI series is usually found on fluvial surfaces that are well aerated, well drained, and moist. These conditions most often exist in riparian zones on floodplains or streambanks (including dikes) and the immediate terrace. Ninety-five of 121 plots (80 percent) are on these three fluvial surfaces; 82 (68 percent) are on streambanks and terraces. Sites also occur on alluvial bars, the banks of overflow channels, and well-drained margins of seeps and springs.

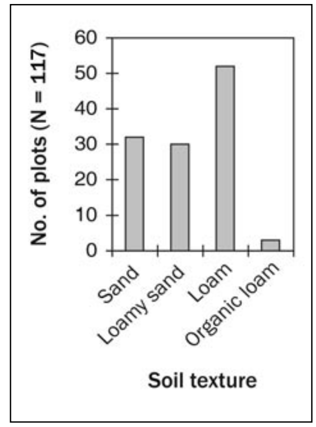
Sitka alder also dominates avalanche sites throughout the Cascade Range, but those used in the ALSI series in this classification only include avalanche sites that are riparian (near creeks). Sitka alder, unlike mountain alder, is uncommon on wetland sites with water saturation of significant duration. There are only 11 plots potentially on such surfaces (lake margins, shrub wetlands, seeps, and springs). However, these labels are deceptive as most of the 11 plots are located on well-drained mineral soils that are in transition to uplands.



Additional insight is gained by looking at distribution of fluvial surfaces by plant association. As with the ALSI series as a whole, all the associations are most common on streambanks and the adjacent terrace. Other than ALSI/ALLUVIAL BAR and ALSI/GYDR, the associations also are found occasionally on other fluvial surfaces. ALSI/ATFI and ALSI/SETR are common in avalanche chutes and seeps or springs, respectively. Note that the ALSI/ALLUVIAL BAR association is not restricted to alluvial bars. Alluvial bar sites along A and B channels are often too small to sample, thus floodplain and streambank sites are more common in the database. The common denominator of the ALSI/ALLUVIAL BAR association is that sites are subject to periodic flood scour, and cobble and gravel soil surfaces are often more prominent than vegetation.

Soils—

Mineral soils are predominant in the ALSI series. Sand, loamy sand, and loam soils are the most common solid texture classes. All these soils are generally moist, well aerated, and well drained except for a few plots located on organic loam soils. Over time, Sitka alder improves soil fertility by fixing nitrogen and by producing nitrogen-rich leaf litter (Haeussler and Coates 1986).



Little additional information is gained by looking at individual plant associations. All associations are found on sand, loamy sand, and loam soils. ALSI-OPHO and ALSI/ATFI are the only associations occasionally found on wet organic loam soils.

	Soil texture				
Plant association	Sand	Loamy sand	Loam	Organic loam	N
ALSI-RUSP	4	1	3	0	8
ALSI-OPHO	2	4	4	2	12
ALSI/ATFI	2	5	9	1	17
ALSI/SETR	6	4	13	0	23
ALSI/ALLUVIAL BAR	3	3	1	0	7
ALSI-COST	5	4	0	0	9
ALSI/GYDR	2	4	6	0	12
ALSI-RILA	7	2	8	0	17
ALSI/MESIC FORB	1	3	8	0	12
Series total	32	30	52	3	117

Water tables were measured on 54 plots. Sitka alder is tolerant of moderately high water tables but requires well-drained soils. It does not do well in wetlands where soil is saturated for long periods. Average water tables for the various plant associations range from 11 to 28 inches (avg. 20 inches) below the soil surface. In comparison, water tables in the ALIN series average -12 inches, with a range of -1 to

	Fluvial surfaces										
Plant association	Alluvial bar	Flood-plain	Stream-bank	Terrace	Overflow channel	Toe-slope	Lake-shore	Shrub wetland	Avalanche chute	Seep/ spring	N
ALSI-RUSP	1	0	3	1	1	0	1	0	0	1	8
ALSI-OPHO	0	1	9	2	2	0	0	0	0	0	14
ALSI/ATFI	0	3	8	3	0	0	0	0	3	1	18
ALSI/SETR	0	2	11	5	0	0	1	1	0	3	23
ALSI/ALLUVIAL BAR	1	3	3	0	0	0	0	0	0	0	7
ALSI-COST	1	0	7	0	1	0	0	0	0	0	9
ALSI/GYDR	0	1	5	6	0	0	0	0	0	0	12
ALSI-RILA	0	2	7	4	1	1	0	0	2	0	17
ALSI/MESIC FORB	0	1	5	3	0	0	1	1	1	1	13
Series total	3	13	58	24	5	1	3	2	6	6	121

-23 inches. Note that plots were usually sampled well after spring peak streamflow when sites had had time to drain; these temporary high water events were not recorded in the data nor were they displayed in the table.

	Water table (inches)			
Plant association	Minimum	Maximum	Average	N
ALSI-RUSP	-14	-8	-11	2
ALSI-OPHO	-28	-4	-13	5
ALSI/ATFI	-24	-4	-14	8
ALSI/SETR	-31	-2	-20	13
ALSI/ALLUVIAL BAR	-31	-8	-21	3
ALSI-COST	-31	-10	-22	5
ALSI/GYDR	-39	-16	-25	6
ALSI-RILA	-47	-14	-27	7
ALSI/MESIC FORB	-39	-12	-28	4
Series	-47	-2	-20	54

Surface flooding was present on only a few plots. The wettest plant associations (ALSI-RUSP, ALSI/ATFI, and ALSI-OPHO) may be flooded periodically, especially where they occur on floodplains. The ALSI/ALLUVIAL BAR association is often flooded during spring runoff. However, as flooding was usually not present at the time of sampling, no table is shown. Soil temperature measurements (degrees Fahrenheit) indicate differences between associations. There is a rough correlation between increasing soil temperature and decreasing plant association elevation.

	Soil temperature (°F)			
Plant association	Minimum	Maximum	Average	N
ALSI/ALLUVIAL BAR	52	64	54	5
ALSI-COST	48	61	53	8
ALSI-RILA	44	61	52	12
ALSI/ATFI	41	55	51	14
ALSI/MESIC FORB	39	61	51	12
ALSI-OPHO	44	57	51	13
ALSI-RUSP	43	60	51	7
ALSI/GYDR	40	54	49	11
ALSI/SETR	33	57	47	19
Series	33	64	50	101

ECOSYSTEM MANAGEMENT

Natural Regeneration of Sitka Alder—

Sitka alder's primary reproduction strategy is to grow from seed (Haeussler and Coates 1986). Seed production begins when shrubs are only 4 to 7 years old (Hungerford 1986). Seed dispersal normally occurs in fall, and germination occurs the following spring. Colonization of sites is aided by the production of abundant, winged, lightweight seed that travel long distances by wind or water (Schopmeyer 1974). Once on the ground, germination requires a moist, bare mineral soil. In riparian zones this bare ground is usually produced by water, and common seedbeds include freshly scoured floodplains, streambanks (including dikes), and alluvial bars. In uplands, bare soil is provided by disturbances such as road cuts, fire, avalanches, soil slumps, and glaciers.

Sitka alder seedlings appear to be fragile during the first growing season. Factors contributing to the low seedling survival rates include summer drought; summer floods; winter scouring and ice flows; herbaceous competition; shade from other shrubs or trees; and browsing by ungulates or rodents. Seedlings that survive their first year usually develop well-established root systems their second year that remain in contact with a permanent water supply.

Sitka alder also can reproduce vegetatively by resprouting from the root crown or stump when damaged by floods, ice scour, fire, or avalanches (Oliver et al. 1985).

Artificial Establishment of Sitka Alder—

Sitka alder seeds germinate quickly on bare mineral soil and can be directly sown onto cool, moist, disturbed sites following flooding, ice scour, debris flows, or slumping. Proven cone collection and seed extraction procedures should be used to obtain seed (Healy and Gill 1974). The expense and time associated with sowing seed may not be necessary if a stocking survey shows that Sitka alder seedlings are already established on the site or that there is a seed source from mature Sitka alder upstream or in adjacent uplands.

Unlike willows, Sitka alder stem cuttings seldom produce roots (Oliver et al. 1985). Planting is successful when using 2- to 3-year-old container-grown seedlings (Healy and Gill 1974). Plantings fail on sites that do not have the potential to grow Sitka alder. Therefore, it is critical to determine that natural and human-induced conditions are favorable for their establishment and survival. Managers should use a wetland/riparian plant association classification to determine if Sitka alder is natural to the site. Site evaluation also may indicate it can be naturally regenerated. (For more information on the short- and long-term revegetation potential of selected riparian wetland plant species, see app. B-5.)

Stand Management—

Scattered trees are often found in ALSI stands, but timber production is not appropriate on these sites, as they are near water, in avalanche chutes, or on the margins of seeps and springs. In some cases, especially in narrow valleys, conifer encroachment may be shading the Sitka alder, thus reducing its cover. Selection cutting or prescribed fire may be used to open the stand to increase the Sitka alder cover.

If a site has been highly altered, managers might consider restoring Sitka alder as soon as possible because of its importance to streambank stability and for overstory cover. Bare streambanks, after being planted or seeded, need protection from the limiting factor that caused Sitka alder to be eliminated from the site. Compacted soils may be disked, replanted, and then protected from further disturbance.

Growth and Yield—

Sitka alder seedlings take 3 to 4 years to reach 3 feet in height and 10 years to reach 13 feet (Harrington and Deal 1982). The 27-foot maximum height reflects long recumbent stems that initially grow out close to the ground and then sweep rapidly upward toward the crown. Most Sitka alder are less than 15 feet vertical height.

Growth attributes	Minimum	Maximum	Average	N
Age (years)	4.0	56.0	27.0	60
Height (feet)	3.0	27.0	12.0	60
Basal diameter (inches)	0.5	7.2	2.8	60

Down Wood—

The overall amount of wood is good compared with other shrub series (app. C-3), with logs covering 5 percent of the ground surface. Therefore down woody debris from adjacent forests is an important feature of ALSI sites, and future supplies of down woody material should be considered in the management of adjacent forests. Data are limited and should be viewed with caution.

Definitions of log decomposition classes are on page 15.

	Down log attributes				
Log decomposition	Tons/ acre	Cu. ft./ acre	Linear ft./ acre	Sq. ft./ acre	% ground cover
Class 1	0.11	9	41	19	0
Class 2	2.26	240	382	299	.69
Class 3	7.10	898	844	800	1.83
Class 4	2.30	726	853	808	1.84
Class 5	1.47	470	349	404	.93
Total	13.24	2,343	2,469	2,330	5.29

Fire—

Fire is thought to be infrequent in Sitka alder stands because of their high moisture content and cool temperatures (Crowe and Clausnitzer 1997). However, in this classification, many ALSI stands occur in narrow valleys where they share their fire history with adjacent upland forest in drought years. Low to moderate fires kill only aboveground stems, and Sitka alder will resprout from root crowns (Fischer and Bradley 1987, Hanson 1979, Stickney 1986, Zasada 1986). Severe fires can completely remove organic soil layers, killing alder roots and eliminating basal sprouting from the root crown. However, seeds from remnant Sitka alder will quickly germinate on bare soil the following spring. In general, Sitka alder's frequency and extent increases rapidly following most fires.

Animals—

Browsing. Sitka alder has poor palatability and has little forage value for livestock and wild ungulates (Dayton 1931, Haeussler and Coates 1986, Steele et al. 1981). Plants are occasionally eaten by ungulates, but sample stands did not reflect situations where stand vigor was reduced by the browsing of Sitka alder (app. B-5).

Livestock. The palatability of the herb undergrowth in ALSI stands is variable but, in general, is moderate to good for at least part of the growing season. However, dense stands of Sitka alder impede the movements of livestock and the palatability issue may be irrelevant except for young open sites on alluvial bars and floodplains or narrow accessible stands along streambanks (Dayton 1931). (For more information on forage palatability, see app. B-1. For potential biomass production, see app. B-5.)

Wildlife. Most ALSI series stands are important to wildlife. Their dense, varied undergrowth supplies food and shelter for large and small mammals and birds. Although low in palatability, young Sitka alder twigs and leaves are eaten by mule deer and elk (Kufeld et al. 1973). Palatable shrubs and herbs typical of the undergrowth may be browsed heavily. Sample stands did not indicate that foraging had reduced stand vigor. Dense stands provide valuable thermal and hiding cover for big game. Hiding cover may be extremely important during hunting seasons. Sitka alder-dominated avalanche chutes are considered excellent habitat for grizzly bears seeking cover and foraging for mesic herbaceous plants as they green up in the spring and berries from the shrubs in summer and fall (Zager 1980). ALSI stands also provide excellent cover and forage for a variety of small mammals. Muskrats, cottontail rabbits, and snowshoe hares eat alder twigs, bark, and leaves (Healy and Gill 1974). Although most streams and valleys associated with Sitka alder are not favorable for large beaver colonies, beaver can eat the bark of Sitka alder as an emergency food and build dams and lodges with the stems (USDA FS 1937). Grouse, redpolls, siskins, goldfinches, and chickadees eat the buds, catkins, and seeds of Sitka alder (Healy and Gill 1974, Martin et al. 1951). (For more information on thermal or feeding cover values, see apps. B-2 and B-3. For information on food values or degree of use, see apps. B-2 and B-4.)

Fish. ALSI stands line many streams and rivers at moderate and higher elevations in eastern Washington. The dense network of stems and roots provide good bank stabilization and are critical to stream channel maintenance. Sitka alder also provides excellent overhanging cover and shade. The importance of Sitka alder in streambank protection, cover, and thermal protection cannot be overemphasized. The multiple Sitka alder stems and the associated undergrowth aid in filtering out sediments during high flows, thereby contributing to the overall building of streambanks and stabilization of the stream. (For more information, see app. B-5, erosion control potential.) Sitka alder and the associated vegetation also provide a critical substrate for insects, which in turn provide food for fish and aquatic insects. The nutrients derived from fallen decomposing leaves are important to the stream ecosystem.

Recreation—

The ALSI series provides an excellent opportunity for viewing elk, deer, songbirds, and waterfowl. Sites also provide access points for fishing along streams and lakes. However, heavy human use in spring and summer can result in damaged soils, bank sloughing, and exposed soils. This is generally a problem only at lower elevations and not a problem in the higher, more isolated environments associated with the ALSI series as a whole. Undeveloped campsites are not usually a problem as the thick Sitka alder stands are not conducive to camping.

Insects and Disease—

Sitka alder is affected by many of the same insects and diseases that infect mountain alder. Cytospora and hypoxylon canker fungi can infect stems of Sitka alder thus predisposing stems to decay and subsequent mortality (Schmitt 1996). Infection is promoted by the presence of wounds to the stems. Leaf and shoot blights (unspecified fungi) cause spotting of leaves and premature leaf drop, and extended infections may kill the shrub. Removal of infection sources is not recommended for foliage and canker diseases as they are spread long distances through abundant airborne spores.

Important insect pests on Sitka alder include fall webworm, forest tent caterpillar, and western tent caterpillar, which cause defoliation; the blue alder agrilus, bronze poplar borer, and poplar borer, that bore into Sitka alder stems, often causing dead tops or mortality; and leaf damaging insects that include the large aspen tortex, aspen leaf-tier, and satin moth (Schmitt 1996).

Estimating Vegetation Potential on Disturbed Sites—

Estimating vegetation potential on disturbed sites is unnecessary because logging and other disturbances usually have little effect on these sites. Livestock and people usually avoid them owing to the dense brush and the isolation of most stands. To estimate the potential in the event of natural disturbances, such as severe flood scour, look for remnant Sitka alder, consult a local classification to predict potential natural vegetation, or look at similar sites in nearby drainages.

Sensitive Species—

Sensitive species were not sampled on the ecology plots (app. D).

ADJACENT SERIES

The ALSI series may be bound by a variety of other series. Adjacent terraces and uplands may support the ABAM, TSME, ABLA2, TSHE, and THPL series. Wetter sites in the SALIX and MEADOW series often occur on more fluvially active surfaces, thus separating some ALSI sites from the direct influence of streams.

RELATIONSHIPS TO OTHER CLASSIFICATIONS

Many of the plant associations in the ALSI series are described in the draft riparian/wetland classification for northeastern Washington (Kovalchik 1992c). Several authors have described plant associations in the ALSI series in northeastern Oregon (Crowe and Clausnitzer 1997), Montana (Hansen et al. 1988, 1995), and on the Mount Hood and Gifford Pinchot NFs (Diaz and Mellen 1996).

U.S. DEPARTMENT OF THE INTERIOR, FISH AND WILDLIFE SERVICE WETLANDS CLASSIFICATION

System:	palustrine
Class:	scrub-shrub
Subclass:	broad-leaved deciduous
Water regime:	(nontidal) temporarily saturated to temporarily flooded

KEY TO THE SITKA ALDER (*ALNUS SINUATA*) PLANT ASSOCIATIONS

1. Young, active, fluvial surfaces with recently worked alluvium the dominant feature of the ground layer; riparian vegetation young and scattered ....**Sitka alder/alluvial bar (ALSI/ALLUVIAL BAR) association**
2. Devil's club (*Oplopanax horridum*) ≥5 percent canopy coverage ....**Sitka alder/devil's club (ALSI-OPHO) association**
3. Lady fern (*Athyrium filix-femina*) and/or alpine lady fern (*Athyrium distentifolium*) ≥5 percent canopy coverage ....**Sitka alder/lady fern (ALSI/ATFI) association**
4. Oak fern (*Gymnocarpium dryopteris*) ≥5 percent canopy coverage ....**Sitka alder/oak fern (ALSI/GYDR) association**
5. Red-osier dogwood (*Cornus stolonifera*) ≥10 percent canopy coverage ....**Sitka alder/red-osier dogwood (ALSI-COST) association**
6. Salmonberry (*Rubus spectabilis*), red raspberry (*Rubus idaeus*), Hudsonbay currant (*Ribes hudsonianum*), and/or stink currant (*Ribes bracteosum*) ≥5 percent canopy coverage (sites in maritime zones west of the Okanogan River) ....**Sitka alder/salmonberry (ALSI-RUSP) association**
7. Arrowleaf groundsel (*Senecio triangularis*), false bugbane (*Trautvetteria caroliniensis*), and/or coolwort foamflower (*Tiarella trifoliata* var. *unifoliata*) ≥1 percent canopy coverage .... **Sitka alder/arrowleaf groundsel (ALSI/SETR) association**
8. Prickly currant (*Ribes lacustre*) ≥2 percent canopy coverage ....**Sitka alder/prickly currant (ALSI-RILA) association**
9. Mesic forbs ≥5 percent canopy coverage ....**Sitka alder/mesic forb (ALSI/MESIC FORB) association**

Table 18—Constancy and mean cover of important plant species in the ALSI plant associations

Species	Code	ALSI-COST 9 plots		ALSI-OPHO 14 plots		ALSI-RILA 17 plots		ALSI-RUSP 8 plots		ALSI/ALLUVIAL BAR 7 plots		ALSI/ATFI 18 plots		ALSI/GYDR 12 plots		ALSI/MESIC FORB 13 plots		ALSI/SETR 23 plots	
		CON[a]	COV[b]	CON	COV	CON	COV	CON	COV	CON	COV	CON	COV	CON	COV	CON	COV	CON	COV
Tree overstory:																			
Pacific silver fir	ABAM	22	3	21	8	—	—	13	5	—	—	28	6	25	3	—	—	—	—
grand fir	ABGR	11	3	—	—	6	5	—	—	29	2	—	—	8	5	8	4	—	—
subalpine fir	ABLA2	11	5	14	Tr[c]	24	6	25	2	14	Tr	28	4	42	5	31	3	48	5
red alder	ALRU	—	—	—	—	—	—	—	—	14	15	—	—	—	—	—	—	—	—
western larch	LAOC	—	—	—	—	6	5	—	—	—	—	—	—	—	—	8	1	4	Tr
Engelmann spruce	PIEN	11	15	14	3	47	12	13	7	29	2	33	2	58	8	15	6	43	4
black cottonwood	POTR2	11	15	7	Tr	6	Tr	13	10	29	3	—	—	17	4	15	1	—	—
Douglas-fir	PSME	—	—	7	Tr	24	11	—	—	43	2	—	—	—	—	15	3	4	Tr
western redcedar	THPL	11	15	21	10	6	10	25	10	29	2	11	3	—	—	8	1	13	4
western hemlock	TSHE	—	—	7	3	—	—	13	3	—	—	11	9	8	10	8	1	13	5
mountain hemlock	TSME	—	—	7	5	—	—	13	1	—	—	—	—	8	4	—	—	—	—
Tree understory:																			
Pacific silver fir	ABAM	11	Tr	36	4	24	2	63	1	—	—	39	1	50	2	8	2	9	2
subalpine fir	ABLA2	—	—	21	Tr	53	3	25	4	29	11	39	Tr	42	3	46	2	61	2
red alder	ALRU	—	—	—	—	—	—	—	—	14	5	—	—	—	—	—	—	—	—
Engelmann spruce	PIEN	33	3	21	1	53	1	25	2	86	2	22	Tr	67	2	15	3	74	2
black cottonwood	POTR2	11	5	7	Tr	—	—	—	—	29	2	—	—	—	—	8	Tr	—	—
Douglas-fir	PSME	11	Tr	—	—	24	1	25	2	43	1	—	—	8	Tr	15	13	—	—
western redcedar	THPL	22	4	43	3	12	2	25	21	29	3	17	Tr	8	3	23	3	17	6
western hemlock	TSHE	11	10	43	1	—	—	25	1	14	Tr	17	1	42	1	23	1	17	3
Shrubs:																			
vine maple	ACCI	22	10	—	—	—	—	13	15	—	—	—	—	—	—	8	2	4	Tr
Douglas maple	ACGLD	44	15	36	10	41	4	13	25	29	Tr	17	5	8	Tr	8	5	9	8
mountain alder	ALIN	22	33	7	15	12	7	—	—	43	22	6	20	—	—	—	—	9	30
Sitka alder	ALSI	100	64	100	60	100	66	100	69	100	53	100	75	100	80	100	79	100	58
red-osier dogwood	COST	100	33	14	10	18	5	13	2	29	9	—	—	17	14	—	—	13	2
bearberry honeysuckle	LOIN	22	2	—	—	53	1	38	2	14	2	28	1	42	3	15	1	57	1
rusty menziesia	MEFE	—	—	7	10	12	39	25	20	—	—	17	1	25	29	—	—	13	10
devil's club	OPHO	—	—	100	28	6	1	13	1	—	—	44	1	25	1	—	—	4	1
Cascade azalea	RHAL	—	—	7	5	24	2	—	—	14	1	6	5	17	19	23	3	26	1
stink currant	RIBR	—	—	—	—	—	—	25	7	—	—	—	—	—	—	—	—	4	2
mapleleaf currant	RIHO	—	—	—	—	—	—	—	—	—	—	—	—	—	—	8	20	—	—
Hudsonbay currant	RIHU	—	—	29	2	6	2	50	6	14	1	17	1	8	2	8	1	9	2
prickly currant	RILA	44	2	57	3	100	10	50	1	86	4	39	1	67	13	31	1	78	9
red raspberry	RUID	—	—	—	—	12	2	25	6	29	3	—	—	—	—	—	—	13	1
western thimbleberry	RUPA	33	11	36	2	47	3	50	11	43	1	61	4	25	5	23	1	35	6
salmonberry	RUSP	33	11	57	6	—	—	63	27	—	—	56	19	17	10	15	2	4	2
Scouler's willow	SASC	11	2	14	8	24	5	—	—	—	—	22	2	25	3	15	3	22	35
Sitka willow	SASI2	11	Tr	—	—	6	2	50	10	29	14	22	8	17	4	—	—	26	9
scarlet elderberry	SARA	—	—	14	1	12	3	—	—	14	Tr	39	4	50	3	15	2	9	1
Cascade mountain-ash	SOSC2	11	1	7	Tr	53	4	38	2	—	—	11	Tr	8	3	—	—	26	5
Douglas spiraea	SPDO	11	7	—	—	—	—	13	12	—	—	—	—	—	—	—	—	—	—
common snowberry	SYAL	33	3	—	—	12	2	13	Tr	—	—	—	—	—	—	8	20	4	Tr
Alaska huckleberry	VAAL	—	—	7	50	6	2	13	10	—	—	—	—	8	20	8	5	4	1
big huckleberry	VAME2	11	Tr	57	1	53	2	50	2	14	Tr	22	1	42	4	38	6	57	2
oval-leaf huckleberry	VAOV	11	Tr	7	5	—	—	13	3	—	—	—	—	—	—	—	—	—	—

Table 18—Constancy and mean cover of important plant species in the ALSI plant associations (continued)

Species	Code	ALSI-COST 9 plots		ALSI-OPHO 14 plots		ALSI-RILA 17 plots		ALSI-RUSP 8 plots		ALSI/ALLUVIAL BAR 7 plots		ALSI/ATFI 18 plots		ALSI/GYDR 12 plots		ALSI/MESIC FORB 13 plots		ALSI/SETR 23 plots	
		CON	COV	CON	COV	CON	COV	CON	COV	CON	COV	CON	COV	CON	COV	CON	COV	CON	COV
Low shrubs and subshrubs:																			
myrtle pachistima	PAMY	56	15	29	2	76	9	50	2	57	1	11	1	50	5	46	6	43	2
dwarf bramble	RULA	—	—	21	1	—	—	38	9	—	—	6	3	8	2	—	—	9	Tr
five-leaved bramble	RUPE	—	—	7	3	6	3	13	5	—	—	17	1	17	4	15	1	13	3
low huckleberry	VAMY	—	—	—	—	12	Tr	—	—	—	—	6	Tr	17	Tr	8	50	13	1
Perennial forbs:																			
deerfoot vanillaleaf	ACTR	11	42	—	—	6	5	13	5	—	—	—	—	8	3	23	21	—	—
sharptooth angelica	ANAR	11	Tr	50	Tr	29	1	38	3	43	1	44	Tr	58	1	23	1	43	1
heart-leaf arnica	ARCO	—	—	—	—	24	2	13	1	29	Tr	—	—	17	10	—	—	17	1
sylvan goatsbeard	ARSY	—	—	43	4	—	—	—	—	—	—	22	4	25	2	15	10	4	Tr
twinflower marshmarigold	CABIR	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	4	8
enchanter's nightshade	CIAL	—	—	50	1	—	—	13	Tr	—	—	50	1	42	1	8	Tr	—	—
queencup beadlily	CLUN	11	Tr	50	2	12	1	63	3	—	—	39	1	50	1	15	2	26	3
sweetscented bedstraw	GATR	11	Tr	43	1	41	Tr	13	1	29	1	61	1	67	1	54	2	78	1
common cow-parsnip	HELA	—	—	36	Tr	24	1	38	1	29	Tr	56	1	67	1	31	Tr	52	1
Fendler's waterleaf	HYFE	—	—	—	—	12	8	13	Tr	—	—	17	2	17	4	31	17	9	1
northern bluebells	MEPAB	—	—	21	Tr	—	—	25	2	—	—	50	1	33	3	8	Tr	13	2
miterwort species	MITEL	—	—	14	2	6	Tr	25	1	14	Tr	67	1	33	1	15	Tr	48	1
broadleaved montia	MOCO	—	—	—	—	—	—	—	—	—	—	17	2	25	1	8	10	4	Tr
sidebells pyrola	PYSE	22	Tr	36	Tr	59	1	38	1	71	Tr	6	Tr	42	Tr	15	2	52	2
dotted saxifrage	SAPU	—	—	57	1	35	Tr	13	Tr	14	Tr	56	1	58	1	8	1	39	1
arrowleaf groundsel	SETR	—	—	64	Tr	18	Tr	38	Tr	14	Tr	50	1	58	1	—	—	83	2
claspleaf twisted-stalk	STAM	—	—	71	1	41	1	13	1	14	Tr	61	1	75	1	15	1	57	1
rosy twisted-stalk	STRO	11	Tr	64	1	12	Tr	50	1	—	—	56	1	33	Tr	—	—	17	1
western meadowrue	THOC	22	Tr	21	1	29	1	—	—	14	Tr	—	—	58	2	31	7	48	2
coolwort foamflower	TITRU	11	Tr	93	3	24	Tr	25	1	—	—	67	1	83	2	8	Tr	70	1
false bugbane	TRCA3	—	—	14	Tr	—	—	—	—	—	—	17	Tr	25	2	8	Tr	22	11
Sitka valerian	VASI	11	Tr	50	1	35	2	25	5	—	—	28	1	33	1	23	1	57	3
American false hellebore	VEVI	—	—	—	—	6	1	—	—	—	—	28	Tr	—	—	8	40	4	Tr
pioneer violet	VIGL	33	Tr	57	1	41	5	13	Tr	—	—	56	2	67	1	31	2	48	2
round-leaved violet	VIOR2	—	—	14	1	—	—	—	—	14	Tr	6	Tr	17	6	—	—	9	2
Grasses or grasslike:																			
wood reed-grass	CILA2	11	2	71	1	29	Tr	50	Tr	57	Tr	67	1	58	1	15	1	52	2
Ferns and fern allies:																			
lady fern	ATFI	—	—	100	14	29	Tr	38	2	—	—	100	20	67	1	8	Tr	57	1
spreading wood-fern	DREX	11	1	—	—	—	—	—	—	—	—	6	17	—	—	—	—	4	3
oak fern	GYDR	11	Tr	79	8	24	1	38	2	—	—	78	9	100	18	—	—	35	3
western brackenfern	PTAQ	—	—	21	3	6	Tr	38	7	14	Tr	—	—	—	—	15	23	—	—

[a]CON = percentage of plots in which the species occurred.
[b]COV = average canopy cover in plots in which the species occurred.
[c]Tr = trace cover, less than 1 percent canopy cover.

MOUNTAIN ALDER SERIES

Alnus incana

ALIN N = 190

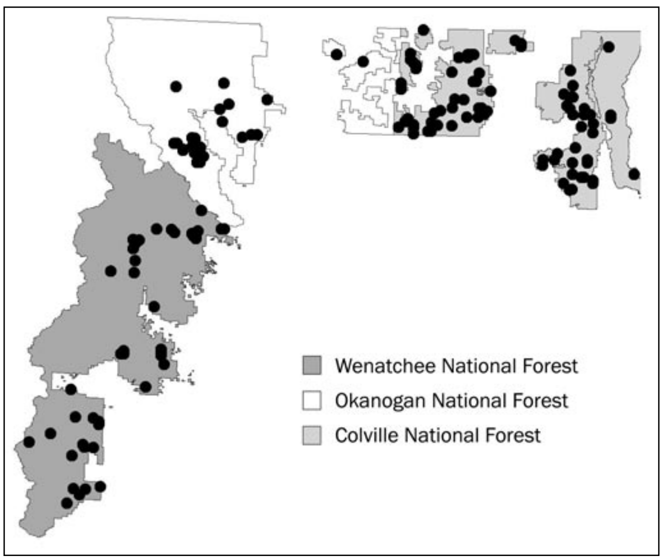


Figure 29—Plot locations for the mountain alder series.

THE RANGE OF mountain alder[1] extends from central Alaska and the Yukon Territories south to Arizona, New Mexico, and California (Hitchcock and Cronquist 1973, Parish et al. 1996). A different subspecies and variety extends eastward from southern Idaho and Alberta to Nova Scotia and Pennsylvania. Another subspecies occurs in Europe and Asia. Mountain alder is common and widely distributed throughout western North America and is the most common alder of the Rocky Mountains, Sierra Nevada, and the east side of the Cascade Range. In the literature, mountain alder is generally considered a species of mid-elevation streams and rivers, seeps and springs, or mountain slopes (Hansen et al. 1988, Kovalchik 1987, Padgett and Youngblood 1986). The literature also describes the species as occurring on moist, well-drained mineral soils associated with the moist edge of streams and rivers. However, this study found mountain alder to occupy a much wider variety of sites in eastern Washington, including wetlands, as well as traditional well-drained streambanks and terraces. Mountain alder is unusual in uplands in eastern Washington.

ALIN is one of the most prominent series in eastern Washington and is very complex owing to the convergence of climates and geology from the Rocky Mountains, western Washington, and British Columbia. Annual precipitation ranges from roughly 10 inches in the dry interior of the study area to more than 50 inches in the maritime climate near the Cascade crest and more than 20 inches in the weaker inland maritime climate in northeastern Washington. In addition, the ALIN series description is affected by the complexity of the sites and thus the relatively large number of shrubs and herbs dominating the ground cover in the many associations. The species present in the understory depend on soil chemistry, aeration, temperature, and water tables. The understory species are numerous and range from sedges on the wettest sites to mesic shrubs and forbs on drier sites.

The ALIN series is abundant throughout eastern Washington and is especially abundant in the continental climate zone that extends from the west half of the Colville NF through the eastern foothills of the Cascade Range. The ALIN series appears to be somewhat less abundant in maritime climates near the Cascade crest and extreme northeastern Washington where mountain alder is restricted to elevations below the lowered distribution (by cold, moist climate) of shrubs such as vine maple, salmonberry, and Sitka alder. However, mountain alder tolerates wetland soils better than these species and extends to higher elevations on poorly drained wetlands.

CLASSIFICATION DATABASE

The ALIN series includes all nonforest stands potentially dominated by at least 25 percent canopy coverage of mountain alder. The series was sampled on all three NFs and all RDs (fig. 29). One hundred ninety riparian and wetland plots were measured in the ALIN series. From this database, 12 major and 3 minor ALIN plant associations are described. One potential, one-plot association (ALIN/POPA) was not used in the database or described in this classification. For the most part, these samples were located in late-seral and climax mountain alder stands, although conditions on some sites may have shifted toward supporting black cottonwood or conifer plant associations owing to sediment accumulations and subsequent lowering of the effective water table.

[1] See appendix A for a cross reference for all species codes and common and scientific names used in this document.

Mountain alder plant associations

	Scientific name	Common name	Ecoclass code	Plots
Major associations:				
ALIN-COST-SYAL	*Alnus incana-Cornus stolonifera-Symphoricarpos albus*	Mountain alder–red-osier dogwood-common snowberry	SW2221	29
ALIN-SPDO	*Alnus incana-Spiraea douglasii*	Mountain alder-Douglas spiraea	SW2212	8
ALIN-SYAL	*Alnus incana-Symphoricarpos albus*	Mountain alder-common snowberry	SW2211	16
ALIN/ALLUVIAL BAR	*Alnus incana*/alluvial bar	Mountain alder/alluvial bar	SWGR11	6
ALIN/ATFI	*Alnus incana/Athyrium filix-femina*	Mountain alder/lady fern	SW2116	28
ALIN/CACA	*Alnus incana/Calamagrostis canadensis*	Mountain alder/bluejoint reedgrass	SW2121	5
ALIN/CAUT	*Alnus incana/Carex urticulata*	Mountain alder/bladder sedge	SW2115	12
ALIN/EQUIS	*Alnus incana/Equisetum* spp.	Mountain alder/horsetail species	SW2117	29
ALIN/GLEL	*Alnus incana/Glyceria elata*	Mountain alder/tall mannagrass	SW2215	17
ALIN/GYDR	*Alnus incana/Gymnocarpium dryopteris*	Mountain alder/oak fern	SW2126	7
ALIN/LYAM	*Alnus incana/Lysichiton americanus*	Mountain alder/skunk cabbage	SW2127	8
ALIN/MESIC FORB	*Alnus incana*/mesic forb	Mountain alder/mesic forb	SW2128	18
Minor associations:				
PALIN/CASCP2	*Alnus incana/Carex scopulorum* var. *prionophylla*	Mountain alder/saw-leaved sedge	SW2125	2
ALIN/PHAR	*Alnus incana/Phalaris arundinacea*	Mountain alder/reed canarygrass	SW2129	2
ALIN/SCMI	*Alnus incana/Scirpus microcarpus*	Mountain alder/small-fruited bulrush	SW2122	3

VEGETATION CHARACTERISTICS

Mountain alder's wide geographic distribution results in differences in botanical characteristics and subsequent taxonomic disagreement (Hitchcock and Cronquist 1973). The taxon is accepted as *Alnus incana*, but disagreement exists below the species level. The species appears to be extremely variable in eastern Washington (including hybridization with red alder), but this guide uses the terminology of Hitchcock and Cronquist (1973), *Alnus incana* spp. *rugosa* var. *occidentalis*. The species is simply referred to as *Alnus incana* or mountain alder in the remainder of this publication.

Mountain alder is usually the dominant shrub in the ALIN series. It ranges from a low average of 33 percent canopy coverage in the ALIN/ALLUVIAL BAR association to 73 percent in the ALIN/SCMI association, with an average of 55 percent for the ALIN series as a whole. Douglas spiraea, red-osier dogwood, and common snowberry are often codominant with mountain alder at lower elevations on streambanks and the immediate terrace. Other common shrubs include Saskatoon serviceberry, bearberry honeysuckle, prickly currant, Nootka or woods rose, western thimbleberry, and willow species. Shrub cover is usually higher in riparian areas compared with wetland sites, where mountain alder may be restricted to relatively dry hummocks, with sedges and other hydrophytic vegetation in the low areas between the hummocks.

The wettest associations are characterized as shrub-fens dominated by mountain alder, with wet-site graminoids such as bladder sedge, small-fruited bulrush, saw-leaved sedge, and reed canarygrass in the undergrowth. Reed canarygrass is considered an introduced species that, once established, may completely dominate the site. Skunk-cabbage, horsetail species, mannagrass species, and lady fern occur on moderately wet sites in mountain alder swamps associated with wetlands, beaver activity, ponds, lakes, seeps, and springs. These wet associations also can be found in linear stringers along seasonally flooded floodplains, streambanks, and overflow channels where the water table remains high throughout the growing season. Forbs such as deerfoot vanillaleaf, sidebells pyrola, arrowleaf groundsel, starry solomonplume, coolwort foamflower, and various violets are associated with more mesic, well-drained ALIN plant associations.

There is a tendency for the cover of associate plant species to decrease with increasing mountain alder cover. However, most of the indicator species usually are well represented or abundant, even under mountain alder exceeding 70 percent canopy cover. Both overstory and understory trees may be scattered within mountain alder stands, especially along streambanks and the adjacent terrace. Tree cover approaching 25 percent may indicate the site is transitional toward forest potential owing to soil deposition and subsequent lowering of the effective water table.

PHYSICAL SETTING

Elevation—

The majority of ALIN series plots are between 1,500 and 4,500 feet. The extreme 5,500-foot Okanogan NF plot is on the margin of a lake well above the normal elevation distribution of the ALIN series and occurs in a dry area. Otherwise, there does not appear to be much difference in site elevations among the NFs. However, elevation summaries are somewhat misleading owing to the influence of maritime climates along the Cascade crest and in extreme northeastern Washington. As mentioned earlier, series such as ACCI, RUSP, and ALSI extend to lower elevations in maritime zones, pushing the upper elevation limits of ALIN series downward compared with drier portions of its range. For example, the lower elevation limit of the ALSI series ranges from 2,000 to 2,600 feet in maritime-influenced climate near the Cascade crest (deep snowpacks and shorter growing seasons). These lower elevation sites often support both Sitka alder and mountain alder (but the ALSI series keys first); there is an elevation band near the Cascade crest (2,500 to 4,500 feet) where the ALSI series occupies sites in riparian zones, whereas the ALIN series occurs in adjacent wetlands, sites that Sitka alder cannot tolerate.

	Elevation (feet)			
Forest	Minimum	Maximum	Average	N
Colville	1,550	4,950	3,624	104
Okanogan	2,250	5,500	3,069	31
Wenatchee	1,320	4,760	2,989	55
Series	1,320	5,500	3,153	190

Additional elevation insight is gained by examining the individual plant associations. ALIN/CACA and ALIN/CASCP2 represent wetland sites found at the highest elevations for the series. The next 6 associations listed also occur at considerable elevations relative to the remaining 7, but all 13 of these association units also occur at lower elevations.

	Elevation (feet)			
Plant association	Minimum	Maximum	Average	N
ALIN/CACA	3,800	5,500	4,453	5
ALIN/CASCP2	4,100	4,100	4,100	2
ALIN/GLEL	2,350	4,630	3,674	17
ALIN/ATFI	2,300	4,630	3,542	28
ALIN/MESIC FORB	1,960	4,760	3,410	18
ALIN/GYDR	2,350	4,550	3,373	7
ALIN/CAUT	2,550	4,642	3,363	12
ALIN-SYAL	1,720	4,300	3,047	16
ALIN/SCMI	2,850	3,050	2,950	3
ALIN/LYAM	1,940	3,600	2,905	8
ALIN/EQUIS	1,320	4,950	2,846	29
ALIN/PHAR	2,400	2,980	2,690	2
ALIN-SPDO	2,100	3,290	2,659	8
ALIN/ALLUVIAL BAR	2,020	3,440	2,618	6
ALIN-COST-SYAL	1,320	3,650	2,615	29
Series	1,320	5,500	3,544	190

Valley Geomorphology—

The ALIN series is found on a variety of valley width and gradient classes. Most plots are located in rather gentle valleys of considerable width. Seventy-three percent of the plots (139) are in valleys more than 99 feet wide and 69 percent (131 of 191) are in valleys with very low to low gradient (less than or equal to 3 percent). The ALIN series is relatively uncommon in very narrow, very steep valleys. This decrease in relative abundance may, in part, reflect a reduction in mountain alder potential owing to shade from overtopping conifers and terrain, a problem of plot access by field crews, or the occurrence of ALSI associations on these cold, steep sites.

	Valley gradient					
Valley width	Very low	Low	Moderate	Steep	Very steep	N
Very broad	23	10	0	0	0	33
Broad	15	25	3	1	0	44
Moderate	17	25	11	5	4	62
Narrow	3	13	9	11	7	43
Very narrow	0	0	2	1	5	8
Series total	58	73	25	18	16	190

Despite variation at the series level, valley geomorphology is still important in determining the distribution of the ALIN plant associations. For example, associations with wet site sedges and herbs, such as ALIN/CACA, ALIN/EQUIS, ALIN/CASCP2, and ALIN/CAUT, are more common on wide, very low to low gradient valleys. Although found on a variety of valley width classes, the wet ALIN/LYAM association is almost totally restricted to very low-gradient sites. Drier associations such as ALIN/COST-SYAL, ALIN/SYAL, and ALIN/MESIC FORB, occur on a variety of valley widths and valley gradients. The distribution of these drier associations is related to the occurrence of well-aerated and well-drained soils, which may be found on various valley width and gradient classes.

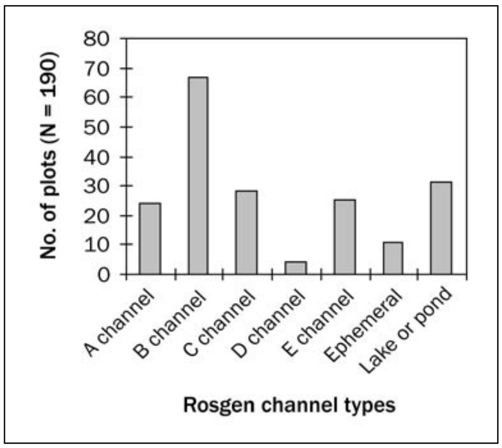
	Valley width					
Plant association	Very broad	Broad	Moderate	Narrow	Very narrow	N
ALIN/CASCP2	2	0	0	0	0	2
ALIN/LYAM	2	0	4	2	0	8
ALIN/CAUT	4	4	4	0	0	12
ALIN/SCMI	2	1	0	0	0	3
ALIN/EQUIS	4	8	10	6	1	29
ALIN/PHAR	1	0	1	0	0	2
ALIN/CACA	1	3	1	0	0	5
ALIN/ATFI	1	7	10	8	2	28
ALIN/GLEL	2	6	7	2	0	17
ALIN-COST-SYAL	3	4	8	13	1	29
ALIN-SPDO	4	3	1	0	0	8
ALIN-SYAL	3	3	6	3	1	16
ALIN/GYDR	0	0	3	2	2	7
ALIN/MESIC FORB	4	3	5	5	1	18
ALIN/ALLUVIAL BAR	0	2	2	2	0	6
Series total	33	44	62	43	8	190

	Valley gradient					
Plant association	Very low	Low	Moderate	Steep	Very steep	N
ALIN/CASCP2	2	0	0	0	0	2
ALIN/LYAM	7	0	0	1	0	8
ALIN/CAUT	11	1	0	0	0	12
ALIN/SCMI	2	1	0	0	0	3
ALIN/EQUIS	7	15	3	1	3	29
ALIN/PHAR	1	1	0	0	0	2
ALIN/CACA	4	1	0	0	0	5
ALIN/ATFI	4	12	5	4	3	28
ALIN/GLEL	7	7	1	2	0	17
ALIN-COST-SYAL	4	9	8	3	5	29
ALIN-SPDO	5	3	0	0	0	8
ALIN-SYAL	2	9	1	2	2	16
ALIN/GYDR	0	3	2	2	0	7
ALIN/MESIC FORB	2	9	4	1	2	18
ALIN/ALLUVIAL BAR	0	2	1	2	1	6
Series total	58	71	24	16	15	184

In summary, the chances of finding mountain alder stands increases with decreasing valley gradient and increasing valley width, but with many exceptions owing to the large number of associations and sites in the ALIN series.

Channel Types—

The variety of valley configurations in the ALIN series supports a variety of channel types. Most moderate to steep gradient valleys contain Rosgen A and B channels. A few steeper gradient plots are associated with ephemeral drainages. Lower gradient valleys support Rosgen C and E channels or lakes and ponds. The few Rosgen D channels are actually locally degraded C channels below logjams. Rosgen E channels, beaver ponds, ponds, and lakes usually are associated with the wettest sites and associations.

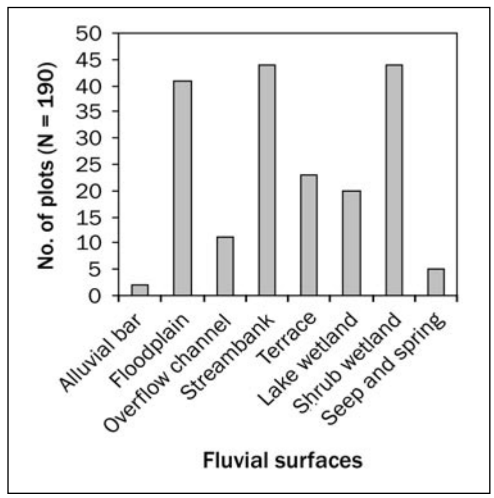


Additional insight is gained by looking at the distribution of Rosgen channel types by ALIN plant associations. For example, associations with wet site graminoids and herbs (such as ALIN/CACA, ALIN/CAUT, ALIN/CASCP2, ALIN/PHAR, ALIN/LYAM, and ALIN/SCMI) are more common on wetland sites along C and E channels or adjacent to ponds and lakes. Drier associations (ALIN-COST-SYAL, ALIN-SYAL, ALIN/ALLUVIAL BAR, and ALIN/MESIC FORB) are more common on well-drained riparian sites along A, B, and C channels.

	Rosgen channel types							
Plant association	A	B	C	D	E	Ephemeral/ intermittent	Lake/ pond	N
ALIN/CASCP2	0	0	0	0	2	0	0	2
ALIN/LYAM	0	1	1	0	3	1	2	8
ALIN/CAUT	0	0	0	0	8	0	4	12
ALIN/SCMI	0	0	1	0	1	0	0	3
ALIN/EQUIS	4	11	4	1	3	0	6	29
ALIN/PHAR	0	0	1	0	1	0	0	2
ALIN/CACA	0	0	0	0	0	1	4	5
ALIN/ATFI	8	8	3	2	1	1	5	28
ALIN/GLEL	1	4	4	0	2	4	2	17
ALIN-COST-SYAL	4	13	5	1	2	2	2	29
ALIN-SPDO	0	0	5	0	2	0	1	8
ALIN-SYAL	2	8	2	0	0	2	2	16
ALIN/GYDR	3	3	1	0	0	0	0	7
ALIN/MESIC FORB	1	14	1	0	0	0	2	18
ALIN/ALLUVIAL BAR	1	5	0	0	0	0	0	6
Series total	24	67	28	4	25	11	31	190

Fluvial Surfaces—

In contrast to the ALSI series, the ALIN series is found on a wider variety of fluvial surfaces that range from well-aerated, well-drained fluvial surfaces along streams to very poorly aerated, wet soils in shrub wetlands. Moist, well-drained conditions most often occur in riparian zones on alluvial bars, floodplains, streambanks (including dikes) and the immediate terrace. One hundred ten plots are located on these four sites. Mountain alder is common (80 plots) on wetter sites with water saturation of significant duration, often with organic soils. These sites include overflow channels; wet margins of beaver pond complexes, lakes or ponds; shrub wetlands; and seeps or springs.

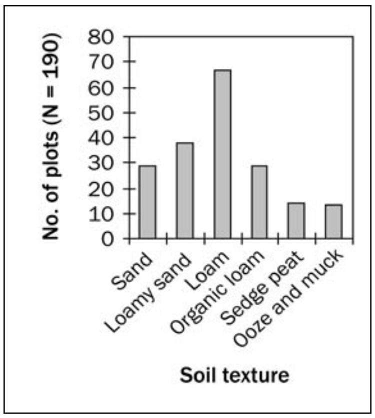


Additional insight is gained by looking at the distribution of fluvial surfaces by plant associations. For example, the wet ALIN/CACA, ALIN/CASCP2, ALIN/CAUT, and ALIN/LYAM associations are almost exclusively associated with wetlands. ALIN/ALLUVIAL BAR, ALIN/GYDR, ALIN/MESIC FORB, ALIN-COAST-SYAL, and ALIN-SYAL are largely associated with riparian fluvial surfaces. Others, such as ALIN/ATFI, ALIN EQUIS, ALIN/GLEL, and ALIN-SPDO seem to have strategies for surviving in both riparian and wetland zones.

Soils—

Soils are predominantly mineral in riparian settings and organic in wetlands. Soil textures on floodplains, streambanks, and terraces are sand, loamy sand, and loam. They are generally moist, well aerated, and well drained. In wetlands the soils are predominantly organic loam but also include sedge peat, ooze, and muck. Mountain alder improves soil fertility by fixing nitrogen and by producing nitrogen-rich leaf litter.

Plant association	Fluvial surfaces								N
	Alluvial bar	Floodplain	Overflow channel	Streambank	Terrace	Lake wetland	Shrub wetland	Seep/spring	
ALIN/CASCP2	0	0	0	0	0	0	2	0	2
ALIN/LYAM	0	1	0	0	0	1	5	1	8
ALIN/CAUT	0	0	0	0	0	1	11	0	12
ALIN/SCMI	0	0	0	1	0	0	2	0	3
ALIN/EQUIS	0	14	3	5	0	4	3	0	29
ALIN/PHAR	0	1	0	0	0	0	1	0	2
ALIN/CACA	0	0	0	0	0	3	2	0	5
ALIN/ATFI	0	4	4	6	2	4	6	2	28
ALIN/GLEL	0	4	1	3	1	1	6	1	17
ALIN-COST-SYAL	1	3	2	12	7	2	1	1	29
ALIN-SPDO	0	2	1	1	1	0	3	0	8
ALIN-SYAL	0	3	0	5	4	2	2	0	16
ALIN/GYDR	0	1	0	5	1	0	0	0	7
ALIN/MESIC FORB	0	4	0	5	7	2	0	0	18
ALIN/ALLUVIAL BAR	1	4	0	1	0	0	0	0	6
Series total	2	41	11	44	23	20	44	5	190



Additional insight is gained by looking at the distribution of soil texture by ALIN plant association. Only the ALIN/CASCP2, ALIN/CAST, and ALIN/LYAM associations are restricted to organic soils. ALIN/ALLUVIAL BAR, ALIN/GYDR, ALIN/MESIC FORB, ALIN-COST-SYAL, ALIN/SPDO, and ALIN-SYAL are most prominent on mineral soils. The remaining associations seem to have strategies for establishing on both mineral and organic soils.

Plant association	Soil texture						N
	Sand	Loamy sand	Loam	Organic loam	Sedge peat	Ooze/ muck	
ALIN/CASCP2	0	0	0	0	2	0	2
ALIN/LYAM	0	0	0	3	0	5	8
ALIN/CAUT	0	0	0	4	7	1	12
ALIN/SCMI	0	0	1	1	0	1	3
ALIN/EQUIS	6	8	7	3	3	2	29
ALIN/PHAR	0	0	1	1	0	0	2
ALIN/CACA	0	1	1	2	1	0	5
ALIN/ATFI	1	4	13	8	1	1	28
ALIN/GLEL	1	2	11	2	0	1	17
ALIN-COST-SYAL	9	6	12	1	0	1	29
ALIN-SPDO	2	1	3	1	0	1	8
ALIN-SYAL	2	3	8	3	0	0	16
ALIN/GYDR	1	4	2	0	0	0	7
ALIN/MESIC FORB	3	7	8	0	0	0	18
ALIN/ALLUVIAL BAR	4	2	0	0	0	0	6
Series total	29	38	67	29	14	13	190

Average measured water tables range from 1 to 23 inches below the soil surface and average -12 inches for the series as a whole. The higher water tables found in the first seven associations correspond well with plant species that are obligate to wetland soils. ALIN/CASCP2 through ALIN/GLEL are the wettest associations as indicated by water tables. The remaining seven associations are drier. However, the -21 inches found on the ALIN/CACA association is probably an aberration of sample size and a late summer sample date, and this association is just as wet as some of the wetter associations. The -23-inch average associated with the ALIN/ALLUVIAL BAR association is also misleading, as these sites are often flooded during spring runoff (i.e., before the sample season).

Plant association	Water table (inches)			N
	Minimum	Maximum	Average	
ALIN/CASCP2	-2	1	-1	2
ALIN/LYAM	-9	0	-4	8
ALIN/CAUT	-20	6	-4	12
ALIN/SCMI	-16	0	-7	3
ALIN/EQUIS	-24	14	-8	29
ALIN/PHAR	-16	-7	-11	2
ALIN/ATFI	-35	1	-12	22
ALIN/GLEL	-43	-2	-13	11
ALIN-COST-SYAL	-43	0	-17	21
ALIN-SPDO	-28	0	-17	6
ALIN-SYAL	-24	-8	-18	9
ALIN/GYDR	-31	-12	-19	6
ALIN/MESIC FORB	-36	-6	-19	12
ALIN/CACA	-24	-19	-21	3
ALIN/ALLUVIAL BAR	-31	-12	-23	4
Series	-43	14	-12	150

The amount of surface flooding at the time of sampling correlated well with water table depth as plant associations with higher water tables also tend to have more surface flooding.

Plant association	Submerged (percent) Minimum	Maximum	Average	N
ALIN/CAUT	0	65	25	12
ALIN/CASCP2	0	40	20	2
ALIN/LYAM	0	50	19	8
ALIN/EQUIS	0	75	14	28
ALIN/SCMI	Trace	40	14	3
ALIN/ATFI	0	81	6	28
ALIN-SPDO	0	30	5	8
ALIN-COST-SYAL	0	70	4	29
ALIN/GLEL	0	35	4	17
ALIN/CACA	1	10	3	4
ALIN/PHAR	0	5	3	2
ALIN/MESIC FORB	0	10	1	18
ALIN-SYAL	0	10	1	16
ALIN/GYDR	0	Trace	0	7
ALIN/ALLUVIAL BAR	0	0	0	6
Series	0	81	7	188

There also are differences in soil temperature (degrees Fahrenheit), although some differences may be more attributable to low sample size for some plant associations. The decreasing order of soil temperature fairly accurately follows an inverse relationship with the association's average elevation.

Plant association	Soil temperature (°F) Minimum	Maximum	Average	N
ALIN/ALLUVIAL BAR	45	63	55	5
ALIN/PHAR	52	55	54	3
ALIN-COST-SYAL	45	62	52	26
ALIN/MESIC FORB	46	59	51	17
ALIN-SPDO	42	58	51	8
ALIN/CASCP2	44	56	50	2
ALIN/GLEL	43	57	50	16
ALIN/CAUT	35	57	50	11
ALIN-SYAL	45	57	49	16
ALIN/SCMI	41	55	49	3
ALIN/LYAM	44	52	49	8
ALIN/EQUIS	38	58	49	28
ALIN/GYDR	42	52	47	6
ALIN/ATFI	34	54	46	26
ALIN/CACA	43	45	44	2
Series	34	63	50	176

In summary, mountain alder, which is usually considered indicative of moist, well-drained, riparian soils, also does well in wetlands having organic soils with long periods of soil saturation.

ECOSYSTEM MANAGEMENT

Natural Regeneration of Mountain Alder—

Colonization of mountain alder is aided by the production of abundant, lightweight seed. The broad wings allow the seed to travel long distances by wind or water (Plummer 1977). The literature reports seedling establishment is better on exposed mineral soil than on organic soils (Zasada 1986). However, about one-third of the plots were located on wetlands with organic soils, and the mountain alder shrubs must have been established from seed germinating on organic soil. In riparian settings, disturbance is provided by the scouring action of water during peak runoff, and common seedbeds include point bars, floodplains, and streambanks or overflow channels.

Mountain alder seeds quickly establish on bare mineral soil as long as a seed source is available. Mountain alder seedlings appear to be fragile. They average only about 9 inches of root growth during the first growing season and are easily pulled from the ground. Browsing by ungulates, hares, rodents, and beaver has a major impact on seedling survival. Other factors contributing to low survival rates for seedlings include summer drought, flood scouring, ice flows, herbaceous competition, and shade from larger or overhanging shrubs or trees. Seedlings that survive their first year usually develop well-established root systems that remain in contact with a permanent water supply during their second year; growth is then rapid.

Mountain alder plants can resprout from the root crown or stump when damaged by floods, ice scour, fire, or beaver (Haeussler and Coates 1986, Kauffman et al. 1985, Zasada 1986). Exposed mountain alder roots have been observed sprouting in streams, and submerged live branches sometimes form adventitious roots (Furlow 1979, Haeussler and Coates 1986), but this was observed neither during this study nor during the work on the author's central Oregon classification (Kovalchik 1987). Dense thickets of alder are probably the result of seeding alone (Steele 1961).

Artificial Establishment of Mountain Alder—

Collected seed can be sown directly on cool, moist, disturbed sites following flooding, ice scour, debris flows, or slumps. Proven cone collection and seed extraction procedures should be used. However, the expense and time associated with collecting and sowing seed may not be necessary if there is an adequate supply of mountain alder still occupying the disturbed site (or nearby).

Unlike most willow species, cut mountain alder stems seldom produce adventitious roots, and propagation from stem cuttings is not recommended. However, plants can be established by using container-grown seedlings or bare-root stock (Platts et al. 1987, Plummer 1977). Plantings will fail on sites that do not have the potential to grow mountain alder. Therefore, it is critical to determine whether natural and human-induced conditions are favorable for their establishment and survival. Managers should use a wetland/riparian plant association classification to determine if mountain alder is natural to the site. Site evaluation also may indicate whether mountain alder can be stocked by natural regeneration. A stocking survey may show that alder seedlings have already been established on the site or that a seed source from mature mountain alder is nearby. (For more information on the short- and long-term revegetation potential of selected riparian wetland plant species, see app. B-5.)

Stand Management—

Scattered conifer and deciduous trees may occur in mountain alder stands, especially plant associations located in riparian zones. However, timber production opportunities are not appropriate on these sites as they are located very close to streams or occur in wetlands, seeps, and springs. Down woody debris from adjacent forests are important features of riparian ALIN sites, and future supplies of down woody material in alder stands should be considered in the management of adjacent forest.

All sampled stands were in fair or better ecological condition so that little is known about methods for rehabilitating disturbed stands. Study of disturbed stands is needed. Where the site has been highly altered, management alternatives should consider restoring mountain alder for its excellent streambank stability values. Bare streambanks should be planted or seeded and protected from the limiting factor that caused alder to be eliminated from the site. Compacted soils should be protected from the compaction source, disked, and replanted. In some cases (especially in narrow valleys), conifer encroachment may be shading the mountain alder, thus reducing its cover. Selection cutting may be used to open the stand, thus increasing the cover of alder.

Growth and Yield—

Height growth of mountain alder is initially rapid. Unpublished data from central Oregon report an average of 7 feet of height growth at 7 years and maximum height growth averaging 23 feet at 33 years (Kovalchik 1987). Initial height growth in eastern Washington appears to be slightly faster (7 feet at 5 years) and maximum heights significantly greater (22 of 45 sampled mountain alder exceeded 30 feet). A summary of age, height, and basal stem diameters for 45 mountain alder stems in riparian settings is shown in the table below.

Growth attributes	Minimum	Maximum	Average	N
Age	5	53	36	45
Height (feet)	7	60	33	45
Basal diameter (inches)	0.6	11.7	5.5	45

These data show that mountain alder appears to reach much larger heights and diameters than noted in the literature. For instance, it seldom exceeded 25 feet in central Oregon (Kovalchik 1987), which agrees well with information in Hitchcock and Cronquist (1973). Numerous large mountain alder were cut down for identification and aging if they were suspected to be red alder, but cone, bark, and leaf characteristics usually confirmed mountain alder rather than red alder. Intermediate forms (based on stem diameters and height) were common, especially in maritime areas. The problem is even more confounding in the Cascade Range where the two alder species may intermix in the same valley. In conclusion, hybrids of red alder and mountain alder may be common in eastern Washington, accounting for uncharacteristic height and diameter compared with that reported in the taxonomic literature. Unfortunately no sectioned-stem data are available for wetlands, such as for ALIN/CAUT sites. Mountain alder height growth on wetland sites (maximum heights less than 25 feet) appears to be more in line with Hitchcock and Cronquist (1973), and no hybridization with red alder is apparent.

Down Wood—

Overall, the amount of down wood is high compared with other nonforest series (app. C-3). Logs cover less than 4 percent of the ground. Of the nonforest series, only the ALSI, COST, OPHO, and SPDO series have more log cover. The relatively high percentage of log cover reflects the close proximity of ALIN series sites to large log-transporting streams or rivers as well as the close proximity of forested plant associations.

	Down log attributes				
Log decomposition	Tons/ acre	Cu. ft./ acre	Linear ft./ acre	Sq. ft./ acre	% ground cover
Class 1	0.72	58	203	111	0.25
Class 2	1.08	111	422	219	.50
Class 3	4.48	544	867	631	1.45
Class 4	1.71	493	573	521	1.20
Class 5	.45	144	154	151	.35
Total	8.44	1,351	2,219	1,634	3.75

Fire—

Fire is usually infrequent in ALIN stands because of the high moisture content and relatively cool temperatures of the sites (Crowe and Clausnitzer 1997). In addition, mountain alder has relatively nonflammable bark and nonresinous leaves, providing some protection from low-intensity fire (Davis et al. 1980). However, during severe drought, alder stands may be burned as severely as the adjacent forest, as happened in the Wenatchee NF's Tyee Fires in 1994. ALIN stands in narrow valleys may burn even in moderate fire years owing to proximity of the coniferous overstory in adjacent uplands. Mountain alder has the ability to resprout from root crowns following light fire, but severe fires can completely remove the organic soil layer, killing alder root crowns and roots and eliminating basal sprouting. Numerous wind-dispersed seeds from remnant onsite or offsite mountain alder will quickly sprout on bare mineral soil the following spring.

Mountain alder's frequency and extent increases rapidly following fire along riparian zones. It appears that this was especially dramatic on the Colville NF following the severe, extensive fires of the early 1990s. In valleys formerly dominated by conifers, mountain alder and other shrubs quickly invaded burned sites. Additionally, down woody debris (from burned, dead trees) increased over time and was quickly followed by a rapid increase in beaver populations in lower gradient valleys. The dams and down logs captured large volumes of sediment, reduced effective valley gradient, and raised water tables. Mountain alder, willows, sedges, and other moist and wet site plants now dominate many sites formerly occupied by conifers owing to the change in site potential initiated by these large fires.

Animals—

Browsing. Mountain alder has a poor to fair palatability rating for livestock and wild ungulates (Crowe and Clausnitzer 1997, Hansen et al. 1995, Kovalchik 1987). Browsing of older stems is usually low. Use of seedlings, young twigs, and sprouts may become heavy when livestock have overgrazed herbaceous forge in late summer (wild ungulate browsing rarely creates significant impacts in the absence of heavy use by livestock). This eventually leads to high-lined (browsed by ungulates), old, decadent stands with little chance of replacement regeneration unless grazing intensity is reduced (app. B-5).

Livestock. The use of mountain alder varies greatly by plant association and grazing intensity. Wetter ALIN plant associations (e.g., ALIN/EQUIS, ALIN/CAUT) receive little grazing pressure owing to general inaccessibility created by the absence of surface water and wet organic soils. Restricting alder use to late summer allows completion of the physiological processes of the various shrubs and herbs, which provide the reproductive and energy requirements of the vegetation for the coming year. However, overuse for several consecutive years may lead to elimination of younger age classes and reduction in mountain alder vigor.

Riparian associations such as ALIN/ALLUVIAL BAR, ALIN/MESIC FORB, and ALIN/SYAL are more susceptible to livestock grazing than ALIN wetlands. Use of the various ALIN associations depends on stand accessibility, stand density, the palatability of other browse species, and the availability and condition of other forage (Crowe and Clausnitzer 1997). With overuse, the mountain alder canopy becomes disrupted and clumpy (Kovalchik 1987). The mountain alder decreases in vigor as indicated by dead shrubs and stems, high lining, and lack of younger age classes. The competitive ability of associated understory dominants also is reduced through grazing and trampling, favoring introduced and increaser herbs. Overgrazing and excessive trampling seriously reduces mountain alder's ability to maintain streambank stability during spring runoff and flooding. The stream reacts by becoming wider and shallower because of streambank trampling and subsequent erosion.

With continued overuse, mountain alder and associated understory vegetation become uncommon, restricted to protected locations or moist microsites, or absent (Kovalchik 1987). Kentucky bluegrass, other introduced grasses, and increaser forbs then dominate the site. Mountain alder cover becomes extremely discontinuous, and the shade provided to the understory and stream channel is reduced. The stream channel becomes even wider and shallower, and most of the streambanks erode owing to the lack of alder and other natural dominants (Kovalchik 1987).

As in the SALIX series, grazing practices incorporating late-season rest will increase the vigor of mountain alder and its plant associates (Hansen et al. 1995, Kovalchik and Elmore 1991). Maintaining dense stands of alder through appropriate grazing systems will limit access by livestock. Any late-season grazing should be monitored closely to prevent a shift from grazing of herbs to browsing of mountain alder. Livestock should be removed from pastures as herbaceous stubble heights approach 4 inches. (For more information on forage palatability, see app. B-1. For potential biomass production, see app. B-5.)

Wildlife. The high structural diversity of the ALIN series provides thermal and hiding cover for many large ungulates (Crowe and Clausnitzer 1997, Healy and Gill 1974). Although low in palatability, use of young alder twigs, sprouts, seedlings, and leaves can be heavy (Hansen et al. 1995). Light to moderate use of the mountain alder has been reported in summer and late fall in Montana (Knowlton 1960). It is a moderately important browse species for mule deer (Kufeld et al. 1973) and may be used by moose in late winter. The more palatable species in the wide variety of associated shrubs and herbs may be used heavily. Although less isolated from human activity than the ALSI series, mountain alder-dominated stands also may provide important habitat for grizzly bears. Bears find appropriate forage in these areas, eating mesic herbaceous plants as they green up in spring and berries from shrubs in summer and fall. Many of the wide, low gradient valleys associated with the ALIN series support viable beaver populations in eastern Washington, especially on the Colville NF. Beavers occasionally eat mountain alder bark, but the stems are more important for building dams and lodges (USDA FS 1937). The many shrubs and forbs found in ALIN associations provide a variety of forage for beaver. Mountain alder stands provide excellent cover and forage for a variety of small mammals, including muskrats, cottontails, and snowshoe hares (Healy and Gill 1974).

Mountain alder buds, catkins, and seeds are an important food source for grouse, redpolls, siskins, goldfinches, and chickadees (Arno and Hammerly 1984, Haeussler and Coates 1986, Martin et al. 1951). Many bird species use mountain alder for nesting, brood rearing, and foraging (Crowe and Clausnitzer 1997). (For more information on thermal or feeding cover values, see apps. B-2 and B-3. For information on food values or degree of use, see apps. B-2 and B-4.)

Fish. Mountain alders line many low- to moderate-elevation streams and rivers in eastern Washington. The dense networks of alder roots are very effective in stabilizing streambanks to withstand severe flooding. However, severe overgrazing and trampling can severely reduce alder cover and its ability to maintain streambank stability (Komarkova 1986, Kovalchik 1987). The importance of mountain alder communities for streambank protection, cover, and thermal protection cannot be overemphasized. The dense multiple stems of mountain alder and other shrubs aid in filtering out sediments during high flows and thereby contribute to overall streambank building, channel maintenance, and stream stabilization. (For more information, see app. B-5, erosion control potential.) Streams lined with ALIN stands develop relatively deep and narrow channels that provide cover, spawning sites, food, and cool temperatures critical to trout and other salmonids (Hansen et al. 1995). The mountain alder also provides a critical substrate for insects with subsequent roles as food for fish and aquatic insects. The nutrients derived from fallen decomposing alder leaves are important to the stream ecosystem.

Recreation—

ALIN series stands provide an excellent opportunity for viewing elk, deer, songbirds, and waterfowl. Many sites are located near roads and are easily accessible, providing access for fishing and dispersed recreational opportunities such as camping. Undeveloped campsites can be a serious problem on drier sites such as the ALIN/SYAL association. Loam soils can become compacted with vehicle and foot traffic, subsequently reducing native vegetation. Alder stands along the streambank may then become open and trampled, thus increasing bank erosion. This subsequently affects the quality of the channel and associated fish habitat.

Insects and Disease—

Cytospora and hypoxylon canker fungi infect stems of mountain alder, predisposing them to decay and subsequent mortality (Schmitt 1996). Infection is promoted by the presence of wounds to the stems. Leaf and shoot blights (unspecified fungi) cause spotting of leaves and premature leaf drop. Extended infections may ultimately kill the shrub. Removal of infection sources is not recommended for foliage and canker diseases as they are spread long distances by abundant airborne spores.

Important mountain alder insect pests include fall webworm, forest tent caterpillar, and western tent caterpillar, which cause defoliation (Schmitt 1996). The blue alder agrilus, bronze poplar borer, and poplar borer are woodborers that attack alder stems and cause dead tops or mortality. Other leaf-damaging insects include the large aspen tortrix, aspen leaf-tier, and satin moth.

Estimating Vegetation Potential on Disturbed Sites—

Estimating vegetation potential on disturbed sites is usually unnecessary in eastern Washington as most mountain alder sites are minimally impacted by logging, livestock, and people (because of thick, inaccessible stands; wet sites; high productivity and resiliency; and the isolated character of some stands). More accessible drainages have been moderately impacted, and it may be somewhat difficult to key the sites associated with these valleys. However, most valleys in eastern Washington NFs are still in fair or better ecological condition, and classification users can usually find enough mountain alder to key to the ALIN series. Similarly, the understory vegetation is rarely absent, and users can lower the cover criteria for the understory one class to key to the association. For the rare stand where the vegetation is gone, users can examine nearby undisturbed drainages with similar environmental conditions to key the site.

Sensitive Species—

Sensitive plant species are fairly common in the ALIN series, especially in the wetter plant associations (app. D).

Plant association	Sensitive species: Wenatchee larkspur	Crested shield fern	Branching montia	McCalla's willow	N
ALIN/CAUT	0	2	0	1	3
ALIN/EQUIS	1	1	0	0	2
ALIN-SYAL	0	0	1	0	1
Series total	1	3	1	1	6

ADJACENT SERIES

The ALIN series occurs at comparatively low elevations and is usually bounded on adjacent upland slopes by coniferous forest in the QUGA, PIPO, PSME, PIEN, ABGR, THPL, and TSHE series. It occasionally extends to lower elevations into upland areas with shrub-steppe. Stands dominated by mountain alder are rare at higher elevation within zones dominated by the ABAM, TSME, and ABLA2 series.

RELATIONSHIPS TO OTHER CLASSIFICATIONS

Many of the plant associations in the ALIN series are described in the draft riparian/wetland classification for northeastern Washington (Kovalchik 1992c). The ALIN series also is described in eastern Washington (Crawford 2003); central and northeastern Oregon (Crowe and Clausnitzer 1997, Kovalchik 1987); Montana (Hansen et al. 1995); the Mount Hood and Gifford Pinchot NFs (Diaz and Mellen 1996); and Idaho, Utah, and Nevada (Manning and Padgett 1995, Padgett et al. 1989, Youngblood et al. 1985a, 1985b).

U.S. DEPARTMENT OF THE INTERIOR, FISH AND WILDLIFE SERVICE WETLANDS CLASSIFICATION

System:	palustrine
Class:	scrub-shrub
Subclass:	broad-leaved deciduous
Water regime:	(nontidal) saturated to temporarily flooded

Note: Awned sedge, marsh horsetail, alpine lady fern, and pyramid spiraea are used in the keys to key out some plant associations. They do not appear in the constancy/cover tables because they did not occur on any plots. However, they were observed as dominants on some unsampled stands, and the author considers these species as alternate indicators for these plant associations.

KEY TO THE MOUNTAIN ALDER (*ALNUS INCANA*) PLANT ASSOCIATIONS

1. Young, active, fluvial surfaces with recently worked alluvium the dominant feature of the ground layer, riparian vegetation scattered .... **Mountain alder/alluvial bar (ALIN/ALLUVIAL BAR) association**
2. Saw-leaved sedge (*Carex scopulorum* var. *prionophylla*) ≥10 percent canopy coverage .... **Mountain alder/saw-leaved sedge (ALIN/CASCP2) association**
3. Bladder sedge (*Carex utriculata*), awned sedge (*Carex atherodes*), and/or water sedge, (*Carex aquatilis*) ≥25 percent canopy coverage .... **Mountain alder/bladder sedge (ALIN/CAUT) association**
4. Small-fruited bulrush (*Scirpus microcarpus*) and/or bigleaf sedge (*Carex amplifolia*) ≥25 percent canopy coverage .... **Mountain alder/small-fruited bulrush (ALIN/SCMI) association**
5. Bluejoint reedgrass (*Calamagrostis canadensis*) ≥25 percent canopy coverage .... **Mountain alder/bluejoint reedgrass (ALIN/CACA) association**
6. Reed canarygrass (*Phalaris arundinacea*) ≥25 percent canopy coverage .... **Mountain alder/reed canarygrass (ALIN/PHAR) community type**
7. Skunk cabbage (*Lysichiton americanus*) ≥5 percent canopy coverage .... **Mountain alder/skunk cabbage (ALIN/LYAM) association**
8. Common horsetail (*Equisetum arvense*), wood horsetail (*E. sylvaticum*), marsh horsetail (*E. palustre*), common scouring-rush (*E. hyemale*), and/or water horsetail (*E. fluviatile*) ≥10 percent canopy coverage and *Athyrium* spp. or *Dryopteris* spp. subordinate to *Equisetum* spp. .... **Mountain alder/horsetail (ALIN/EQUIS) association**
9. Lady fern (*Athyrium filix-femina*), alpine lady fern (*Athyrium distentifolium*) and/or shield fern/wood-fern species (*Dryopteris* species) ≥5 percent canopy coverage and dominant over horsetail species .... **Mountain alder/lady fern (ALIN/ATFI) association**
10. Oak fern (*Gymnocarpium dryopteris*) ≥5 percent canopy coverage .... **Mountain alder/oak fern (ALIN/GYDR) association**
11. Douglas (*Spiraea douglasii*) and/or pyramid spiraea (*Spiraea pyramidata*) ≥10 percent canopy coverage .... **Mountain alder-Douglas spiraea (ALIN-SPDO) association**
12. Tall mannagrass (*Glyceria elata*), fowl mannagrass (*Glyceria striata*) and/or wood reed-grass (*Cinna latifolia*) ≥5 percent canopy coverage .... **Mountain alder/tall mannagrass (ALIN/GLEL) association**
13. Red-osier dogwood (*Cornus stolonifera*) ≥10 percent canopy coverage .... **Mountain alder–red-osier dogwood-common snowberry (ALIN-COST-SYAL) association**
14. Common snowberry (*Symphoricarpos albus*) ≥5 percent canopy coverage .... **Mountain alder-common snowberry (ALIN-SYAL) association**
15. Mesic forbs ≥5 percent canopy coverage .... **Mountain alder/mesic forb (ALIN/MESIC FORB) association**

Table 19—Constancy and mean cover of important plant species in the ALIN plant associations—Part 1

Species	Code	ALIN/ COST-SYAL 29 plots		ALIN/ SPDO 8 plots		ALIN- SYAL 16 plots		ALIN/ ALLUVIAL BAR 6 plots		ALIN/ ATFI 28 plots		ALIN/ CACA 5 plots		ALIN- CASCP2 2 plots		ALIN- CAUT 12 plots		ALIN/ EQUIS 29 plots	
		CON[a]	COV[b]	CON	COV	CON	COV	CON	COV	CON	COV	CON	COV	CON	COV	CON	COV	CON	COV
Tree overstory:																			
subalpine fir	ABLA2	6	2	—	—	21	3	40	3	100	3	17	3	14	3	17	3	14	3
Engelmann spruce	PIEN	38	4	17	3	50	4	20	Tr	100	5	33	5	28	6	33	5	28	6
black cottonwood	POTR2	19	10	17	18	11	2	—	—	—	—	—	—	21	4	—	—	21	4
Douglas-fir	PSME	25	3	17	2	7	4	—	—	—	—	—	—	14	7	—	—	14	7
western redcedar	THPL	—	—	17	Tr	25	3	—	—	—	—	8	2	21	6	8	2	21	6
Tree understory:																			
subalpine fir	ABLA2	—	—	—	—	11	2	60	2	50	2	25	1	14	3	25	1	14	3
Engelmann spruce	PIEN	44	6	50	3	39	2	100	2	50	2	42	1	31	3	42	1	31	3
black cottonwood	POTR2	13	Tr	83	Tr	4	Tr	20	1	—	—	—	—	28	2	—	—	28	2
Douglas-fir	PSME	25	2	100	2	7	1	—	—	—	—	—	—	10	5	—	—	10	5
western redcedar	THPL	13	2	67	1	39	2	—	—	—	—	25	3	31	7	25	3	31	7
Shrubs:																			
Douglas maple	ACGLD	44	3	50	1	25	12	—	—	—	—	8	Tr	34	4	8	Tr	34	4
mountain alder	ALIN	100	58	100	33	100	49	100	61	100	50	100	49	100	56	100	49	100	56
Sitka alder	ALSI	13	13	33	2	—	—	40	3	—	—	—	—	10	3	—	—	10	3
Saskatoon serviceberry	AMAL	44	2	83	1	14	1	40	2	—	—	8	3	31	2	8	3	31	2
red-osier dogwood	COST	94	4	83	2	79	13	40	Tr	—	—	75	3	76	10	75	3	76	10
ocean-spray	HODI	19	22	50	2	4	Tr	—	—	—	—	—	—	21	1	—	—	21	1
bearberry honeysuckle	LOIN	31	2	17	Tr	29	1	80	1	—	—	25	2	31	4	25	2	31	4
Hudsonbay currant	RIHU	31	3	—	—	18	8	20	Tr	—	—	25	3	28	3	25	3	28	3
prickly currant	RILA	56	3	67	1	79	3	60	1	—	—	25	1	62	4	25	1	62	4
Nootka rose	RONU	25	2	—	—	4	Tr	—	—	—	—	8	1	7	2	8	1	7	2
woods rose	ROWO	19	4	—	—	—	—	—	—	—	—	8	1	14	1	8	1	14	1
red raspberry	RUID	56	4	33	1	50	2	20	20	—	—	25	2	34	2	25	2	34	2
western thimbleberry	RUPA	50	3	17	Tr	64	6	20	Tr	—	—	—	—	38	4	—	—	38	4
Bebb's willow	SABE	13	6	—	—	4	3	20	7	—	—	42	4	7	4	42	4	7	4
Drummond's willow	SADR	—	—	—	—	4	1	60	4	50	3	8	1	—	—	8	1	—	—
dusky willow	SAME2	—	—	—	—	—	—	—	—	—	—	—	—	7	2	—	—	7	2
Mackenzie's willow	SARIM	—	—	—	—	—	—	20	2	—	—	8	Tr	10	3	8	Tr	10	3
Scouler's willow	SASC	—	—	50	Tr	4	1	20	3	—	—	8	20	10	2	8	20	10	2
Sitka willow	SASI2	—	—	50	4	—	—	—	—	—	—	8	3	7	2	8	3	7	2
Douglas spiraea	SPDO	6	5	—	—	11	7	20	3	—	—	17	40	3	5	17	40	3	5
common snowberry	SYAL	100	41	33	Tr	54	6	—	—	—	—	17	2	59	4	17	2	59	4
Low shrubs and subshrubs:																			
bunchberry dogwood	COCA	31	2	—	—	11	1	40	3	—	—	25	2	21	2	25	2	21	2
twinflower	LIBOL	19	3	—	—	18	2	60	7	—	—	17	1	17	4	17	1	17	4
myrtle pachistima	PAMY	50	6	83	Tr	14	Tr	20	3	—	—	—	—	21	2	—	—	21	2
Perennial forbs:																			
western yarrow	ACMI	19	Tr	83	Tr	4	Tr	60	Tr	—	—	17	1	14	Tr	17	1	14	Tr
deerfoot vanillaleaf	ACTR	13	58	—	—	4	25	—	—	—	—	—	—	—	—	—	—	—	—
Columbia monkshood	ACCO	44	1	—	—	61	1	20	Tr	—	—	—	—	17	1	—	—	17	1
baneberry	ACRU	31	Tr	17	Tr	61	1	—	—	—	—	—	—	10	1	—	—	10	1
common pearly-everlasting	ANMA	19	1	100	1	4	Tr	40	Tr	—	—	8	Tr	14	1	8	Tr	14	1
sharptooth angelica	ANAR	50	Tr	50	1	32	1	20	1	—	—	8	3	34	2	8	3	34	2
wild ginger	ASCA3	6	10	—	—	25	2	—	—	—	—	—	—	14	2	—	—	14	2
fewflower aster	ASMO	25	2	—	—	21	2	20	7	50	2	17	1	21	4	17	1	21	4
enchanter's nightshade	CIAL	56	1	33	Tr	54	3	—	—	—	—	8	Tr	38	6	8	Tr	38	6

Table 19—Constancy and mean cover of important plant species in the ALIN plant associations—Part 1 (continued)

		ALIN/ COST-SYAL 29 plots		ALIN/ SPDO 8 plots		ALIN-SYAL 16 plots		ALIN/ ALLUVIAL BAR 6 plots		ALIN/ ATFI 28 plots		ALIN/ CACA 5 plots		ALIN-CASCP2 2 plots		ALIN-CAUT 12 plots		ALIN/ EQUIS 29 plots	
Species	**Code**	**CON**[a]	**COV**[b]	**CON**	**COV**	**CON**	**COV**	**CON**	**COV**	**CON**	**COV**	**CON**	**COV**	**CON**	**COV**	**CON**	**COV**	**CON**	**COV**
Watson's willow-weed	EPWA	13	Tr	—	—	18	1	60	1	—	—	42	2	14	1	42	2	14	1
small bedstraw	GATR	—	—	—	—	11	1	40	Tr	50	2	50	1	14	1	50	1	14	1
sweetscented bedstraw	GATR	63	1	67	Tr	64	1	40	1	—	—	25	2	45	1	25	2	45	1
largeleaf avens	GEMA	63	1	—	—	61	1	60	1	50	Tr	58	1	52	2	58	1	52	2
common cow-parsnip	HELA	44	4	17	Tr	54	1	20	Tr	—	—	8	Tr	17	3	8	Tr	17	3
skunk cabbage	LYAM	—	—	—	—	11	1	—	—	—	—	17	2	—	—	17	2	—	—
northern bluebells	MEPAB	13	1	—	—	25	2	—	—	—	—	—	—	10	2	—	—	10	2
broadleaved montia	MOCO	—	—	17	Tr	18	4	—	—	—	—	—	—	3	5	—	—	3	5
marsh cinquefoil	POPA3	—	—	—	—	7	1	40	1	—	—	58	2	10	1	58	2	10	1
sidebells pyrola	PYSE	13	1	17	Tr	7	Tr	40	2	—	—	—	—	14	1	—	—	14	1
dotted saxifrage	SAPU	6	Tr	33	Tr	14	1	—	—	—	—	—	—	10	4	—	—	10	4
arrowleaf groundsel	SETR	6	Tr	33	Tr	75	3	60	1	100	11	42	1	28	4	42	1	28	4
starry solomonplume	SMST	94	2	—	—	79	5	20	1	50	1	50	2	31	1	50	2	31	1
claspleaf twisted-stalk	STAM	31	1	—	—	71	1	—	—	—	—	17	Tr	41	1	17	Tr	41	1
coolwort foamflower	TITRU	19	2	—	—	61	2	20	2	—	—	—	—	14	1	—	—	14	1
false bugbane	TRCA3	13	1	—	—	21	2	—	—	—	—	8	3	7	1	8	3	7	1
American speedwell	VEAM	31	1	—	—	50	1	40	Tr	50	2	50	2	45	3	50	2	45	3
Canadian violet	VICA	13	3	—	—	14	1	20	2	—	—	—	—	7	2	—	—	7	2
pioneer violet	VIGL	25	4	67	Tr	43	3	20	3	50	2	17	1	24	2	17	1	24	2
Grass or grasslike:																			
redtop	AGAL	13	8	—	—	11	Tr	20	15	—	—	17	4	3	3	17	4	3	3
bluejoint reedgrass	CACA	13	1	—	—	32	1	100	49	100	35	58	18	28	5	58	18	28	5
bigleaf sedge	CAAM	—	—	—	—	18	1	—	—	—	—	—	—	7	2	—	—	7	2
water sedge	CAAQA	—	—	—	—	—	—	—	—	50	Tr	—	—	—	—	—	—	—	—
Sitka sedge	CAAQS	—	—	—	—	—	—	—	—	—	—	17	35	7	Tr	17	35	7	Tr
Cusick's sedge	CACU2	—	—	—	—	—	—	—	—	—	—	17	33	7	3	17	33	7	3
soft-leaved sedge	CADI	—	—	—	—	32	7	—	—	—	—	50	2	21	1	50	2	21	1
saw-leaved sedge	CASCP2	—	—	—	—	—	—	20	Tr	100	50	—	—	3	5	—	—	3	5
bladder sedge	CAUT	6	5	—	—	7	Tr	60	1	50	Tr	92	36	21	4	92	36	21	4
wood reed-grass	CILA2	44	2	33	Tr	71	2	—	—	—	—	—	—	34	4	—	—	34	4
blue wildrye	ELGL	56	5	67	Tr	25	1	—	—	—	—	8	2	48	2	8	2	48	2
tall mannagrass	GLEL	44	2	67	3	75	3	40	5	50	2	58	4	59	9	58	4	59	9
fowl mannagrass	GLST	25	1	—	—	18	Tr	—	—	—	—	8	2	17	2	8	2	17	2
reed canarygrass	PHAR	—	—	—	—	7	Tr	—	—	—	—	17	13	3	Tr	17	13	3	Tr
Kentucky bluegrass	POPR	—	—	17	Tr	—	—	—	—	—	—	8	Tr	10	1	8	Tr	10	1
small-fruited bulrush	SCMI	—	—	—	—	11	1	—	—	—	—	50	3	17	2	50	3	17	2
Ferns and fern allies:																			
lady fern	ATFI	56	2	50	Tr	100	29	40	Tr	—	—	33	3	45	3	33	3	45	3
coastal shield fern	DRAR	6	Tr	—	—	4	10	—	—	50	1	—	—	14	1	—	—	14	1
wood-fern	DRCA	—	—	—	—	4	Tr	—	—	50	1	8	2	3	3	8	2	3	3
common horsetail	EQAR	56	1	83	2	68	4	100	3	50	2	58	4	97	29	58	4	97	29
water horsetail	EQFL	—	—	—	—	4	20	—	—	—	—	33	1	10	35	33	1	10	35
common scouring-rush	EQHY	19	1	17	Tr	7	1	—	—	—	—	—	—	31	14	—	—	31	14
sedgelike horsetail	EQSC	—	—	—	—	—	—	—	—	—	—	—	—	3	2	—	—	3	2
wood horsetail	EQSY	6	2	—	—	—	—	20	Tr	50	3	8	2	7	6	8	2	7	6
oak fern	GYDR	6	3	—	—	57	12	20	Tr	—	—	—	—	17	4	—	—	17	4

[a] CON = percentage of plots in which the species occurred.
[b] COV = average canopy cover in plots in which the species occurred.
[c] Tr = trace cover, less than 1 percent canopy cover.

Table 19—Constancy and mean cover of important plant species in the ALIN plant associations—Part 2

Species	Code	ALIN/ GLEL 17 plots		ALIN/ GYDR 7 plots		ALIN- LYAM 8 plots		ALIN/ MESIC FORB 18 plots		ALIN/ PHAR 2 plots		ALIN/ SCMI 3 plots	
		CON[a]	COV[b]	CON	COV	CON	COV	CON	COV	CON	COV	CON	COV
Tree overstory:													
subalpine fir	ABLA2	12	3	14	Tr	—	—	22	6	—	—	—	—
Engelmann spruce	PIEN	35	3	29	5	13	Tr	17	12	—	—	—	—
black cottonwood	POTR2	12	3	14	15	13	10	28	5	—	—	33	Tr
Douglas-fir	PSME	6	3	29	4	—	—	22	5	—	—	—	—
western redcedar	THPL	12	4	14	15	50	7	11	7	50	Tr	—	—
Tree understory:													
subalpine fir	ABLA2	18	1	43	2	13	Tr	22	2	—	—	—	—
Engelmann spruce	PIEN	41	2	57	10	—	—	33	2	—	—	—	—
black cottonwood	POTR2	6	Tr	—	—	—	—	28	2	50	5	33	Tr
Douglas-fir	PSME	24	2	57	2	—	—	22	Tr	—	—	—	—
western redcedar	THPL	18	3	14	5	50	2	28	2	50	Tr	33	4
Shrubs:													
Douglas maple	ACGLD	6	7	29	4	25	3	39	2	—	—	—	—
mountain alder	ALIN	100	65	100	49	100	61	100	70	100	55	100	73
Sitka alder	ALSI	—	—	14	2	—	—	11	2	—	—	—	—
Saskatoon serviceberry	AMAL	29	2	29	1	13	2	11	Tr	—	—	33	Tr
red-osier dogwood	COST	76	18	86	11	88	19	61	4	100	4	67	1
ocean-spray	HODI	—	—	—	—	13	Tr	33	3	—	—	—	—
bearberry honeysuckle	LOIN	53	3	29	6	13	2	44	5	50	Tr	33	Tr
Hudsonbay currant	RIHU	29	19	29	3	25	5	11	3	—	—	—	—
prickly currant	RILA	76	4	71	7	50	1	67	10	—	—	—	—
Nootka rose	RONU	6	3	14	2	13	3	6	2	50	Tr	—	—
woods rose	ROWO	18	2	14	5	—	—	17	1	—	—	—	—
red raspberry	RUID	47	6	29	2	25	4	11	4	50	2	33	1
western thimbleberry	RUPA	47	2	57	2	—	—	61	3	50	Tr	—	—
Bebb's willow	SABE	18	2	—	—	—	—	—	—	—	—	67	Tr
Drummond's willow	SADR	12	1	—	—	—	—	—	—	—	—	33	Tr
dusky willow	SAME2	—	—	—	—	—	—	6	7	50	1	—	—
Mackenzie's willow	SARIM	—	—	—	—	—	—	11	5	—	—	—	—
Scouler's willow	SASC	12	11	29	2	—	—	6	1	—	—	—	—
Sitka willow	SASI2	—	—	—	—	—	—	6	Tr	—	—	—	—
Douglas spiraea	SPDO	12	2	—	—	38	23	11	Tr	—	—	33	Tr
common snowberry	SYAL	59	19	43	17	38	6	33	1	100	1	—	—
Low shrubs and subshrubs:													
bunchberry dogwood	COCA	18	1	29	3	—	—	11	10	—	—	33	Tr
twinflower	LIBOL	29	3	14	3	—	—	33	5	—	—	—	—
myrtle pachistima	PAMY	12	Tr	14	Tr	—	—	22	1	—	—	—	—
Perennial forbs:													
western yarrow	ACMI	24	Tr	14	Tr	—	—	39	1	50	Tr	67	1
deerfoot vanillaleaf	ACTR	6	1	—	—	—	—	22	20	—	—	—	—
Columbia monkshood	ACCO	29	1	43	1	—	—	17	1	—	—	33	Tr
baneberry	ACRU	18	1	43	1	13	3	44	4	—	—	—	—
common pearly-everlasting	ANMA	24	1	14	Tr	—	—	6	5	—	—	—	—
sharptooth angelica	ANAR	47	9	43	1	25	8	56	1	—	—	—	—
wild ginger	ASCA3	6	3	29	Tr	25	1	6	6	—	—	—	—
fewflower aster	ASMO	24	15	14	Tr	13	2	—	—	—	—	—	—
enchanter's nightshade	CIAL	47	3	43	2	63	5	28	10	—	—	33	Tr
Watson's willow-weed	EPWA	29	1	14	2	13	Tr	11	1	—	—	100	2
small bedstraw	GATR	—	—	—	—	—	—	—	—	—	—	67	Tr
sweetscented bedstraw	GATR	71	2	43	2	38	1	50	1	50	Tr	—	—
largeleaf avens	GEMA	76	2	71	3	38	1	6	1	50	Tr	67	1
common cow-parsnip	HELA	53	4	43	1	13	Tr	22	1	—	—	33	Tr
skunk cabbage	LYAM	12	1	14	Tr	100	40	6	Tr	50	1	—	—
northern bluebells	MEPAB	35	2	—	—	25	Tr	22	9	—	—	—	—
broadleaved montia	MOCO	18	2	14	2	13	5	28	1	—	—	—	—
marsh cinquefoil	POPA3	—	—	—	—	—	—	6	Tr	50	Tr	33	Tr
sidebells pyrola	PYSE	6	Tr	43	1	—	—	56	Tr	—	—	—	—
dotted saxifrage	SAPU	18	9	14	Tr	—	—	22	Tr	—	—	—	—
arrowleaf groundsel	SETR	53	7	43	1	50	3	39	1	—	—	33	Tr
starry solomonplume	SMST	53	2	43	1	75	2	56	2	—	—	—	—
claspleaf twisted-stalk	STAM	29	1	100	2	13	3	39	1	—	—	—	—
coolwort foamflower	TITRU	12	2	57	4	13	3	28	1	—	—	—	—
false bugbane	TRCA3	35	9	43	6	—	—	28	Tr	—	—	—	—
American speedwell	VEAM	65	1	43	1	75	1	6	Tr	50	Tr	67	3
Canadian violet	VICA	29	4	29	2	13	7	—	—	—	—	—	—
pioneer violet	VIGL	53	2	57	2	38	3	44	9	—	—	—	—

Table 19—Constancy and mean cover of important plant species in the ALIN plant associations—Part 2 (continued)

		ALIN/ GLEL 17 plots		ALIN/ GYDR 7 plots		ALIN-LYAM 8 plots		ALIN/ MESIC FORB 18 plots		ALIN/ PHAR 2 plots		ALIN/ SCMI 3 plots	
Species	**Code**	**CON**	**COV**	**CON**	**COV**	**CON**	**COV**	**CON**	**COV**	**CON**	**COV**	**CON**	**COV**
Grass or grasslike:													
redtop	AGAL	18	2	—	—	—	—	—	—	50	10	33	2
bluejoint reedgrass	CACA	35	6	14	Tr	25	1	17	2	—	—	—	—
bigleaf sedge	CAAM	18	Tr	—	—	25	1	6	Tr	—	—	33	35
water sedge	CAAQA	—	—	—	—	—	—	—	—	—	—	—	—
Sitka sedge	CAAQS	6	Tr	—	—	—	—	—	—	—	—	33	2
Cusick's sedge	CACU2	—	—	—	—	—	—	—	—	—	—	—	—
soft-leaved sedge	CADI	29	2	29	5	13	Tr	11	Tr	—	—	33	7
saw-leaved sedge	CASCP2	6	Tr	—	—	—	—	11	2	—	—	33	2
bladder sedge	CAUT	12	Tr	—	—	13	3	11	Tr	50	2	67	2
wood reed-grass	CILA2	71	7	71	5	25	2	50	1	—	—	—	—
blue wildrye	ELGL	41	6	14	3	—	—	17	4	—	—	—	—
tall mannagrass	GLEL	76	11	57	2	88	5	22	1	50	2	67	8
fowl mannagrass	GLST	12	15	29	2	—	—	6	Tr	—	—	—	—
reed canarygrass	PHAR	6	Tr	—	—	13	25	6	Tr	100	73	—	—
Kentucky bluegrass	POPR	6	Tr	—	—	13	1	—	—	50	35	33	5
small-fruited bulrush	SCMI	12	4	—	—	13	1	—	—	—	—	100	36
Ferns and fern allies:													
lady fern	ATFI	53	2	86	3	75	23	22	1	50	2	33	5
coastal shield fern	DRAR	18	1	—	—	13	Tr	—	—	—	—	—	—
wood-fern	DRCA	—	—	—	—	25	3	—	—	—	—	—	—
common horsetail	EQAR	71	2	71	2	63	6	61	1	50	5	67	4
water horsetail	EQFL	—	—	—	—	38	1	6	Tr	—	—	—	—
common scouring-rush	EQHY	12	1	—	—	13	1	17	1	50	1	—	—
sedgelike horsetail	EQSC	—	—	29	13	—	—	—	—	—	—	—	—
wood horsetail	EQSY	6	5	14	5	—	—	—	—	—	—	33	2
oak fern	GYDR	18	2	100	7	13	Tr	17	1	—	—	—	—

[a] CON = percentage of plots in which the species occurred.

[b] COV = average canopy cover in plots in which the species occurred.

[c] Tr = trace cover, less than 1 percent canopy cover.

RED-OSIER DOGWOOD SERIES

Cornus stolonifera

COST N = 40

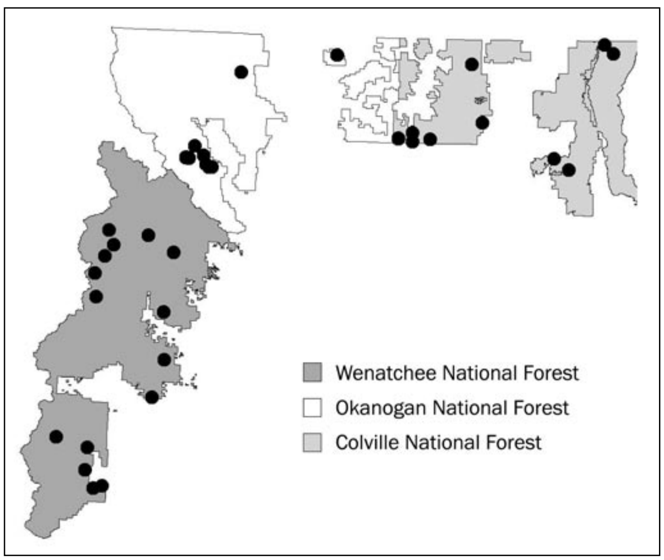


Figure 30—Plot locations for the red-osier dogwood series.

THE RANGE OF red-osier dogwood[1] extends from Alaska and the Yukon Territory, east to Labrador and Newfoundland, and south to Virginia, Kansas, and northern Mexico (Hansen et al. 1988, Hitchcock and Cronquist 1973).

[1] See appendix A for a cross reference for all species codes and common and scientific names used in this document.

Within its entire range, red-osier dogwood is characterized as a species found in swamps, low meadows, and riparian zones but also found in open forest understory and along forest margins (Haeussler and Coates 1986, Viereck and Little 1972). In eastern Washington, however, red-osier dogwood occurs on a much narrower range of sites that are mostly in riparian and wetland zones; it rarely occurs in uplands.

Stands dominated or otherwise characterized by an abundance of red-osier dogwood are common throughout eastern Washington. The climate associated with the COST series is variable. Annual precipitation varies from well under 20 inches in the dry interior of the study area, to more than 100 inches in maritime climate along the Cascade crest, and more than 50 inches in the weaker inland maritime climate in northeastern Washington. The COST series appears to be less abundant in the wet maritime zone along the Cascade crest, where other series, such as RUSP and ACCI supplant it, than on similar sites in continental climates. In general, most sites supporting the COST series appear to favor relatively warm valley temperatures associated with low to moderate elevation and relatively wide valleys. Any lack of precipitation in these climates is compensated for by the moist nature of the riparian sites associated with the COST series. In summary, COST is a relatively simple series with few plant associations owing to limited site variation (fluvial surfaces) and restricted elevations (low to moderate).

CLASSIFICATION DATABASE

The COST series includes all nonforest stands potentially dominated by at least 25 percent canopy coverage of red-osier dogwood. It was sampled on all three NFs and on all but the Lake Chelan and Newport RDs (it has been observed on these two RDs). Forty riparian and wetland plots were sampled in the COST series (fig. 30). From this database, three major COST plant associations and one minor COST plant association are described. One potential, one-plot association (COST-SPDO) was not used in the database and is not described in this classification. These samples are located mostly in late-seral and climax red-osier dogwood stands, although species composition on some sites may indicate that the vegetation potential may be shifting toward cottonwood or conifer dominance owing to sediment accumulation and subsequent lowering of the water table.

Red-osier dogwood plant associations

	Scientific name	Common name	Ecoclass code	Plots
Major associations:				
COST/ATFI	*Cornus stolonifera/Athyrium filix-femina*	Red-osier dogwood/lady fern	SW2321	11
COST/MESIC FORB	*Cornus stolonifera*/mesic forb	Red-osier dogwood/mesic forb	SW2323	7
COST-SYAL	*Cornus stolonifera-Symphoricarpos albus*	Red-osier dogwood-common snowberry	SW2324	18
Minor associations:				
COST/EQUIS	*Cornus stolonifera/Equisetum* species	Red-osier dogwood/horsetail species	SW2322	4

VEGETATION CHARACTERISTICS

Red-osier dogwood's wide geographic range results in differences in botanical characteristics and subsequent taxonomic disagreement (Gleason and Cronquist 1963, Hitchcock and Cronquist 1973). It has several subspecies, and hybridizes with other dogwood species. However, little obvious variation in the species has been observed in eastern Washington. The plants observed within the study area are *C. stolonifera occidentalis* (Hitchcock and Cronquist 1973), but for convenience this guide uses *Cornus stolonifera* for naming red-osier dogwood.

Red-osier dogwood usually dominates the COST series. Its canopy coverage ranges from a low average of 65 percent in the COST/EQUIS association to 86 percent in the COST/MESIC FORB association, with an average of 76 percent for the COST series as a whole. Dense, nearly pure stands of dogwood with 90 to 100 percent canopy coverage are common. Red-osier dogwood is a strong competitor, and the cover of other plants tends to decrease with increasing dogwood cover. However, indicator species for the various associations usually are present, even where dogwood and other shrubs exceeded 70 percent canopy coverage. The exception is the COST/MESIC FORB association, where red-osier dogwood and other shrub cover is so dense that it substantially limits the cover of vegetation growing below it (depauperate undergrowth).

The constancy and cover of other species varies according to the plant association and the abundance of shrubs. A relatively short species list is associated with the COST series because of shrub overstory density, limited elevation range, or the limited number of associations and sites. Common snowberry is well represented beneath red-osier dogwood on warm, well-drained streambanks and terraces on the COST-SYAL association. Common horsetail, lady fern, alpine lady fern, or oak fern are well represented to abundant on very moist to wet floodplains, streambanks, and terraces in the COST/ATFI and COST/EQUIS associations. These sites are subject to frequent flooding but are stable and may be experiencing rapid sediment deposition.

A paucity of indicators (other than red-osier dogwood) characterizes the COST/MESIC FORB association. A variety of shrubs and forbs may be present but may not have consistently high constancy or cover and thus may not make good indicators for these generally moist, well-drained sites. The COST/MESIC FORB association usually occurs on older portions of alluvial bars or point bars and it has deeper, finer textured soils than the fresh, skeletal soils of new alluvial bars (usually dominated by willow species or mountain alder). Other than red-osier dogwood, no single species predominates, and the species present depend on their ability to tolerate red-osier dogwood shade and the opportunity for seral species to colonize new alluvium.

It is common for trees to be scattered in both overstory and understory on COST series plots, especially older stands with deep deposits of fine-textured alluvial soils. Tree cover approaching 25 percent may indicate the site is changing toward forest potential owing to deep sediment accumulation.

PHYSICAL SETTING

Elevation—

The majority of COST series plots are between 1,700 and 3,500 feet. Only four plots are above 3,500 feet. Elevation summaries for eastern Washington as a whole are somewhat misleading owing to the influence of maritime climates along the Cascade crest and extreme northeastern Washington. Other series, such as ACCI or ALSI, extend to lower elevations in the Cascade Range on sites that might otherwise be dominated by red-osier dogwood, thus pushing the upper elevation limits of the COST series downward compared with drier portions of its range, such as on the Colville NF (4,325 feet in upper elevation). However, averages are about the same among the three forests, with the Wenatchee NF averaging only 300 feet in elevation lower than the Colville NF.

	Elevation (feet)			
Forest	Minimum	Maximum	Average	N
Colville	1,550	4,325	2,912	11
Okanogan	2,050	3,400	2,768	11
Wenatchee	1,700	3,700	2,633	18
Series	1,550	4,325	2,747	40

Elevations appear to differ little between plant associations. The COST/ATFI association is at higher elevations, whereas COST/EQUIS is lower. However, elevations among all four associations significantly overlap.

	Elevation (feet)			
Plant association	Minimum	Maximum	Average	N
COST/ATFI	2,240	3,700	2,949	7
COST-SYAL	2,250	3,400	2,750	11
COST/MESIC FORB	1,700	4,325	2,705	18
COST/EQUIS	1,550	3,175	2,575	4
Series	1,550	4,325	2,747	40

Valley Geomorphology—

The COST series is found in various valley width and gradient classes. Most plots are located in very low- to moderate-gradient valleys of considerable width. Approximately 70 percent of the plots are located in valleys more than 99 feet wide, and 85 percent are located in valleys with less than 6 percent valley gradient. The COST series is relatively uncommon only in very narrow and very steep valleys. This may reflect a reduction in red-osier dogwood potential owing to excessive shade from overtopping conifers or terrain or less probability of finding periodically flooded fluvial surfaces of sufficient size to initiate and support red-osier dogwood dominated stands.

Valley width	Valley gradient					
	Very low	Low	Moderate	Steep	Very steep	N
Very broad	3	4	0	0	0	7
Broad	1	8	2	0	0	11
Moderate	2	6	2	0	0	10
Narrow	0	4	1	1	2	8
Very narrow	0	0	1	1	2	4
Series total	6	22	6	2	4	40

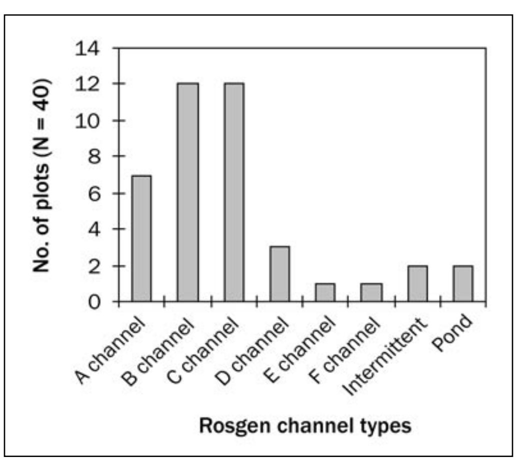
These generalities vary somewhat by association, where COST/ATFI prefers the cooler temperatures associated with narrower valley bottoms, whereas COST-SYAL and COST/MESIC FORB occur more often in relatively warmer broad, low-gradient valleys.

Plant association	Valley width					
	Very broad	Broad	Moderate	Narrow	Very narrow	N
COST/ATFI	0	1	1	4	1	7
COST/EQUIS	1	0	3	0	0	4
COST-SYAL	2	3	2	3	1	11
COST/MESIC FORB	4	7	4	1	2	18
Series total	7	11	10	8	4	40

Plant association	Valley gradient					
	Very low	Low	Moderate	Steep	Very steep	N
COST/ATFI	0	4	2	0	1	7
COST/EQUIS	0	2	2	0	0	4
COST-SYAL	2	5	1	1	2	11
COST/MESIC FORB	4	11	1	1	1	18
Series total	6	22	6	2	4	40

Channel Types—

The COST series is associated with a variety of channel types, but most fall in the Rosgen A, B, and C classes. Moderate to steep gradient valleys generally support A and B channel types. Low gradient valleys support B, C, and D (degraded C) channels, whereas very low gradient valleys support C and E channels. There is a tendency for streams and rivers (especially in the wider valleys) to be larger B and C channels that produce large active fluvial surfaces on which red-osier dogwood could establish. The COST series also may dominate the dry margins of ponds and lakes on sites transitional to upland forests. This situation is much more common than the two pond plots indicate as small ponds and glacial kettles were not sampled often.

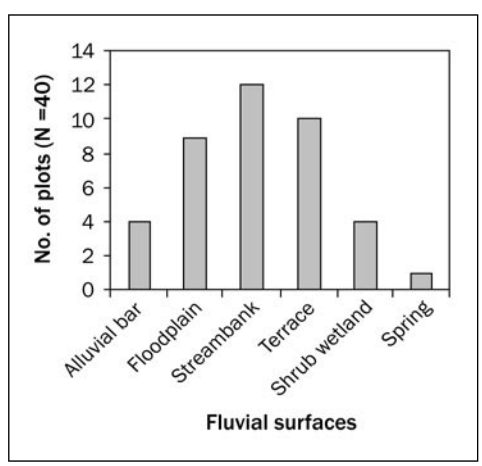


No meaningful patterns are evident when looking at individual associations except for the prominence of B and C channels along COST/EQUIS, COST/SYAL, and COST/MESIC FORB associations. COST/ATFI is usually located along A channels.

Plant association	Rosgen channel types								
	A	B	C	D	E	F	Intermittent	Pond	N
COST/MESIC FORB	2	5	7	0	1	1	0	2	18
COST/ATFI	3	1	1	1	0	0	1	0	7
COST/EQUIS	0	3	1	0	0	0	0	0	4
COST-SYAL	2	3	3	2	0	0	1	0	11
Series total	7	12	12	3	1	1	2	2	40

Fluvial Surfaces—

In contrast to the ALIN and SALIX series, the COST series is found on a limited variety of fluvial surfaces. The COST series is most prominent in riparian zones on moist, periodically flooded fluvial surfaces such as floodplains, streambanks, and immediate terraces along the edges of streams, rivers, and overflow channels. It is also found on the banks of glacial kettles, ponds, and lakes on the sharp transition to uplands. It is less common in wetlands such as beaver dam complexes, shrub-fen wetlands, or wet organic soils. Although many plots are seasonally flooded or saturated, these sites usually are well drained and well aerated, especially in the COST-SYAL and COST/MESIC FORB associations. Eighty percent of the plots are located on these kinds of sites. The relationship is even stronger as three of the four plots coded as shrub wetlands were actually on riparian wetland sites on streambanks and terraces. These stands were so extensive, they appeared more of a wetland rather than riparian zone. The spring plot also was located in an overflow channel and therefore on a riparian wetland.



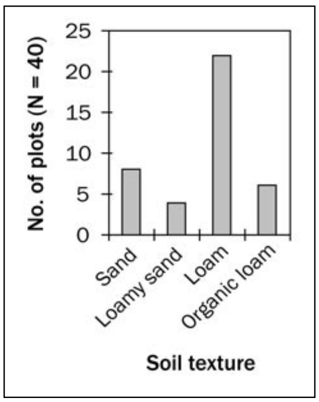
Additional insight is gained by looking at individual associations. As with the COST series as a whole, most stands in the COST/MESIC FORB and COST-SYAL associations are associated with streambanks and terraces. Plots also are found on alluvial bars, floodplains, and shrub wetlands. COST/ATFI, however, is most often found on wet floodplains and wetter portions of terraces. COST/EQUIS is found on a variety of wet sites.

In summary, information on valley configuration, stream channels, and fluvial surfaces indicates that the chances of finding COST series stands increase with decreasing valley gradient and increasing valley width plus sites subject to periodic flooding. Exceptions include narrower, steeper valleys with small, periodically flooded fluvial surfaces and the banks of lakes and ponds.

	Fluvial surfaces						
Plant association	Alluvial bar	Flood-plain	Stream-bank	Terrace	Shrub wetland	Spring	N
COST/ATFI	0	5	0	2	0	0	7
COST/EQUIS	1	1	0	1	0	1	4
COST/MESIC FORB	2	2	7	4	3	0	18
COST-SYAL	1	1	5	3	1	0	11
Series total	4	9	12	10	4	1	40

Soils—

Loam soils are predominant on these active fluvial surfaces. Alluvial bars and floodplains usually have sand to sandy loam textures and usually contain considerable coarse fragments. Sites with deeper deposits of sediment such as older floodplains, upper streambanks, terraces, and the margins of ponds generally have deeper, finer-textured loam soils. Older red-osier dogwood stands or those with wetter soils may develop deep accumulations of organic loam.



Additional information is gained by looking at individual plant associations. COST/ATFI and COST/MESIC FORB are prevalent on loam soils although they also are found on other soils. However, the COST series as a whole has mixed soil textures as explained above.

	Soil texture				
Plant association	Sand	Loamy sand	Loam	Organic loam	N
COST/ATFI	1	1	5	0	7
COST/EQUIS	1	0	2	1	4
COST-SYAL	3	1	5	2	11
COST/MESIC FORB	3	2	10	3	18
Series total	8	4	22	6	40

Average water table depths at the time of sampling for the various plant associations range from 18 to 25 inches below the soil surface and average -22 inches for the COST series. The COST/ATFI association appears to be the wettest association, whereas COST/SYAL had the deepest water tables. The plots reflect summer (sample season) conditions, and water tables were seldom measured during peak streamflow when some sites may have been flooded. Therefore the reported maximum measured water tables are misleading (growing season biased) and should be considered as indexes only.

	Water table (inches)			
Plant association	Minimum	Maximum	Average	N
COST/ATFI	-12	-24	-18	2
COST/MESIC FORB	-35	-6	-20	5
COST/EQUIS	-47	-4	-21	4
COST-SYAL	-49	-12	-25	6
Series	-47	-4	-22	17

Soil temperatures at the time of sampling ranged from 44 to 59 degrees Fahrenheit and averaged 52 degrees Fahrenheit for the COST series. COST/EQUIS was the warmest association, whereas the COST/SYAL was the coldest. However, considerable overlap exists among associations, and the data should be treated with caution.

	Soil temperature (°F)			
Plant association	Minimum	Maximum	Average	N
COST/EQUIS	47	59	53	4
COST/MESIC FORB	45	59	52	16
COST/ATFI	44	57	51	6
COST-SYAL	46	53	50	8
Series	44	59	52	34

In summary, COST series stands are indicative of temporarily flooded or temporarily saturated mineral soils that are moist and well drained during the growing season. Red-osier dogwood tolerates temporary soil saturation and flooding but generally does not tolerate wetlands with long periods of soil saturation or flooding.

ECOSYSTEM MANAGEMENT

Natural Regeneration of Red-Osier Dogwood—

Red-osier dogwood is a deciduous, many-stemmed shrub that grows from 6 to 18 feet tall (Hitchcock and Cronquist 1973, Smith et al. 1995, Viereck and Little 1972). The natural regeneration of red-osier dogwood is both sexual and asexual. The flowers require out-crossing to become fertile. Pollinators include the honeybee, bumblebee, solitary bee, and possibly beetles, flies, and butterflies (Eyde 1988). Young plants may first produce seed at 3 or 4 years of age, but older plants are more prolific (Smith et al. 1995). Seeds are dispersed primarily through the guts of songbirds, but other animals such as bear, mice, grouse, ducks, and trout may eat the fruit and disperse the seeds (Eyde 1988, Smith et al. 1995, Vines 1960). The seeds have dormant embryos and need cold stratification for 1 to 3 months to germinate (Brinkman 1974, Hansen 1989, Shaw 1984). In addition, the hard seed coats may need scarification (Smithberg 1974) such as being scoured by floodwater or passing through the digestive tract of birds and mammals. The seed may remain viable in the soil seed bank for many years.

Red-osier dogwood forms dense thickets through vegetative reproduction by rooting at branch nodes that are in contact with moist ground (Haeussler and Coates 1986, Hansen et al. 1988). Such layering is common on riparian sites in eastern Washington. Plants also produce new shoots from the roots as well as from the bases of dying or girdled branches (Pauls 1986, Smithberg 1974). Although red-osier dogwood has root primordia capable of producing new plants from cuttings, it is unusual to observe broken pieces of dogwood stems rooting in the wild as is so often observed with willows. This may have some implications on the use of cuttings as a means of establishing red-osier dogwood on disturbed sites.

Artificial Establishment of Red-Osier Dogwood—

Red-osier dogwood is recommended for rehabilitating appropriate sites within its elevation range. It is well adapted to disturbed sites, spreads rapidly, is excellent at stabilizing soils, and is easy to establish (Plummer 1977, Stark 1966). Red-osier dogwood requires fresh soil water, well-aerated soils, and is useful in stabilizing eroding streambanks or floodplains (Lines et al. 1979, Hansen et al. 1988). It is moderately easy to establish plants from seed as well as from transplants (Plummer 1977). Nursery-grown seedlings or rooted cuttings are easily established on moist, well-drained sites and grow rapidly. Cuttings of red-osier dogwood are reported to root easily without treatment when planted where sufficient moisture and aeration is available (Doran 1957). Younger, leafy, branching material may root better than older stems. Aboveground stems will desiccate if too little stem is put in the ground. Therefore, as with willows, cuttings should be planted with at least 60 percent (preferably 80 percent) of the stem within moist soil, thus allowing for development of a root system capable of supporting the aboveground biomass. Contrary to willows, whose cuttings are obtained and planted during dormancy, actively growing dogwood cuttings can be used in spring and late summer. For instance, 100 percent of red-osier dogwood cuttings taken in August were rooted in 5 weeks, and 90 percent of those cut in April were rooted in 8 weeks (Doran 1957). However, the author has limited awareness of planting successes with cuttings and recommends rooted cuttings or seedlings for establishing dogwood.

Whatever the source, seeding and planting will fail on sites that do not have the potential to grow red-osier dogwood. Therefore it is critical to determine that natural and human-induced conditions are favorable for their establishment and survival. Managers should use a wetland/riparian plant association classification to determine if dogwood is natural to the site. Site evaluation also may indicate whether dogwood can be stocked by natural regeneration. A stocking survey may show that seedlings have already established on the site or that a seed source from mature plants is nearby. Most planting recommendations in the SALIX series are appropriate for red-osier dogwood. (For more information on the short- and long-term revegetation potential of selected riparian wetland plant species, see app. B-5.)

Stand Management—

Scattered trees often occur within COST series. However, timber harvesting is not appropriate on these sites as they are located very close to lakes, ponds, rivers, and streams. Down woody debris from adjacent forests or deposited by floodwaters is an important feature of COST series sites, and future supplies of down woody material should be considered in the management of adjacent and upstream forest.

All sample plots were in fair or better ecological condition so that little is known about successional pathways in the wake of disturbance. A study of disturbed stands is needed. Some associations in the COST series are subject to recurring scouring and deposition by floods. Therefore, where the site has been highly altered (in a negative sense such as following severe flood damage), managers may consider restoring dogwood for its excellent streambank stability values. Damaged streambanks and floodplains could be planted or seeded to speed restoration of red-osier dogwood. The site also needs protection from the limiting factor that caused red-osier dogwood cover and site conditions to be altered.

Coarse-textured soils with high coarse-fragment content minimize most soil-compaction problems associated with trampling or equipment operation. Deeper loam soils are subject to compaction. Compacted soils may be protected from the compaction source, disked, and replanted with red-osier dogwood and its associates. In some cases, depositional loam soils may be deep enough for the sites to be transitional to black cottonwood or conifer potential. Conifer or black cottonwood encroachment may shade the dogwood and reduce its percentage of cover. Selection cutting or prescribed fire may be used to open the stand, increase the cover of dogwood, and delay the transition to forest. However, it is probably better to not disrupt natural soil succession and the associated transition from one series to another.

Growth and Yield—

Initial height growth of red-osier dogwood is rapid but quickly tapers off as stem heights exceed 10 feet. Ten red-osier dogwood stems from a variety of sites were destructively sampled to determine age and stem height. The age of 0.6- to 1.4-inch stems ranged from 5 to 25 years and averaged 12.6 years. Stem heights ranged from 8 to 18 feet and averaged 10.5 feet. The 18-foot stem is misleading as it reflects the total length of a recumbent stem that swooped up on the end. Eight- to ten-foot heights are more typical for red-osier dogwood stems in eastern Washington. Dogwood stem ages are similar to those of many of the shrubby willows, and it is likely that individual stems succumb to insects and diseases or browsing before they can attain significant age or height. The dead stem is usually replaced by resprouting from the next live stem bud, stem base, or root crown.

Growth attributes	Minimum	Maximum	Average	N
Age (years)	5	25	12.60	10
Height (feet)	8	18	10.50	10
Basal diameter (inches)	0.60	1.40	1.11	9

Down Wood—

The overall amount of down woody debris is high compared with other nonforest series (app. C-3). Logs cover 6 percent of the ground surface of COST series stands. Of the nonforest series, only the SPDO and OPHO series have higher log cover. The high percentage of log cover reflects the proximity of COST series sites to large, log-transporting streams and rivers as well as the proximity of forested plant associations.

Definitions of log decomposition classes are on page 15.

	Down log attributes				
Log decomposition	Tons/ acre	Cu. ft./ acre	Linear ft./ acre	Sq. ft./ acre	% ground cover
Class 1	1.16	117	90	95	0
Class 2	.97	102	401	219	.50
Class 3	10.23	1,266	1,168	1,164	2.70
Class 4	4.08	1,201	601	826	1.90
Class 5	1.22	412	158	260	.60
Total	17.66	3,098	2,418	2,564	5.90

Fire—

Fires are somewhat infrequent in the COST series owing to the high moisture content and relatively cool temperatures of riparian sites. However, during severe drought, red-osier dogwood may be burned as severely as the adjacent forest (e.g., as happened in the Tyee Fire in 1994). Stands in narrow valleys may burn even in moderate fire years owing to proximity of conifer stands. Moderate to severe fire usually kills the aboveground foliage of red-osier dogwood. However, the roots survive all but the most severe fires where the duff is removed and the upper soil is heated for extended periods (Fischer and Bradley 1987). Red-osier dogwood usually regenerates rapidly following fire by resprouting from the roots and by germination of seed in the soil.

Animals—

Browsing. Red-osier dogwood stems have a poor to high palatability rating for livestock, wild ungulates, and small mammals (Crowe and Clausnitzer 1997, Hansen et al. 1995). Tannins appear to inhibit protein availability in red-osier dogwood leaves, but there appears to be little inhibition of protein in the stem (Roath and Krueger 1982). Browsing of older stems is low, but use of seedlings, young twigs, and new sprouts may be heavy, especially where livestock grazing has reduced other forage resources. Browsing wild ungulates rarely create significant impacts in the absence of heavy use by livestock except on winter ranges or in cases of unusual buildups of populations. Continual overuse eventually leads to old decadent stands with little chance of replacement regeneration (app. B-5).

Livestock. Use by livestock differs greatly by association, stand density, stand accessibility, the palatability of other browse species, the availability and condition of other forage, and grazing intensity (Crowe and Clausnitzer 1997). Wetter associations (COST/EQUIS and COST/ATFI) may receive somewhat lighter grazing owing to seasonally wet soil where use may be delayed to mid or late summer. However, the physiological processes of the various shrubs and herbs are often completed by late summer, providing for the reproductive and energy requirements of the vegetation for the coming year. In theory, drier red-osier dogwood associations (COST/MESIC FORB and COST/SYAL) are more susceptible to livestock damage as they are accessible earlier in summer. In reality, many red-osier dogwood stands are too dense to be grazed except in the open margin.

Light livestock use may result in some increase in red-osier dogwood biomass and cover (Aldous 1952). However, with continued overuse, the red-osier dogwood canopy becomes disrupted, clumpy, or decreases in vigor as indicated by dead shrubs, clubbed stems, high-lining, and lack of younger age classes. The competitive ability of associated dominants also is reduced through grazing and trampling in favor of introduced grasses and increaser forbs. With continued overuse, both red-osier dogwood and associated shrubs become uncommon and restricted to protected locations or absent. Kentucky bluegrass, other introduced grasses, and increaser forbs begin to dominate the site. The shrub canopy becomes very discontinuous, thus reducing the shade provided to the understory and stream channel. Overgrazing and excessive trampling seriously reduces red-osier dogwood's ability to maintain streambank stability during spring runoff and flooding (Crowe and Clausnitzer 1997). The stream channel then becomes wide and shallow, and most of the streambanks are eroded owing to the lack of red-osier dogwood and other shrubs.

Maintaining dense stands of red-osier dogwood limits access by livestock. As in the SALIX series (Kovalchik and Elmore 1991), grazing practices incorporating late-season rest increase the vigor of dogwood and its associates. Late-season grazing systems should be monitored closely to prevent a shift from grazing of herbs to browsing of shrubs. Damage from grazing livestock can be limited by removing them when herbaceous stubble heights either under the red-osier dogwood or on adjacent MEADOW associations approach 4 inches or when browsing appears to be excessive.

Total herbage production in the COST series is low to moderate and ranges from 100 to 2,300 (average 1,061) pounds per acre dry weight in northeastern Oregon (Crowe and Clausnitzer 1997). The high variability is in response to the density of the shrub canopy and soil texture. It is doubtful that any eastern Washington plots exceed 500 pounds per acre under dense shrub cover. Red-osier dogwood is rated as fair in palatability to sheep and cattle and poor for horses but will be browsed when other forage species are lacking. (For more information on forage palatability, see app. B-1. For potential biomass production, see app. B-5.)

Wildlife. The high structural diversity of the COST series provides food, thermal cover, and hiding cover for many large ungulates (Crowe and Clausnitzer 1997, Hansen et al. 1995). The palatability of red-osier dogwood ranges from poor for elk, to fair for white-tailed deer, and to good for mule deer and moose (Dittberner and Olson 1983, Sampson and Jespersen 1963). Use of young twigs, sprouts, seedlings, and leaves can be heavy, especially on winter ranges. The variety of associated shrubs and herbs may be used heavily. Dense thickets of dogwood provide good fawning and rearing areas for mule deer (Crowe and Clausnitzer 1997). Red-osier dogwood fruits are important grizzly and black bear food in the northern Rocky Mountains (Rogers and Applegate 1983). Red-osier dogwood stands provide excellent cover and forage for a variety of small mammals. Muskrats, deer mice, cottontail rabbits, and snowshoe hairs eat the fruit, twigs, bark, and leaves (Crowe and Clausnitzer 1997). Beavers eat the bark of dogwood and build dams and lodges with the stems (Hansen et al. 1995). Red-osier dogwood is most valuable as a food source in its early growth stages when it resprouts after fire or some other disturbance (Wright and Bailey 1982). Low-gradient valley and wetland sites may be excellent for beaver production, but dam impoundment may raise the water table and kill the dogwood. Some of the wider, lower gradient valleys supporting red-osier dogwood stands may have large streams with too much energy for dam construction but which may be suitable for beaver denning in streambanks.

Red-osier dogwood fruit is initially low in sugar and less attractive to wildlife. However, it stays on the plant into the winter and is available when other fruits are gone (Stevens 1970, Stiles 1980). Numerous birds including songbirds, ducks, crows, ravens, wild turkey, and grouse eat the fruits in fall and winter. The dense shrubs provide hiding and thermal cover for many species of birds. Many bird species use red-osier dogwood stands for nesting, brood rearing, and foraging (Crowe and Clausnitzer 1997). (For more information on thermal or feeding cover values, see apps. B-2 and B-3. For information on food values or degree of use, see apps. B-2 and B-4.)

Fish. Stands of red-osier dogwood belonging to the COST series line many low- to moderate-elevation streams and rivers in eastern Washington. The COST series also occurs on the banks of lakes and ponds. The dense networks of roots are very effective in stabilizing and protecting banks and other fluvially active surfaces so they can withstand severe flooding or wave action. The importance of red-osier dogwood in streambank protection, stream cover, and thermal protection cannot be emphasized enough. The dense multiple stems and the associated undergrowth aid in filtering out sediments during high flows, thereby contributing to the overall building of the streambanks and floodplains, channel maintenance, and stabilization of the stream. (For more information, see app. B-5, erosion control potential.) Streams lined with red-osier dogwood develop stable channels that provide the cover, spawning sites, food, and cool temperatures critical to trout and other salmonids. Trout eat the fruits of dogwood. Red-osier dogwood and associated vegetation also provide a critical substrate for insects, with subsequent impacts as fish and aquatic insect food. The nutrients derived from fallen decomposing leaves are important to improving the productivity of the stream ecosystem.

Recreation—

Sites supporting the COST series provide an excellent opportunity for viewing moose, elk, deer, and songbirds. Due to low elevations, sites usually are close to roads and thus easily accessible, providing access for fishing. However, due to seasonal flooding, campsites and home sites should be located elsewhere (Hansen et al. 1995). Heavy human use in spring and summer can result in damaged soils, bank sloughing, and exposed soils along streambanks. However, this is usually not a problem in dense red-osier dogwood thickets.

Estimating Vegetation Potential on Disturbed Sites—

Estimating vegetation potential on disturbed sites is not usually necessary because these sites are often minimally impacted by human activities on FS lands in eastern Washington. Buffer zones (no logging), dense stands, seasonal flooding, and in some cases, difficult access, all limit use by livestock and people. Occasionally, more accessible drainages have been moderately impacted, and it may be somewhat difficult to key the COST series sites. However, most stands are still in fair to excellent ecological condition, and classification users can almost always find enough red-osier dogwood shrubs to key the COST series. Similarly, the understory vegetation is rarely absent, and users can lower the cover criteria for the understory one class to key the appropriate plant association. For the rare stand where the vegetation is largely gone, users can look at similar sites in adjacent drainages or use personal experience to key the site to the COST series.

Sensitive Species—

Sensitive species were not found on the COST series ecology plots. *Botrychium* species have been reported under red-osier dogwood stands on the Okanogan NF (Clausnitzer 1998) (see app. D).

ADJACENT SERIES

The COST series occurs at lower elevations and is usually bound on adjacent upland slopes by coniferous forest in the QUGA, PIPO, PSME, PIEN, ABGR, THPL, and TSHE series. It also can extend to lower elevations into areas with shrub-steppe in the uplands. Stands dominated by red-osier dogwood are rare at higher elevation within zones dominated by the ABAM, TSME, and ABLA2 series.

RELATIONSHIPS TO OTHER CLASSIFICATIONS

On account of low plot numbers, a single COST plant association was described in the draft classification for riparian/wetland zones in northeastern Washington (Kovalchik 1992c). With more plots, this original association has been expanded into the four COST plant associations described in this classification.

Plant associations belonging to the COST series have been described in eastern Washington and Montana (Crawford 2003, Hansen et al. 1995, Kovalchik 1992c); Idaho, Utah, and Nevada (Manning and Padgett 1995, Padgett et al. 1989, Youngblood et al. 1985a, 1985b); the Mount Hood and Gifford Pinchot NFs (Diaz and Mellen 1996); and northeastern Oregon (Crowe and Clausnitzer 1997).

U.S. DEPARTMENT OF THE INTERIOR, FISH AND WILDLIFE SERVICE WETLANDS CLASSIFICATION

System:	palustrine
Class:	scrub-shrub
Subclass:	broad-leaved deciduous
Water regime:	(nontidal) saturated to temporarily flooded

KEY TO THE RED-OSIER DOGWOOD (*CORNUS STOLONIFERA*) PLANT ASSOCIATIONS

1. Lady fern *(Athyrium filix-femina)*, alpine lady fern *(Athyrium distentifolium)*, oak fern *(Gymnocarpium dryopteris)*, and/or wood-fern species (*Dryopteris* species) ≥5 percent canopy coverage .... **Red-osier dogwood/lady fern (COST/ATFI) association**
2. Horsetail species (*Equisetum species*) ≥10 percent canopy coverage .... **Red-osier dogwood/horsetail (COST/EQUIS) association**
3. Common snowberry (*Symphoricarpos albus*) ≥5 percent canopy coverage .... **Red-osier dogwood–common snowberry (COST-SYAL) association**
4. Mesic forbs ≥5 percent canopy coverage (or understory depauperate) .... **Red-osier dogwood/mesic forb (COST/MESIC FORB) association**

Table 20—Constancy and mean cover of important plant species in the COST plant associations

		COST-SYAL 11 plots		COST/ATFI 7 plots		COST/EQUIS 4 plots		COST/MESIC FORB 18 plots	
Species	**Code**	**CON[a]**	**COV[b]**	**CON**	**COV**	**CON**	**COV**	**CON**	**COV**
Shrubs:									
vine maple	ACCI	—	—	14	5	—	—	11	13
Douglas maple	ACGLD	36	17	29	34	25	Tr[c]	39	8
mountain alder	ALIN	73	8	29	9	75	8	44	10
red-osier dogwood	COST	100	73	100	68	100	65	100	86
bearberry honeysuckle	LOIN	55	2	14	99	75	3	17	9
Lewis' mock orange	PHLE2	9	Tr	—	—	25	5	28	3
Hudsonbay currant	RIHU	36	2	43	5	50	1	28	6
prickly currant	RILA	82	4	71	8	75	5	33	2
Nootka rose	RONU	45	1	14	5	25	Tr	21	4
red raspberry	RUID	55	1	29	1	50	Tr	—	—
western thimbleberry	RUPA	73	1	71	4	75	3	50	2
salmonberry	RUSP	9	1	29	42	—	—	22	3
Bebb's willow	SABE	—	—	—	—	—	—	6	10
Mackenzie's willow	SARIM2	9	5	—	—	25	5	6	2
Scouler's willow	SASC	36	26	14	5	—	—	28	9
Sitka willow	SASI2	9	7	—	—	25	3	11	Tr
Douglas spiraea	SPDO	9	3	—	—	—	—	6	5
common snowberry	SYAL	100	14	71	13	75	10	44	2
Low shrubs and subshrubs:									
myrtle pachistima	PAMY	45	3	14	Tr	50	3	6	Tr
Perennial forbs:									
baneberry	ACRU	73	1	71	1	75	1	39	Tr
pathfinder	ADBI	27	1	14	Tr	50	3	—	—
sharptooth angelica	ANAR	45	Tr	43	1	50	1	22	1
aster species	ASTER	18	1	14	1	50	3	6	Tr
enchanter's nightshade	CIAL	27	1	86	8	—	—	28	Tr
Hooker's fairy-bell	DIHO	45	Tr	14	Tr	50	Tr	28	Tr
rough bedstraw	GAAS	—	—	29	1	50	Tr	11	Tr
sweetscented bedstraw	GATR	82	1	71	1	25	Tr	39	Tr
largeleaf avens	GEMA	27	2	43	1	75	1	17	Tr
common cow-parsnip	HELA	18	1	43	9	25	Tr	22	Tr
northern bluebells	MEPAB	—	—	29	26	—	—	22	2
fivestamen miterwort	MIPE	—	—	14	Tr	50	11	—	—
purple sweet-root	OSPU	55	1	29	Tr	50	1	28	Tr
sidebells pyrola	PYSE	18	Tr	14	Tr	50	Tr	6	Tr
western solomonplume	SMRA	45	1	57	1	75	1	22	1
starry solomonplume	SMST	100	1	43	4	75	1	50	4
claspleaf twisted-stalk	STAM	36	2	71	1	25	3	6	Tr
western meadowrue	THOC	36	1	29	1	75	2	17	1
false bugbane	TRCA3	9	5	29	3	—	—	22	1
stinging nettle	URDI	27	1	57	4	50	1	22	Tr
pioneer violet	VIGL	45	1	43	1	75	3	17	Tr
Grass or grasslike:									
brome species	BROMU	9	Tr	—	—	50	1	6	Tr
Dewey's sedge	CADE	9	Tr	14	Tr	50	Tr	—	—
wood reed-grass	CILA2	55	2	57	1	25	3	28	1
fowl mannagrass	GLST	9	10	—	—	25	1	—	—
Ferns and fern allies:									
alpine lady fern	ATDI	—	—	14	7	—	—	—	—
lady fern	ATFI	36	2	86	10	25	Tr	22	2
common horsetail	EQAR	45	1	57	2	100	31	17	Tr
oak fern	GYDR	—	—	43	12	—	—	11	Tr

[a] CON = percentage of plots in which the species occurred.
[b] COV = average canopy cover in plots in which the species occurred.
[c] Tr = trace cover, less than 1 percent canopy cover.

DOUGLAS SPIRAEA SERIES

Spiraea douglasii

SPDO N = 22

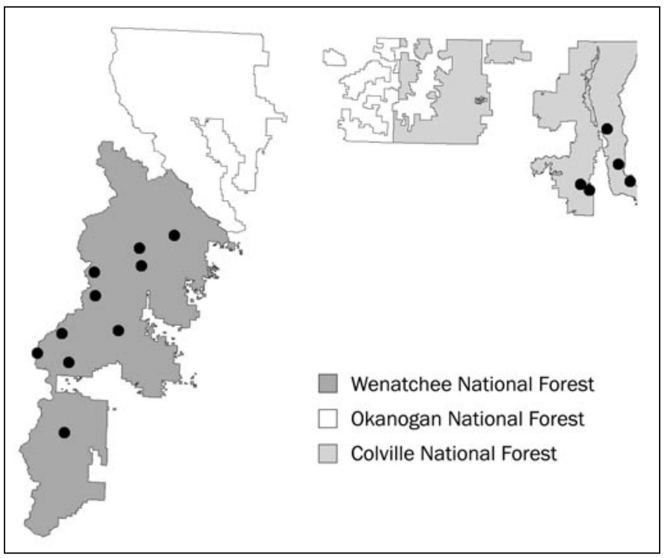


Figure 31—Plot locations for the Douglas spiraea series.

DOUGLAS SPIRAEA[1] occurs from Alaska south to northern California, and east to western Montana. Pyramid spiraea (considered an ecological equivalent of Douglas spiraea, and potentially useful in the key to the SPDO series) occurs from British Columbia south to Oregon and east to western Montana (Hitchcock and Cronquist 1973). Douglas and pyramid spiraea are generally characterized as shrubs of moist to wet riparian areas and wetlands (Banner et al. 1986, Klinka et al. 1985). They are tolerant of seasonally flooded conditions and saturated soils but do not survive well on sites with summer drought. These species often indicate low- to moderate-elevation sites with nightly development of cold-air drainage or frost pockets (MacKinnon et al. 1992) but warm daytime temperatures.

The climate associated with the SPDO series is limited compared with more widespread series. Douglas and pyramid spiraea are found in maritime or inland maritime climate in eastern Washington and usually occur near the Cascade crest or in extreme northeastern Washington east of the Columbia River. Annual precipitation is relatively high compared with eastern Washington as a whole and varies from more than 25 inches in the inland maritime zone to more than 50 inches near the Cascade crest. However, such generalities need to be interpreted somewhat carefully when considering cold air drainage and elevated water tables in valleys associated with Douglas and pyramid spiraea dominance. In general, the SPDO series appears to require somewhat warm daytime valley temperatures (and perhaps evening frost pockets), low to moderate elevations, and high precipitation relative to the rest of eastern Washington.

The SPDO series is relatively uncommon in eastern Washington but is locally common in maritime areas of the Colville, Okanogan, and Wenatchee NFs. The series appears to be absent within dry continental climate zones. SPDO series has few plant associations owing to the low number of plots, lack of species richness, and limited range of sites.

CLASSIFICATION DATABASE

The SPDO series includes all nonforest stands potentially dominated by at least 25 percent canopy coverage of either Douglas or pyramid spiraea or, occasionally, stands where black hawthorn and the two spiraeas are codominant. All three stands of black hawthorn (CRDO-SPDO association) are located on sites with extensive stands of Douglas spiraea surrounding the clumps of hawthorn. As the sites are equivalent, the CRDO-SPDO association was collapsed into the SPDO series. Sample plots are located on the Sullivan Lake, Newport, Cle Elum, Entiat, Lake Wenatchee, Leavenworth, and Naches RDs (fig. 31). The SPDO series also has been observed on the west end of the Lake Chelan RD and on lands administered by the Okanogan NF lying west of the Cascade crest. Twenty-two riparian and wetland plots were sampled in the SPDO series. From this database, two major plant associations and one minor plant association are described. Generally, these samples are located in late-seral to climax stands, although species compositions on some sites indicate that the vegetation potential may be shifting toward conifers owing to sediment accumulation and subsequent lowering of the water table.

[1] See appendix A for a cross reference for all species codes and common and scientific names used in this document.

Douglas spiraea plant associations

	Scientific name	Common name	Ecoclass code	Plots
Major associations:				
SPDO	*Spiraea douglasii*	Douglas spiraea	SW4113	11
SPDO/CACA	*Spiraea douglasii/Calamagrostis canadensis*	Douglas spiraea/bluejoint reedgrass	SW4115	8
Minor associations:				
CRDO-SPDO	*Crataegus douglasii-Spiraea douglasii*	Black hawthorn-Douglas spiraea	SW3112	3

VEGETATION CHARACTERISTICS

The currently accepted name of Douglas spiraea is *Spiraea douglasii*. Varieties *douglasii* and *menziesii* occur in the Cascade Range and eastern Washington, respectively, and are freely transitional to each other (Hitchcock and Cronquist 1973). The accepted name of pyramid spiraea is *Spiraea pyramidata,* and there appears to be obvious transition between Douglas and pyramid spiraea in eastern Washington (it was often difficult to tell intermediate material apart). Therefore these species, varieties, and intergrades were grouped into *Spiraea douglasii* in the data for eastern Washington, and are simply referred to as Douglas spiraea in the remainder of this guide.

Douglas spiraea is abundant and dominates most sites in the SPDO series, averaging 67 percent canopy coverage for the SPDO series as a whole. Douglas spiraea is considered shade tolerant, but its cover can be reduced significantly under taller shrub canopies such as found under black hawthorn in the CRDO-SPDO association. Douglas spiraea coverage ranges from a low 27 percent in the CRDO-SPDO association, to 54 percent in the wet SPDO/CACA association, and 90 percent in the SPDO association.

There appear to be fewer plant species in the SPDO series compared with other series because of the dense shrub overstory, limited elevation range, limited climate, and the limited number of associations and sites. SPDO and CRDO-SPDO generally support few species beyond the dominance of Douglas spiraea or black hawthorn. The wetter SPDO/CACA association usually has a more open shrub canopy and supports a greater variety of graminoids and forbs. Common cow-parsnip is the only herb exceeding 50 percent constancy in any association. Common graminoids include bladder sedge, inflated sedge, lenticular sedge, small-fruited bulrush, gray sedge, and Idaho or Thurber bentgrass. Bluejoint reedgrass is the dominant herb in the SPDO/CACA association.

Overstory and understory trees may be scattered on SPDO series plots, especially in stands on drier terraces. Tree cover approaching 25 percent may indicate the site is changing toward forest potential owing to deep sediment accumulation.

PHYSICAL SETTING

Elevation—

The majority of SPDO series plots are between 2,400 and 3,200 feet. Little difference is apparent in average elevation between the Colville and Wenatchee NFs except that base elevations are higher on the Colville NF (2,560 feet) and three unusually high-elevation plots are located on the Wenatchee NF (up to 4,700 feet).

	Elevation (feet)			
Forest	Minimum	Maximum	Average	N
Colville	2,560	3,330	2,950	6
Wenatchee	1,850	4,700	3,031	16
Series	1,850	4,700	3,009	22

Additional insight is gained by looking at individual associations. Three unusual Wenatchee SPDO/CACA plots range from 4,420 to 4,700 feet in elevation, over 1,000 feet higher than the maximum elevation associated with the other SPDO series plots. Without the three plots, the upper elevation distribution of the SPDO/CACA association would not have been much different from CRDO-SPDO and SPDO. In addition, two Wenatchee SPDO association plots were located at 1,850 and 1,900 feet, the lowest elevations for the SPDO series.

	Elevation (feet)			
Plant association	Minimum	Maximum	Average	N
SPDO/CACA	2,650	4,700	3,521	8
CRDO-SPDO	2,380	3,330	2,787	3
SPDO	1,850	3,300	2,695	11
Series	1,850	4,700	3,009	22

Valley Geomorphology—

The SPDO series is found on a rather limited variety of valley width and gradient classes. Ninety-five percent (21 of 22) of the plots are located in valleys more than 99 feet wide, and 64 percent are in valleys more than 330 feet wide. Twenty of 22 plots are located in valleys equal to or less than 3 percent valley gradient, and 64 percent (14 of 22) of the plots are located in valleys less than 1 percent valley gradient. These wide, low gradient valleys and basins create opportunities to conserve soil moisture through the growing season and consequently provide moist to wet riparian and wetland fluvial surfaces for the SPDO series.

Valley width	Valley gradient					N
	Very low	Low	Moderate	Steep	Very steep	
Very broad	7	3	1	0	0	11
Broad	1	2	0	0	0	3
Moderate	5	1	1	0	0	7
Narrow	1	0	0	0	0	1
Very narrow	0	0	0	0	0	0
Series total	14	6	2	0	0	22

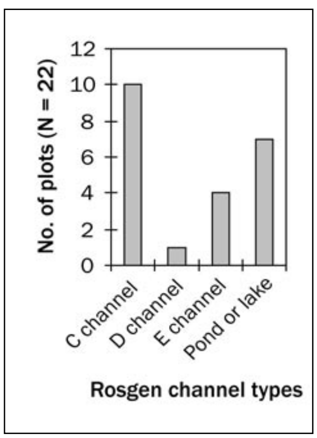
In addition, little difference in valley width and gradient classes is apparent among the three associations. All are located in valleys with moderate to very broad width. The wet SPDO/CACA association is most prominent in very broad valleys and is almost totally restricted to very low gradient valleys.

Plant association	Valley width					N
	Very broad	Broad	Moderate	Narrow	Very narrow	
CRDO-SPDO	2	0	1	0	0	3
SPDO	4	2	4	1	0	11
SPDO/CACA	5	1	2	0	0	8
Series total	11	3	7	1	0	22

Plant association	Valley gradient					N
	Very low	Low	Moderate	Steep	Very steep	
CRDO-SPDO	2	1	0	0	0	3
SPDO	5	5	1	0	0	11
SPDO/CACA	7	0	1	0	0	8
Series total	14	6	2	0	0	22

Channel Types—

Most SPDO plots are located along Rosgen C and E channel types, which is consistent with the relatively wide and gentle valleys characterizing the series. One plot is located along a disturbed D channel (C channel damaged by a large logjam). Seven plots occur on the seasonally flooded margins of lakes and beaver ponds. These conditions reflect sites capable of conserving moisture with seasonal to permanently flooded water tables.

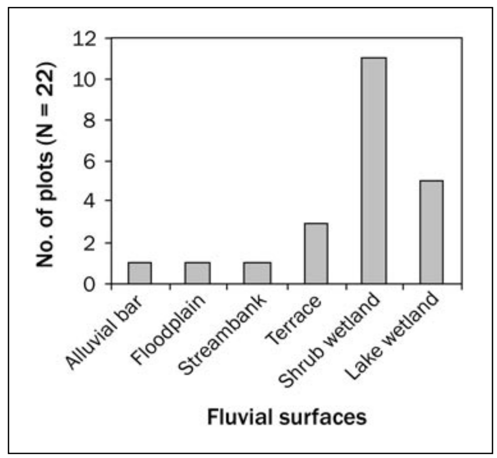


The data for individual associations support the above observations, as most associations are located near C and E channels. All three associations also can be found on wetlands bordering lakes and ponds.

Plant association	Rosgen channel types				N
	C	D	E	Pond/lake	
CRDO-SPDO	2	0	0	1	3
SPDO	5	1	2	3	11
SPDO/CACA	3	0	2	3	8
Series total	10	1	4	7	22

Fluvial Surfaces—

The SPDO series is found on a limited variety of fluvial surfaces. The few riparian zone plots usually occur on seasonally flooded streambanks and terraces. Most plots are in shrub/meadow wetlands associated with poorly drained basins and the margins of beaver ponds and lakes. Several plots are on low gradient alluvial fans adjacent to lakes. Sites associated with new fluvial surfaces such as alluvial bars and floodplains are unusual (only two plots).



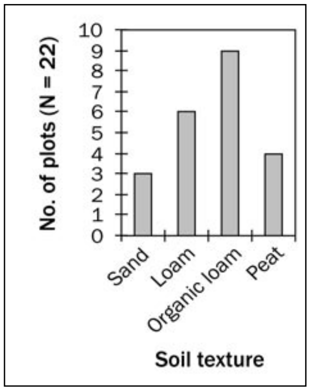
Similar patterns can be shown for individual plant associations. The majority of plots (15 of 22) in each association are located in wetlands. Four of six riparian zone plots (alluvial bars, floodplains, streambanks, and wet terraces) are associated with the SPDO association.

Plant association	Fluvial surfaces						N
	Alluvial bar	Flood-plain	Stream-bank	Terrace	Shrub wetland	Lake wetland	
CRDO-SPDO	0	0	0	1	1	1	3
SPDO	1	1	1	1	5	2	11
SPDO/CACA	0	0	0	1	5	2	8
Series total	1	1	1	3	11	5	22

In summary, the probability of finding SPDO stands increases with increasing valley width, decreasing valley gradient, and sites subject to seasonal or permanent flooding.

Soils—

Soil textures are quite variable, depending on site. Most riparian plots are located on mineral soils with sand and loam textures. Wetland soils are more typically organic loam or peat texture on more permanently flooded sites. Sites on the edges of beaver ponds or in valley bottoms associated with E channels also tended to favor organic loam or peat soils. Stands on the margins of lakes range from fine-textured loam to organic loam and peat soils. Valleys with C channels are the most variable. Sandy soils predominate on active fluvial surfaces such as floodplains and alluvial bars, whereas organic loams dominate wetland terraces.



Little additional information is gained by looking at individual plant associations. All three associations occur on a variety of soil texture classes. SPDO/CACA especially seems to favor wetter organic loam and peat soils, whereas the SPDO and CRDO/SPDO associations occur equally on wet organic or mineral soils.

Plant association	Soil texture: Sand	Loam	Organic loam	Peat	N
CRDO-SPDO	1	1	1	0	3
SPDO	2	3	5	1	11
SPDO/CACA	0	2	3	3	8
Series total	3	6	9	4	22

Douglas spiraea is tolerant of permanently waterlogged soils but is also found on riparian sites with widely fluctuating water tables (Holland 1986). Average water tables at the time of sampling ranged from 23 inches below to 19 inches above the soil surface for SPDO and SPDO/CACA, respectively. SPDO/CACA soils are often wet throughout the growing season compared with the SPDO and CRDO/SPDO associations. Data are not available for CRDO/SPDO, but it is presumed to be similar to SPDO, if not drier. The reported water tables may be misleading as many of the plots showed evidence that they were temporarily flooded at snowmelt or during stream peak flow, which usually occurred before the sample season. Three plots in the SPDO/CACA and SPDO associations were flooded well into summer.

Plant association	Water table (inches): Minimum	Maximum	Average	N
SPDO/CACA	-35	0	-19	5
SPDO	-63	14	-23	8
Series	-63	14	-22	13

Average soil temperature differences between associations were negligible. SPDO/CACA sites are at higher elevations and should have soils that are colder than those associated with the SPDO and CRDO/SPDO associations. This assumption is not reflected in the data.

Plant association	Soil temperature (°F): Minimum	Maximum	Average	N
SPDO/CACA	47	67	55	8
SPDO	39	65	53	11
CRDO-SPDO	51	53	52	3
Series total	39	67	54	22

ECOSYSTEM MANAGEMENT

Natural Regeneration of Douglas Spiraea—

Douglas spiraea produces small fusiform seeds in ventrally dehiscent follicles (Hitchcock and Cronquist 1973). The seeds are probably dispersed via animals and strong winds (Munz 1973). Both Douglas and pyramid spiraea are strongly rhizomatous shrubs that form dense colonies and can sprout from the rhizome as well as from the stem base and root crown following disturbance (Boggs et al. 1990, Kovalchik 1987).

Artificial Establishment of Douglas Spiraea—

Within its range and site limitations, Douglas spiraea may be valuable for revegetating degraded sites. Nursery-grown seedlings should grow well on appropriate sites, and they have the added benefit of continued spreading by rhizome extension after planting. Plantings will fail on sites that do not have the potential to support Douglas spiraea. Therefore it is critical to determine whether natural and human-induced conditions are favorable for its establishment and survival. Managers should use a wetland/riparian plant association classification to determine if it is natural to the site (Hansen et al. 1995, Kovalchik 1987).

Site evaluation also may indicate that Douglas spiraea can be established by natural regeneration. A stocking survey may show that plants are already established on the site and may expand by rhizome extension when released from the limiting factors that are reducing its abundance. As Douglas spiraea is an aggressive pioneer species on clearcuts in western Washington (Klinka et al. 1985, Long 1977), as well as on avalanche chutes in British Columbia (Banner et al. 1986), there is a strong probability that Douglas spiraea will rapidly colonize disturbed riparian and wetland sites. (For more information on the short- and long-term revegetation potential of selected riparian wetland plant species, see app. B-5.)

Stand Management—

Sample plots were in fair or better ecological condition and little is known about rehabilitating disturbed stands. A study of disturbed stands is needed. Where on active fluvial surfaces such as alluvial bars, floodplains, and streambanks, the SPDO series is subject to recurring scouring and deposition by floods. Therefore, where the site has been highly altered, management should consider restoring Douglas spiraea for its excellent streambank stability values. Bare fluvial surfaces could be planted or seeded and protected from the limiting factors that caused the cover and condition to be altered from its natural potential. Douglas spiraea's moderately rapid growth and its ability to spread by rhizomes allow it to quickly stabilize deteriorated sites.

Where deposition has been significant on terraces, fine-textured soils may be subject to compaction and trampling, especially wet soils. In some cases, deposition may be sufficient for the sites to be transitional to forest potential, and conifer or cottonwood encroachment may shade and reduce the cover of Douglas spiraea and its associates. Selection cutting or prescribed fire may be used to open the stand, thus increasing the cover of shrubs and delaying the transition to forest.

Down Wood—

Logs may play an important role in the structure and function of the SPDO series. The overall amount of wood is high compared with other shrub series (app. C-3). Logs cover more than 10 percent of the ground surface. Log biomass (tons per acre) is also high for a shrub series. This indicates many SPDO series sites occur within one tree height of forest communities or that logs may be transported to riparian sites during flood events. Future supplies of down wood should be considered in the management of adjacent and upstream forests.

Definitions of log decomposition classes are on page 15.

	Down log attributes				
Log decomposition	Tons/ acre	Cu. ft./ acre	Linear ft./ acre	Sq. ft./ acre	% ground cover
Class 1	9.82	1,505	1,438	1,404	3.2
Class 2	5.05	647	318	430	1.0
Class 3	1.13	362	605	473	1.1
Class 4	.04	14	11	12	0
Class 5	16.04	2,528	2,372	2,319	5.3
Total	32.08	5,056	4,744	4,638	10.6

Fire—

Fire is infrequent in the SPDO series owing to the high moisture content of the soils and vegetation, especially the SPDO/CACA association. In presettlement times, wildfires may have been more common in drought years, allowing fires from adjacent uplands to encroach on the stand (Hansen et al. 1995). During drought, stands may be burned as severely as the adjacent forest. However, Douglas spiraea and black hawthorn, although moderately sensitive to fire, will regenerate from basal stem and rhizome sprouting and seed germination. Very hot fires are potentially more damaging. Duff and litter buildups are often deep under the dense shrub canopies, and shrub cover may be reduced where severe fires remove the duff, which contains most of the rhizomes. This is especially true with peat soils.

Animals—

Browsing. Browse production must be quite high throughout the SPDO series (Boggs et al. 1990, Hansen et al. 1988), but Douglas spiraea has a low palatability rating for domestic and wild ungulates (Kovalchik et al. 1988). Browsing of stems is probably low except where other forage resources have been heavily reduced by livestock grazing, on big game winter ranges, or in cases of unusual buildups of wild ungulate populations (app. B-5).

Livestock. SPDO series stands produce low to moderate amounts of herbage depending on the plant association and density of the shrub layer (Hansen et al. 1995, Kovalchik 1987). Total forage production is unknown but appears very low in the dense stands associated with the SPDO and CRDO/SPDO associations. Herbage production is probably moderate in the more open SPDO/CACA association. Actual use of Douglas spiraea is usually minor owing to its low palatability, but it often retains its leaves well into fall, and some browsing may occur at that time. Douglas spiraea is easily damaged by trampling and soil compaction (Boggs et al. 1990, Kovalchik 1992c), but dense stands and the scarcity of palatable herbs limit the overall grazing potential of the SPDO and CRDO/SPDO associations. In any of the associations, heavy grazing will tend to open the shrub stands and increase herb cover. Very severe grazing will cause native species to be replaced with a sward of disturbance-related species such as Kentucky bluegrass, common dandelion, and species of thistle.

Actual use of the SPDO series varies greatly by stand density, stand accessibility, the palatability of other browse species, the availability and condition of herbage, herbage availability in adjacent plant communities, and grazing intensity. SPDO/CACA may receive moderate grazing owing to the relative abundance of palatable graminoids. However, seasonally wet soils usually delay use of all associations until at least midsummer when the physiological processes of the various shrubs and herbs have been completed, providing for the reproductive and energy requirements of the vegetation for the coming year. In reality, many Douglas spiraea stands are too dense or wet to be grazed at all, and livestock grazing has had minimal impact on stands in eastern Washington NFs. (For more information on forage palatability, see app. B-1. For potential biomass production, see app. B-5.)

Wildlife. Black-tailed deer reportedly browse pyramid spiraea in western Washington (Brown 1961, Cowan 1945). However, observations suggest use of either species of spiraea is probably low by all classes of wild ungulates in eastern Washington. Overall use of the SPDO/CACA association may be moderate compared with the other associations because of the more abundant cover of palatable graminoids and forbs. Stands of CRDO/SPDO usually are so dense as to preclude most use by large ungulates, but ungulates will readily eat any herbaceous vegetation that is within reach (Hansen et al. 1988, 1995). The berries of black hawthorn dry on the twigs and supply food for small mammals and birds well into winter. Rodents eat the fruit and seeds of black hawthorn (Kovalchik et al. 1988). Beavers usually are present in nearby beaver ponds, lakes, and streams but likely do not rely on the SPDO series for browse or forage. Beavers may use the stems of Douglas spiraea and black hawthorn as dam building materials or emergency food.

The importance of SPDO stands to passerines is demonstrated by a breeding population of nesting long-billed marsh wrens in a Douglas spiraea emergent shrub community in Washington (Verner 1975). Black hawthorn provides good structural diversity and thermal/hiding cover for birds and should support a rich bird population even during winter (Daubenmire 1970, Hansen et al. 1995). The characteristic tangled branching and thorns of black hawthorn is attractive for cover and nesting sites for birds such as magpies and thrushes. (For more information on thermal or feeding cover values, see apps. B-2and B-3. For information on food values or degree of use, see apps. B-2 and B-4.)

Fish. SPDO series stands provide a relatively dense network of roots and stems that are very effective in stabilizing streambanks, lakeshores, and other active fluvial surfaces so that they can withstand flooding and wave action. The dense multiple stems aid in filtering out sediments during high flows, thereby contributing to the overall building of the streambanks and floodplains, channel maintenance, and stabilization of the stream (for more information, see app. B-5, erosion control potential). Streams lined with these shrubs generally develop stable channels that provide cover, food, spawning sites, and cool temperatures for trout and other salmonids. Where located away from permanent streams, such as overflow channels, ephemeral draws, and terraces, the dense multiple shrub stems aid in filtering out sediments during high flows.

Recreation—

The mosaics of the SPDO series with adjacent riparian and wetland plant communities provide an excellent opportunity for viewing elk, deer, moose, and songbirds. Many low-elevation sites are near roads or trails, providing access for day hiking or fishing. Owing to seasonal flooding, campsites and home sites should be located elsewhere. Heavy human use in spring and summer can result in damaged soils, bank sloughing, and exposed soils along streambanks and lakeshores, but this is usually not a problem in these dense shrub stands. Hiking trails should be routed around dense stands associated with the SPDO series. Black hawthorn may be useful for planting in recreation areas as a biological barrier to protect physical structures, fragile natural areas, or to direct foot traffic (Hansen et al. 1988).

Insects and Disease—

Information about the insects and diseases of Douglas and pyramid spiraea is unknown. Black hawthorn insect pests include fall webworm, forest tent caterpillar, western tent caterpillar, large aspen tortrix, aspen leaf-tier, satin moth, bronze poplar borer, blue alder agrilus, and poplar borer (Schmitt 1996). Infestations are generally low. White juniper rust and mottled rot are the principal leaf rust and root rot of Black hawthorn.

Estimating Vegetation Potential on Disturbed Sites—

Identification of disturbed SPDO series sites is usually unnecessary because sites are minimally impacted by human activities on FS lands in eastern Washington. This is because of the use of buffer zones (logging excluded), dense shrub stands, and seasonal flooding. The major disturbance factor is flooding. Most stands are still in fair to excellent ecological condition, and classification users can almost always find abundant Douglas spiraea or black hawthorn to key to the SPDO series and plant associations. Where the understory vegetation is depauperate, users can lower the cover criteria for the understory one class to key the various associations. For sites where the potential natural vegetation is gone (rare), users can use experience or look at similar sites in nearby undisturbed valleys to key the SPDO series.

Sensitive Species—

Sensitive species were not found on SPDO series sample plots (app. D).

ADJACENT SERIES

Adjacent terraces and upland slopes usually are dominated by coniferous forest in the THPL and TSHE series. Drier, warmer slopes may support the PSME or ABGR series. Occasionally, plots are located at higher elevation within the ABAM, TSME, and ABLA2 series.

RELATIONSHIPS TO OTHER CLASSIFICATIONS

A single Douglas spiraea plant association is described in the draft riparian/wetland classification for northeastern Washington (Kovalchik 1992c). Additional data have allowed the classification of three plant associations within the SPDO series in the final classification. Plant associations and habitat types belonging to the SPDO series also are described in central and northeastern Oregon (Crowe and Clausnitzer 1997, Kovalchik 1987) and Montana (Hansen et al. 1995).

U.S. DEPARTMENT OF THE INTERIOR, FISH AND WILDLIFE SERVICE WETLANDS CLASSIFICATION

System:	palustrine
Class:	scrub-shrub
Subclass:	broad-leaved deciduous
Water regime:	(nontidal) intermittently to seasonally flooded

KEY TO THE DOUGLAS SPIRAEA (*SPIRAEA DOUGLASII*) PLANT ASSOCIATIONS

1. Black hawthorn (*Crataegus douglasii*) ≥25 percent canopy coverage .... **Black hawthorn-Douglas spiraea (CRDO-SPDO) association**
2. Bluejoint reedgrass (*Calamagrostis canadensis*) ≥10 percent canopy coverage .... **Douglas spiraea/bluejoint reedgrass (SPDO/CACA) association**
3. Bluejoint reedgrass (*Calamagrostis canadensis*) <10 percent canopy coverage .... **Douglas spiraea (SPDO) association**

Table 21—Constancy and mean cover of important plant species in the SPDO plant associations

Species	Code	CRDO-SPDO 3 plots		SPDO 11 plots		SPDO/CACA 8 plots	
		CON[a]	COV[b]	CON	COV	CON	COV
Shrubs:							
mountain alder	ALIN	33	15	45	4	13	3
Sitka alder	ALSI	—	—	9	Tr[c]	13	15
black hawthorn	CRDOD	100	58	36	3	—	—
Pursh buckthorn	RHPU	33	6	—	—	—	—
Hudsonbay currant	RIHU	—	—	—	—	13	6
whitestem gooseberry	RIIN	—	—	—	—	13	7
salmonberry	RUSP	—	—	18	2	13	6
Barclay's willow	SABA	33	5	—	—	—	—
Douglas spiraea	SPDO	100	27	100	90	100	54
common snowberry	SYAL	67	26	9	35	38	3
Alaska huckleberry	VAAL	—	—	9	5	13	Tr
Perennial forbs:							
fewflower aster	ASMO	—	—	—	—	13	5
twinflower marshmarigold	CABI	—	—	—	—	13	6
alpine willow-weed	EPAL	—	—	9	Tr	25	15
peregrine fleabane	ERPE	—	—	—	—	25	8
broadpetal strawberry	FRVIP	—	—	—	—	13	10
small bedstraw	GATR	—	—	—	—	13	40
largeleaf avens	GEMA	—	—	9	Tr	13	5
common cow-parsnip	HELA	67	2	9	3	—	—
trailing St. John's-wort	HYAN	—	—	—	—	13	50
bigleaf lupine	LUPO	—	—	—	—	13	5
skunk cabbage	LYAM	—	—	9	5	—	—
marsh cinquefoil	POPA3	—	—	—	—	13	5
Canada goldenrod	SOCA	—	—	9	2	50	3
stinging nettle	URDI	33	5	18	2	—	—
round-leaved violet	VIOR2	—	—	—	—	13	60
marsh violet	VIPA2	—	—	—	—	13	30
violet species	VIOLA	33	Tr	9	Tr	13	10
Grasses or grasslike:							
Idaho bentgrass	AGID	—	—	—	—	13	20
Thurber's bentgrass	AGTH	—	—	—	—	50	4
fringed brome-grass	BRCI	—	—	9	2	13	15
bluejoint reedgrass	CACA	33	Tr	18	Tr	100	43
brownish sedge	CABR6	—	—	—	—	13	10
gray sedge	CACA4	—	—	—	—	13	8
lenticular sedge	CALE5	—	—	9	Tr	13	20
bladder sedge	CAUT	—	—	—	—	25	9
inflated sedge	CAVE	—	—	9	Tr	13	25
Baltic rush	JUBA	—	—	9	5	13	10
small-fruited bulrush	SCMI	—	—	27	1	25	28
Ferns and fern allies:							
common horsetail	EQAR	—	—	27	2	50	1
water horsetail	EQFL	—	—	—	—	13	5

[a]CON = percentage of plots in which the species occurred.
[b]COV = average canopy cover in plots in which the species occurred.
[c]Tr = trace cover, less than 1 percent canopy cover.

MISCELLANEOUS SHRUB SERIES AND PLANT ASSOCIATIONS N = 35

THIS SECTION IS composed of six minor shrub-dominated series, each with one association or community type. Data were so limited that it was not possible to classify multiple plant associations in any series. The ACGL, OPHO, and RUSP[1] series have 7, 13, and 9 plots, respectively. The ACGL series (ACGL association) is somewhat common at low elevations in continental climates on all three NFs. The OPHO series (OPHO association) occurs in wetter precipitation zones and is uncommon on the Colville and Wenatchee NFs. Its status on the Okanogan NF is unknown. RUSP (RUSP-RIHU association) is characteristic of maritime climates on the Wenatchee and Okanogan NFs. Descriptions for these series/associations are short compared with series with more plots and associations, and they resemble plant association descriptions. The POFR, RHAL, and SYAL series (POFR, RHAL, and SYAL community types) have only two plots each, are rare, and are described in a few paragraphs. As only one association is in each series, the following descriptions substitute for any future plant association descriptions.

PHYSICAL SETTING

The data for the various miscellaneous shrub series are presented in a common set of environmental tables. Each series is then described individually. Sample plot locations for the ACGLD, OPHO, and RUSP series are shown in figs. 32, 33, and 34.

[1] See appendix A for a cross reference for all species codes and common and scientific names used in this document.

Elevation—

Plant association	Elevation (feet)			N
	Minimum	Maximum	Average	
ACGLD	1,410	3,800	2,671	7
OPHO	2,475	3,950	3,330	13
RUSP	2,450	6,360	3,844	9
POFR	4,400	4,400	4,400	2
RHAL	5,200	5,700	5,460	2
SYAL	1,550	3,330	2,440	2

Valley Geomorphology—

Plant association	Valley width					N
	Very broad	Broad	Moderate	Narrow	Very narrow	
ACGLD	0	0	0	4	3	7
OPHO	1	1	2	5	4	13
RUSP	0	0	2	6	0	8
POFR	0	0	2	0	0	2
RHAL	0	0	0	0	2	2
SYAL	1	0	1	0	0	2

Plant association	Valley gradient					N
	Very low	Low	Moderate	Steep	Very steep	
ACGLD	0	1	1	1	4	7
OPHO	0	1	3	2	7	13
RUSP	0	2	3	0	3	8
POFR	0	2	0	0	0	2
RHAL	0	0	0	0	2	2
SYAL	1	1	0	0	0	2

Channel Types—

Plant association	Rosgen channel type					N
	A	B	C	E	Intermittent and ephemeral	
ACGLD	3	1	0	1	2	7
OPHO	7	3	0	0	3	13
RUSP	4	4	0	0	0	8
POFR	0	0	0	2	0	2
RHAL	2	0	0	0	0	2
SYAL	0	1	0	0	1	2

Fluvial Surfaces—

Plant association	Fluvial surface						N
	Flood-plain	Stream-bank	Terrace	Shrub wetland	Toe-slope	Spring	
ACGLD	1	4	0	0	2	0	7
OPHO	4	5	2	0	1	1	13
RUSP	6	1	0	0	0	1	8
POFR	0	0	0	2	0	0	2
RHAL	0	2	0	0	0	0	2
SYAL	0	0	1	1	0	0	2

Soils—

Plant association	Soil texture				N
	Sand	Loamy sand	Loam	Organic loam	
ACGLD	2	1	4	0	7
OPHO	0	1	12	0	13
RUSP	1	1	5	1	9
POFR	0	0	0	2	2
RHAL	1	0	1	0	2
SYAL	1	0	1	0	2

Miscellaneous shrub plant associations

	Scientific name	Common name	Ecoclass code	Plots
Major associations:				
ACGLD	*Acer glabrum* var. *douglasii*	Douglas maple	SW72	7
OPHO	*Oplopanax horridum*	Devil's club	SW7113	13
RUSP-RIHU	*Rubus spectabilis-Ribes hudsonianum*	Salmonberry-Hudsonbay currant	SW5131	9
Minor associations:				
POFR	*Potentilla fruticosa*	Shrubby cinquefoil	SW50	2
RHAL	*Rhododendron albiflorum*	Cascade azalea	SW42	2
SYAL	*Symphoricarpos albus*	Common snowberry	SM31	2

KEY TO THE MISCELLANEOUS SHRUB SERIES

1. Tall or short willows, bog birch, Cascade huckleberry, moss-heathers, mountain-heaths, partridgefoot, vine maple, Sitka alder, mountain alder, red-osier dogwood, Douglas spiraea, and/or pyramid spiraea, or black hawthorn ≥25 percent canopy coverage .... **Go back to the start of the shrub series key**
2. Devil's club (*Oplopanax horridum*) ≥5 percent canopy coverage .... **Devil's club series and devil's club (OPHO) plant association**
3. Salmonberry (*Rubus spectabilis*), stink currant (*Ribes bracteosum*), or Hudsonbay currant (*Ribes hudsonianum*) ≥25 percent canopy coverage .... **Salmonberry series and salmonberry-Hudsonbay currant (RUSP-RIHU) plant association**
4. Cascade azalea (*Rhododendron albiflorum*) or rusty menziesia (*Menziesia ferruginea*) ≥25 percent canopy coverage .... **Cascade azalea series and Cascade azalea (RHAL) community type**
5. Douglas maple (*Acer glabrum* var. *douglasii*), common chokecherry (*Prunus virginiana*), and/or Saskatoon serviceberry (*Amelanchier alnifolia*) ≥25 percent canopy coverage .... **Douglas maple series and Douglas maple (ACGLD) plant association**
6. Shrubby cinquefoil (*Potentilla fruticosa*) ≥25 percent canopy coverage .... **Shrubby cinquefoil series and shrubby cinquefoil (POFR) plant association**
7. Common snowberry (*Symphoricarpos albus*) ≥25 percent canopy coverage .... **Common snowberry series and common snowberry (SYAL) community type**

DOUGLAS MAPLE SERIES

(ACGLD plant association SW72)

Acer glabrum var. *douglasii*

ACGLD N = 7

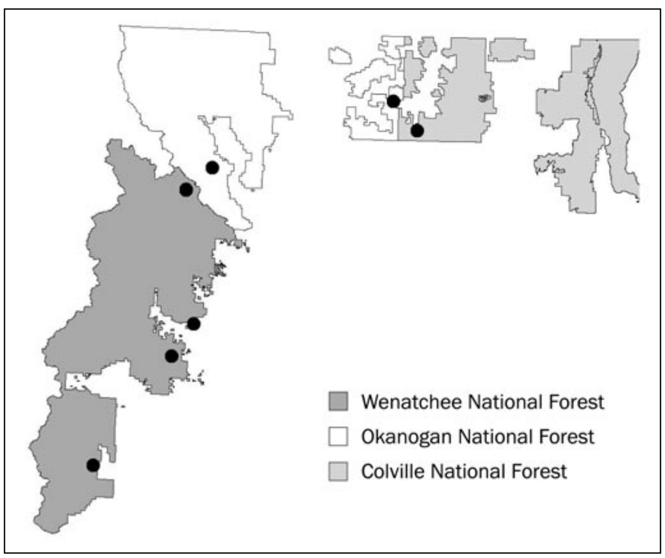


Figure 32—Plot locations for the Douglas maple series.

VEGETATION CHARACTERISTICS

The ACGLD series is dominated by a variety of tall shrubs characteristic of rather dry sites for riparian zones. Douglas maple dominated six of the seven sample plots, and common chokecherry dominated the seventh plot. Other prominent shrubs included Saskatoon serviceberry, red-osier dogwood, ocean-spray, western thimbleberry, common snowberry, and myrtle pachistima. Herb cover was variable. A few plots, especially those on the Colville NF, may be successional to the PSME series. Many plots, however, were located in shrub-steppe zones and the indicated climax was tall shrubs, especially Douglas maple and Saskatoon serviceberry.

PHYSICAL SETTING

The ACGLD series is one of the driest series in this study. It occurs from very low to moderately low elevations throughout central and northeastern Washington, although it is uncommon on the Colville NF. Ecology plot elevations ranged from 1,410 to 3,800 feet and averaged 2,671 feet. Unsampled stands in the ACGLD series occur at lower elevations in V-notched canyons and valleys on NF and other lands adjacent to the Columbia River near Wenatchee. The ACGLD series is also common in the foothills along the Okanogan River.

Sites are generally hot and dry and occur in the lower elevation distribution of forest zones or shrub-steppe. Most stands are associated with narrow, steep, V-shaped valleys and canyons. Sites are somewhat variable. Five of seven plots were located within these kinds of valleys on floodplains and streambanks. Two of these stands extended up onto the adjacent toeslopes. The streams associated with the ACGLD series usually are intermittent or ephemeral. Two plots were located at the base of talus and rubble slopes in canyons. In either case, summer drought prevents the dominance of more common riparian species such as mountain alder and red-osier dogwood. Channel types were variable. Five of seven plots were associated with A, intermittent, or ephemeral channels. Field observations suggest a few of the A channels might be dry later in the summer. If true, ephemeral and intermittent conditions are most common in this series except in larger canyons with perennial streams. Given the range of sites, soils are understandably variable. They range from very stony sand and loamy sand textures in the canyons to deep loams on toeslopes. Soils are moist in spring or may even be briefly saturated on some sites but are dry by mid-summer.

ECOSYSTEM MANAGEMENT

Natural Regeneration of Douglas Maple—

Seed is produced annually with large crops every 1 to 3 years. The winged seed is dispersed by wind throughout fall and winter (Olson and Gabriel 1974). They require about 6 months of chilling to germinate (Shaw 1984), and germination rates are moderate to high. Seedlings respond best to partial shade and light soil scarification (Steele and Geier-Hayes 1989). Douglas maple sprouts from the base following fire or logging damage, but it does not appear to spread by layering (Haeussler and Coates 1986, Wasser 1982).

Artificial Establishment of Douglas Maple—

Maple can be established from seed broadcast on slightly scarified mineral soil or from nursery grown seedlings.

(For more information on the short- and long-term revegetation potential of selected riparian wetland plant species, see app. B-5.)

Fire—

The aboveground portions of Douglas maple and associated shrubs in the ACGLD series are generally easily killed by fire. However, numerous sprouts then arise from the root crown (Leege 1968). This sprouting ability allows Douglas maple to immediately become part of the postfire community.

Animals—

Livestock. Use by livestock is limited by dense stands, steep terrain, and generally low palatability. Sheep and goats may browse Douglas maple more than cattle (Wasser 1982). When grazing reduces the shrub cover below normal levels, sites may become vulnerable to stream erosion during spring runoff and following summer storms. (For more information on forage palatability, see app. B-1. For potential biomass production, see app. B-5.)

Wildlife and Fish. Douglas maple is a highly valued browse species. Deer, elk, and moose eat the leaves and twigs throughout the year (Arno and Hammerly 1984). It is an especially valuable winter food source. These animals relish young plants and new sprouts. This shrub is an important dominant of seral brush fields that develop after fire or logging. Eventually the shrubs outgrow the reach of browsing animals and cease to be an important source of browse (Brown et al. 1977). (For more information on thermal or feeding cover values, see apps. B-2 and B-3. For information on food values or degree of use, see apps. B-2 and B-4. For more information on erosion control potential, see app. B-5.)

Estimating Vegetation Potential on Disturbed Sites—

Estimating vegetation potential on disturbed sites is usually unnecessary as all observed stands were in fair or better ecological condition. Douglas maple and the associated shrubs are not favored forage for cattle, making these stands less sensitive to grazing damage. Additionally, stands are not totally eliminated by fire or logging. In the rare case where stands are highly degraded, such as where several years of heavy grazing have followed wildfire, recognizing the ephemeral nature of soil moisture on these sites is critical. The ACGLD soil becomes too dry during the mid- to late-summer growing season for more mesic dominants such as mountain alder and red-osier dogwood. The presence of scattered individuals or dead stems of shrubs mentioned in the vegetation composition section indicates the potential for this series and association.

RELATIONSHIPS TO OTHER CLASSIFICATIONS

The ACGLD series has not been described in other riparian and wetland classifications.

U.S. DEPARTMENT OF THE INTERIOR, FISH AND WILDLIFE SERVICE WETLANDS CLASSIFICATION

System:	palustrine
Class:	scrub-shrub
Subclass:	broad-leaved deciduous
Water regime:	(nontidal) intermittently saturated to intermittently flooded

DEVIL'S CLUB SERIES
(OPHO plant association SW7113)
Oplopanax horridum
OPHO N = 13

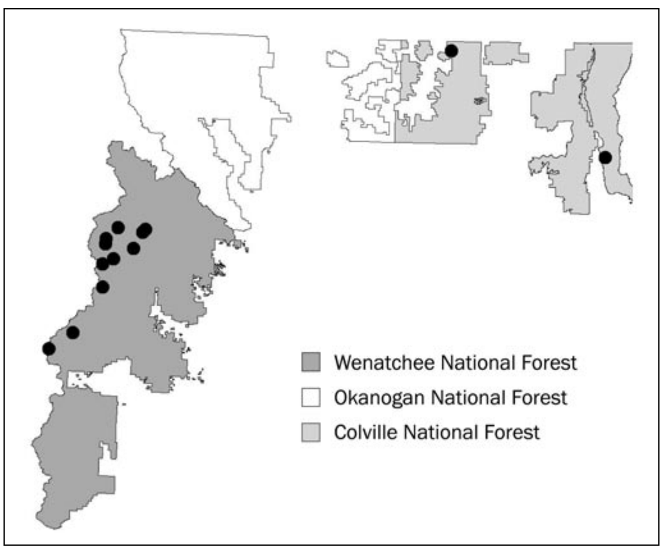


Figure 33—Plot locations for the devil's club series.

VEGETATION CHARACTERISTICS

Devil's club is well represented to dominant and averaged 45 percent canopy coverage. Lady fern or oak fern usually are well represented to abundant in the herb layer. As the OPHO series keys fairly early relative to other shrubs, the devil's club shrub is not necessarily dominant. Other shrubs may have more cover than devil's club. Salmonberry, for instance, is well represented to dominant on 6 of the 13 plots. In the absence of devil's club, these plots would otherwise key to the RUSP-RIHU association that is very similar to the OPHO association. Other prominent plants found in the OPHO series include western thimbleberry, sylvan goatsbeard, coolwort foamflower, and queencup beadlily. Shrubs such as Sitka alder can be well represented, but if Sitka alder canopy coverage were greater than 24 percent, such stands would key to the ALSI/OPHO plant association.

PHYSICAL SETTING

OPHO is a cold, moist series. Sites are similar to plant associations in conifer and shrub series (THPL/OPHO, ALSI/OPHO, POTR2/OPHO, AND ALSI/OPHO associations) that have devil's club well represented in the undergrowth. Perhaps sites are too moist for conifers such as western redcedar or western hemlock, and shrubs such as Sitka alder, to dominate. The OPHO series occurs at moderate elevations throughout the NFs of eastern Washington. It appears to be especially common on the Wenatchee NF. It was not sampled on the Okanogan NF but is probably present in small amounts. Ecology plot elevations ranged from 2,475 to 3,950 feet and averaged 3,330 feet.

OPHO occurs in a variety of valleys but appears to prefer narrow valleys, perhaps owing to cold air drainage and generally higher soil moisture. Most plots occur in valleys with greater than 3 percent valley gradient and are most abundant where gradients exceed 7 percent. OPHO seems to prefer fairly active fluvial surfaces such as floodplains, streambanks, and their immediately adjacent terraces. However, it also can occur on subirrigated toeslopes and springs. Most plots are associated with A and B channels, but three plots occurred along intermittent channels and in ephemeral draws. Soils usually are moderately deep loams, with measured water tables averaging 18 inches below the soil surface.

ECOSYSTEM MANAGEMENT

Natural Regeneration of Devil's Club—

Devil's club reproduces vegetatively, probably from rhizomes. It also reproduces from seed. Once established, seedling growth is slow.

Fire—

Cool, moist devil's club sites burn infrequently. These moist ravines and streamside areas may serve as a firebreak to low- and moderate-severity fires. The OPHO series is often located in small patches intermixed with similar forested associations with devil's club in the undergrowth (e.g., THPL/OPHO) and together may experience infrequent, severe, stand-replacing fires, which regress the site to pioneer conditions (Davis et al. 1980). Devil's cub may resprout from root crowns or rhizomes following fire.

Animals—

Livestock. Use of devil's club by livestock is unknown but is presumed to be very low. (For more information on forage palatability, see app. B-1. For potential biomass production, see app. B-5.)

Wildlife and Fish. Devil's club has been reported as having low palatability for browsing animals because of its prickly leaves and stems (Hanley and McKendrick 1983, Viereck and Little 1972). Deer and elk use it lightly in summer, and in one study it composed only 3.4 percent of the diet of Roosevelt elk on the Pacific Northwest coast (Jenkins and Starkey 1991). However, use can be heavy on both leaves and fruit in eastern Washington. Other specialists on the Mount Baker-Snoqualmie and Wenatchee NFs agree (Henderson 1998, Lillybridge 1998). Grizzly and black bear use OPHO areas because of fish availability and devil's club's edible berries, leaves, and stems (Almack 1986, DeMeo 1989). Devil's club provides hiding, escape, and thermal cover for various species of birds, rodents, and the vagrant shrew (Hoffman 1960). Devil's club growing on streambanks provides shade for salmonids and their eggs. (For more information on thermal or feeding cover values, see apps. B-2 and B-3. For information on food values or degree of use, see apps. B-2 and B-4. For more information on erosion control potential, see app. B-5.)

Estimating Vegetation Potential on Disturbed Sites—

Disturbed sites are unusual. Livestock find little forage value in the association. In addition, these sites tend to be in wet, narrow valleys isolated from road development and logging. Presently, these sites occur within buffer zones and riparian reserves with little management affecting vegetation, further protecting the sites.

RELATIONSHIPS TO OTHER CLASSIFICATIONS

A similar OPHO association has been described on the Mount Hood and Gifford Pinchot NFs (Diaz and Mellen 1996).

U.S. DEPARTMENT OF THE INTERIOR, FISH AND WILDLIFE SERVICE WETLANDS CLASSIFICATION

System:	palustrine
Class:	scrub-shrub
Subclass:	broad-leaved deciduous
Water regime:	(nontidal) intermittently saturated to intermittently flooded

SALMONBERRY SERIES

(RUSP-RIHU plant association SW5131)

Rubus spectabilis

RUSP N = 8

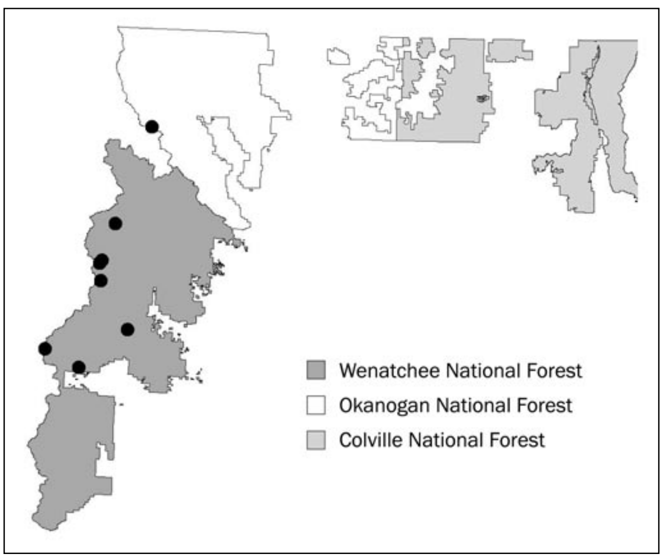


Figure 34—Plot locations for the salmonberry series.

VEGETATION CHARACTERISTICS

A shrub layer composed primarily of salmonberry characterizes the RUSP series. Hudsonbay currant and stink currant also are used to identify the series. Together these three shrubs averaged 49 percent canopy coverage. Like the OPHO and ATFI-GYDR series, lady fern and/or oak fern are often well represented to abundant in the herb layer. Other plants that may be common include Sitka alder, Cascade azalea, Sitka mountain-ash, various huckleberries, sylvan goatsbeard, coolwort foamflower, and Sitka valerian.

PHYSICAL SETTING

RUSP is a very cold, moist series. Sites are similar to the OPHO and ATFI plant associations, perhaps even wetter. RUSP occurs at moderate elevations and is common in strong maritime climate areas of the Cascade Range. It appears to be especially common on the Wenatchee NF. Only one plot was located on the Okanogan NF, but the RUSP series may be common on the upper Twisp River and the lands to the west between Ross Lake and the Cascade crest.

Ecology plot elevations ranged from 2,450 to 6,360 feet but averaged only 3,844 feet. The high-elevation plot (6,360 feet) was located on a relatively warm, very steep, west aspect in a spring-fed area below Asgard Pass. All other plots were located below 4,520 feet and were more typical of the RUSP series. Salmonberry occurs in moderate to narrow valley widths, perhaps owing to cold air drainage and generally higher soil moisture. It does not appear to be common in very narrow valleys, perhaps owing to a lack of floodplain development in restricted bottoms. Valley gradient is more variable but in general was greater than 2 percent. The key to understanding the RUSP series is that the salmonberry seems to prefer very active fluvial surfaces such as floodplains in strong maritime climate. Only the Asgard Pass plot occurred on a different fluvial surface, a spring within a large talus slope. All plots were associated with A and B channels. Soils ranged from skeletal sand and loamy sand to loams. Soils are very moist and water tables at the time of sampling averaged 18 inches below the soil surface. However, the soil surface of floodplain sites is often flooded during spring runoff.

ECOSYSTEM MANAGEMENT

Natural Regeneration of Salmonberry—

Salmonberry can reproduce sexually or vegetatively. It is very versatile and can sprout vigorously from the stump, root crown, stem base, or roots, and from the dense network of rhizomes (Barber 1976). It also can root when stem tips come into permanent contact with the ground. It responds vigorously to fire and mechanical disturbance but spreads even in the absence of disturbance. Salmonberry also produces large numbers of seeds (Barber 1976). Seeds have a very hard coat and a dormant embryo, and germination often requires some kind of mechanical or chemical scarification. This occurs naturally as seeds overwinter in the soil. Most germination occurs the following summer, but the seed remains viable in the soil seedbank for several years. The seed is eaten by a variety of birds and mammals, and digestive acids provide scarification, which enhances germination (Barber 1976). Mineral soil is best for good germination.

Fire—

Cold, moist salmonberry sites burn infrequently and may serve as a firebreak to low- and moderate-severity fires. The RUSP series and the adjacent forests undergo severe, infrequent, stand-replacing fires that regress the site to pioneer conditions. Salmonberry will then come back vigorously from the stump, root crown, rhizomes, and seed in the soil (Barber 1976, Zasada et al. 1989).

Animals—

Livestock. Salmonberry is seldom eaten by cattle but is considered fair sheep browse (Dayton 1931). (For more information on forage palatability, see app. B-1. For potential biomass production, see app. B-5.)

Wildlife and fish. Salmonberry provides food and cover for a variety of birds and mammals (Barber 1976). Deer and elk use the leaves and young twigs year-round, but use tends to be heavier in summer. Moose, if present, browse the young stem tips early in the growing season. Grizzly bear, black bear, and coyote eat salmonberry fruit. Other fruit-eating mammals include mice, rodents, raccoon, skunk, squirrels, ground squirrels, pika, chipmunks, and fox (Core 1974). The fruits are eaten by a variety of birds including ruffed grouse, American robin, gray catbird, California quail, blue grouse, pine grosbeak, thrushes, and towhees. Salmonberry growing on floodplains and streambanks provides protection and shade for salmonids and their eggs. (For more information on thermal or feeding cover values, see apps. B-2 and B-3. For information on food values or degree of use, see apps. B-2 and B-4. For more information on erosion control potential, see app. B-5.)

Estimating Vegetation Potential on Disturbed Sites—

Disturbed RUSP sites are unusual and occur mostly following severe flood disturbance. Livestock grazing is rare as cattle and sheep find little forage value on these sites. In addition, these sites tend to be on relatively wet floodplains well removed from road development and logging. Presently these sites occur within buffer zones with little management affecting vegetation, further protecting the site.

RELATIONSHIPS TO OTHER CLASSIFICATIONS

A similar RIBR-RUSP/PEFR2 association has been described for the Gifford Pinchot and Mount Hood NFs (Diaz and Mellen 1996).

U.S. DEPARTMENT OF THE INTERIOR, FISH AND WILDLIFE SERVICE WETLANDS CLASSIFICATION

System:	palustrine
Class:	scrub-shrub
Subclass:	broad-leaved deciduous
Water regime:	(nontidal) temporarily to to intermittently flooded

SHRUBBY CINQUEFOIL SERIES
(POFR community type SW50)
Potentilla fruticosa
POFR N = 2

TWO PLOTS WERE sampled in the headwaters of Lost Creek on the Tonasket RD. Both plots were located at 4,400 feet elevation in a small, low-gradient, meadow-dominated, basin along Lost Creek. Both plots had received heavy use by cattle but had been rested for about 4 years. Shrubby cinquefoil, shortbeaked sedge, and Baltic rush (the latter two being recognized as increasers following overgrazing) dominated the drier plot. This plot likely represents a disturbed site, and tufted hairgrass was probably codominant with shrubby cinquefoil before grazing. The wetter plot was in better condition because cattle avoided the wet, organic soils. Here shrubby cinquefoil and bladder sedge were dominant. Increaser graminoids (Baltic rush, fowl bluegrass, and Kentucky bluegrass) were well represented owing to past livestock use. Again, tufted hairgrass was likely codominant with shrubby cinquefoil and bladder sedge before grazing. The POFR series is similar to shrubby cinquefoil-dominated plant associations described in the Rocky Mountains and northeastern Oregon (Crowe and Clausnitzer 1997, Hansen et al. 1995). Similar associations also occur in British Columbia. Therefore, the POFR series is likely an extension of British Columbia flora that extends into the Tonasket RD from Canada. Highly disturbed remnants of the POFR series were observed elsewhere on the Tonasket RD and may occur elsewhere in eastern Washington (but are rare).

CASCADE AZALEA SERIES
(RHAL community type SW42)
Rhododendron albiflorum
RHAL N = 2

ONE PLOT WAS sampled in the headwaters of Pass Creek on the Sullivan Lake RD (Colville NF), and the other was sampled in the upper reaches of Trout Creek on the Winthrop RD (Okanogan NF). Elevations of the two plots were 5,200 and 5,700 feet, respectively. Both were located on streambanks in very narrow, steep valleys within forests whose undergrowth was dominated by Cascade azalea. These plots may possibly represent early-seral stages of TSHE/RHAL and ABLA2/RHAL associations, thus the community type status. Cascade azalea was codominant with rusty menziesia in one plot. Oak fern was well represented in the understory. Cascade azalea dominated the shrub layer of the other plot. Common horsetail and a variety of forbs were well represented in the understory. The RHAL series has not been described elsewhere.

COMMON SNOWBERRY SERIES
(SYAL community type SM31)
Symphoricarpos albus
SYAL N = 2

BOTH PLOTS WERE located at relatively low elevations (avg. 2,440 feet) on the Colville NF. One plot was on a moderately broad, very low gradient alluvial fan by South Skookum Lake on the Newport RD. Common snowberry was dominant (80 percent canopy coverage) and Nootka rose was well represented. Scattered red-osier dogwood indicates the site may be a seral stage of the COST-SYAL association. The other plot was located on an old terrace in a moderately narrow, low-gradient section of Trout Creek on the Kettle Falls RD. Common snowberry, California hazel, and Lewis' mock orange were abundant. Mountain alder was scattered but may indicate this site is a seral stage of the ALIN-SYAL association. The SYAL series has not been described elsewhere.

Table 22—Constancy and mean cover of important plant species in the miscellaneous shrub plant associations

		ACGLD 7 plots		OPHO 14 plots		POFR 2 plots		RHAL 2 plots		RUSP-RIHU 8 plots		SYAL 2 plots	
Species	**Code**	**CON[a]**	**COV[b]**	**CON**	**COV**	**CON**	**COV**	**CON**	**COV**	**CON**	**COV**	**CON**	**COV**
Tree overstory:													
Pacific silver fir	ABAM	—	—	23	7	—	—	—	—	38	1	—	—
subalpine fir	ABLA2	—	—	—	—	—	—	100	8	13	15	—	—
Engelmann spruce	PIEN	—	—	8	15	—	—	—	—	—	—	—	—
lodgepole pine	PICO	—	—	—	—	100	2	—	—	—	—	—	—
black cottonwood	POTR2	14	7	8	Tr[c]	—	—	—	—	—	—	—	—
western hemlock	TSHE	—	—	8	5	—	—	50	2	25	8	—	—
Tree understory:													
Pacific silver fir	ABAM	—	—	54	2	—	—	—	—	88	6	—	—
subalpine fir	ABLA2	—	—	—	—	—	—	100	4	25	1	—	—
Engelmann spruce	PIEN	14	2	8	Tr	—	—	50	1	—	—	—	—
lodgepole pine	PICO	—	—	—	—	100	2	—	—	—	—	—	—
Douglas-fir	PSME	14	2	—	—	—	—	—	—	—	—	50	3
western redcedar	THPL	—	—	15	4	—	—	50	2	—	—	—	—
western hemlock	TSHE	—	—	38	1	—	—	50	7	38	2	—	—
mountain hemlock	TSME	—	—	8	Tr	—	—	—	—	50	5	—	—
Shrubs:													
Douglas maple	ACGLD	86	43	23	14	—	—	—	—	—	—	50	5
mountain alder	ALIN	29	11	8	5	—	—	—	—	—	—	—	—
Sitka alder	ALSI	—	—	46	4	—	—	—	—	63	6	—	—
Saskatoon serviceberry	AMAL	57	7	—	—	—	—	—	—	—	—	50	5
red-osier dogwood	COST	57	9	8	15	—	—	—	—	—	—	100	3
California hazel	COCO2	14	2	—	—	—	—	—	—	—	—	50	35
ocean-spray	HODI	43	6	—	—	—	—	—	—	—	—	—	—
rusty menziesia	MEFE	—	—	15	3	—	—	50	15	38	3	—	—
devil's club	OPHO	—	—	100	45	—	—	—	—	13	Tr	—	—
Lewis' mock orange	PHLE2	14	Tr	—	—	—	—	—	—	—	—	50	35
common chokecherry	PRVI	43	14	—	—	—	—	—	—	—	—	—	—
Cascade azalea	RHAL	—	—	23	7	—	—	100	29	50	11	—	—
stink currant	RIBR	—	—	8	25	—	—	—	—	13	15	—	—
Hudsonbay currant	RIHU	14	5	38	2	—	—	—	—	63	25	—	—
prickly currant	RILA	57	2	38	2	—	—	50	2	38	2	—	—
Nootka rose	RONU	29	4	—	—	—	—	—	—	—	—	100	8
red raspberry	RUID	29	3	8	2	—	—	—	—	—	—	100	3
western thimbleberry	RUPA	86	5	69	8	—	—	50	1	38	4	—	—
salmonberry	RUSP	—	—	62	18	—	—	—	—	88	33	—	—
Mackenzie's willow	SARIM2	—	—	—	—	—	—	—	—	—	—	50	15
Sitka willow	SASI2	—	—	8	10	—	—	—	—	25	8	—	—
Sitka mountain-ash	SOSI	—	—	—	—	—	—	—	—	50	4	—	—
Douglas spiraea	SPDO	14	10	—	—	—	—	—	—	—	—	50	2
common snowberry	SYAL	57	40	8	10	—	—	—	—	—	—	100	65
Alaska huckleberry	VAAL	—	—	15	8	—	—	—	—	38	4	—	—
big huckleberry	VAME	14	Tr	38	3	—	—	100	5	88	2	—	—
oval-leaf huckleberry	VAOV	—	—	8	10	—	—	—	—	13	5	—	—
Oregon jollygrape	BEAQ	71	1	8	Tr	—	—	—	—	—	—	50	2
twinflower	LIBOL	14	20	15	1	—	—	—	—	—	—	—	—
myrtle pachistima	PAMY	57	13	8	Tr	—	—	—	—	—	—	—	—
red mountain-heath	PHEM	—	—	—	—	—	—	50	12	13	Tr	—	—
shrubby cinquefoil	POFL	—	—	—	—	100	33	—	—	—	—	—	—
dwarf bramble	RULA	—	—	23	1	—	—	—	—	63	1	—	—
five-leaved bramble	RUPE	—	—	15	2	—	—	50	1	38	1	—	—
grouse huckleberry	VASC	—	—	—	—	—	—	50	10	—	—	—	—
Perennial forbs:													
western yarrow	ACMI	14	Tr	—	—	100	2	—	—	—	—	—	—
deerfoot vanillaleaf	ACTR	—	—	8	Tr	—	—	—	—	25	13	—	—
sharptooth angelica	ANAR	29	Tr	31	2	—	—	—	—	25	Tr	50	Tr
clasping arnica	ARAM	—	—	15	3	—	—	50	5	25	Tr	—	—
Chamiso arnica	ARCH	—	—	—	—	100	3	—	—	—	—	—	—
heart-leaf arnica	ARCO	29	5	8	Tr	—	—	—	—	13	Tr	50	2
mountain arnica	ARLA	—	—	8	Tr	—	—	50	2	25	Tr	—	—
sylvan goatsbeard	ARSY	—	—	38	13	—	—	—	—	38	1	—	—
wild ginger	ASCA3	—	—	15	14	—	—	—	—	—	—	—	—
aster species	ASTER	—	—	—	—	100	9	100	4	13	Tr	—	—
twinflower marshmarigold	CABI	—	—	8	1	—	—	50	1	13	1	—	—
queencup beadlily	CLUN	14	Tr	69	2	—	—	50	Tr	38	Tr	—	—
alpine willow-weed	EPAL	—	—	38	Tr	—	—	50	3	13	1	—	—
fireweed	EPAN	—	—	8	2	—	—	50	Tr	25	1	—	—
broadpetal strawberry	FRVIP	29	1	—	—	100	2	—	—	—	—	—	—

Table 22—Constancy and mean cover of important plant species in the miscellaneous shrub plant associations (continued)

		ACGLD 7 plots		OPHO 14 plots		POFR 2 plots		RHAL 2 plots		RUSP-RIHU 8 plots		SYAL 2 plots	
Species	Code	CON	COV	CON	COV	CON	COV	CON	COV	CON	COV	CON	COV
sweetscented bedstraw	GATR	71	1	31	1	—	—	50	Tr	63	1	—	—
largeleaf avens	GEMA	14	Tr	—	—	100	2	—	—	13	Tr	100	Tr
false saxafrage	LEPY	—	—	—	—	—	—	50	10	—	—	—	—
Canby's licorice-root	LICA2	—	—	8	1	—	—	100	3	—	—	—	—
northern bluebells	MEPAB	14	Tr	15	2	—	—	—	—	25	1	50	1
fivestamen miterwort	MIPE	—	—	31	1	—	—	50	3	50	1	—	—
miterwort species	MITEL	14	2	28	10	—	—	50	Tr	25	3	—	—
sweet-root species	OSMOR	29	2	—	—	—	—	50	Tr	—	—	50	1
fringed grass-of-parnassia	PAFI	—	—	8	Tr	—	—	100	2	13	Tr	—	—
arctic butterbur	PEFR2	14	30	—	—	—	—	—	—	—	—	—	—
fanleaf cinquefoil	POFL2	—	—	8	1	—	—	50	5	—	—	—	—
northwest cinquefoil	POGR	—	—	—	—	100	3	—	—	—	—	—	—
dotted saxifrage	SAPU	—	—	31	Tr	—	—	50	1	75	1	—	—
arrowleaf groundsel	SETR	—	—	15	Tr	—	—	100	2	50	Tr	50	Tr
western solomonplume	SMRA	57	1	23	5	—	—	—	—	13	5	50	2
starry solomonplume	SMST	29	2	38	Tr	—	—	—	—	13	Tr	100	2
claspleaf twisted-stalk	STAM	29	1	62	1	—	—	50	Tr	38	Tr	—	—
rosy twisted-stalk	STRO	—	—	31	1	—	—	—	—	63	1	—	—
coolwort foamflower	TITRU	—	—	92	5	—	—	50	1	75	2	—	—
white trillium	TROV	—	—	62	Tr	—	—	—	—	13	Tr	—	—
globeflower	TRLA4	—	—	—	—	—	—	50	15	—	—	—	—
stinging nettle	URDI	43	1	8	Tr	—	—	—	—	13	3	100	2
Sitka valerian	VASI	—	—	23	1	—	—	50	10	63	3	—	—
pioneer violet	VIGL	28	2	77	1	—	—	—	—	63	1	50	1
Grasses or grasslike:													
cutting wheatgrass	AGCA	—	—	—	—	100	2	—	—	—	—	—	—
Oregon bentgrass	AGOR	—	—	—	—	100	2	—	—	—	—	—	—
winter bentgrass	AGSC	—	—	—	—	100	2	—	—	—	—	—	—
brome species	BROMU	14	5	—	—	50	2	—	—	—	—	50	1
bluejoint reedgrass	CACA	—	—	—	—	50	7	—	—	—	—	—	—
slender-beaked sedge	CAAT	—	—	—	—	100	2	—	—	—	—	—	—
thick-headed sedge	CAPA	14	Tr	—	—	100	2	—	—	—	—	—	—
shortbeaked sedge	CASI2	—	—	—	—	50	20	—	—	—	—	—	—
bladder sedge	CAUT	—	—	—	—	100	19	—	—	—	—	—	—
wood reed-grass	CILA2	29	1	23	1	—	—	50	Tr	38	Tr	—	—
timber oatgrass	DAIN	—	—	—	—	100	4	—	—	—	—	—	—
tufted hairgrass	DECE	—	—	—	—	100	23	—	—	—	—	—	—
blue wildrye	ELGL	57	Tr	—	—	—	—	50	1	13	Tr	100	2
timothy	PHPR	—	—	—	—	100	2	—	—	—	—	—	—
fowl bluegrass	POPA	—	—	—	—	50	5	—	—	—	—	—	—
Kentucky bluegrass	POPR	—	—	—	—	100	4	—	—	—	—	—	—
Ferns and fern allies:													
lady fern	ATFI	14	2	92	12	—	—	50	Tr	75	27	—	—
brittle bladderfern	CYFR	71	1	15	2	—	—	—	—	25	Tr	50	Tr
common horsetail	EQAR	29	Tr	8	Tr	50	1	50	7	13	1	50	1
common scouring-rush	EQHY	29	1	8	Tr	—	—	—	—	—	—	50	1
oak fern	GYDR	14	1	85	18	—	—	50	5	88	7	—	—
sword fern	POMU	—	—	31	Tr	—	—	50	Tr	13	Tr	—	—

[a] CON = percentage of plots in which the species occurred.

[b] COV = average canopy cover in plots in which the species occurred.

[c] Tr = trace cover, less than 1 percent canopy cover.

Return to Part 1 Return to Part 2

AQUATIC SERIES

AQUATIC N = 59

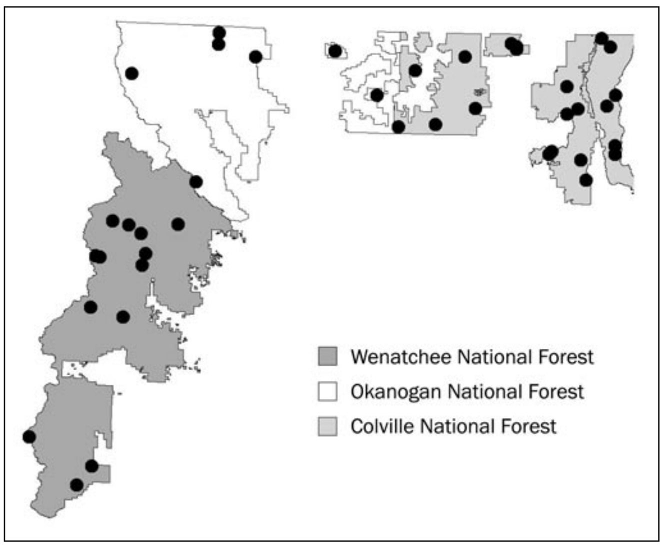


Figure 35—Plot locations for the AQUATIC series.

AS A WHOLE, the numerous plant species used to characterize the AQUATIC[1] series are widely distributed across the temperate to subarctic latitudes of North America. Most of these plants occur from Alaska to southeastern Canada, and extend south through much of the Western, north central, and Northeastern United States. Some of the plants are circumpolar. (All the cross references to species codes, common, and scientific names are located in app. A.) The general site requirements and distribution for each species are described below (Hitchcock and Cronquist 1973):

- Creeping spike-rush is found in shallowly flooded water and shorelines. It is widespread in temperate and cold-temperature regions of the Northern Hemisphere. Creeping spike-rush also occurs throughout the Pacific Northwest.
- Water horsetail is found in shallow, standing water, and is circumboreal. It is found throughout the Pacific Northwest.
- Northern mannagrass and western mannagrass are found in shallow standing water. They occur from Alaska to central California, east to Newfoundland, Maine, and Pennsylvania. These mannagrasses occur throughout the Pacific Northwest.
- Indian water-lily and cow-lily are found in deep standing water and occur in western North America. They are found throughout the Pacific Northwest.
- Bur-reed species are plants of shallow standing water. They are found from Alaska south through the Pacific Northwest region, east to Newfoundland, and the Northeastern states. Bur-reed species occur throughout the Pacific Northwest.
- Common cattail is a species of shallow standing water and wet places. It occurs from Alaska to Mexico, east through most of southern Canada, and throughout the United States. It is found throughout the Pacific Northwest.
- Pondweed species are plants of moderately deep standing water. The primary indicator species (grass-leaved and floatingleaf pondweed) are found from Alaska south on both sides of the Cascade Range to California and in Arizona and Colorado. These two species occur throughout the Pacific Northwest and extend east through most of Central and Northeastern United States and southeastern Canada. The pondweed genus, as a whole, occurs all over North America. In addition, other pondweeds also can be used to identify the AQUATIC series.
- Softstem bulrush and hardstem bulrush are plants of marshes and muddy shores that are widespread in temperate North America. Softstem bulrush extends south into tropical America. Hardstem bulrush is most common in the Western United States. They both occur throughout the Pacific Northwest.

This is a complex series. It includes eight plant associations, each characterized by one or more species or genera. For simplicity, all AQUATIC plant associations are lumped into the AQUATIC series based on similarity of site (aquatic, and shoreline).

The AQUATIC series includes all herbaceous associations supporting rooted vascular or emergent vegetation that grows in deep water or in shallow water along the shoreline of permanently standing water. These sites include natural ponds and lakes, seasonally flooded shorelines, beaver

[1] See appendix A for a cross reference for all species codes and common and scientific names used in this document.

ponds, reservoirs, sloughs, or the quiet backwaters of Rosgen E and C channels. In general, the species characterizing the AQUATIC series can be listed by decreasing water depth: Indian water-lily or cow-lily, pondweed species or water ladysthumb, bur-reed species, northern or western manna-grass, softstem and hardstem bulrush, water horsetail, creeping spike-rush, and common cattail, respectively.

The most important factor determining the distribution of the AQUATIC series species and their corresponding associations is water depth. Secondary factors are wave action, water temperature, oxygenation, and chemistry. The transition from deep to shallow water and shoreline characteristics is probably more important to the distribution of the AQUATIC series and plant associations in lakes and ponds, than size of the water body and wave action. In deep freshwater lakes, the progression of associations in the AQUATIC series often goes from NUPO in deep water, to POTAM in moderately deep water, and finally, to SCVA (in addition, perhaps ELPA) on the shoreline. ELPA, EQFL, or GLBO associations may dominate shallow margins of freshwater ponds, whereas TYLA may dominate if poorly oxygenated.

The transition from one association to another may be different from the above. Species may experience zones of intermixing (mosaic) in the transition of sites (water depth) from one association to another. Abrupt changes in water depth may skip associations entirely. For example, abrupt changes such as from NUPO or POTAM associations to fen or bog associations such as CAUT or ERPO2 may occur when there is a steep vertical jump from deep or shallow water to the peat mat overhanging it (such as Fish Lake on the Wenatchee NF). The above discussion refers to ponds and lakes only. Only the ELPA, EQFL, and SPARG associations were found in sluggish streams or overflow channels.

Given that elevation for the AQUATIC series extends from below lower timberline to alpine environments, the climate range associated with the AQUATIC series is extreme. Annual precipitation varies from under 10 inches at low elevation in the dry interior of the study area to well over 100 inches in maritime climate zones along the Cascade crest, and over 40 inches in the weaker inland maritime climate in the Selkirk Mountains of northeastern Washington. In general, ambient air temperature should modify the temperature and other water qualities of the water body supporting the AQUATIC series. However, such generalities need to be interpreted carefully when considering cold air drainage and permanently flooded water tables in sites associated with the AQUATIC series. For instance, low precipitation and high summer temperatures at low elevation may be modified by the inflow of cold water from streams originating at higher elevation. In fact, measured water temperatures appear to be surprisingly similar between plant associations in the AQUATIC series (see the “soils” subsection).

CLASSIFICATION DATABASE

The AQUATIC series includes all stands dominated by what the author considers aquatic vegetation (as listed), and is common throughout eastern Washington. AQUATIC series plots were sampled on all three NFs and all but the Twisp RD (fig. 35). The absence or low plot numbers on some RDs is an artifact of plot distribution, and not actual occurrence, as lakes and ponds are common throughout all three NFs. Plots are somewhat limited, as aquatic classification was not the primary goal of this study. Aquatic sites were sampled only when easily accessible from the shore. Fifty-nine riparian and wetland sampling plots were measured in the AQUATIC series. From this database, six major and two minor aquatic plant associations are recognized. Three potential one-plot associations (ELAC, PUPA, and SELAG) are not used in the database or described in this classification. All samples represent mature, stable aquatic and shoreline communities in good ecological condition.

VEGETATION CHARACTERISTICS

Eleven genera or species are used to define the AQUATIC series and the eight plant associations within it. Therefore, it is difficult to characterize the species composition of the AQUATIC series without considering the associations in some detail:

- The ELPA association is characterized by the dominance of creeping spike-rush. Other common species include water lentil, pondweed species, bladder sedge, inflated sedge, reed mannagrass, and pale false mannagrass.
- The EQFL association is characterized by the dominance of water horsetail. Other species are infrequent but include common water milfoil, Cusick’s sedge, smooth sedge, slender sedge, bladder sedge, and creeping spike-rush.

AQUATIC plant associations

	Scientific name	Common name	Ecoclass code	Plots
Major associations:				
ELPA	*Eleocharis palustris*	Creeping spike-rush	MW4912	8
EQFL	*Equisetum fluviatile*	Water horsetail	WL0111	11
GLBO	*Glyceria borealis*	Northern mannagrass	WL0112	5
NUPO	*Nuphar polysepalum*	Indian water-lily	WL0101	9
SPARG	*Sparganium* spp.	Bur-reed species	WL0113	10
TYLA	*Typha latifolia*	Common cattail	MT8121	9
Minor associations:				
POTAM	*Potamogeton* spp.	Pondweed species	WL0103	4
SCVA	*Scirpus validus*	Softstem bulrush	MT1931	3

- The GLBO association is characterized by the dominance of northern or western mannagrass. Other common plant species include Watson's willow-weed, bur-reed species, common cattail, bladder sedge, and creeping spike-rush.
- The NUPO association is characterized by the dominance of Indian water-lily or cow-lily. Other plant species are infrequent but include Canada waterweed, bur-reed species, and water horsetail.
- The SPARG association is characterized by the dominance of bur-reed species. Other common plant species include water lentil, creeping spike-rush, northern mannagrass, and bladder sedge.
- The TYLA association is characterized by the dominance of common cattail. Other common plant species include water lentil, bladder sedge, and water horsetail.
- The POTAM association is characterized by the dominance of grass-leaved or floating leaf pondweed (occasionally water ladysthumb). Other common plant species include water lentil, Indian water-lily, watercrowfoot buttercup, and northern mannagrass.
- The SCVA association is characterized by the dominance of softstem (occasionally hardstem) bulrush. Other common plant species include Indian water-lily, water ladysthumb, watercrowfoot buttercup, common bladderwort, water sedge, and slender sedge.

PHYSICAL SETTING

Elevation—

The elevations of plots in the AQUATIC series range from 1,850 to 7,350 feet, with the majority being below 5,500 feet. On the Colville NF, the range was 2,240 to 5,100 feet, but there are known unsampled aquatic sites in excess of 6,000 feet as well as below 2,000 feet. The Okanogan NF sample plots ranged from 4,150 to 7,350 feet. There may be few lakes and ponds below 4,000 feet on FS lands, but they are common on other land ownerships at much lower elevation. The Wenatchee NF plots ranged from 1,850 to 6,970 feet but, again, there are sites below 1,800 feet on other ownerships. Therefore, elevation range for the AQUATIC series may be an artifact of sample plot distribution, as plant associations belonging to the AQUATIC series have been observed from elevations below 1,000 feet in the Columbia basin to over 7,000 feet along the crest. Data are limited and should be viewed with caution.

	Elevation (feet)			
Forest	Minimum	Maximum	Average	N
Colville	2,240	5,100	3,227	36
Okanogan	4,150	7,350	5,278	8
Wenatchee	1,850	6,970	3,696	15
Series	1,850	7,350	3,624	59

In addition, elevation differed between the associations. Most associations occur below 5,300 feet, but the GLBO and SPARG associations extend to considerably higher elevations. This perhaps reflects the species' ability to withstand deeply frozen water and submerged soil at these high elevations.

	Elevation (feet)			
Plant association	Minimum	Maximum	Average	N
ELPA	1,850	4,621	3,279	8
EQFL	2,325	5,320	3,694	11
GLBO	3,290	6,970	4,792	5
NUPO	2,550	5,100	3,834	9
POTAM	1,950	4,650	3,051	4
SCVA	2,550	4,150	3,083	3
SPARG	2,500	7,350	4,049	10
TYLA	1,950	4,300	2,950	9
Series	1,850	7,350	3,624	59

Valley Geomorphology—

Plots in the AQUATIC series were located in a limited variety of valley width and gradient classes. Most plots were restricted to wide and gentle valleys. According to plot data, all but 2 of 59 plots were located in valleys more than 99 feet wide, and most of these were located in valleys wider than 330 feet. Almost all these valleys are essentially flat (less than 1 percent valley gradient). Only three plots were in valleys with 1 to 3 percent valley gradient.

	Valley gradient					
Valley width	Very low	Low	Moderate	Steep	Very steep	N
Very broad	22	1	0	0	0	23
Broad	17	1	0	0	0	18
Moderate	15	1	0	0	0	16
Narrow	2	0	0	0	0	2
Very narrow	0	0	0	0	0	0
Series total	56	3	0	0	0	59

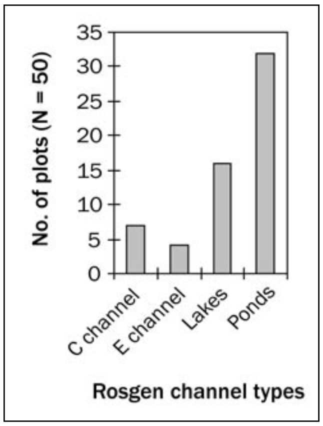
The same pattern is reflected in the plant associations, which are almost totally restricted to very low gradient valleys of moderate to very broad valley widths.

	Valley width					
Plant association	Very broad	Broad	Moderate	Narrow	Very narrow	N
ELPA	1	3	3	1	0	8
EQFL	8	2	1	0	0	11
GLBO	0	2	2	1	0	5
NUPO	5	1	3	0	0	9
POTAM	1	2	1	0	0	4
SCVA	1	2	0	0	0	3
SPARG	3	3	4	0	0	10
TYLA	4	3	2	0	0	9
Series total	23	18	16	2	0	59

Plant association	Valley gradient					N
	Very low	Low	Moderate	Steep	Very steep	
ELPA	7	1	0	0	0	8
EQFL	10	1	0	0	0	11
GLBO	5	0	0	0	0	5
NUPO	9	0	0	0	0	9
POTAM	4	0	0	0	0	4
SCVA	3	0	0	0	0	3
SPARG	9	1	0	0	0	10
TYLA	9	0	0	0	0	9
Series total	56	3	0	0	0	59

Channel Types—

Fifty of 59 plots were in standing water, along the shores of ponds (including beaver ponds), or lakes. The other plots were located in quiet backwaters of Rosgen C or E channels or in tiny pools within wetlands.

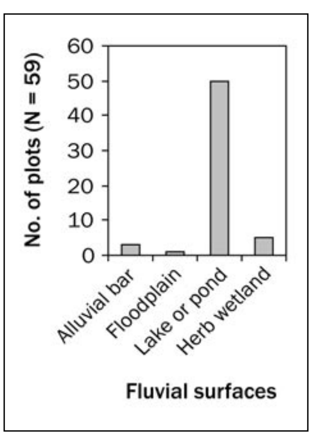


Little additional information is gained by looking at the distribution of plant associations by channel type. GLBO, NUPO, POTAM, SCVA, and TYLA associations are almost always found in lake or pond ecosystems. The other three associations are occasionally found in quiet portions of Rosgen C and E channels or their backwaters.

Plant association	Rosgen channel types				N
	C	E	Lakes	Ponds	
ELPA	1	2	2	3	8
EQFL	3	0	3	5	11
GLBO	1	0	1	3	5
NUPO	0	0	4	5	9
POTAM	0	0	1	3	4
SCVA	0	0	1	2	3
SPARG	1	2	2	5	10
TYLA	1	0	2	6	9
Series total	7	4	16	32	59

Fluvial Surfaces—

In contrast to other series, the AQUATIC series is found on a limited variety of fluvial surfaces. Most were found along the margins of lakes or ponds (50 of 59 plots). The rest were associated with very quiet water in Rosgen C or E channels that were coded alluvial bars and floodplains (for lack of a better code category) or in small, semiponded areas within herb wetlands. These sites are all permanently or semipermanently flooded during the growing season.

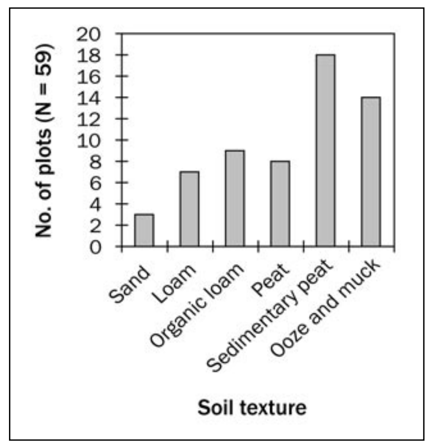


The same fluvial surface pattern holds when looking at the plant associations, all of which are by far most common along the margins of ponds and lakes.

Plant association	Fluvial surfaces				N
	Alluvial bar	Flood-plain	Lake/pond	Herb wetland	
ELPA	2	0	4	2	8
EQFL	1	1	8	1	11
GLBO	0	0	5	0	5
NUPO	0	0	9	0	9
POTAM	0	0	4	0	4
SCVA	0	0	3	0	3
SPARG	0	0	9	1	10
TYLA	0	0	8	1	9
Series total	3	1	50	5	59

Soils—

Soils are variable. Thirty-two of 59 plots were coded as sedimentary peat, ooze, or muck. Loam, organic loam, and peat soils were also common. In general, sedimentary peat, ooze, and mucks are more common in deeper water. Peat, organic loam, and mineral soils are more prominent in streams, shallowly ponded water, or along shores.



Additional insight is gained by looking at individual plant associations. All associations usually are found growing on organic soils. The GLBO, NUPO, POTAM, and SPARG associations are mostly found growing on sedimentary soils, on the margins of ponds, and lakes. ELPA pots were evenly split between loam and organic soils.

Plant association	Soil texture						N
	Sand	Loam	Organic loam	Peat	Sedimentary peat	Ooze/muck	
ELPA	0	4	1	0	1	2	8
EQFL	1	0	4	2	2	2	11
GLBO	1	0	0	0	3	1	5
NUPO	0	0	0	2	5	2	9
POTAM	0	1	1	0	2	0	4
SCVA	0	0	1	2	0	0	3
SPARG	1	1	1	1	4	2	10
TYLA	0	1	1	1	1	5	9
Series total	3	7	9	8	18	14	59

Water depths for the associations ranged from several feet for NUPO and POTAM associations to 1 or 2 feet for SCVA and TYLA associations. ELPA, EQFL, GLBO, and SPARG associations are found in shallowly ponded water. The depths summarized in the tables are somewhat misleading. Aquatic plots were taken only from the shore, off logs, or when accessible with hip boots. The depths of NUPO, POTAM, and to lesser extent the other associations, would have been deeper if AQUATIC series vegetation had been sampled from a boat.

	Water table (inches)			
Plant association	Minimum	Maximum	Average	N
NUPO	8	28	19	9
SPARG	8	39	15	10
ELPA	6	20	13	7
POTAM	6	17	11	4
EQFL	0	22	9	10
GLBO	2	28	9	5
SCVA	0	16	8	3
TYLA	-6	16	5	9
Series	-6	39	12	56

Surface flooding ranged from 51 to 100 percent and averaged 83 percent for the series as a whole. The NUPO and POTAM associations were 100 percent flooded on all plots. Late-season periods of bare soil occurred on some plots in the TYLA, EQFL, SPARG, ELPA, SCVA, and GLBO associations. The percentage of flooding is much higher compared with the other wet series such as SALIX, ALIN, and MEADOW.

	Submerged (percent)			
Plant association	Minimum	Maximum	Average	N
POTAM	100	100	100	4
NUPO	100	100	100	9
GLBO	70	100	94	5
SCVA	80	100	93	3
ELPA	0	100	87	8
SPARG	0	100	83	10
EQFL	0	100	78	11
TYLA	0	100	51	9
Series	0	100	83	59

Daytime water temperatures ranged from 43 to 72 degrees Fahrenheit and averaged 56 degrees Fahrenheit. The reasons for differences in water temperature between the associations are not clear. It makes sense that the shallowly flooded shoreline in TYLA and SCVA associations are among the warmest sites. However, it seems the POTAM association should have had cooler water because of its greater water depth. Also it seems that temperatures for the SPARG association should be more similar to GLBO. Perhaps temperature is one of the key controlling factors for the distribution of some of the associations. Bur-reed species do better where water temperatures are relatively warm in comparison with the GLBO association. The water temperature for the AQUATIC series appears to be generally high (warm) compared with soil temperatures for other series. Plots were few so the data should be considered with caution. The temperatures were taken at a 5-inch depth in the water and varied depending on whether the temperature was taken in the cool morning or warm afternoon.

	Water temperature (°F)			
Plant association	Minimum	Maximum	Average	N
TYLA	43	68	58	9
POTAM	47	65	57	3
SCVA	56	60	57	3
SPARG	52	72	57	6
ELPA	44	67	56	7
NUPO	43	65	56	7
EQFL	45	64	54	9
GLBO	47	67	54	5
Series	43	72	56	49

ECOSYSTEM MANAGEMENT

Natural Regeneration of AQUATIC Series Plants—

The AQUATIC series indicator species regenerate by a variety of sexual and vegetative strategies. Indian water-lily, cow-lily, pondweed species, water ladysthumb, bur-weed species, mannagrass species, and water horsetail all reproduce by rhizomes and seed. Conditions for the production of horsetails from spores are rare, and they reproduce primarily by vegetative means (Duckett and Duckett 1980, Marshall 1984). The majority of shoots grow from rhizomes, which may outweigh aerial shoots by a ratio of 100:1 (Achuff 1989, Correll 1956, Crouch 1985). Creeping spike-rush regenerates primarily from rhizomes (Routledge 1987) but, like softstem and hardstem bulrushes, the hard achenes and seed are almost always stored in the seed bank. They germinate under suitable conditions associated with moist mud or shallow standing water. Colonized areas are not conducive to seedling establishment owing to the dense sod of spike-rush stands. Softstem and hardstem bulrush also reproduce from seed and rhizomes (Fernald 1950, Godfrey and Wooten 1979). The hard seeds can remain viable in the seed bank for as long as 20 years (Harris and Marshall 1963, Wienhold and van der Valk 1989). Colonized areas are not conducive to seedling establishment. Seed likely germinates best in shallow water or on exposed, moist, vegetation-free soil. Once established, maintenance and spread of bulrush stands is through rhizome expansion.

Common cattail reproduces vegetatively by extension of the rhizome system, which is largely responsible for the maintenance and expansion of existing stands. Each spike of cattail may produce over 117,000 minute seeds (Yeo 1964). At maturity, the spikes burst under dry conditions, and bristly hairs aid seed dispersal. When the seed is released, it is capable of immediate germination but requires moist or wet substrates, warm temperatures, low oxygen concentrations, and long days for germination to occur (Bonnewell et al. 1983, Sifton 1959). The seed may overwinter in northern latitudes on account of temperature limitations (McNaughton 1966). Germination requirements are best met in shallow water or on moist mud flats in vegetation-free areas. Once established, a single seedling may spread rapidly and cover an area of 624 square feet in 2 years (Grace and Wetzel 1981, Yeo 1964). Seedling establishment is essentially nonexistent within dense cattail stands, as the dense vegetation cover reduces light and temperatures for germination (Grace and Harrison 1986, McNaughton 1968).

Artificial Establishment of AQUATIC Series Plants—

As described above, almost all the aquatic indicators reproduce vigorously from either rhizomes or seeds. Live rooted plants, plugs, or segments of rhizomes can be used to rapidly establish any of these plants on appropriate sites. The seed of bulrush and spike-rush is stored for many years in soil seed banks making it readily available for quick germination and establishment on newly disturbed sites. Plants will then spread from rhizomes. (For more information on the short- and long-term revegetation potential of selected riparian wetland plant species, see app. B-5.)

Stand Management—

All sampled stands were in fair or better ecological condition. Where sites have been highly altered, management should consider restoring aquatic vegetation for its excellent wildlife, fisheries, and shoreline stability values. Bare shores can be planted with live plants, plugs, or rhizomes; or seeded and protected from the factor that caused the aquatic vegetation to be eliminated from the site. However, seed banks usually contain sufficient seed to regenerate disturbed sites.

Excessively dense stands of common cattail or softstem bulrush may be undesirable on waters managed for ducks. On sites where water levels are stable, management-initiated reduction of cattail cover may be difficult (Beule 1979, Martin et al. 1957). Where water levels can be controlled, drawdown followed by burning and rapid reflooding may kill cattail if the regrowth is kept completely submerged. Conversely, cattail cover may decrease dramatically when water levels rise in internally drained lakes and ponds during wet climate cycles.

Growth and Yield—

No forage or growth estimates were taken during this study. However, potential biomass production for the SCVA and TYLA associations is high, whereas the other associations are moderate (Hansen et al. 1995). The total biomass of common cattail stands may reach 15 tons per acre. (For more information on potential biomass production, see app. B-5.)

Down Wood—

The overall cover of wood is very low compared with other series (app. C-3). Logs cover only 1 percent of the water surface (or ground in the case of associations that are occasionally not flooded during late summer). However, these logs protect the shoreline from wave action, facilitate shoreline development in eddies behind logs, serve as detritus source, and provide important cover and habitat for aquatic animals. It is important to note that the source of down wood is mostly offsite, except where beaver develop ponds and kill nearby trees.

	Down log attributes				
Log condition	Tons/ acre	Cu. ft./ acre	Linear ft./ acre	Sq. ft./ acre	% ground cover
Class 1	0.33	35	92	57	0.1
Class 2	.26	34	113	64	.1
Class 3	.23	42	98	64	.1
Class 4	.12	37	55	50	.1
Class 5	.94	148	358	235	.5
Total	1.88	296	716	470	1.1

Fire—

The AQUATIC series is almost always growing on permanently flooded or temporarily flooded soils, so the heat of fire cannot harm them. However, fire is not out of the realm of possibility on shoreline and shallow water associations such as SCVA, TYLA, ELPA, and GLBO. On flooded sites and on sites with exposed but saturated soils, fire consumes the aboveground biomass. Underground rhizomes usually remain undamaged and plants survive (Gorenzel et al. 1981, Smith and Kadlec 1985). Plants quickly resprout following a summer or fall fire, when growth is reinitiated in spring. The aboveground standing crop of creeping spike-rush may be nearly double following fire compared with unburned stands (Young 1986). Winter burning of common cattail is an efficient method to remove accumulated litter and thin stands (Ball 1984). When soils do become dry, owing to drought or wetland drainage, fires may burn into the organic soils and kill the plants (Smith 1942).

Animals—

Livestock. Permanent to seasonally flooded conditions and saturated soils, as well as the low palatability of aquatic vegetation, limit the grazing value of the AQUATIC series for livestock (Hansen et al. 1995). In drought years, shoreline and shallow water associations such as GLBO, TYLA, ELPA, and SCVA may be used more heavily (in fall) because availability and palatability of upland forage is limited. Point source trampling by livestock gaining access to water is a problem in some grazing allotments. Northern mannagrass is rated as highly palatable for livestock, but GLBO sites usually are flooded and use is low. Horsetails ingested in large quantities can cause scours, paralysis, and death in horses. Cattle, sheep, and goats are rarely affected by ingesting horsetail (Hansen et al. 1995). (For more information on forage palatability, see app. B-1. For potential biomass production, see app. B-5.)

Wildlife. Water horsetail is seldom grazed by wildlife owing to its low palatability. Elk, moose, and deer make moderate use of all species of mannagrass (Hansen et al. 1995). White-tailed deer may use the TYLA and SCVA associations for forage and hiding cover. Moose are especially fond of aquatic habitat and eat Indian water-lily, cow-lily, pondweeds, water ladysthumb, bur-reed species, mannagrass species, and many other kinds of vegetation found on these associations. Horsetail species are an important part of the spring diet of black bears in interior Alaska (Kuchler 1964), and common horsetail is a spring food of grizzly bears in Yellowstone National Park (Gleason and Cronquist 1991). Water horsetail may provide the same benefits in eastern Washington. Common cattail along with softstem and hardstem bulrush are staple foods for muskrat. Muskrats use the stems for hiding cover and construction of their dens. Many associations in the AQUATIC series are found in beaver ponds or on edges of lakes supporting beaver populations. The variety of herbs associated with the AQUATIC series, as well as the shrubs and herbs in the adjacent carrs and fens, provide a variety of forage and dam-building materials for beaver. Although willow species and quaking aspen are often thought of as primarily beaver forage, other aquatic vegetation was observed being used. Beaver extensively used the roots, rhizomes, and foliage of common cattail, softstem or hardstem bulrush, Indian water-lily, and sedges.

Broad zones of AQUATIC associations provide valuable nesting and feeding areas for waterfowl (Hansen et al. 1995). The seeds of spike-rush and bulrush are eaten by a variety of birds. Creeping spike-rush foliage provides valuable hiding and nesting cover for waterfowl. Waterfowl use the EQFL association for nesting and hiding cover. Mannagrass seeds provide good forage for ducks and many other species of birds. Water lentil, a floating plant found on many of these associations, is an important food for many waterfowl species (Parish et al. 1996). TYLA and SCVA associations provide valuable nesting and roosting cover for a variety of songbirds, most notably red-winged and yellow-headed blackbirds. The structure and density of TYLA associations affect their usefulness for nesting and hiding cover for waterfowl (Kantrud 1990, Murkin et al. 1982). In general, ducks rarely nest in dense extensive stands of common cattail but are attracted to wetlands where open water and cattail are intermixed in roughly equal portions. Ruddy and redhead ducks will nest under these open stand conditions (Beule 1979, Conway 1949). (For more information on thermal or feeding cover values, see apps. B-2 and B-3. For information on food values or degree of use, see apps. B-2 and B-4.)

Fish. The AQUATIC series provides valuable spawning areas, feeding areas, and hiding cover for many species of fish (Hansen et al. 1995). (For more information, see app. B-5, erosion control potential.)

Recreation—

Aquatic associations provide valuable bird watching, fishing, and waterfowl hunting opportunities. Humans trample shoreline vegetation near campgrounds or while fishing.

Estimating Vegetation Potential on Disturbed Sites—

Estimating vegetation potential on disturbed sites is usually unnecessary on FS lands because these sites usually are minimally impacted by human uses owing to the flooded nature of the sites. Usually, plenty of native vegetation is present to aid identification of the AQUATIC series and plant associations. For the rare stand where the vegetation is gone, users can use nearby undisturbed stands or personal observations from similar sites to help estimate site potential.

Sensitive Species—

Sensitive species were not found on AQUATIC series plots (app. D).

ADJACENT SERIES

The AQUATIC series usually grades into bogs, and wetlands in the SALIX, MEADOW, or ALIN series.

RELATIONSHIPS TO OTHER CLASSIFICATIONS

Kovalchik (1992c) described many of the plant associations in the AQUATIC series in the draft classification for northeastern Washington. Several authors have described similar AQUATIC associations in eastern Washington, central and eastern Oregon, and Montana (Crowe and Clausnitzer 1997, Hansen et al. 1995, Kovalchik 1987, Kovalchik 1992c). These include the ELPA association of central Oregon; ELPA and TYLA associations of northeastern Oregon; and EQFL, POAM2, TYLA, ELPA, and GLBO habitat types of Montana.

U.S. DEPARTMENT OF THE INTERIOR, FISH AND WILDLIFE SERVICE WETLANDS CLASSIFICATION

Owing to its variability, the classification will vary according to flood regime. It is possible for individual associations to fit into different wetland classification types depending on the size of the water body and its flood regime. The TYLA, SPARG, ELPA, EQFL, GLBO, and SCVA associations usually belong to the system palustrine; class, emergent wetland; subclass, persistent; water regime (nontidal), semipermanently to permanently flooded. The NUPO and POTAM associations usually belong to the system lacustrine; class, floating; subclass, persistent; water regime, (nontidal) permanently flooded.

KEY TO THE AQUATIC PLANT ASSOCIATIONS

1. Indian water-lily (*Nuphar polysepalum*), and/or cow-lily (*Nuphar variegatum*) ≥25 percent canopy coverage or dominant .... **Indian water-lily (NUPO) association**
2. Pondweeds (*Potamogeton* species), and/or water ladysthumb (*Polygonum amphibium*) ≥25 percent canopy coverage or dominant .... **Pondweed (POTAM) association**
3. Softstem bulrush (*Scirpus validus*), and/or hardstem bulrush (*Scirpus acutus*) ≥25 percent canopy coverage or dominant .... **Softstem bulrush (SCVA) association**
4. Bur-reed species (*Sparganium* species) ≥25 percent canopy coverage or dominant .... **Bur-reed (SPARG) association**
5. Northern mannagrass (*Glyceria borealis*), and/or western mannagrass (*Glyceria occidentalis*) ≥25 percent canopy coverage or dominant .... **Northern mannagrass (GLBO) association**
6. Water horsetail (*Equisetum fluviatile*) ≥25 percent canopy coverage or dominant .... **Water horsetail (EQFL) association**
7. Common cattail (*Typha latifolia*) ≥25 percent canopy coverage or dominant .... **Common cattail (TYLA) association**
8. Creeping spike-rush (*Eleocharis palustris*) ≥25 percent canopy coverage or dominant .... **Creeping spike-rush (ELPA) association**

Table 23—Constancy and mean cover of important plant species in the AQUATIC plant associations

Species	Code	ELPA 8 plots		EQFL 11 plots		GLBO 5 plots		NUPO 9 plots		POTAM 4 plots		SCVA 3 plots		SPARG 10 plots		TYLA 9 plots	
		CON[a]	COV[b]	CON	COV	CON	COV	CON	COV	CON	COV	CON	COV	CON	COV	CON	COV
Perennial forbs:																	
nodding beggars-tick	BICE	—	—	—	—	20	2	11	Tr[c]	—	—	—	—	10	10	11	Tr
western water-hemlock	CIDO	38	2	9	1	20	Tr	—	—	25	Tr	—	—	20	8	—	—
Canada waterweed	ELCA3	—	—	—	—	20	3	11	45	—	—	—	—	10	10	—	—
waterweed species	ELODE	—	—	—	—	—	—	—	—	25	65	—	—	—	—	—	—
Watson's willow-weed	EPWA	—	—	—	—	40	1	—	—	—	—	—	—	—	—	11	10
water lentil	LEMI	50	10	—	—	20	5	11	Tr	50	Tr	—	—	30	13	33	44
skunk-cabbage	LYAM	13	5	—	—	—	—	—	—	—	—	—	—	—	—	—	—
common monkey-flower	MIGUG	13	2	—	—	—	—	—	—	—	—	—	—	—	—	11	5
common water-milfoil	MYSBE	—	—	9	40	—	—	11	3	—	—	—	—	—	—	11	5
Indian water-lily	NUPO	13	Tr	—	—	—	—	89	32	50	15	33	Tr	—	—	—	—
cow-lily	NUVA	—	—	9	Tr	—	—	11	30	—	—	—	—	—	—	11	3
water ladysthumb	POAM2	—	—	—	—	—	—	—	—	—	—	67	3	—	—	—	—
grass-leaved pondweed	POGR3	13	Tr	—	—	—	—	—	—	25	75	—	—	—	—	—	—
floatingleaf pondweed	PONA2	13	20	9	Tr	—	—	11	1	75	47	—	—	—	—	—	—
watercrowfoot buttercup	RAAQ	25	39	—	—	—	—	—	—	50	8	—	—	—	—	—	—
lesser spearwort	RAFL	—	—	—	—	—	—	—	—	25	5	—	—	—	—	11	2
small yellow water-buttercup	RAGM	13	1	—	—	20	3	—	—	—	—	—	—	10	5	—	—
Suksdorf's buttercup	RASU	—	—	—	—	—	—	—	—	—	—	—	—	—	—	11	10
skullcap species	SCUTE	—	—	9	5	—	—	—	—	—	—	—	—	—	—	11	Tr
simplestem bur-reed	SPEM	25	1	9	Tr	40	1	11	5	25	10	—	—	50	34	11	1
small bur-reed	SPMI	13	1	9	Tr	20	2	22	7	—	—	—	—	50	48	11	Tr
bur-reed species	SPARG	13	Tr	—	—	—	—	11	5	—	—	—	—	10	70	—	—
common cattail	TYLA	38	2	18	3	20	15	22	4	25	Tr	—	—	10	2	100	72
lesser bladderwort	UTMI	—	—	—	—	—	—	—	—	—	—	—	—	10	5	—	—
bladderwort species	UTRIC	—	—	—	—	20	5	—	—	—	—	—	—	—	—	—	—
common bladderwort	UTVU	—	—	—	—	—	—	22	4	—	—	67	2	—	—	—	—
water pimpernel	VEAN	13	1	—	—	—	—	—	—	—	—	—	—	10	35	—	—
Grasses or grasslike:																	
water sedge	CAAQA	13	Tr	—	—	—	—	—	—	—	—	67	26	—	—	—	—
awned sedge	CAAT2	13	5	—	—	—	—	—	—	—	—	—	—	—	—	11	5
Cusick's sedge	CACU2	13	3	9	20	—	—	11	Tr	—	—	33	Tr	—	—	22	6
smooth sedge	CALA	—	—	9	15	—	—	—	—	—	—	—	—	—	—	—	—
slender sedge	CALA4	—	—	18	7	—	—	11	2	—	—	67	3	10	Tr	22	3
bladder sedge	CAUT	38	15	73	1	40	9	33	1	25	3	33	Tr	40	5	67	11
inflated sedge	CAVE	50	16	18	3	—	—	—	—	—	—	—	—	—	—	11	1
creeping spike-rush	ELPA	100	28	18	9	40	7	33	2	—	—	—	—	20	10	33	3
northern mannagrass	GLBO	25	4	9	Tr	80	31	33	1	75	5	—	—	20	3	11	2
tall mannagrass	GLEL	—	—	18	Tr	20	5	—	—	—	—	—	—	—	—	22	2
reed mannagrass	GLGR	13	50	—	—	—	—	—	—	—	—	—	—	—	—	—	—
western mannagrass	GLOC	—	—	—	—	20	35	—	—	—	—	—	—	—	—	—	—
pale false mannagrass	PUPAM	25	13	27	1	—	—	—	—	—	—	—	—	—	—	—	—
small-fruited bulrush	SCMI	13	7	9	Tr	—	—	—	—	—	—	—	—	—	—	11	5
softstem bulrush	SCVA	13	2	—	—	—	—	11	3	—	—	100	52	—	—	—	—
Ferns and fern allies:																	
water horsetail	EQFL	13	5	100	44	—	—	56	3	—	—	—	—	10	5	44	4
quilwort species	ISOET	13	Tr	9	5	20	Tr	—	—	—	—	—	—	—	—	—	—

[a] CON = percentage of plots in which the species occurred.

[b] COV = average canopy cover in plots in which the species occurred.

[c] Tr = trace cover, less than 1 percent canopy cover.

MEADOW SERIES

Fens, Meadows, and Bogs N = 260

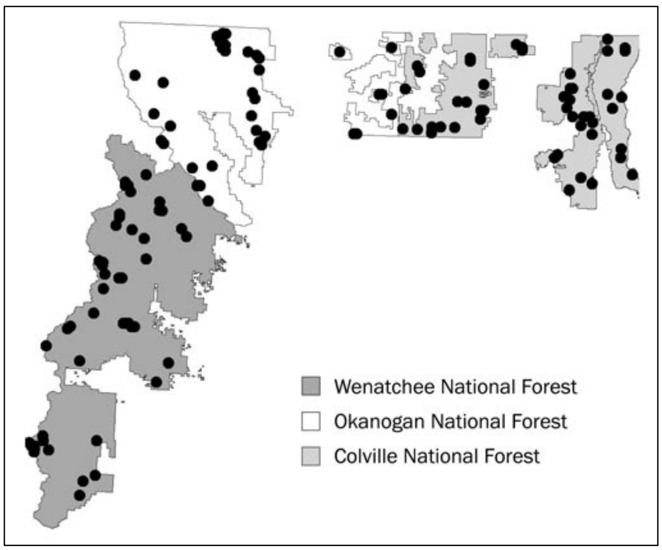


Figure 36—Plot locations for the MEADOW series.

MANY OF THE graminoids used to define the MEADOW[1] series and the numerous MEADOW plant associations are characteristic of northern latitudes. The indicator species occur from Alaska to eastern Canada and south into the United States. Several of the species are circumboreal; others are very widespread and extend well into the southern states. All the cross references to species codes and common and scientific names are located in appendix A, and the general site requirements and distribution for each species are described below (Hitchcock and Cronquist 1973):

- Water sedge grows in shallow water and wet places. It is circumboreal and extends south to California (mainly in and east of the Cascade Range), New Mexico, and New Jersey.
- Sitka sedge (an alternative indicator for the CAAQ association) is found in shallow water and wet places. It is circumboreal and is found from Alaska to California (mainly in and west of the Cascade Range) and occasionally east to northern Idaho.
- Bluejoint reedgrass grows in wet places and is found from Alaska to Quebec, south to all but the Southeastern United States.
- Slender sedge is found on flat, poorly drained wetlands (poor fens). It is circumboreal and extends south to the Cascade Range of central Oregon (Kovalchik 1987) and east to Pennsylvania. One slender sedge stand is found in the Blue Mountains of northeastern Oregon (Crowe and Clausnitzer 1997).
- Buxbaum's sedge (an alternate indicator of the CALA4 association) is a species of peat bogs and poor fens. It is circumboreal and extends south to central California, Utah, Colorado, and North Carolina.
- Black alpine sedge occurs in moist uplands as well as moist riparian and wetland zones. This high-elevation species is found throughout the mountains of western North America, extending south to California and Colorado.
- Holm's sedge, another high-elevation sedge, occurs in wet meadows and on lakeshores (occasionally moist upland meadows). It is found from southern British Columbia to California and east to western Montana, Wyoming, and Colorado.
- Saw-leaved sedge, a subalpine species, grows in wet fens and swamps. It occurs from southern British Columbia through the Cascade Range and Selkirk Mountains of Washington, east to northwestern Montana, northern and central Idaho, and northeastern Oregon.
- Showy sedge is found near or above the timberline in wet meadows and shallowly flooded water. It is circumboreal, extending south into the Cascade Range of north-central Washington (one population is located in the Selkirk Mountains) and the Rocky Mountains to Nevada, Utah, Colorado, and east in Canada to Labrador.
- Bladder sedge (misnamed beaked sedge in Hitchcock and Cronquist 1973; see Kovalchik 1991a) grows in shallow water and wet places. It is circumboreal and extends south to California, New Mexico, Nebraska, and Delaware.
- Awned sedge (an alternate indicator for the CAUT association) is found in shallow water, wet fens, and meadows. It is circumboreal and extends south to southern Oregon, Colorado, and New York.

[1] See appendix A for a cross reference for all species codes and common and scientific names used in this document.

- Inflated sedge grows in shallow water and wet places. It is circumboreal and extends south to California, New Mexico, Missouri, and Delaware.
- Timber oatgrass grows on a variety of sites, from prairies to alpine meadows. It is found on the dry margins of wetlands in this classification. Its range extends from Alaska to California in the mountains of the Western States, east across Canada to Newfoundland, and is found in northern Michigan.
- Few-flowered spike-rush is a species of bogs and poor fens. It is circumboreal and extends south through Washington to California, New Mexico, Illinois, and New Jersey.
- Many-spiked cotton-grass grows in bogs and poor fens. It is circumboreal and extends south to central Oregon, northern New Mexico, northern Utah, and Idaho.
- Small-fruited bulrush is a species of wet ground. It extends throughout the mountainous regions of the Western United States and Canada, and east to the Atlantic provinces and states.
- Columbia sedge is found on wet ground, especially on lakeshores. It occurs from southern British Columbia to northwestern Oregon, east to Idaho and northwestern Montana.
- Cusick's sedge is a species of wet places. It is found from southern British Columbia to California, east to northwestern Montana, northwestern Wyoming, and central Idaho.
- Sheep sedge grows in wet places, often above timberline. It is found from the Olympic Mountains and Cascade Range of Washington (and adjacent British Columbia), south to the Sierra Mountains of California, and east to Montana and Colorado.
- Lenticular sedge grows in shallow water and wet places. It is widespread in North America.
- Mud sedge grows in bogs and poor fens. It is circumboreal and extends south through Washington to Oregon, California, Nevada, and Utah.
- Poor sedge (an alternate indicator for the CALI association) is found in bogs and poor fens. It is circumboreal and extends south to Washington, northern Idaho, and northeast Utah.
- Beaked sedge (misnamed as bladder sedge in Hitchcock and Cronquist 1973; see Kovalchik 1991a) is found in wet, poor fens and fens. It is circumboreal, but in the Western United States is known from only three locations in northeastern Washington (Kovalchik 1991b) and one population in Glacier National Park. It is widely scattered across the boreal zone in Canada but is common in Eurasia.
- Russet sedge grows in shallow water and wet places and is circumboreal. This high-elevation species extends south to the Cascade Range in north central Washington, Nevada, Utah, and Colorado, and east to Labrador.
- Tufted hairgrass is found from coastal marshes and prairies to alpine ridges. It is limited to the dry margins of moist to wet meadows in this classification. Its range extends from Alaska to Greenland, south to most of the United States and northern Mexico. It is also Eurasian.
- Sheep fescue grows on a variety of sites from prairies to subalpine meadows. It is found on the dry margins of wetlands in this classification. It is found from British Columbia to Newfoundland, Oregon, Utah, Colorado, and Nebraska.
- Tall mannagrass grows in wet meadows and carrs and is widespread in North America.
- Reed mannagrass (an alternative indicator for the GLEL association) is a species of sloughs, meadows, and damp ground. It occurs from Alaska to northwestern Oregon and northern Nevada, east into eastern Canada and the Northeastern United States.
- The dominant species in the POPR community type include Kentucky bluegrass, reed canarygrass, redtop, and Oregon bentgrass. These introduced or increaser grasses are lumped together into a single community type (not enough plots) representing a general altered vegetative state. These grasses are not discussed any further in this section. Between them they occur at low to moderate elevations throughout the study area.

Sites dominated by the above graminoids are broadly characterized as fens, poor fens, meadows, and bogs. Each plant association is dominated by different graminoids that make up the 24 associations in the MEADOW series. Graminoid dominance and relative similarities between sites are the basis for this grouping.

Climate, elevation, and hydrologic conditions (such as presence of water and its chemistry) are important factors in the distribution of these graminoids and their plant associations. Given the range of sites associated with the graminoids, the MEADOW series is extremely diverse. Annual precipitation varies from under 10 inches at low elevation in the continental climate associated with the dry interior of the study area to well over 80 inches in maritime climate along the Cascade crest to over 20 inches in the weaker inland maritime climate in the Selkirk Mountains of northeastern Washington. Such generalities need to be interpreted carefully when considering cold air drainage and high water tables associated with the MEADOW series. In general, climate is highly modified by soil water properties such as temperature, aeration, and fertility. The effects of low precipitation and high summer temperatures on sites characteristically at low elevation may be modified by the inflow of cool water from streams originating at higher elevation (or from springs) and cold air drainage. For example, the cool climate and short growing seasons normally associated with the higher elevation associations may extend to lower elevation owing to cold air drainage and cold water seepage.

CLASSIFICATION DATABASE

The MEADOW series includes almost all riparian and wetland plant associations dominated by moist-to-wet site members of the Cyperaceae and Gramineae families (sedge, bulrush, spike-rush, cotton-grass, grasses). SCVA and ELPA are the only graminoid-dominated plant associations not included in the MEADOW series (see the AQUATIC series). The MEADOW series was sampled on all NFs and RDs (fig. 36). The somewhat poor distribution and low number of plots in some areas is probably an artifact of the sampling process. For instance, difficult access limited the number of samples in wilderness areas and lands administered by the Okanogan NF found west of the Cascade crest. As an example, the CASA2 association (only four plots) is probably common in the inaccessible high-elevation areas west of the Okanogan Cascade crest. There were 252 riparian and wetland plots sampled in the MEADOW series. Four plots from other ecology sampling projects were included to augment species composition, distribution, and elevation for the MEADOW series. From this database, 13 major and 11 minor (fewer than five plots, except for the POPR community type) plant associations are described. Four potential, one-plot associations (CAAM, CALU, CARE, and CAMU2) are not used in the database or described in this classification. With the exception of the POPR community type, information presented in the MEADOW series represents mature, stable communities in good ecological condition.

VEGETATION CHARACTERISTICS

Climate, water table depth, water chemistry, duration of surface water, and water aeration all play important roles in the occurrence of individual plant species and plant associations. Most of the associations within the MEADOW series are classic fens and meadows with nutrient-rich, well-aerated soil and water. Elevation, precipitation, growing season, soil and water characteristics, and climate strongly influence the species dominating these fens and meadows. For example, the CAUT, CALA4, CAAQ, and CAVE associations usually are found at low to moderately high elevations, whereas CANI2, CASCB, and CASP associations are characteristic of high elevations. Other sites are representative of bogs and poor fens. For example, CALA4 is a poor fen that is intermediate in soil and water characteristics between true bogs and fens. ELPA2, ERPO2, and CALI are characteristic of nutrient-poor, poorly aerated bogs. Meadows are generally found on moist to wet, well-aerated mineral soils. However, these meadows usually are drier in comparison to fens and bogs. Examples are the higher elevation DAIN and FEOVR associations located on well-drained mineral soils that are in the zone transitional from wetlands to upland. The CACA association dominates similar sites at lower elevations.

MEADOW plant associations

	Scientific name	Common name	Ecoclass code	Plots
Major associations:				
CAAQA	*Carex aquatilis*	Water sedge	MM2914	11
CACA	*Calamagrostis canadensis*	Bluejoint reedgrass	GM4111	12
CALA4	*Carex lasiocarpa*	Slender sedge	MM2920	11
CANI2	*Carex nigricans*	Black alpine sedge	MS2111	30
CASCB	*Carex scopulorum* var. *bracteosa*	Holm's sedge	MS3111	17
CASCP2	*Carex scopulorum* var. *prionophylla*	Saw-leaved sedge	MS3114	18
CASP	*Carex spectabilis*	Showy sedge	MS3115	11
CAUT	*Carex utriculata*	Bladder sedge	MM2917	55
CAVE	*Carex vesicaria*	Inflated sedge	MW1923	10
DAIN	*Danthonia intermedia*	Timber oatgrass	MD1111	5
ELPA2	*Eleocharis pauciflora*	Few-flowered spike-rush	MW4911	13
ERPO2	*Eriophorum polystachion*	Many-spiked cotton-grass	MW1114	19
SCMI	*Scirpus microcarpus*	Small-fruited bulrush	MM2924	6
Minor associations:				
CAAP3	*Carex aperta*	Columbia sedge	MW1111	2
CACU2-WA	*Carex cusickii*	Cusick's sedge	MW1112	4
CAIL	*Carex illota*	Sheep sedge	MS3112	3
CALE5	*Carex lenticularis*	Lenticular sedge	MW2919	3
CALI	*Carex limosa*	Mud sedge	MW1113	4
CARO2	*Carex rostrata*	Beaked sedge	MW1924	3
CASA2	*Carex saxatilis*	Russet sedge	MS3113	4
DECE	*Deschampsia cespitosa*	Tufted hairgrass	MM1912	4
FEOVR	*Festuca ovina*	Sheep fescue	MD43	2
GLEL	*Glyceria elata*	Tall mannagrass	MM2925	4
POPR	*Poa pratensis*	Kentucky bluegrass	MD3111	5

MEADOW series sites in good ecological condition are often dominated by one or two graminoid species. For example, the CAUT association (a fen) is very clearly dominated by bladder sedge and awned sedge, and other species generally have low constancy and cover except where site conditions are transitional to other plant associations. On the other hand, poor soil aeration and low nutrient availability limit the amount of plant cover that can develop on bog sites. Therefore, a relatively large number of bog-tolerant species find their niche and are often common or well represented in the CALI, ERPO2, and ELPA2 associations.

There are 34 species used as indicators to key, name, and characterize the MEADOW series and the 24 MEADOW plant associations. Therefore, it is difficult to describe the MEADOW series as a whole without considering the associations in some detail. The 13 major associations are described below:

- The CACA association is dominated by bluejoint reedgrass. Herbs with high constancy include small bedstraw and largeleaf avens. Fewflower aster, fanleaf cinquefoil, arrowleaf groundsel, Canada goldenrod, Cooley's hedge-nettle, pioneer violet, redtop, and small-fruited bulrush are well represented on some sites.
- The DAIN association is dominated by timber oatgrass. Other shrubs and herbs with high constancy include Farr's willow, red mountain-heath, dwarf huckleberry, umber pussytoes, aster species, fanleaf cinquefoil, bluejoint reedgrass, saw-leaved sedge, and green fescue.
- The ELPA2 association is dominated by few-flowered spike-rush. Other herbs with high constancy include elephanthead pedicularis, ladies-tresses, bluejoint reedgrass, and cotton-grass species. All of these plants, with the exception of bluejoint reedgrass, are indicative of bog conditions.
- The ERPO2 association is dominated by various cotton-grass species. Many-spiked cotton-grass is the usual dominant, but Chamisso cotton-grass or green-keeled cotton-grass dominate some sites. Other herbs with high constancy include elephanthead pedicularis, Holm's sedge, saw-leaved sedge, and bladder sedge.
- The SCMI association is dominated by small-fruited bulrush. Other herbs with high constancy include mountain alder, smooth willow-weed, and lenticular sedge.
- The CAAQ association is dominated by either water sedge or Sitka sedge. Other herbs with high constancy include marsh cinquefoil, bluejoint reedgrass, and bladder sedge.
- The CALA4 association is dominated by slender sedge and Buxbaum's sedge. Other herbs with high constancy include small bedstraw, marsh cinquefoil, and bladder sedge.
- The CANI2 association is dominated by black alpine sedge. Other shrubs and herbs with high constancy include red mountain-heath, dwarf huckleberry, elephanthead pedicularis, and fanleaf cinquefoil.
- The CASCB association is dominated by Holm's sedge. Other shrubs and herbs with high constancy include fanleaf cinquefoil, bluejoint reedgrass, and black alpine sedge.
- The CASCP2 association is dominated by saw-leaved sedge. Other shrubs and herbs with high constancy include red mountain-heath, common bogbean, and bluejoint reedgrass.
- The CASP association is dominated by showy sedge. Other shrubs and herbs with high constancy reflect higher elevations and include red mountain-heath, partridgefoot, and black alpine sedge.
- The CAUT association is dominated by bladder sedge and/or awned sedge. Other herbs have low constancy and are uncommon owing to the wide environmental distribution of the association. Only bluejoint reedgrass has more than 40 percent constancy. Those with 30 to 40 percent constancy include small bedstraw, largeleaf avens, and marsh cinquefoil.
- The CAVE association is dominated by inflated sedge. Other herbs are generally scarce. Those with relatively high constancy include small bedstraw, bladder sedge, and creeping spike-rush.

The 11 minor associations are described below:

- The CAAP3 association is dominated by Columbia sedge. Other herbs are scarce. Those with relatively high constancy include Holm's sedge, creeping spike-rush, and green-keeled cotton-grass.
- The CACU2 association is dominated by Cusick's sedge. Other shrubs and herbs are scarce. Those with relatively high constancy include mountain alder, marsh cinquefoil, gray sedge, bladder sedge, and fowl mannagrass.
- The CAIL association is dominated by sheep sedge. Other shrubs and herbs are scarce. Those with relatively high constancy include tea-leaved willow, twinflower marshmarigold, alpine willow-weed, cleftleaf groundsel, and black alpine sedge.
- The CALE5 association is dominated by lenticular sedge. Other herbs are scarce. Those with relatively high constancy include sheep sedge, saw-leaved sedge, and many-spiked cotton-grass.
- The CALI association is dominated by mud sedge and/or poor sedge. Other shrubs and herbs are scarce. Those

with relatively high constancy include Farr's willow, common bogbean, marsh cinquefoil, scheuchzeria, lesser panicled sedge, bladder sedge, and slender cotton-grass.

- The CARO2 association is dominated by beaked sedge. Other herbs are scarce. Those with relatively high constancy include marsh cinquefoil, slender sedge, and bladder sedge.
- The CASA2 association is dominated by russet sedge. Other shrubs and herbs are scarce. Those with relatively high constancy include Farr's willow, elephanthead pedicularis, cleftleaf groundsel, bluejoint reedgrass, thick-headed sedge, and water horsetail.
- The DECE association is dominated by tufted hairgrass. Other herbs are scarce. Those with relatively high constancy include western yarrow, western aster, Watson willow-weed, broadpetal strawberry, small bedstraw, largeleaf avens, slender-beaked sedge, thick-headed sedge, bladder sedge, and reed canarygrass.
- The FEOVR association is dominated by sheep fescue. A variety of other shrubs and herbs are present on these transitional sites. Those with relatively high constancy include dwarf huckleberry, thick-headed sedge, timber oatgrass, and spike trisetum.
- The GLEL association is dominated by tall mannagrass and/or reed mannagrass. Other shrubs and herbs are scarce. Those with relatively high constancy include mountain alder, fewflower aster, Watson willow-weed, small bedstraw, largeleaf avens, redtop, bladder sedge, creeping spike-rush, small-fruited bulrush, and common horsetail.
- The POPR community type is composed of all sites dominated by introduced or increaser grasses, which include Kentucky bluegrass, reed canarygrass, redtop, or Oregon bentgrass. Other shrubs and herbs are surprisingly scarce on these vegetatively altered sites.

PHYSICAL SETTING

Elevation—

The MEADOW series is capable of occurring at all elevations on NF ownership. On the Colville NF, most plots were between 2,000 and 6,500 feet, but unsampled MEADOW sites are likely in excess of 6,500 feet in the Selkirk Mountains as well as below 2,000 feet on lands of other ownership. The Okanogan and Wenatchee NF plots ranged from 3,800 to 7,650 and 1,940 to 7,530 feet, respectively. Meadow sites have been observed both above and below these elevations, especially on low-elevation sites on lands of other ownership. Therefore, plot elevation ranges are often an artifact of sample plot distribution, with lower elevation limits constrained by NF boundaries and upper elevations constrained by the accessibility of the mountains sampled. In general, the MEADOW series is widespread and occurs from elevations below 1,000 feet in the Columbia basin to well over 7,000 feet along the Cascade crest and over 6,000 feet in the Kettle River Range and Selkirk Mountains.

	Elevation (feet)			
Forest	Minimum	Maximum	Average	N
Colville	1,940	6,520	3,928	90
Okanogan	3,800	7,650	5,963	71
Wenatchee	1,940	4,530	4,864	95
Series	1,940	7,650	4,813	256

Elevation varies considerably between plant associations. Many associations, such as CACA, CAUT, and ELPA2, average less than 5,000 feet in elevation with occasional plots extending into the subalpine, timberline, and alpine zones. Other associations, such as CANI2, CASCB, and CASCP2, are more reflective of high-elevation environments in excess of 5,400 feet. However, some plots in these high-elevation associations may extend to moderate elevations in cold air drainages or extreme maritime areas where the timberline environment is lowered owing to extreme snowpacks and short growing seasons.

	Elevation (feet)			
Plant association	Minimum	Maximum	Average	N
CAIL	5,500	7,100	6,547	3
CANI2	4,130	7,530	6,259	30
CASA2	5,320	7,380	6,258	4
CASCB	3,950	7,350	6,252	17
FEOVR	6,150	6,150	6,150	2
DAIN	4,980	7,050	5,999	5
CAAP3	4,030	7,270	5,650	2
CASCP2	3,975	6,620	5,548	18
CASP	4,600	7,220	5,480	11
ERPO2	3,560	7,350	5,435	19
CARO2	4,637	4,980	4,753	3
ELPA2	2,950	6,060	4,750	13
CALE5	3,200	5,500	4,583	3
DECE	3,150	5,385	4,331	4
CAUT	2,240	7,350	4,132	55
CALA4	2,900	5,600	4,096	11
CACA	2,210	7,650	4,038	12
CAAQ	2,550	5,210	3,855	11
CAVE	2,380	4,621	3,461	10
CALI	1,940	5,100	3,395	4
GLEL	2,210	4,025	3,146	4
CACU2-WA	2,750	3,900	3,125	4
SCMI	2,250	4,000	3,051	6
POPR	1,900	3,800	2,930	5
Series	1,940	7,650	4,813	256

Valley Geomorphology—

The MEADOW series is found in a limited variety of valley width and gradient classes. Most plots are found in broader, lower gradient valleys. Sixty-eight percent of the plots were located in valleys more than 330 feet wide. Ninety-two percent of the plots were located in valleys wider than 99 feet. Eighty-five percent of the plots occurred in valleys with low to very low gradient (0 to 3 percent). Only 38 plots had greater than 3 percent valley gradient and most of these were located in the subalpine or alpine zones. At upper elevations, fens, meadows, and bogs often occurred on steeper gradients where late snowmelt, summer storms, and short growing seasons contribute to and maintain excess soil moisture, even on relatively steep slopes.

	Valley gradient					
Valley width	Very low	Low	Moderate	Steep	Very steep	N
Very broad	66	11	2	1	0	80
Broad	54	23	9	4	1	91
Moderate	32	19	0	1	6	58
Narrow	4	3	0	3	7	17
Very narrow	0	0	1	0	3	4
Series total	156	56	12	9	17	250

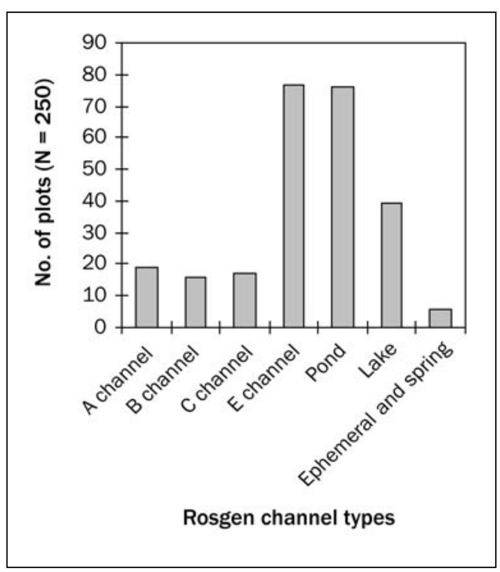
The data for individual associations reflect these assumptions. Only the CASCP2 association is equally distributed across all valley width classes. Between them, the CANI2, CASCB, CASCP2, and CASP associations (all high-elevation fens) represent 29 of the 35 moderate to very steep valley gradient plots. Looking at the overall data, the MEADOW series appears to be uncommon in narrow (less than 99 feet) and steeper (greater than 3 percent) valleys except at high elevations.

	Valley width					
Plant association	Very broad	Broad	Moderate	Narrow	Very narrow	N
CAAP3	0	0	1	0	0	1
CAAQ	7	3	1	0	0	11
CACA	2	6	2	1	0	11
CACU2-WA	0	2	2	0	0	4
CAIL	0	2	0	1	0	3
CALA4	6	4	1	0	0	11
CALE5	1	0	1	1	0	3
CALI	2	1	1	0	0	4
CANI2	6	12	7	3	1	29
CARO2	2	1	0	0	0	3
CASA2	2	0	1	1	0	4
CASCB	2	9	4	1	0	16
CASCP2	5	1	4	5	3	18
CASP	0	7	4	0	0	11
CAUT	23	15	16	0	0	54
CAVE	3	4	3	0	0	10
DAIN	2	1	0	1	0	4
DECE	2	2	0	0	0	4
ELPA2	7	4	0	2	0	13
ERPO2	4	7	7	1	0	19
FEOVR	0	2	0	0	0	2
GLEL	0	3	1	0	0	4
POPR	1	3	1	0	0	5
SCMI	3	2	1	0	0	6
Series total	80	91	58	17	4	250

	Valley gradient					
Plant association	Very low	Low	Moderate	Steep	Very steep	N
CAAP3	1	0	0	0	0	1
CAAQ	10	1	0	0	0	11
CACA	8	3	0	0	0	11
CACU2-WA	2	1	1	0	0	4
CAIL	2	1	0	0	0	3
CALA4	11	0	0	0	0	11
CALE5	3	0	0	0	0	3
CALI	4	0	0	0	0	4
CANI2	10	10	4	2	3	29
CARO2	3	0	0	0	0	3
CASA2	3	0	0	0	1	4
CASCB	9	5	1	0	1	16
CASCP2	4	6	2	4	2	18
CASP	1	0	3	2	5	11
CAUT	47	7	0	0	0	54
CAVE	9	1	0	0	0	10
DAIN	2	1	0	0	1	4
DECE	3	1	0	0	0	4
ELPA2	7	3	1	0	2	13
ERPO2	9	7	0	1	2	19
FEOVR	0	2	0	0	0	2
GLEL	2	2	0	0	0	4
POPR	3	2	0	0	0	5
SCMI	3	3	0	0	0	6
Series total	156	56	12	9	17	250

Channel Types—

Forty-five percent of the plots were located in wetlands adjacent to lakes, ponds, or beaver ponds. Most streams running through MEADOW series sites were Rosgen E channels. Rosgen E channels would have been even more frequent except where ponds and streams were intermixed along a plot; the pond code often took precedence over the stream channel code. Rosgen A, B, and C channels were of secondary importance, with the A and B channels often found in steeper valleys at high elevation. Most C channels were associated with larger low-elevation streams.

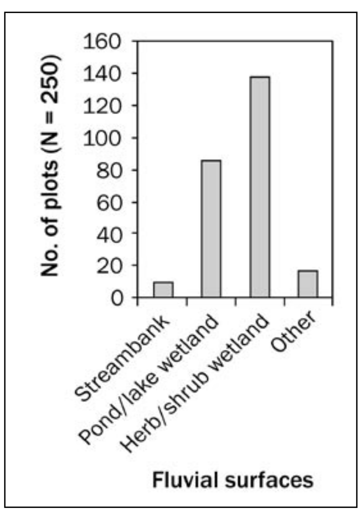


These observations are verified by looking at individual associations. The higher elevation associations (ERPO2, CANI2, CASCB, CASCP2, CASP, etc.) include 71 percent of the 35 A and B channel types. The lower elevation associations (CAVE, CAAQ, CACA, CALA4, CAUT, ELPA2, etc.) include 62 percent of the 209 Rosgen C and E channels, lakes, and ponds (including beaver ponds).

Plant association	Rosgen channel types							N
	A	B	C	E	Pond	Lake	Ephemeral and springs	
CAAP3	0	0	0	0	1	0	0	1
CAAQ	0	0	2	4	3	2	0	11
CACA	0	2	0	1	4	2	2	11
CACU2-WA	0	0	0	2	2	0	0	4
CAIL	0	0	0	0	2	1	0	3
CALA4	0	0	0	2	5	4	0	11
CALE5	0	0	0	1	2	0	0	3
CALI	0	0	0	0	1	3	0	4
CANI2	3	4	1	12	4	5	0	29
CARO2	0	0	0	1	1	1	0	3
CASA2	0	0	0	2	2	0	0	4
CASCB	1	2	1	7	2	3	0	16
CASCP2	2	3	0	7	4	1	1	18
CASP	9	1	0	1	0	0	0	11
CAUT	0	1	2	18	23	9	1	54
CAVE	0	0	2	2	4	2	0	10
DAIN	0	0	0	3	1	0	0	4
DECE	0	1	1	0	0	1	1	4
ELPA2	2	1	0	7	3	0	0	13
ERPO2	2	0	1	4	8	3	1	19
FEOVR	0	0	0	2	0	0	0	2
GLEL	0	1	1	0	2	0	0	4
POPR	0	0	2	1	0	2	0	5
SCMI	0	0	4	0	2	0	0	6
Series total	19	16	17	77	76	39	6	250

Fluvial Surfaces—

In contrast to many other series, the MEADOW series is found on a limited variety of fluvial surfaces. Eighty-eight percent (222 plots) of the sample plots were located in wetlands adjacent to natural lakes and ponds, the margins of beaver ponds, and/or shrub- or herb-dominated wetlands. The remaining 28 plots are associated with streambanks, alluvial bars, flood plains, overflow channels, avalanche chutes, and springs. The common site attributes are (1) the vegetation is dominated by graminoids, (2) the sites have measurably high water tables for much of the growing season, and (3) the sites are too wet for trees and shrubs.

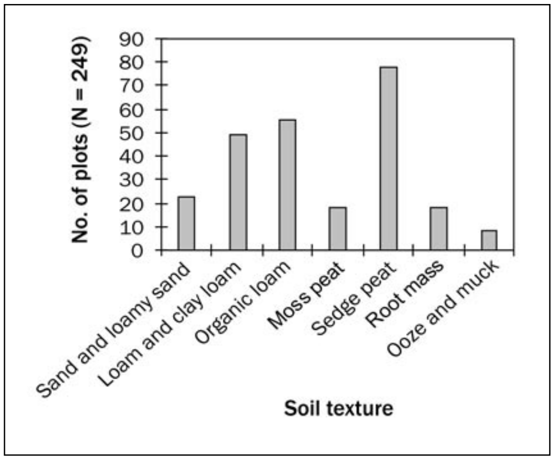


Little additional insight is gained by looking at the distribution of fluvial surfaces by plant association. Most associations are located in wetlands adjacent to ponds or lakes or within herb- or shrub-dominated wetlands. The CASCP2 association is the most prominent association on streambanks. The POPR community type was prominent on alluvial bars (reed canary grass) and toeslopes (Kentucky bluegrass). Fifty percent of the SCMI association occurred on floodplains.

Plant association	Fluvial surfaces				N
	Stream-bank	Pond/lake wetland	Herb/shrub wetland	Other	
CAAP3	0	0	1	0	1
CAAQ	0	4	7	0	11
CACA	0	4	5	2	11
CACU2-WA	0	4	0	0	4
CAIL	0	3	0	0	3
CALA4	0	4	7	0	11
CALE5	0	2	1	0	3
CALI	0	4	0	0	4
CANI2	2	7	19	1	29
CARO2	0	1	2	0	3
CASA2	0	3	1	0	4
CASCB	1	4	10	1	16
CASCP2	5	5	6	2	18
CASP	1	0	9	1	11
CAUT	0	22	30	2	54
CAVE	0	4	6	0	10
DAIN	0	1	3	0	4
DECE	0	1	3	0	4
ELPA2	0	1	11	1	13
ERPO2	1	7	9	2	19
FEOVR	0	0	2	0	2
GLEL	0	1	2	1	4
POPR	0	2	1	2	5
SCMI	0	1	2	3	6
Series total	10	85	137	18	250

Soils—

Soils in the MEADOW series are variable. Seventy-two percent of the plots were coded as organic soils in the rooting zone. Most of these soils had sedge peat or organic loam textures. Forty-four other plots had moss peat, root mass, and ooze or muck soils. Loam and clay loam textures were also common, but some of these may have been organic loam soils as field crews had trouble distinguishing between loam and organic loam textures (greater than 12 percent organic material). The sand and loamy sand soils usually are associated with frequently flooded alluvial bars, floodplains, and streambanks (coarse fragment percentages are high). Loam soils were largely reflective of sites dominated by drier grass or sedge sites such as the CACA, DAIN, FEOVR, CANI2, or CASP associations, where the soils are drier and well aerated by late summer.



Additional insight is gained by looking at the distribution of soil texture by plant association. The wettest associations (CACU2-WA through DECE) occurred primarily on organic soils. The drier associations (CALE5 through CAAP3) usually occurred on mineral soils.

Plant association	Soil texture: Sand and loamy sand	Loam and clay loam	Organic loam	Moss loam	Sedge peat	Root mass	Ooze/muck	N
CACU2-WA	0	0	0	0	0	2	2	4
CARO2	0	0	0	0	1	1	1	3
CASA2	0	1	1	0	2	0	0	4
CALA4	0	0	1	1	6	3	0	11
ELPA2	1	0	1	1	9	1	0	13
ERPO2	0	0	3	6	9	1	0	19
CAAQ	1	0	1	0	7	2	0	11
CAUT	2	4	14	1	22	7	4	54
CASCP2	1	3	6	2	5	0	1	18
CALI	0	0	0	3	0	1	0	4
CAVE	0	3	3	0	4	0	0	10
DECE	0	1	1	0	2	0	0	4
CACA	0	6	5	0	0	0	0	11
CAIL	0	1	1	0	1	0	0	3
GLEL	1	0	2	0	1	0	0	4
CASCB	3	5	3	2	3	0	0	16
CANI2	5	10	9	2	3	0	0	29
CALE5	1	1	1	0	0	0	0	3
CASP	5	4	0	0	1	0	0	10
DAIN	0	2	1	0	1	0	0	4
POPR	1	3	1	0	0	0	0	5
FEOVR	0	2	0	0	0	0	0	2
SCMI	2	2	1	0	1	0	0	6
CAAP3	0	1	0	0	0	0	0	1
Series	23	49	55	18	78	18	8	249

Average water depths for the MEADOW series (at the time of sampling) averaged 4 inches below the soil surface. The measured depths for individual plant associations range from more than 8 inches below the soil surface for the relatively dry GLEL, CANI2, CASCB, CALE5, CASP, DAIN, CACA, DECE, FEOVR, and CAAP3 associations, to at or above the soil surface for the wet CASA2, CAVE, CARO2, CAUT, and CACU2-WA associations. The other listed associations are intermediate in soil moisture as represented by water tables. Most of the wetter MEADOW associations are flooded or have saturated soils for most of the growing season. The soils of the drier associations usually are saturated to partially flooded at snowmelt but become moist but well drained within the rooting zone by midsummer.

Plant association	Water table (inches): Minimum	Maximum	Average	N
CASA2	0	8	4	4
CAVE	-12	18	2	6
CARO2	0	4	2	3
CAUT	-24	22	1	53
CACU2-WA	-2	2	0	4
CALI	-1	0	0	4
SCMI	-8	6	-1	5
CALA4	-15	3	-1	10
ELPA2	-6	1	-2	13
ERPO2	-7	1	-2	16
CAAQ	-31	22	-3	10
CASCP2	-20	0	-5	15
CAIL	-15	-4	-7	3
GLEL	-16	-4	-9	3
CASCB	-28	0	-9	13
CANI2	-59	1	-9	21
CALE5	-15	-8	-11	2
CASP	-33	0	-13	4
DAIN	-16	-12	-13	3
CACA	-31	2	-14	5
POPR	-41	-2	-17	3
DECE	-28	-7	-19	4
FEOVR	-33	-17	-25	2
CAAP3	-31	-31	-31	1
Series	-59	22	-4	207

The average percentage of soil surface flooding (at the time of sampling) shows similar patterns. Although all associations may be partially to totally flooded at snowmelt, the flooding rapidly decreases in the relatively dry GLEL through FEOVR associations, whereas some degree of surface flooding is maintained throughout summer in the CASA2 through ELPA2 associations. The water table and submerged data represent a continuum of sampling throughout the growing season, and the interpretations need to be taken with a degree of caution.

Plant association	Submerged (percent)			N
	Minimum	Maximum	Average	
CASA2	30	100	74	4
CAUT	0	100	54	54
CACU2-WA	12	60	49	4
CARO2	20	90	48	3
CAAQ	0	100	40	11
SCMI	0	100	38	6
CALI	5	65	38	4
CAVE	0	100	36	10
CALA4	0	75	35	11
ERPO2	0	90	24	19
ELPA2	0	65	19	13
CAIL	0	30	10	3
CASCP2	0	75	10	17
CACA	0	55	9	10
CASCB	0	35	8	16
GLEL	0	15	7	3
POPR	0	25	7	5
CANI2	0	40	4	28
CASP	0	20	2	11
DAIN	0	0	0	4
DECE	0	0	0	4
FEOVR	0	0	0	2
Series	0	100	26	242

Although little difference is apparent between many associations, as shown in the following table, average soil temperatures at the time of sampling (degrees Fahrenheit) are high for bog and poor fen associations (ERPO2, ELPA2, and CALA4) as well as for shallowly flooded sites (CACU2-WA and CASA2). The herb cover on these associations is open and allows exposure of the soil surface to direct sunlight heating during the day. These sites are often shallowly flooded well into the growing season, and as water temperatures rise during sunny days, warm water temperatures are conducted into the porous peat soil. Higher elevation associations such as CANI2, CASP, CASCP2, and CASCB usually have dense herb cover (shade), cool mean daily temperatures, and generally have cool soils. However, moderate-elevation associations such as CAUT and CAAQ also have cool soils, perhaps as a result of deeper standing water and dense sedge cover that provides shade. The water volume may function as a heat sink that reacts slowly to solar inputs and diurnal temperature changes, thus modifying soil temperatures compared with less flooded soils.

Plant association	Soil temperature (°F)			N
	Minimum	Maximum	Average	
CASA2	56	70	63	2
CACU2-WA	55	60	58	3
CALI	46	65	57	3
ELPA2	43	67	56	11
CALA4	44	62	54	10
SCMI	47	62	53	5
ERPO2	34	68	53	14
CAVE	40	67	52	8
GLEL	50	54	52	3
CALE5	42	60	51	3
CAAQ	42	57	50	10
CACA	42	58	50	10
CASP	43	67	50	11
CASCP2	40	61	50	15
CASCB	44	62	50	12
DECE	48	51	49	4
CAUT	36	68	48	53
CANI2	38	62	48	22
Series	34	70	52	199

ECOSYSTEM MANAGEMENT

Natural Regeneration of MEADOW Series Plants—

The sedges used as indicator species in this classification are all rhizomatous. In general, long rhizomes produce additional shoots at the rhizome nodes, whereas short rhizomes produce culms in tufts or tillered clumps (Bernard 1990). Therefore, vegetative reproduction is a major source of regeneration of sedges. Pieces of culms or rhizomes can be broken off by ice or bank erosion and transported by water to new locations where they root from the base or rhizome nodes. Seed production rates are variable. About 6 to 9 percent of the shoots of water sedge culms flower each year (Bliss and Grulke 1988), whereas bladder sedge is a prolific seeder (Dittberner and Olson 1983). The resulting abundant seeds are stored in the soil seed bank for many years. In general, disturbed areas are colonized by seedling establishment (from seed or pieces of rhizomes) on dry sites and by rhizome expansion on wetter sites (McKendrick 1987). Occupied, undisturbed areas are not conducive to seedling establishment owing to competition from the dense sedge canopy and rhizomes.

Few-flowered spike-rush reproduces primarily by vegetative expansion from rhizomes. The hard seeds are stored for long periods in the seed bank and can germinate under proper conditions (generally where the herb cover has been reduced by factors such as fire or grazing). Occupied, undisturbed areas are not conducive to seedling establishment.

Cotton-grass species also reproduce by seed and rhizomes. Wind-borne dispersal of seed is aided by the dense tuft of stylar hairs at the base of the achene. The seed may remain viable for hundreds of years and make up a large portion of the seed bank on cotton-grass bogs (Gartner et al. 1983). Seeds germinate on suitable seedbeds such as live mosses and liverworts, dead leaves, or peat after overwintering, and when the soil substrate is exposed to light and warm temperatures. Seedling establishment is best where herb cover has been reduced on disturbed bog sites. Seedling establishment is rare on mature and in well-established bog communities. Growth is dependent on nutrient availability and is most rapid following fire.

Small-fruited bulrush, like many of the other Cyperaceae in this classification, regenerates from seed or by vegetative expansion through rhizome growth. The hard seed can remain viable in the soil for many years. Small-fruited bulrush is considered an increaser on recently deposited alluvium, and seedling establishment is more favorable on disturbed sites compared with more stable areas already colonized by bulrush. Once established, maintenance and spread of the small-fruited bulrush stand is through rhizome expansion.

Mannagrass species reproduce by both rhizome extension and seed. The grass seed is probably stored in the seed bank for several years and is available to colonize disturbed sties first by seed germination and then rhizome extension.

Bluejoint reedgrass produces abundant, wind-borne seed (MacDonald and Lieffers 1991). Seed can remain viable in the soil for up to 5 years (Conn and Farr'sis 1987, Hardy BBT Limited 1989). Bluejoint reedgrass also reproduces vegetatively by rhizomes, and seedlings are capable of producing an extensive network of rhizomes during a single growing season. Small sections of rhizomes with two or more internodes can produce shoots and establish new clones (Powelson and Lieffers 1991).

Tufted hairgrass is a perennial bunchgrass that reproduces solely by seed (Gehring and Linhart 1992). The seed remains viable for several years in the seed bank. Germination is more favorable on disturbed sites compared with colonized sites. However, once a disturbed site becomes dominated by invader species such as Kentucky bluegrass, it is almost impossible for tufted hairgrass to establish on the site (Kovalchik 1987).

Timber oatgrass reproduces by seeds and tillering (Stubbendieck et al. 1986). Seedling establishment is best on exposed mineral soil. It also produces self-fertilized spikelets (cleistogenes) in the axils of the lower leaves (Welsh et al. 1987). This enables the plant to reproduce even if development of the flowering stalk is retarded. Sheep fescue is a perennial bunchgrass that reproduces by seed (Hitchcock and Cronquist 1973). Kentucky bluegrass, reed canarygrass, redtop, and Oregon bentgrass are invader and increaser (last two species) grasses that reproduce both from rhizomes and seed (Hitchcock and Cronquist 1973).

Artificial Establishment of MEADOW Series Plants—

As described in the previous section, almost all the MEADOW series indicator plants reproduce vigorously from rhizomes, the soil seed bank, or freshly dispersed seed. Live rooted plants, plugs, or segments of rhizomes can be used to rapidly establish many of these plants on appropriate fen, poor fen, or bog sites. Direct seeding of native grasses may be more appropriate for drier sites such as the DAIN and FEOVR associations or the drier edges of the CACA and DECE associations. In addition, the soil seed bank may provide for quick germination and establishment on newly disturbed sites. Individual plants will then spread from rhizomes. (For more information on the short- and long-term revegetation potential of selected riparian wetland plant species, see app. B-5.)

Stand Management—

The scattered conifers found on some sites are located on dry microsites such as hummocks or are invading drier transitional sites on the edges of wetlands. These trees have value as components of structural diversity as well as a future supply of snags and logs. Conifer vegetation adjacent to fens, poor fens, meadows, and bogs provide horizontal diversity at a landscape scale as well as contributing to woody debris input to MEADOW series sites.

Where sites have been highly altered, management should consider restoring MEADOW series vegetation for its excellent wildlife, fisheries, and streambank/shoreline stability values. Bare streambanks can be planted with live plants, plugs, and rhizomes or seeded, but the site must be protected from the limiting factor(s) that caused the vegetation to be originally decreased in cover or eliminated from the site. However, there usually are enough seeds in seed banks or rhizomes in nearby vegetation to regenerate disturbed sites.

Down Wood—

The overall amount of down woody debris is low compared with forest series (app. C-3). As trees generally do not grow onsite (except occasional dry microsites), logs cover less than 1 percent of the ground surface. However, these logs are extremely important for their added structural diversity and habitat for wildlife.

	Down log attributes				
Log decomposition	Tons/ acre	Cu. ft./ acre	Linear ft./ acre	Sq. ft./ acre	% ground cover
Class 1	0.05	4	7	5	0
Class 2	.23	25	71	40	.1
Class 3	.55	71	186	112	.3
Class 4	.69	197	267	219	.5
Class 5	0	1	2	1	0
Total	1.52	298	533	377	.9

Fire—

Fens, poor fens, bogs, and wet meadows near timberline or in alpine zones rarely dry out enough to carry fire. Although unusual, many of the low- to moderate-elevation fen associations such as CAUT, CAAQ, and CALA4 will carry fire in the late fall or early spring when the previous culms are dry. Nonuse by livestock in the year preceding the fire is essential (Hansen et al. 1995). These sites usually are flooded or have saturated soils so that the heat of fire cannot harm them, except in severe drought years. Fall or spring fire consumes the aboveground biomass, but underground rhizomes remain undamaged, and plants quickly resprout during the growing season. Fire reduces litter accumulation and temporarily increases productivity. Species composition dominance will not change appreciably from that present before the fire. However, hot fires during periods of extreme drought can burn into the organic soil killing rhizomes and plants.

Associations such as DAIN, DECE, FEOVR, and CACA occur on drier (usually) mineral soils at the edge of wetlands and may be subject to more frequent fire (DeBenedetti and Parsons 1979, Hansen et al. 1995). Bluejoint reedgrass is resistant to all but the most intense ground fire as it quickly resprouts from rhizomes (Lyon and Stickney 1976). In addition, fire tends to reduce the abundance of associated species, dramatically increasing the cover of bluejoint reedgrass and other rhizomatous species (Haeussler and Coates 1986). Sheep fescue and tufted hairgrass have a dense, tufted base that is resistant to damage by low- to-moderate-intensity fire (DeBenedetti and Parsons 1979, Hansen et al. 1995). High-intensity fires do not usually destroy the root crown, but repeated burning could reduce their density and cover in favor of rhizomatous competitors. Timber oatgrass is intermediate in postfire regeneration response, and it takes 5 to 10 years to approximate preburn frequency and cover (Volland and Dell 1981).

Bog sites such as the CALI, ERPO2, and ELPA2 associations are resistant to damage by fire owing to saturated soils and sprouting from rhizomes of cotton-grass species and few-flowered spike-rush (Gartner et al. 1983, Kovalchik 1987). In addition, the biomass of the vegetation on these associations may be too low to carry a surface fire in normal years. Fire during periods of extreme drought may dry the soils enough to allow a deep, smoldering fire that destroys organic soils, rhizomes, and plants. However, such fires will create ideal seedbeds for the establishment of seedlings from the soil seed banks or, in the case of cotton-grass, from light, abundant, wind-borne seed (Gartner et al. 1986). Deeply burning ground fire reduces the accumulation of peat and may change the site potential away from bog species toward short willows and sedges.

Animals—

Biomass production. Forage estimates were not done for this study. However, potential biomass production for the plant associations in the taller, thicker graminoid communities is generally high, whereas production for the bog and shorter grass communities is low to moderate (Hansen et al. 1995, Kovalchik 1987). Total air-dry herbaceous biomass (pounds per acre) in several northeastern Oregon plant associations is shown in the following table (Crowe and Clausnitzer 1997). Stands in eastern Washington may be similar (app. B-5).

	Herbage production (pounds/acre dry weight)	
Plant association	Range	Average
ELPA2	488–900	536
GLEL	366–2,200	1,076
CALE5	833–2,000	1,523
SCMI	500–2,967	1,764
CASCB	733–3,377	2,092
DECE	900–5,066	2,538
CACU2-WA	1,387–4,033	2,563
CAUT	200–8,000	2,753
CAAQ	1,000–5,333	2,786
CACA	1,667–7,533	3,352

Livestock. Livestock use of the MEADOW series is variable depending on the plant association, season of use, previous grazing history, extent of the site, palatability of the herbs, forage production, soil wetness, and length of seasonal flooding (Hansen et al. 1995). On narrow riparian or wetland sites within rangelands, the MEADOW series may be heavily used, particularly when upland plants are overused or where livestock distribution or stocking rate problems occur. On larger fens and meadows, livestock use is usually less severe owing to abundant forage and wet soils. However, use and resultant long-term damage may be high on the drier, accessible fringe in associations such as DAIN, FEOVR, DECE, and CACA. Bogs (CALI, ERPO2, and ELPA2 associations) are especially resistant to livestock use and damage owing to permanently wet soils and the generally low palatability of the herbs.

Livestock forage values are variable and range from poor to good depending on the species (Hansen et al. 1995). Sheep have been reported to graze cotton-grass in Canada (Chapin and Slack 1979, Grant et al. 1987, Wein and MacLean 1973). Associations dominated by more palatable graminoids tend to be grazed earlier in summer if soils are not saturated. Palatability of sedges varies seasonally. Many of the sedges, even coarse sedges such as bladder sedge, provide palatable forage in spring, but use is usually delayed by flooded or wet soil. Some sedges may become tough in summer, but palatability usually increases late in the growing season relative to the uplands, especially after the first frost. At this time, both the availability and palatability of herbaceous forage in uplands is low, and livestock use may turn to the wetland and riparian zones.

In theory, MEADOW series vegetation should respond satisfactorily to more traditional upland grazing systems

(Hansen et al. 1995). Late-season use of less than 40 percent of the aboveground biomass (about a 4-inch stubble height) followed by a period of rest is best (Kovalchik and Elmore 1991). On sites adjacent to streams, residual cover can filter out sediments and protect streambanks during fall rains or spring runoff. Removing cattle from the allotment for at least 30 days during the growing season should provide for sedge regrowth and sufficient residual cover for streambank protection.

Frisina (1991) states that for a grazing system to be successful, it must meet the basic biological requirements of the plants such as photosynthesis, food storage, reproduction, and seedling establishment. To meet these requirements, long periods of rest are needed. It is during long growing-season rest periods that the essential biological processes of food production and storage, reproduction, and seedling establishment take place. In some instances, additional periods of rest may be required to improve or maintain the plant community.

Wet soils may deter animal use until late summer, which allows the graminoids to replenish carbohydrate reserves early in the growing season and persist within these associations (Hansen et al. 1995). Heavy grazing, especially for several seasons in a row, will markedly decrease the vigor and cover of highly palatable species, resulting in an increase in less palatable species such as Baltic rush or increaser grasses and forbs.

Wet mineral soils are very susceptible to compaction. Organic soils can be broken and churned by grazing animals at the wrong season of the year. For both soil types these actions can be very damaging (Hansen et al. 1995). The biomass productivity of these sites may be lowered as the soils are compacted, perhaps on account of lower soil porosity. This makes the sites less favorable for the usual plant dominants. Churned soils also lower biomass productivity through plant damage alone. The recovery from damage depends on the severity of disturbance. The combination of churned and compacted soil, replacement of natural dominants with increaser species and weeds, plus physical damage to the plants can result in long-term damage to the site that can take decades, even centuries to recover to predisturbance conditions. Improper trail location can lead to rutting, often in multiple parallel paths. Cattle can create rutting at water access points or while traveling along the stream or river channel. Ruts from any of these sources may concentrate floodwaters, creating streambank erosion or new channels. (For more information on forage palatability, see app. B-1. For potential biomass production, see app. B-5.)

Wildlife. The hiding and thermal cover value of the MEADOW series is generally poor for elk, deer, and moose unless in mosaic patterns with other series that provide cover such as SALIX and ALIN (app. B-3). Bluejoint reedgrass has been reported to furnish large amounts of forage for big game species and makes up a major portion of the winter diet of elk (Gullion 1964, Kufeld 1973, USDA FS 1937). Elk, deer, and moose may make moderate use of water sedge, inflated sedge, awned sedge, and tufted hairgrass. Slender sedge is seldom grazed by large ungulates on account of its low palatability, although deer have been observed eating its seed heads (Kovalchik 1987). Several members of the forb component of these graminoid-dominated sites may be important to bears (Foote 1983, Knight and Blanchard 1983). Horsetail species are a common component in many MEADOW associations and are an important part of the spring diet of black bears in interior Alaska. Horsetails also are a common spring food of grizzly bears. Bears also are known to eat tufted hairgrass (Hardy BBT Limited 1989). Thistle, white clover, common and water horsetail, American vetch, western yarrow, broadpetal strawberry, sweet-root, and Sitka valerian occur in small quantities in MEADOW plots and are important food sources for grizzly bears in Montana (Hansen et al. 1995).

Beaver play a vital role in the health, maintenance, and structure of riparian ecosystems (Gordon et al. 1992, Hansen et al. 1995). Beaver dams assist in controlling downcutting of channels, bank erosion, and the movement of sediments downstream. When beavers construct a dam, they raise the water table in the surrounding area, which provides water for hydrophilous plants such as willow and sedge. The beaver dam also slows down the water in the channel, which allows suspended sediment to be deposited behind the dam. The combination of sediment deposition plus plant production raises the channel and pond bed, creating a wetland environment that is excellent waterfowl and fish habitat. Water storage provided by beaver dams and surrounding soils benefits the water regime by releasing water during summer low flow periods. Landowners often trap and kill beaver because they are considered a nuisance. However, beaver produce such desirable habitat and beneficial stream functions that their removal from a stream system needs to be closely evaluated. The variety of herbs associated with the MEADOW series as well as the shrubs and herbs in the adjacent carrs and fens provide a variety of forage as well as dam building materials for beaver. Although willows and aspen are generally thought of as primary beaver forage, beaver have been observed to make extensive use of the roots, rhizomes, and foliage of common cattail, small-fruited bulrush, Indian water-lily, sedges, and other AQUATIC and MEADOW vegetation in study plots.

The wettest MEADOW series sites (such as the CALA4, CAUT, and CAVE associations) are flooded long enough to provide important nesting habitat for waterfowl (Kovalchik 1987). Additionally, these and other plant associations are often adjacent to open water where they provide valuable feeding areas for waterfowl. These wet associations may be more important as feeding grounds than nesting grounds owing to the low stature of the plants, lack of structural diversity, and high water levels (Youngblood et al. 1985a). The seeds of the various graminoids provide valuable food for a variety of waterfowl and songbirds. Birds commonly associated with fen habitat include mallard, green-winged teal, common yellowthroat, red-winged blackbird, song sparrow, common snipe, sandhill crane, and tree swallow (Douglas and Ratti 1984). The CAUT association is an important breeding and feeding ground for geese in northern Canada (Vogl 1964). (For more information on thermal or feeding cover values, see apps. B-2 and B-3. For information on food values or degree of use, see apps. B-2 and B-4.)

Fish. The MEADOW series provides valuable spawning areas, feeding areas (insects), and hiding cover for many species of fish. The wettest MEADOW series sites (such as the CASCP2, CASCB, CAUT, and CAAQ associations) are often located adjacent to streams, rivers, lakes, or ponds supporting trout fisheries (Hansen et al. 1995). The rhizomatous growth habit of the graminoids usually provides a dense sod that stabilizes soils and streambanks, and provides overhead cover for fish habitat. (For more information, see app. B-5, erosion control potential.) The sod also may be undercut and sag into the water providing additional excellent cover for fish. The weight of livestock can cause sloughing where the sod is undercut and suspended over the water (Hansen et al. 1995).

Recreation—

The MEADOW series provide valuable bird or big game animal watching, fishing, and waterfowl hunting opportunities. Heavy use by people in spring and summer can result in soil compaction, bank damage, and exposed soils along streambanks. Ruts from any source may concentrate floodwaters, creating streambank erosion or new channels. Improper off-road vehicle use also creates long-term ecosystem damage. Many MEADOW sites have been literally destroyed by inconsiderate off-road vehicle use. Vigorous efforts to discourage off-road travel on MEADOW series sites are appropriate for resource protection of new roads and trails, which should be located in adjacent uplands. The key to natural restoration of MEADOW sites is to change the management factors that led to the deterioration of the site. Eliminating or discouraging use of dispersed campsites or off-road vehicle use will often lead to the reestablishment of native vegetation and ultimately the return of the site to proper functioning condition.

Estimating Vegetation Potential on Disturbed Sites—

Estimating vegetation potential on disturbed sites is not usually necessary on FS lands in eastern Washington because most sites are minimally affected by people on account of wet soils (which discourage livestock and off-road vehicle use) and high productivity (resiliency) of the sites. There is usually sufficient native vegetation to identify the MEADOW series and plant associations. For the rare stand where the potential natural vegetation has been altered to increaser or invader species, users can rely on past experience or look at adjacent drainages to help estimate the potential.

Sensitive Species—

The MEADOW series supports more sensitive plants than all other series combined (app. D). Thirty-one of the 54 individual sensitive plants found were located on the CALA4, CASA2, CAUT, and ELPA2 associations. Sensitive plants also are relatively common on the CACU2, CARO2, CASCP2, DAIN, and ERPO2 associations. Russet sedge and green-keeled cotton-grass are particularly common on the ecology plots and could perhaps be eliminated from the Washington state sensitive plant species list (app. D).

	Sensitive species														
Plant association	pale agoseris	yellow sedge	Smoky Mountain sedge	beaked sedge	russet sedge	western singlespike sedge	bulbed water-hemlock	crested shield-fern	green-keeled cotton-grass	water avens	curved woodrush	marsh muhly	hoary willow	McCalla's willow	N
CAAP3									1						1
CAAQ										1					1
CACU2-WA		1						1							2
CALA4		1		1			1		2						5
CALI									1						1
CAMU2									1						1
CANI2			1												1
CARO2				3											3
CASA2					4				1						5
CASCB					1				1		1				3
CASCP2					1				2						3
CAUT		1			1		1		3	2			2		10
DAIN					1	1			1						3
ELPA2		1			2				5	1		1		1	11
ERPO2					1				2						3
FEOVR	1														1
Series total	1	4	1	4	11	1	2	1	20	4	1	1	2	1	54

ADJACENT SERIES

The numerous plant associations in the MEADOW series occur at all elevations and can be found adjacent to virtually all upland forest series described for eastern Washington NFs (Lillybridge et al. 1995, Williams et al. 1995). The MEADOW series also is bounded by shrub-steppe at lower elevations and alpine meadows, rock, and cliffs above timberline.

RELATIONSHIPS TO OTHER CLASSIFICATIONS

Kovalchik (1992c) described many of the plant associations in the MEADOW series in the draft classification for northeastern Washington. MEADOW associations and community types are described throughout North America. Classifications in and near the study area include those in eastern Washington, northern Idaho, and Montana (Crawford 2003; Hansen et al. 1988, 1995; Kovalchik 1992c); central and northeastern Oregon (Crowe and Clausnitzer 1997, Kovalchik 1987); and Idaho, Utah, and Nevada (Manning and Padgett 1995; Padgett et al. 1989; Youngblood et al. 1985a, 1985b).

U.S. DEPARTMENT OF THE INTERIOR, FISH AND WILDLIFE SERVICE WETLANDS CLASSIFICATION

Owing to its variability, the classification will vary according to the MEADOW plant association and flood regime. It is possible for individual associations to belong to different wetland classification classes, depending on the size of the water body and the flood regime. Most of the wettest associations belong to the system palustrine; class, emergent wetland; subclass, persistent; water regime, (nontidal) temporarily saturated to semipermanently flooded.

KEY TO THE MEADOW PLANT ASSOCIATIONS

1. Aquatic sites on the edges of lakes or ponds or in sluggish streams, usually with standing water for all or much of the growing season, potential vegetation with species such as NUPO, POTAM, POAM2, SCVA, SPARG, GLBO, EQFL, TYLA, ELPA, or PUPAM with combined canopy coverage of at least 25 percent or dominant .... **Go to "Key to the Aquatic Plant Associations"** (p. 238)
2. Potential vegetation dominated by sedge (*Carex* spp.*)* with combined canopy coverage of at least 25 percent or dominant and *Eriophorum* and *Eleocharis* spp. <25 percent .... **"Key to the Sedge Plant Associations"** (below)
3. Sedge species with a combined canopy coverage of <25 percent or not dominant .... **"Key to the Nonsedge Plant Associations"** (below)

Key to the Sedge *(Carex)* Plant Associations

1. Russet sedge (*Carex saxatilis*) ≥25 percent canopy coverage or dominant .... **Russet sedge (CASA2) association**
2. Saw-leaved sedge (*Carex scopulorum* var. *prionophylla*) ≥25 percent canopy coverage or dominant .... **Saw-leaved sedge (CASCP2) association**
3. Holm's sedge (*Carex scopulorum* var. *bracteosa*) ≥25 percent canopy coverage or dominant .... **Holm's sedge (CASCB) association**
4. Showy sedge (*Carex spectabilis*) ≥25 percent canopy coverage or dominant .... **Showy sedge (CASP) association**
5. Sheep sedge (*Carex illota*) ≥25 percent canopy coverage or dominant .... **Sheep sedge (CAIL) association**
6. Black alpine sedge (*Carex nigricans*) ≥25 percent canopy coverage or dominant (plots with hidden, minute, *Ericaceous* shrubs should stay here) .... **Black alpine sedge (CANI2) association**
7. Cusick's sedge (*Carex cusickii)* ≥25 percent canopy coverage or dominant .... **Cusick's sedge (CACU2) association**
8. Beaked sedge (*Carex rostrata*) ≥25 percent canopy coverage or dominant .... **Beaked sedge (CARO2) association**
9. Bladder sedge (*Carex utriculata*) and/or awned sedge (*Carex atherodes*) ≥25 percent canopy coverage or dominant .... **Bladder sedge (CAUT) association**
10. Inflated sedge (*Carex vesicaria*) ≥25 percent canopy coverage or dominant .... **Inflated sedge (CAVE) association**

11. Columbia sedge (*Carex aperta*) ≥25 percent canopy coverage or dominant .... **Columbia sedge (CAAP3) association**
12. Water sedge (*Carex aquatilis* var. *aquatilis*) and/or Sitka sedge (*Carex aquatilis* var. *sitchensis*) ≥25 percent canopy coverage or dominant .... **Water sedge (CAAQ) association**
13. Mud sedge (*Carex limosa*) and/or poor sedge (*Carex paupercula*) ≥25 percent canopy coverage or dominant .... **Mud sedge (CALI) association**
14. Slender sedge (*Carex lasiocarpa*) and/or Buxbaum's sedge (*Carex buxbaumii*) ≥25 percent canopy coverage or dominant .... **Slender sedge (CALA4) association**
15. Lenticular sedge (*Carex lenticularis*) ≥25 percent canopy coverage or dominant .... **Lenticular sedge (CALE5) association**

Key to the Nonsedge Plant Associations

1. Creeping spike-rush (*Eleocharis palustris*) ≥25 percent canopy coverage or dominant .... **Go to the key to the AQUATIC series or creeping spike-rush (ELPA) association**
2. Few-flowered spike-rush (*Eleocharis pauciflora*) ≥25 percent canopy coverage or dominant .... **Few-flowered spike-rush (ELPA2) association**
3. Cotton-grass species (*Eriophorum* spp.), individually or in combination, ≥10 percent canopy coverage .... **Many-spiked cotton-grass (ERPO2) association**
4. Small-fruited bulrush (*Scirpus microcarpus*) ≥25 percent canopy coverage or dominant .... **Small-fruited bulrush (SCMI) association**
5. Tall mannagrass (*Glyceria elata*) and/or reed mannagrass (*G. grandis*) ≥25 percent canopy coverage or dominant .... **Tall mannagrass (GLEL) association**
6. Bluejoint reedgrass (*Calamagrostis canadensis*) ≥25 percent canopy coverage or dominant .... **Bluejoint reedgrass (CACA) association**
7. Tufted hairgrass (*Deschampsia cespitosa*) ≥25 percent canopy coverage or dominant .... **Tufted hairgrass (DECE) association**
8. Timber oatgrass (*Danthonia intermedia*) ≥25 percent canopy coverage or dominant (plots with abundant but hidden, minute, *Ericaceous* shrubs should stay here) .... **Timber oatgrass (DAIN) association**
9. Sheep fescue (*Festuca ovina* var. *rybergii)* ≥25 percent canopy coverage or dominant (plots with abundant but hidden, minute, *Ericaceous* shrubs should stay here) .... **Sheep fescue (FEOVR) association**
10. Introduced or increaser grasses such as Kentucky bluegrass (*Poa pratensis*), reed canarygrass (*Phalaris arundinacea*), redtop (*Agrostis alba*), or Oregon bentgrass (*Agrostis oregonensis*) ≥25 percent canopy coverage or dominant .... **POPR community type**

Table 24—Constancy and mean cover of important plant species in the MEADOW plant associations—Part 1

		CACA 12 plots		DAIN 5 plots		DECE 4 plots		ELPA2 13 plots		ERPO2 19 plots		FEOVR 2 plots	
Species	Code	CON[a]	COV[b]	CON	COV	CON	COV	CON	COV	CON	COV	CON	COV
Tree understory:													
subalpine fir	ABLA2	17	2	40	8	—	—	15	Tr[c]	32	1	—	—
Engelmann spruce	PIEN	17	1	40	4	25	Tr	23	1	32	1	—	—
lodgepole pine	PICO	8	Tr	20	4	25	Tr	23	1	11	3	50	Tr
Shrubs:													
mountain alder	ALIN	25	6	—	—	—	—	—	—	11	3	—	—
red-osier dogwood	COST	25	Tr	—	—	—	—	—	—	—	—	—	—
Low shrubs and subshrubs:													
red mountain-heath	PHEM	8	15	40	5	—	—	—	—	16	1	—	—
Farr's willow	SAFA	—	—	60	7	—	—	31	2	5	Tr	—	—
tea-leaved willow	SAPLM2	—	—	—	—	—	—	8	Tr	5	8	50	15
dwarf huckleberry	VACA	8	20	100	10	—	—	8	Tr	11	Tr	100	25
Perennial forbs:													
western yarrow	ACMI	33	1	20	3	75	2	—	—	—	—	50	1
woolly pussytoes	ANLA	8	2	40	1	—	—	—	—	—	—	50	5
umber pussytoes	ANUM	8	2	60	5	—	—	—	—	—	—	—	—
fewflower aster	ASMO	17	31	—	—	—	—	8	Tr	5	Tr	—	—
western aster	ASOC	17	1	—	—	50	15	—	—	—	—	—	—
aster species	ASTER	25	2	80	2	—	—	15	3	16	3	—	—
twinflower marshmarigold	CABI	17	5	—	—	—	—	31	2	21	3	—	—
alpine willow-weed	EPAL	—	—	20	Tr	25	Tr	8	1	11	Tr	—	—
smooth willow-weed	EPGL	—	—	—	—	—	—	—	—	5	Tr	—	—
Watson's willow-weed	EPWA	8	2	—	—	50	1	—	—	—	—	—	—
peregrine fleabane	ERPE	8	3	20	Tr	25	1	—	—	—	—	—	—
broadpetal strawberry	FRVIP	8	2	—	—	50	1	8	Tr	5	1	50	5
small bedstraw	GATR	42	2	—	—	75	1	8	Tr	—	—	—	—
largeleaf avens	GEMA	50	2	—	—	50	1	—	—	—	—	50	1
partridgefoot	LUPE	—	—	20	Tr	—	—	—	—	—	—	—	—
broadleaf lupine	LULA	—	—	40	Tr	—	—	—	—	—	—	—	—
common bogbean	METR	—	—	—	—	—	—	8	2	11	6	—	—
elephanthead pedicularis	PEGR	17	3	40	1	—	—	62	2	47	2	—	—
fanleaf cinquefoil	POFL2	8	15	80	4	—	—	31	Tr	16	1	50	3
marsh cinquefoil	POPA3	17	5	—	—	—	—	8	3	11	3	—	—
scheuchzeria	SCPA	—	—	—	—	—	—	8	3	—	—	—	—
cleftleaf groundsel	SECY	—	—	20	5	—	—	8	1	11	4	—	—
arrowleaf groundsel	SETR	17	18	—	—	25	Tr	—	—	16	2	—	—
Canada goldenrod	SOCA	8	77	—	—	25	15	8	2	—	—	—	—
ladies-tresses	SPRO	—	—	20	1	—	—	38	Tr	11	Tr	—	—
Cooley's hedge-nettle	STCO4	8	48	—	—	—	—	—	—	—	—	—	—
globeflower	TRLA4	—	—	20	Tr	—	—	8	Tr	11	8	—	—
Sitka valerian	VASI	8	3	20	Tr	—	—	—	—	5	1	—	—
American false hellebore	VEVI	8	8	—	—	—	—	—	—	16	Tr	—	—
thyme-leaved speedwell	VESE	—	—	20	3	50	Tr	—	—	—	—	—	—
Wormskjold's speedwell	VEWO	17	1	20	2	—	—	15	1	11	1	—	—
pioneer violet	VIGL	17	26	—	—	—	—	8	Tr	—	—	—	—
Grasses or grasslike:													
redtop	AGAL	17	20	—	—	—	—	—	—	5	2	—	—
Oregon bentgrass	AGOR	8	1	—	—	—	—	8	5	—	—	—	—
Thurber's bentgrass	AGTH	—	—	—	—	—	—	15	1	21	1	—	—
bluejoint reedgrass	CACA	100	60	60	4	25	Tr	38	1	32	1	—	—
Columbia sedge	CAAP3	8	10	—	—	—	—	—	—	—	—	—	—
water sedge	CAAQA	8	Tr	—	—	—	—	8	5	—	—	—	—
Sitka sedge	CAAQS	8	Tr	—	—	—	—	8	7	5	3	—	—
awned sedge	CAAT2	8	Tr	—	—	—	—	—	—	—	—	—	—
slender-beaked sedge	CAAT	8	1	—	—	75	4	—	—	—	—	—	—
Buxbaum's sedge	CABU2	—	—	—	—	—	—	15	11	5	60	—	—
gray sedge	CACA4	8	3	—	—	—	—	—	—	11	Tr	—	—
Cusick's sedge	CACU2	—	—	—	—	—	—	—	—	—	—	—	—
lesser panicled sedge	CADI2	—	—	—	—	—	—	—	—	5	3	—	—
sheep sedge	CAIL	—	—	20	Tr	—	—	8	Tr	21	4	—	—
slender sedge	CALA4	—	—	—	—	—	—	15	3	—	—	—	—
tufted sedge	CALE5	8	1	20	Tr	25	Tr	23	1	11	Tr	—	—
mud sedge	CALI	—	—	—	—	—	—	23	1	11	6	—	—
black alpine sedge	CANI2	—	—	40	4	—	—	8	Tr	26	7	—	—
thick-headed sedge	CAPA	25	2	40	2	50	4	15	2	—	—	100	6
beaked sedge	CARO2	—	—	—	—	—	—	—	—	—	—	—	—
russet sedge	CASA2	—	—	20	2	—	—	15	9	5	Tr	—	—

Table 24—Constancy and mean cover of important plant species in the MEADOW plant associations—Part 1 (continued)

		CACA 12 plots		DAIN 5 plots		DECE 4 plots		ELPA2 13 plots		ERPO2 19 plots		FEOVR 2 plots	
Species	**Code**	**CON**	**COV**	**CON**	**COV**	**CON**	**COV**	**CON**	**COV**	**CON**	**COV**	**CON**	**COV**
Holm's sedge	CASCB	8	Tr	—	—	25	8	23	5	37	9	—	—
saw-leaved sedge	CASCP2	17	2	60	Tr	—	—	31	10	37	6	50	2
showy sedge	CASP	—	—	20	Tr	—	—	—	—	16	5	—	—
bladder sedge	CAUT	33	3	—	—	50	11	31	5	37	4	—	—
inflated sedge	CAVE	17	2	—	—	—	—	—	—	—	—	—	—
timber oatgrass	DAIN	—	—	100	34	25	Tr	31	2	—	—	100	5
tufted hairgrass	DECE	17	8	—	—	100	54	8	1	—	—	—	—
creeping spike-rush	ELPA	—	—	—	—	—	—	—	—	—	—	—	—
few-flowered spike-rush	ELPA2	—	—	—	—	—	—	100	55	47	7	—	—
Chamisso cotton-grass	ERCH2	—	—	—	—	—	—	—	—	5	40	—	—
slender cotton-grass	ERGR8	—	—	—	—	—	—	—	—	—	—	—	—
many-spiked cotton-grass	ERPO2	8	Tr	—	—	—	—	46	8	84	33	—	—
green-keeled cotton-grass	ERVI	—	—	20	3	—	—	38	13	11	40	—	—
sheep fescue	FEOVR	—	—	—	—	—	—	—	—	—	—	100	43
green fescue	FEVI	—	—	60	6	—	—	—	—	—	—	—	—
tall mannagrass	GLEL	33	3	—	—	—	—	—	—	—	—	—	—
reed mannagrass	GLGR	—	—	—	—	—	—	—	—	—	—	—	—
fowl mannagrass	GLST	—	—	—	—	—	—	8	2	—	—	—	—
Baltic rush	JUBA	8	1	—	—	25	7	—	—	—	—	—	—
Drummond's rush	JUDR	—	—	40	Tr	—	—	—	—	—	—	—	—
Reed canarygrass	PHAR	—	—	—	—	—	—	—	—	—	—	—	—
Kentucky bluegrass	POPR	17	1	—	—	75	1	—	—	—	—	—	—
small-fruited bulrush	SCMI	8	20	—	—	—	—	—	—	—	—	—	—
spike trisetum	TRSP	—	—	40	8	25	Tr	—	—	—	—	100	4
Ferns and fern allies:													
common horsetail	EQAR	33	3	40	Tr	—	—	15	1	26	3	—	—
water horsetail	EQFL	—	—	—	—	—	—	—	—	11	1	—	—

[a] CON = percentage of plots in which the species occurred.
[b] COV = average canopy cover in plots in which the species occurred.
[c] Tr = trace cover, less than 1 percent canopy cover.

Table 24—Constancy and mean cover of important plant species in the MEADOW plant associations—Part 2

		GLEL 4 plots		POPR 5 plots		SCMI 6 plots		CAAP3 2 plots		CAAQ 11 plots		CACU2-WA 4 plots	
Species	**Code**	**CON**[a]	**COV**[b]	**CON**	**COV**	**CON**	**COV**	**CON**	**COV**	**CON**	**COV**	**CON**	**COV**
Tree understory:													
subalpine fir	ABLA2	—	—	—	—	—	—	—	—	—	—	—	—
Engelmann spruce	PIEN	—	—	—	—	—	—	—	—	9	Tr	25	Tr[c]
lodgepole pine	PICO	—	—	—	—	—	—	—	—	9	Tr	—	—
Shrubs:													
mountain alder	ALIN	50	6	—	—	50	4	—	—	18	1	75	10
red-osier dogwood	COST	50	Tr	40	2	17	Tr	—	—	9	1	25	2
Low shrubs and subshrubs:													
red mountain-heath	PHEM	—	—	—	—	—	—	—	—	—	—	—	—
Farr's willow	SAFA	—	—	—	—	—	—	—	—	9	7	—	—
tea-leaved willow	SAPLM2	—	—	—	—	—	—	—	—	9	2	—	—
dwarf huckleberry	VACA	—	—	—	—	—	—	—	—	—	—	—	—
Perennial forbs:													
western yarrow	ACMI	—	—	40	1	—	—	—	—	9	Tr	—	—
woolly pussytoes	ANLA	—	—	—	—	—	—	—	—	—	—	—	—
umber pussytoes	ANUM	—	—	—	—	—	—	—	—	—	—	—	—
fewflower aster	ASMO	50	2	—	—	—	—	—	—	—	—	—	—
western aster	ASOC	25	Tr	—	—	17	Tr	—	—	—	—	—	—
aster species	ASTER	—	—	—	—	—	—	—	—	—	—	25	1
twinflower marshmarigold	CABI	—	—	—	—	—	—	—	—	—	—	—	—
alpine willow-weed	EPAL	—	—	—	—	—	—	—	—	—	—	—	—
smooth willow-weed	EPGL	25	7	—	—	50	1	—	—	—	—	—	—
Watson's willow-weed	EPWA	50	11	20	3	—	—	—	—	9	Tr	—	—
peregrine fleabane	ERPE	—	—	—	—	—	—	—	—	—	—	—	—
broadpetal strawberry	FRVIP	—	—	40	4	—	—	—	—	—	—	25	Tr
small bedstraw	GATR	75	3	—	—	17	15	—	—	27	1	25	2
largeleaf avens	GEMA	75	2	20	1	17	Tr	—	—	27	1	25	Tr
partridgefoot	LUPE	—	—	—	—	—	—	—	—	—	—	—	—
broadleaf lupine	LULA	—	—	—	—	—	—	—	—	—	—	—	—

Table 24—Constancy and mean cover of important plant species in the MEADOW plant associations—Part 2 (continued)

		GLEL 4 plots		POPR 5 plots		SCMI 6 plots		CAAP3 2 plots		CAAQ 11 plots		CACU2-WA 4 plots	
Species	**Code**	**CON**	**COV**	**CON**	**COV**	**CON**	**COV**	**CON**	**COV**	**CON**	**COV**	**CON**	**CON**
common bogbean	METR	—	—	—	—	—	—	—	—	—	—	—	—
elephanthead pedicularis	PEGR	—	—	—	—	—	—	—	—	9	5	—	—
fanleaf cinquefoil	POFL2	—	—	—	—	—	—	—	—	—	—	—	—
marsh cinquefoil	POPA3	25	Tr	—	—	—	—	—	—	55	3	50	10
scheuchzeria	SCPA	—	—	—	—	—	—	—	—	—	—	—	—
cleftleaf groundsel	SECY	—	—	—	—	—	—	—	—	—	—	—	—
arrowleaf groundsel	SETR	—	—	—	—	—	—	—	—	—	—	—	—
Canada goldenrod	SOCA	—	—	20	1	—	—	—	—	—	—	—	—
ladies-tresses	SPRO	—	—	—	—	—	—	—	—	—	—	—	—
Cooley's hedge-nettle	STCO4	—	—	—	—	—	—	—	—	9	1	25	2
globeflower	TRLA4	—	—	—	—	—	—	—	—	—	—	—	—
Sitka valerian	VASI	—	—	—	—	—	—	—	—	—	—	—	—
American false hellebore	VEVI	—	—	—	—	—	—	—	—	—	—	—	—
thyme-leaved speedwell	VESE	—	—	—	—	17	Tr	—	—	—	—	—	—
Wormskjold's speedwell	VEWO	—	—	—	—	—	—	—	—	—	—	—	—
pioneer violet	VIGL	—	—	—	—	—	—	—	—	—	—	—	—
Grasses or grasslike:													
redtop	AGAL	50	1	40	31	17	1	—	—	—	—	—	—
Oregon bentgrass	AGOR	—	—	20	60	—	—	—	—	—	—	—	—
Thurber's bentgrass	AGTH	—	—	—	—	—	—	—	—	9	3	—	—
bluejoint reedgrass	CACA	25	15	—	—	33	8	—	—	45	15	25	1
Columbia sedge	CAAP3	—	—	—	—	—	—	100	43	—	—	—	—
water sedge	CAAQA	—	—	—	—	—	—	—	—	18	79	—	—
Sitka sedge	CAAQS	—	—	—	—	17	Tr	—	—	82	46	—	—
awned sedge	CAAT2	—	—	—	—	—	—	—	—	—	—	—	—
slender-beaked sedge	CAAT	25	Tr	20	3	—	—	—	—	—	—	—	—
Buxbaum's sedge	CABU2	—	—	—	—	—	—	—	—	—	—	—	—
gray sedge	CACA4	—	—	—	—	—	—	—	—	18	4	50	1
Cusick's sedge	CACU2	—	—	—	—	—	—	—	—	9	3	100	56
lesser panicled sedge	CADI2	—	—	—	—	—	—	—	—	—	—	—	—
sheep sedge	CAIL	—	—	—	—	—	—	—	—	—	—	—	—
slender sedge	CALA4	—	—	—	—	—	—	—	—	—	—	—	—
tufted sedge	CALE5	25	Tr	20	1	50	8	—	—	9	54	—	—
mud sedge	CALI	—	—	—	—	—	—	—	—	—	—	—	—
black alpine sedge	CANI2	—	—	—	—	—	—	—	—	—	—	—	—
thick-headed sedge	CAPA	25	Tr	20	12	33	Tr	—	—	—	—	—	—
beaked sedge	CARO2	—	—	—	—	—	—	—	—	—	—	—	—
russet sedge	CASA2	—	—	—	—	—	—	—	—	—	—	—	—
Holm's sedge	CASCB	—	—	—	—	—	—	50	5	—	—	—	—
saw-leaved sedge	CASCP2	—	—	—	—	—	—	—	—	18	3	—	—
showy sedge	CASP	—	—	—	—	—	—	—	—	—	—	—	—
bladder sedge	CAUT	50	5	—	—	33	11	50	Tr	100	9	100	6
inflated sedge	CAVE	25	Tr	—	—	33	1	—	—	9	2	—	—
timber oatgrass	DAIN	—	—	20	Tr	—	—	—	—	—	—	—	—
tufted hairgrass	DECE	—	—	20	3	—	—	—	—	—	—	—	—
creeping spike-rush	ELPA	75	1	—	—	33	2	50	1	9	Tr	—	—
few-flowered spike-rush	ELPA2	—	—	—	—	—	—	—	—	—	—	—	—
Chamisso cotton-grass	ERCH2	—	—	—	—	—	—	—	—	—	—	—	—
slender cotton-grass	ERGR8	—	—	—	—	—	—	—	—	—	—	—	—
many-spiked cotton-grass	ERPO2	—	—	—	—	—	—	—	—	18	Tr	—	—
green-keeled cotton-grass	ERVI	—	—	—	—	—	—	50	15	—	—	—	—
sheep fescue	FEOVR	—	—	—	—	—	—	—	—	—	—	—	—
green fescue	FEVI	—	—	—	—	—	—	—	—	—	—	—	—
tall mannagrass	GLEL	75	35	—	—	33	4	—	—	—	—	—	—
reed mannagrass	GLGR	25	35	—	—	—	—	—	—	—	—	25	1
fowl mannagrass	GLST	—	—	—	—	17	Tr	—	—	—	—	75	4
Baltic rush	JUBA	—	—	—	—	17	3	—	—	9	3	—	—
Drummond's rush	JUDR	—	—	—	—	—	—	—	—	—	—	—	—
reed canarygrass	PHAR	—	—	20	75	17	20	—	—	—	—	—	—
Kentucky bluegrass	POPR	25	1	40	40	33	Tr	—	—	—	—	—	—
small-fruited bulrush	SCMI	50	9	—	—	100	62	—	—	—	—	—	—
spike trisetum	TRSP	—	—	—	—	—	—	—	—	—	—	—	—
Ferns and fern allies:													
common horsetail	EQAR	75	5	40	2	67	2	50	Tr	18	1	25	Tr
water horsetail	EQFL	—	—	—	—	17	5	—	—	—	—	—	—

[a] CON = percentage of plots in which the species occurred.
[b] COV = average canopy cover in plots in which the species occurred.
[c] Tr = trace cover, less than 1 percent canopy cover.

Table 24—Constancy and mean cover of important plant species in the MEADOW plant associations—Part 3

		CAIL 3 plots		CALA4 11 plots		CALE5 3 plots		CALI 4 plots		CANI2 30 plots		CARO2 3 plots	
Species	**Code**	**CON[a]**	**COV[b]**	**CON**	**COV**	**CON**	**COV**	**CON**	**COV**	**CON**	**COV**	**CON**	**CON**
Tree understory:													
subalpine fir	ABLA2	—	—	—	—	—	—	—	—	40	2	—	—
Engelmann spruce	PIEN	33	Tr	9	Tr[c]	—	—	—	—	33	1	—	—
lodgepole pine	PICO	—	—	27	Tr	—	—	—	—	3	3	—	—
Shrubs:													
mountain alder	ALIN	—	—	18	Tr	—	—	—	—	—	—	—	—
red-osier dogwood	COST	—	—	—	—	—	—	—	—	—	—	—	—
Low shrubs and subshrubs:													
red mountain-heath	PHEM	—	—	—	—	—	—	—	—	63	2	—	—
Farr's willow	SAFA	33	Tr	9	2	—	—	50	16	20	2	—	—
tea-leaved willow	SAPLM2	67	2	9	1	—	—	—	—	10	5	—	—
dwarf huckleberry	VACA	—	—	—	—	—	—	—	—	40	5	—	—
Perennial forbs:													
western yarrow	ACMI	—	—	—	—	—	—	—	—	3	Tr	—	—
woolly pussytoes	ANLA	—	—	—	—	—	—	—	—	27	1	—	—
umber pussytoes	ANUM	—	—	—	—	—	—	—	—	10	1	—	—
fewflower aster	ASMO	—	—	—	—	—	—	—	—	7	5	—	—
western aster	ASOC	—	—	9	2	—	—	—	—	—	—	—	—
aster species	ASTER	—	—	9	1	—	—	—	—	13	4	—	—
twinflower marshmarigold	CABI	67	6	—	—	—	—	—	—	23	3	—	—
alpine willow-weed	EPAL	67	1	9	1	—	—	25	Tr	47	2	—	—
smooth willow-weed	EPGL	—	—	—	—	—	—	—	—	—	—	—	—
Watson's willow-weed	EPWA	—	—	9	1	—	—	—	—	—	—	—	—
peregrine fleabane	ERPE	—	—	—	—	—	—	—	—	10	4	—	—
broadpetal strawberry	FRVIP	—	—	—	—	—	—	—	—	—	—	—	—
small bedstraw	GATR	—	—	45	1	—	—	—	—	—	—	—	—
largeleaf avens	GEMA	—	—	27	Tr	—	—	—	—	—	—	—	—
partridgefoot	LUPE	—	—	—	—	—	—	—	—	33	3	—	—
broadleaf lupine	LULA	—	—	—	—	—	—	—	—	10	1	—	—
common bogbean	METR	—	—	36	5	—	—	50	4	—	—	33	5
elephanthead pedicularis	PEGR	—	—	9	3	—	—	—	—	40	2	33	1
fanleaf cinquefoil	POFL2	—	—	—	—	—	—	—	—	57	2	—	—
marsh cinquefoil	POPA3	—	—	82	7	—	—	75	6	—	—	67	1
scheuchzeria	SCPA	—	—	—	—	—	—	75	10	—	—	—	—
cleftleaf groundsel	SECY	67	10	—	—	—	—	—	—	40	4	—	—
arrowleaf groundsel	SETR	—	—	—	—	—	—	—	—	20	1	—	—
Canada goldenrod	SOCA	—	—	9	Tr	—	—	—	—	—	—	—	—
ladies-tresses	SPRO	—	—	9	Tr	—	—	50	1	—	—	—	—
Cooley's hedge-nettle	STCO4	—	—	—	—	—	—	—	—	—	—	—	—
globeflower	TRLA4	—	—	—	—	—	—	—	—	13	9	—	—
Sitka valerian	VASI	—	—	—	—	—	—	—	—	20	3	—	—
American false hellebore	VEVI	—	—	—	—	—	—	—	—	30	3	—	—
thyme-leaved speedwell	VESE	—	—	—	—	—	—	—	—	10	2	—	—
Wormskjold's speedwell	VEWO	33	Tr	—	—	—	—	—	—	27	1	—	—
pioneer violet	VIGL	—	—	—	—	—	—	—	—	—	—	—	—
Grasses or grasslike:													
redtop	AGAL	—	—	—	—	—	—	—	—	—	—	—	—
Oregon bentgrass	AGOR	—	—	36	3	—	—	—	—	—	—	—	—
Thurber's bentgrass	AGTH	33	2	—	—	—	—	—	—	20	7	—	—
bluejoint reedgrass	CACA	—	—	18	1	—	—	25	Tr	17	3	—	—
Columbia sedge	CAAP3	—	—	9	15	—	—	—	—	—	—	—	—
water sedge	CAAQA	—	—	9	10	—	—	—	—	—	—	—	—
Sitka sedge	CAAQS	—	—	9	3	—	—	25	2	—	—	—	—
awned sedge	CAAT2	—	—	—	—	—	—	—	—	—	—	—	—
slender-beaked sedge	CAAT	—	—	—	—	—	—	—	—	—	—	—	—
Buxbaum's sedge	CABU2	—	—	27	20	—	—	—	—	—	—	—	—
gray sedge	CACA4	—	—	36	2	—	—	25	5	—	—	—	—
Cusick's sedge	CACU2	—	—	18	Tr	—	—	—	—	—	—	—	—
lesser panicled sedge	CADI2	—	—	9	Tr	—	—	50	5	—	—	—	—
sheep sedge	CAIL	100	57	9	Tr	33	5	—	—	10	5	—	—
slender sedge	CALA4	—	—	82	54	—	—	25	1	—	—	67	2
tufted sedge	CALE5	33	7	—	—	100	47	—	—	—	—	—	—
mud sedge	CALI	—	—	27	6	—	—	100	28	—	—	33	3
black alpine sedge	CANI2	100	19	—	—	—	—	—	—	100	51	—	—
thick-headed sedge	CAPA	—	—	—	—	—	—	—	—	3	Tr	—	—
beaked sedge	CARO	—	—	9	1	—	—	—	—	—	—	100	60
russet sedge	CASA2	—	—	—	—	—	—	—	—	—	—	—	—

Table 24—Constancy and mean cover of important plant species in the MEADOW plant associations—Part 3 (continued)

		CAIL 3 plots		CALA4 11 plots		CALE5 3 plots		CALI 4 plots		CANI2 30 plots		CARO2 3 plots	
Species	Code	CON	COV	CON	COV	CON	COV	CON	COV	CON	COV	CON	CON
Holm's sedge	CASCB	33	Tr	—	—	—	—	—	—	33	5	—	—
saw-leaved sedge	CASCP2	—	—	—	—	33	Tr	—	—	20	4	—	—
showy sedge	CASP	—	—	—	—	—	—	—	—	23	5	—	—
bladder sedge	CAUT	—	—	91	8	—	—	50	3	—	—	67	3
inflated sedge	CAVE	—	—	—	—	33	5	—	—	—	—	—	—
timber oatgrass	DAIN	—	—	—	—	—	—	—	—	13	5	—	—
tufted hairgrass	DECE	—	—	—	—	—	—	—	—	13	5	—	—
creeping spike-rush	ELPA	—	—	9	1	—	—	—	—	—	—	—	—
few-flowered spike-rush	ELPA2	—	—	18	4	—	—	25	12	3	1	—	—
Chamisso cotton-grass	ERCH2	—	—	27	4	—	—	—	—	—	—	—	—
slender cotton-grass	ERGR8	—	—	—	—	—	—	50	3	—	—	—	—
many-spiked cotton-grass	ERPO2	—	—	27	1	33	Tr	25	2	7	2	33	1
green-keeled cotton-grass	ERVI	—	—	18	Tr	—	—	25	Tr	—	—	—	—
sheep fescue	FEOVR	—	—	—	—	—	—	—	—	—	—	—	—
green fescue	FEVI	—	—	—	—	—	—	—	—	3	Tr	—	—
tall mannagrass	GLEL	—	—	—	—	—	—	—	—	—	—	—	—
reed mannagrass	GLGR	—	—	—	—	—	—	—	—	—	—	—	—
fowl mannagrass	GLST	—	—	—	—	—	—	—	—	—	—	—	—
Baltic rush	JUBA	—	—	9	20	—	—	—	—	—	—	—	—
Drummond's rush	JUDR	67	Tr	—	—	—	—	—	—	37	2	—	—
Reed canarygrass	PHAR	—	—	—	—	—	—	—	—	—	—	—	—
Kentucky bluegrass	POPR	—	—	—	—	—	—	—	—	—	—	—	—
small-fruited bulrush	SCMI	—	—	—	—	—	—	—	—	—	—	—	—
spike trisetum	TRSP	33	2	—	—	—	—	—	—	10	1	—	—
Ferns and fern allies:													
common horsetail	EQAR	—	—	—	—	—	—	—	—	10	6	—	—
water horsetail	EQFL	—	—	36	2	33	Tr	25	3	—	—	33	5

[a]CON = percentage of plots in which the species occurred.
[b]COV = average canopy cover in plots in which the species occurred.
[c]Tr = trace cover, less than 1 percent canopy cover.

Table 24—Constancy and mean cover of important plant species in the MEADOW plant associations—Part 4

		CASA2 4 plots		CASCB 17 plots		CASCP2 18 plots		CASP 11 plots		CAUI 55 plots		CAVE 10 plots	
Species	Code	CON[a]	COV[b]	CON	COV	CON	COV	CON	COV	CON	COV	CON	CON
Tree understory:													
subalpine fir	ABLA2	—	—	29	1	67	2	64	1	—	—	—	—
Engelmann spruce	PIEN	—	—	18	3	61	2	—	—	5	1	—	—
lodgepole pine	PICO	—	—	—	—	11	3	—	—	4	2	—	—
Shrubs:													
mountain alder	ALIN	—	—	—	—	—	—	—	—	27	3	—	—
red-osier dogwood	COST	—	—	—	—	—	—	—	—	4	2	—	—
Low shrubs and subshrubs:													
red mountain-heath	PHEM	—	—	24	5	44	1	45	2	—	—	—	—
Farr's willow	SAFA	75	1	29	5	17	5	9	Tr[c]	4	2	—	—
tea-leaved willow	SAPLM2	—	—	12	2	6	Tr	—	—	4	10	—	—
dwarf huckleberry	VACA	—	—	24	1	11	3	9	2	4	1	—	—
Perennial forbs:													
western yarrow	ACMI	—	—	18	1	17	1	9	1	2	Tr	—	—
woolly pussytoes	ANLA	—	—	6	Tr	—	—	18	2	—	—	—	—
umber pussytoes	ANUM	25	Tr	12	Tr	—	—	9	2	—	—	—	—
fewflower aster	ASMO	—	—	24	7	11	3	—	—	7	2	—	—
western aster	ASOC	—	—	6	Tr	—	—	—	—	2	2	—	—
aster species	ASTER	25	Tr	6	5	—	—	27	1	11	1	—	—
twinflower marshmarigold	CABI	—	—	24	6	17	5	—	—	—	—	—	—
alpine willow-weed	EPAL	25	Tr	41	1	22	2	27	Tr	4	Tr	—	—
smooth willow-weed	EPGL	—	—	18	1	—	—	—	—	—	—	—	—
Watson's willow-weed	EPWA	—	—	—	—	—	—	—	—	22	1	—	—
peregrine fleabane	ERPE	—	—	6	Tr	17	7	18	2	4	7	—	—
broadpetal strawberry	FRVIP	—	—	6	Tr	6	1	—	—	4	1	—	—
small bedstraw	GATR	—	—	6	1	11	2	—	—	33	2	30	3
largeleaf avens	GEMA	—	—	6	Tr	—	—	9	Tr	35	1	10	1
partridgefoot	LUPE	—	—	—	—	11	3	45	4	—	—	—	—
broadleaf lupine	LULA	—	—	—	—	6	10	—	—	—	—	—	—

Table 24—Constancy and mean cover of important plant species in the MEADOW plant associations—Part 4 (continued)

		CASA2 4 plots		CASCB 17 plots		CASCP2 18 plots		CASP 11 plots		CAUI 55 plots		CAVE 10 plots	
Species	Code	CON	COV	CON	COV	CON	COV	CON	COV	CON	COV	CON	CO
common bogbean	METR	—	—	—	—	—	—	—	—	2	Tr	10	Tr
elephanthead pedicularis	PEGR	50	Tr	29	4	44	1	27	2	2	Tr	—	—
fanleaf cinquefoil	POFL2	25	Tr	47	6	28	6	73	4	—	—	—	—
marsh cinquefoil	POPA3	—	—	—	—	—	—	—	—	31	6	—	—
scheuchzeria	SCPA	—	—	—	—	—	—	—	—	—	—	—	—
cleftleaf groundsel	SECY	50	Tr	29	1	—	—	9	5	—	—	—	—
arrowleaf groundsel	SETR	—	—	35	3	56	4	27	1	4	1	—	—
Canada goldenrod	SOCA	—	—	—	—	—	—	—	—	2	1	—	—
ladies-tresses	SPRO	—	—	—	—	17	1	—	—	—	—	—	—
Cooley's hedge-nettle	STCO4	—	—	—	—	—	—	—	—	4	1	—	—
globeflower	TRLA4	—	—	18	8	28	2	—	—	—	—	—	—
Sitka valerian	VASI	—	—	18	3	33	11	36	4	—	—	—	—
American false hellebore	VEVI	—	—	12	Tr	11	3	73	1	—	—	—	—
thyme-leaved speedwell	VESE	—	—	12	Tr	6	Tr	—	—	2	Tr	—	—
Wormskjold"s speedwell	VEWO	—	—	29	1	17	Tr	36	Tr	4	1	—	—
pioneer violet	VIGL	—	—	6	2	17	Tr	—	—	4	Tr	—	—
Grasses or grasslike:													
redtop	AGAL	—	—	—	—	—	—	—	—	4	1	—	—
Oregon bentgrass	AGOR	—	—	—	—	—	—	—	—	5	1	—	—
Thurber's bentgrass	AGTH	—	—	6	17	28	3	9	3	2	1	—	—
bluejoint reedgrass	CACA	50	Tr	41	3	39	7	27	27	45	3	30	1
Columbia sedge	CAAP3	—	—	—	—	—	—	—	—	—	—	—	—
water sedge	CAAQA	—	—	—	—	—	—	—	—	5	5	10	Tr
Sitka sedge	CAAQS	—	—	—	—	—	—	—	—	7	13	—	—
awned sedge	CAAT2	—	—	—	—	—	—	—	—	7	39	—	—
slender-beaked sedge	CAAT	—	—	—	—	—	—	—	—	4	Tr	—	—
Buxbaum's sedge	CABU2	—	—	—	—	—	—	—	—	2	5	10	Tr
gray sedge	CACA4	—	—	6	6	6	1	—	—	27	3	—	—
Cusick's sedge	CACU2	—	—	—	—	—	—	—	—	13	4	—	—
lesser panicled sedge	CADI2	—	—	—	—	—	—	—	—	4	1	—	—
sheep sedge	CAIL	25	Tr	29	1	17	2	9	Tr	2	7	—	—
slender sedge	CALA4	—	—	—	—	—	—	—	—	9	6	—	—
tufted sedge	CALE5	25	Tr	6	Tr	11	1	—	—	4	5	10	10
mud sedge	CALI	25	Tr	—	—	6	2	—	—	2	20	—	—
black alpine sedge	CANI2	25	1	47	6	28	7	55	16	—	—	—	—
thick-headed sedge	CAPA	50	Tr	29	2	11	4	9	Tr	4	Tr	—	—
beaked sedge	CARO2	—	—	—	—	—	—	—	—	—	—	—	—
russet sedge	CASA2	100	50	6	Tr	6	Tr	—	—	2	3	—	—
Holm's sedge	CASCB	25	Tr	100	55	—	—	—	—	2	25	—	—
saw-leaved sedge	CASCP2	—	—	—	—	100	56	9	7	4	1	—	—
showy sedge	CASP	—	—	12	38	—	—	100	47	—	—	—	—
bladder sedge	CAUT	—	—	6	Tr	—	—	—	—	100	61	40	3
inflated sedge	CAVE	—	—	—	—	—	—	—	—	13	18	100	69
timber oatgrass	DAIN	—	—	6	Tr	11	Tr	9	5	—	—	—	—
tufted hairgrass	DECE	—	—	12	1	—	—	—	—	5	15	10	5
creeping spike-rush	ELPA	—	—	—	—	—	—	—	—	13	3	40	2
few-flowered spike-rush	ELPA2	25	Tr	18	4	11	5	—	—	—	—	—	—
Chamisso cotton-grass	ERCH2	—	—	—	—	—	—	—	—	2	1	—	—
slender cotton-grass	ERGR8	—	—	—	—	—	—	—	—	—	—	—	—
many-spiked cotton-grass	ERPO2	25	15	24	3	17	4	9	Tr	5	1	—	—
green-keeled cotton-grass	ERVI	25	25	6	1	11	Tr	—	—	5	4	—	—
sheep fescue	FEOVR	—	—	6	2	—	—	—	—	—	—	—	—
green fescue	FEVI	—	—	6	Tr	—	—	9	1	—	—	—	—
tall mannagrass	GLEL	—	—	—	—	—	—	—	—	9	1	10	Tr
reed mannagrass	GLGR	—	—	—	—	—	—	—	—	4	Tr	—	—
fowl mannagrass	GLST	—	—	—	—	6	3	—	—	9	6	10	10
Baltic rush	JUBA	—	—	—	—	—	—	—	—	2	5	—	—
Drummond's rush	JUDR	25	Tr	24	1	22	2	18	2	—	—	—	—
reed canarygrass	PHAR	—	—	—	—	—	—	—	—	7	7	—	—
Kentucky bluegrass	POPR	—	—	6	Tr	6	1	—	—	4	1	—	—
small-fruited bulrush	SCMI	—	—	—	—	—	—	—	—	18	3	—	—
spike trisetum	TRSP	—	—	6	Tr	6	Tr	—	—	—	—	—	—
Ferns and fern allies:													
common horsetail	EQAR	25	Tr	24	3	11	Tr	9	3	13	2	10	Tr
water horsetail	EQFL	50	Tr	—	—	—	—	—	—	15	5	20	8

[a] CON = percentage of plots in which the species occurred.
[b] COV = average canopy cover in plots in which the species occurred.
[c] Tr = trace cover, less than 1 percent canopy cover.

FORB SERIES

FORB N = 29

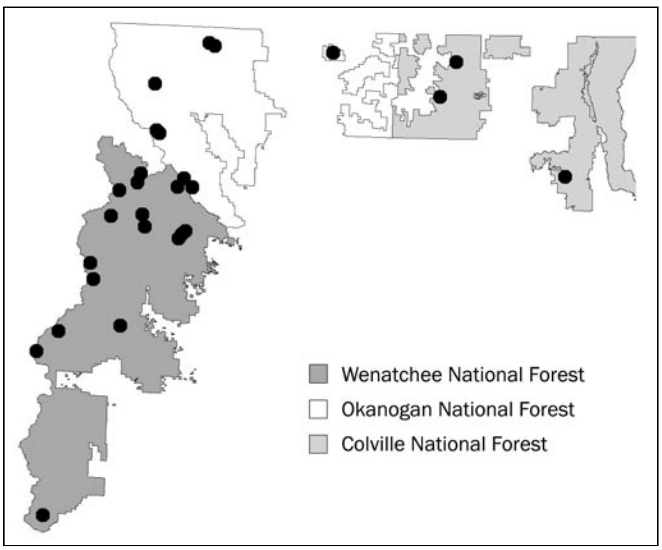


Figure 37—Plot locations for the FORB series.

AS A WHOLE, the numerous plant species used to characterize the FORB[1] series are widely distributed in the mountains of temperate and arctic North America. Most of these plants can be found from Alaska south through the mountains of British Columbia, Alberta, Washington, northern Idaho, Montana, and Oregon. All the cross references to species codes and common and scientific names are located in appendix A, and the general site requirements and distribution for each indicator species are described below (Hitchcock and Cronquist 1973):

- Alpine lady fern is found on the borders of streams, often near timberline, and is circumboreal. It extends south through North America to California, Colorado, and Quebec.
- Lady fern is found in moist woods, meadows, and swamps. It is circumboreal and is found throughout the Pacific Northwest.
- Oak fern is a species of moist woods and streambanks. It is circumboreal and is found from Alaska to eastern Canada and south to Oregon, Arizona, Idaho, and Virginia.
- Lewis' monkey-flower is a species found on moist floodplains and streambanks. It is found at upper elevations throughout the mountains of the Pacific Northwest.
- Globeflower is found in swamps to alpine meadows. It occurs from British Columbia south through the Olympic Mountains and Cascade Range of Washington, the Wallowa Mountains of Oregon, Colorado, and then extends east to Connecticut.
- Twinflower marshmarigold is a species of wet subalpine and alpine sites. It is found from Alaska south to California, Idaho, Utah, and Colorado.
- Broadleaf lupine is a species of lowland prairies to alpine ridges. It also is found in moist, well-drained riparian and wetland zones. It is found from Alaska south through the Cascade Range and coastal mountains to California.
- Dotted saxifrage is a species found on moderate- to high-elevation streambanks. It is found from Alaska south through the coastal and Cascade Range of Washington and Oregon, and east through British Columbia and Alberta. Merten's and brook saxifrage occur in similar environments but with somewhat more extensive ranges, generally ranging south from Alaska to California, the Wallowa Mountains of Oregon, Idaho, and Montana.

The FORB series is complex as it includes five plant associations, each dominated by different species. Each species responds to differences in water depth, temperature, chemistry, and aeration. Most associations are found along streams on moist, well-drained alluvium. They are associated with peak-flow flooding and "summer splash" from the adjacent stream. Some plots were located in springs or in fens. Elevation (growing season and temperature) also strongly influences the plant species growing on these sites. For instance, lady fern and oak fern are found at low to moderate elevations, whereas other indicator species are characteristic of high elevations or very cold air drainages. For simplicity, all forb-dominated associations were grouped into one FORB series based on the single similarity of forb dominance. The FORB series was not classified with the MEADOW series because the vegetation composition and sites associated with the five FORB plant associations is different from the graminoid-dominated fens, bogs, and meadows of the MEADOW series.

[1] See appendix A for a cross reference for all species codes and common and scientific names used in this document.

The species characterizing the FORB series grow in a wide range of environments. Growing seasons may be relatively long in the moderate-elevation ATFI-GYDR association, yet very short in the subalpine/alpine LULA and TRLA4-CABI associations. Annual precipitation varies from under 20 inches at low elevation in the dry interior of the study area to over 80 inches in the maritime climate along the Cascade crest and over 30 inches in the weaker inland maritime climate in the Selkirk Mountains of northeastern Washington. However, such generalities need to be interpreted carefully when considering cold air drainage and high water tables in sites associated with FORB series vegetation. The cold climate and short growing seasons normally associated with high-elevation associations may extend to lower elevations in cold air drainages, especially in deep, narrow, V-shaped valleys.

CLASSIFICATION DATABASE

The FORB series includes all terrestrial riparian and wetland sites dominated by forbs. It does not include forb-dominated sites in the AQUATIC series. The FORB series was sampled on all three eastern Washington NFs, but on only about half of the RDs (fig. 37). The poor distribution and low number of plots is probably an artifact of plot distribution as many sites in the FORB series are very small and may have been overlooked during the sampling process. For instance, SAPU and MILE sites usually are linear, a couple of feet in width, and difficult to sample. Therefore, it is possible that some associations in the FORB series are more common than depicted in this classification. Twenty-nine riparian and wetland plots were sampled in the FORB series. From this database, three major and two minor plant associations are described. Five potential, one-plot associations (VASI, ANAL, CAPE, PEFR, and SELAG) are not used in the database nor described in this classification. For the most part, these samples were located in mature, stable communities in good ecological condition.

VEGETATION CHARACTERISTICS

Because 10 species are used as indicators to define the FORB series and five FORB plant associations, it is difficult to characterize the FORB series without considering the FORB plant associations in some detail:

1. Most sites in the ATFI-GYDR association are dominated by lady fern and/or oak fern. Sites at higher elevations are dominated by alpine lady fern. Other common herbs include sweetscented bedstraw, arrowleaf groundsel, claspleaf or rosy twisted-stalk species, coolwort foamflower, pioneer violet, and wood reed-grass. Prickly currant is the most common shrub.
2. Broadleaf lupine is well represented in the LULA association. Field crews named the lupines found on the plots as broadleaf lupine, but the identification is not verified (no collections). Therefore, users of this guide should consider other moist-site lupines such as bigleaf lupine when classifying these sites. Other common herbs include hairy arnica, alpine willow weed, Gray’s licorice-root, dotted saxifrage, arrowleaf groundsel, Cusick’s speedwell, Drummond’s rush, and alpine timothy.
3. The MILE association is characterized by Lewis’ monkey-flower. Other common herbs include alpine willow-weed, partridgefoot, fanleaf cinquefoil, dotted saxifrage, spike bentgrass, black alpine sedge, showy sedge, Drummond’s rush, Merten’s rush, and alpine timothy.
4. Dotted saxifrage (possible alternate indicators are Merten’s and brook saxifrage) is well represented in the SAPU association. Many of the associated herbs reflect the cool, moist, “splash zone” environment of the SAPU association and include mountain arnica, Jeffrey’s shooting-star, alpine willow-weed, fringed grass-of-parnassia, miterwort species, arrowleaf groundsel, and Sitka valerian. Mosses are prominent and at first glance may be the most conspicuous feature of the association.
5. TRLA4-CABI association vegetation reflects its moderate to high elevation, gentle terrain, and moist soils. Combinations of twinflower marshmarigold and globeflower dominate. Other common herbs include mountain arnica, Canby’s licorice-root, arrowleaf groundsel, Sitka valerian, American false hellebore, pioneer violet, and Holm’s sedge. A variety of high-elevation graminoids may indicate that some of these sites are transitional to fens.

FORB plant associations

	Scientific name	Common name	Ecoclass code	Plots
Major associations:				
ATFI-GYDR	*Athyrium filix-femina–Gymnocarpium dryopteris*	Lady fern–oak fern	FW4241	12
SAPU	*Saxifraga punctata*	Dotted saxifrage	FW4242	6
TRLA4-CABI	*Trollius laxus-Caltha biflora*	Globeflower-twinflower marshmarigold	FW4243	6
Minor associations:				
LULA	*Lupinus latifolius*	Broadleaf lupine	FS6011	2
MILE	*Mimulus lewisii*	Lewis’ monkey-flower	FS3011	3

PHYSICAL SETTING

Elevation—

The majority of FORB series plots are between 3,000 and 7,000 feet. These elevations are more an artifact of a limited number of sample plots rather than actual distribution of the FORB series. For example, the elevation range on the Colville NF was 3,920 to 4,360 feet based on only three plots, but the FORB series has been observed both below and above this range.

	Elevation (feet)			
Forest	**Minimum**	**Maximum**	**Average**	**N**
Colville	3,920	4,360	4,210	3
Okanogan	4,160	6,930	5,539	7
Wenatchee	3,500	7,120	5,009	19
Series	3,500	7,120	5,004	29

Additional insight is gained by comparing individual associations with elevation. The ATFI-GYDR association averages 4,272 feet in elevation but has been observed at elevations as high as 5,440 feet, especially where it is dominated by alpine lady fern. The other four associations (MILE, SAPU, TRLA4-CABI, and LULA) have been observed at elevations higher than reported in the table below. All but the LULA association can extend down to moderate elevations in severe cold air drainage.

	Elevation (feet)			
Plant association	**Minimum**	**Maximum**	**Average**	**N**
LULA	6,970	7,120	7,045	2
TRLA4-CABI	3,975	6,930	5,636	6
SAPU	4,670	6,500	5,307	6
MILE	4,140	6,004	5,182	3
ATFI-GYDR	3,500	5,440	4,272	12
Series	3,500	7,120	5,004	29

In general, the FORB series is widespread and occurs from elevations near the lower elevation of the forest boundaries to over 7,000 feet along the Cascade crest and over 6,000 feet in the Kettle River Range and Selkirk Mountains. These associations probably do not occur at elevations below the general forest zone nor in the Columbia basin.

Valley Geomorphology—

The FORB series is found in a variety of valley width and gradient classes. Most plots occur in relatively narrow, steep valleys. About 62 percent of the sample plots (17 of 29) were in valleys less than 99 feet wide, whereas 66 percent (19 of 29) were in valleys with more than 6 percent valley gradient. A second concentration of plots occurs in broad, low gradient valleys.

Additional understanding can be gained by looking at plant associations. For example, although located in a variety of valley width classes, four of six plots in the TRLA4-CABI association were located in low gradient valleys. However,

	Valley gradient					
Valley width	**Very low**	**Low**	**Moderate**	**Steep**	**Very steep**	**N**
Very broad	0	2	0	0	1	3
Broad	1	2	1	1	1	6
Moderate	0	0	0	1	2	3
Narrow	0	2	1	2	3	8
Very narrow	0	1	0	0	8	9
Series total	1	7	2	4	15	29

other than their herbaceous composition, all six plots are similar to some sites in the MEADOW series. The ATFI-GYDR and SAPU associations, on the other hand, occur in narrow, steep valleys. All five associations have some plots in valleys less than 6 percent valley gradient and more than 99 feet wide. It could be generalized from plot data that the FORB series are uncommon in broader (greater than 99 feet) and gentler (less than 6 percent) valleys, but this may be somewhat inaccurate because of the low number of plots.

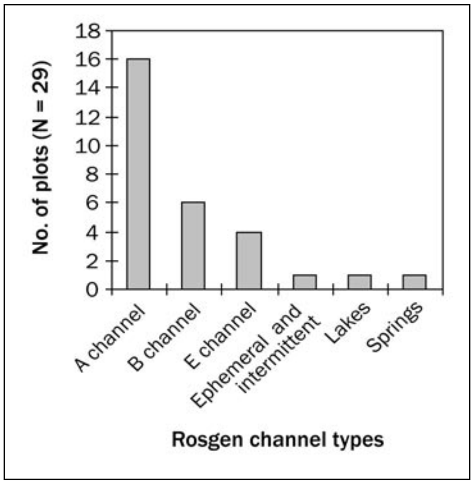
	Valley width					
Plant association	**Very broad**	**Broad**	**Moderate**	**Narrow**	**Very narrow**	**N**
ATFI-GYDR	0	1	1	4	6	12
LULA	0	1	0	0	1	2
MILE	1	2	0	0	0	3
SAPU	1	0	1	2	2	6
TRLA4-CABI	1	2	1	2	0	6
Series total	3	6	3	8	9	29

	Valley gradient					
Plant association	**Very low**	**Low**	**Moderate**	**Steep**	**Very steep**	**N**
ATFI-GYDR	0	2	1	2	7	12
LULA	1	0	0	0	1	2
MILE	0	0	1	0	2	3
SAPU	0	1	0	2	3	6
TRLA4-CABI	0	4	0	0	2	6
Series total	1	7	2	4	15	29

Channel Types—

Nearly 90 percent of the plots were located in riparian zones along Rosgen A or B channel types.

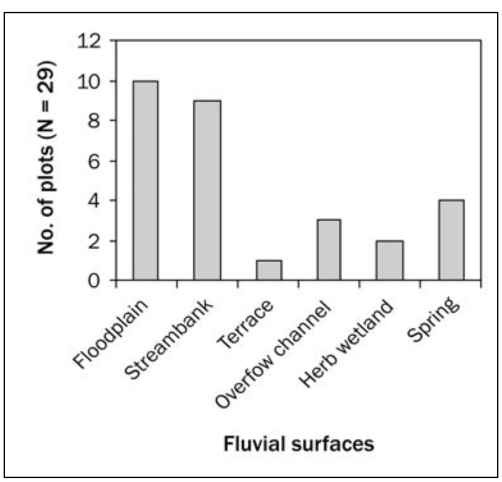
Additional insight is gained by looking at the distribution of plant associations by Rosgen channel types. All four E channels were along TRLA4-CABI, an association with site characteristics closely related to the MEADOW series, and usually associated with gentle valley gradients. One TRLA4-CABI plot was along an A channel and another along a low-gradient, spring zone. ATFI-GYDR, MILE, and SAPU associations are strongly tied to A and B channel types. Ephemeral, lake, and spring channel types are uncommon, although of three spring plots sampled, only one is listed because the others were located on terraces and the channels were coded as Rosgen B types.



Plant association	Rosgen channel type						
	A	B	E	Ephemeral and intermittent	Lake	Spring	N
ATFI-GYDR	8	3	0	1	0	0	12
LULA	1	0	0	0	1	0	2
MILE	2	1	0	0	0	0	3
SAPU	4	2	0	0	0	0	6
TRLA4-CABI	1	0	4	0	0	1	6
Series total	16	6	4	1	1	1	29

Fluvial Surfaces—

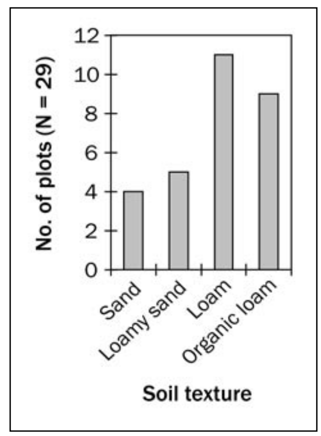
The FORB series is found on a limited variety of fluvial surfaces. Contrary to the MEADOW series, most plots are located in riparian zones on frequently flooded surfaces such as floodplains and lower streambanks. Three plots occurred in overflow channels. Two plots were in wetlands on drier margins of fens. Three of the four spring plots supported the ATFI-GYDR association, and three of these spring plots were located on terraces and could have been coded as old, overflow channels. The common factor between most plots is that they have moist, well-drained soils on account of their proximity to streams or seepage.



Additional insight is gained by looking at the distribution of fluvial surfaces by plant association. Eight of the 12 ATFI-GYDR plots were located on floodplains and streambanks. An additional three plots were located in spring zones (on terraces). Almost all MILE and SAPU plots were on floodplains and lower streambanks. The proximity of these sites to summer "splash" from the closely adjacent stream contributes to these sites being wet, although well drained, throughout the growing season.

Plant association	Fluvial surfaces						
	Flood-plain	Stream-bank	Terrace	Overflow channel	Herb wetland	Spring	N
ATFI-GYDR	4	4	0	1	0	3	12
LULA	0	1	0	0	1	0	2
MILE	3	0	0	0	0	0	3
SAPU	2	3	0	1	0	0	6
TRLA4-CABI	1	1	1	1	1	1	6
Series total	10	9	1	3	2	4	29

Soils—



Mineral soils account for 20 of 29 plots in the FORB series. Organic loam texture is common. Most of the sand and loamy sand soils were associated with frequently flooded sites on floodplains and lower streambanks. Less flood-prone sites such as overflow channels, terraces, herb wetlands, and springs tended to support finer textured loam and organic loam soils.

In general, however, these figures are inconsistent, reflecting soil differences both within and among the various associations. Most ATFI-GYDR, LULA, and TRLA4-CABI plots occurred on loam and organic loam soils. Those associated with MILE and SAPU were variable but were usually sand to sandy loam (coarse fragments usually high).

Plant association	Soil texture				
	Sand	Loamy sand	Loam	Organic loam	N
ATFI-GYDR	0	2	6	4	12
LULA	0	1	1	0	2
MILE	1	1	1	0	3
SAPU	3	1	1	1	6
TRLA4-CABI	0	0	2	4	6
Series total	4	5	11	9	29

Water tables were measured on 17 plots and averaged 9 inches below the soil surface. The measured depths for individual plant associations ranged from an average 13 inches below the soil surface for TRLA4-CABI to three inches below the soil surface for the MILE association. MILE, LULU, and SAPU appear to be the wettest associations based on water tables. This is reasonable as all three associations usually are within a few feet of the stream edge. Soils within the rooting zone of most associations are saturated or flooded early in the growing season, becoming moist but well aerated late in the growing season.

	Water table (inches)			
Plant association	Minimum	Maximum	Average	N
MILE	-8	2	-3	2
LULA	-4	-4	-4	1
SAPU	-12	0	-6	4
ATFI-GYDR	-17	-1	-11	7
TRLA4-CABI	-24	-4	-13	4
Series	-24	2	-9	17

The soil surface was rarely submerged at the time of sampling in the FORB series (no table is shown). However, it is reasonable to expect that some of these associations are partially flooded at peak runoff or snowmelt, especially where sites are associated with floodplains, overflow channels, or lower streambanks.

There was little difference in soil temperature among the associations. It is especially confounding that MILE and LULA, the two highest average elevation associations, have the warmest soil temperatures. Unlike upland associations, climatic variations may not be reflected in the soil temperatures of associations when there are large volumes of water flowing through the soil matrix. However, data are limited and should be viewed with caution.

	Soil temperature (°F)			
Plant association	Minimum	Maximum	Average	N
MILE	53	53	53	3
LULA	52	52	52	2
ATFI-GYDR	43	54	49	12
SAPU	43	53	49	5
TRLA4-CABI	47	52	49	4
Series	43	54	50	26

ECOSYSTEM MANAGEMENT

Natural Regeneration of FORB Series Plants—

Lady fern and alpine lady fern regenerate sexually by spores and vegetatively by expansion through rhizome growth (Campbell and Franklin 1979). Lady ferns also spread by water transport of whole plants or pieces of rhizomes as long as they remain moist. They even reproduced by sprouting from rhizomes transported by the pyroclastic flows of the Mount St. Helens eruption (Adams et al. 1987).

Oak fern also reproduces by both spores and rhizome extension. The spores of oak fern and lady fern are adapted for high wind dispersal (Kirkpatrick et al. 1990). Spores also are found in the seed bank, even where adult plants are absent (Milberg 1991, Mladenoff 1990).

Dotted saxifrage reproduces from both seed and horizontal rootstock extension. The small, hard seed may remain viable in the soil for a few years, but there is no literature to verify these observations. The plants may be able to regenerate from pieces of the rootstock.

Lewis' monkey-flower reproduces from both seed and rhizome extension. The small, hard seed probably remains viable for several years in the seed bank. It is reasonable to expect the plant can regenerate from pieces of rhizomes.

Lupine species are not rhizomatous but will sprout from the root caudex. They most often regenerate from seed (Steele and Geier-Hayes 1993, Stubbendieck et al. 1986, Van Dyne 1958). The seeds are heavy, not widely dispersed, and will germinate in full sun or partial shade. They can be stored for many years in the seed bank.

Twinflower marshmarigold and globeflower reproduce primarily by seed. The small, hard seed may remain viable in the seed bank for several years. They also will sprout from the root caudex.

Artificial Establishment of FORB Series Plants—

As described above, almost all the forb indicators reproduce vigorously from rhizomes, seed banks, or freshly dispersed seed. Live rooted plants, plugs, or rhizome segments can be used to establish most of them on appropriate FORB series sites. (For more information on the short- and long-term revegetation potential of selected riparian wetland plant species, see app. B-5.)

Stand Management—

The scattered conifers found on FORB series sites are generally located on microsites such as hummocks. They should not be considered for timber harvest because of their value to wildlife and as a future supply of snags and logs. Many of these sites are located adjacent to extensive stands of conifers, and the forest edge also should be considered for retention of these values.

Growth and Yield—

Forage estimates were not made during this study nor are there data for these associations in other classifications. Estimated biomass production for the plant associations in the FORB series may range from low in the SAPU and MILE associations, to moderate in the TRLA4-CABI and LULA associations, and high in the ATFI-GYDR association.

Down Wood—

The overall amount of down wood is moderate compared with other nonforest series (app. C-3). Logs cover 4.5 percent of the ground surface. Log biomass is also moderate for the shrub series. This indicates some sites are narrow and occur within one tree height of forest communities. Logs may play an important role in the function and structure of the FORB series.

	Down log attributes				
Log condition	Tons/ acre	Cu. ft./ acre	Linear ft./ acre	Sq. ft./ acre	% ground cover
Class 1	0.27	22	166	66	0.2
Class 2	3.91	379	421	389	.9
Class 3	2.48	313	567	425	1.0
Class 4	2.48	795	953	890	2.0
Class 5	.49	157	248	186	.4
Total	9.63	1,666	2,355	1,956	4.5

Fire—

Many of the indicator species in the FORB series are adapted to survive fire by resprouting from rhizomes or the root caudex. Both lady fern and oak fern tend to occur in moist forested valleys that burn infrequently (Arno and Davis 1980). These ferns are top-killed and resprout from rhizomes after light-intensity fire. Fires during periods of drought can burn into the duff or mineral soil killing rhizomes and plants. Fern cover also may be reduced when adjacent overstory conifer stands burn, because of the increased soil temperatures and reduced soil moisture that results when plants are exposed to full sunlight. Lupines, in general, have stout, deep taproots and will sprout from the root caudex following fire. In addition, lupine seeds are stored in the soil seed bank and germinate on mineral soil in full sunlight or partial shade (Steele and Geier-Hayes 1993).

Animals—

Livestock. Observations suggest that livestock use of the FORB series is variable depending on the plant association, adjacent plant associations, season of use, previous grazing history, extent of site, herb palatability, forage production, soil wetness, and length of seasonal flooding. High-elevation associations (MILE, LUPO, and TRLA4-CABI) rarely are within existing grazing allotments, although they probably were impacted in the past. Lupines are considered an increaser in overgrazed pastures, and it is possible the LULA association is a long-lasting enduring community type created by past overgrazing. The high-elevation TRLA4-CABI association often occurs in mosaic with MEADOW associations such as CANI2 and CASCB. However, most plots appear to be slightly dry for sedge dominance, and it is unlikely that these plots reflect past grazing disturbance. If fens and meadows containing TRLA4-CABI as part of the mosaic are overused, this association will be one of the first to degrade owing to its relatively lower soil moisture and accessibility earlier in the growing season compared with wetter sites in the MEADOW series. Where TRLA4-CABI sites occur within forests, on slumps, or in springs, they probably receive little use by livestock, even in active allotments. The few MILE plots appear to be natural communities that do not reflect past grazing disturbances. The SAPU association usually lies within forest valleys that receive little impact from livestock. In addition, SAPU also occurs on rather inaccessible floodplains and lower streambanks, further reducing its potential use by livestock. ATFI-GYDR is usually not heavily impacted by livestock grazing owing to the low palatability of the ferns, moist to wet soils, and their location within forested valley bottoms that receive little livestock use.

Livestock forage values are generally poor for the indicator species in the FORB series. Other plants providing fair to good forage include alpine aster, alpine leafybract aster, wood reed-grass, mannagrass species, and arrowleaf groundsel. However, many forbs in the FORB series tend to be low in palatability and function as increasers/invaders when livestock overuse sites. Lady ferns contain folic acid and may be poisonous to some classes of livestock (Dayton 1960, Ratliff 1985). Lupines contain alkaloids that may be harmful to sheep, cattle, and horses.

Cattle can create streambank sloughing when drinking water or traveling along the channel. Ruts from any of these sources may concentrate surface or flood water, creating streambank erosion or new channels. Trails at stream crossings can severely damage streambanks supporting SAPU, ATFI-GYDR, and MILE associations, and the damage can extend upstream and downstream following severe peak flows. Wet mineral soils are very susceptible to compaction, whereas wet organic soils can be broken and churned by grazing animals. For both soil types these actions can be very damaging (Hansen et al. 1995). The productivity of these sites may be lowered as the soils are compacted, perhaps owing to less soil porosity, making the sites less favorable for the natural dominants. Churned soils also lower biomass productivity through plant damage alone. The recovery from damage depends on the severity of disturbance. The combination of churned and compacted soil, replacement of natural dominants with increaser species and weeds, plus physical damage to the plants can result in long-term damage to the site that can take decades, even centuries to recover to predisturbance conditions. (For more information on forage palatability, see app. B-1. For potential biomass production, see app. B-5.)

Wildlife. Elk consume lady fern and oak fern fronds in spring and early summer, but these plants are not major food sources (Harcombe et al. 1983, Schwartz and Mitchell 1945). Grizzly bears have been reported to eat lady fern and oak fern fronds (Alaback 1982, Banner et al. 1986). Elk, deer, and small mammals are known to feed on lupine and eat the seed. Lupine may make up a large portion of the diet of pocket gophers in June (Lillybridge et al. 1995). Birds are known to eat the seeds of lupine. FORB series sites are of low importance to beavers. (For more information on thermal or feeding cover values, see apps. B-2 and B-3. For information on food values or degree of use, see apps. B-2 and B-4.)

Fish. The FORB series is often adjacent to streams that provide valuable spawning areas, feeding areas, and hiding cover for trout. The rhizome growth habit of herbs such as alpine lady fern, lady fern, oak fern, Lewis' monkey-flower, and saxifrage species help stabilize soils and streambanks. Sites on streambanks and floodplains are susceptible to the force of moving water. Where it has been highly altered, management should consider restoring forb meadow vegetation to provide plant diversity, wildlife and fish habitat, and streambank stability values. (For more information, see app. B-5, erosion control potential.) Bare streambanks can be planted with live plants, plugs, and rhizomes or seeded. Success will depend on protecting restoration efforts from the limiting factor that caused the vegetation to be reduced in cover or eliminated from the site in the first place. However, there usually are enough rhizomes and seeds in the soil seed bank or nearby vegetation to regenerate disturbed sites.

Recreation—

Forb-dominated plant associations are often next to water or near sites that provide valuable fishing and waterfowl hunting opportunities. They also are valuable sites for the enjoyment of watching songbirds or big game animals. Heavy use by people in spring and summer can result in soil compaction, bank damage, and exposed soils. Trail location on drier sites is important, as trails on FORB series sites tend to become rutted or to produce multiple, threaded trails through wet terrain. Off-road vehicles also create long-term damage on FORB series sites. Maintaining existing roads, discouraging off-road travel, and locating new roads and trails on adjacent uplands would be helpful in maintaining these sites.

Estimating Vegetation Potential on Disturbed Sites—

Estimating vegetation potential on disturbed sites is usually unnecessary on FS lands because FORB series sites are not usually affected by current management practices. However, where a site is next to good forage-producing communities within grazing allotments, damage can be severe. In that case, there is usually plenty of native vegetation to identify the FORB series and plant associations. For stands where the potential natural vegetation is largely gone, such as where floods have scoured the SAPU association, personal experience or similar sites in nearby drainages can help in estimating the site potential.

Sensitive Species—

One sensitive species, Smoky Mountain sedge, was found on a MILE association plot (app. D).

ADJACENT SERIES

Adjacent terraces and upland slopes are often dominated by coniferous forest in the TSHE, ABLA2, ABAM, and TSME series. Wetter sites often support plant associations in the SALIX and MEADOW series. This is especially true next to TRLA4-CABI association. The ALSI series may occur on streambanks next to the SAPU and ATFI-GYDR associations.

RELATIONSHIPS TO OTHER CLASSIFICATIONS

Several of the plant associations in the FORB series were known at the time of the draft classification for northeastern Washington (Kovalchik 1992c) but were not listed on account of low plot numbers. Therefore, virtually all FORB plant associations listed in this classification are newly classified climax communities. Plant associations similar to those found in the FORB series are unusual in other wetland and riparian classifications. The SAAR4 association of northeastern Oregon (Crowe and Clausnitzer 1997), SAAR4-SETR association of the Mount Hood and Gifford Pinchot NFs (Diaz and Mellen 1996), and CLUN association of central Oregon (Kovalchik 1987) are similar to the SAPU association of eastern Washington.

U.S. DEPARTMENT OF THE INTERIOR, FISH AND WILDLIFE SERVICE WETLANDS CLASSIFICATION

Most of the FORB associations belong to the system palustrine; class, emergent wetland; subclass, persistent; water regime (nontidal) intermittently saturated to temporarily flooded.

KEY TO FORB PLANT ASSOCIATIONS

1. Lady fern (*Athyrium filix-femina*), alpine lady fern (*A. distentifolium*), and/or oak fern, (*Gymnocarpium dryopteris*) ≥10 percent canopy coverage or dominant ....**Lady fern–oak fern (ATFI-GYDR) association**

2. Lewis' monkey-flower (*Mimulus lewisii*) ≥25 percent canopy coverage or dominant .... **Lewis' monkey-flower (MILE) association**

3. Globeflower (*Trollius laxus*) and/or twinflower marshmarigold (*Caltha biflora*) ≥10 percent canopy coverage or dominant ....**Globeflower-twinflower marshmarigold (TRLA4-CABI) association**

4. Sites are splash zones along streambanks and floodplains; saxifrages such as dotted, Merten's, or brook saxifrage (*Saxifraga* spp.) ≥5 percent canopy coverage or dominant ....**Dotted saxifrage (SAPU) association**

5. Broadleaf lupine (*Lupinus latifolius*) ≥10 percent canopy coverage or dominant ....**Broadleaf lupine (LULA) association**

Table 25—Constancy and mean cover of important plant species in the FORB plant associations

		ATFI-GYDR 12 plots		LULA 2 plots		MILE 3 plots		SAPU 6 plots		TRLA4-CABI 6 plots	
Species	**Code**	**CON[a]**	**COV[b]**	**CON**	**COV**	**CON**	**COV**	**CON**	**COV**	**CON**	**COV**
Tree overstory:											
subalpine fir	ABLA2	8	10	—	—	—	—	—	—	67	4
Engelmann spruce	PIEN	17	9	—	—	—	—	17	Tr[c]	33	2
Tree understory:											
subalpine fir	ABLA2	25	1	—	—	33	Tr	33	3	83	2
Engelmann spruce	PIEN	25	1	50	1	—	—	33	Tr	17	1
mountain hemlock	TSME	8	1	—	—	—	—	33	5	17	1
Shrubs:											
Sitka alder	ALSI	33	8	—	—	33	3	17	2	—	—
rusty menziesia	MEFE	33	5	—	—	—	—	—	—	17	3
Cascade azalea	RHAL	25	4	—	—	—	—	17	1	33	5
prickly currant	RILA	58	5	—	—	—	—	50	1	—	—
undergreen willow	SACO2	—	—	50	5	33	5	—	—	17	10
Perennial forbs:											
western yarrow	ACMI	—	—	50	Tr	—	—	17	Tr	—	—
sharptooth angelica	ANAR	42	1	—	—	33	10	33	3	33	Tr
Holboell's rockcress	ARHO	—	—	50	Tr	—	—	—	—	—	—
small-leaf rockcress	ARMI2	—	—	50	Tr	—	—	—	—	—	—
mountain arnica	ARLA	25	1	—	—	33	1	67	4	67	3
hairy arnica	ARMO	—	—	100	25	—	—	—	—	33	1
alpine aster	ASAL	—	—	50	5	—	—	—	—	33	6
alpine leafybract aster	ASFO	—	—	—	—	—	—	—	—	33	8
aster species	ASTER	25	9	—	—	—	—	—	—	33	4
twinflower marshmarigold	CABI	8	3	—	—	33	5	—	—	100	23
Jeffrey's shooting-star	DOJE	—	—	—	—	—	—	67	4	17	5
alpine willow-weed	EPAL	17	1	100	5	100	3	67	2	17	2
red willow-weed	EPLA	—	—	—	—	33	50	—	—	—	—
peregrine fleabane	ERPE	—	—	50	Tr	33	15	17	2	—	—
sweetscented bedstraw	GATR	58	1	—	—	—	—	17	Tr	—	—
common cow-parsnip	HELA	17	Tr	—	—	—	—	50	1	—	—
false saxafrage	LEPY	—	—	—	—	33	1	33	7	33	1
Canby's licoriceroot	LICA2	—	—	—	—	—	—	—	—	67	1
Gray's licoriceroot	LIGR	17	2	100	5	33	1	17	1	—	—
partridgefoot	LUPE	—	—	—	—	67	5	17	10	—	—
broadleaf lupine	LULA	—	—	100	58	—	—	—	—	—	—
Lewis' monkey-flower	MILE	—	—	50	5	100	32	33	Tr	—	—
large mountain mimulus	MITIC	—	—	—	—	33	7	—	—	—	—
fivestamen miterwort	MIPE	33	2	—	—	—	—	83	3	—	—
miterwort species	MITEL	33	4	—	—	33	5	17	1	17	Tr
broadleaved montia	MOCO	—	—	—	—	—	—	50	4	—	—
purple sweet-root	OSPU	17	Tr	—	—	33	Tr	50	1	—	—
fringed grass-of-parnassia	PAFI	8	Tr	—	—	—	—	50	5	50	2
elephanthead pedicularis	PEGR	—	—	50	Tr	33	Tr	—	—	50	Tr

Table 25—Constancy and mean cover of important plant species in the FORB plant associations (continued)

Species	Code	ATFI-GYDR 12 plots		LULA 2 plots		MILE 3 plots		SAPU 6 plots		TRLA4-CABI 6 plots	
		CON	COV	CON	COV	CON	COV	CON	COV	CON	COV
skunkleaf polemonium	POPU	—	—	50	7	—	—	—	—	—	—
fanleaf cinquefoil	POFL2	—	—	50	3	67	1	33	2	33	9
sidebells pyrola	PYSE	42	Tr	—	—	—	—	67	Tr	—	—
dotted saxifrage	SAPU	33	1	100	1	67	1	100	17	50	1
arrowleaf groundsel	SETR	50	3	100	13	33	20	83	2	83	4
claspleaf twisted-stalk	STAM	92	2	—	—	33	Tr	50	1	33	6
rosy twisted-stalk	STRO	33	7	—	—	—	—	50	1	17	30
coolwort foamflower	TITRU	67	9	—	—	33	Tr	33	13	17	5
globeflower	TRLA4	—	—	—	—	—	—	33	2	67	19
Sitka valerian	VASI	33	5	50	Tr	33	2	100	11	100	12
American false hellebore	VEVI	8	1	—	—	—	—	50	Tr	67	6
Cusick's speedwell	VECU	—	—	100	2	—	—	—	—	—	—
Wormskjold's speedwell	VEWO	—	—	—	—	67	Tr	—	—	33	1
pioneer violet	VIGL	75	1	—	—	33	Tr	50	1	67	4
Grass or grasslike:											
spike bentgrass	AGEX	—	—	—	—	67	3	—	—	17	Tr
Thurber's bentgrass	AGTH	8	1	—	—	67	3	17	25	50	1
bluejoint reedgrass	CACA	—	—	—	—	—	—	—	—	33	5
Hood's sedge	CAHO	—	—	50	Tr	—	—	—	—	—	—
black alpine sedge	CANI2	—	—	50	Tr	67	3	17	Tr	50	8
Holm's sedge	CASCB	—	—	50	2	—	—	—	—	17	2
saw-leaved sedge	CASCP2	—	—	—	—	—	—	33	1	17	5
showy sedge	CASP	—	—	—	—	67	1	—	—	33	9
wood reed-grass	CILA2	67	1	—	—	—	—	17	15	—	—
mountain hairgrass	DEAT	—	—	50	1	67	Tr	—	—	17	1
green fescue	FEVI	—	—	50	1	—	—	—	—	—	—
Drummond's rush	JUDR	—	—	100	2	100	2	17	Tr	83	Tr
Merten's rush	JUME	—	—	—	—	67	14	—	—	33	2
tuberous rush	JUNO	—	—	50	2	—	—	—	—	—	—
smooth woodrush	LUHI	—	—	50	Tr	33	1	33	Tr	33	Tr
alpine timothy	PHAL	—	—	100	2	67	1	—	—	50	Tr
Cusick's bluegrass	POCUE	—	—	50	Tr	—	—	—	—	—	—
Ferns and fern allies:											
alpine lady fern	ATDI	8	30	—	—	33	20	—	—	—	—
lady fern	ATFI	83	39	—	—	—	—	17	Tr	—	—
common horsetail	EQAR	8	Tr	—	—	33	Tr	17	Tr	33	18
oak fern	GYDR	58	42	—	—	—	—	33	Tr	—	—

[a] CON = percentage of plots in which the species occurred.
[b] COV = average canopy cover in plots in which the species occurred.
[c] Tr = trace cover, less than 1 percent canopy cover.

METRIC AND ENGLISH EQUIVALENTS

When you know:	Multiply by:	To obtain:
Inches (in)	2.540	Centimeters
Feet (ft)	0.305	Meters
Miles (mi)	1.609	Kilometers
Acres (ac)	0.405	Hectares
Ounces (oz)	28.35	Grams
Pounds (lb)	0.453	Kilograms
Pounds per acre (lb/ac)	1.129	Kilograms per hectare
Linear feet per acre	0.753	Linear meters per hectare
Square feet per acre (ft^2/ac)	0.229	Square meters per hectare
Cubic feet per acre (ft^3/ac)	0.07	Cubic meters per hectare
Trees per acre	2.471	Trees per hectare
Degrees Fahrenheit (°F)	0.5555 (°F - 32)	Degrees Celsius (°C)
Centimeters (cm)	0.394	Inches
Meters (m)	3.28	Feet
Square millimeters (mm^2)	.00155	Square inches

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Appendix A—Aquatic, Riparian, and Wetland Plant, Animal, and Insect Species, and Diseases Mentioned in This Classification

Key to Appendixes A-1 and A-2

OBL (obligate wetland plants)
FAC (facultative plants)
FACW (facultative wetland plants)
FACU (facultative upland plants)
Y = a species that is used to key and characterize the series and plant associations
N = a plant that occurs with at least 50 percent constancy in at least one plant association

Appendix A-1—Aquatic, Riparian, and Wetland Plants Listed by Scientific Name

PNW region code	Plants database code	Scientific name	Common name	Indicator species	Hydrologic status
Trees:					
ABAM	ABAM	*Abies amabilis*	Pacific silver fir	Y	FACU
ABCO	ABCO	*Abies concolor*	white fir	N	FACU
ABGR	ABGR	*Abies grandis*	grand fir	Y	FACU
ABLA2	ABLA3	*Abies lasiocarpa*	subalpine fir	Y	FACU
ABPR	ABPR	*Abies procera*	noble fir	N	FACU
ACMA	ACMA3	*Acer macrophyllum*	bigleaf maple	Y	FACU
ALRU	ALRU2	*Alnus rubra*	red alder	Y	FACW
BEPA	BEPA	*Betula papyrifera*	paper birch	Y	FACU-
CHNO	CHNO	*Chamaecyparis nootkatensis*	Alaska yellow-cedar	N	FACU
LALY	LALY	*Larix lyallii*	subalpine larch	Y	FACU
LAOC	LAOC	*Larix occidentalis*	western larch	N	FACU
PIEN	PIEN	*Picea engelmannii*	Engelmann spruce	Y	FACU
PIGL	PIGL	*Picea glauca*	white spruce	Y	FACU
PIAL	PIAL	*Pinus albicaulis*	whitebark pine	N	FACU
PICO	PICO	*Pinus contorta*	lodgepole pine	Y	FACU
PIMO	PIMO3	*Pinus monticola*	western white pine	N	FACU
PIPO	PIPO	*Pinus ponderosa*	ponderosa pine	N	FACU
POTR	POTR5	*Populus tremuloides*	quaking aspen	Y	FACU
POTR2	POTR15	*Populus trichocarpa*	black cottonwood	Y	FACW
PSME	PSME	*Pseudotsuga menziesii*	Douglas-fir	Y	FACU
QUGA	QUGA4	*Quercus garryana*	Oregon white oak	Y	FACU
THPL	THPL	*Thuja plicata*	western redcedar	Y	FACU
TSHE	TSHE	*Tsuga heterophylla*	western hemlock	Y	FACU
TSME	TSME	*Tsuga mertensiana*	mountain hemlock	Y	FACU
Shrubs:					
ACCI	ACCI	*Acer circinatum*	vine maple	Y	FACU
ACGLD	ACGLD4	*Acer glabrum* var. *douglasii*	Douglas maple	Y	FACU
ALIN	ALIN2	*Alnus incana*	mountain alder	Y	FACW
ALSI	ALSI3	*Alnus sinuata*	Sitka alder	Y	FAC+
AMAL	AMAL2	*Amelanchier alnifolia*	Saskatoon serviceberry	Y	FACU
ARUV	ARUV	*Arctostaphylos uva-ursi*	bearberry	Y	FACU-
BEAQ	BEAQ	*Berberis aquifolium*	Oregon hollygrape	N	FACU
BENE	BENE2	*Berberis nervosa*	Cascade hollygrape	N	FACU
BERE	BERE	*Berberis repens*	creeping hollygrape	N	FACU
BEGL	BEGL	*Betula glandulosa*	bog birch	Y	OBL
BEGLG	BEGLG	*Betula glandulosa* var. *glandulosa*	bog birch	Y	OBL
BEOC	BEOC2	*Betula occidentalis*	water birch	N	FACW
CAME	CAME7	*Cassiope mertensiana*	Merten's moss-heather	Y	FAC
CAST5	CAST6	*Cassiope stelleriana*	Alaska moss-heather	Y	FAC
CATE2	CATE11	*Cassiope tetragona*	four-angled moss-heather	Y	FAC
CHME	CHME	*Chimaphila menziesii*	little prince's-pine	N	FACU
CHUM	CHUM	*Chimaphila umbellata*	western prince's-pine	N	FACU
CHUMO	CHUMO	*Chimaphila umbellata* var. *occidentalis*	western prince's-pine	N	FACU
COCA	COCA13	*Cornus canadensis*	bunchberry dogwood	Y	FACW-
COST	COST	*Cornus stolonifera*	red-osier dogwood	Y	FACW
COSTO	COST4	*Cornus stolonifera* var. *occidentalis*	red-osier dogwood	Y	FACW
COCO2	COCO6	*Corylus cornuta*	California hazel	Y	FAC+
CRDOD	CRDOD	*Crataegus douglasii* var. *douglasii*	black hawthorn	Y	FAC
GAHI	GAHI2	*Gaultheria hispidula*	moxieplum	N	OBL
GAHU	GAHU	*Gaultheria humifusa*	western wintergreen	N	FAC+
GAOV	GAOV2	*Gaultheria ovatifolia*	slender wintergreen	N	FAC+
HODI	HODI	*Holodiscus discolor*	oceanspray	N	FACU
KAMI	KAMI	*Kalmia microphylla*	alpine laurel	N	FACW
LEGL	LEGL	*Ledum glandulosum*	Labrador tea	Y	FACW-
LEGLG	LEGLG	*Ledum glandulosum* var. *glandulosum*	Labrador tea	Y	FACW-

Appendix A-1—Aquatic, Riparian, and Wetland Plants Listed by Scientific Name (continued)

PNW region code	Plants database code	Scientific name	Common name	Indicator species	Hydrologic status
LIBOL	LIBOL	*Linnaea borealis* var. *longiflora*	twinflower	Y	FACU+
LOIN	LOIN5	*Lonicera involucrata*	bearberry honeysuckle	N	FACW
LOUT	LOUT2	*Lonicera utahensis*	Utah honeysuckle	N	FACU
MEFE	MEFE	*Menziesia ferruginea*	rusty menziesia	Y	FACU+
OPHO	OPHO	*Oplopanax horridum*	devil's club	Y	FACW
PAMY	PAMY	*Pachistima myrsinites*	myrtle pachistima	Y	FACU-
PHLE2	PHLE4	*Philadelphus lewisii*	Lewis' mock orange	N	FAC
PHEM	PHEM	*Phyllodoce empetriformis*	red mountain-heath	Y	FAC
PHGL	PHGL6	*Phyllodoce glanduliflora*	cream mountain-heath	Y	FAC
POFR	POFR15	*Potentilla fruticosa*	shrubby cinquefoil	Y	FAC
PREM	PREM	*Prunus emarginata*	bittercherry	N	FACU
PRVI	PRVI	*Prunus virginiana*	common chokecherry	Y	FACU
RHAL2	RHAL	*Rhamnus alnifolia*	alder buckthorn	N	FACW
RHPU	PHPU	*Rhamnus purshiana*	Pursh buckthorn	N	FACW
RHAL	RHAL2	*Rhododendron albiflorum*	Cascade azalea	Y	FACU
RIBR	RIBR	*Ribes bracteosum*	stink currant	Y	FACW
RIHO	RIHO2	*Ribes howellii*	mapleleaf currant	N	FAC
RIHU	RIHU	*Ribes hudsonianum*	Hudsonbay currant	Y	FACW+
RIIN	RIIN2	*Ribes inerme*	whitestem gooseberry	N	FACU
RILA	RILA	*Ribes lacustre*	prickly currant	Y	FACW
RILA2	RILA3	*Ribes laxiflorum*	western currant	N	FAC
RIBES	RIBES	*Ribes* spp.	currant species	N	FAC
ROGY	ROGY	*Rosa gymnocarpa*	baldhip rose	N	FAC
RONU	RONU	*Rosa nutkana*	Nootka rose	N	FAC
ROSA	ROSA	*Rosa* spp.	rose species	N	FAC
ROWO	ROWO	*Rosa woodsii*	Wood's rose	N	FAC
RUID	RUID	*Rubus idaeus*	red raspberry	N	FAC
RULA	RULA	*Rubus lasiococcus*	dwarf bramble	Y	FACU
RUPA	RUPA	*Rubus parviflorus*	western thimbleberry	N	FAC+
RUPE	RUPE	*Rubus pedatus*	five-leaved bramble	N	FACW
RUPU2	RUPU	*Rubus pubescens*	dwarf red blackberry	N	FACW-
RUSP	RUSP	*Rubus spectabilis*	salmonberry	Y	FACW-
RUUR	RUUR	*Rubus ursinus*	Pacific blackberry	N	FACW-
SABA	SABA3	*Salix barclayi*	Barclay's willow	Y	FACW+
SABE	SABE2	*Salix bebbiana*	Bebb's willow	Y	FACW+
SABEP	SABEP	*Salix bebbiana* var. *perrostrata*	Bebb's willow	Y	FACW+
SABO2	SABO2	*Salix boothii*	Booth's willow	Y	OBL
SABR2	SABR	*Salix brachycarpa*	short-fruited willow	Y	OBL
SACA9	SACA4	*Salix candida*	hoary willow	Y	OBL
SACA6	SACA6	*Salix cascadensis*	Cascade willow	Y	FAC
SACO2	SACO2	*Salix commutata*	undergreen willow	Y	OBL
SADR	SADR	*Salix drummondiana*	Drummond's willow	Y	OBL
SAEA	SAEA	*Salix eastwoodiae*	Eastwood's willow	N	OBL
SAEX	SAEX	*Salix exigua*	coyote willow	Y	OBL
SAEXE	SAEXE	*Salix exigua* var. *exigua*	coyote willow	Y	OBL
SAFA	SAFA	*Salix farriae*	Farr's willow	Y	OBL
SAGEG	SAGEG	*Salix geyeriana* var. *geyeriana*	Geyer's willow	Y	FACW+
SAGEM	SAGEM	*Salix geyeriana* var. *meleiana*	Geyer's willow	Y	FACW+
SAGL	SAGL	*Salix glauca*	glaucous willow	Y	OBL
SALAC	SALAC	*Salix lasiandra* var. *caudata*	whiplash willow	Y	FACW+
SALAL	SALAL	*Salix lasiandra* var. *lasiandra*	Pacific willow	Y	FACW+
SALE	SALE	*Salix lemmonii*	Lemmon's willow	Y	OBL
SAMA	SAMA12	*Salix maccalliana*	McCalla's willow	Y	OBL
SAME2	SAME2	*Salix melanopsis*	dusky willow	Y	OBL
SANI	SANI8	*Salix nivalis*	snow willow	Y	FAC
SANIN	SANIN	*Salix nivalis* var. *nivalis*	snow willow	Y	FACs
SAPE3	SAPE2	*Salix pedicellaris*	bog willow	Y	OBL
SAPI	SAPI	*Salix piperi*	Piper's willow	Y	OBL
SAPLM2	SAPLM3	*Salix planifolia* var. *monica*	tea-leaved willow	Y	OBL
SAPS2	SAPS	*Salix pseudomonticola*	false mountain willow	Y	OBL
SARIM2	SARIM4	*Salix rigida* var. *mackenzieana*	Mackenzie's willow	Y	OBL
SASC	SASC	*Salix scouleriana*	Scouler's willow	Y	FAC
SASI2	SASI3	*Salix sitchensis*	Sitka willow	Y	FACW
SALIX	SALIX	*Salix* spp.	willow species	Y	FACW
SATW	SATW	*Salix tweedyi*	Tweedy's willow	Y	OBL
SARA	SARA2	*Sambucus racemosa*	scarlet elderberry	N	FACU
SHCA	SHCA	*Shepherdia canadensis*	russet buffaloberry	N	FACU
SHCA	SHCA	*Shepherdia canadensis*	russet buffaloberry	N	FACU
SOSC2	SOSC2	*Sorbus scopulina*	Cascade mountain-ash	N	FACU
SOSI	SOSI2	*Sorbus sitchensis*	Sitka mountain-ash	N	FACU
SPBE	SPBE2	*Spiraea betulifolia*	shiny-leaf spiraea	N	FACU

Appendix A-1—Aquatic, Riparian, and Wetland Plants Listed by Scientific Name (continued)

PNW region code	Plants database code	Scientific name	Common name	Indicator species	Hydrologic status
SPBEL	SPBEL	*Spiraea betulifolia* var. *lucida*	shiny-leaf spiraea	N	FACU
SPDE	SPDE	*Spiraea densiflora*	subalpine spiraea	N	FAC+
SPDO	SPDO	*Spiraea douglasii*	Douglas spiraea	Y	OBL
SPDOD	SPDOD	*Spiraea douglasii* var. *douglasii*	Douglas spiraea	Y	OBL
SPDOM	SPDOM	*Spiraea douglasii* var. *menziesii*	Menzies spiraea	Y	OBL
SPPY	SPPY	*Spiraea pyramidata*	pyramid spiraea	Y	OBL
SYAL	SYAL	*Symphoricarpos albus*	common snowberry	Y	FACU
VAAL	VAAL	*Vaccinium alaskaense*	Alaska huckleberry	Y	FACU
VACA	VACA	*Vaccinium caespitosum*	dwarf huckleberry	Y	FACU
VADE	VADE	*Vaccinium deliciosum*	Cascade huckleberry	Y	FACU
VAGL	VAGL	*Vaccinium globulare*	Globe huckleberry	N	FACU
VAME	VAME	*Vaccinium membranaceum*	big huckleberry	Y	FACU
VAMY	VAMY2	*Vaccinium myrtillus*	low huckleberry	Y	FACU
VAOC2	VAOC	*Vaccinium occidentale*	western bog blueberry	N	OBL
VAOV	VAOV	*Vaccinium ovalifolium*	oval-leaf huckleberry	Y	FACU
VAPA	VAPA	*Vaccinium parvifolium*	red whortleberry	N	FACU
VASC	VASC	*Vaccinium scoparium*	grouse huckleberry	Y	FACU
VIED	VIED	*Viburnum edule*	moosewood viburnum	N	FACW
Grasslike:					
CAAM	CAAM10	*Carex amplifolia*	bigleaf sedge	Y	FACW+
CAAP3	CAAP3	*Carex aperta*	Columbia sedge	Y	FACW+
CAAQA	CAAQA	*Carex aquatilis* var. *aquatilis*	water sedge	Y	OBL
CAAQS	CAAQS	*Carex aquatilis* var. *sitchensis*	Sitka sedge	Y	OBL
CAAR2	CAAR3	*Carex arcta*	northern clustered sedge	N	FACW+
CAAT2	CAAT2	*Carex atherodes*	awned sedge	Y	OBL
CAAT	CAAT3	*Carex athrostachya*	slender-beaked sedge	N	FAC
CAAT3	CAAT5	*Carex atrata*	blackened sedge	N	FACW+
CABR6	CABR15	*Carex brunnescens*	brownish sedge	N	FACW+
CABU2	CABU6	*Carex buxbaumii*	Buxbaum's sedge	Y	OBL
CACA4	CACA5	*Carex canescens*	gray sedge	N	FACW+
CACO	CACO11	*Carex concinnoides*	northwestern sedge	N	FACU
CACR3	CACR4	*Carex crawfordii*	Crawford's sedge	N	FAC
CACU2	CACU5	*Carex cusickii*	Cusick's sedge	Y	OBL
CADE	CADE	*Carex deweyana*	Dewey's sedge	N	FACW+
CADI2	CADI4	*Carex diandra*	lesser panicled sedge	N	OBL
CADI	CADI6	*Carex disperma*	soft-leaved sedge	Y	FACW+
CAFL	CAFL4	*Carex flava*	yellow sedge	N	OBL
CAGE	CAGE	*Carex geyeri*	elk sedge	N	FACU
CAHO	CAHO	*Carex hoodii*	Hood's sedge	N	FAC
CAIL	CAIL	*Carex illota*	sheep sedge	Y	FACW+
CAIN2	CAIN10	*Carex integra*	smooth-beaked sedge	N	FACW+
CAIN5	CAIN11	*Carex interior*	inland sedge	N	OBL
CALA	CALA13	*Carex laeviculmis*	smooth sedge	N	FACW+
CALA3	CALA30	*Carex lanuginosa*	woolly sedge	Y	OBL
CALA4	CALA4	*Carex lasiocarpa*	slender sedge	Y	OBL
CALE5	CALE5	*Carex lenticularis*	lenticular sedge	Y	OBL
CALI	CALI	*Carex limosa*	mud sedge	Y	OBLtus
CALU	CALU7	*Carex luzulina*	woodrush sedge	N	OBL
CAME2	CAME	*Carex mertensii*	Merten's sedge	N	FAC
CAMU2	CAMU3	*Carex muricata*	muricate sedge	N	OBL
CANE	CANE	*Carex nebraskensis*	Nebraska sedge	N	OBL
CANI2	CANI2	*Carex nigricans*	black alpine sedge	Y	FACW-
CAPA	CAPA19	*Carex pachystachya*	thick-headed sedge	N	FACU
CAPA9	CAPA22	*Carex paupercula*	poor sedge	Y	OBL
CAPR9	CAPR10	*Carex proposita*	Smoky Mountain sedge	N	FACU
CARE	CARE4	*Carex retrorsa*	retrorse sedge	N	OBL
CARO2	CARO6	*Carex rostrata*	beaked sedge	Y	OBL
CASA2	CASA10	*Carex saxatilis* var. *major*	russet sedge	Y	OBL
CASCB	CASCB	*Carex scopulorum* var. *bracteosa*	Holm's sedge	Y	FACW+
CASCP2	CASCP	*Carex scopulorum* var. *prionophylla*	saw-leaved sedge	Y	OBL
CASC3	CASC10	*Carex scirpoidea*	western singlespike sedge	N	FAC+
CASCP	CASCP	*Carex scirpoidea* var. *pseudoscirpoidea*	western singlespike sedge	N	FAC+
CASI2	CASI3	*Carex simulata*	shortbeaked sedge	N	OBL
CASP	CASP5	*Carex spectabilis*	showy sedge	Y	FAC
CAUT	CAUT	*Carex utriculata*	bladder sedge	Y	OBL
CAVE	CAVE6	*Carex vesicaria*	inflated sedge	Y	OBL
ELAC	ELAC	*Eleocharis acicularis*	needle spike-rush	N	OBL
ELPA	ELPA3	*Eleocharis palustris*	creeping spike-rush	Y	OBL
ELPA2	ELPA6	*Eleocharis pauciflora*	few-flowered spike-rush	Y	OBL
ERCH2	ERCH7	*Eriophorum chamissonis*	Chamisso cotton-grass	Y	OBL
ERGR2	ERGR8	*Eriophorum gracile*	slender cotton-grass	Y	OBL

Appendix A-1—Aquatic, Riparian, and Wetland Plants Listed by Scientific Name (continued)

PNW region code	Plants database code	Scientific name	Common name	Indicator species	Hydrologic status
ERPO2	ERPO3	*Eriophorum polystachion*	many-spiked cotton-grass	Y	OBL
ERVI	ERVI9	*Eriophorum viridicarinatum*	green-keeled cotton-grass	Y	OBL
JUBA	JUBA	*Juncus balticus*	Baltic rush	N	FACW+
JUDR	JUDR	*Juncus drummondii*	Drummond's rush	N	FACU
JUFI	JUFI	*Juncus filiformis*	thread rush	N	FACW+
JUME	JUME3	*Juncus mertensianus*	Merten's rush	N	OBL
JUNO	JUNO2	*Juncus nodosus*	tuberous rush	N	FACW+
JUPA	JUPA	*Juncus parryi*	Parry's rush	N	FACU
LUAR4	LUAR5	*Luzula arcuata*	curved woodrush	N	FACU
LUHI	LUHI4	*Luzula hitchcockii*	smooth woodrush	Y	FACU
LUPA	LUPA4	*Luzula parviflora*	smallflowered woodrush	N	FACU
SCAC	SCAC	*Scirpus acutus*	hardstem bulrush	Y	OBL
SCMI	SCMI2	*Scirpus microcarpus*	small-fruited bulrush	Y	OBL
SCVA	SCVA	*Scirpus validus*	softstem bulrush	Y	OBL
Grasses:					
AGCA	AGCA	*Agropyron caninum*	cutting wheatgrass	N	FACU
AGAL	AGAL3	*Agrostis alba*	redtop	N	FACW
AGEX	AGEX	*Agrostis exarata*	spike bentgrass	N	FACW
AGID	AGID	*Agrostis idahoensis*	Idaho bentgrass	N	FACW
AGOR	AGOR	*Agrostis oregonensis*	Oregon bentgrass	N	FACW-
AGSC	AGSC5	*Agrostis scabra*	winter bentgrass	N	FAC+
AGTH	AGTH	*Agrostis thurberiana*	Thurber's bentgrass	N	FACW
AGVA	AGVA	*Agrostis variabilis*	variant bentgrass	N	FACW
BRCI	BRCI	*Bromus ciliatus*	fringed brome-grass	N	FACU+
BRIN	BRIN2	*Bromus inermis*	smooth brome	N	FACU
BROMU	BROMU	*Bromus* spp.	brome species	N	FACU+
BRVU	BRVU	*Bromus vulgaris*	Columbia brome	N	FACU+
CACA	CACA4	*Calamagrostis canadensis*	bluejoint reedgrass	Y	FACW+
CANE3	CANE4	*Calamagrostis neglecta*	slimstem reedgrass	N	FACW
CARU	CARU	*Calamagrostis rubescens*	pinegrass	N	FACU
CILA2	CILA2	*Cinna latifolia*	wood reed-grass	Y	FACW
CINNA	CINNA	*Cinna* spp.	woodreed species	N	FACW
DAIN	DAIN	*Danthonia intermedia*	timber oatgrass	Y	FACU+
DEAT	DEAT2	*Deschampsia atropurpurea*	mountain hairgrass	N	FACU+
DECE	DECE	*Deschampsia cespitosa*	tufted hairgrass	Y	FACW
ELCA	ELCA4	*Elymus canadensis*	Canada wildrye	N	FACW-
ELCI	ELCI2	*Elymus cinereus*	basin wildrye	N	FACW-
ELGL	ELGL	*Elymus glaucus*	blue wildrye	N	FACU
FEOC	FEOC	*Festuca occidentalis*	western fescue	N	FACW-
FEOVR	FEOVR	*Festuca ovina* var. *rydbergii*	sheep fescue	Y	FACU
FEVI	FEVI	*Festuca viridula*	green fescue	N	FACU
GLBO	GLBO	*Glyceria borealis*	northern mannagrass	Y	OBL
GLEL	GLEL	*Glyceria elata*	tall mannagrass	Y	FACW+
GLGR	GLGR	*Glyceria grandis*	reed mannagrass	Y	OBL
GLOC	GLOC	*Glyceria occidentalis*	western mannagrass	Y	OBL
GLST	GLST	*Glyceria striata*	fowl mannagrass	Y	OBL
MUGL	MUGL3	*Muhlenbergia glomerata*	marsh muhly	N	OBL
PHAR	PHAR3	*Phalaris arundinacea*	reed canarygrass	Y	FACW
PHAL	PHAL2	*Phleum alpinum*	alpine timothy	N	FAC
PHPR	PHPR3	*Phleum pratense*	timothy	N	FAC
POCUE	POCUE	*Poa cusickii epilis*	Cusick's bluegrass	N	FACU
POLE	POLE2	*Poa leptocoma*	bog bluegrass	N	FACW
POPA	POPA4	*Poa palustris*	fowl bluegrass	N	FACW
POPR	POPR	*Poa pratensis*	Kentucky bluegrass	Y	FAC
PUPAH	PUPAH	*Puccinellia pauciflora* var. *holmii*	weak alkaligrass	N	OBL
PUPAM	PUPAM2	*Puccinellia pauciflora* var. *microtheca*	pale false mannagrass	N	OBL
TRSP	TRSP2	*Trisetum spicatum*	spike trisetum	N	FACU
Forbs:					
ACMI	ACMI	*Achillea millefolium*	western yarrow	N	FACU
ACTR	ACTR	*Achlys triphylla*	deerfoot vanillaleaf	Y	FAC+
ACCO	ACCO4	*Aconitum columbianum*	Columbia monkshood	N	FACW
ACRU	ACRU2	*Actaea rubra*	baneberry	N	FACW-
ADBI	ADBI	*Adenocaulon bicolor*	pathfinder	N	FAC+
AGEL2	AGEL	*Agoseris elata*	tall agoseris	N	FACU
AGGL	AGGL	*Agoseris glauca*	pale agoseris	N	FACW
ALLIU	ALLIU	*Allium* spp.	wild onion species	N	FACU
ANMA	ANMA	*Anaphalis margaritacea*	common pearly-everlasting	N	FACU
ANOR	ANOR	*Anemone oregana*	Oregon anemone	N	FACU
ANAR	ANAR3	*Angelica arguta*	sharptooth angelica	N	FACW
ANAL	ANAL3	*Antennaria alpina*	alpine pussytoes	N	FACU

Appendix A-1—Aquatic, Riparian, and Wetland Plants Listed by Scientific Name (continued)

PNW region code	Plants database code	Scientific name	Common name	Indicator species	Hydrologic status
ANMI	ANMI2	*Antennaria microcephala*	rose pussytoes	N	FACU
ANRA	ANRA	*Antennaria racemosa*	raceme pussytoes	N	FACU
ANUM	ANUM	*Antennaria umbrinella*	umber pussytoes	N	FACU
ARHO	ARHO	*Arabis holboellii*	Holboell's rockcress	N	FACU
ARMI2	ARMI3	*Arabis microphylla*	small-leaf rockcress	N	FACU
ARNU3	ARNU3	*Aralia nudicaulis*	wild sarsaparilla	Y	FACW-
ARMA3	ARMA4	*Arenaria macrophylla*	largeleaf sandwort	N	FAC
ARAM	ARAM	*Arnica amplexicaulis*	clasping arnica	N	FACW-
ARCH	ARCH	*Arnica chamissonis*	Chamisso arnica	N	FACW-
ARCO	ARCO	*Arnica cordifolia*	heart-leaf arnica	N	FACU
ARLA	ARLA8	*Arnica latifolia*	mountain arnica	Y	FAC
ARMO	ARMO4	*Arnica mollis*	hairy arnica	N	FAC
ARNIC	ARNIC	*Arnica* spp.	arnica species	N	FAC
ARLU	ARLU	*Artemisia ludoviciana*	herbaceous sage	N	FACU
ARSY	ARSY2	*Aruncus sylvester*	sylvan goatsbeard	N	FAC
ASCA3	ASCA2	*Asarum caudatum*	wild ginger	Y	FACW-
ASAL	ASAL2	*Aster alpigenus*	alpine aster	N	FACU
ASCO	ASCO3	*Aster conspicuus*	showy aster	N	FACU
ASFO	ASFO	*Aster foliaceus*	alpine leafybract aster	N	FACW-
ASMO	ASMO3	*Aster modestus*	fewflower aster	N	FACW-
ASOC	ASOC	*Aster occidentalis*	western aster	N	FACW-
ASSI2	ASSI	*Aster sibiricus*	arctic aster	N	FACU
ASTER	ASTER	*Aster* spp.	aster species	N	FACU
BICE	BICE	*Bidens cernua*	nodding beggars-tick	N	OBL
CABI	CABI2	*Caltha biflora*	twinflower marshmarigold	Y	FACW+
CABIB	CABIB	*Caltha biflora* var. *biflora*	twinflower marshmarigold	Y	FACW+
CABIR	CABIR	*Caltha biflora* var. *rotundifolia*	twinflower marshmarigold	Y	FACW+
CALE2	CALE2	*Caltha leptosepala*	elkslip	N	FACW
CAPE3	CAPE4	*Cardamine pennsylvanica*	Pacific bittercress	N	FACW
CIDO	CIDO	*Cicuta douglasii*	western water-hemlock	N	OBL
CIBU	CIBU	*Cicuta bulbifera*	bulbed water-hemlock	N	OBL
CIAL	CIAL	*Circaea alpina*	enchanter's nightshade	N	FACW
CIAR	CIAR4	*Cirsium arvense*	Canada thistle	N	FACW-
CIRCI	CIRCI	*Cirsium* spp.	thistle species	N	FAC
CLLI	CLLI	*Clematis ligusticifolia*	western white clematis	N	FAC
CLUN	CLUN2	*Clintonia uniflora*	queencup beadlily	Y	FACU+
DEVI	DEVI	*Delphinium viridescens*	Wenatchee larkspur	N	FACW
DIHO	DIHO3	*Disporum hookeri*	Hooker's fairy-bells	N	FAC+
DITR	DITR	*Disporum trachycarpum*	roughfruit fairy-bells	N	FAC
DOCO	DOCO	*Dodecatheon conjugens*	slimpod shooting-star	N	FAC
DODE	DODE	*Dodecatheon dentatum*	dentate shooting-star	N	FAC+
DOJE	DOJE	*Dodecatheon jeffreyi*	Jeffrey's shooting-star	N	FACW
DODEC	DODEC	*Dodecatheon* spp.	shooting-star species	N	FAC+
ELCA3	ELCA7	*Elodea canadensis*	Canada waterweed	N	OBL
ELODE	ELODE	*Elodea* spp.	waterweed species	N	OBL
EPAL	EPAL	*Epilobium alpinum*	alpine willow-weed	N	FAC+
EPAN	EPAN	*Epilobium angustifolium*	fireweed	N	FACU
EPGL	EPGL	*Epilobium glaberrimum*	smooth willow-weed	N	FACW
EPLA	EPLA	*Epilobium latifolium*	red willow-weed	N	FACW
EPILO	EPILO	*Epilobium* spp.	willow-weed species	N	FAC
EPWA	EPWA3	*Epilobium watsonii*	Watson's willow-weed	N	FACW
ERAU	ERAU	*Erigeron aureus*	golden fleabane	N	FAC
ERPE	ERPE3	*Erigeron peregrinus*	peregrine fleabane	N	FACW
ERPEC	ERPEC	*Erigeron peregrinus* var. *callianthemus*	peregrine fleabane	N	FACW
ERPES	ERPES3	*Erigeron peregrinus* var. *scaposus*	peregrine fleabane	N	FACW
FRVEB	FRVEB3	*Fragaria vesca* var. *bracteata*	woods strawberry	N	FACU
FRVIP	FRVIP3	*Fragaria virginiana* var. *platypetala*	broadpetal strawberry	N	FACU
GAAP	GAAP2	*Galium aparine*	catchweed bedstraw	N	FAC-
GAAS	GAAS	*Galium asperrimum*	rough bedstraw	N	FACU
GABO	GABO2	*Galium boreale*	northern bedstraw	N	FACU
GAKA	GAKA	*Galium kamtschaticum*	boreal bedstraw	N	FACU
GATRI	GATR2	*Galium trifidum*	small bedstraw	N	OBL
GATR	GATR3	*Galium triflorum*	sweetscented bedstraw	N	FACU
GECA	GECA	*Gentiana calycosa*	Rainier pleated gentian	N	FACW
GEMA	GEMA4	*Geum macrophyllum*	largeleaf avens	N	FACW
GEMAP	GEMAP	*Geum macrophyllum* var. *perincisum*	largeleaf avens	N	FACW
GERI2	GERI2	*Geum rivale*	water avens	N	FACW
GETR	GETR	*Geum triflorum*	old man's whiskers	N	FACU
GOOB	GOOB2	*Goodyera oblongifolia*	western rattlesnake plantain	N	FACU-
HADI2	HADI7	*Habenaria dilatata*	white bog-orchid	N	OBL
HASA	HASA	*Habenaria saccata*	slender bog-orchid	N	OBL

Appendix A-1—Aquatic, Riparian, and Wetland Plants Listed by Scientific Name (continued)

PNW region code	Plants database code	Scientific name	Common name	Indicator species	Hydrologic status
HELA	HELA4	*Heracleum lanatum*	common cow-parsnip	N	FAC+
HIAL	HIAL2	*Hieracium albiflorum*	white hawkweed	N	FACU
HIGR	HIGR	*Hieracium gracile*	slender hawkweed	N	FAC
HYCA	HYCA4	*Hyrdophyllum capitatum*	ballhead waterleaf	N	FAC
HYFE	HYFE	*Hydrophyllum fendleri*	Fendler's waterleaf	N	FACW-
HYAN	HYAN2	*Hypericum anagalloides*	trailing St. John's-wort	N	FACW
LAPA2	LAPA5	*Lathyrus pauciflorus*	fewflower peavine	N	FAC
LATHY	LATHY	*Lathyrus* spp.	peavine species	N	FAC
LEMI	LEMI3	*Lemna minor*	water lentil	N	OBL
LEPY	LEPY	*Leptarrhena pyrolifolia*	false saxafrage	N	FACW
LICA2	LICA2	*Ligusticum canbyi*	Canby's licorice-root	N	FAC
LIGR	LIGR	*Ligusticum grayi*	Gray's licorice-root	N	FAC
LICA3	LICA10	*Listera caurina*	northwestern twayblade	N	FACW-
LUPE	LUPE	*Luetkea pectinata*	partridgefoot	Y	FAC+
LULA	LULA4	*Lupinus latifolius*	broadleaf lupine	Y	FAC+
LUPO	LUPO2	*Lupinus polyphyllus*	bigleaf lupine	Y	FACW-
LUPIN	LUPIN	*Lupinus* spp.	lupine species	N	FAC
LYAM	LYAM3	*Lysichiton americanus*	skunk cabbage	Y	OBL
MEAR3	MEAR4	*Mentha arvensis*	field mint	N	FACW-
METR	METR3	*Menyanthes trifoliata*	common bogbean	N	OBL
MEPA	MEPA6	*Mertensia paniculata*	panicle bluebells	N	FACW
MECI	MECI13	*Mertensia ciliata*	mountain bluebells	N	FACU
MEPAB	MEPAB	*Mertensia paniculata* var. *borealis*	northern bluebells	N	FACW
MIGUG	MIGUG	*Mimulus guttatus* var. *guttatus*	common monkey-flower	N	OBL
MILE	MILE2	*Mimulus lewisii*	Lewis' monkey-flower	Y	FACW+
MITI	MITI	*Mimulus tilingii*	large mountain mimulus	N	OBL
MITIC	MITIC	*Mimulus tilingii* var. *caespitosus*	large mountain mimulus	N	OBL
MIPE	MIPE	*Mitella pentandra*	fivestamen miterwort	N	FACW
MITEL	MITEL	*Mitella* spp.	miterwort species	N	FACW-
MIST2	MIST3	*Mitella stauropetala*	smallflower miterwort	N	FACW-
MITR2	MITR4	*Mitella trifida*	three-parted miterwort	N	FACW-
MOCO	MOCO4	*Montia cordifolia*	broadleaved montia	N	FACW
MODI3	MODI4	*Montia diffusa*	branching montia	N	FACW
MOPAP	MOPAP	*Montia parvifolia* var. *parvifolia*	littleleaf minerslettuce	N	FAC
MYSPE	MYSPE	*Myriophyllum spicatum* var. *exalbescens*	common water-milfoil	N	OBL
NUPO	NUPO2	*Nuphar polysepalum*	Indian water-lily	Y	OBL
NUVA	NUVA	*Nuphar variegatum*	cow-lily	Y	OBL
OSCH	OSCH	*Osmorhiza chilensis*	mountain sweet-root	N	FAC
OSOC	OSOC	*Osmorhiza occidentalis*	western sweet-root	N	FAC
OSPU	OSPU	*Osmorhiza purpurea*	purple sweet-root	N	FAC
OSMOR	OSMOR	*Osmorhiza* spp.	sweet-root species	N	FAC
PAFI	PAFI3	*Parnassia fimbriata*	fringed grass-of-parnassia	N	OBL
PEGR	PEGR2	*Pedicularis groenlandica*	elephanthead pedicularis	N	OBL
PEFR2	PEFR5	*Petasites frigidus*	arctic butterbur	N	FACW
PESA	PESA5	*Petasites sagittatus*	arrowleaf coltsfoot	N	OBL
POPU	POPU3	*Polemonium pulcherrimum*	skunkleaf polemonium	Y	FAC+
POAM2	POAM8	*Polygonum amphibium*	water ladysthumb	Y	OBL
POBI	POBI6	*Polygonum bistortoides*	American bistort	N	FACW+
POCO4	POCO8	*Polygonum coccineum*	water smartweed	Y	OBL
POLYG	POLYG4	*Polygonum* spp.	knotweed species	Y	OBL
POGR3	POGR8	*Potamogeton gramineus*	grass-leaved pondweed	Y	OBL
PONA2	PONA4	*Potamogeton natans*	floatingleaf pondweed	Y	OBL
POTAM	POTAM	*Potamogeton* spp.	pondweed species	Y	OBL
PODI	PODI2	*Potentilla diversifolia*	diverse-leaved cinquefoil	N	FAC
POFL2	POFL3	*Potentilla flabellifolia*	fanleaf cinquefoil	N	FAC+
POGR	POGR9	*Potentilla gracilis*	northwest cinquefoil	N	FACU
POPA3	POPA14	*Potentilla palustris*	marsh cinquefoil	N	OBL
PYAS	PYAS	*Pyrola asarifolia*	pink wintergreen	N	FACW-
PYSE	PYSE	*Pyrola secunda*	sidebells pyrola	N	FACU+
PYROLA	PYROLA	*Pyrola* spp.	pyrola species	N	FACU
PYUN	PYUN	*Pyrola uniflora*	woodnymph pyrola	N	FACW
RAAQ	RAAQ	*Ranunculus aquatilis*	watercrowfoot buttercup	N	OBL
RAFL	RAFL2	*Ranunculus flammula*	lesser spearwort	N	OBL
RAGM	RAGM	*Ranunculus gmelinii*	small yellow water-buttercup	N	FACW
RASU	RASU4	*Ranunculus suksdorfii*	Suksdorf's buttercup	N	FACW
RAUN2	PAUN	*Ranunculus uncinatus*	hooked buttercup	N	FACW
SAMA3	SAMA2	*Sanicula marilandica*	black snake-root	N	FACW
SAAR	SAAR13	*Saxifraga arguta*	brook saxifrage	Y	FACW
SAME	SAME7	*Saxifraga mertensiana*	Merten's saxifrage	Y	FACW
SAOR	SAOR2	*Saxifraga oregana*	bog saxifrage	Y	FACW
SAPU	SAPU6	*Saxifraga punctata*	dotted saxifrage	Y	FACW

Appendix A-1—Aquatic, Riparian, and Wetland Plants Listed by Scientific Name (continued)

PNW region code	Plants database code	Scientific name	Common name	Indicator species	Hydrologic status
SCPA	SCPA2	*Scheuchzeria palustris*	scheuchzeria	N	OBL
SCUTE	SCUTE	*Scutellaria* spp.	skullcap species	N	FACW
SECY	SECY	*Senecio cymbalarioides*	cleftleaf groundsel	N	FAC+
SEHY	SEHY2	*Senecio hydrophilus*	alkali-marsh butterweed	N	FACW-
SETR	SETR	*Senecio triangularis*	arrowleaf groundsel	Y	FACW
SMRA	SMRA	*Smilacina racemosa*	western solomonplume	N	FAC
SMST	SMST	*Smilacina stellata*	starry solomonplume	N	FAC
SOCA	SOCA6	*Solidago canadensis*	Canada goldenrod	N	FACU
SPEM	SPEM2	*Sparganium emersum*	simplestem bur-reed	Y	OBL
SPMI	SPMI	*Sparganium minimum*	small bur-reed	Y	OBL
SPARG	SPARG	*Sparganium* spp.	bur-reed species	Y	OBL
SPRO	SPRO	*Spiranthes romanzoffiana*	ladies-tresses	N	OBL
STCO4	STCO14	*Stachys cooleyae*	Cooley's hedge-nettle	N	FACW
STAM	STAM2	*Streptopus amplexifolius*	claspleaf twisted-stalk	Y	FACW
STAMC	STAMC	*Streptopus amplexifolius* var. *chalazatus*	claspleaf twisted-stalk	Y	FACW
STRO	STRO4	*Streptopus roseus*	rosy twisted-stalk	Y	FACU+
TAOF	TAOF	*Taraxacum officinale*	common dandelion	N	FAC
THOC	THOC	*Thalictrum occidentale*	western meadowrue	N	FACU
TITRU	TITRU	*Tiarella trifoliata* var. *unifoliata*	coolwort foamflower	Y	FAC+
TRCA3	TRCA	*Trautvetteria caroliniensis*	false bugbane	Y	FACW
TRLA2	TRLA6	*Trientalis latifolia*	broadleaf starflower	N	FACW-
TRRE	TRRE3	*Trifolium repens*	white clover	N	FACU
TROV	TROV2	*Trillium ovatum*	white trillium	N	FAC+
TRLA4	TRLA14	*Trollius laxus*	globeflower	Y	OBL
TYLA	TYLA	*Typha latifolia*	common cattail	Y	OBL
URDI	URDI	*Urtica dioica*	stinging nettle	N	FACW-
UTMI	UTMI	*Utricularia minor*	lesser bladderwort	N	OBL
UTRIC	UTRIC	*Utricularia* spp.	bladderwort species	N	OBL
UTVU	UTVU	*Utricularia vulgaris*	common bladderwort	N	OBL
VASI	VASI	*Valeriana sitchensis*	Sitka valerian	Y	FAC+
VEVI	VEVI	*Veratrum viride*	American false hellebore	N	FACW
VEAM	VEAM2	*Veronica americana*	American speedwell	N	OBL
VEAN	VEAN2	*Veronica anagallis* var. *aquatica*	water pimpernel	N	OBL
VECU	VECU	*Veronica cusickii*	Cusick's speedwell	N	FACW
VESC	VESC2	*Veronica scutellata*	marsh speedwell	N	OBL
VESE	VESE	*Veronica serpyllifolia*	thyme-leaved speedwell	N	FAC
VEWO	VEWO2	*Veronica wormskjoldii*	Wormskjold's speedwell	N	FAC+
VIAM	VIAM	*Vicia americana*	American vetch	N	FAC
VIAD	VIAD	*Viola adunca*	hook violet	N	FACU
VICA	VICA4	*Viola canadensis*	Canadian violet	N	FACW
VIGL	VIGL	*Viola glabella*	pioneer violet	N	FACW
VIMA	VIMA2	*Viola macloskeyi*	Macloskey's violet	N	OBL
VIOR2	VIOR	*Viola orbiculata*	round-leaved violet	N	FACU
VIPA2	VIPA4	*Viola palustris*	marsh violet	N	FACW
VIOLA	VIOLA	*Viola* spp.	violet species	N	FAC
XETE	XETE	*Xereophyllum tenax*	beargrass	N	FACU
Ferns and fern allies:					
ATDI	ATDI	*Athyrium distentifolium*	alpine lady fern	Y	FACW
ATFI	ATFI	*Athyrium filix-femina*	lady fern	Y	FACW
BLSP	BLSP	*Blechnum spicant*	deerfern	N	FAC
BOTRY	BOTRY	*Botrychium* spp.	grape-fern	N	FAC+
CHARA	CHARA	*Chara* spp.	water millfoil species	N	OBL
CYFR	CYFR	*Cystopteris fragilis*	brittle bladderfern	N	FAC
DRAR	DRAR3	*Dryopteris arguta*	coastal shield fern	Y	FACW
DRAU	DRAU	*Dryopteris austriaca*	mountain wood fern	Y	FACW
DRCA	DRCA11	*Dryopteris carthusiana*	wood fern	Y	FACW
DRCR2	DRCR4	*Dryopteris cristata*	crested shield fern	Y	OBL
DREX	DREX	*Dryopteris expansa*	spreading wood fern	Y	FACW
DRFI	DRFI2	*Dryopteris filix-mas*	male wood fern	Y	FACW
DRYOP	DRYOP	*Dryopteris* spp.	wood fern species	Y	FACW
EQAR	EQAR	*Equisetum arvense*	common horsetail	Y	FACW
EQFL	EQFL	*Equisetum fluviatile*	water horsetail	Y	OBL
EQHY	EQHY	*Equisetum hyemale*	common scouring-rush	Y	FAC
EQPA	EQPA	*Equisetum palustre*	marsh horsetail	Y	FACW
EQSC	EQSC	*Equisetum scirpoides*	sedgelike horsetail	N	FACW
EQSY	EQSY	*Equisetum sylvaticum*	wood horsetail	Y	FACW
EQUIS	EQUIS	*Equisetum* spp.	horsetail species	Y	FACW
GYDR	GYDR	*Gymnocarpium dryopteris*	oak fern	Y	FACW-
ISOET	ISOET	*Isoetes* spp.	quilwort species	N	OBL
LYAN	LYAN2	*Lycopodium annotinum*	stiff clubmoss	N	FACW-
POMU	POMU	*Polystichum munitum*	sword fern	N	FACW-
PTAQ	PTAQ	*Pteridium aquilinum*	western brackenfern	N	FACU

Appendix A-2—Aquatic, Riparian, and Wetland Plants Listed by Common Name

Common name	Scientific name	PNW region code	Plants database code	Indicator species	Hydrologic status
Alaska huckleberry	*Vaccinium alaskaense*	VAAL	VAAL	Y	FACU
Alaska moss-heather	*Cassiope stelleriana*	CAST5	CAST6	Y	FAC
Alaska yellow-cedar	*Chamaecyparis nootkatensis*	CHNO	CHNO	N	FACU
alder buckthorn	*Rhamnus alnifolia*	RHAL2	RHAL	N	FACW
alkali-marsh butterweed	*Senecio hydrophilus*	SEHY	SEHY2	N	FACW-
alpine aster	*Aster alpigenus*	ASAL	ASAL2	N	FACU
alpine bluegrass	*Poa alpina*	POAL	POAL2	N	FAC
alpine lady fern	*Athyrium distentifolium*	ATDI	ATDI	Y	FACW
alpine laurel	*Kalmia microphylla*	KAMI	KAMI	N	FACW
alpine leafybract aster	*Aster foliaceus*	ASFO	ASFO	N	FACW-
alpine pussytoes	*Antennaria alpina*	ANAL	ANAL3	N	FACU
alpine timothy	*Phleum alpinum*	PHAL	PHAL2	N	FAC
alpine willow-weed	*Epilobium alpinum*	EPAL	EPAL	N	FAC+
American bistort	*Polygonum bistortoides*	POBI	POBI6	N	FACW+
American false hellebore	*Veratrum viride*	VEVI	VEVI	N	FACW
American speedwell	*Veronica americana*	VEAM	VEAM2	N	OBL
American vetch	*Vicia americana*	VIAM	VIAM	N	FAC
arnica species	*Arnica* spp.	ARNIC	ARNIC	N	FAC
arrowleaf coltsfoot	*Petasites sagittatus*	PESA	PESA5	N	OBL
arrowleaf groundsel	*Senecio triangularis*	SETR	SETR	Y	FACW
arctic aster	*Aster sibiricus*	ASSI2	ASSI	N	FACU
arctic butterbur	*Petasites frigidus*	PEFR2	PEFR5	N	FACW
aster species	*Aster* spp.	ASTER	ASTER	N	FACU
awned sedge	*Carex atherodes*	CAAT2	CAAT2	Y	OBL
baldhip rose	*Rosa gymnocarpa*	ROGY	ROGY	N	FAC
ballhead waterleaf	*Hydrophyllum capitatum*	HYCA	HYCA4	N	FAC
Baltic rush	*Juncus balticus*	JUBA	JUBA	N	FACW+
baneberry	*Actaea rubra*	ACRU	ACRU2	N	FACW-
Barclay's willow	*Salix barclayi*	SABA	SABA3	Y	FACW+
basin wildrye	*Elymus cinereus*	ELCI	ELCI2	N	FACW-
beaked sedge	*Carex rostrata*	CARO2	CARO6	Y	OBL
bearberry	*Arctostaphylos uva-ursi*	ARUV	ARUV	Y	FACU-
bearberry honeysuckle	*Lonicera involucrata*	LOIN	LOIN5	N	FACW
beargrass	*Xereophyllum tenax*	XETE	XETE	N	FACU
Bebb's willow	*Salix bebbiana*	SABE	SABE2	Y	FACW+
Bebb's willow	*Salix bebbiana* var. *perrostrata*	SABEP	SABEP	Y	FACW+
big huckleberry	*Vaccinium membranaceum*	VAME	VAME	Y	FACU
bigleaf lupine	*Lupinus polyphyllus*	LUPO	LUPO2	Y	FACW-
bigleaf maple	*Acer macrophyllum*	ACMA	ACMA3	Y	FACU
bigleaf sedge	*Carex amplifolia*	CAAM	CAAM10	Y	FACW+
bittercherry	*Prunus emarginata*	PREM	PREM	N	FACU
black alpine sedge	*Carex nigricans*	CANI2	CANI2	Y	FACW-
black cottonwood	*Populus trichocarpa*	POTR2	POTR15	Y	FACW
black hawthorn	*Crataegus douglasii* var. *douglasii*	CRDOD	CRDOD	Y	FAC
black snake-root	*Sanicula marilandica*	SAMA3	SAMA2	N	FACW
blackened sedge	*Carex atrata*	CAAT3	CAAT5	N	FACW+
bladder sedge	*Carex utriculata*	CAUT	CAUT	Y	OBL
bladderwort species	*Utricularia* spp.	UTRIC	UTRIC	N	OBL
blue wildrye	*Elymus glaucus*	ELGL	ELGL	N	FACU
bluejoint reedgrass	*Calamagrostis canadensis*	CACA	CACA4	Y	FACW+
bog birch	*Betula glandulosa*	BEGL	BEGL	Y	OBL
bog birch	*Betula glandulosa* var. *glandulosa*	BEGLG	BEGLG	Y	OBL
bog bluegrass	*Poa leptocoma*	POLE	POLE2	N	FACW
bog saxifrage	*Saxifraga oregana*	SAOR	SAOR2	Y	FACW
bog willow	*Salix pedicellaris*	SAPE3	SAPE2	Y	OBL
Booth's willow	*Salix boothii*	SABO2	SABO2	Y	OBL
boreal bedstraw	*Galium kamtschaticum*	GAKA	GAKA	N	FACU
branching montia	*Montia diffusa*	MODI3	MODI4	N	FACW
brittle bladderfern	*Cystopteris fragilis*	CYFR	CYFR	N	FAC
broadleaf lupine	*Lupinus latifolius*	LULA	LULA4	Y	FAC+
broadleaf starflower	*Trientalis latifolia*	TRLA2	TRLA6	N	FACW-
broadleaved montia	*Montia cordifolia*	MOCO	MOCO4	N	FACW
broadpetal strawberry	*Fragaria virginiana* var. *platypetala*	FRVIP	FRVIP3	N	FACU
brome species	*Bromus* spp.	BROMU	BROMU	N	FACU+
brook saxifrage	*Saxifraga arguta*	SAAR	SAAR13	Y	FACW
brownish sedge	*Carex brunnescens*	CABR6	CABR15	N	FACW+
bulbed water-hemlock	*Cicuta bulbifera*	CIBU	CIBU	N	OBL
bunchberry dogwood	*Cornus canadensis*	COCA	COCA13	Y	FACW-
bur-reed species	*Sparganium* spp.	SPARG	SPARG	Y	OBL
Buxbaum's sedge	*Carex buxbaumii*	CABU2	CABU6	Y	OBL
California hazel	*Corylus cornuta*	COCO2	COCO6	Y	FAC+

Appendix A-2—Aquatic, Riparian, and Wetland Plants Listed by Common Name (continued)

Common name	Scientific name	PNW region code	Plants database code	Indicator species	Hydrologic status
Canada goldenrod	*Solidago canadensis*	SOCA	SOCA6	N	FACU
Canada thistle	*Cirsium arvense*	CIAR	CIAR4	N	FACW-
Canada waterweed	*Elodea canadensis*	ELCA3	ELCA7	N	OBL
Canada wildrye	*Elymus canadensis*	ELCA	ELCA4	N	FACW-
Canadian violet	*Viola canadensis*	VICA	VICA4	N	FACW
Canby's licorice-root	*Ligusticum canbyi*	LICA2	LICA2	N	FAC
Cascade azalea	*Rhododendron albiflorum*	RHAL	RHAL2	Y	FACU
Cascade hollygrape	*Berberis nervosa*	BENE	BENE2	N	FACU
Cascade huckleberry	*Vaccinium deliciosum*	VADE	VADE	Y	FACU
Cascade mountain-ash	*Sorbus scopulina*	SOSC2	SOSC2	N	FACU
Cascade willow	*Salix cascadensis*	SACA6	SACA6	Y	FAC
catchweed bedstraw	*Galium aparine*	GAAP	GAAP2	N	FAC-
Chamisso arnica	*Arnica chamissonis*	ARCH	ARCH	N	FACW-
Chamisso cotton-grass	*Eriophorum chamissonis*	ERCH2	ERCH7	Y	OBL
clasping arnica	*Arnica amplexicaulis*	ARAM	ARAM	N	FACW-
claspleaf twisted-stalk	*Streptopus amplexifolius*	STAM	STAM2	Y	FACW
claspleaf twisted-stalk	*Streptopus amplexifolius* var. *chalazatus*	STAMC	STAMC	Y	FACW
cleftleaf groundsel	*Senecio cymbalarioides*	SECY	SECY	N	FAC+
coastal shield fern	*Dryopteris arguta*	DRAR	DRAR3	Y	FACW
Columbia brome	*Bromus vulgaris*	BRVU	BRVU	N	FACU+
Columbia monkshood	*Aconitum columbianum*	ACCO	ACCO4	N	FACW
Columbia sedge	*Carex aperta*	CAAP3	CAAP3	Y	FACW+
common bladderwort	*Utricularia vulgaris*	UTVU	UTVU	N	OBL
common bogbean	*Menyanthes trifoliata*	METR	METR3	N	OBL
common cattail	*Typha latifolia*	TYLA	TYLA	Y	OBL
common chokecherry	*Prunus virginiana*	PRVI	PRVI	Y	FACU
common cow-parsnip	*Heracleum lanatum*	HELA	HELA4	N	FAC+
common dandelion	*Taraxacum officinale*	TAOF	TAOF	N	FAC
common horsetail	*Equisetum arvense*	EQAR	EQAR	Y	FACW
common monkey-flower	*Mimulus guttatus* var. *guttatus*	MIGUG	MIGUG	N	OBL
common pearly-everlasting	*Anaphalis margaritacea*	ANMA	ANMA	N	FACU
common scouring-rush	*Equisetum hyemale*	EQHY	EQHY	Y	FAC
common snowberry	*Symphoricarpos albus*	SYAL	SYAL	Y	FACU
common water-milfoil	*Myriophyllum spicatum* var. *exalbescens*	MYSPE	MYSPE	N	OBL
Cooley's hedge-nettle	*Stachys cooleyae*	STCO4	STCO14	N	FACW
coolwort foamflower	*Tiarella trifoliata* var. *unifoliata*	TITRU	TITRU	Y	FAC+
cow-lily	*Nuphar variegatum*	NUVA	NUVA	Y	OBL
coyote willow	*Salix exigua*	SAEX	SAEX	Y	OBL
coyote willow	*Salix exigua* var. *exigua*	SAEXE	SAEXE	Y	OBL
Crawford's sedge	*Carex crawfordii*	CACR3	CACR4	N	FAC
cream mountain-heath	*Phyllodoce glanduliflora*	PHGL	PHGL6	Y	FAC
creeping hollygrape	*Berberis repens*	BERE	BERE	N	FACU
creeping spike-rush	*Eleocharis palustris*	ELPA	ELPA3	Y	OBL
crested shield fern	*Dryopteris cristata*	DRCR2	DRCR4	Y	OBL
currant species	*Ribes* spp.	RIBES	RIBES	N	FAC
curved woodrush	*Luzula arcuata*	LUAR4	LUAR5	N	FACU
Cusick's bluegrass	*Poa cusickii* var. *epilis*	POCUE	POCUE	N	FACU
Cusick's sedge	*Carex cusickii*	CACU2	CACU5	Y	OBL
Cusick's speedwell	*Veronica cusickii*	VECU	VECU	N	FACW
cutleaf groundsel	*Senecio cymbalarioides*	SECY	SECY	N	FAC+
cutting wheatgrass	*Agropyron caninum*	AGCA	AGCA	N	FACU
deerfern	*Blechnum spicant*	BLSP	BLSP	N	FAC
deerfoot vanillaleaf	*Achlys triphylla*	ACTR	ACTR	Y	FAC+
dentate shooting-star	*Dodecatheon dentatum*	DODE	DODE	N	FAC+
devil's club	*Oplopanax horridum*	OPHO	OPHO	Y	FACW
Dewey's sedge	*Carex deweyana*	CADE	CADE	N	FACW+
diverse-leaved cinquefoil	*Potentilla diversifolia*	PODI	PODI2	N	FAC
dotted saxifrage	*Saxifraga punctata*	SAPU	SAPU6	Y	FACW
Douglas maple	*Acer glabrum* var. *douglasii*	ACGLD	ACGLD4	Y	FACU
Douglas spiraea	*Spiraea douglasii*	SPDO	SPDO	Y	OBL
Douglas spiraea	*Spiraea douglasii* var. *douglasii*	SPDOD	SPDOD	Y	OBL
Douglas spiraea	*Spiraea douglasii* var. *menziesii*	SPDOM	SPDOM	Y	OBL
Douglas-fir	*Pseudotsuga menziesii*	PSME	PSME	Y	FACU
Drummond's rush	*Juncus drummondii*	JUDR	JUDR	N	FACU
Drummond's willow	*Salix drummondiana*	SADR	SADR	Y	OBL
dusky willow	*Salix melanopsis*	SAME2	SAME2	Y	OBL
dwarf bramble	*Rubus lasiococcus*	RULA	RULA	Y	FACU
dwarf huckleberry	*Vaccinium caespitosum*	VACA	VACA	Y	FACU
dwarf red blackberry	*Rubus pubescens*	RUPU2	RUPU	N	FACW-
Eastwood's willow	*Salix eastwoodiae*	SAEA	SAEA	N	OBL
elephanthead pedicularis	*Pedicularis groenlandica*	PEGR	PEGR2	N	OBL

Appendix A-2—Aquatic, Riparian, and Wetland Plants Listed by Common Name (continued)

Common name	Scientific name	PNW region code	Plants database code	Indicator species	Hydrologic status
elk sedge	*Carex geyeri*	CAGE	CAGE	N	FACU
elkslip	*Caltha leptosepala*	CALE2	CALE2	N	FACW
enchanter's nightshade	*Circaea alpina*	CIAL	CIAL	N	FACW
Engelmann spruce	*Picea engelmannii*	PIEN	PIEN	Y	FACU
false bugbane	*Trautvetteria caroliniensis*	TRCA3	TRCA	Y	FACW
false mountain willow	*Salix pseudomonticola*	SAPS2	SAPS	Y	OBL
false saxafrage	*Leptarrhena pyrolifolia*	LEPY	LEPY	N	FACW
fanleaf cinquefoil	*Potentilla flabellifolia*	POFL2	POFL3	N	FAC+
Farr's willow	*Salix farriae*	SAFA	SAFA	Y	OBL
Fendler's waterleaf	*Hydrophyllum fendleri*	HYFE	HYFE	N	FACW-
fewflower aster	*Aster modestus*	ASMO	ASMO3	N	FACW-
fewflower peavine	*Lathyrus pauciflorus*	LAPA2	LAPA5	N	FAC
few-flowered spike-rush	*Eleocharis pauciflora*	ELPA2	ELPA6	Y	OBL
field mint	*Mentha arvensis*	MEAR3	MEAR4	N	FACW-
fireweed	*Epilobium angustifolium*	EPAN	EPAN	N	FACU
five-leaved bramble	*Rubus pedatus*	RUPE	RUPE	N	FACW
fivestamen miterwort	*Mitella pentandra*	MIPE	MIPE	N	FACW
floatingleaf pondweed	*Potamogeton natans*	PONA2	PONA4	Y	OBL
four-angled moss-heather	*Cassiope tetragona*	CATE2	CATE11	Y	FAC
fowl bluegrass	*Poa palustris*	POPA	POPA4	N	FACW
fowl mannagrass	*Glyceria striata*	GLST	GLST	Y	OBL
fringed brome-grass	*Bromus ciliatus*	BRCI	BRCI	N	FACU+
fringed grass-of-parnassia	*Parnassia fimbriata*	PAFI	PAFI3	N	OBL
Geyer's willow	*Salix geyeriana* var. *geyeriana*	SAGEG	SAGEG	Y	FACW+
Geyer's willow	*Salix geyeriana* var. *meleiana*	SAGEM	SAGEM	Y	FACW+
glaucous willow	*Salix glauca*	SAGL	SAGL	Y	OBL
globeflower	*Trollius laxus*	TRLA4	TRLA14	Y	OBL
globe huckleberry	*Vaccinium globulare*	VAGL	VAGL	N	FACU
golden fleabane	*Erigeron aureus*	ERAU	ERAU	N	FAC
grand fir	*Abies grandis*	ABGR	ABGR	Y	FACU
grape-fern	*Botrychium* spp.	BOTRY	BOTRY	N	FAC+
grass-leaved pondweed	*Potamogeton gramineus*	POGR3	POGR8	Y	OBL
gray sedge	*Carex canescens*	CACA4	CACA5	N	FACW+
Gray's licorice-root	*Ligusticum grayi*	LIGR	LIGR	N	FAC
green fescue	*Festuca viridula*	FEVI	FEVI	N	FACU
green-keeled cotton-grass	*Eriophorum viridicarinatum*	ERVI	ERVI9	Y	OBL
grouse huckleberry	*Vaccinium scoparium*	VASC	VASC	Y	FACU
hairy arnica	*Arnica mollis*	ARMO	ARMO4	N	FAC
hardstem bulrush	*Scirpus acutus*	SCAC	SCAC	Y	OBL
heart-leaf arnica	*Arnica cordifolia*	ARCO	ARCO	N	FACU
herbaceous sage	*Artemisia ludoviciana*	ARLU	ARLU	N	FACU
hoary willow	*Salix candida*	SACA9	SACA4	Y	OBL
Holboell's rockcress	*Arabis holboellii*	ARHO	ARHO	N	FACU
Holm's sedge	*Carex scopulorum* var. *bracteosa*	CASCB	CASCB	Y	FACW+
Hood's sedge	*Carex hoodii*	CAHO	CAHO	N	FAC
hook violet	*Viola adunca*	VIAD	VIAD	N	FACU
hooked buttercup	*Ranunculus uncinatus*	RAUN2	PAUN	N	FACW
Hooker's fairy-bells	*Disporum hookeri*	DIHO	DIHO3	N	FAC+
Hudsonbay currant	*Ribes hudsonianum*	RIHU	RIHU	Y	FACW+
Idaho bentgrass	*Agrostis idahoensis*	AGID	AGID	N	FACW
Indian water-lily	*Nuphar polysepalum*	NUPO	NUPO2	Y	OBL
inflated sedge	*Carex vesicaria*	CAVE	CAVE6	Y	OBL
inland sedge	*Carex interior*	CAIN5	CAIN11	N	OBL
Jeffrey's shooting-star	*Dodecatheon jeffreyi*	DOJE	DOJE	N	FACW
Kentucky bluegrass	*Poa pratensis*	POPR	POPR	Y	FAC
knotweed species	*Polygonum* spp.	POLYG	POLYG4	Y	OBL
Labrador tea	*Ledum glandulosum*	LEGL	LEGL	Y	FACW-
Labrador tea	*Ledum glandulosum* var. *glandulosum*	LEGLG	LEGLG	Y	FACW-
ladies-tresses	*Spiranthes romanzoffiana*	SPRO	SPRO	N	OBL
lady fern	*Athyrium filix-femina*	ATFI	ATFI	Y	FACW
large mountain mimulus	*Mimulus tilingii*	MITI	MITI	N	OBL
large mountain mimulus	*Mimulus tilingii* var. *caespitosus*	MITIC	MITIC	N	OBL
largeleaf avens	*Geum macrophyllum*	GEMA	GEMA4	N	FACW
largeleaf avens	*Geum macrophyllum* var. *perincisum*	GEMAP	GEMAP	N	FACW
largeleaf sandwort	*Arenaria macrophylla*	ARMA3	ARMA4	N	FAC
Lemmon's willow	*Salix lemmonii*	SALE	SALE	Y	OBL
lenticular sedge	*Carex lenticularis*	CALE5	CALE5	Y	OBL
lesser bladderwort	*Utricularia minor*	UTMI	UTMI	N	OBL
lesser panicled sedge	*Carex diandra*	CADI2	CADI4	N	OBL
lesser spearwort	*Ranunculus flammula*	RAFL	RAFL2	N	OBL
Lewis' mock orange	*Philadelphus lewisii*	PHLE2	PHLE4	N	FAC

Appendix A-2—Aquatic, Riparian, and Wetland Plants Listed by Common Name (continued)

Common name	Scientific name	PNW region code	Plants database code	Indicator species	Hydrologic status
Lewis' monkey-flower	*Mimulus lewisii*	MILE	MILE2	Y	FACW+
little prince's-pine	*Chimaphila menziesii*	CHME	CHME	N	FACU
littleleaf montia	*Montia parviflora*	MOPAP	MOPAP	N	FAC
lodgepole pine	*Pinus contorta*	PICO	PICO	Y	FACU
low huckleberry	*Vaccinium myrtillus*	VAMY	VAMY2	Y	FACU
lupine species	*Lupinus* spp.	LUPIN	LUPIN	N	FAC
McCalla's willow	*Salix maccalliana*	SAMA	SAMA12	Y	OBL
Mackenzie's willow	*Salix rigida* var. *mackenzieana*	SARIM2	SARIM4	Y	OBL
Macloskey's violet	*Viola macloskeyi*	VIMA	VIMA2	N	OBL
male wood fern	*Dryopteris filix-mas*	DRFI	DRFI2	Y	FACW
many-spiked cotton-grass	*Eriophorum polystachion*	ERPO2	ERPO3	Y	OBL
mapleleaf currant	*Ribes howellii*	RIHO	RIHO2	N	FAC
marsh cinquefoil	*Potentilla palustris*	POPA3	POPA14	N	OBL
marsh horsetail	*Equisetum palustre*	EQPA	EQPA	Y	FACW
marsh muhly	*Muhlenbergia glomerata*	MUGL	MUGL3	N	OBL
marsh speedwell	*Veronica scutellata*	VESC	VESC2	N	OBL
marsh violet	*Viola palustris*	VIPA2	VIPA4	N	FACW
Merten's moss-heather	*Cassiope mertensiana*	CAME	CAME7	Y	FAC
Merten's rush	*Juncus mertensianus*	JUME	JUME3	N	OBL
Merten's saxifrage	*Saxifraga mertensiana*	SAME	SAME7	Y	FACW
Merten's sedge	*Carex mertensii*	CAME2	CAME	N	FAC
miterwort species	*Mitella* spp.	MITEL	MITEL	N	FACW-
moosewood viburnum	*Viburnum edule*	VIED	VIED	N	FACW
mountain alder	*Alnus incana*	ALIN	ALIN2	Y	FACW
mountain arnica	*Arnica latifolia*	ARLA	ARLA8	Y	FAC
mountain bluebells	*Mertensia ciliata*	MECI	MECI13	N	FACU
mountain hairgrass	*Deschampsia atropurpurea*	DEAT	DEAT2	N	FACU+
mountain hemlock	*Tsuga mertensiana*	TSME	TSME	Y	FACU
mountain sweet-root	*Osmorhiza chilensis*	OSCH	OSCH	N	FAC
mountain wood fern	*Dryopteris austriaca*	DRAU	DRAU	Y	FACW
moxie plum	*Gaultheria hispidula*	GAHI	GAHI2	N	OBL
mud sedge	*Carex limosa*	CALI	CALI	Y	OBL
muricate sedge	*Carex muricata*	CAMU2	CAMU3	N	OBL
myrtle pachistima	*Pachistima myrsinites*	PAMY	PAMY	Y	FACU-
Nebraska sedge	*Carex nebraskensis*	CANE	CANE	N	OBL
needle spike-rush	*Eleocharis acicularis*	ELAC	ELAC	N	OBL
noble fir	*Abies procera*	ABPR	ABPR	N	FACU
nodding beggars-tick	*Bidens cernua*	BICE	BICE	N	OBL
Nootka rose	*Rosa nutkana*	RONU	RONU	N	FAC
northern bedstraw	*Galium boreale*	GABO	GABO2	N	FACU
northern bluebells	*Mertensia paniculata* var. *borealis*	MEPAB	MEPAB	N	FACW
northern clustered sedge	*Carex arcta*	CAAR2	CAAR3	N	FACW+
northern mannagrass	*Glyceria borealis*	GLBO	GLBO	Y	OBL
northwest cinquefoil	*Potentilla gracilis*	POGR	POGR9	N	FACU
northwestern sedge	*Carex concinnoides*	CACO	CACO11	N	FACU
northwestern twayblade	*Listera caurina*	LICA3	LICA10	N	FACW-
oak fern	*Gymnocarpium dryopteris*	GYDR	GYDR	Y	FACW-
oceanspray	*Holodiscus discolor*	HODI	HODI	N	FACU
old man's whiskers	*Geum triflorum*	GETR	GETR	N	FACU
Oregon anemone	*Anemone oregana*	ANOR	ANOR	N	FACU
Oregon bentgrass	*Agrostis oregonensis*	AGOR	AGOR	N	FACW-
Oregon hollygrape	*Berberis aquifolium*	BEAQ	BEAQ	N	FACU
Oregon white oak	*Quercus garryana*	QUGA	QUGA4	Y	FACU
oval-leaf huckleberry	*Vaccinium ovalifolium*	VAOV	VAOV	Y	FACU
Pacific bittercress	*Cardamine pensylvanica*	CAPE3	CAPE4	N	FACW
Pacific blackberry	*Rubus ursinus*	RUUR	RUUR	N	FACW-
Pacific silver fir	*Abies amabilis*	ABAM	ABAM	Y	FACU
Pacific willow	*Salix lasiandra* var. *lasiandra*	SALAL	SALAL	Y	FACW+
pale agoseris	*Agoseris glauca*	AGGL	AGGL	N	FACW
pale false mannagrass	*Puccinellia pauciflora* var. *microtheca*	PUPAM	PUPAM2	N	OBL
panicle bluebells	*Mertensia paniculata*	MEPA	MEPA6	N	FACW
paper birch	*Betula papyrifera*	BEPA	BEPA	Y	FACU
Parry's rush	*Juncus parryi*	JUPA	JUPA	N	FACU
partridgefoot	*Luetkea pectinata*	LUPE	LUPE	Y	FAC+
pathfinder	*Adenocaulon bicolor*	ADBI	ADBI	N	FAC+
peavine species	*Lathyrus* spp.	LATHY	LATHY	N	FAC
peregrine fleabane	*Erigeron peregrinus*	ERPE	ERPE3	N	FACW
peregrine fleabane	*Erigeron peregrinus* var. *callianthemus*	ERPEC	ERPEC	N	FACW
peregrine fleabane	*Erigeron peregrinus* var. *scaposus*	ERPES	ERPES3	N	FACW
pinegrass	*Calamagrostis rubescens*	CARU	CARU	N	FACU
pink wintergreen	*Pyrola asarifolia*	PYAS	PYAS	N	FACW-

Appendix A-2—Aquatic, Riparian, and Wetland Plants Listed by Common Name (continued)

Common name	Scientific name	PNW region code	Plants database code	Indicator species	Hydrologic status
pioneer violet	*Viola glabella*	VIGL	VIGL	N	FACW
Piper's willow	*Salix piperi*	SAPI	SAPI	Y	OBL
ponderosa pine	*Pinus ponderosa*	PIPO	PIPO	N	FACU
pondweed species	*Potamogeton* spp.	POTAM	POTAM	Y	OBL
poor sedge	*Carex paupercula*	CAPA9	CAPA22	Y	OBL
prickly currant	*Ribes lacustre*	RILA	RILA	Y	FACW
purple sweet-root	*Osmorhiza purpurea*	OSPU	OSPU	N	FAC
Pursh buckthorn	*Rhamnus purshiana*	RHPU	PHPU	N	FACW
Pussytoe spp.	*Antennaria* spp.	ANTEN	ANTEN	N	FACU
pyramid spiraea	*Spiraea pyramidata*	SPPY	SPPY	Y	OBL
pyrola species	*Pyrola* spp.	PYROLA	PYROLA	N	FACU
quaking aspen	*Populus tremuloides*	POTR	POTR5	Y	FACU
queencup beadlily	*Clintonia uniflora*	CLUN	CLUN2	Y	FACU+
quilwort species	*Isoetes* spp.	ISOET	ISOET	N	OBL
raceme pussytoes	*Antennaria racemosa*	ANRA	ANRA	N	FACU
Rainier pleated gentian	*Gentiana calycosa*	GECA	GECA	N	FACW
red alder	*Alnus rubra*	ALRU	ALRU2	Y	FACW-
red mountain-heath	*Phyllodoce empetriformis*	PHEM	PHEM	Y	FAC
red raspberry	*Rubus idaeus*	RUID	RUID	N	FAC
red whortleberry	*Vaccinium parvifolium*	VAPA	VAPA	N	FACU
red willow-weed	*Epilobium latifolium*	EPLA	EPLA	N	FACW
red-osier dogwood	*Cornus stolonifera*	COST	COST	Y	FACW
red-osier dogwood	*Cornus stolonifera* var. *occidentalis*	COSTO	COST4	Y	FACW
redtop	*Agrostis alba*	AGAL	AGAL3	N	FACW
reed canarygrass	*Phalaris arundinacea*	PHAR	PHAR3	Y	FACW
reed mannagrass	*Glyceria grandis*	GLGR	GLGR	Y	OBL
retrorse sedge	*Carex retrorsa*	CARE	CARE4	N	OBL
rose pussytoes	*Antennaria microcephala*	ANMI	ANMI2	N	FACU
rose species	*Rosa* spp.	ROSA	ROSA	N	FAC
rosy twisted-stalk	*Streptopus roseus*	STRO	STRO4	Y	FACU+
rough bedstraw	*Galium asperrimum*	GAAS	GAAS	N	FACU
roughfruit fairy-bells	*Disporum trachycarpum*	DITR	DITR	N	FAC
round-leaved violet	*Viola orbiculata*	VIOR2	VIOR	N	FACU
russet buffaloberry	*Shepherdia canadensis*	SHCA	SHCA	N	FACU
russet sedge	*Carex saxatilis major*	CASA2	CASA10	Y	OBL
rusty menziesia	*Menziesia ferruginea*	MEFE	MEFE	Y	FACU+
salmonberry	*Rubus spectabilis*	RUSP	RUSP	Y	FACW-
Saskatoon serviceberry	*Amelanchier alnifolia*	AMAL	AMAL2	Y	FACU
saw-leaved sedge	*Carex scopulorum* var. *prionophylla*	CASCP2	CASCP	Y	OBL
scarlet elderberry	*Sambucus racemosa*	SARA	SARA2	N	FACU
scheuchzeria	*Scheuchzeria palustris*	SCPA	SCPA2	N	OBL
Scouler's willow	*Salix scouleriana*	SASC	SASC	Y	FAC
sedgelike horsetail	*Equisetum scirpoides*	EQSC	EQSC	N	FACW
sharptooth angelica	*Angelica arguta*	ANAR	ANAR3	N	FACW
sheep fescue	*Festuca ovina* var. *rydbergii*	FEOVR	FEOVR	Y	FACU
sheep sedge	*Carex illota*	CAIL	CAIL	Y	FACW+
shiny-leaf spiraea	*Spiraea betulifolia*	SPBE	SPBE2	N	FACU
shiny-leaf spiraea	*Spiraea betulifolia* var. *lucida*	SPBEL	SPBEL	N	FACU
shootingstar species	*Dodecatheon* spp.	DODEC	DODEC	N	FAC+
shortbeaked sedge	*Carex simulata*	CASI2	CASI3	N	OBL
short-fruited willow	*Salix brachycarpa*	SABR2	SABR	Y	OBL
showy aster	*Aster conspicuus*	ASCO	ASCO3	N	FACU
showy sedge	*Carex spectabilis*	CASP	CASP5	Y	FAC
shrubby cinquefoil	*Potentilla fruticosa*	POFR	POFR15	Y	FAC
sidebells pyrola	*Pyrola secunda*	PYSE	PYSE	N	FACU+
simplestem bur-reed	*Sparganium emersum*	SPEM	SPEM2	Y	OBL
Sitka alder	*Alnus sinuata*	ALSI	ALSI3	Y	FAC+
Sitka mountain-ash	*Sorbus sitchensis*	SOSI	SOSI2	N	FACU
Sitka sedge	*Carex aquatilis* var. *sitchensis*	CAAQS	CAAQS	Y	OBL
Sitka valerian	*Valeriana sitchensis*	VASI	VASI	Y	FAC+
Sitka willow	*Salix sitchensis*	SASI2	SASI3	Y	FACW
skullcap species	*Scutellaria* spp.	SCUTE	SCUTE	N	FACW
skunk cabbage	*Lysichiton americanus*	LYAM	LYAM3	Y	OBL
skunkleaf polemonium	*Polemonium pulcherrimum*	POPU	POPU3	Y	FAC+
slender bog-orchid	*Habenaria saccata*	HASA	HASA	N	OBL
slender cotton-grass	*Eriophorum gracile*	ERGR2	ERGR8	Y	OBL
slender hawkweed	*Hieracium gracile*	HIGR	HIGR	N	FAC
slender sedge	*Carex lasiocarpa*	CALA4	CALA4	Y	OBL
slender wintergreen	*Gaultheria ovatifolia*	GAOV	GAOV2	N	FAC+
slender-beaked sedge	*Carex athrostachya*	CAAT	CAAT3	N	FAC
slimpod shooting-star	*Dodecatheon conjugens*	DOCO	DOCO	N	FAC

Appendix A-2—Aquatic, Riparian, and Wetland Plants Listed by Common Name (continued)

Common name	Scientific name	PNW region code	Plants database code	Indicator species	Hydrologic status
slimstem reedgrass	*Calamagrostis neglecta*	CANE3	CANE4	N	FACW
small bedstraw	*Galium trifidum*	GATRI	GATR2	N	OBL
small bur-reed	*Sparganium minimum*	SPMI	SPMI	Y	OBL
small yellow water-buttercup	*Ranunculus gmelinii*	RAGM	RAGM	N	FACW
smallflower miterwort	*Mitella stauropetala*	MIST2	MIST3	N	FACW-
smallflowered woodrush	*Luzula parviflora*	LUPA	LUPA4	N	FACU
small-fruited bulrush	*Scirpus microcarpus*	SCMI	SCMI2	Y	OBL
small-leaf rockcress	*Arabis microphylla*	ARMI2	ARMI3	N	FACU
Smoky Mountain sedge	*Carex proposita*	CAPR9	CAPR10	N	FACU
smooth brome	*Bromus inermis*	BRIN	BRIN2	N	FACU
smooth sedge	*Carex laeviculmis*	CALA	CALA13	N	FACW+
smooth willow-weed	*Epilobium glaberrimum*	EPGL	EPGL	N	FACW
smooth woodrush	*Luzula hitchcockii*	LUHI	LUHI4	Y	FACU
smooth-beaked sedge	*Carex integra*	CAIN2	CAIN10	N	FACW+
snow willow	*Salix nivalis*	SANI	SANI8	Y	FAC
snow willow	*Salix nivalis* var. *nivalis*	SANIN	SANIN	Y	FAC
soft-leaved sedge	*Carex disperma*	CADI	CADI6	Y	FACW+
softstem bulrush	*Scirpus validus*	SCVA	SCVA	Y	OBL
spike bentgrass	*Agrostis exarata*	AGEX	AGEX	N	FACW
spike trisetum	*Trisetum spicatum*	TRSP	TRSP2	N	FACU
spreading wood fern	*Dryopteris expansa*	DREX	DREX	Y	FACW
starry solomonplume	*Smilacina stellata*	SMST	SMST	N	FAC
stiff clubmoss	*Lycopodium annotinum*	LYAN	LYAN2	N	FACW-
stinging nettle	*Urtica dioica*	URDI	URDI	N	FACW-
stink currant	*Ribes bracteosum*	RIBR	RIBR	Y	FACW
subalpine fir	*Abies lasiocarpa*	ABLA2	ABLA3	Y	FACU
subalpine larch	*Larix lyallii*	LALY	LALY	Y	FACU
subalpine spiraea	*Spiraea densiflora*	SPDE	SPDE	N	FAC+
Suksdorf's buttercup	*Ranunculus suksdorfii*	RASU	RASU4	N	FACW
sweet-root species	*Osmorhiza* spp.	OSMOR	OSMOR	N	FAC
sweetscented bedstraw	*Galium triflorum*	GATR	GATR3	N	FACU
sword fern	*Polystichum munitum*	POMU	POMU	N	FACW-
sylvan goatsbeard	*Aruncus sylvester*	ARSY	ARSY2	N	FAC
tall agoseris	*Agoseris elata*	AGEL2	AGEL	N	FACU
tall mannagrass	*Glyceria elata*	GLEL	GLEL	Y	FACW+
tea-leaved willow	*Salix planifolia monica*	SAPLM2	SAPLM3	Y	OBL
thick-headed sedge	*Carex pachystachya*	CAPA	CAPA19	N	FACU
thistle species	*Cirsium* spp.	CIRCI	CIRCI	N	FAC
thread rush	*Juncus filiformis*	JUFI	JUFI	N	FACW+
three-parted miterwort	*Mitella trifida*	MITR2	MITR4	N	FACW-
Thurber's bentgrass	*Agrostis thurberiana*	AGTH	AGTH	N	FACW
thyme-leaved speedwell	*Veronica serpyllifolia*	VESE	VESE	N	FAC
timber oatgrass	*Danthonia intermedia*	DAIN	DAIN	Y	FACU+
timothy	*Phleum pratense*	PHPR	PHPR3	N	FAC
trailing St. John's-wort	*Hypericum anagalloides*	HYAN	HYAN2	N	FACW
tuberous rush	*Juncus nodosus*	JUNO	JUNO2	N	FACW+
tufted hairgrass	*Deschampsia cespitosa*	DECE	DECE	Y	FACW
Tweedy's willow	*Salix tweedyi*	SATW	SATW	Y	OBL
twinflower	*Linnaea borealis* var. *longiflora*	LIBOL	LIBOL	Y	FACU+
twinflower marshmarigold	*Caltha biflora*	CABI	CABI2	Y	FACW+
twinflower marshmarigold	*Caltha biflora* var. *biflora*	CABIB	CABIB	Y	FACW+
twinflower marshmarigold	*Caltha biflora* var. *rotundifolia*	CABIR	CABIR	Y	FACW+
umber pussytoes	*Antennaria umbrinella*	ANUM	ANUM	N	FACU
undergreen willow	*Salix commutata*	SACO2	SACO2	Y	OBL
Utah honeysuckle	*Lonicera utahensis*	LOUT	LOUT2	N	FACU
variant bentgrass	*Agrostis variabilis*	AGVA	AGVA	N	FACW
vine maple	*Acer circinatum*	ACCI	ACCI	Y	FACU
violet species	*Viola* spp.	VIOLA	VIOLA	N	FAC
water avens	*Geum rivale*	GERI2	GERI2	N	FACW
water birch	*Betula occidentalis*	BEOC	BEOC2	N	FACW
water horsetail	*Equisetum fluviatile*	EQFL	EQFL	Y	OBL
water ladysthumb	*Polygonum amphibium*	POAM2	POAM8	Y	OBL
water lentil	*Lemna minor*	LEMI	LEMI3	N	OBL
water millfoil species	*Chara* spp.	CHARA	CHARA	N	OBL
water pimpernel	*Veronica anagallis-aquatica*	VEAN	VEAN2	N	OBL
water sedge	*Carex aquatilis* var. *aquatilis*	CAAQA	CAAQA	Y	OBL
water smartweed	*Polygonum coccineum*	POCO4	POCO8	Y	OBL
watercrowfoot buttercup	*Ranunculus aquatilis*	RAAQ	RAAQ	N	OBL
waterweed species	*Elodea* spp.	ELODE	ELODE	N	OBL
Watson's willow-weed	*Epilobium watsonii*	EPWA	EPWA3	N	FACW
wax currant	*Ribes cereum*	RICE	RICE	N	FACU

Appendix A-2—Aquatic, Riparian, and Wetland Plants Listed by Common Name (continued)

Common name	Scientific name	PNW region code	Plants database code	Indicator species	Hydrologic status
weak alkaligrass	*Puccinellia pauciflora* var. *holmii*	PUPAH	PUPAH	N	OBL
Wenatchee larkspur	*Delphinium viridescens*	DEVI	DEVI	N	FACW
western aster	*Aster occidentalis*	ASOC	ASOC	N	FACW-
western bog blueberry	*Vaccinium occidentale*	VAOC2	VAOC	N	OBL
western brackenfern	*Pteridium aquilinum*	PTAQ	PTAQ	N	FACU
western currant	*Ribes laxiflorum*	RILA2	RILA3	N	FAC
western fescue	*Festuca occidentalis*	FEOC	FEOC	N	FACW-
western hemlock	*Tsuga heterophylla*	TSHE	TSHE	Y	FACU
western larch	*Larix occidentalis*	LAOC	LAOC	N	FACU
western mannagrass	*Glyceria occidentalis*	GLOC	GLOC	Y	OBL
western meadowrue	*Thalictrum occidentale*	THOC	THOC	N	FACU
western prince's-pine	*Chimaphila umbellata*	CHUM	CHUM	N	FACU
western prince's-pine	*Chimaphila umbellata* var. *occidentalis*	CHUMO	CHUMO	N	FACU
western rattlesnake plantain	*Goodyera oblongifolia*	GOOB	GOOB2	N	FACU-
western redcedar	*Thuja plicata*	THPL	THPL	Y	FACU
western singlespike sedge	*Carex scirpoidea* var. *pseudoscirpoidea*	CASCP	CASCP	N	FAC+
western singlespike sedge	*Carex scirpoidea* var. *scirpoidea*	CASC3	Unknown	N	FAC+
western solomonplume	*Smilacina racemosa*	SMRA	SMRA	N	FAC
western sweet-root	*Osmorhiza occidentalis*	OSOC	OSOC	N	FAC
western thimbleberry	*Rubus parviflorus*	RUPA	RUPA	N	FAC+
western water-hemlock	*Cicuta douglasii*	CIDO	CIDO	N	OBL
western white clematis	*Clematis ligusticifolia*	CLLI	CLLI	N	FAC
western white pine	*Pinus monticola*	PIMO	PIMO3	N	FACU
western wintergreen	*Gaultheria humifusa*	GAHU	GAHU	N	FAC+
western yarrow	*Achillea millefolium*	ACMI	ACMI	N	FACU
whiplash willow	*Salix lasiandra caudata*	SALAC	SALAC	Y	FACW+
white bog-orchid	*Habenaria dilatata*	HADI2	HADI7	N	OBL
white clover	*Trifolium repens*	TRRE	TRRE3	N	FACU
white fir	*Abies concolor*	ABCO	ABCO	N	FACU
white hawkweed	*Hieracium albiflorum*	HIAL	HIAL2	N	FACU
white spruce	*Picea glauca*	PIGL	PIGL	Y	FACU
white trillium	*Trillium ovatum*	TROV	TROV2	N	FAC+
whitebark pine	*Pinus albicaulis*	PIAL	PIAL	N	FACU
whitestem gooseberry	*Ribes inerme*	RIIN	RIIN2	N	FACU
wild ginger	*Asarum caudatum*	ASCA3	ASCA2	Y	FACW-
wild onion species	*Allium* spp.	ALLIU	ALLIU	N	FACU
wild sarsaparilla	*Aralia nudicaulis*	ARNU3	ARNU3	Y	FACW-
willow species	*Salix* spp.	SALIX	SALIX	Y	FACW
willow-weed species	*Epilobium* spp.	EPILO	EPILO	N	FAC
winter bentgrass	*Agrostis scabra*	AGSC	AGSC5	N	FAC+
wood horsetail	*Equisetum sylvaticum*	EQSY	EQSY	Y	FACW
wood reed-grass	*Cinna latifolia*	CILA2	CILA2	Y	FACW
wood fern	*Dryopteris carthusiana*	DRCA	DRCA11	Y	FACW
wood fern species	*Dryopteris* spp.	DRYOP	DRYOP	Y	FACW
woodnymph pyrola	*Pyrola uniflora*	PYUN	PYUN	N	FACW
woodreed species	*Cinna* spp.	CINNA	CINNA	N	FACW
wood reed-grass	*Cinna latifolia*	CILA2	CILA2	Y	FACW
woodrush sedge	*Carex luzulina*	CALU	CALU7	N	OBL
woods rose	*Rosa woodsii*	ROWO	ROWO	N	FAC
woods strawberry	*Fragaria vesca* var. *bracteata*	FRVEB	FRVEB3	N	FACU
woolly pussytoes	*Antennaria lanata*	ANLA	ANLA3	N	FACU
woolly sedge	*Carex lanuginosa*	CALA3	CALA30	Y	OBL
Wormskjold's speedwell	*Veronica wormskjoldii*	VEWO	VEWO2	N	FAC+
yellow sedge	*Carex flava*	CAFL	CAFL4	N	OBL

Appendix A-3—Insect Species Mentioned in This Classification

Common name	Scientific name
Alder flea beetle	*Altica ambiens*
Alder wooly sawfly	*Eriocampa ovata*
Aspen leaf-tier	*Sciaphila duplex*
Balsam woolly adelgid	*Adelges piceae*
Blue alder agrilus	*Agrilus burkei*
Bronze poplar borer	*Agrilus liragus*
Cedar gall midge	*Mayetiola thujae*
Cone maggot	*Earomyia abietum*
Douglas-fir beetle	*Dendroctonus pseudotsugae*
Douglas-fir cone moth	*Barbara colfaxiana*
Douglas-fir seed chalcid	*Megastigmus spermotrophus*

Appendix A-3—Insect Species Mentioned in This Classification (continued)

Common name	Scientific name
Douglas-fir tussock moth	*Orgyia pseudotsugata*
Fall webworm	*Hyphantria cunea*
Fir engraver	*Scolytus ventralis*
Forest tent caterpillar	*Malacosoma disstria*
Green-striped forest looper	*Melanolophia imitata*
Hemlock sawfly	*Neodiprion tsugae*
Large aspen tortrix	*Choristoneura conflictana*
Mountain pine beetle	*Dendroctonus ponderosae*
Pacific tent caterpillar	*Malacosoma constrictum*
Poplar borer	*Saperda calcarata*
Saddleback looper	*Ectropis crepuscularia*
Satin moth	*Leucoma salicis*
Silver fir beetle	*Pseudohylesinus sericeus*
Spruce beetle	*Dendroctonus rufipennis*
Steremnius weevil	*Stermnius* spp.
Striped alder sawfly	*Hemichroa crocea*
Western balsam bark beetle	*Dryocoetes confusus*
Western black-headed budworm	*Acleris gloverana*
Western cedar borer	*Trachykele blondeli*
Western hemlock looper	*Lambdina fiscellaria*
Western larch borer	*Tetropium velutinum*
Western oak looper	*Lambdina fiscellaria*
Western pine beetle	*Dendroctonus brevicomus*
Western spruce budworm	*Choristoneura occidentalis*
Western tent caterpillar	*Malacosoma californicum*
Wooly alder aphid	*Prociphilus tesselatus*

Appendix A-4—Diseases Mentioned in This Classification

Common name	Scientific name
Annosus root disease	*Heterobasidion (Fomes) annosum*
Armillaria root rot	*Armillaria ostoyae*
	A. sinapina—can cause root rot of hardwoods
Black canker	*Ceratocystis fimbriata*
Brown crumbly rot	*Fomitopsis (Fomes) pinicola*
Brown cubical rot	*Laetiporus (Polyporus) sulphureus*
Brown felt blight	*Herpotrichia juniperi*
Brown stringy rot	*Echinodontium tinctorium*
Brown trunk rot	*Fomitopsis (Fomes) officinalis*
Cytospora canker	*Cytospora chrysosperma*
Dwarf mistletoe	*Arceuthobium* species
False tinder fungus	*Phellinus tremulae (Fomes igniarius)*
Hypoxylon canker	*Entoleuca mammata (Hypoxylon mammatum)*
Indian paint fungus	*Echinodontium tinctorium*
Laminated root rot	*Phellinus weirii*
Long pocket rot	*Hericium abietis*
Melampsora rust	*Melampsora albertensis*—causes aspen-conifer rust
	Melampsora occidentalis—causes conifer-cottonwood rust
Mottled rot	*Pholiota adiposa*
Oak anthracnose	*Apiognomonia quercina*
Red belt fungus	*Fomitopsis (Fomes) pinicola*
Red heart rot	*Stereum sanguinolentum*
Red ring rot	*Phellinus (Fomes) pini*
Rust red stringy rot	*Echinodontium tinctorium*
Schweinitzii butt rot	*Phaeolus (Polyporus) schweinitzii*
Shepherd's crook	*Venturia macularis*
	V. populina—can cause shepherd's crook on cottonwood
Sooty-bark canker	*Encoelia pruinosa (Cenangium singulare)*
Spruce broom rust	*Chrysomyxa arctostaphyli*
Tomentosus root disease	*Inonotus tomentosus*
White heart rot	*Phellinus igniarius*
White juniper rust	*Gymnosporangium* species
White pine blister rust	*Cronartium ribicola*
White pocket rot	*Phellinus (Fomes) pini*
White spongy root rot	*Heterobasidion (Fomes) annosum*
Yellow root rot	*Perenniporia subacida*

Appendix A-5—Wildlife Species Mentioned in This Classification

Common name	Scientific name
American dipper	*Cinclus mexicanus*
American marten	*Martes americana*
American robin	*Turdus migratorius*
Bald eagle	*Haliaeetus leucocephalus*
Barred owl	*Strix varia*
Bats	*Myotis* spp.
Beaver	*Castor canadensis*
Bighorn sheep	*Ovis canadensis*
Black bear	*Ursus americanus*
Black-headed grosbeak	*Pheucticus melanocephalus*
Black-tailed deer	*Odocoileus hemionus* var. *columbianus*
Bluebirds	*Sialia* spp.
Blue grouse	*Dendragapus obscurus*
Blue heron	*Ardea herodias*
Bog lemming	*Synaptomys borealis*
Brown creeper	*Certhia americana*
Bushy-tailed wood rat	*Neotoma cinerea*
California quail	*Callipepla californica*
Caribou	*Rangifer tarandus*
Chestnut-backed chickadee	*Poecile rufescens*
Chickadee	*Poecile* spp.
Chipmunk	*Tamias* spp.
Chipping sparrow	*Spizella passerina*
Clark’s nutcracker	*Nucifraga columbiana*
Common snipe	*Gallinago gallinago*
Common yellowthroat	*Geothlypis trichas*
Cottontail rabbit	*Sylvilagus nuttalli*
Coyote	*Canis latrans*
Crossbill	*Loxia* spp.
Crow	*Corvus brachyrhynchos*
Deer mice	*Peromyscus maniculatus*
Elk	*Cervus elaphus*
Field mice	*Microtus* spp.
Fisher	*Martes pennanti*
Flicker	*Colaptes auratus*
Flycatcher	*Empidonax* spp., *Contopus* spp.
Flying squirrel	*Glaucomys sabrinus*
Fox	*Vulpes fulva*
Franklin’s grouse	*Falcipennis canadensis*
Golden-crowned kinglet	*Regulus satrapa*
Goldfinch	*Carduelis tristis*
Goshawks	*Accipiter gentilis*
Gray catbird	*Dumetella carolinensis*
Great gray owl	*Strix nebulosa*
Great horned owl	*Bubo virginianus*
Green-winged teal	*Anas crecca*
Grizzly bear	*Ursus arctos*
Ground squirrels	*Spermophilus* spp.
Hairy woodpecker	*Picoides villosus*
Hares	*Lepus* spp.
Harlequin duck	*Histrionicus histrionicus*
Hummingbird	*Selasphorus* spp., *Stellula* spp.
Kinglet	*Regulus* spp.
Lazuli bunting	*Passerina amoena*
Long-billed marsh wrens	*Cistothorus palustris*
Magpie	*Pica hudsonia*
Mallard	*Anas platyrhynchos*
Meadow vole	*Microtus pennsylvanicus*
Moose	*Alces alces*
Mountain beaver	*Aplodontia rufa*
Mountain goat	*Oreamnus americanus*
Mourning dove	*Zenaida macroura*
Mule deer	*Odocoileus hemionus*
Muskrat	*Ondatra zibethica*
Northern spotted owl	*Strix occidentalis*
Nuthatch	*Sitta* spp.
Oregon junco	*Junco hyemalis*
Osprey	*Pandion haliaetus*
Pika	*Ochotona princeps*
Pileated woodpecker	*Dryocopus pileatus*
Pine grosbeak	*Pinicola enucleator*
Pine siskin	*Carduelis pinus*

Appendix A-5—Wildlife Species Mentioned In This Classification (continued)

Common name	Scientific name
Pocket gopher	*Thomomys* spp.
Porcupine	*Erethizon dorsatum*
Ptarmigan	*Lagopus leucurus*
Quail	*Callipepla californica*
Raccoon	*Procyon lotor*
Raven	*Corvus corax*
Red-backed vole	*Clethrionomys* spp.
Red-breasted nuthatch	*Sitta canadensis*
Redhead duck	*Aythya americana*
Red-naped sapsucker	*Sphyrapicus nuchalis*
Redpoll	*Carduelis* spp.
Red squirrel	*Tamiasciurus hudsonicus*
Red tree vole	*Aborimus longicaudus*
Red-winged blackbird	*Agelaius phoeniceus*
Roosevelt elk	*Cervus canadensis* var. *roosevelti*
Ruffed grouse	*Bonasa umbellus*
Ruddy duck	*Oxyura jamaicensis*
Sandhill crane	*Grus canadensis*
Sheep	*Ovis* spp.
Shrew	*Sorex* spp.
Skunk	*Mephitis* spp.
Snowshoe hare	*Lepus americanus*
Song sparrow	*Melospiza melodia*
Spruce grouse	*Dendragapus canadensis*
Steller's jay	*Cyanocitta stelleri*
Thrush	*Catharus* spp.
Towhee	*Pipilo* spp.
Tree swallow	*Tachycineta bicolor*
Trout	*Oncoryhynchus* spp. *Salvelinus* spp.
Turkey	*Meleagris gallopavo*
Vagrant shrew	*Sorex vagrans*
Varied thrush	*Ixoreus naevius*
Vaux's swift	*Chaetura vauxi*
Warbler	*Dendroica* spp., *Phylloscopus* spp.
Weasel	*Mustela frenata*
White-footed mice	*Peromyscus leucopus*
White-tailed deer	*Odocoileus virginianus*
Williamson's sapsucker	*Sphyrapicus thyroideus*
Wood duck	*Aix sponsa*
Yellow-bellied sapsucker	*Sphyrapicus varius*
Yellow-headed blackbird	*Xanthocephalus xanthocephalus*

APPENDIX B: Management Information for Selected Plant Species

APPENDIXES B-1 to B-5 contain the following management information on a species-by-species basis: (B-1) forage palatability for cattle, sheep, and horses; energy and protein value; (B-2) thermal or feeding cover and food values for elk, mule deer, and white-tailed deer; (B-3) thermal or feeding cover values for upland game birds, waterfowl, small nongame birds, and small mammals; (B-4) food value or degree of use for upland game birds, waterfowl, small nongame birds, and small mammals; and (B-5) potential biomass production, erosion control potential, short-term revegetation potential, and long-term revegetation potential.

Management information is from *The Plant Information Network (PIN) Database: Colorado, Montana, North Dakota, Utah, and Wyoming* by Dittberner and Olson (1983), with some modifications. In some instances, no management information was available for certain plant species. The author then used professional experience along with information that was available for species with similar morphological or physiological characteristics. Unfortunately, this is a partial list of the many species found in appendix A. Information for many of the indicator and common plant species is not available.

Appendix B-1: Forage Palatability for Cattle, Sheep, and Horses; Energy and Protein Value (Adapted from Hansen et al. 1995, Crowe and Clausnitzer 1997)

Palatability refers to the relish and degree of use shown by livestock for a plant or plant part:

- **G** (good) = highly relished and consumed to a high degree;
- **F** (fair) = moderately relished and consumed to a moderate degree;
- **P** (poor) = not relished and normally consumed to only a small degree or not at all.

Value refers to the energy and protein value of the plant as food source for livestock measured as high (**H**), medium (**M**), or low (**L**).

Scientific name	Common name	Cattle forage palatability	Sheep forage palatability	Horse forage palatability	Energy value	Protein value
Trees:						
Abies lasiocarpa	subalpine fir	P	P	P	M	L
Picea engelmann	Engelmann spruce	P	P	P	M	L
Picea glauca	white spruce	P	P	P	M	L
Pinus contorta	lodgepole pine	P	P	P	M	L
Pinus ponderosa	ponderosa pine	P	P	P	M	L
Populus tremuloides	quaking aspen	F	G	F	M	M
Populus trichocarpa	black cottonwood	P	F	P	M	M
Pseudotsuga menziesii	Douglas-fir	P	P	P	M	L
Shrubs:						
Acer glabrum var. *douglasii*	Douglas maple	P	F	P	M	L
Alnus incana	mountain alder	P	F	P	M	L
Amelanchier alnifolia	Saskatoon serviceberry	F	G	F	M	M
Arctostaphylos uva-ursi	bearberry	P	P	P		
Betula glandulosa	bog birch	P	F	P	L	L
Betula occidentalis	water birch	P	P	P	M	M
Cornus stolonifera	red-osier dogwood	F	F	P	M	L
Crataegus douglasii var. *douglasii*	black hawthorn	F	F	P	M	M
Kalmia microphylla	alpine laurel	P	P	P		
Ledum glandulosum	Labrador tea				M	M
Lonicera utahensis	Utah honeysuckle	F	F	P	L	L
Potentilla fruticosa	shrubby cinquefoil	P	F	P	M	L
Prunus virginiana	common chokecherry	F	G	P	H	M
Ribes lacustre	prickly currant				M	L
Rosa woodsii	woods rose	F	F	P	L	L
Rubus parviflorus	western thimbleberry	P	F	P		
Rubus parviflorus	western thimbleberry	P	F	P	L	L
Salix bebbiana	Bebb's willow	G	G	G	M	L
Salix boothii	Booth's willow	F	F	F	M	L
Salix commutata	undergreen willow				M	L
Salix drummondiana	Drummond's willow	P	F	P	M	L
Salix exigua	coyote willow	F	F	F	M	L
Salix geyeriana	Geyer's willow	F	G	G	M	L
Salix lasiandra	Pacific and whiplash willows	F	F	F	M	L
Salix planifolia var. *monica*	tea-leaved willow		M	L		
Salix rigida var. *mackenziana*	Mackenzie's willow	F	G	G	M	L
Spiraea betulifolia	shiny-leaf spiraea	P	F	P		
Symphoricarpos albus	common snowberry	F	F	P	M	M
Vaccinium caespitosum	dwarf huckleberry	P	F	P	L	M
Vaccinium scoparium	grouse huckleberry	P	F	P	L	M

Appendix B-1: Forage Palatability for Cattle, Sheep, and Horses, Energy and Protein Value (Adapted from Hansen et al. 1995, Crowe and Clausnitzer 1997) (continued)

Scientific name	Common name	Cattle forage palatability	Sheep forage palatability	Horse forage palatability	Energy value	Protein value
Graminoids:						
Agrostis alba	redtop	F	F	F	L	L
Bromus vulgaris	Columbia brome	G	F	G	M	L
Calamagrostis canadensis	bluejoint reedgrass	G	F	G	M	L
Calamagrostis rubescens	pinegrass	F	P	F	M	L
Carex aquatilis	Sitka and water sedges	G	G	G	M	M
Carex atherodes	awned sedge	G	F	G	M	L
Carex buxbaumii	Buxbaum's sedge	G	G	F	M	M
Carex lanuginosa	woolly sedge	G	G	F	M	L
Carex lasiocarpa	slender sedge	P	P	P	M	M
Carex lenticularis	lenticular sedge	F	F	F	M	M
Carex limosa	mud sedge	F	F	F	M	M
Carex nigricans	black alpine sedge	F	F	F	M	M
Carex scopulorum var. *bracteosa*	Holm's sedge	F	F	F	M	M
Carex scopulorum var. *prionophylla*	saw-leaved sedge	F	F	F	M	M
Carex utriculata	bladder sedge	F	F	G	M	L
Carex vesicaria	inflated sedge	F	F	F	M	L
Deschampsia cespitosa	tufted hairgrass	G	F	G	M	L
Eleocharis palustris	creeping spike-rush	P	P	P	M	L
Eleocharis pauciflora	few-flowered spike-rush	P	P	P	M	L
Elymus canadensis	Canada wildrye	F	F	G	H	L
Elymus cinereus	basin wildrye	G	F	G	H	L
Elymus glaucus	blue wildrye	G	F	G	H	L
Glyceria borealis	northern mannagrass	G	G	G	M	L
Glyceria grandis	reed mannagrass	G	G	G	M	L
Glyceria striata	fowl mannagrass	G	G	G	M	L
Juncus balticus	Baltic rush	F	P	F	M	L
Phalaris arundinacea	reed canarygrass	G	G	G	M	L
Phleum alpinum	alpine timothy	G	G	G	H	L
Phleum pratense	timothy	G	G	G	M	L
Poa palustris	fowl bluegrass	F	F	F	M	L
Poa pratensis	Kentucky bluegrass	G	G	G	M	L
Puccinellia pauciflora	weak alkaligrass and pale false mannagrass	F	F	F	M	L
Scirpus acutus	hardstem bulrush	F	P	F	M	L
Scirpus microcarpus	small-fruited bulrush	F	F	F	M	L
Scirpus validus	softstem bulrush	F	P	P	M	L
Forbs:						
Achillea millefolium	western yarrow	P	F	P	L	L
Actaea rubra	baneberry	P	F	P	L	L
Aralia nudicaulis	wild sarsaparilla				L	L
Arnica cordifolia	heart-leaf arnica	P	F	P	L	L
Aster foliaceus	alpine leafybract aster	F	G	G	L	L
Cirsium arvense	Canada thistle	P	P	P	L	L
Epilobium angustifolium	fireweed	F	G	F	L	L
Equisetum arvense	common horsetail	P	P	P	L	L
Equisetum fluviatile	water horsetail	P	P	P	L	L
Fragaria virginiana var. *platypetala*	broadpetal strawberry	P	G	P	L	L
Galium boreale	northern bedstraw	P	F	P	L	L
Geum triflorum	old man's whiskers	P	F	P	L	L
Heracleum lanatum	common cow-parsnip	G	G	G	L	L
Mertensia ciliata	mountain bluebells	F	G	F	L	L
Osmorhiza chilensis	mountain sweet-root	F	F	F	L	L
Pedicularis groenlandica	elephanthead pedicularis	P	F	P	L	L
Polygonum amphibium	water ladysthumb	F	F	F	L	L
Polygonum bistortoides	American bistort	P	F	P	L	L
Potentilla gracilis	northwest cinquefoil	P	F	P	L	L
Senecio triangularis	arrowleaf groundsel	F	G	F	L	L
Smilacina stellata	starry solomonplume	P	F	P	L	L
Solidago canadensis	Canada goldenrod	P	P	P	L	L
Thalictrum occidentale	western meadowrue	P	F	P	L	L
Trifolium repens	white clover	G	G	G	L	L
Typha latifolia	common cattail	P	P	P	L	L
Urtica dioica	stinging nettle	P	F	P	L	L
Viola canadensis	Canadian violet	F	G	P	L	L
Viola glabella	pioneer violet	F	G	P	L	L

Appendix B-2: Thermal or Feeding Cover and Food Values for Elk, Mule Deer, and White-Tailed Deer (Adapted from Hansen et al. 1995, Crowe and Clausnitzer 1997)

Thermal or feeding cover value refers to the degree to which a plant provides protection from the environment during one or more seasons.

- **G** (good) = readily utilized for cover when available;
- **F** (fair) = moderately utilized for cover when available;
- **P** (poor) = rarely or never utilized for cover when available.

Food value refers to the use shown by a wildlife species for a plant or plant part, as well as to the plant's availability throughout its range.

- **G** (good) = readily to moderately available in the plant's range and consumed to a high degree;
- **F** (fair) = readily to moderately available in the plant's range but consumed only to a moderate degree;
- **P** (poor) = available but the plant is consumed to only a small degree or not at all.

Scientific name	Common name	Elk cover value	Mule deer cover value	White-tailed deer cover value	Elk food value	Mule deer food value	White-tailed deer food value
Trees:							
Abies amabilis	Pacific silver fir	F	F	F	P	P	P
Abies grandis	grand fir	F	F	F	P	P	P
Abies lasiocarpa	subalpine fir	F	F	F	P	P	P
Alnus rubra	red alder	G	G	G	P	P	P
Picea engelmannii	Engelmann spruce	G	G	G	P	P	P
Picea glauca	white spruce	G	G	G	P	P	P
Pinus contorta	lodgepole pine	G	G	G	P	P	P
Pinus ponderosa	ponderosa pine	G	G	G	P	P	P
Populus tremuloides	quaking aspen	G	G	G	F	F	F
Populus trichocarpa	black cottonwood	F	F	G	P	P	P
Pseudotsuga menziesii	Douglas-fir	G	G	G	P	F	P
Thuja plicata	western redcedar	G	G	G	P	P	P
Tsuga heterophylla	western hemlock	G	G	G	P	P	P
Tsuga mertensiana	mountain hemlock	G	G	G	P	P	P
Shrubs:							
Acer glabrum var. *douglasii*	Douglas maple	F	F	F	F	G	F
Alnus incana	mountain alder	F	F	F	P	P	P
Alnus sinuata	Sitka alder	F	F	F	P	P	P
Amelanchier alnifolia	Saskatoon serviceberry	P	F	F	F	G	G
Betula glandulosa	bog birch	P	P	P	P	P	P
Betula occidentalis	water birch	F	G	G	F	P	F
Cornus stolonifera	red-osier dogwood	F	F	F	P	G	G
Crataegus douglasii var. *douglasii*	black hawthorn	F	G	G	F	F	F
Kalmia microphylla	alpine laurel	F	F	F	P	P	P
Lonicera utahensis	Utah honeysuckle	F	F	F			
Potentilla fruticosa	shrubby cinquefoil	P	P	P	F	F	F
Prunus virginiana	common chokecherry	F	G	G	F	G	G
Ribes lacustre	prickly currant	P	F	F	G	F	F
Rosa woodsii	woods rose	F	G	G	F	F	F
Salix bebbiana	Bebb's willow	G	G	G	G	F	F
Salix boothii	Booth's willow	G	G	G	F	F	F
Salix drummondiana	Drummond's willow	G	G	G	F	F	F
Salix exigua	coyote willow	G	G	G	F	F	F
Salix geyeriana	Geyer's willow	G	G	G	G	G	G
Salix lasiandra	Pacific and whiplash willows	G	G	G			
Salix planifolia monica	tea-leaved willow	F	F	F			
Spiraea betulifolia	shiny-leaf spiraea	P	P	P	P	F	F
Symphoricarpos albus	common snowberry	P	F	F	F	F	F
Vaccinium caespitosum	dwarf huckleberry	P	P	P	G	G	F
Vaccinium scoparium	grouse huckleberry	P	P	P	P	P	P
Graminoids:							
Agrostis alba	redtop	P	P	P	G	G	F
Bromus vulgaris	Columbia brome	P	P	P	F	F	F
Calamagrostis canadensis	bluejoint reedgrass	P	P	P	F	P	P
Calamagrostis rubescens	pinegrass	P	P	P	P	P	P
Carex aquatilis	Sitka and water sedges	P	P	P	F	F	F
Carex atherodes	awned sedge	P	P	P	F	F	F
Carex lanuginosa	woolly sedge	P	P	P	F	F	F
Carex lasiocarpa	slender sedge	P	P	P	P	P	P
Carex utriculata	bladder sedge	P	P	P	F	F	P
Carex vesicaria	inflated sedge	P	P	P	F	P	P
Deschampsia cespitosa	tufted hairgrass	P	P	P	G	F	F
Eleocharis palustris	creeping spike-rush	P	P	P	F	F	P
Eleocharis pauciflora	few-flowered spike-rush	P	P	P	F	F	P
Elymus canadensis	Canada wildrye	P	P	P	F	F	P
Elymus cinereus	basin wildrye	P	P	P	G	F	F
Elymus glaucus	blue wildrye	P	P	P	G	G	F

Appendix B-2: Thermal or Feeding Cover and Food Values for Elk, Mule Deer, and White-tailed Deer (Adapted from Hansen et al. 1995, Crowe and Clausnitzer 1997) (continued)

Scientific name	Common name	Elk cover value	Mule deer cover value	White-tailed deer cover value	Elk food value	Mule deer food value	White-tailed deer food value
Glyceria borealis	northern mannagrass	P	P	P	F	F	P
Glyceria grandis	reed mannagrass	P	P	P	F	F	P
Glyceria striata	fowl mannagrass	P	P	P	F	F	P
Juncus balticus	Baltic rush	P	P	P	F	P	P
Phalaris arundinacea	reed canarygrass	P	G	G	G	F	F
Phleum pratense	timothy	P	P	P	F	F	F
Poa palustris	fowl bluegrass	P	P	P	G	G	G
Poa pratensis	Kentucky bluegrass	P	P	P	G	F	G
Puccinellia pauciflora	weak alkaligrass and pale false mannagrass	P	P	P	G	F	P
Scirpus acutus	hardstem bulrush	P	F	P	P	P	P
Scirpus validus	softstem bulrush	P	G	G	P	P	P
Forbs:							
Achillea millefolium	western yarrow	P	P	P	P	P	P
Actaea rubra	baneberry	P	P	P	F	F	F
Arnica latifolia	mountain arnica	P	P	P	F	F	F
Aster foliaceus	alpine leafybract aster	P	P	P	G	G	F
Cirsium arvense	Canada thistle	P	P	P	P	F	P
Epilobium angustifolium	fireweed	P	P	P	F	F	F
Equisetum arvense	common horsetail	P	P	P	P	P	P
Fragaria virginiana var. *platypetala*	broadpetal strawberry	P	P	P	F	G	G
Galium boreale	northern bedstraw	P	P	P	P	F	P
Heracleum lanatum	common cow-parsnip	P	P	P	G	G	G
Mertensia ciliata	mountain bluebells	P	P	P	P	P	P
Pedicularis groenlandica	elephanthead pedicularis	P	P	P	F	F	P
Polygonum amphibium	water ladysthumb	P	P	P	P	P	P
Potentilla gracilis	northwest cinquefoil	P	P	P	P	P	P
Senecio triangularis	arrowleaf groundsel	P	P	P	G	F	F
Smilacina stellata	starry solomonplume	P	P	P	P	F	F
Solidago canadensis	Canada goldenrod	P	P	P	P	F	F
Thalictrum occidentale	western meadowrue	P	P	P	F	F	F
Typha latifolia	common cattail	P	F	G	P	P	P
Urtica dioica	stinging nettle	P	P	P	P	P	P
Viola glabella	pioneer violet	P	P	P	F	F	F

Appendix B-3: Thermal or Feeding Cover Values for Upland Game Birds, Waterfowl, Small Nongame Birds, and Small Mammals (Adapted from Hansen et al. 1995, Crowe and Clausnitzer 1997)

Thermal or feeding cover value refers to the degree to which a plant provides protection from the environment (e.g., thermal, nesting, brooding, or feeding cover), during one or more seasons.

- **G** (good) = readily utilized for cover when available;
- **F** (fair) = moderately utilized for cover when available;
- **P** (poor) = rarely or never utilized for cover when available.

Scientific name	Common name	Upland game bird cover value	Waterfowl cover value	Small nongame bird cover value	Small mammal cover value
Trees:					
Abies lasiocarpa	subalpine fir	G	P	F	G
Picea engelmannii	Engelmann spruce	G	P	G	G
Picea glauca	white spruce	G	P	G	G
Pinus contorta	lodgepole pine	G	P	G	G
Pinus ponderosa	ponderosa pine	G	P	G	G
Populus tremuloides	quaking aspen	G	F	G	G
Populus trichocarpa	black cottonwood	F	F	G	G
Pseudotsuga menziesii	Douglas-fir	G	P	G	G
Shrubs:					
Acer glabrum var. *douglasii*	Douglas maple	F	F	F	F
Alnus incana	mountain alder	F	G	F	F
Amelanchier alnifolia	Saskatoon serviceberry	F	G	F	F
Betula glandulosa	bog birch	F	G	F	F
Betula occidentalis	water birch	G	G	G	G
Cornus stolonifera	red-osier dogwood	F	F	F	F
Crataegus douglasii var. *douglasii*	black hawthorn	F	F	F	F
Kalmia microphylla	alpine laurel	F	P	F	F
Lonicera utahensis	Utah honeysuckle	F	P	F	F

Appendix B-3: Thermal or Feeding Cover Values for Upland Game Birds, Waterfowl, Small Nongame Birds, and Small Mammals (Adapted from Hansen et al. 1995, Crowe and Clausnitzer 1997) (continued)

Scientific name	Common name	Upland game bird cover value	Waterfowl cover value	Small nongame bird cover value	Small mammal cover value
Potentilla fruticosa	shrubby cinquefoil	F	P	P	P
Prunus virginiana	common chokecherry	G	G	G	G
Ribes lacustre	prickly currant	G	G	G	G
Rosa woodsii	woods rose	F	G	F	F
Salix bebbiana	Bebb's willow	G	F	G	G
Salix boothii	Booth's willow	G	F	G	G
Salix drummondiana	Drummond's willow	G	F	G	G
Salix exigua	coyote willow	G	G	G	G
Salix geyeriana	Geyer's willow	G	F	G	G
Salix lasiandra	Pacific and whiplash willows	G	F	G	G
Salix planifolia monica	tea-leaved willow	F	F	F	F
Spiraea betulifolia	shiny-leaf spiraea	P	G	P	P
Symphoricarpos albus	common snowberry	G	G	G	G
Vaccinium caespitosum	dwarf huckleberry	P	G	P	P
Vaccinium scoparium	grouse huckleberry	P	G	P	P
Graminoids:					
Agrostis alba	redtop	G	G	F	F
Bromus inermis	smooth brome	G	G	G	F
Calamagrostis canadensis	bluejoint reedgrass	P	G	P	P
Calamagrostis rubescens	pinegrass	F	G	P	P
Carex aquatilis	Sitka and water sedges	P	F	F	F
Carex lanuginosa	woolly sedge	P	F	F	F
Carex lasiocarpa	slender sedge	P	F	F	F
Carex lenticularis	lenticular sedge	P	F	F	F
Carex utriculata	bladder sedge	P	P	F	F
Carex vesicaria	inflated sedge	P	F	F	F
Deschampsia cespitosa	tufted hairgrass	P	G	P	P
Eleocharis palustris	creeping spike-rush	F	G	F	F
Eleocharis pauciflora	few-flowered spike-rush	F	G	F	F
Elymus cinereus	basin wildrye	F	G	P	P
Elymus glaucus	blue wildrye	F	G	P	P
Glyceria borealis	northern mannagrass	F	G	G	G
Glyceria grandis	reed mannagrass	F	G	G	G
Glyceria striata	fowl mannagrass	F	G	G	G
Juncus balticus	Baltic rush	F	G	F	F
Phalaris arundinacea	reed canarygrass	F	G	F	F
Phleum alpinum	alpine timothy	P	F	P	P
Phleum pratense	timothy	F	G	F	F
Poa pratensis	Kentucky bluegrass	G	G	G	G
Puccinellia pauciflora	weak alkaligrass and pale false mannagrass	F	G	F	G
Scirpus acutus	hardstem bulrush	G	G	G	F
Scirpus validus	softstem bulrush	G	G	G	G
Forbs—most forbs are generally poor to fair except for the following species:					
Typha latifolia	common cattail	G	G	G	F

Appendix B-4: Food Value or Degree of Use for Upland Game Birds, Waterfowl, Small Nongame Birds, and Small Mammals (Adapted from Hansen et al. 1995 and Crowe and Clausnitzer 1997)

Food value refers to the use shown by a wildlife species for a plant or plant part, as well as to the plant's availability throughout its range.

- **G** (good) = readily to moderately available in the plant's range and consumed to a high degree;
- **F** (fair) = readily to moderately available in the plant's range but consumed only to a moderate degree;
- **P** (poor) = available but the plant is consumed to only a small degree or not at all.

Scientific name	Common name	Upland game bird food species	Waterfowl food value	Small nongame bird food value	Small mammal food value
Trees:					
Abies lasiocarpa	subalpine fir	F	P	P	F
Picea engelmannii	Engelmann spruce	F	P	G	G
Picea glauca	white spruce	F	P	G	G
Pinus contorta	lodgepole pine	G	P	P	P
Pinus ponderosa	ponderosa pine	G	P	G	G
Populus tremuloides	quaking aspen	G	F	G	G
Populus trichocarpa	black cottonwood	G	F	G	G
Pseudotsuga menziesii	Douglas-fir	G	P	P	F
Shrubs:					
Acer glabrum var. *douglasii*	Douglas maple	F	P	F	F
Alnus incana	mountain alder	F	P	G	F

Appendix B-4: Food Value or Degree of Use for Upland Game Birds, Waterfowl, Small Nongame Birds, and Small Mammals (Adapted from Hansen et al. 1995 and Crowe and Clausnitzer 1997) (continued)

Scientific name	Common name	Upland game bird food species	Waterfowl food value	Small nongame bird food value	Small mammal food value
Amelanchier alnifolia	Saskatoon serviceberry	F	P	F	F
Betula glandulosa	bog birch	F	P	F	F
Betula occidentalis	water birch	G	F	F	G
Cornus stolonifera	red-osier dogwood	F	F	F	F
Crataegus douglasii var. *douglasii*	black hawthorn	F	P	F	F
Lonicera utahensis	Utah honeysuckle	F	F	G	F
Potentilla fruticosa	shrubby cinquefoil	P	P	F	F
Prunus virginiana	common chokecherry	G	P	G	G
Ribes lacustre	prickly currant	G	F	G	G
Rosa woodsii	woods rose	G	P	G	G
Rubus parviflorus	western thimbleberry	F	P	F	F
Salix bebbiana	Bebb's willow	G	F	G	G
Salix boothii	Booth's willow	G	F	G	G
Salix drummondiana	Drummond's willow	G	F	F	F
Salix exigua	coyote willow	G	F	G	G
Salix geyeriana	Geyer's willow	G	F	G	G
Spiraea betulifolia	shiny-leaf spiraea	P	P	P	P
Symphoricarpos albus	common snowberry	F	F	F	F
Vaccinium caespitosum	dwarf huckleberry	F	P	F	G
Vaccinium scoparium	grouse huckleberry	F	P	P	P
Graminoids:					
Agrostis alba	redtop	F	F	F	F
Bromus vulgaris	Columbia brome	G	F	G	G
Calamagrostis canadensis	bluejoint reedgrass	P	G	P	P
Carex aquatilis	Sitka and water sedges	P	F	F	F
Carex atherodes	awned sedge	P	F	F	F
Carex lanuginosa	woolly sedge	F	F	F	F
Carex lasiocarpa	slender sedge	F	F	F	F
Carex utriculata	bladder sedge	F	F	G	G
Carex vesicaria	inflated sedge	F	F	G	G
Deschampsia cespitosa	tufted hairgrass	F	G	P	P
Eleocharis palustris	creeping spike-rush	P	G	F	F
Eleocharis pauciflora	few-flowered spike-rush	P	G	F	F
Elymus cinereus	basin wildrye	F	F	P	P
Elymus glaucus	blue wildrye	F	F	P	P
Glyceria borealis	northern mannagrass	G	G	F	G
Glyceria grandis	reed mannagrass	G	G	F	G
Glyceria striata	fowl mannagrass	F	F	F	G
Juncus balticus	Baltic rush	G	G	F	F
Phalaris arundinacea	reed canarygrass	F	F	F	F
Phleum pratense	timothy	F	G	F	F
Poa palustris	fowl bluegrass	F	F	F	F
Poa pratensis	Kentucky bluegrass	F	G	F	F
Puccinellia pauciflora	weak alkaligrass and pale false mannagrass	F	F	F	F
Scirpus acutus	hardstem bulrush	G	G	G	F
Scirpus validus	softstem bulrush	G	G	G	G
Forbs:					
Achillea millefolium	western yarrow	P	P	P	P
Actaea rubra	baneberry	P	P	F	F
Arnica cordifolia	heart-leaf arnica	P	P	P	P
Aster foliaceus	alpine leafybract aster	F	F	G	G
Cirsium arvense	Canada thistle	F	P	F	P
Epilobium angustifolium	fireweed	F	P	F	P
Epilobium glaberrimum	smooth willow-weed	F	G	F	F
Equisetum arvense	common horsetail	P	P	P	P
Fragaria virginiana var. *platypetala*	broadpetal strawberry	P	P	P	F
Galium boreale	northern bedstraw	P	P	P	P
Galium trifidum	small bedstraw	P	P	P	P
Galium triflorum	sweetscented bedstraw	P	P	P	P
Heracleum lanatum	common cow-parsnip	F	F	P	P
Mertensia ciliata	mountain bluebells	F	P	F	F
Osmorhiza chilensis	mountain sweet-root	F	F	G	G
Polygonum amphibium	water ladysthumb	F	G	F	F
Potentilla gracilis	northwest cinquefoil	P	P	P	P
Senecio triangularis	arrowleaf groundsel	F	P	G	G
Smilacina stellata	starry solomonplume	F	P	F	F
Solidago canadensis	Canada goldenrod	F	P	F	F
Typha latifolia	common cattail	G	G	G	F
Viola adunca	hook violet	P	P	P	P

Appendix B-5: Potential Biomass Production, Erosion Control Potential, Short-Term Revegetation Potential, and Long-Term Revegetation Potential (Adapted from Hansen et al. 1995 and Crowe and Clausnitzer 1997)

Potential biomass production refers to the relative ability of a plant to produce plant material by weight on an annual basis. Species are rated as if they were growing on typical sites. Therefore, a plant may have a higher or lower biomass production than the rating given if it occurs on a site more favorable or less favorable than its normal site.

- **H** (high) = plant possesses ability to produce a greater yield of dry plant material than most other species of the same life form;
- **M** (medium) = plant produces an average yield of dry plant material compared with other species of the same life form;
- **L** (low) = plant produces a low yield of dry plant material compared with other species of the same life form;
- **V** (very low) = plant produces a very low yield of dry plant material compared with other species of the same life form.

Erosion control potential refers to a plant that commonly exhibits growth habit, plant structure, biomass, or root system that has the potential to reduce soil erosion.

- **H** (high) = plant that has aggressive growth habits, persistent plant structure, high potential biomass, or good soil-binding root-rhizome-runner system in established stands;
- **M** (medium) = plant that has moderately aggressive growth, moderately persistent plant structure, moderate potential biomass, or moderate soil-binding root-rhizome-runner system in established stands;
- **L** (low) = plant that has poor growth, persistence, biomass, or soil-binding root system that makes it generally inadequate for erosion control.

Short-term revegetation potential refers to the ability of a plant to become quickly established and exhibit rapid growth within 1 to 3 years (includes annuals).

- **H** (high) = plant demonstrates rapid growth, good cover, and good reproduction;
- **M** (medium) = plant demonstrates moderately rapid growth, fair cover, and fair reproduction;
- **L** (low) = plant demonstrates slow growth, poor cover, and poor reproduction.

Long-term revegetation potential refers to the ability of a plant to become established and persist over a period of more than 3 years.

- **H** (high) = plant demonstrates good growth, cover, reproduction, and stand maintenance characteristics;
- **M** (medium) = plant demonstrates fair growth, cover, reproduction, and stand maintenance characteristics;
- **L** (low) = plant demonstrates poor growth, cover, reproduction, and stand maintenance characteristics.

Scientific name	Common name	Potential biomass production	Erosion control potential	Short-term revegetation potential	Long-term revegetation potential
Trees:					
Abies lasiocarpa	subalpine fir	H	M	L	M
Picea engelmannii	Engelmann spruce	H	M	L	M
Picea glauca	white spruce	H	M	L	M
Pinus contorta	lodgepole pine	H	L	L	M
Pinus ponderosa	ponderosa pine	H	M	L	M
Populus tremuloides	quaking aspen	M	H	L	H
Populus trichocarpa	black cottonwood	H	H	L	M
Pseudotsuga menziesii	Douglas-fir	H	M	L	H
Thuja plicata	western redcedar	H	M	L	M
Shrubs:					
Acer glabrum var. *douglasii*	Douglas maple	M	M	L	M
Alnus incana	mountain alder	M	H	L	M
Amelanchier alnifolia	Saskatoon serviceberry	M	M	L	M
Betula glandulosa	bog birch	M	H	L	H
Betula occidentalis	water birch	M	H	L	M
Cornus stolonifera	red-osier dogwood	M	H	L	H
Crataegus douglasii var. *douglasii*	black hawthorn	M	M	L	M
Kalmia microphylla	alpine laurel	L	M	L	M
Ledum glandulosum	Labrador tea	L	M	L	M
Lonicera utahensis	Utah honeysuckle	M	M	L	M
Potentilla fruticosa	shrubby cinquefoil	H	M	L	M
Prunus virginiana	common chokecherry	H	M	L	H
Ribes lacustre	prickly currant	M	M	L	M
Rosa woodsii	woods rose	M	H	L	M
Rubus parviflorus	western thimbleberry	M	M	L	M
Salix bebbiana	Bebb's willow	M	H	L	M
Salix boothii	Booth's willow	H	H	L	M
Salix candida	hoary willow	M	H	L	M
Salix commutata	undergreen willow	M	H	L	M
Salix drummondiana	Drummond's willow	H	H	L	M
Salix exigua	coyote willow	M	H	L	M
Salix geyeriana	Geyer's willow	H	H	L	M
Salix lasiandra	Pacific and whiplash willows	H	H	L	M
Salix planifolia var. *monica*	tea-leaved willow	M	H	L	M
Salix rigida	Mackenzie's willow	H	H	L	M
Spiraea betulifolia	shiny-leaf spiraea	M	M	L	M
Symphoricarpos albus	common snowberry	M	M	L	M
Vaccinium caespitosum	dwarf huckleberry	M	M	L	M
Vaccinium scoparium	grouse huckleberry	M	M	L	M
Graminoids:					
Agrostis alba	redtop	M	H	H	H

Appendix B-5: Potential Biomass Production, Erosion Control Potential, Short-Term Revegetation Potential, and Long-Term Revegetation Potential (Adapted from Hansen et al. 1995 and Crowe and Clausnitzer 1997) (continued)

Scientific name	Common name	Potential biomass production	Erosion control potential	Short-term revegetation potential	Long-term revegetation potential
Bromus vulgaris	Columbia brome	M	M	M	H
Calamagrostis canadensis	bluejoint reedgrass	M	H	L	H
Calamagrostis rubescens	pinegrass	M	M	L	M
Carex aquatilis	Sitka and water sedges	H	H	M	M
Carex atherodes	awned sedge	H	H	M	M
Carex buxbaumii	Buxbaum's sedge	M	M	L	M
Carex lanuginosa	woolly sedge	M	H	M	M
Carex lasiocarpa	slender sedge	M	H	M	M
Carex lenticularis	lenticular sedge	H	H	M	M
Carex limosa	mud sedge	M	M	L	M
Carex scopulorum var. *bracteosa*	Holm's sedge	M	H	L	M
Carex scopulorum var. *prionophylla*	saw-leaved sedge	M	H	L	M
Carex utriculata	bladder sedge	H	H	M	H
Carex vesicaria	inflated sedge	H	H	M	H
Deschampsia cespitosa	tufted hairgrass	M	L	L	M
Eleocharis palustris	creeping spike-rush	M	H	H	M
Eleocharis pauciflora	few-flowered spike-rush	M	H	H	M
Elymus canadensis	Canada wildrye	H	M	M	M
Elymus cinereus	basin wildrye	H	H	M	H
Elymus glaucus	blue wildrye	M	M	M	H
Glyceria borealis	northern mannagrass	M	M	M	M
Glyceria grandis	reed mannagrass	H	M	M	M
Glyceria striata	fowl mannagrass	L	M	L	M
Juncus balticus	Baltic rush	M	M	L	M
Phalaris arundinacea	reed canarygrass	H	H	M	H
Phleum alpinum	alpine timothy	M	M	L	M
Phleum pratense	timothy	M	M	M	H
Poa palustris	fowl bluegrass	M	M	M	M
Poa pratensis	Kentucky bluegrass	M	L	M	H
Puccinellia pauciflora	weak alkaligrass and pale false mannagrass	M	M	L	M
Scirpus acutus	hardstem bulrush	H	M	M	M
Scirpus microcarpus	small-fruited bulrush	M	M	L	M
Scirpus validus	softstem bulrush	H	M	M	M
Forbs:					
Achillea millefolium	western yarrow	L	L	H	M
Actaea rubra	baneberry	M	L	L	L
Aralia nudicaulis	wild sarsaparilla	M	M	L	M
Arnica cordifolia	heart-leaf arnica	L	L	L	L
Arnica latifolia	mountain arnica	L	L	L	L
Caltha biflora	twinflower marshmarigold	M	M	L	L
Cirsium arvense	Canada thistle	M	M	L	M
Epilobium angustifolium	fireweed	H	L	H	M
Epilobium glaberrimum	smooth willow-weed	L	L	M	M
Equisetum arvense	common horsetail	L	M	H	M
Equisetum fluviatile	water horsetail	M	M	H	M
Fragaria virginiana var. *platypetala*	broadpetal strawberry	L	L	L	L
Galium boreale	northern bedstraw	L	L	L	L
Galium trifidum	small bedstraw	L	L	L	L
Galium triflorum	sweetscented bedstraw	L	L	L	L
Geum macrophyllum	largeleaf avens	M	L	L	L
Heracleum lanatum	common cow-parsnip	H	M	L	L
Mertensia ciliata	mountain bluebells	M	M	L	M
Mertensia paniculata	panicle bluebells	M	M	L	M
Pedicularis groenlandica	elephanthead pedicularis	L	L	L	L
Polygonum amphibium	water ladysthumb	M	M	M	M
Polygonum bistortoides	American bistort	L	L	L	L
Potentilla diversifolia	diverse-leaved cinquefoil	L	M	M	M
Potentilla gracilis	northwest cinquefoil	M	L	M	M
Senecio triangularis	arrowleaf groundsel	M	M	L	L
Smilacina stellata	starry solomonplume	L	L	L	L
Solidago canadensis	Canada goldenrod	M	M	M	M
Sparganium emersum	simplestem bur-reed	M	M	L	L
Thalictrum occidentale	western meadowrue	M	L	L	L
Typha latifolia	common cattail	H	H	L	H
Urtica dioica	stinging nettle	H	M	L	L
Viola adunca	hook violet	L	L	L	L
Viola orbiculata	round-leaved violet	L	L	L	L

APPENDIX C: Productivity Information

Appendix C contains the following information on a species-by-species basis for trees in the deciduous and conifer series: (C-1a) basal area (sq. ft./acre) by series and species; (C-1b) basal area (sq. ft./acre) by series; (C-2) site index (50-, 80- and 100-year base age, depending on species); (C-3) down log attributes by condition class and series (including tons/acre, cu. ft./acre, linear ft./acre, sq. ft./acre, and percentage of cover/acre); (C-4) number of snags/acre by d.b.h. class (inches) by series.

Appendix C-1a: Basal Area by Species by Series

	Basal area (sq. ft./acre)															
	Coniferous series										Deciduous series					
Species code	ABAM	ABGR	ABLA2	LALY	PICO	PIEN	PSME	THPL	TSHE	TSME	BEPA	ACMA	ALRU	POTR	POTR2	QUGA
ABAM	100	—	Tr	—	—	—	—	—	1	58	—	—	—	—	—	—
ABGR	2	83	2	—	—	—	—	20	25	—	—	—	7	1	1	—
ABPR	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
ABLA2	28	—	51	24	—	13	—	6	6	27	—	—	—	—	—	—
ACMA	—	2	—	—	—	—	—	Tr	—	—	—	155	—	—	—	—
ALRU	—	—	—	—	—	—	—	1	—	—	—	20	111	—	—	—
BEPA	—	—	—	—	—	1	—	1	Tr	—	94	—	—	4	4	—
CHNO	18	1	—	—	—	2	—	—	Tr	6	—	—	—	—	—	—
LALY	—	—	—	45	—	—	—	—	—	—	—	—	—	—	—	—
LAOC	2	13	6	—	—	11	6	5	14	—	20	—	—	—	1	—
PIAL	—	—	Tr	—	—	—	—	—	—	3	—	—	—	—	—	—
PICO	1	4	14	—	133	18	2	1	3	—	6	—	—	—	1	—
PIEN	49	19	109	42	—	125	—	48	19	24	—	—	—	—	6	—
PIMO	1	—	Tr	—	—	—	—	Tr	6	—	—	—	—	—	—	—
PIPO	—	5	Tr	—	—	3	23	4	Tr	—	3	—	6	3	3	40
POTR	—	—	Tr	—	—	2	4	1	—	—	3	—	—	181	2	8
POTR2	2	23	2	—	—	5	6	7	1	—	—	—	—	9	135	—
QUGA	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	104
PSME	13	91	15	—	—	32	249	31	23	5	3	—	6	6	9	28
THPL	27	—	—	—	—	1	—	162	103	1	—	—	14	1	2	—
TSHE	35	—	Tr	—	—	Tr	—	1	61	9	—	—	4	—	—	—
TSME	2	—	—	—	—	—	—	—	1	26	—	—	—	—	—	—
Total	281	240	203	111	133	212	282	286	263	157	131	175	148	205	169	180

Note: Tr = trace.

Appendix C-1b: Basal Area by Series

	Total basal area (sq. ft./acre)		
Series	Range	Mean	Number of plots
Coniferous forest:			
ABAM	20–520	281	43
ABGR	20–640	240	24
ABLA2	20–520	203	114
LALY	80–144	111	3
PICO	60–220	133	3
PIEN	20–400	212	91
PSME	140–480	282	10
THPL	60–640	286	75
TSHE	60–533	263	83
TSME	40–320	157	23
Deciduous forest:			
BEPA	80–200	131	7
ACMA	80–360	175	4
ALRU	40–360	148	10
POTR	80–400	205	31
POTR2	20–340	169	46
QUGA	100–300	180	5

Appendix C-2: Site Index (feet) by Species by Series

		Coniferous series																			
		ABAM		ABGR		ABLA2		LALY		PICO		PIEN		PSME		THPL		TSHE		TSME	
Species code	Base age	#	SI	#	SI	#	SI	#	SI	#	SI	#	SI	#	SI	#	SI	#	SI	#	SI
ABAM	100	63	97	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	27	56
ABGR	50	3	104	24	82	—	—	—	—	—	—	—	—	—	—	22	75	32	77	—	—
ABLA2	50	10	56	—	—	115	55	2	18	—	—	23	43	—	—	4	65	14	65	12	26
ABPR	100	3	118	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
ACMA	80	—	—	2	55	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
ALRU	50	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
BEPA	80	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
CHNO	100	3	75	—	—	—	—	—	—	—	—	—	—	—	—	—	—	2	58	—	—
LALY	50	—	—	—	—	—	—	4	17	—	—	—	—	—	—	—	—	—	—	—	—
LAOC	50	—	—	5	74	38	64	—	—	—	—	27	68	—	—	12	76	37	75	—	—
PIAL	100	—	—	—	—	2	44	—	—	—	—	—	—	—	—	—	—	—	—	—	—
PICO	100	—	—	—	—	43	66	—	—	3	82	18	68	—	—	—	—	3	109	—	—
PIEN	50	39	78	4	78	194	63	3	34	—	—	127	63	—	—	51	78	31	71	12	38
PIMO	50	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	6	69	—	—
PIPO	100	—	—	5	107	—	—	—	—	—	—	5	109	4	115	3	122	4	129	—	—
POTR	80	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
POTR2	80	—	—	2	80	—	—	—	—	—	—	3	122	—	—	2	142	—	—	—	—
PSME	50	6	86	20	82	22	60	—	—	—	—	50	68	19	83	53	77	41	82	—	—
QUGA	80	—	—	—	—	—	—	—	—	—	—	—	—	—	—	86	87	—	—	—	—
THPL	100	11	85	—	—	—	—	—	—	—	—	—	—	—	—	—	—	81	76	—	—
TSHE	50	13	65	—	—	—	—	—	—	—	—	—	—	—	—	—	—	45	60	2	50
TSME	50	2	56	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	24	49

Note: # = number of site index (SI) trees.

Appendix C-2: Site Index (feet) by Species by Series (continued)

		Deciduous series											
		ACMA		ALRU		BEPA		POTR		POTR2		QUGA	
Species code	Base age	#	SI	#	SI	#	SI	#	SI	#	SI	#	SI
ABAM	100	—	—	—	—	—	—	—	—	—	—	—	—
ABGR	50	—	—	—	—	2	90	—	—	—	—	—	—
ABLA2	50	—	—	—	—	—	—	—	—	—	—	—	—
ABPR	100	—	—	—	—	—	—	—	—	—	—	—	—
ACMA	80	5	64	—	—	—	—	—	—	—	—	—	—
ALRU	50	—	—	11	82	—	—	—	—	—	—	—	—
BEPA	80	—	—	—	—	2	88	2	65	2	79	—	—
CHNO	100	—	—	—	—	—	—	—	—	—	—	—	—
LALY	50	—	—	—	—	—	—	—	—	—	—	—	—
LAOC	50	—	—	—	—	3	84	—	—	—	—	—	—
PIAL	100	—	—	—	—	—	—	—	—	—	—	—	—
PICO	100	—	—	—	—	—	—	—	—	2	105	—	—
PIEN	50	—	—	—	—	—	—	—	—	4	81	—	—
PIMO	50	—	—	—	—	—	—	—	—	—	—	—	—
PIPO	100	—	—	—	—	—	—	3	88	4	88	3	80
POTR	80	—	—	—	—	—	—	38	67	—	—	—	—
POTR2	80	—	—	—	—	—	—	3	122	32	106	—	—
PSME	50	—	—	—	—	2	55	4	72	12	72	—	—
QUGA	80	—	—	—	—	—	—	—	—	—	—	—	—
THPL	100	—	—	2	121	—	—	—	—	2	79	—	—
TSHE	50	—	—	—	—	—	—	—	—	—	—	—	—
TSME	50	—	—	—	—	—	—	—	—	—	—	—	—

Note: # = number of site index (SI) trees.

Appendix C-3: Down Log Attributes by Decomposition, Class, and Series

Series	Number of plots	Log decomposition	Down log attributes				
			Tons/acre	Cu. ft./acre	Linear ft./acre	Sq. ft./acre	% cover/acre
ABAM	29	Class 1	3.14	265	182	222	0.5
		Class 2	4.30	724	605	534	1.2
		Class 3	11.87	1,519	1,012	1,288	3.0
		Class 4	5.00	1,604	1,487	1,585	3.6
		Class 5	7.06	2,261	1,302	1,771	4.1
		Series total	31.37	6,373	4,587	5,400	12.4
ABGR	24	Class 1	1.01	84	210	109	0.3
		Class 2	5.24	552	700	561	1.3
		Class 3	2.17	271	682	421	1.0
		Class 4	1.06	341	611	456	1.0
		Class 5	7.88	2,526	1,098	1,742	4.0
		Series total	17.36	3,774	3,301	3,289	7.6
ABLA2	90	Class 1	2.57	216	321	252	0.6
		Class 2	5.23	552	1,109	777	1.8
		Class 3	6.94	889	2,095	1,308	3.0
		Class 4	3.18	1,020	1,433	1,182	2.7
		Class 5	2.67	857	912	897	2.1
		Series total	20.59	3,534	5,870	4,416	10.1
PIEN	74	Class 1	0.74	62	205	113	0.3
		Class 2	3.29	353	843	509	1.2
		Class 3	6.73	853	1,965	1,279	2.9
		Class 4	2.56	812	1,094	960	2.2
		Class 5	1.91	612	429	531	1.2
		Series total	15.23	2,692	4,536	3,392	7.8
PSME	7	Class 1	0	0	0	0	0
		Class 2	.90	111	499	254	.6
		Class 3	9.53	1,056	1,389	1,118	2.6
		Class 4	2.01	645	268	445	1.0
		Class 5	.04	12	244	61	.1
		Series total	12.48	1,824	2,400	1,878	4.3
THPL	62	Class 1	1.21	109	301	182	0.4
		Class 2	7.62	837	1,018	850	2.0
		Class 3	20.82	2,735	2,862	2,697	6.2
		Class 4	3.15	799	1,033	938	2.2
		Class 5	33.52	1,753	916	1,269	2.0
		Series total	66.32	6,233	6,130	5,936	13.6
TSHE	51	Class 1	2.33	213	456	304	0.7
		Class 2	3.53	374	659	498	1.1
		Class 3	15.22	1,931	3,473	1,803	4.1
		Class 4	5.86	1,606	1,639	1,592	3.7
		Class 5	5.54	1,776	1,352	1,584	3.6
		Series total	32.48	5,900	7,579	5,781	13.3
TSME	24	Class 1	1.18	100	188	149	0.3
		Class 2	8.48	905	686	794	1.8
		Class 3	3.71	475	1,023	677	1.6
		Class 4	1.98	636	849	760	1.7
		Class 5	1.43	459	760	603	1.4
		Series total	16.78	2,575	3,506	2,983	6.8
POTR2	51	Class 1	0.50	49	79	59	0.1
		Class 2	1.87	248	420	252	.6
		Class 3	4.48	604	1,219	777	1.8
		Class 4	2.75	831	737	700	1.6
		Class 5	.47	153	171	166	.4
		Series total	12.05	1,885	2,626	1,954	4.5
POTR	32	Class 1	0.84	77	168	124	0.3
		Class 2	.96	109	488	232	.5
		Class 3	8.56	1,097	2,697	1,647	3.8
		Class 4	1.71	368	967	621	1.4
		Class 5	.05	18	85	41	.1
		Series total	12.12	1,669	4,405	2,665	6.1

Appendix C-3: Down Log Attributes by Decomposition, Class, and Series (continued)

Series	Number of plots	Log decomposition	Down log attributes				
			Tons/acre	Cu. ft./acre	Linear ft./acre	Sq. ft./acre	% cover/acre
BEPA	6	Class 1	0	0	0	0	0
		Class 2	9.06	836	725	706	1.6
		Class 3	45.08	5,776	2,544	3,738	8.6
		Class 4	2.74	501	810	621	1.4
		Class 5	.80	258	185	246	.6
		Series total	57.68	7,371	4,264	5,311	12.2
ALRU	12	Class 1	0.13	11	227	57	0.1
		Class 2	.22	24	334	98	.2
		Class 3	.90	115	739	279	.6
		Class 4	.55	176	568	317	.7
		Class 5	.19	62	320	154	.4
		Series total	1.99	388	2,188	905	2.1
ACCI	12	Class 1–5	13.16	1,842	1,983	1,947	4.5
ALIN	190	Class 1	0.72	58	203	111	0.3
		Class 2	1.08	111	422	219	.5
		Class 3	4.48	544	867	631	1.4
		Class 4	1.71	493	573	521	1.2
		Class 5	.45	144	154	151	.3
		Series total	8.44	1,351	2,219	1,634	3.8
ALSI	122	Class 1	0.11	9	41	19	0
		Class 2	2.26	240	382	299	.7
		Class 3	7.10	898	844	800	1.8
		Class 4	2.30	726	853	808	1.9
		Class 5	1.47	470	349	404	.9
		Series total	13.24	2,343	2,469	2,330	5.3
COST	40	Class 1	1.16	117	90	95	0.2
		Class 2	.97	102	401	219	.5
		Class 3	10.23	1,266	1,168	1,164	2.7
		Class 4	4.08	1,201	601	826	1.9
		Class 5	1.22	412	158	260	.6
		Series total	17.66	3,098	2,418	2,564	5.9
HEATH	18	Class 1–5	0.22	67	407	174	0.4
OPHO	13	Class 1	1.68	179	52	109	0.3
		Class 2	5.71	726	1,397	1,025	2.4
		Class 3	5.09	1,631	1,135	1,323	3.0
		Class 4	1.99	638	498	603	1.4
		Class 5	14.47	3,174	3,082	3,060	7.0
		Series total	28.94	6,348	6,164	6,120	14.0
SALIX	156	Class 1	0.06	4	9	7	0
		Class 2	.94	218	155	184	.4
		Class 3	4.11	595	456	472	1.1
		Class 4	.94	301	219	248	.6
		Class 5	.08	26	67	45	.1
		Series total	6.13	1,144	906	956	2.2
SPDO	22	Class 1	9.82	1,505	1,438	1,404	3.2
		Class 2	5.05	647	318	430	1.0
		Class 3	1.13	362	605	473	1.1
		Class 4	.04	14	11	12	0
		Class 5	16.04	2,528	2,372	2,319	5.3
		Series total	32.08	5,056	4,744	4,638	10.6
AQUATIC	62	Class 1	0.33	35	92	57	0.1
		Class 2	.26	34	113	64	.1
		Class 3	.23	42	98	64	.1
		Class 4	.12	37	55	50	.1
		Class 5	.94	148	358	235	.5
		Series total	1.88	296	716	470	1.1

Appendix C-3: Down Log Attributes by Decomposition, Class, and Series (continued)

Series	Number of plots	Log decomposition	Down log attributes				
			Tons/acre	Cu. ft./acre	Linear ft./acre	Sq. ft./acre	% cover/acre
FORB	34	Class 1	0.27	22	166	66	0.2
		Class 2	3.91	379	421	389	.9
		Class 3	2.48	313	567	425	1.0
		Class 4	2.48	795	953	890	2.0
		Class 5	.49	157	248	186	.4
		Series total	9.63	1,666	2,355	1,956	4.5
MEADOW	260	Class 1	0.05	4	7	5	0
		Class 2	.23	25	71	40	.1
		Class 3	.55	71	186	112	.3
		Class 4	.69	197	267	219	.5
		Class 5	0	1	2	1	0
		Series total	1.52	298	533	377	.9

Note: Definitions of the log decomposition classes can be found on page 15.

Appendix C-4: Snag Attributes by Series

Series	Number of plots	Snag condition	Snags/acre by d.b.h. class (inches) 5–9.9	10–15.5	15.6–21.5	21.6+	Total
ABAM	29	Class 1	5.1	3.1	3.2	2.3	13.7
		Class 2	9.2	4.4	2.0	1.0	16.6
		Class 3	.7	5.0	1.2	.9	7.8
		Class 4	1.0	4.3	1.0	1.5	7.8
		Class 5	2.3	2.1	1.2	2.0	7.6
		Series total	18.3	18.9	8.6	7.7	53.5
ABGR	24	Class 1	17.0	5.7	3.3	2.8	28.8
		Class 2	2.4	.4	2.1	—	4.9
		Class 3	—	—	—	—	0
		Class 4	—	—	.5	.2	.7
		Class 5	—	—	.5	.7	1.2
		Series total	19.4	6.1	6.4	3.7	35.6
ABLA2	96	Class 1	23.5	4.1	1.2	1.0	29.8
		Class 2	7.0	3.1	.8	.4	11.3
		Class 3	3.1	.8	.1	.1	4.1
		Class 4	1.2	2.7	.8	.3	5.0
		Class 5	2.1	1.3	.5	.2	4.1
		Series total	36.9	12.0	3.4	2.0	54.3
PIEN	76	Class 1	18.4	3.6	2.1	0.5	24.6
		Class 2	—	5.1	1.3	—	6.4
		Class 3	1.3	1.5	.9	—	3.7
		Class 4	—	2.8	.2	.3	3.3
		Class 5	1.9	.6	.3	.5	3.3
		Series total	21.6	13.6	4.8	1.3	41.3
POTR	33	Class 1	10.6	2.3	0.9	—	13.8
		Class 2	8.9	.6	—	—	9.5
		Class 3	1.3	—	—	—	1.3
		Class 4	2.3	.9	—	.4	3.6
		Class 5	2.3	.9	1.6	.9	5.7
		Series total	25.4	4.7	2.5	1.3	33.9
POTR2	43	Class 1	—	1.3	.3	.5	2.1
		Class 2	1.7	—	.2	.1	2.0
		Class 3	—	—	—	—	0
		Class 4	—	—	.3	.1	.4
		Class 5	—	2.1	.8	.7	3.6
		Series total	1.7	3.4	1.6	1.4	8.1
THPL	69	Class 1	4.4	2.6	1.2	0.5	8.7
		Class 2	13.3	1.8	.5	.2	15.8
		Class 3	.1	.8	1.4	.4	2.7
		Class 4	3.8	4.5	—	1.1	9.4
		Class 5	1.6	2.3	—	.4	4.3
		Series total	23.2	12.0	3.1	2.6	40.9
TSHE	53	Class 1	5.5	1.9	1.1	0.4	8.9
		Class 2	—	1.2	.3	1.0	2.5
		Class 3	1.1	3.8	1.3	.2	6.4
		Class 4	2.9	1.9	1.2	.1	6.1
		Class 5	1.8	.2	1.0	.6	3.6
		Series total	11.3	9.0	4.9	2.3	27.5
TSME	26	Class 1	—	2.4	1.6	1.1	5.1
		Class 2	14.3	5.7	2.6	1.2	23.8
		Class 3	2.2	2.8	.4	.4	5.8
		Class 4	—	.7	.3	.1	1.1
		Class 5	—	—	.4	.8	1.2
		Series total	16.5	11.6	5.3	3.6	37.0

Note: Definitions of the snag condition classes can be found on page 15.

APPENDIX D: Occurrences of Threatened and Sensitive Species by Series

Scientific name	Common name	ABLA2	ALIN	AQUATIC	BEPA	FORB	MEADOW	OPHO	PIEN	POTR	POTR2	SALIX	TSHE	Total
Agoseris elata	tall agoseris	—	—		—	—	1	—	2	—	—	4	—	7
Aster sibiricus	arctic aster	—	—		—	—		—	—	—	—	1	—	1
Carex flava	yellow sedge	—	—		—	—	4	—	—	—	—	1	—	5
Carex proposita	Smoky Mountain sedge	—	—		—	1	1	—	—	—	—	—	—	2
Carex rostrata	beaked sedge	—	—	2	—	—	4	—	—	—	—	—	—	6
Carex saxatilis var. *major*	russet sedge	—	—	—	—	—	11	—	—	—	—	1	—	12
Carex scirpoidea var. *scirpoidea*	western singlespike sedge	—	—	—	—	—	1	—	—	—	—	—	—	1
Cicuta bulbifera	bulbed water-hemlock	—	—	—	—	—	2	—	—	—	—	—	—	2
Delphinium viridescens	Wenatchee larkspur	—	1	—	—	—		—	—	—	—	—	—	1
Dryopteris cristata	crested shield fern	—	3	—	—	—	1	—	—	—	—	1	—	5
Eriophorum viridicarinatum	green-keeled cotton-grass	—	—	—	—	—	20	—	—	—	—	4	—	24
Gaultheria hispidula	moxieplum	—	—	—	—	—		—	1	—	—	—	—	1
Galium kamtschaticum	boreal bedstraw	—	—	—	—	—		1	—	—	—	—	—	1
Geum rivale	water avens	—	—	—	—	—	4	—	—	—	—	2	—	6
Luzula arcuata	curved woodrush	—	—	—	—	—	1	—	—	—	—	—	—	1
Montia diffusa	branching montia	—	1	—	—	—		—	—	—	—	—	—	1
Muhlenbergia glomerata	marsh muhly	—	—	—	—	—	1	—	—	—	—	—	—	1
Salix candida	hoary willow	—	—	2	—	—	2	—	—	—	—	4	—	8
Salix glauca	glaucous willow	—	—	—	—	—		—	1	—	—	1	—	2
Salix maccalliana	McCalla's willow	—	1	2	—	—	1	—	—	—	—	1	—	5
Salix pedicellaris	bog willow	—	1	—	—	—	—	—	—	—	—	2	—	3
Salix pseudomonticola	false mountain willow	—	—	—	—	—	—	—	—	—	—	3	—	3
Salix tweedyi	Tweedy's willow	2	—	—	—	—	—	—	—	—	—	—	—	2
Sanicula marilandica	black snake-root	—	—	—	2	—	—	—	—	2	—	6	2	12
	Total	2	7	6	2	1	54	1	4	2	0	31	2	112

APPENDIX E: Comparisons for Important Sedges (*Carex*) in Eastern Washington

Comparison for Important Sedges (*Carex*) in Eastern Washington

Scientific name	Common name	Plants	Leaves	Floral bracts	Pistillate spikes	Pistillate scales	Perigynia	Achene
Carex amplifolia	bigleaf sedge	Stout, robust, to 3 feet tall, low to moderate elevation	Flat, large, 8–20 mm wide, well distributed	Leaflike, lowest bract exceeds the inflorescence	Cylindrical, 4–10 cm long, 5 mm wide, on short erect peduncle	Dark, scarious margins and pale, greenish midstripe	Crowded, inflated, 2.6–3.3 mm long, prominant beak	Trigonous, 3 stigmas
Carex aperta	Columbia sedge	Loosely tufted on short rhizomes, to 2.5 feet tall	Flat, 2–6 mm wide	Leaflike, from shorter to longer than the inflorescence	Cylindric, 1–4 cm long, sessile or the lowest ones pedunculate	Narrow, tapering to a narrow point, more than the perigynia, brown-black	Somewhat loose, 2.1–3 mm long, somewhat inflated, pale coppery	Lenticular, 3 stigmas
Carex aquatilis var. *aquatilis*	water sedge	1.5–3 feet tall, moist to wet soils, moderate elevation	Elongate, flat, 2–7 mm on lower 1/3 stem	Leaflike, lowest bract exceeds the inflorescence	Cylindrical, sessile or nearly so, 1.5–4.5 cm long, 3–5 mm wide	Reddish- to purplish-black, generally shorter than perigynia	Lens-shaped, 2–3.3 mm long, face nerveless	Lenticular, 3 stigmas
Carex aquatilis var. *sitchensis*	Sitka sedge	Stout, to 5 feet tall, wet soil to shallow water, low to moderate elevation	Flat, blue-glaucous, to 1 cm wide, basal sheaths brownish	Leaflike, lowest bract exceeds the inflorescence	Cylindrical, 3–10 cm long, on a long peduncle	Reddish- to purplish-black, generally shorter than perigynia	Lens-shaped, 3–5 mm long, face nerveless	Lenticular, 3 stigmas
Carex atherodes	awned sedge	Stout, robust, from creeping rhizomes, to 3.5 feet tall	Flat, 4–10 mm wide, sheaths villous-hirsute	Leaflike, lowest bract exceeds the inflorescence	Cylindrical, sessile or nearly so, 2–10 cm long, 10 mm wide	Narrow, lanceolate, 1–5 mm awn, pale green or scarious	Crowded, inflated, abruptly beaked, 4–7 mm long, strongly spreading, nerved	Trigonous, 3 stigmas
Carex buxbaumii	Buxbaum's sedge	1.5–3 feet tall, creeping rhizomes, moderate elevation	Elongate, flat, 2–4 mm wide, well distributed	Leaflike, lowest bract shorter to slightly exceeds the inflorescence	2–5, somewhat remote and cylindrical, sessile or nearly so, 1–3 cm long, 0+ above 0->in the terminal spike	Lanceolate, brown to purplish with a paler midrib, awn 0.5–3 mm long	Lens-shaped but not strongly flattened, elliptic-ovate, nerved	Trigonous, 3 stigmas
Carex cusickii	Cusick's sedge	Coarse, densely tufted, eared, 0.5–3.5 feet tall, low to moderate elevation	Elongate, flat, 3–5 mm wide, well distributed sheaths red dotted	Very reduced and scalelike	Small, the flowers closely aggregated in several wide-spread heads	Lanceolate, pale to brownish, hyaline-scarious, mid-rib sometimes awned	Planoconvex, 2.5–3.5 mm long, with a prominent, coarse, serrulate, pale or greenish beak	Lenticular, 2 stigmas
Carex integra	smooth-beaked sedge	Tufted, rhizomes absent, otherwise plants much like *C. iliota*	Clustered near the base, flat, 1–3 mm wide	Very reduced and scalelike	3–6 spikes in a somewhat crowded head, paler and looser than *C. illota*	Brownish, shorter and narrower than the perigynia, hyaline-scarious, midrib	Planoconvex, plump, appressed-ascending, 2.5–3.2 mm long, widest below middle	Lenticular, 2 stigmas

Comparisons for Important Sedges (*Carex*) in Eastern Washington (continued)

Scientific name	Common name	Plants	Leaves	Floral bracts	Pistillate spikes	Pistillate scales	Perigynia	Achene
Carex lanuginosa	woolly sedge	Loose, slender, to 3 feet tall, moist soils, low to moderate elevation	Flat, 2–5 mm wide, well distributed, sheaths reddish filamentous	Leaflike, lowest bract exceeds the inflorescence	Cylindrical, sessile or nearly so, 1–4 cm long	Brownish with pale midstripe, acute to awn-tipped, narrower than perigynia	Turgid, greenish, densely short-hairy, obscurely nerved, 3–3.3 mm long	Trigonous, 3 stigmas
Carex lasiocarpa	slender sedge	Stiff, wiry, to 3 feet tall, wet, flat sites and floating root mats, moderate elevation	Folded, 1–1.5 mm, well distibuted, sheaths brownish and filamentous	Leaflike, lowest bract exceeds the inflorescence	Cylindrical, sessile or nearly so, 1–4 cm long	Brownish with pale midstripe, acute to awn-tipped, narrower than perigynia	Turgid, brownish, densely short-hairy, obscurely nerved, 2.8–4.3 cm long	Trigonous, 3 stigmas
Carex lenticularis	lenticular sedge	Strongly tufted, to 2 feet tall, stream-banks, lakeshores, shallowly flooded ponds at high elevation	Elongate, flat, 2–4 mm wide, mostly basal	Leaflike, lowest bract exceeds the inflorescence	Cylindrical, sessile or the lowest pedunculate, 1.5–5 cm long	Scarious and blackish to dark brown, paler greenish midstripe, white hyaline margins	Lens-shaped, 1.9–3 mm long, face nerved	Lenticular, 3 stigmas
Carex limosa	mud sedge	Singly from long creeping rhizomes, to 1 foot tall, roots covered with yellow-brown tomentum	Leaves few, 1–2 mm, tending to be channeled rather than flat	Lowest leafy bract 2–10 cm long	Somewhat cylindrical, 0-> spike solitary, 0+ spikes 1–2.5 cm long on long peduncles	Light to dark brown, about as long and wide as the perigynia	Pale, ovate, marginally nerved, nerved on faces, 2.3–4.2 mm long	Trigonous, 3 stigmas
Carex nigricans	black alpine sedge	Loosely tufted to sod-forming, 6–12 inches tall, moist soil, high elevation	Firm, flat, crowded near the base, 4–13 cm long and 1–5.3 mm wide	Bractless	Single, oblong terminal spikelet, 1–2 mm long, 6–10 mm wide	Dark brown to blackish, soon spreading and deciduous at maturity	Lanceolate, 3–4.5 mm long, lower perigynia reflexed at maturity	Trigonous, 3 stigmas
Carex paupercula	poor sedge	Loosely tufted from rhizomes, to 1 foot tall, roots covered with yellow-brown tomentum	Leaves numerous, flat, 1–3 mm wide	Lowest leafy bract 2–10 cm long	Somewhat cylindrical, 0-> spike solitary, 0+ spikes 7–15 mm long on long peduncles	Light to dark brown, longer and narrower than the perigynia and with narrow point	Pale, ovate, marginally nerved, nerved on faces, 2.3–4.2 mm long	Trigonous, 3 stigmas
Carex rostrata	beaked sedge	Similar to *C. utriculata*, stout and robust from long rhizomes, 2–3 feet tall, quaking or floating peat	Strongly glaucous on upper surface, dark green below, 1.5–4 mm wide	Leaflike, the lowest bract exceeds the inflorescence	Cylindrical, <4 cm long, about 0.5 cm wide on relatively short peduncles	Straminous, narrower and shorter than the perigynia, acuminate or short awned	Crowded, inflated, abruptly beaked, 3.5–4.5 mm long, strongly spreading, nerved	Trigonous, 3 stigmas
Carex saxatilis	russet sedge	Turf-forming from rhizomes, to 2 feet tall, high elevation	Leaves largely basal, flat, 2–4 mm wide	Leaflike, 3–15 cm long	Cylindrical, 1–3 cm long, generally erect, short pedunculate	Slightly shorter and narrower than perigynia, pale, hyaline, with an erose tip	Gray- to red- brown, body elliptic-ovate, 3.5–5 mm long, +/- lenticular and inflated	Lenticular, 2 (3) stigmas

Comparisons for Important Sedges (*Carex*) in Eastern Washington (continued)

Scientific name	Common name	Plants	Leaves	Floral bracts	Pistillate spikes	Pistillate scales	Perigynia	Achene
Carex scopulorum var. *bracteosa*	Holm's sedge	Sod-forming from rhizomes, 1–2 feet tall, upper subalpine and alpine zones	Firm, generally flat, 2–6 mm wide, largely basal	Lowest leaflike bract much shorter than the inflorescence	Short and stout, erect, short-cylindrical, 1–2.5 cm long and 5–10 mm wide	Narrower and +/- the length of the perigynia	Lenticular, faces nerveless, 1.8–3.3 mm long	Lenticular, 2 stigmas
Carex scopulorum var. *prionophylla* (was *C. prionophylla*)	saw-leaved sedge	Densely tufted from very short rhizomes, 2–3 feet tall, upper subalpine zones	Loose, generally flat, 2–5 mm wide, largely basal	Lowest leaflike bract much shorter than the inflorescence	Long and slender, erect, long-cylindrical, 1–3 cm long, short-pedunculate	Reddish-brown to purplish-black, generally shorter and narrower than perigynia	Lenticular, the faces nerveless, 2.0–3.4 mm long	Lenticular, 2 stigmas
Carex spectabilis	showy sedge	Sod-forming to loosely tufted, 1–2 feet tall, shallow water, upper subalpine to alpine	Flat, 2–7 mm wide, usually well distributed but sometimes largely basal	Lowest leaflike bract shorter to equalling the inflorescence	Short-cylindrical, lower spikes often nodding on elongate peduncles, 1–3 cm long	Red-brown to black, pale midvein often with an awn tip to 1 mm long	Lenticular, elliptic, the faces nerveless, 2.9–5.0 mm long	Trigonous, 3 stigmas
Carex utriculata (erroneously *C. rostrata* in Hitchcock and Cronquist 1973)	bladder sedge	Stout and robust from long stout rhizomes, 2–4 feet tall, wet sites, low to high elevations	Stout, flat, 4–12 mm, well distributed, scabrous	Leaflike, the lowest bract exceeds the inflorescence	Cylindrical, 2–10 cm long and 1 cm wide, like a "corncob," short peduncle	Usually narrower and shorter than perigynia, accuminate or short awned	Crowded, inflated, abruptly beaked, 4–7 mm long, strongly spreading, nerved	Trigonous, 3 stigmas
Carex vesicaria	inflated sedge	Loosely tufted on short rhizomes, to 3 feet tall, tall, wet soils, low to moderate elevation	Flat, stout, 3–8 mm, well-distributed	Leaflike, lowest bract exceeds the inflorescence	Cylindrical, 2–7 cm long and 1 cm wide, short peduncle	Usually narrower and shorter than perigynia, accuminate or short awned	Ascending, inflated, beak gradually tapering, 5–11 mm long, nerved	Trigonous, 3 stigmas

Comparisons for Willow (*Salix*) Species in Eastern Washington

Scientific name	Common name	Life form habitat	Twigs	Leaf shape and margin	Leaf color and pubescens	Pistilate aments	Floral branchlets	Capsules and stamens	Floral bracts
Salix bebbiana	Bebb's willow	Many-stemmed shrub to 25 feet tall, moist soil, moderate elevation	Reddish-brown, not glaucous, young twigs with fine wavy hair	Elliptic to elliptic-ovate, entire to slightly serrate	Green above, glaucous below, appressed hairs or glabrate on either side	Expanding with the leaves, 1.5–4 cm long	Small–leaved, branchlets 3–15 mm long	Long–beaked, 5–9 mm long, short hairy, 2 stamens	Narrow, yellow, to light brown, sparse to densely hairy
S. boothii	Booth's willow	Many-stemmed shrub to 12 feet tall, moderate to moderate-high elevation.	Young twigs glabrous to pubescent, glabrous by second year	Broadly elliptic to lanceolate, finely toothed to entire, 2.5–6 cm long	Green above, slightly paler below but not glaucous	Expanding with the leaves, 2–4 mm long	Small–leaved, 1–3 mm long	Glabrous, 2 stamens	Brown to black, long curly hairs
S. brachycarpa	short-fruited willow	Erect shrub to 4 feet tall, variety of sites including alkali, low to high elevation	Dark to reddish, moderate tomentum, hairy into third year, not glaucous	Broadly elliptic to obovate, rounded base, acute tip, entire	Green above and glaucous below, fine loose tomentum	Expanding with the leaves, 1.5–2 cm long	Leafy, 3–5 mm long	Densely pubescent, sessile, 3–5 mm long, 2 stamens	Yellow, brown, or greenish, pubescent throughout, persistent
S. candida	hoary willow	Erect low shrub to 5 or 6 feet tall, bogs and swamps	White-tomentum persistent into second year	Narrowly oblong, 4.5–8.5 cm long, margins revolute and entire	Glabrous to thin tomentose above and white-tomentose below	Expanding with the leaves, 1–3 cm long	Leafy bracts to 1.5 cm long, branchlets only 1–5 mm long	Tomentose, 5–7.5 mm long, 2 stamens	Pale to brown, woolly villous, persistent
S. cascadensis	Cascade willow	Creeping, rhizomatous shrub to 6 inches tall, mostly alpine	Thick and woody	Firm, elliptic, entire, acute, 1–1.5 cm long	Glabrous except when young	Expanding with the leaves, 1–2 cm long	Short, leafy branchlets	Tomentose, 4–5 mm long	Dark, long-hairy, persistent
S. commutata	undergreen willow	Many-stemmed shrub to 5 or 6 feet tall, high subalpine to alpine	Young twigs dense pubescent into the second year	Broad elliptic to obovate, entire to glandular	Gray-green, covered with loose erect silky hairs	Expanding with leaves, 3–5 cm long	Leafy branchlets 1–2.5 cm long	Generally glabrous, 3–6 mm long, 2 stamens	Light to dark brown, long wavy hairs, persistent
S. drummondiana	Drummond's willow	Many-stemmed shrub to 12 feet tall, moderate to moderate-high elevation	Green-purple, glabrous or sparse-hairy, glaucous for 2 years	Elliptic to lance-elliptic, rolled margins, entire	Dark green above, white silvery pubescent below	Expanding before the leaves, sessile, 1.5–4 cm long	Aments sessile, if present, branchlets to 2 mm long	Brown to blackish, long-hairy, persistent	
S. exigua var. *exigua*	coyote willow	Colonial shrubs to 15 feet tall, streambanks and gravel bars, low to moderate elevation	Young twigs pubescent, glabrous and brownish second year	Linear–lanceolate, entire to serrulate-dentate, gland-toothed	Gray-green to silver, pubescent, not glaucous below	Expanding after leaves, 3–5 cm long	Branchlets very leafy, 1–20 cm long	Sessile, usually hairy, 3–5 mm long	Yellow, brown, often hairy, narrow and pointed, deciduous
S. farriae	Farr's willow	Low branched shrub to 3 feet tall, moderately high to high elevation	Young twigs pubescent, older twigs brownish and glabrous	Oblanceolate, entire or minutely serrate, 3–5 cm long and 1–2 cm wide	Green above and glaucous below, sparse hairy but soon glabrous, net veined	Expanding with leaves, 1–2.5 cm long	Leafy branchlets up to 1.5 cm long	Glabrous, 4–6 mm long, stipes 0.2–1 mm long, 2 stamens	Brown or black, from nearly glabrous to long–silky hairy on both surfaces

Comparisons for Willow (*Salix*) Species in Eastern Washington (continued)

Scientific name	Common name	Life form habitat	Twigs	Leaf shape and margin	Leaf color and pubescens	Pistilate aments	Floral branchlets	Capsules and stamens	Floral bracts
S. geyeriana var. *geyeriana*	Geyer's willow	Many-stemmed shrubs to 15 feet tall, east of Cascades, moderate elevation	Young twigs dense-hairy, glaucous for 2 or more years	Narrow–elliptic, entire, 2–4.5 cm long and 8–12 mm wide	Gray-green above and paler and glaucous below, hairy on both sides	Expanding with the leaves, only 1–1.5 cm long	Leafy, up to 1 cm long	Short-hairy, 3–6 mm long, 2 stamens	Yellow to pale brown, short-hairy
S. geyeriana var. *meleiana*	Geyer's willow	Similar to SAGEG but in and west of Cascades	Similar to SAGEG but less glaucous	Similar to SAGEG	Similar to SAGEG but less pubescent, hairs rusty in color	Similar to SAGEG	Similar to SAGEG	Similar to SAGEG	Similar to SAGEG
S. glauca	glaucous willow	Branching shrubs to 5 or 6 feet tall, moderate elevation	Twigs dark brown or reddish, villous-tomentose	Oblanceolate, entire, 2.5–4.5 cm long and 1–2 cm wide	Villous-tomentose on both sides and glaucous below	Expanding with leaves, 1.2–3 cm long	Leafy branchlets 0.5–2 cm long	Hairy, 4–8 mm long	Light brown, short-hairy
S. lasiandra var. *caudata*	whiplash willow	Shrub or small tree 18–45 feet tall, streambanks, low to moderate elevation	Lustrous red to olive, young twigs pubescent into second year	Lanceolate, long-accuminate, serrate, 5–11 cm long, glands on the petiole	Shiny green on both sides, paler below, initially hairy but later glabrate	Expanding with leaves, 2–4.5 cm long	Large–leaved, 10–35 mm long	Glabrous, 4–8 mm long, 2 stamens	Yellow, hairy on the lower portions
S. lasiandra var. *lasiandra*	Pacific willow	Similar to SALAC but in and west of the Cascade mountains	Similar to SALAC	Similar to SALAC	Similar to SALAC but glaucous below	Similar to SALAC	Similar to SALAC	Similar to SALAC	Similar to SALAC
S. lemmonii	Lemmon's willow	Many-stemmed shrubs to 15 feet tall, low to moderate elevation	Young twigs sparse-hairy, very glaucous into second year	Lanceolate-elliptic, entire, larger than SAGE	Green above and pale-glaucous below, glabrate	Expanding with leaves, 1.5–2.5 cm long	Leafy, to 1 cm long	Thinly short-hairy, 3–6 mm long	Brown to black, short-hairy
S. maccalliana	McCalla's willow	Shrubs to 9 feet tall, rare moderate elevation	Twigs brown to yellowish, glabrous to sparsely hairy	Lanceolate to oblong, leathery, the margins coarsely toothed	Green above and paler below, not glaucous, hairy only when young	Large	Long leafy branchlets	Tomentose, 6–8 mm long, 2 stamens	Pale, densely hairy
S. melanopsis	dusky willow	Similar to *s. exigua*	Similar to *s. exigua*	Similar to *s. exigua* but leaves usually less narrow and with callus to glandular teeth	Similar to *s. exigua* but less hairy and soon glabrate	Similar to *s. exigua*	Similar to s. *exigua*	Similar to s. *exigua* except glabrous	Similar to s. *exigua* but glabrous, broad and blunt
S. nivallis	snow willow	Matted, spreading shrub 4 inches tall	Twigs stout and hairless except just below	Elliptic to obovate, reticulate-veiny below	Dark green above and glaucous below	Serotinous, terminating shoots of the season	Slender pedunculate but leafless	Villous–puberulent, 3–5 mm long, style very short	Green to yellow, glabrous outside but hairy within
S. pedicellaris	bog willow	Branched shrub to 5 feet tall, bogs at moderate elevations	Twigs dark, glabrous	Oblanceolate, entire, acute to obtuse, 3.5–6 cm long and 0.5–2 cm broad	At first silky but soon glabrous, glaucous below	Expanding with the leaves, rather short and 1–3 cm long	Short leafy branchlets 1–2 cm long, leaves somewhat reduced	Glabrous, 4–6.5 mm long, style almost obsolete, pedicle 1–3 mm long	Persistent, yellowish, long-hairy within

Comparisons for Willow (Salix) Species in Eastern Washington (continued)

Scientific name	Common name	Life form habitat	Twigs	Leaf shape and margin	Leaf color and pubescens	Pistilate aments	Floral branchlets	Capsules and stamens	Floral bracts
S. piperi	Piper's willow	Many-stemmed shrub to 8 feet tall, moderate elevation in strong maritime climate	Twigs brown, villous at first but soon glabrate	Oblanceolate, entire or crenate-serrate	Shiny green above and strongly glaucous below, hairy when young, soon glabrous	Expand before leaves, large and thick, 4–12 cm long and 1.5 cm wide	Subsessile or up to 1 cm long with small bracts to 1 cm long	Glabrous, 4–6 mm long, 2 stamens	Dark brown to black, densely long-villous, persistent
S. planifolia var. *monica*	tea–leaved willow	Low branched shrub to 3 feet tall, moderately high to high elevation	Young twigs glabrous or sparsely hairy, older twigs brown or reddish, glabrous	Oblanceolate, entire or minutely serrate, 2.5–3.5 cm long and 0.8–1.5 cm wide	Green above and glaucous below, sparse hairy but soon glabrous, partially parallel-veined.	Expanding with or before the leaves, 2–4 cm long	Short leafy branchlets just 1–3 mm long	Short-hairy, 3.5–5.5 mm long, stipes to 1 mm long, 2 stamens	Dark brown to black, long-hairy, persistent
S. pseudomonticola	false mountain willow	Rounded shrub up to 12 feet tall, moderate elevation	Young twigs sparsely to densely hairy, older twigs dark brown to red sometimes hairy	Widely oblanceolate, thick and leathery, fine-toothed	Green above and glaucous below, at first pubescent below but soon glabrous	Expanding before the leaves, 1–5 cm long	Floral branchlets up to 5 mm long, usually without bracts	Glabrous, 4–7 mm long, stipes 0.5–2 mm long, 2 stamens	Brown to black, sparsely to densely long-hairy
S. rigida var. *mackenzieana*	Mackenzie's willow	Sparingly–branched shrub to 12 feet tall, streambanks, low to moderate elevation	Reddish-brown, slender, not glaucous, glabrous	Lanceolate, usually cordate base, acuminate, fine-toothed, entire, 5–10 cm long	Shiny green above and glaucous below, glabrous or soon glabrate	Expanding with or before the leaves, 3–6 mm long	Leafy, long	Glabrous, 3–7 mm long, stipes 2–4.5 mm long, 2 stamens	Minute, brown to blackish, glabrous, persistent
S. scouleriana	Scouler's willow	Shrub or small tree 13–30 feet tall, uplands, streambanks, moderate elevation	Young twigs short-hairy, stripped bark has a skunky odor	Obovate to oblanceolate, broadest below the tip, entire, 3.5–8 cm long	Green above and glaucous below, sparse reddish hairs on lower surface	Expanding before the leaves, soon deciduous, 1.5–6 cm long	More or less sessile, if present, minute and leaflets to 5 mm long	Somewhat long-beaked, densely short-hairy, 5–8 mm long	Brown to black, short-hairy
S. sitchensis	Sitka willow	Branched shrub to 15 feet tall, Cascades and Selkirks, moderate to moderate-high elevation	Dark brown, dense-velvety	Obovate, widest just below the tip, entire 4–9 cm long	Dark green above and dense velvety-white below	Expanding with leaves, 3–8 cm long	Small leaved, to 1 cm long	Densely short-hairy, 3.5–5 mm long, 1 stamen	Brown to black, long-hairy
S. tweedyii	Tweedy's willow	Shrub to 12 feet tall, rare in eastern Washington, moderate elevation	Stout, young twigs with long, dense pubescence that persists into second year	Elliptic ovate, finely serrate with gland–tipped teeth	Green on both sides, not glaucous, upper surface with loose tomentum, especially along the ribs, less so above	Expanding with or before leaves, 3–9 cm long	Sessile on twigs of the previous year	Glabrous, nearly sessile, glabrous, 4.5–7 mm long, 2 stamens	Dark brown to black, densely to sparsely long–hairy, persistent

APPENDIX G: Species Comparisons by Series

Species Comparisons by Series—Part 1

		ABAM 62 plots		ABGR 36 plots		ABLA2 139 plots		PICO 3 plots		PIEN 100 plots		LALY 6 plots		PSME 11 plots	
Species	Code	CON[a]	COV[b]	CON	COV	CON	COV	CON	COV	CON	COV	CON	COV	CON	COV
Tree overstory:															
Pacific silver fir	ABAM	97	28	—	—	2	1	—	—	1	3	—	—	—	—
grand fir	ABGR	6	7	92	38	3	10	—	—	—	—	—	—	—	—
subalpine fir	ABLA2	29	14	6	10	93	16	—	—	46	9	33	9	—	—
bigleaf maple	ACMA	—	—	17	6	—	—	—	—	—	—	—	—	9	20
red alder	ALRU	—	—	—	—	—	—	—	—	—	—	—	—	—	—
paper birch	BEPA	—	—	—	—	1	8	—	—	5	10	—	—	9	3
Alaska yellow-cedar	CHNO	23	14	6	3	1	3	—	—	2	20	—	—	—	—
subalpine larch	LALY	—	—	—	—	1	3	—	—	—	—	67	5	—	—
western larch	LAOC	6	5	11	2	22	12	—	—	22	14	—	—	9	15
Engelmann spruce	PIEN	48	16	31	12	96	30	33	Tr[c]	95	35	33	13	9	Tr
whitebark pine	PIAL	—	—	—	—	2	11	—	—	—	—	17	Tr	—	—
lodgepole pine	PICO	5	6	3	35	35	12	100	55	28	16	—	—	9	10
ponderosa pine	PIPO	2	5	14	3	1	2	—	—	7	11	—	—	27	16
quaking aspen	POTR	2	2	—	—	—	—	—	—	10	11	—	—	18	7
black cottonwood	POTR2	3	3	22	13	4	5	—	—	8	10	—	—	18	7
Douglas-fir	PSME	24	10	75	25	37	13	—	—	40	21	—	—	100	56
Oregon white oak	QUGA	—	—	—	—	—	—	—	—	—	—	—	—	—	—
western redcedar	THPL	42	13	3	5	1	2	—	—	—	—	—	—	9	1
western hemlock	TSHE	69	21	6	1	1	5	—	—	3	4	—	—	—	—
mountain hemlock	TSME	16	4	—	—	1	Tr	—	—	—	—	—	—	—	—
Shrubs:															
vine maple	ACCI	11	22	25	39	—	—	—	—	1	2	—	—	—	—
Douglas maple	ACGLD	5	1	44	14	13	6	—	—	30	7	—	—	73	16
mountain alder	ALIN	2	3	22	7	24	6	—	—	40	9	—	—	27	6
Sitka alder	ALSI	16	8	—	—	28	10	—	—	10	6	—	—	—	—
Saskatoon serviceberry	AMAL	—	—	44	1	24	2	—	—	42	2	—	—	82	8
bog birch	BEGLG	—	—	—	—	—	—	—	—	4	10	—	—	—	—
red-osier dogwood	COST	5	1	22	2	16	4	—	—	46	19	—	—	36	9
California hazel	COCO2	2	5	6	12	—	—	—	—	1	2	—	—	—	—
black hawthorn	CRDOD	—	—	—	—	—	—	—	—	1	2	—	—	27	2
oceanspray	HODI	—	—	22	13	—	—	—	—	5	3	—	—	36	3
rusty menziesia	MEFE	42	9	—	—	7	16	—	—	3	10	—	—	—	—
devil's club	OPHO	40	21	6	1	4	9	—	—	1	1	—	—	—	—
common chokecherry	PRVI	—	—	3	Tr	—	—	—	—	1	Tr	—	—	18	4
Cascade azalea	RHAL	24	11	—	—	22	22	—	—	3	8	—	—	—	—
stink currant	RIBR	2	1	—	—	—	—	—	—	—	—	—	—	—	—
Hudsonbay currant	RIHU	10	4	6	3	11	2	—	—	9	2	—	—	—	—
prickly currant	RILA	39	3	53	3	70	4	33	2	58	3	—	—	36	3
western thimbleberry	RUPA	32	4	67	5	37	4	—	—	42	3	—	—	55	8
salmonberry	RUSP	39	5	6	1	2	2	—	—	2	Tr	—	—	—	—
Bebb's willow	SABE	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Booth's willow	SABO2	—	—	—	—	2	3	—	—	1	2	—	—	—	—
Cascade willow	SACA6	—	—	—	—	—	—	—	—	—	—	—	—	—	—
undergreen willow	SACO2	—	—	—	—	—	—	—	—	3	3	—	—	—	—
Drummond's willow	SADR	—	—	—	—	1	10	33	3	6	6	—	—	—	—
coyote willow	SAEX	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Farr's willow	SAFA	—	—	—	—	1	9	—	—	9	7	17	Tr	—	—
Geyer's willow	SAGEG	—	—	—	—	—	—	33	3	—	—	—	—	—	—
Geyer's willow	SAGEM	—	—	—	—	—	—	33	2	—	—	—	—	—	—
Pacific willow	SALAL	—	—	—	—	—	—	—	—	—	—	—	—	—	—
dusky willow	SAME2	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Piper's willow	SAPI	—	—	—	—	—	—	—	—	1	2	—	—	—	—
tea-leaved willow	SAPLM2	—	—	—	—	1	Tr	—	—	—	—	—	—	—	—
Mackenzie's willow	SARIM2	—	—	—	—	1	4	—	—	—	—	—	—	—	—
Scouler's willow	SASC	—	—	6	5	8	4	—	—	8	3	—	—	36	2
Sitka willow	SASI2	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Douglas spiraea	SPDO	2	20	3	Tr	1	20	—	—	3	7	—	—	—	—
common snowberry	SYAL	8	5	72	12	21	4	—	—	53	9	—	—	100	50
Alaska huckleberry	VAAL	32	5	—	—	—	—	—	—	2	15	—	—	—	—
big huckleberry	VAME	84	13	17	6	36	8	—	—	15	3	—	—	—	—
oval-leaf huckleberry	VAOV	6	13	—	—	—	—	—	—	—	—	—	—	—	—
Low shrubs and subshrubs:															
bearberry	ARUV	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Merten's moss-heather	CAME	—	—	—	—	—	—	—	—	1	Tr	50	35	—	—

Species Comparisons by Series—Part 1 (continued)

		ABAM 62 plots		ABGR 36 plots		ABLA2 139 plots		PICO 3 plots		PIEN 100 plots		LALY 6 plots		PSME 11 plots	
Species	**Code**	**CON**	**COV**	**CON**	**COV**	**CON**	**COV**	**CON**	**COV**	**CON**	**COV**	**CON**	**COV**	**CON**	**COV**
four-angled moss-heather	CATE2	—	—	—	—	3	Tr	—	—	—	—	50	63	—	—
bunchberry dogwood	COCA	34	13	—	—	34	7	—	—	56	7	—	—	—	—
Labrador tea	LEGL	5	22	—	—	25	13	—	—	22	14	83	8	—	—
twinflower	LIBOL	40	6	33	8	43	7	33	3	58	9	—	—	9	25
myrtle pachistima	PAMY	29	2	78	3	40	7	—	—	21	7	—	—	73	3
red mountain-heath	PHEM	—	—	—	—	13	4	—	—	2	1	100	13	—	—
shrubby cinquefoil	POFR	—	—	—	—	—	—	100	14	1	Tr	—	—	—	—
five-leaved bramble	RUPE	35	5	—	—	18	6	—	—	12	4	—	—	—	—
dwarf huckleberry	VACA	—	—	—	—	7	4	67	12	17	4	83	6	—	—
Cascade huckleberry	VADE	—	—	—	—	1	3	—	—	—	—	—	—	—	—
low huckleberry	VAMY	13	3	3	3	26	6	—	—	18	3	—	—	—	—
grouse huckleberry	VASC	10	3	6	4	39	15	—	—	19	11	50	13	—	—
Perennial forbs:															
deerfoot vanillaleaf	ACTR	35	14	56	25	1	10	—	—	1	1	—	—	—	—
baneberry	ACRU	34	1	31	1	28	1	—	—	24	1	—	—	18	1
wild sarsaparilla	ARNU3	—	—	—	—	1	18	—	—	6	6	—	—	—	—
heart-leaf arnica	ARCO	10	1	22	1	35	2	—	—	29	2	—	—	36	3
mountain arnica	ARLA	23	5	6	1	22	6	—	—	2	2	17	2	—	—
wild ginger	ASCA3	18	4	11	9	1	2	—	—	1	2	—	—	—	—
alpine aster	ASAL	—	—	—	—	—	—	—	—	—	—	17	2	—	—
twinflower marshmarigold	CABI	3	1	—	—	4	1	—	—	3	2	50	3	—	—
twinflower marshmarigold	CABIR	—	—	—	—	1	1	—	—	1	15	—	—	—	—
queencup beadlily	CLUN	76	6	33	5	26	5	—	—	22	4	—	—	—	—
old man's whiskers	GETR	34	1	44	1	45	1	—	—	47	2	—	—	36	1
ballhead waterleaf	HYCA	—	—	3	Tr	—	—	—	—	—	—	—	—	9	Tr
water lentil	LEMI	—	—	—	—	—	—	—	—	—	—	—	—	—	—
partridgefoot	LUPE	2	Tr	—	—	3	14	—	—	—	—	67	10	—	—
broadleaf lupine	LULA	—	—	—	—	9	8	—	—	3	Tr	17	Tr	—	—
bigleaf lupine	LUPO	3	4	—	—	9	1	33	2	13	1	—	—	—	—
skunk cabbage	LYAM	—	—	—	—	—	—	—	—	1	2	—	—	—	—
northern bluebells	MEPAB	10	1	8	1	2	Tr	—	—	3	Tr	—	—	—	—
Lewis' monkey-flower	MILE	5	Tr	—	—	1	Tr	—	—	1	Tr	—	—	—	—
littleleaf montia	MOPAP	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Indian water-lily	NUPO	—	—	—	—	—	—	—	—	—	—	—	—	—	—
cow-lily	NUVA	—	—	—	—	—	—	—	—	—	—	—	—	—	—
grass-leaved pondweed	POGR3	—	—	—	—	—	—	—	—	—	—	—	—	—	—
floatingleaf pondweed	PONA2	—	—	—	—	—	—	—	—	—	—	—	—	—	—
fanleaf cinquefoil	POFL2	2	Tr	—	—	2	1	—	—	—	—	50	1	—	—
dotted saxifrage	SAPU	8	1	3	Tr	12	4	—	—	8	1	—	—	—	—
arrowleaf groundsel	SETR	11	1	14	Tr	41	2	—	—	31	2	—	—	—	—
western solomonplume	SMRA	21	2	67	1	15	1	—	—	20	1	—	—	27	1
starry solomonplume	SMST	40	4	61	4	28	2	—	—	55	2	—	—	64	1
simplestem bur-reed	SPEM	—	—	—	—	—	—	—	—	—	—	—	—	—	—
small bur-reed	SPMI	—	—	—	—	—	—	—	—	—	—	—	—	—	—
bur-reed species	SPARG	—	—	—	—	—	—	—	—	—	—	—	—	—	—
claspleaf twisted-stalk	STAM	26	1	11	Tr	50	1	—	—	52	1	—	—	—	—
rosy twisted-stalk	STRO	47	3	6	Tr	8	Tr	—	—	4	Tr	—	—	—	—
coolwort foamflower	TITRU	71	7	14	2	35	5	—	—	21	2	—	—	—	—
false bugbane	TRCA3	18	7	11	2	25	11	—	—	18	7	—	—	—	—
globeflower	TRLA4	3	Tr	3	2	18	4	—	—	13	1	33	3	—	—
common cattail	TYLA	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Sitka valerian	VASI	44	4	6	3	34	7	—	—	12	7	33	5	—	—
Canadian violet	VICA	—	—	—	—	3	3	—	—	11	2	—	—	9	3
pioneer violet	VIGL	50	2	50	1	26	2	—	—	22	2	—	—	27	3
round-leaved violet	VIOR2	27	2	—	—	23	1	—	—	9	Tr	—	—	—	—
marsh violet	VIPA2	—	—	—	—	2	Tr	—	—	3	Tr	—	—	9	Tr
Grass or grasslike:															
redtop	AGAL	—	—	—	—	—	—	—	—	1	Tr	—	—	—	—
spike bentgrass	AGEX	—	—	—	—	—	—	33	3	—	—	—	—	—	—
Idaho bentgrass	AGID	—	—	—	—	—	—	—	—	2	Tr	—	—	—	—
Oregon bentgrass	AGOR	—	—	—	—	—	—	33	Tr	—	—	—	—	—	—
winter bentgrass	AGSC	—	—	—	—	—	—	33	3	4	Tr	—	—	—	—
bluejoint reedgrass	CACA	3	Tr	—	—	10	1	100	30	36	5	—	—	—	—
slimstem reedgrass	CANE3	—	—	—	—	—	—	67	3	—	—	—	—	—	—
bigleaf sedge	CAAM	—	—	—	—	—	—	—	—	1	Tr	—	—	—	—
Columbia sedge	CAAP3	—	—	—	—	—	—	—	—	—	—	—	—	—	—
water sedge	CAAQA	—	—	—	—	—	—	33	2	2	4	—	—	—	—
Sitka sedge	CAAQS	—	—	—	—	—	—	—	—	2	5	—	—	—	—

Species Comparisons by Series—Part 1 (continued)

Species	Code	ABAM 62 plots		ABGR 36 plots		ABLA2 139 plots		PICO 3 plots		PIEN 100 plots		LALY 6 plots		PSME 11 plots	
		CON	COV	CON	COV	CON	COV	CON	COV	CON	COV	CON	COV	CON	COV
awned sedge	CAAT2	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Buxbaum's sedge	CABU2	—	—	—	—	—	—	33	5	—	—	—	—	—	—
Cusick's sedge	CACU2	—	—	—	—	—	—	—	—	—	—	—	—	—	—
lesser panicled sedge	CADI2	—	—	—	—	—	—	—	—	—	—	—	—	—	—
woolly sedge	CALA3	—	—	—	—	—	—	33	3	—	—	—	—	—	—
slender sedge	CALA4	—	—	—	—	—	—	—	—	—	—	—	—	—	—
lenticular sedge	CALE5	2	Tr	—	—	—	—	—	—	—	—	—	—	—	—
mud sedge	CALI	—	—	—	—	—	—	—	—	—	—	—	—	—	—
black alpine sedge	CANI2	—	—	—	—	7	2	—	—	1	15	83	4	—	—
beaked sedge	CARO2	—	—	—	—	—	—	—	—	—	—	—	—	—	—
russet sedge	CASA2	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Holm's sedge	CASCB	—	—	—	—	4	3	—	—	2	45	33	Tr	—	—
saw-leaved sedge	CASCP2	2	3	—	—	19	2	—	—	31	29	—	—	—	—
showy sedge	CASP	—	—	—	—	—	—	—	—	—	—	17	1	—	—
bladder sedge	CAUT	2	Tr	—	—	—	—	33	20	8	4	—	—	—	—
inflated sedge	CAVE	—	—	—	—	—	—	33	5	—	—	—	—	—	—
wood reed-grass	CILA2	10	Tr	6	Tr	19	1	33	2	16	2	—	—	9	Tr
timber oatgrass	DAIN	—	—	—	—	—	—	67	9	1	Tr	—	—	—	—
tufted hairgrass	DECE	—	—	—	—	—	—	67	4	—	—	—	—	—	—
creeping spike-rush	ELPA	—	—	—	—	—	—	—	—	—	—	—	—	—	—
few-flowered spike-rush	ELPA2	—	—	—	—	—	—	—	—	1	2	—	—	—	—
blue wildrye	ELGL	2	Tr	11	Tr	5	2	33	2	22	3	—	—	18	1
Chamisso cotton-grass	ERCH2	—	—	—	—	—	—	—	—	—	—	—	—	—	—
many-spiked cotton-grass	ERPO2	—	—	—	—	—	—	—	—	1	Tr	—	—	—	—
green-keeled cotton-grass	ERVI	—	—	—	—	—	—	—	—	—	—	—	—	—	—
sheep fescue	FEOVR	—	—	—	—	1	Tr	—	—	2	Tr	—	—	—	—
tall mannagrass	GLEL	—	—	6	Tr	4	Tr	33	2	11	1	—	—	9	Tr
reed mannagrass	GLGR	—	—	—	—	—	—	—	—	—	—	—	—	—	—
western mannagrass	GLOC	—	—	—	—	—	—	—	—	—	—	—	—	—	—
fowl mannagrass	GLST	—	—	—	—	1	1	33	3	2	1	—	—	—	—
smooth woodrush	LUHI	3	Tr	—	—	11	2	—	—	1	1	83	3	—	—
reed canarygrass	PHAR	—	—	—	—	—	—	—	—	—	—	—	—	—	—
timothy	PHPR	—	—	—	—	1	1	67	2	1	1	—	—	—	—
Kentucky bluegrass	POPR	—	—	3	Tr	1	2	67	4	1	Tr	—	—	9	2
pale false mannagrass	PUPAM	—	—	—	—	1	Tr	—	—	—	—	—	—	—	—
small-fruited bulrush	SCMI	2	3	—	—	—	—	—	—	3	5	—	—	—	—
softstem bulrush	SCVA	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Ferns and fern allies:															
alpine lady fern	ATDI	—	—	—	—	1	Tr	—	—	1	3	—	—	—	—
lady fern	ATFI	48	6	14	2	24	4	—	—	20	1	—	—	9	Tr
wood fern species	DRYOP	—	—	—	—	1	25	—	—	1	20	—	—	—	—
common horsetail	EQAR	15	2	11	Tr	27	1	67	2	55	13	—	—	—	—
water horsetail	EQFL	—	—	—	—	—	—	—	—	4	1	—	—	—	—
common scouring-rush	EQHY	—	—	3	Tr	1	Tr	33	Tr	11	2	—	—	18	4
marsh horsetail	EQPA	—	—	—	—	—	—	—	—	1	3	—	—	—	—
wood horsetail	EQSY	—	—	—	—	—	—	—	—	—	—	—	—	—	—
oak fern	GYDR	58	11	8	1	23	15	—	—	12	8	—	—	—	—

[a] CON = percentage of plots in which the species occurred.
[b] COV = average canopy cover in plots in which the species occurred.
[c] Tr = trace cover, less than 1 percent canopy cover.

Species Comparisons by Series—Part 2

		THPL 90 plots		TSHE 117 plots		TSME 25 plots		ACMA 4 plots		ALRU 13 plots		BEPA 7 plots		POTR 33 plots	
Species	Code	CON[a]	COV[b]	CON	COV	CON	COV	CON	COV	CON	COV	CON	COV	CON	COV
Tree overstory:															
Pacific silver fir	ABAM	2	3	3	3	84	24	—	—	—	—	—	—	—	—
grand fir	ABGR	46	15	56	16	—	—	—	—	23	5	43	2	12	2
subalpine fir	ABLA2	13	6	23	5	40	11	—	—	—	—	14	3	—	—
bigleaf maple	ACMA	1	2	—	—	—	—	100	49	8	8	—	—	—	—
red alder	ALRU	6	15	3	6	—	—	25	20	100	66	—	—	—	—
paper birch	BEPA	10	8	8	4	—	—	—	—	—	—	100	36	18	15
Alaska yellow-cedar	CHNO	—	—	1	15	8	18	—	—	—	—	—	—	—	—
subalpine larch	LALY	—	—	—	—	—	—	—	—	—	—	—	—	—	—
western larch	LAOC	23	6	21	10	—	—	—	—	—	—	57	11	9	3
Engelmann spruce	PIEN	61	18	38	10	36	9	—	—	—	—	14	3	6	Tr[c]
whitebark pine	PIAL	—	—	—	—	12	6	—	—	—	—	—	—	—	—
lodgepole pine	PICO	12	2	9	7	—	—	—	—	—	—	57	4	18	3
ponderosa pine	PIPO	7	18	1	5	—	—	25	Tr	8	5	—	—	12	10
quaking aspen	POTR	2	2	—	—	—	—	—	—	—	—	43	7	100	54
black cottonwood	POTR2	21	6	6	5	—	—	25	5	8	2	14	Tr	24	9
Douglas-fir	PSME	58	16	50	15	—	—	25	1	31	8	71	2	30	6
Oregon white oak	QUGA	—	—	—	—	—	—	—	—	—	—	—	—	—	—
western redcedar	THPL	98	41	86	29	12	8	—	—	15	5	57	5	3	Tr
western hemlock	TSHE	13	2	96	24	20	14	—	—	15	2	57	3	—	—
mountain hemlock	TSME	—	—	—	—	96	15	—	—	—	—	—	—	—	—
Shrubs:															
vine maple	ACCI	18	23	26	19	—	—	—	—	54	36	—	—	3	50
Douglas maple	ACGLD	47	5	23	3	—	—	75	2	31	6	71	4	27	25
mountain alder	ALIN	31	8	9	3	—	—	25	47	15	27	71	10	52	13
Sitka alder	ALSI	20	3	9	6	20	15	—	—	46	15	29	2	—	—
Saskatoon serviceberry	AMAL	39	1	21	1	—	—	100	1	31	Tr	71	2	61	3
bog birch	BEGLG	1	5	—	—	—	—	—	—	—	—	—	—	—	—
red-osier dogwood	COST	42	4	15	4	—	—	75	44	38	19	71	10	67	36
California hazel	COCO	6	2	8	2	—	—	—	—	15	14	29	5	9	5
black hawthorn	CRDOD	1	Tr	—	—	—	—	—	—	—	—	—	—	6	5
oceanspray	HODI	7	8	2	1	—	—	100	15	54	3	29	Tr	12	8
rusty menziesia	MEFE	11	3	17	5	36	17	—	—	—	—	—	—	—	—
devil's club	OPHO	30	14	39	10	32	8	—	—	31	22	29	2	—	—
common chokecherry	PRVI	—	—	—	—	—	—	—	—	—	—	14	Tr	12	17
Cascade azalea	RHAL	6	1	7	4	64	31	—	—	—	—	—	—	—	—
stink currant	RIBR	2	1	1	Tr	8	4	—	—	15	1	—	—	—	—
Hudsonbay currant	RIHU	6	1	2	Tr	16	6	—	—	15	27	—	—	12	2
prickly currant	RILA	56	2	40	2	8	2	25	Tr	54	2	86	2	36	5
western thimbleberry	RUPA	66	5	49	2	8	1	25	Tr	62	9	86	3	42	3
salmonberry	RUSP	9	4	10	2	32	9	—	—	38	15	—	—	—	—
Bebb's willow	SABE	1	3	—	—	—	—	—	—	—	—	14	3	12	4
Booth's willow	SABO2	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Cascade willow	SACA6	—	—	—	—	—	—	—	—	—	—	—	—	—	—
undergreen willow	SACO2	—	—	—	—	4	5	—	—	—	—	—	—	—	—
Drummond's willow	SADR	—	—	—	—	—	—	—	—	—	—	14	Tr	—	
coyote willow	SAEX	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Farr's willow	SAFA	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Geyer's willow	SAGEG	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Geyer's willow	SAGEM	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Pacific willow	SALAL	—	—	—	—	—	—	—	—	—	—	—	—	—	—
dusky willow	SAME2	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Piper's willow	SAPI	—	—	—	—	4	35	—	—	—	—	—	—	—	—
tea-leaved willow	SAPLM2	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Mackenzie's willow	SARIM2	—	—	—	—	4	1	—	—	—	—	—	—	—	—
Scouler's willow	SASC	7	2	1	Tr	—	—	25	Tr	—	—	—	—	33	7
Sitka willow	SASI2	1	1	—	—	12	3	—	—	8	3	—	—	—	—
Douglas spiraea	SPDO	1	5	1	2	4	15	—	—	—	—	29	11	6	Tr
common snowberry	SYAL	37	3	15	2	—	—	75	22	23	14	100	4	88	42
Alaska huckleberry	VAAL	—	—	1	2	44	21	—	—	—	—	—	—	—	—
big huckleberry	VAME	21	4	67	3	88	21	—	—	8	Tr	—	—	—	—
oval-leaf huckleberry	VAOV	—	—	—	—	—	—	—	—	8	Tr	—	—	—	—
Low shrubs and subshrubs:															
bearberry	ARUV														
Merten's moss-heather	CAME	—	—	—	—	12	2	—	—	—	—	—	—	—	—
four-angled moss-heather	CATE2	—	—	—	—	—	—	—	—	—	—	—	—	—	—
bunchberry dogwood	COCA	27	4	23	5	12	3	—	—	—	—	43	7	9	1
Labrador tea	LEGL	—	—	—	—	16	1	—	—	—	—	—	—	—	—

Species Comparisons by Series—Part 2 (continued)

		THPL 90 plots		TSHE 117 plots		TSME 25 plots		ACMA 4 plots		ALRU 13 plots		BEPA 7 plots		POTR 33 plots	
Species	**Code**	**CON**	**COV**	**CON**	**COV**	**CON**	**COV**	**CON**	**COV**	**CON**	**COV**	**CON**	**COV**	**CON**	**COV**
twinflower	LIBOL	54	7	70	6	4	Tr	—	—	8	Tr	57	17	24	4
myrtle pachistima	PAMY	49	4	59	3	8	1	100	1	38	4	43	2	27	13
red mountain-heath	PHEM	—	—	—	—	48	8	—	—	—	—	—	—	—	—
shrubby cinquefoil	POFR	—	—	—	—	—	—	—	—	—	—	—	—	—	—
five-leaved bramble	RUPE	4	4	20	6	64	5	—	—	—	—	—	—	—	—
dwarf huckleberry	VACA	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Cascade huckleberry	VADE	—	—	—	—	32	22	—	—	—	—	—	—	—	—
low huckleberry	VAMY	10	1	9	1	12	12	—	—	—	—	14	2	—	—
grouse huckleberry	VASC	1	1	3	1	8	4	—	—	—	—	—	—	—	—
Perennial forbs:															
deerfoot vanillaleaf	ACTR	7	7	26	15	8	3	—	—	38	7	—	—	—	—
baneberry	ACRU	47	2	35	1	—	—	25	Tr	31	4	14	Tr	33	1
wild sarsaparilla	ARNU3	23	9	10	9	—	—	—	—	—	—	57	3	12	9
heart-leaf arnica	ARCO	4	1	7	2	—	—	25	Tr	8	1	—	—	6	Tr
mountain arnica	ARLA	3	Tr	1	4	52	2	—	—	8	1	—	—	—	—
wild ginger	ASCA3	34	6	38	4	—	—	—	—	46	1	14	15	—	—
alpine aster	ASAL	—	—	—	—	—	—	—	—	—	—	—	—	—	—
twinflower marshmarigold	CABI	1	Tr	—	—	12	1	—	—	—	—	—	—	—	—
twinflower marshmarigold	CABIR	—	—	—	—	8	7	—	—	—	—	—	—	—	—
queencup beadlily	CLUN	58	3	86	4	36	7	—	—	15	3	86	2	3	Tr
old man's whiskers	GETR	53	2	59	1	4	2	25	Tr	38	Tr	57	1	21	2
ballhead waterleaf	HYCA	—	—	—	—	—	—	50	Tr	8	Tr	—	—	—	—
water lentil	LEMI	—	—	—	—	—	—	—	—	—	—	—	—	—	—
partridgefoot	LUPE	—	—	—	—	12	2	—	—	—	—	—	—	—	—
broadleaf lupine	LULA	—	—	—	—	4	Tr	—	—	—	—	—	—	—	—
bigleaf lupine	LUPO	—	—	—	—	12	1	—	—	—	—	—	—	—	—
skunk cabbage	LYAM	8	1	8	4	—	—	—	—	—	—	—	—	3	3
northern bluebells	MEPAB	8	Tr	5	1	8	Tr	—	—	15	Tr	—	—	3	25
Lewis' monkey-flower	MILE	1	Tr	—	—	4	1	—	—	15	1	—	—	—	—
littleleaf montia	MOPAP	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Indian water-lily	NUPO	—	—	—	—	—	—	—	—	—	—	—	—	—	—
cow-lily	NUVA	—	—	—	—	—	—	—	—	—	—	—	—	—	—
grass-leaved pondweed	POGR3	—	—	—	—	—	—	—	—	—	—	—	—	—	—
floatingleaf pondweed	PONA2	—	—	—	—	—	—	—	—	—	—	—	—	—	—
fanleaf cinquefoil	POFL2	—	—	—	—	20	Tr	—	—	—	—	—	—	—	—
dotted saxifrage	SAPU	4	Tr	3	Tr	32	1	—	—	8	Tr	—	—	—	—
arrowleaf groundsel	SETR	14	1	22	1	40	1	—	—	—	—	14	1	6	2
western solomonplume	SMRA	31	1	14	1	—	—	75	1	62	1	29	1	18	2
starry solomonplume	SMST	62	4	62	3	16	3	75	1	15	Tr	57	1	70	3
simplestem bur-reed	SPEM	—	—	—	—	—	—	—	—	—	—	—	—	—	—
small bur-reed	SPMI	—	—	—	—	—	—	—	—	—	—	—	—	—	—
bur-reed species	SPARG	—	—	—	—	—	—	—	—	—	—	—	—	—	—
claspleaf twisted-stalk	STAM	49	1	49	1	40	1	—	—	38	Tr	71	1	12	Tr
rosy twisted-stalk	STRO	7	3	9	1	44	3	—	—	15	Tr	29	Tr	3	1
coolwort foamflower	TITRU	51	4	79	4	44	4	—	—	15	3	29	4	12	1
false bugbane	TRCA3	13	4	15	2	4	2	—	—	15	3	—	—	—	—
globeflower	TRLA4	—	—	3	1	4	1	—	—	—	—	—	—	—	—
common cattail	TYLA	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Sitka valerian	VASI	4	Tr	3	11	64	3	—	—	—	—	—	—	—	—
Canadian violet	VICA	6	2	4	2	—	—	—	—	—	—	14	3	12	6
pioneer violet	VIGL	46	2	26	2	28	1	50	Tr	62	1	—	—	27	1
round-leaved violet	VIOR2	12	2	35	3	16	Tr	—	—	8	Tr	—	—	—	—
marsh violet	VIPA2	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Grass or grasslike:															
redtop	AGAL	1	Tr	—	—	—	—	—	—	8	1	29	2	15	2
spike bentgrass	AGEX	—	—	—	—	8	1	—	—	—	—	43	4	6	6
Idaho bentgrass	AGID	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Oregon bentgrass	AGOR	—	—	—	—	—	—	—	—	—	—	—	—	—	—
winter bentgrass	AGSC	—	—	—	—	—	—	—	—	—	—	14	10	6	6
bluejoint reedgrass	CACA	3	1	1	1	8	2	—	—	—	—	14	3	15	12
slimstem reedgrass	CANE3	—	—	—	—	—	—	—	—	—	—	—	—	—	—
bigleaf sedge	CAAM	1	40	1	Tr	—	—	—	—	—	—	—	—	—	—
Columbia sedge	CAAP3	—	—	—	—	—	—	—	—	—	—	—	—	—	—
water sedge	CAAQA	—	—	—	—	—	—	—	—	8	Tr	—	—	3	2
Sitka sedge	CAAQS	1	3	1	1	—	—	—	—	—	—	—	—	—	—
awned sedge	CAAT2	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Buxbaum's sedge	CABU2	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Cusick's sedge	CACU2	—	—	—	—	—	—	—	—	—	—	—	—	—	—

Species Comparisons by Series—Part 2 (continued)

		THPL 90 plots		TSHE 117 plots		TSME 25 plots		ACMA 4 plots		ALRU 13 plots		BEPA 7 plots		POTR 33 plots	
Species	**Code**	**CON**	**COV**	**CON**	**COV**	**CON**	**COV**	**CON**	**COV**	**CON**	**COV**	**CON**	**COV**	**CON**	**COV**
lesser panicled sedge	CADI2	—	—	—	—	—	—	—	—	—	—	—	—	—	—
woolly sedge	CALA3	—	—	—	—	—	—	—	—	—	—	—	—	15	18
slender sedge	CALA4	—	—	—	—	—	—	—	—	—	—	—	—	—	—
lenticular sedge	CALE5	—	—	1	Tr	—	—	—	—	—	—	—	—	3	Tr
mud sedge	CALI	—	—	—	—	—	—	—	—	—	—	—	—	—	—
black alpine sedge	CANI2	—	—	—	—	8	1	—	—	—	—	—	—	—	—
beaked sedge	CARO2	—	—	—	—	—	—	—	—	—	—	—	—	—	—
russet sedge	CASA2	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Holm’s sedge	CASCB	—	—	—	—	—	—	—	—	—	—	—	—	—	—
saw-leaved sedge	CASCP2	1	Tr	—	—	32	1	—	—	—	—	—	—	—	—
showy sedge	CASP	—	—	—	—	8	1	—	—	—	—	—	—	—	—
bladder sedge	CAUT	—	—	—	—	—	—	—	—	—	—	—	—	6	7
inflated sedge	CAVE	—	—	—	—	—	—	—	—	—	—	—	—	3	3
wood reed-grass	CILA2	26	1	17	Tr	8	Tr	—	—	31	2	29	Tr	12	1
timber oatgrass	DAIN	—	—	—	—	—	—	—	—	—	—	—	—	—	—
tufted hairgrass	DECE	—	—	—	—	—	—	—	—	—	—	—	—	6	1
creeping spike-rush	ELPA	—	—	—	—	—	—	—	—	—	—	—	—	—	—
few-flowered spike-rush	ELPA2	—	—	—	—	—	—	—	—	—	—	—	—	—	—
blue wildrye	ELGL	8	2	3	1	4	1	50	Tr	23	Tr	43	3	30	2
Chamisso cotton-grass	ERCH2	—	—	—	—	—	—	—	—	—	—	—	—	—	—
many-spiked cotton-grass	ERPO2	—	—	—	—	—	—	—	—	—	—	—	—	—	—
green-keeled cotton-grass	ERVI	—	—	—	—	—	—	—	—	—	—	—	—	—	—
sheep fescue	FEOVR	—	—	—	—	—	—	—	—	—	—	—	—	—	—
tall mannagrass	GLEL	11	2	3	1	—	—	—	—	31	Tr	—	—	12	Tr
reed mannagrass	GLGR	—	—	—	—	—	—	—	—	8	1	—	—	—	—
western mannagrass	GLOC	—	—	—	—	—	—	—	—	—	—	—	—	—	—
fowl mannagrass	GLST	2	Tr	2	Tr	4	Tr	—	—	—	—	14	10	9	9
smooth woodrush	LUHI	—	—	—	—	12	1	—	—	—	—	—	—	—	—
reed canarygrass	PHAR	1	Tr	—	—	—	—	—	—	—	—	—	—	—	—
timothy	PHPR	—	—	—	—	—	—	—	—	—	—	14	2	6	2
Kentucky bluegrass	POPR	1	3	—	—	—	—	—	—	—	—	14	3	15	3
pale false mannagrass	PUPAM	—	—	—	—	—	—	—	—	—	—	—	—	—	—
small-fruited bulrush	SCMI	1	Tr	—	—	—	—	—	—	—	—	—	—	3	Tr
softstem bulrush	SCVA	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Ferns and fern allies:															
alpine lady fern	ATDI	1	7	—	—	—	—	—	—	—	—	—	—	—	—
lady fern	ATFI	52	10	61	7	24	10	—	—	46	24	29	1	15	1
wood fern species	DRYOP	—	—	1	Tr	—	—	—	—	—	—	—	—	—	—
common horsetail	EQAR	34	5	10	1	20	1	—	—	38	1	57	1	39	1
water horsetail	EQFL	—	—	—	—	—	—	—	—	—	—	—	—	—	—
common scouring-rush	EQHY	6	Tr	1	Tr	—	—	25	2	15	1	29	1	21	1
marsh horsetail	EQPA	—	—	—	—	—	—	—	—	—	—	—	—	—	—
wood horsetail	EQSY	—	—	—	—	—	—	—	—	—	—	—	—	—	—
oak fern	GYDR	40	7	59	10	24	7	—	—	8	Tr	14	2	3	3

[a] CON = percentage of plots in which the species occurred.
[b] COV = average canopy cover in plots in which the species occurred.
[c] Tr = trace cover, less than 1 percent canopy cover.

Species Comparisons by Series—Part 3

Species	Code	POTR2 50 plots		QUGA 6 plots		ACCI 12 plots		ACGL 7 plots		ALIN 190 plots		ALSI 121 plots		COST 40 plots	
		CON[a]	COV[b]	CON	COV	CON	COV	CON	COV	CON	COV	CON	COV	CON	COV
Tree overstory:															
Pacific silver fir	ABAM	2	Tr[c]	—	—	8	Tr	—	—	—	—	12	5	5	5
grand fir	ABGR	10	5	—	—	42	1	—	—	6	7	5	3	13	4
subalpine fir	ABLA2	2	7	—	—	—	—	—	—	13	3	29	4	13	4
bigleaf maple	ACMA	—	—	—	—	8	5	—	—	2	9	—	—	—	—
red alder	ALRU	2	Tr	—	—	17	3	—	—	—	—	1	15	—	—
paper birch	BEPA	22	15	—	—	—	—	—	—	3	9	—	—	8	5
Alaska yellow-cedar	CHNO	—	—	—	—	—	—	—	—	1	3	4	3	—	—
subalpine larch	LALY	—	—	—	—	—	—	—	—	—	—	—	—	—	—
western larch	LAOC	2	5	—	—	—	—	—	—	5	4	2	2	—	—
Engelmann spruce	PIEN	24	8	—	—	—	—	—	—	29	5	32	6	23	5
whitebark pine	PIAL	—	—	—	—	—	—	—	—	—	—	—	—	—	—
lodgepole pine	PICO	8	4	—	—	—	—	—	—	9	4	6	4	3	Tr
ponderosa pine	PIPO	26	4	67	20	—	—	14	Tr	4	3	—	—	—	—
quaking aspen	POTR	28	7	17	20	—	—	—	—	5	3	1	Tr	5	8
black cottonwood	POTR2	100	45	17	2	17	4	14	7	17	6	8	4	23	4
Douglas-fir	PSME	48	6	67	17	17	3	29	4	15	5	9	5	15	8
Oregon white oak	QUGA	—	—	83	50	—	—	—	—	—	—	—	—	—	—
western redcedar	THPL	18	6	—	—	42	5	—	—	16	4	12	7	18	4
western hemlock	TSHE	4	Tr	—	—	25	1	—	—	2	Tr	7	5	3	Tr
mountain hemlock	TSME	—	—	—	—	—	—	—	—	—	—	2	3	—	—
Shrubs:															
vine maple	ACCI	6	28	—	—	100	66	—	—	1	1	4	7	8	10
Douglas maple	ACGLD	48	9	50	4	—	—	86	43	29	6	21	8	35	14
mountain alder	ALIN	66	26	—	—	33	66	29	11	100	56	9	22	53	9
Sitka alder	ALSI	14	14	—	—	25	47	—	—	8	6	100	67	15	2
Saskatoon serviceberry	AMAL	44	2	33	3	8	Tr	57	7	28	1	7	1	15	1
bog birch	BEGLG	—	—	—	—	—	—	—	—	2	5	—	—	—	—
red-osier dogwood	COST	84	31	—	—	42	40	57	9	79	14	18	17	100	77
California hazel	COCO	16	19	83	17	—	—	14	2	4	6	2	1	8	7
black hawthorn	CRDOD	10	19	—	—	—	—	14	4	5	6	1	1	3	7
oceanspray	HODI	14	8	50	3	—	—	43	6	14	4	3	2	10	3
rusty menziesia	MEFE	—	—	—	—	—	—	—	—	1	Tr	12	18	—	—
devil's club	OPHO	6	27	—	—	50	20	—	—	3	2	23	15	10	2
common chokecherry	PRVI	10	1	67	8	—	—	43	14	3	4	—	—	3	1
Cascade azalea	RHAL	—	—	—	—	—	—	—	—	1	1	15	4	—	—
stink currant	RIBR	—	—	—	—	—	—	—	—	—	—	2	5	—	—
Hudsonbay currant	RIHU	6	1	—	—	17	5	14	5	20	6	14	3	35	4
prickly currant	RILA	46	5	—	—	17	3	57	2	58	4	63	7	58	4
western thimbleberry	RUPA	64	4	—	—	50	1	86	5	44	4	40	5	63	2
salmonberry	RUSP	4	2	—	—	50	10	—	—	2	6	26	14	18	14
Bebb's willow	SABE	4	3	—	—	—	—	—	—	9	3	—	—	3	10
Booth's willow	SABO2	—	—	—	—	—	—	—	—	2	3	—	—	—	—
Cascade willow	SACA6	—	—	—	—	—	—	—	—	—	—	—	—	—	—
undergreen willow	SACO2	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Drummond's willow	SADR	2	Tr	—	—	—	—	—	—	6	2	1	3	—	—
coyote willow	SAEX	—	—	—	—	—	—	—	—	1	Tr	—	—	—	—
Farr's willow	SAFA	—	—	—	—	—	—	—	—	1	3	1	Tr	—	—
Geyer's willow	SAGEG	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Geyer's willow	SAGEM	—	—	—	—	—	—	—	—	2	6	—	—	3	5
Pacific willow	SALAL	—	—	—	—	—	—	—	—	1	1	—	—	—	—
dusky willow	SAME2	—	—	—	—	—	—	—	—	4	2	1	3	3	3
Piper's willow	SAPI	—	—	—	—	—	—	—	—	—	—	—	—	—	—
tea-leaved willow	SAPLM2	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Mackenzie's willow	SARIM2	4	2	—	—	—	—	—	—	4	3	—	—	8	4
Scouler's willow	SASC	30	4	—	—	8	10	43	2	10	9	17	11	25	15
Sitka willow	SASI2	4	2	—	—	8	Tr	—	—	6	5	17	8	10	3
Douglas spiraea	SPDO	8	17	17	Tr	—	—	14	10	13	27	2	10	5	4
common snowberry	SYAL	64	29	83	47	8	Tr	57	40	55	15	7	4	68	10
Alaska huckleberry	VAAL	—	—	—	—	—	—	—	—	1	2	5	15	—	—
big huckleberry	VAME	2	Tr	—	—	8	Tr	14	Tr	4	1	41	2	3	Tr
oval-leaf huckleberry	VAOV	—	—	—	—	—	—	—	—	—	—	2	3	—	—
Low shrubs and subshrubs:															
bearberry	ARUV														
Merten's moss-heather	CAME	—	—	—	—	—	—	—	—	—	—	—	—	—	—
four-angled moss-heather	CATE2	—	—	—	—	—	—	—	—	—	—	—	—	—	—
bunchberry dogwood	COCA	6	2	—	—	17	Tr	—	—	16	3	6	2	8	Tr
Labrador tea	LEGL	—	—	—	—	—	—	—	—	3	14	2	2	—	—

Species Comparisons by Series—Part 3 (continued)

		POTR2 50 plots		QUGA 6 plots		ACCI 12 plots		ACGL 7 plots		ALIN 190 plots		ALSI 121 plots		COST 40 plots	
Species	**Code**	**CON**	**COV**	**CON**	**COV**	**CON**	**COV**	**CON**	**COV**	**CON**	**COV**	**CON**	**COV**	**CON**	**COV**
twinflower	LIBOL	4	4	—	—	—	—	14	20	19	4	12	2	13	4
myrtle pachistima	PAMY	34	2	33	1	50	18	57	13	25	2	45	5	23	2
red mountain-heath	PHEM	—	—	—	—	—	—	—	—	—	—	2	1	—	—
shrubby cinquefoil	POFR	—	—	—	—	—	—	—	—	—	—	—	—	—	—
five-leaved bramble	RUPE	—	—	—	—	—	—	—	—	7	1	11	2	—	—
dwarf huckleberry	VACA	—	—	—	—	—	—	—	—	1	1	—	—	—	—
Cascade huckleberry	VADE	—	—	—	—	—	—	—	—	—	—	—	—	—	—
low huckleberry	VAMY	—	—	—	—	8	Tr	—	—	4	2	7	6	—	—
grouse huckleberry	VASC	—	—	—	—	—	—	—	—	—	—	9	1	—	—
Perennial forbs:															
deerfoot vanillaleaf	ACTR	—	—	—	—	—	—	—	—	5	26	6	17	5	1
baneberry	ACRU	30	1	—	—	42	Tr	29	2	29	1	21	2	58	1
wild sarsaparilla	ARNU3	10	3	—	—	—	—	—	—	7	2	—	—	3	Tr
heart-leaf arnica	ARCO	4	1	—	—	—	—	29	5	12	1	11	2	15	1
mountain arnica	ARLA	—	—	—	—	8	Tr	—	—	2	2	17	2	—	—
wild ginger	ASCA3	12	2	—	—	25	2	—	—	11	2	4	2	8	3
alpine aster	ASAL	—	—	—	—	—	—	—	—	—	—	1	Tr	—	—
twinflower marshmarigold	CABI	—	—	—	—	—	—	—	—	2	Tr	4	1	—	—
twinflower marshmarigold	CABIR	—	—	—	—	—	—	—	—	—	—	1	8	—	—
queencup beadlily	CLUN	12	4	—	—	42	Tr	14	Tr	15	1	30	2	13	6
old man's whiskers	GETR	46	1	—	—	33	Tr	71	1	51	1	50	1	55	1
ballhead waterleaf	HYCA	2	Tr	—	—	—	—	—	—	3	Tr	1	Tr	—	—
water lentil	LEMI	—	—	—	—	—	—	—	—	1	1	—	—	—	—
partridgefoot	LUPE	—	—	—	—	—	—	—	—	—	—	1	3	—	—
broadleaf lupine	LULA	—	—	—	—	—	—	—	—	—	—	1	1	—	—
bigleaf lupine	LUPO	—	—	—	—	—	—	—	—	2	Tr	2	1	—	—
skunk cabbage	LYAM	—	—	—	—	—	—	—	—	10	17	1	Tr	—	—
northern bluebells	MEPAB	8	2	—	—	—	—	14	Tr	14	3	18	1	15	10
Lewis' monkey-flower	MILE	—	—	—	—	—	—	—	—	2	1	9	1	—	—
littleleaf montia	MOPAP	—	—	—	—	—	—	14	Tr	1	10	2	1	—	—
Indian water-lily	NUPO	—	—	—	—	—	—	—	—	—	—	—	—	—	—
cow-lily	NUVA	—	—	—	—	—	—	—	—	—	—	—	—	—	—
grass-leaved pondweed	POGR3	—	—	—	—	—	—	—	—	—	—	—	—	—	—
floatingleaf pondweed	PONA2	—	—	—	—	—	—	—	—	—	—	—	—	—	—
fanleaf cinquefoil	POFL2	—	—	—	—	—	—	—	—	—	—	5	1	—	—
dotted saxifrage	SAPU	—	—	—	—	8	Tr	—	—	10	3	36	1	5	Tr
arrowleaf groundsel	SETR	10	1	—	—	8	Tr	—	—	37	3	42	1	15	1
western solomonplume	SMRA	26	1	—	—	75	Tr	57	1	19	1	24	1	40	1
starry solomonplume	SMST	50	4	17	10	83	3	29	2	54	2	17	1	65	2
simplestem bur-reed	SPEM	—	—	—	—	—	—	—	—	—	—	—	—	—	—
small bur-reed	SPMI	—	—	—	—	—	—	—	—	—	—	—	—	—	—
bur-reed species	SPARG	—	—	—	—	—	—	—	—	1	Tr	—	—	—	—
claspleaf twisted-stalk	STAM	8	2	—	—	8	Tr	29	1	33	1	45	1	28	2
rosy twisted-stalk	STRO	2	Tr	—	—	—	—	—	—	3	Tr	28	1	5	1
coolwort foamflower	TITRU	4	2	—	—	33	Tr	—	—	21	2	49	2	20	1
false bugbane	TRCA3	8	2	—	—	—	—	—	—	14	4	12	5	18	2
globeflower	TRLA4	2	5	—	—	—	—	—	—	1	1	6	1	—	—
common cattail	TYLA	—	—	—	—	—	—	—	—	3	3	—	—	—	—
Sitka valerian	VASI	—	—	—	—	—	—	—	—	2	1	34	2	10	1
Canadian violet	VICA	10	4	—	—	—	—	14	3	10	3	2	2	10	2
pioneer violet	VIGL	22	2	—	—	58	Tr	14	Tr	35	3	43	2	35	1
round-leaved violet	VIOR2	2	Tr	—	—	8	Tr	—	—	2	Tr	7	2	3	Tr
marsh violet	VIPA2	—	—	—	—	—	—	—	—	1	1	1	Tr	—	—
Grass or grasslike:															
redtop	AGAL	6	6	—	—	—	—	14	Tr	10	3	1	Tr	3	2
spike bentgrass	AGEX	2	4	—	—	8	Tr	—	—	4	1	6	Tr	3	Tr
Idaho bentgrass	AGID	—	—	—	—	—	—	—	—	1	Tr	2	Tr	—	—
Oregon bentgrass	AGOR	—	—	—	—	—	—	—	—	2	1	—	—	—	—
winter bentgrass	AGSC	—	—	—	—	—	—	—	—	4	2	1	Tr	5	1
bluejoint reedgrass	CACA	12	3	—	—	8	Tr	—	—	25	11	7	1	5	2
slimstem reedgrass	CANE3	—	—	—	—	—	—	—	—	—	—	—	—	—	—
bigleaf sedge	CAAM	4	3	—	—	—	—	—	—	8	3	—	—	5	1
Columbia sedge	CAAP3	2	5	—	—	—	—	—	—	—	—	—	—	3	3
water sedge	CAAQA	—	—	—	—	—	—	—	—	1	Tr	—	—	3	Tr
Sitka sedge	CAAQS	—	—	—	—	—	—	—	—	3	12	—	—	—	—
awned sedge	CAAT2	—	—	—	—	—	—	—	—	2	21	—	—	—	—
Buxbaum's sedge	CABU2	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Cusick's sedge	CACU2	—	—	—	—	—	—	—	—	2	18	—	—	—	—

Species Comparisons by Series—Part 3 (continued)

		POTR2 50 plots		QUGA 6 plots		ACCI 12 plots		ACGL 7 plots		ALIN 190 plots		ALSI 121 plots		COST 40 plots	
Species	**Code**	**CON**	**COV**	**CON**	**COV**	**CON**	**COV**	**CON**	**COV**	**CON**	**COV**	**CON**	**COV**	**CON**	**COV**
lesser panicled sedge	CADI2	2	Tr	—	—	—	—	—	—	—	—	—	—	—	—
woolly sedge	CALA3	2	3	—	—	—	—	—	—	1	2	—	—	—	—
slender sedge	CALA4	—	—	—	—	—	—	—	—	1	1	—	—	—	—
lenticular sedge	CALE5	2	2	—	—	8	Tr	—	—	5	1	2	Tr	5	1
mud sedge	CALI	—	—	—	—	—	—	—	—	—	—	—	—	—	—
black alpine sedge	CANI2	—	—	—	—	—	—	—	—	—	—	2	Tr	—	—
beaked sedge	CARO2	—	—	—	—	—	—	—	—	—	—	—	—	—	—
russet sedge	CASA2	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Holm's sedge	CASCB	—	—	—	—	—	—	—	—	—	—	—	—	—	—
saw-leaved sedge	CASCP2	—	—	—	—	—	—	—	—	4	14	12	1	—	—
showy sedge	CASP	—	—	—	—	—	—	—	—	—	—	2	2	—	—
bladder sedge	CAUT	4	2	—	—	—	—	—	—	17	14	1	1	3	Tr
inflated sedge	CAVE	2	5	—	—	—	—	—	—	2	1	—	—	—	—
wood reed-grass	CILA2	14	1	—	—	8	Tr	29	1	40	3	47	1	40	1
timber oatgrass	DAIN	—	—	—	—	—	—	—	—	—	—	—	—	—	—
tufted hairgrass	DECE	—	—	—	—	—	—	—	—	—	—	1	2	—	—
creeping spike-rush	ELPA	—	—	—	—	—	—	—	—	—	—	—	—	—	—
few-flowered spike-rush	ELPA2	—	—	—	—	—	—	—	—	—	—	—	—	—	—
blue wildrye	ELGL	42	2	83	1	—	—	57	Tr	31	3	16	1	18	Tr
Chamisso cotton-grass	ERCH2	—	—	—	—	—	—	—	—	1	Tr	—	—	—	—
many-spiked cotton-grass	ERPO2	—	—	—	—	—	—	—	—	—	—	—	—	—	—
green-keeled cotton-grass	ERVI	—	—	—	—	—	—	—	—	—	—	—	—	—	—
sheep fescue	FEOVR	—	—	—	—	—	—	—	—	—	—	—	—	—	—
tall mannagrass	GLEL	16	1	—	—	17	Tr	14	Tr	53	5	11	1	30	1
reed mannagrass	GLGR	—	—	—	—	—	—	—	—	2	1	—	—	—	—
western mannagrass	GLOC	—	—	—	—	—	—	—	—	—	—	—	—	—	—
fowl mannagrass	GLST	4	1	—	—	8	Tr	14	1	11	2	1	1	5	6
smooth woodrush	LUHI	—	—	—	—	—	—	—	—	—	—	2	1	—	—
reed canarygrass	PHAR	2	Tr	—	—	—	—	—	—	5	20	—	—	—	—
timothy	PHPR	2	Tr	—	—	—	—	—	—	3	1	—	—	—	—
Kentucky bluegrass	POPR	10	1	50	1	—	—	—	—	7	5	1	Tr	3	2
pale false mannagrass	PUPAM	—	—	—	—	8	Tr	—	—	4	1	1	Tr	—	—
small-fruited bulrush	SCMI	2	Tr	—	—	—	—	—	—	12	7	1	Tr	5	1
softstem bulrush	SCVA	—	—	—	—	—	—	—	—	1	3	—	—	—	—
Ferns and fern allies:															
alpine lady fern	ATDI	—	—	—	—	—	—	—	—	1	1	2	1	3	7
lady fern	ATFI	18	2	—	—	50	11	14	2	49	11	51	9	38	5
wood fern species	DRYOP	—	—	—	—	—	—	—	—	—	—	—	—	—	—
common horsetail	EQAR	48	1	—	—	8	Tr	29	Tr	68	8	30	1	40	9
water horsetail	EQFL	—	—	—	—	—	—	—	—	7	10	—	—	—	—
common scouring-rush	EQHY	40	3	—	—	—	—	29	1	19	4	1	1	18	2
marsh horsetail	EQPA	—	—	—	—	—	—	—	—	—	—	1	10	—	—
wood horsetail	EQSY	—	—	—	—	—	—	—	—	—	—	—	—	—	—
oak fern	GYDR	6	Tr	—	—	25	2	14	1	21	7	44	9	13	7

[a] CON = percentage of plots in which the species occurred.
[b] COV = average canopy cover in plots in which the species occurred.
[c] Tr = trace cover, less than 1 percent canopy cover.

Species Comparisons by Series—Part 4

		HEATH 18 plots		OPHO 13 plots		POFR 2 plots		RHAL 2 plots		RUSP 8 plots		SALIX 152 plots		SPDO 22 plots	
Species	**Code**	**CON[a]**	**COV[b]**	**CON**	**COV**	**CON**	**COV**	**CON**	**COV**	**CON**	**COV**	**CON**	**COV**	**CON**	**COV**
Tree overstory:															
Pacific silver fir	ABAM	6	Tr[c]	23	7	—	—	—	—	38	1	1	Tr	5	5
grand fir	ABGR	—	—	—	—	—	—	—	—	—	—	—	—	5	7
subalpine fir	ABLA2	11	Tr	—	—	—	—	100	8	13	15	7	3	9	4
bigleaf maple	ACMA	—	—	—	—	—	—	—	—	—	—	—	—	—	—
red alder	ALRU	—	—	—	—	—	—	—	—	—	—	—	—	—	—
paper birch	BEPA	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Alaska yellow-cedar	CHNO	—	—	—	—	—	—	—	—	—	—	1	Tr	—	—
subalpine larch	LALY	6	Tr	—	—	—	—	—	—	—	—	—	—	—	—
western larch	LAOC	—	—	8	Tr	—	—	—	—	—	—	—	—	—	—
Engelmann spruce	PIEN	22	1	8	15	—	—	—	—	—	—	24	4	—	—
whitebark pine	PIAL	6	Tr	—	—	—	—	—	—	—	—	—	—	—	—
lodgepole pine	PICO	—	—	—	—	100	2	—	—	—	—	16	3	—	—
ponderosa pine	PIPO	—	—	—	—	—	—	—	—	—	—	—	—	9	1
quaking aspen	POTR	—	—	—	—	—	—	—	—	—	—	1	1	—	—
black cottonwood	POTR2	—	—	8	Tr	—	—	—	—	—	—	2	2	—	—
Douglas-fir	PSME	—	—	—	—	—	—	—	—	—	—	1	5	5	7
Oregon white oak	QUGA	—	—	—	—	—	—	—	—	—	—	—	—	—	—
western redcedar	THPL	—	—	8	1	—	—	—	—	—	—	1	10	—	—
western hemlock	TSHE	—	—	8	5	—	—	50	2	25	8	—	—	—	—
mountain hemlock	TSME	11	Tr	15	4	—	—	—	—	25	3	1	3	14	3
Shrubs:															
vine maple	ACCI	—	—	15	7	—	—	—	—	—	—	1	Tr	—	—
Douglas maple	ACGLD	—	—	23	14	—	—	—	—	—	—	3	2	—	—
mountain alder	ALIN	—	—	8	5	—	—	—	—	—	—	26	10	32	5
Sitka alder	ALSI	—	—	46	4	—	—	—	—	63	6	15	10	9	8
Saskatoon serviceberry	AMAL	—	—	—	—	—	—	—	—	—	—	5	1	5	3
bog birch	BEGLG	—	—	—	—	—	—	—	—	—	—	16	20	—	—
red-osier dogwood	COST	—	—	8	15	—	—	—	—	—	—	13	6	27	2
California hazel	COCO	—	—	—	—	—	—	—	—	—	—	—	—	5	2
black hawthorn	CRDOD	—	—	—	—	—	—	—	—	—	—	—	—	32	27
oceanspray	HODI	—	—	—	—	—	—	—	—	—	—	1	2	—	—
rusty menziesia	MEFE	—	—	15	3	—	—	50	15	38	3	—	—	5	1
devil's club	OPHO	—	—	100	45	—	—	—	—	13	Tr	1	Tr	—	—
common chokecherry	PRVI	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Cascade azalea	RHAL	22	1	23	7	—	—	100	29	50	11	5	4	5	Tr
stink currant	RIBR	—	—	8	25	—	—	—	—	13	15	1	9	—	—
Hudsonbay currant	RIHU	—	—	38	2	—	—	—	—	63	25	7	1	5	6
prickly currant	RILA	—	—	38	2	—	—	50	2	38	2	12	3	—	—
western thimbleberry	RUPA	—	—	69	8	—	—	50	1	38	4	7	6	5	Tr
salmonberry	RUSP	—	—	62	18	—	—	—	—	88	33	5	8	14	3
Bebb willow	SABE	—	—	—	—	—	—	—	—	—	—	7	15	5	2
Booth's willow	SABO2	—	—	—	—	—	—	—	—	—	—	9	26	5	2
Cascade willow	SACA6	11	6	—	—	—	—	—	—	—	—	2	15	—	—
undergreen willow	SACO2	22	3	—	—	—	—	50	1	—	—	14	31	—	—
Drummond's willow	SADR	—	—	—	—	—	—	—	—	—	—	24	42	5	2
coyote willow	SAEX	—	—	—	—	—	—	—	—	—	—	1	30	—	—
Farr's willow	SAFA	6	2	—	—	—	—	—	—	13	1	22	33	—	—
Geyer's willow	SAGEG	—	—	—	—	—	—	—	—	—	—	1	60	—	—
Geyer's willow	SAGEM	—	—	—	—	50	2	—	—	—	—	7	22	—	—
Pacific willow	SALAL	—	—	—	—	—	—	—	—	—	—	3	12	—	—
dusky willow	SAME2	—	—	—	—	—	—	—	—	—	—	7	36	—	—
Piper's willow	SAPI	—	—	—	—	—	—	—	—	—	—	3	47	5	3
tea-leaved willow	SAPLM2	—	—	—	—	—	—	—	—	—	—	11	37	—	—
Mackenzie's willow	SARIM2	—	—	—	—	—	—	—	—	—	—	5	23	—	—
Scouler's willow	SASC	—	—	—	—	—	—	—	—	—	—	6	58	—	—
Sitka willow	SASI2	—	—	8	10	—	—	—	—	25	8	30	47	14	2
Douglas spiraea	SPDO	—	—	—	—	—	—	—	—	—	—	17	25	100	68
common snowberry	SYAL	—	—	8	10	—	—	—	—	—	—	4	2	27	16
Alaska huckleberry	VAAL	6	3	15	8	—	—	—	—	38	4	—	—	9	3
big huckleberry	VAME	6	5	38	3	—	—	100	5	88	2	3	3	9	Tr
oval-leaf huckleberry	VAOV	—	—	8	10	—	—	—	—	13	5	—	—	—	—
Low shrubs and subshrubs:															
bearberry	ARUV														
Merten's moss-heather	CAME	67	17	—	—	—	—	—	—	—	—	1	7	—	—
four-angled moss-heather	CATE2	6	35	—	—	—	—	—	—	—	—	1	1	—	—
bunchberry dogwood	COCA	—	—	8	Tr	—	—	—	—	—	—	3	1	5	5
Labrador tea	LEGL	22	15	—	—	—	—	—	—	13	1	9	4	—	—

Species Comparisons by Series—Part 4 (continued)

Species	Code	HEATH 18 plots		OPHO 13 plots		POFR 2 plots		RHAL 2 plots		RUSP 8 plots		SALIX 152 plots		SPDO 22 plots	
		CON	COV	CON	COV	CON	COV	CON	COV	CON	COV	CON	COV	CON	COV
twinflower	LIBOL	—	—	15	1	—	—	—	—	—	—	5	2	—	—
myrtle pachistima	PAMY	—	—	8	Tr	—	—	—	—	—	—	6	19	—	—
red mountain-heath	PHEM	100	27	—	—	—	—	50	12	13	Tr	7	1	—	—
shrubby cinquefoil	POFR	—	—	—	—	100	33	—	—	—	—	2	16	—	—
five-leaved bramble	RUPE	6	Tr	15	2	—	—	50	1	38	1	1	3	—	—
dwarf huckleberry	VACA	22	23	—	—	—	—	—	—	—	—	14	7	—	—
Cascade huckleberry	VADE	72	18	—	—	—	—	50	3	—	—	5	2	—	—
low huckleberry	VAMY	—	—	—	—	—	—	50	Tr	—	—	3	1	—	—
grouse huckleberry	VASC	6	2	—	—	—	—	50	10	—	—	5	5	—	—
Perennial forbs:															
deerfoot vanillaleaf	ACTR	—	—	8	Tr	—	—	—	—	25	13	1	5	—	—
baneberry	ACRU	—	—	38	1	—	—	—	—	—	—	4	Tr	5	Tr
wild sarsaparilla	ARNU3	—	—	—	—	—	—	—	—	—	—	—	—	—	—
heart-leaf arnica	ARCO	—	—	8	Tr	—	—	—	—	13	Tr	1	7	—	—
mountain arnica	ARLA	39	1	8	Tr	—	—	50	2	25	Tr	4	1	—	—
wild ginger	ASCA3	—	—	15	14	—	—	—	—	—	—	—	—	—	—
alpine aster	ASAL	11	2	—	—	—	—	50	2	—	—	1	Tr	—	—
twinflower marshmarigold	CABI	22	6	8	1	—	—	50	1	13	1	2	4	5	6
twinflower marshmarigold	CABIR	—	—	—	—	—	—	—	—	—	—	1	1	—	—
queencup beadlily	CLUN	—	—	69	2	—	—	50	Tr	38	Tr	—	—	9	Tr
old man’s whiskers	GETR	—	—	31	1	—	—	50	Tr	63	1	13	2	18	Tr
ballhead waterleaf	HYCA	—	—	—	—	—	—	—	—	—	—	1	Tr	—	—
water lentil	LEMI	—	—	—	—	—	—	—	—	—	—	1	1	5	15
partridgefoot	LUPE	67	3	—	—	—	—	—	—	—	—	1	1	—	—
broadleaf lupine	LULA	—	—	—	—	—	—	—	—	—	—	3	4	—	—
bigleaf lupine	LUPO	—	—	—	—	50	1	—	—	—	—	7	2	5	5
skunk cabbage	LYAM	—	—	—	—	—	—	—	—	—	—	2	5	5	5
northern bluebells	MEPAB	—	—	15	2	—	—	—	—	25	1	9	6	23	2
Lewis’ monkey-flower	MILE	11	2	—	—	—	—	—	—	25	1	3	1	—	—
littleleaf montia	MOPAP	—	—	8	Tr	—	—	—	—	—	—	—	—	—	—
Indian water-lily	NUPO	—	—	—	—	—	—	—	—	—	—	—	—	—	—
cow-lily	NUVA	—	—	—	—	—	—	—	—	—	—	—	—	—	—
grass-leaved pondweed	POGR3	—	—	—	—	—	—	—	—	—	—	1	Tr	5	1
floatingleaf pondweed	PONA2	—	—	—	—	—	—	—	—	—	—	—	—	—	—
fanleaf cinquefoil	POFL2	78	4	8	1	—	—	50	5	—	—	14	4	5	4
dotted saxifrage	SAPU	28	6	31	Tr	—	—	50	1	75	1	14	3	—	—
arrowleaf groundsel	SETR	44	1	15	Tr	—	—	100	2	50	Tr	29	3	—	—
western solomonplume	SMRA	—	—	23	5	—	—	—	—	13	5	3	2	—	—
starry solomonplume	SMST	—	—	38	Tr	—	—	—	—	13	Tr	9	1	9	2
simplestem bur-reed	SPEM	—	—	—	—	—	—	—	—	—	—	—	—	5	Tr
small bur-reed	SPMI	—	—	—	—	—	—	—	—	—	—	1	Tr	—	—
bur-reed species	SPARG	—	—	—	—	—	—	—	—	—	—	—	—	—	—
claspleaf twisted-stalk	STAM	—	—	62	1	—	—	50	Tr	38	Tr	3	1	—	—
rosy twisted-stalk	STRO	6	Tr	31	1	—	—	—	—	63	1	2	1	5	Tr
coolwort foamflower	TITRU	—	—	92	5	—	—	50	1	75	2	3	6	5	Tr
false bugbane	TRCA3	—	—	8	5	—	—	—	—	—	—	2	1	—	—
globeflower	TRLA4	17	5	—	—	—	—	50	15	—	—	10	6	—	—
common cattail	TYLA	—	—	—	—	—	—	—	—	—	—	1	2	9	3
Sitka valerian	VASI	56	3	23	1	—	—	50	10	63	3	14	10	5	Tr
Canadian violet	VICA	—	—	—	—	—	—	—	—	—	—	1	7	—	—
pioneer violet	VIGL	—	—	77	1	—	—	—	—	63	1	18	4	9	1
round-leaved violet	VIOR2	6	Tr	—	—	—	—	50	Tr	13	Tr	1	Tr	5	60
marsh violet	VIPA2	—	—	—	—	—	—	—	—	—	—	3	2	5	30
Grass or grasslike:															
redtop	AGAL	—	—	—	—	—	—	—	—	—	—	4	2	—	—
spike bentgrass	AGEX	—	—	—	—	—	—	50	1	13	Tr	8	1	9	1
Idaho bentgrass	AGID	11	Tr	—	—	—	—	—	—	—	—	3	2	5	20
Oregon bentgrass	AGOR	—	—	—	—	100	2	—	—	—	—	1	Tr	—	—
winter bentgrass	AGSC	—	—	—	—	100	2	—	—	—	—	10	2	5	5
bluejoint reedgrass	CACA	17	2	—	—	50	7	—	—	—	—	50	10	50	31
slimstem reedgrass	CANE3	—	—	—	—	50	3	—	—	—	—	1	3	—	—
bigleaf sedge	CAAM	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Columbia sedge	CAAP3	—	—	—	—	—	—	—	—	—	—	2	22	—	—
water sedge	CAAQA	—	—	—	—	—	—	50	2	—	—	5	11	—	—
Sitka sedge	CAAQS	—	—	—	—	50	2	—	—	—	—	7	32	5	1
awned sedge	CAAT2	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Buxbaum’s sedge	CABU2	—	—	—	—	—	—	—	—	—	—	1	10	—	—
Cusick’s sedge	CACU2	—	—	—	—	—	—	—	—	—	—	1	9	5	2

Species Comparisons by Series—Part 4 (continued)

		HEATH 18 plots		OPHO 13 plots		POFR 2 plots		RHAL 2 plots		RUSP 8 plots		SALIX 152 plots		SPDO 22 plots	
Species	**Code**	**CON**	**COV**	**CON**	**COV**	**CON**	**COV**	**CON**	**COV**	**CON**	**COV**	**CON**	**COV**	**CON**	**COV**
lesser panicled sedge	CADI2	—	—	—	—	—	—	—	—	—	—	1	20	—	—
woolly sedge	CALA3	—	—	—	—	50	2	—	—	—	—	2	Tr	14	1
slender sedge	CALA4	—	—	—	—	—	—	—	—	—	—	3	21	—	—
lenticular sedge	CALE5	—	—	8	Tr	—	—	—	—	—	—	9	7	9	10
mud sedge	CALI	—	—	—	—	—	—	—	—	—	—	3	9	—	—
black alpine sedge	CANI2	83	10	—	—	—	—	50	2	13	1	11	11	—	—
beaked sedge	CARO2	—	—	—	—	—	—	—	—	—	—	—	—	—	—
russet sedge	CASA2	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Holm's sedge	CASCB	6	1	—	—	—	—	—	—	—	—	9	18	5	1
saw-leaved sedge	CASCP2	22	1	—	—	—	—	—	—	—	—	26	28	5	Tr
showy sedge	CASP	50	3	—	—	—	—	50	1	—	—	8	9	—	—
bladder sedge	CAUT	—	—	—	—	100	19	—	—	—	—	37	21	9	9
inflated sedge	CAVE	—	—	—	—	—	—	—	—	—	—	5	9	9	13
wood reed-grass	CILA2	—	—	23	1	—	—	50	Tr	38	Tr	10	3	—	—
timber oatgrass	DAIN	17	6	—	—	100	4	—	—	—	—	5	7	—	—
tufted hairgrass	DECE	6	Tr	—	—	100	23	—	—	—	—	4	1	—	—
creeping spike-rush	ELPA	—	—	—	—	—	—	—	—	—	—	1	1	—	—
few-flowered spike-rush	ELPA2	6	Tr	—	—	—	—	—	—	—	—	2	16	—	—
blue wildrye	ELGL	—	—	—	—	—	—	50	1	13	Tr	10	1	5	Tr
Chamisso cotton-grass	ERCH2	—	—	—	—	—	—	—	—	—	—	2	1	—	—
many-spiked cotton-grass	ERPO2	11	3	—	—	—	—	—	—	—	—	4	12	5	1
green-keeled cotton-grass	ERVI	—	—	—	—	—	—	—	—	—	—	3	3	—	—
sheep fescue	FEOVR	—	—	—	—	—	—	—	—	—	—	2	5	—	—
tall mannagrass	GLEL	—	—	—	—	—	—	—	—	13	1	10	5	—	—
reed mannagrass	GLGR	—	—	—	—	—	—	—	—	—	—	2	27	—	—
western mannagrass	GLOC	—	—	—	—	—	—	—	—	—	—	—	—	—	—
fowl mannagrass	GLST	—	—	—	—	—	—	—	—	—	—	2	2	5	1
smooth woodrush	LUHI	56	3	8	1	—	—	—	—	13	Tr	3	1	—	—
reed canarygrass	PHAR	—	—	—	—	—	—	—	—	—	—	3	1	14	2
timothy	PHPR	—	—	—	—	100	2	—	—	—	—	2	1	—	—
Kentucky bluegrass	POPR	—	—	—	—	100	4	—	—	—	—	3	Tr	5	Tr
pale false mannagrass	PUPAM	—	—	—	—	—	—	—	—	—	—	3	Tr	5	2
small-fruited bulrush	SCMI	—	—	—	—	—	—	—	—	—	—	11	5	23	12
softstem bulrush	SCVA	—	—	—	—	—	—	—	—	—	—	1	7	—	—
Ferns and fern allies:															
alpine lady fern	ATDI	—	—	—	—	—	—	—	—	13	Tr	—	—	—	—
lady fern	ATFI	6	Tr	92	12	—	—	50	Tr	75	27	11	1	9	3
wood fern species	DRYOP	—	—	—	—	—	—	—	—	—	—	—	—	—	—
common horsetail	EQAR	17	Tr	8	Tr	50	1	50	7	13	1	33	5	32	2
water horsetail	EQFL	—	—	—	—	—	—	—	—	—	—	8	2	5	5
common scouring-rush	EQHY	—	—	8	Tr	—	—	—	—	—	—	1	Tr	—	—
marsh horsetail	EQPA	6	Tr	—	—	—	—	—	—	—	—	1	2	—	—
wood horsetail	EQSY	—	—	—	—	—	—	—	—	—	—	—	—	—	—
oak fern	GYDR	—	—	85	18	—	—	50	5	88	7	4	1	5	Tr

[a] CON = percentage of plots in which the species occurred.
[b] COV = average canopy cover in plots in which the species occurred.
[c] Tr = trace cover, less than 1 percent canopy cover.

Species Comparisons by Series—Part 5

Species	Code	SYAL 2 plots CON[a]	SYAL COV[b]	AQUATIC 61 plots CON	AQUATIC COV	FORB 29 plots CON	FORB COV	MEADOW 256 plots CON	MEADOW COV
Tree overstory:									
Pacific silver fir	ABAM	—	—	—	—	10	5	—	—
grand fir	ABGR	—	—	—	—	—	—	—	—
subalpine fir	ABLA2	—	—	—	—	17	5	4	2
bigleaf maple	ACMA	—	—	—	—	—	—	—	—
red alder	ALRU	—	—	—	—	—	—	—	—
paper birch	BEPA	—	—	—	—	—	—	—	—
Alaska yellow-cedar	CHNO	—	—	—	—	—	—	—	—
subalpine larch	LALY	—	—	—	—	—	—	—	—
western larch	LAOC	—	—	—	—	—	—	—	—
Engelmann spruce	PIEN	—	—	—	—	17	4	6	3
whitebark pine	PIAL	—	—	—	—	—	—	—	—
lodgepole pine	PICO	—	—	—	—	—	—	3	2
ponderosa pine	PIPO	—	—	—	—	—	—	Tr[c]	Tr
quaking aspen	POTR	—	—	—	—	—	—	—	—
black cottonwood	POTR2	—	—	—	—	3	10	—	—
Douglas-fir	PSME	—	—	—	—	—	—	—	—
Oregon white oak	QUGA	—	—	—	—	—	—	—	—
western redcedar	THPL	—	—	—	—	—	—	Tr	3
western hemlock	TSHE	—	—	—	—	—	—	—	—
mountain hemlock	TSME	—	—	—	—	3	3	Tr	Tr
Shrubs:									
vine maple	ACCI	—	—	—	—	3	1	—	—
Douglas maple	ACGLD	50	5	—	—	7	13	—	—
mountain alder	ALIN	—	—	11	3	17	1	13	4
Sitka alder	ALSI	—	—	2	1	21	6	1	4
Saskatoon serviceberry	AMAL	50	5	—	—	3	Tr	1	Tr
bog birch	BEGLG	—	—	3	3	—	—	4	5
red-osier dogwood	COST	100	3	7	1	7	5	5	1
California hazel	COCO	50	35	—	—	—	—	—	—
black hawthorn	CRDOD	50	1	—	—	—	—	—	—
oceanspray	HODI	—	—	—	—	—	—	—	—
rusty menziesia	MEFE	—	—	—	—	17	5	Tr	Tr
devil's club	OPHO	—	—	—	—	7	2	—	—
common chokecherry	PRVI	—	—	—	—	—	—	—	—
Cascade azalea	RHAL	—	—	—	—	21	4	5	1
stink currant	RIBR	—	—	—	—	3	1	—	—
Hudsonbay currant	RIHU	—	—	2	1	—	—	2	Tr
prickly currant	RILA	—	—	2	1	34	4	2	3
western thimbleberry	RUPA	—	—	—	—	24	1	Tr	5
salmonberry	RUSP	—	—	—	—	3	15	Tr	7
Bebb's willow	SABE	—	—	7	Tr	—	—	7	1
Booth's willow	SABO2	—	—	2	Tr	—	—	2	3
Cascade willow	SACA6	—	—	—	—	—	—	2	4
undergreen willow	SACO2	—	—	—	—	10	7	4	2
Drummond's willow	SADR	—	—	2	2	—	—	10	2
coyote willow	SAEX	—	—	—	—	—	—	Tr	3
Farr's willow	SAFA	—	—	—	—	3	17	13	4
Geyer's willow	SAGEG	—	—	2	2	—	—	—	—
Geyer's willow	SAGEM	—	—	—	—	—	—	2	1
Pacific willow	SALAL	—	—	2	2	—	—	Tr	2
dusky willow	SAME2	—	—	—	—	—	—	1	1
Piper's willow	SAPI	—	—	—	—	—	—	1	2
tea-leaved willow	SAPLM2	—	—	—	—	—	—	6	5
Mackenzie's willow	SARIM2	50	15	3	1	—	—	2	1
Scouler's willow	SASC	—	—	—	—	—	—	1	Tr
Sitka willow	SASI2	—	—	3	1	3	1	4	2
Douglas spiraea	SPDO	50	2	5	4	—	—	6	2
common snowberry	SYAL	100	65	—	—	7	1	1	3
Alaska huckleberry	VAAL	—	—	2	Tr	14	2	1	1
big huckleberry	VAME	—	—	—	—	28	2	4	1
oval-leaf huckleberry	VAOV	—	—	—	—	—	—	—	—
Low shrubs and subshrubs:									
bearberry	ARUV								
Merten's moss-heather	CAME	—	—	—	—	3	Tr	7	2
four-angled moss-heather	CATE2	—	—	—	—	—	—	2	2
bunchberry dogwood	COCA	—	—	—	—	7	1	Tr	Tr
Labrador tea	LEGL	—	—	—	—	7	1	6	2

Species Comparisons by Series—Part 5 (continued)

		SYAL 2 plots		AQUATIC 61 plots		FORB 29 plots		MEADOW 256 plots	
Species	**Code**	**CON**	**COV**	**CON**	**COV**	**CON**	**COV**	**CON**	**COV**
twinflower	LIBOL	—	—	—	—	7	Tr	1	1
myrtle pachistima	PAMY	—	—	—	—	14	Tr	Tr	1
red mountain-heath	PHEM	—	—	—	—	14	3	16	3
shrubby cinquefoil	POFR	—	—	—	—	—	—	1	3
five-leaved bramble	RUPE	—	—	2	Tr	3	1	1	Tr
dwarf huckleberry	VACA	—	—	—	—	3	1	13	6
Cascade huckleberry	VADE	—	—	—	—	7	4	8	4
low huckleberry	VAMY	—	—	2	Tr	7	1	2	1
grouse huckleberry	VASC	—	—	—	—	10	2	4	2
Perennial forbs:									
deerfoot vanillaleaf	ACTR	—	—	—	—	3	1	—	—
baneberry	ACRU	—	—	—	—	17	1	1	Tr
wild sarsaparilla	ARNU3	—	—	—	—	—	—	Tr	1
heart-leaf arnica	ARCO	50	2	—	—	17	1	—	—
mountain arnica	ARLA	—	—	—	—	41	3	4	1
wild ginger	ASCA3	—	—	2	Tr	—	—	Tr	2
alpine aster	ASAL	—	—	—	—	10	5	1	3
twinflower marshmarigold	CABI	—	—	—	—	21	12	10	4
twinflower marshmarigold	CABIR	—	—	—	—	7	37	Tr	3
queencup beadlily	CLUN	—	—	—	—	17	4	—	—
old man's whiskers	GETR	—	—	5	1	28	1	2	Tr
ballhead waterleaf	HYCA	—	—	—	—	—	—	—	—
water lentil	LEMI	—	—	25	15	—	—	4	6
partridgefoot	LUPE	—	—	—	—	10	7	7	3
broadleaf lupine	LULA	—	—	—	—	7	58	2	2
bigleaf lupine	LUPO	—	—	—	—	7	Tr	3	2
skunk cabbage	LYAM	—	—	2	5	—	—	Tr	2
northern bluebells	MEPAB	50	1	—	—	10	Tr	2	1
Lewis' monkey-flower	MILE	—	—	—	—	21	17	2	4
littleleaf montia	MOPAP	—	—	—	—	—	—	—	—
indian water-lily	NUPO	—	—	20	24	—	—	2	1
cow-lily	NUVA	—	—	5	11	—	—	—	—
grass-leaved pondweed	POGR3	—	—	3	38	—	—	Tr	7
floatingleaf pondweed	PONA2	—	—	10	27	—	—	2	2
fanleaf cinquefoil	POFL2	—	—	—	—	24	4	20	3
dotted saxifrage	SAPU	—	—	—	—	59	7	5	3
arrowleaf groundsel	SETR	50	Tr	—	—	66	5	13	3
western solomonplume	SMRA	50	2	—	—	10	1	—	—
starry solomonplume	SMST	100	2	—	—	10	Tr	2	1
simplestem bur-reed	SPEM	—	—	23	14	—	—	2	2
small bur-reed	SPMI	—	—	18	23	—	—	1	Tr
bur-reed species	SPARG	—	—	5	25	—	—	1	1
claspleaf twisted-stalk	STAM	—	—	2	Tr	59	2	2	1
rosy twisted-stalk	STRO	—	—	2	Tr	28	7	1	3
coolwort foamflower	TITRU	—	—	—	—	41	8	1	1
false bugbane	TRCA3	—	—	2	Tr	7	2	1	1
globeflower	TRLA4	—	—	—	—	21	13	6	6
common cattail	TYLA	—	—	31	36	—	—	6	2
Sitka valerian	VASI	—	—	—	—	62	9	9	5
Canadian violet	VICA	50	1	—	—	—	—	1	2
pioneer violet	VIGL	—	—	2	Tr	59	2	4	6
round-leaved violet	VIOR2	—	—	—	—	10	1	2	6
marsh violet	VIPA2	—	—	—	—	—	—	1	1
Grass and grasslike:									
redtop	AGAL	—	—	—	—	3	Tr	4	11
spike bentgrass	AGEX	—	—	2	Tr	10	2	2	Tr
Idaho bentgrass	AGID	—	—	—	—	—	—	1	1
Oregon bentgrass	AGOR	—	—	—	—	—	—	4	8
winter bentgrass	AGSC	—	—	2	Tr	—	—	6	2
bluejoint reedgrass	CACA	—	—	3	Tr	7	5	36	12
slimstem reedgrass	CANE3	—	—	—	—	—	—	1	2
bigleaf sedge	CAAM	—	—	—	—	—	—	1	3
Columbia sedge	CAAP3	—	—	—	—	—	—	2	28
water sedge	CAAQA	—	—	5	17	—	—	4	21
Sitka sedge	CAAQS	—	—	3	4	—	—	7	25
awned sedge	CAAT2	—	—	3	5	—	—	2	31
Buxbaum's sedge	CABU2	—	—	—	—	—	—	3	18
Cusick's sedge	CACU2	—	—	10	6	—	—	5	18

Species Comparisons by Series—Part 5 (continued)

Species	Code	SYAL 2 plots CON[a]	COV[b]	AQUATIC 61 plots CON	COV	FORB 29 plots CON	COV	MEADOW 256 plots CON	COV
lesser panicled sedge	CADI2	—	—	2	2	—	—	2	3
woolly sedge	CALA3	—	—	—	—	—	—	Tr	3
slender sedge	CALA4	—	—	13	3	—	—	7	28
lenticular sedge	CALE5	50	Tr	7	1	7	1	10	10
mud sedge	CALI	—	—	—	—	—	—	6	10
black alpine sedge	CANI2	—	—	—	—	24	4	24	30
beaked sedge	CARO2	—	—	3	2	—	—	2	45
russet sedge	CASA2	—	—	—	—	—	—	4	20
Holm's sedge	CASCB	—	—	—	—	7	2	17	26
saw-leaved sedge	CASCP2	—	—	2	Tr	10	2	18	24
showy sedge	CASP	—	—	—	—	14	5	9	27
bladder sedge	CAUT	—	—	48	6	—	—	43	33
inflated sedge	CAVE	—	—	11	10	—	—	9	34
wood reed-grass	CILA2	—	—	—	—	31	3	—	—
timber oatgrass	DAIN	—	—	—	—	—	—	8	10
tufted hairgrass	DECE	—	—	—	—	3	Tr	7	17
creeping spike-rush	ELPA	—	—	33	14	—	—	7	2
few-flowered spike-rush	ELPA2	—	—	—	—	—	—	13	26
blue wildrye	ELGL	100	2	—	—	—	—	2	2
Chamisso cotton-grass	ERCH2	—	—	—	—	—	—	2	10
many-spiked cotton-grass	ERPO2	—	—	—	—	—	—	18	14
green-keeled cotton-grass	ERVI	—	—	—	—	—	—	7	11
sheep fescue	FEOVR	—	—	—	—	—	—	1	29
tall mannagrass	GLEL	50	Tr	10	2	14	Tr	6	9
reed mannagrass	GLGR	—	—	2	50	—	—	2	9
western mannagrass	GLOC	—	—	2	35	—	—	1	1
fowl mannagrass	GLST	—	—	2	Tr	7	2	5	5
smooth woodrush	LUHI	—	—	—	—	21	Tr	10	2
reed canarygrass	PHAR	50	Tr	10	1	—	—	2	21
timothy	PHPR	—	—	—	—	—	—	5	4
Kentucky bluegrass	POPR	—	—	—	—	—	—	5	7
pale false mannagrass	PUPAM	50	Tr	10	19	—	—	4	2
small-fruited bulrush	SCMI	—	—	7	3	—	—	7	23
softstem bulrush	SCVA	—	—	8	32	—	—	1	4
Ferns and fern allies:									
alpine lady fern	ATDI	—	—	—	—	7	25	Tr	1
lady fern	ATFI	—	—	2	Tr	38	35	4	3
wood fern species	DRYOP	—	—	—	—	—	—	—	—
common horsetail	EQAR	50	1	2	Tr	17	7	18	2
water horsetail	EQFL	—	—	38	23	—	—	9	4
common scouring-rush	EQHY	50	1	—	—	—	—	4	2
marsh horsetail	EQPA	—	—	—	—	7	3	1	1
wood horsetail	EQSY								
oak fern	GYDR	—	—	2	Tr	31	33	Tr	3

[a] CON = percentage of plots in which the species occurred.
[b] COV = average canopy cover in plots in which the species occurred.
[c] Tr = trace cover, less than 1 percent canopy cover.

APPENDIX H: Aquatic, Riparian, and Wetland Field Form

General Location ____

____

Observer ______________________ Plot# __________ Date ____ /____ /____

Forest ________ District ________ Watershed __________ Northing __________ Easting __________

Elevation ___ feet Valley Aspect _____ degrees

Crown Cover Class	Valley Shape	Valley Gradient	Valley Width	Valley Side Slope
Trace = 1 or 2 plants	1000 = U-shaped	100 = <1%	10 = >300 m	1 = <30%
Scarce = <1%	2000 = V-shaped	200 = 1–3%	20 = 100–300 m	2 = 30–60%
Common = 1–5%	5000 = canyon	300 = 4–5%	30 = 30–100 m	3 = >60%
Well represented = 5–25%		400 = 6–8%	40 = 10–30 m	
Abundant = 25–50%		500 = >8%	50 = <10 m	
Dominant = 50–75%				
Pure = >75%				

Valley, stream, fluvial surface, and plant association cross-section sketch______________________________

Trees	% Cover OS	% Cover US		% Cover OS	% Cover US
(ABAM) Pacific silver fir	____	____	(POTR) Quaking aspen	____	____
(ABGR) Grand fir	____	____	(POTR2) Black cottonwood	____	____
(ABLA2) Subalpine fir	____	____	(PSME) Douglas-fir	____	____
(ACMA) Bigleaf maple	____	____	(QUGA) Oregon white oak	____	____
(ALRU) Red alder	____	____	(THPL) Western redcedar	____	____
(BEPA) Paper birch	____	____	(TSHE) Western hemlock	____	____
(LALY) Subalpine larch	____	____	(TSME) Mountain hemlock	____	____
(PICO) Lodgepole pine	____	____	Other trees ______________	____	____
(PIPO) Ponderosa pine	____	____	Other trees ______________	____	____
(PIEN) Engelmann spruce	____	____	Overhanging trees __________	____	____

Shrubs and Subshrubs	% Cover
(ACCI) Vine maple	_____
(ACGLD) Douglas maple	_____
(ALIN) Mountain alder	_____
(ALSI) Sitka alder	_____
(AMAL) Serviceberry	_____
(CAME) Merten's moss-heather+	_____
(COCA) Bunchberry dogwood	_____
(COCO2) California hazel	_____
(COST) Red-osier dogwood	_____
(CRDOD) Douglas hawthorn	_____
(LEGL) Labrador tea	_____
(LIBOL) Twinflower	_____
(PAMY) Myrtle pachistima	_____
(PHEM) Red mountain-heath+	_____
(POFR) Shrubby cinquefoil	_____
(PRVI) Chokecherry	_____
(MEFE) Rusty menziesia	_____
(OPHO) Devil's club	_____
(RHAL) Cascade azalea	_____
(RIBR) Stink current	_____
(RILA) Prickly currant	_____
(RIHU) Hudsonbay currant	_____
(RULA) Dwarf bramble	_____
(RUSP) Salmonberry	_____
(SACO2) Undergreen willow	_____
Willow species >5 feet tall	_____
Willow species <5 feet tall	_____
(SPDO) Douglas spiraea+	_____
(SYAL) Common snowberry	_____
(VAAL) Alaska huckleberry	_____
(VACA) Dwarf huckleberry	_____
(VADE) Cascade huckleberry	_____
(VASC) Grouse huckleberry	_____
(VAME) Big huckleberry	_____
(VAMY) Low huckleberry	_____
Other shrubs ______________________	_____
Other shrubs ______________________	_____
Other shrubs ______________________	_____

Grasses	% Cover
(CACA) Bluejoint reedgrass	_____
(DECE) Tufted hairgrass	_____
(FEOVR) Sheep fescue	_____
(GLBO) Northern mannagrass+	_____
(GLEL) Tall mannagrass+	_____
(DAIN) Timber oatgrass	_____
(POPR) Kentucky bluegrass	_____
(PHAR) Reed canarygrass	_____
Other grasses _____________________	_____
Other grasses _____________________	_____

Grasslike	% Cover
(CAAP3) Columbia sedge	_____
(CAAQ) Aquatic sedge+	_____
(CAAT) Awned sedge	_____
(CABU2) Buxbaum's sedge	_____
(CACU2) Cusick's sedge	_____
(CADI) Soft-leaved sedge	_____
(CAIL) Sheep sedge	_____
(CALA3) Woolly sedge	_____
(CALA4) Slender sedge	_____
(CALE5) Lenticular sedge	_____
(CALI) Mud sedge+	_____
(CANI2) Black alpine sedge	_____
(CARO2) Beaked sedge	_____
(CASA2) Russet sedge	_____
(CASCB) Holm's sedge	_____
(CASCP2) Saw-leaved sedge	_____
(CASP) Showy sedge	_____
(CAUT) Bladder sedge	_____
(CAVE) Inflated sedge	_____
(ELPA) Creeping spike-rush	_____
(ELPA2) Few-flowered spike-rush	_____
(ERPO2) Many-spiked cotton-grass+	_____
(LUHI) Smooth woodrush	
(SCMI) Small-fruited bulrush	_____
(SCVA) Softstem bulrush+	_____
Other grasslike _____________________	_____
Other grasslike _____________________	_____
Other grasslike _____________________	_____

Forbs, Ferns and Fern Allies	% Cover
(ACTR) Deerfoot vanillaleaf	_____
(ARLA) Mountain arnica	_____
(ARNU3) Wild sarsaparilla	_____
(ASCA3) Wild ginger	_____
(ATFI) Lady fern+	_____
(CABI) Twinflower marshmarigold+	_____
(CLUN) Queencup beadlily	_____
(EQUIS) Horsetail species	_____
(EQFL) Water horsetail	_____
(EQHY) Common scouring-rush	_____
(GYDR) Oak fern	_____
(LULA) Broadleaf lupine+	_____
(LYAM) Skunk-cabbage	_____
(MILE) Lewis' monkey-flower	_____
(NUPO) Indian water-lily+	_____
(POAM2) Water ladysthumb	_____
(POPU) Skunkleaf polemonium	_____
(POTAM) Pondweed species	_____
(SAPU) Dotted saxifrage+	_____
(SPARG) Bur-reed species	_____
(SETR) Arrowleaf groundsel	_____
(STAMC) Claspleaf twisted-stalk	_____
(STRO) Rosy twisted-stalk	_____
(TITRU) Coolwort foamflower	_____
(TRCA3) False bugbane	_____
(TRLA4) Globeflower	_____
(TYLA) Common cattail	_____
Other forbs _______________________	_____
Other forbs _______________________	_____
Other forbs _______________________	_____

Duff and Litter	_____
Fresh Alluvial Deposition	_____

Plant Association ___________________________

Community Type ___________________________

Condition Class
5 = existing vegetation similar to association guide
4 = intermediate between 5 and 3
3 = cover of native dominants codominant with increasers
2 = intermediate between 3 and 1
1 = community dominated by nonnative spp. or increasers

\+ indicates similar species can also be indicators of a plant association. See series chapter information for details.

GLOSSARY

abandoned (meander) channel—A former stream or river channel that has been cut off from the rest of the stream or river and often lacks year-long standing water.

abundant—When relating to plant coverage in the association key, any species having a canopy coverage of 25 percent or more in a stand.

accidental (incidental)—A species that is found rarely or occasionally as scattered individuals in an association (often as a random or chance occurrence).

aerobic—Conditions in which molecular oxygen is present in the soil environment.

alkaline—Water or soil with a pH greater than 7.4.

alluvial soil—Sediments (clay, silt, sand, gravel, cobbles, and boulders) deposited by running water, ordinarily occurring on floodplains but also on terraces during larger flood events.

alluvial terrace—Deposits of alluvial soil that mark former floodplains. Typically, a floodplain may have several sets of terraces at different elevations and of different ages (the higher the elevation, the older the age).

alluvium—An accumulation of sediments deposited by streams and rivers.

alpine—Elevation ranges found above the upper limits of (erect) tree growth.

anaerobic—A condition in which molecular oxygen is absent from the soil environment. This commonly occurs in wetlands, especially bogs, where soils experience prolonged saturation by water.

Andisols—Thick mineral soils developed in volcanic ash, cinders, other volcanic ejecta, or volcaniclastic materials.

aquatic ecosystem—The stream channel or lake bed, the water, and the vegetative communities associated with them, forming an interacting system.

association—See plant association.

available water holding capacity—The capacity of a soil to hold water in a form available to plants, expressed in inches of water per inch of soil depth. Commonly defined as the amount of water held between field capacity and wilting point. The classes are (1) Low = 0 to 0.12; (2) Moderate = 0.13 to 0.17; and (3) High >0.17

backwater areas—Seasonal or permanent water bodies found in the lowest parts of floodplains.

bank—The sloping land bordering a channel. The bank has a steeper slope than the bottom of the channel and is usually steeper than the land surrounding the channel.

bars (alluvial)—An elongated landform formed by waves and currents, usually running parallel to the shore and composed predominantly of unconsolidated sand, gravel, stones, cobbles, or stone. Examples include:

> ***point bars***—Bars that are formed on the inside of meander channels.
>
> ***side bars***—Bars that are formed along the edges of relatively straight sections of rivers
>
> ***midchannel bars***—Bars found within the channel that become more noticeable during low flow periods.
>
> ***delta bars***—Bars formed immediately downstream of the main confluences of a tributary and the main channel.

basal area—The area of the cross section of a tree trunk 4.5 feet above the ground, usually expressed as the sum of tree basal areas in square feet per acre.

basin—A depression or hollow in the land. It is surrounded by higher ground.

beaver dams—Dams built by beavers that span the stream channel. In general, water is still flowing through the riparian wetland system.

bog—A soil and vegetation complex in which the lower parts are dead peat, gradually changing upwards to living plant tissues. This soil is usually saturated, relatively acidic, and dominated at ground level by mosses. Bogs may be either forested or open. They are distinguished from swamps and fens by the dominance of mosses and the presence of peat deposits. Bogs are usually a sphagnum moss-dominated community whose only water source is rainwater. Bogs are extremely low in nutrients, form acidic peat soil, and are a northern phenomenon generally associated with low temperatures, anaerobic conditions, and short growing seasons. Similar conditions dominated by other mosses or with water sources from cold, anaerobic, nutrient-poor seep water are common in eastern Washington.

browse—Shrubby or woody forage consumed by wildlife.

canopy cover—The ground area covered by the generalized outline of an individual plant's foliage, or collectively covered by all individuals of a species within a stand or sample area. Canopy coverage is expressed as a percentage of the total area of the plot.

(average) canopy cover—Refers to the "average" canopy cover of a particular species for the stands in which it was recorded. For example, the number of stands sampled for a particular plant association may be 20. However, a particular species may occur in only 7 of the 20 stands. The average canopy cover therefore represents the "average" canopy cover of that species in the seven stands.

canyon—A long, deep, narrow, very steep-sided valley with high and precipitous walls and high local relief.

capillary fringe—A zone immediately above the water table in which water is drawn upward from the water table by capillary action.

carr—Shrub-dominated wetlands on organic soil. It is also referred to as a shrub carr. Carrs in eastern Washington are typically dominated by willows and mountain alder. Other communities are dominated by species such as red-osier dogwood or Douglas spiraea. Peat or other mosses are sometimes present.

caudex—A short, more or less vertical, often woody, persistent stem at or just beneath the ground surface.

channel—An open conduit either naturally or artificially created that periodically or continuously contains moving water, or that forms a connecting link between two bodies of standing water.

classification—The orderly arrangement of objects according to their differences and similarities.

clay—Soil with rock fragments less than 0.002 mm in diameter.

climax—Climax is usually defined as the plant community that will come to occupy a site under existing climate, soils, and topography conditions. It is the "stable state" where change in the vegetation is minimal over time and competition is so great from dominant species that "invaders" are excluded and "increasers" are held to low levels.

climax species—A species that is self-regenerating in the absence of disturbance, with no evidence of replacement by other species.

cobbles—Soils with rock fragments 3 to 10 inches in diameter.

colluvial—Pertaining to material transported and deposited by gravitational action and local unconcentrated runoff at the base of steep slopes.

colluvium—Unconsolidated earth material deposited on and at the base of steep slopes by gravitational action and local unconcentrated runoff on and at the base of steep slopes.

common—When relating to plant coverage, any species having a canopy coverage of 1 percent or more in a stand.

community (plant community)—An assemblage of plants occurring together at any point in time, thus denoting no particular ecological status.

community type—An aggregation of all plant communities distinguished by floristic and structural similarities in both overstory and undergrowth layers. In this classification, it is used to name naturalized riparian communities such as reed canarygrass or seral communities such as small-fruited bulrush.

constancy—The percentage of sampled stands in which a species occurs.

crown—The leafy top of a shrub or tree.

depauperate—Describing an unusually sparse coverage of undergrowth vegetation. This condition usually develops beneath an especially dense forest canopy, often on sites having a deep layer of duff.

disturbed—Directly or indirectly altered, by humans, from a natural condition, yet retaining some natural characteristics.

diversity—The number and amount of species in a community per unit area.

dominant—The species controlling the environment.

drained—A condition in which ground or surface water has been removed by artificial means.

ecological status—The degree of departure of the current vegetation from climax. The cause of departure is not considered; therefore, ecological status may include, but is not limited to, the concept of range condition. The only consideration is the difference in species density and composition between existing and climax vegetation. Three classes are used: Climax/Late Seral, Mid Seral, and Early Seral.

ecosystem—A complete interacting system of organisms and their environment.

ecotone—The boundary between adjacent plant communities.

edaphic—The climactic status owing to soil or topography rather than climate.

emergent plant—A rooted herbaceous plant species that has parts extending above a water surface.

emergent wetland (Cowardin et al. 1979)—A class of wetland habitats characterized by erect, rooted, herbaceous hydrophytes, excluding mosses and lichens.

Entisol—Soils that have little or no evidence of horizon development, usually as a result of recent flood deposition. Entisols encountered during this study belong to the Cryofluvent subgroup.

ephemeral stream—A stream or stretch of stream that flows only in response to precipitation. It receives no water from springs and no long-continued supply from melting snow or other surface source. Its stream channel is at all times above the water table. These streams do not normally flow for more than 30 days.

epipedon—Diagnostic soil surfaces formed at the soil surface.

erosion—The wearing of land surfaces by running water, waves, moving ice and wind, or by such processes as mass wasting and corrosion.

facultative plants (FAC)—A plant species that is equally likely to occur in wetlands or nonwetlands (estimated probability 1 to 33 percent).

facultative upland plants (FACU)—A plant species that usually occurs in nonwetlands (estimated probability 67 to 99 percent), but is occasionally found in wetlands (estimated probability 1 to 33 percent).

facultative wetland plants (FACW)—A plant species that usually occurs in wetlands (estimated probability 67 to 99 percent), but is occasionally found in nonwetlands (estimated probability 1 to 33 percent).

fen—A peatland dominated by graminoids, sometimes with sparse scattered shrubs or trees. The water table is at the surface most of the year. There may be a flow of groundwater upward through the peat. The soils are usually circumneutral and mineral- and oxygen-rich and intergrade with bog and marsh.

flooded—A condition in which the soil surface is temporarily covered with flowing water from any source, such as streams overflowing their banks and runoff from adjacent surrounding slopes.

floodplain—The nearly level alluvial plain that borders a stream. It is usually a constructional landform built of recent sediment deposited during overflow and lateral migration of the stream. In this classification it refers to the alluvial plain immediately adjacent to the stream influenced by 1- to 3-year flooding.

flood storage—The process by which peak flows (from precipitation, runoff, groundwater discharge, etc.) enter a wetland and are delayed in their downslope journey.

fluvial—Pertaining to or produced by the action of a stream or river.

fluvial surfaces—The various land surfaces associated with the riparian zone such as point bars, floodplains, streambanks, terraces, and overflow channels.

foothills—Steeply sloping uplands (with hill relief up to 1,000 feet) that fringe a mountain range or high plateau escarpment.

forage condition—An ecological concept used to interpret livestock grazing impacts on vegetation. It describes the departure from potential under existing environmental conditions and assumes a causal relationship between the vegetation and domestic ungulate grazing.

forage (herbage) production—The aboveground biomass (air-dried pounds per acre) of all grasses, sedges, and forbs; no allowance is made for proper use factors.

foraging/feeding—The gathering or consumption of food for nutrition.

forb—Any herbaceous plant, usually broad-leaved, that is not a grass or grass-like plant.

forested wetland (Cowardin et al. 1979)—A class of wetland habitat characterized by woody vegetation that is 6 m (20 ft) tall or taller.

frequently flooded—A class of flood frequency in which flooding is common in most years (more than a 50 percent chance of flooding in any year, or more than 50 times in 100 years).

freshwater impounded wetland—A palustrine or lacustrine wetland formed in a topographic depression or by the natural or artificial damming of a river, stream, or other channel.

gallery forest—A strip of forest confined to a stream margin or floodplain in an otherwise unforested landscape.

geomorphic surface—A mappable part of the land surface that is defined in terms of morphology origin, age, and stability of component landforms.

geomorphology—The science that treats the general configuration of the earth's surface; specifically the study of the classification, description, nature, origin, and development of landforms and their relationships to underlying structures, and of the history of geologic changes as recorded by these surface features.

glacial outwash—Stratified sand and gravel carried, sorted, and deposited by water that originated mainly from the melting of glacial ice.

glacial till—Unsorted, unstratified glacial drift, generally unconsolidated, deposited directly by a glacier without subsequent reworking by water from the glacier.

gleyed soils—Soils having an intense reduction of iron during soil development, or reducing conditions owing to stagnant water, as indicated by base colors that approach neutral (bluish, grayish, or greenish), with or without mottles. In the more extreme condition, ferrous iron is present.

graminoid—Refers to grass or grasslike plants such as grasses, sedges, and rushes.

gravel—A soil mixture composed primarily of rock fragments 0.08 inch to 3 inches in diameter. Usually contains much sand.

groundwater—Water occupying the interconnected pore spaces in the soil or geologic material below the water table; this water has a positive pressure.

growing season—The portion of the year when soil temperatures are above biological zero (41 degrees Fahrenheit) as defined by standard soil taxonomy.

habitat type—All the land capable of producing similar plant communities at climax. USDA FS Region 6 loosely uses plant association to name climax plant communities, making it synonymous to a habitat type.

herbaceous—Nonwoody vegetation such as grasses and forbs.

herbage production—See forage production.

high-lining—The process by which crowns of trees and tall shrubs are shaped by browsing animals; it results in the removal of lower branches to a line as high as the browsing animals can reach.

Histosols—A soil order composed of organic soils (peats and mucks) with generally greater than 50 percent organic matter in the upper 80 cm (32 inches) or that are of any thickness if overlaying rock. This classification violates the 80-cm rule, as some organic soils in eastern Washington have not developed sufficient thickness to meet the rule in the postglacial period, yet all the soil within the plant rooting zone is organic. Suborders are distinguished by the degree of decomposition of organic material and the presence of moss fibers:

> ***fibric***—Plant remains are so little decomposed that at least three-fourths (by volume) are not destroyed by rubbing and their botanical origin can be determined.
>
> ***hemic***—Organic materials are intermediate in decomposition between fibric and sapric. About half of the organic fibers are destroyed by rubbing the soil between the fingers.
>
> ***sapric***—Consists of highly decomposed plant remains. At least five-sixths of the fibers rub smooth. The botanic origin cannot be determined. Soils are usually black and consist of the residue that remains after aerobic decomposition on sites with widely fluctuating water tables.
>
> ***limnic***—Consists of thick layers of sedimentary organic material on the bottoms of lakes or ponds. The fibers rub smooth. Usually olive to olive brown color. Formed under totally anaerobic decomposition.

hydric soil (USDA SCS 1990)—A soil that is saturated, flooded, or ponded long enough during the growing season to develop anaerobic conditions in the upper part of the soil profile. Hydric soil indicators are Histisol, histic epipedon, sulfuric odor, aquic moisture regime, reducing conditions, gleyed or low-chroma colors, concretions, high organic content, and listing on local Hydric Soils List (Environmental Laboratory 1987).

hydrophyte—Any macrophytic plant that grows in water or on a substrate that is at least potentially deficient in oxygen as a result of excessive water content; plants typically found in wetland or aquatic habitat.

impounded—Bodies of water formed in a topographic depression or by the natural or artificial damming of a river, stream, or other channel.

Inceptisol—Soils that lack the mollic epipedon and have high available water throughout the growing season. Textures are finer than loamy sand, and the altered horizons have lost bases but retain some weatherable minerals. Surface horizons are gray to black and are high in carbon.

indicator plant—A plant whose presence or abundance indicates certain environmental conditions and the presence of a habitat type, association, or community type.

intermittent stream—A stream, or reach of a stream, that flows for protracted periods only when it receives groundwater discharge or continued contributions from melting snow or other surface and shallow subsurface sources.

inundation—A condition in which water temporarily or permanently covers a land surface.

krummholz—Trees that are dwarfed and twisted because of severe climate (wind, low temperature, etc.) at the high-elevation limits of forest development.

lacustrine—Permanently flooded lakes and reservoirs, whose total area exceeds 20 acres or whose maximum depth exceeds 6.6 feet at low water.

landform—Any element of the landscape characterized by a distinctive surface expression, internal structure, or both, and sufficiently conspicuous to be included in a physiographic description.

long-duration flooding—A duration class in which inundation for a single event ranges from 7 days to 1 month.

low elevation—Elevation ranges generally occurring between sea level and the midmontane zone. NOTE: The upper limit of this region varies with microclimatic conditions and may extend above the base of adjacent foothills.

major type—Refers to a plant association or community type that occupies an extensive area within a wetland zone. Also, any plant association that has at least five plots in the classification database.

marsh—Wetlands where the vegetation is dominated by graminoids, with the water table at or above the surface most of the year and with little or no accumulation of peat.

meander—A meander is one of a series of sinuous loops, with sine-wave form, in the course of a stream channel. Highly meandering stream channels commonly have cross sections with low width-to-depth ratios, fine-grained bank materials, and low gradient.

mineral soil—Soils composed of predominantly mineral materials (sands, silts, clays) instead of organic materials. The soil contains less than 20 percent organic matter.

minor type—Refers to a plant association or community type that occupies little area within a wetland zone. Also, any plant association that has fewer than five plots in the classification database.

moderate elevation (midmontane)—Elevation zones identified by vegetation that does not extend below the upper elevation of adjacent foothills or into the subalpine. The boundary between the midmontane and subalpine zones varies considerably from one geographical region to another and with microclimatic conditions.

mollic epipedon—Abstraction of soil properties common to the soils of the steppes of North America, Europe, and Asia based on the horizons at or near the surface rather than the deeper ones.

Mollisol—A soil having a dark brown to black surface horizon (mollic epipedon) that is relatively thick, has a high base saturation, and usually well-developed structure. The mollic epipedon is the result of underground decomposition of organic residues in the presence of a bivalent cation such as calcium.

monotypic stands—Stands composed primarily of a single species.

moraine—A rounded ridge, hill, or mound of rubble left behind by a retreating glacier.

mottling—Variation of coloration in soils as represented by localized spots, patches, or blotches of contrasting color. Commonly develops under alternating wet and dry periods with associated reduction and oxidation environments. Mottling generally indicates poor aeration and impeded drainage.

natural—Dominated by native biota and occurring within a physical system that has developed through natural processes without human intervention.

obligate wetland plants—Refers to a plant species that occurs almost always (estimated probability greater than 99 percent) under natural conditions in wetlands.

organic loam—A generalized name for soils having more than 12 percent organic particles in addition to clay, silt, and sand.

organic soil—Soils composed of primarily organic rather than mineral material. Equivalent to Histisol.

overbank flooding—Any situation in which inundation occurs as a result of the water level of a river or stream rising above bank level.

oxbow lake—A meander channel of a stream or river that is formed by breaching a meander loop during flood stage. The ends of the cut-off meander are blocked by bank sediments.

palustrine—Tidal and nontidal wetlands dominated by trees, shrubs, persistent emergent herbs, and emergent mosses or lichens where salinity from ocean-derived salts is below 0.5 parts per thousand (ppt). Also included are wetlands without such vegetation, but with all of the following characteristics: area less than 20 acres; lacking active wave-formed or bedrock shoreline features; maximum water depth less than 6.6 feet at low water; ocean-derived salinity less than 0.5 ppt.

parent material—The unconsolidated and undeveloped mineral or organic matter from which the soil is developed.

peat—Unconsolidated soil material consisting largely of underdecomposed or only slightly decomposed organic matter accumulated under conditions of excessive soil moisture.

moss peat—Peat soil composed of partially decomposed sphagnum or other mosses.

***sedge peat*—**Peat soil composed of partially decomposed graminoids, especially sedges.

woody peat—Peat soil composed of partially decomposed wood.

perched water table—Zone of saturated soil that lies above a zone of saturated soil within 80 inches of the soil surface. Also called episaturation.

perennial stream—A stream that runs above ground throughout its length and throughout the year.

permanently flooded—Water covers the land surface throughout the year in all years (may be absent during extreme drought periods).

pioneer plants—Herbaceous annual and seedling perennial plants that colonize bare areas such as gravel bars as a first stage in secondary succession.

plant association—Normal usage is a climax community type (Pfister et al. 1977). In this classification, however, it refers to an assemblage of native riparian and wetland vegetation occurring together in equilibrium with the environment for a given fluvial surface (i.e., the potential natural vegetation on a fluvial surface).

plant community—See community.

pond—Small bodies of water encircled by wetland vegetation. Wave action is minimal, allowing emergent vegetation to establish. Usually less than 3 acres in area.

ponded—A condition in which free water covers the soil surface. For example, a closed depression. The water is removed only by percolation, evaporation, or transpiration.

poorly drained—Water is removed so slowly that the soil is saturated periodically during the growing season or remains wet for long periods (longer than 7 days).

poor fen—A peatland that is intermediate in nutrient status and vegetation composition between a fen and a bog. An example is the *Carex lasiocarpa* (CALA4) plant association.

poorly represented—When relating to plant coverage in the association descriptions, any species that has a canopy coverage less than 5 percent.

pothole—A depressional wetland caused by glaciation. The body of water is less than 20 acres in size.

redox concentrations—A redoximorphic feature characterized by zones in the soil of accumulation of iron and manganese oxides. These may form nodules, concretions, soft bodies, or pore linings and vary in shape, size, and color.

redox depletions—A redoximorphic feature characterized by zones in the soil of low chroma (less than 3) where iron and manganese oxides alone have been removed, or where both iron/manganese oxides and clay have been removed.

reservoir—An artificial (dammed) water body with at least 20 acres covered by surface water.

restored—Artificially returned from a disturbed or totally altered condition, to a state that mimics the original, natural condition.

riparian—Of, on, or relating to the banks of a natural course of water. That land, next to running water, where plants dependent on a perpetual source of water occur.

riparian species—Plant species occurring within the riparian zone.

riparian wetland—An out-of-channel, palustrine wetland associated with the flowing water of a riparian system.

riparian or wetland ecosystem—The ecosystem located between aquatic and terrestrial environments. This classification treats this concept rather broadly or loosely by including transitional (also known as xeroriparian) ecosystems lying between riparian and terrestrial ecosystems. Thus, in the broad sense, these ecosystems are identified by the presence of vegetation that requires or tolerates free or unbound water or conditions that are more moist than normal (Franklin and Dyrness 1973).

riparian zone (ecosystem)—The interface between aquatic and terrestrial ecosystems that is defined by the presence of vegetation that requires or tolerates free or unbound water or conditions that are more moist than normal (Franklin and Dyrness 1973). The term is treated rather broadly in this classification and includes transitional (xeroriparian) ecosystems.

riverine system (Cowardin et al. 1979)—Any wetland and deepwater habitat contained within a channel, with the exception of wetlands dominated by trees, shrubs, persistent emergents, and emergent mosses or lichens.

root crown—The persistent base of a plant.

saline—Soil or water containing sufficient soluble salts to interfere with the growth of plants.

sand—Composed predominantly of coarse-grained mineral sediments with diameters larger than 0.003 inches and smaller than 0.08 inches in diameter.

saturated—A soil condition in which all voids (pore spaces) between soil particles are filled with water.

scarce—When relating to plant coverage in the association descriptions, any species that is very scattered, represented by a few individuals, or has canopy coverage of less than 1 percent.

seasonally flooded—Surface water is present for extended periods especially early in the growing season, but is absent by the end of the season in most years. When surface water is absent, the water table is often near the land surface (see also: semipermanently flooded.)

sediment—Solid material, both mineral and organic, that is in suspension, is being transported or has been moved from its site of origin by water, and has come to rest on the earth's surface.

sediment trapping—The process by which particulate matter is deposited and retained (by any mechanism or process) within a wetland.

seep—Groundwater discharge areas where the water table comes close to the soil surface. In general, seeps have less flow than a spring and may not result in water forming an unconfined flow.

semipermanently flooded—Surface water persists throughout the growing season in most years. When surface water is absent, the water table is usually at or very near the land surface.

seral—Refers to species or communities that have not theoretically attained a steady state with the environment, where current populations of some species are being replaced by other species.

series—Refers to a group of plant associations having the same climax species characterizing the dominant plant cover. Thus the willow series is characterized by all plant associations dominated by species of willows, and the Pacific silver fir series is composed of all plant associations potentially dominated by Pacific silver fir at climax.

shore (streambank)—Land on or near an ocean, lake, river, or stream between the ordinary high-water mark and low-water mark.

shoreline (streambank) anchoring—The stabilization of soil at the water's edge, or in shallow water, by fibrous plant roots—may include long-term buildup of riparian soil.

shrub—A woody plant that at maturity is usually less than 20 feet (6 meters) tall and generally exhibits several erect, spreading, or prostrate stems and has a bushy appearance; e.g., mountain alder (*Alnus incana*) or Geyer willow (*Salix geyeriana*). This term is used somewhat loosely in this classification as some shrubs, such as mountain alder, variably meet the definition of shrub or tree depending on site. Therefore, some users may interpret some plants indicated as "shrubs" in this classification as trees.

silt—Rock fragments between 0.0008 inches and 0.00008 inches in diameter; as a textural class, a mixture of 20 to 50 percent sand, 30 to 80 percent silt, and 10 to 30 percent clay-sized particles.

site index—An index of timberland productivity based on the height of specific trees at 50 or 100 years (formulas for specific tree species are given in references).

sphagnum bog—A palustrine-impounded wetland with a mineral-poor substrate composed primarily of *Sphagnum* spp., and which is acidic (pH 5.5 or lower).

spring—A groundwater discharge area that has more flow than seeps and often produces a channel or pool below the source.

stable—The condition of little or no perceived change in plant communities that are in relative equilibrium with existing environmental conditions; describes persistent but not necessarily culminating stages (climax) in plant succession.

stand—An existing plant community that is relatively uniform in composition, structural, and site conditions; thus it may serve as a local example of a community type or association.

stockpond—An artificial (dammed) body of water of less than 20 acres covered by surface water.

stone—Rock fragments larger than 10 inches but less than 24 inches.

stream—A natural waterway that is defined as first to third order.

streambank—That portion of the channel cross section that controls the lateral movement of water.

stream order—A classification of streams according to the number of the tributaries. Order 1 streams have no tributaries; a stream of any higher order has two or more tributaries of the next lower order.

subalpine—The elevation region, identifiable by characteristic vegetation, between the midmontane and alpine zones. The boundaries between these zones differ considerably from one geographical region to another and with microclimatic conditions.

succession—The progressive changes in plant communities toward a steady state. Primary succession begins on a bare surface not previously occupied by plants, such as a recently deposited gravel bar. Secondary succession occurs following disturbances on sites that previously supported vegetation.

swale—A depression or topographic low area.

sward (turf)—An expanse of grass or grasslike plants (fens, bogs, meadows).

swamp—Vegetation dominated by trees, with the water table at or above the surface most of the year and with little or no accumulation of peat. Often intergrades with bog, fen, or carr.

taproot—The primary root continuing the axis of the plant downward. Such roots can be thick or thin.

terrace—A steplike surface, bordering a valley floor or shoreline that represents the former position of an alluvial plain or lake. In this classification it refers to the often multiple terraces beyond the 1- to 3-year floodplain (see alluvial terrace).

timber production—The indexing of a forest stand to produce wood fiber in cubic feet per acre per year.

toeslope—The geomorphic component that forms the outermost gently inclined surface at the base of a hill slope.

topography—The relative positions and elevations of the natural or humanmade features of an area that describe the configuration of its surface.

transition zone (ecosystem)—The interface between the riparian or wetland and adjacent terrestrial ecosystems that is identified by conditions that are more moist than normal. Soils are briefly saturated only in the spring, if at all, although soil moisture relationships are excellent due to the proximity to riparian or wetland sites. Also referred to as xeroriparian.

tree—A woody plant that at maturity is usually 20 feet or more in height and generally has a single trunk unbranched to about 3 feet above the ground, and a more or less definite crown.

upland—Land at a higher elevation, in general, than the alluvial plain or low stream terrace.

valley—An elongate, relatively large, externally drained depression of the earth's surface that is primarily developed by stream erosion.

very long duration flooding—A duration class in which inundation for a single event is greater than 1 month.

very poorly drained—Water is removed so slowly that free water remains at or near the soil surface during most of the growing season.

volcanic—Pertaining to the structures, rocks, and landforms produced by volcanic action.

water path—Used in the description of bogs such as the few-flowered spike-rush (ELPA2) association to describe shallow, wide depressions in which water collects and flows during periods of high water, but which are not streambeds.

water regime (nontidal)—Includes the following types (Cowardin et al. 1979):

permanently flooded—Water covers the land surface throughout the year in all years. Vegetation is composed of hydrophytes.

intermittently exposed—Surface water is present throughout the year except in years of extreme drought.

semipermanently flooded—Surface water persists throughout the growing season in most years. When surface water is absent, the water table is usually at or very near the soil surface.

seasonally flooded—Surface water is present for extended periods especially early in the growing season, but is absent by the end of the growing season in most years. When surface water is absent, the water table is usually at or very near the soil surface.

saturated—The substrate is saturated to the surface for extended periods during the growing season, but surface water is seldom present.

temporarily flooded—Surface water is present for brief periods during the growing season, but the water table usually lies well below the soil surface for most of the season.

intermittently flooded—The substrate is usually exposed, but the surface water is present for variable periods without the detectable seasonal periodicity. Weeks, months, even years may intervene between periods of inundation. Plant communities may change as soil moisture changes.

water table—The depth below which the ground is saturated with water. The depth to standing water.

weathering—All physical and chemical changes produced in rocks or other deposits at or near the earth's surface by atmospheric agents with essentially no transport of the altered material. These changes result in disintegration and decomposition of the material.

well represented—When relating to plant coverage, any species having a canopy coverage of greater than 5 percent.

wetland—An area having one or more of the following three attributes: (1) at least periodically the substrate is dominated by facultative or obligate hydrophytes, (2) the substrate is predominantly hydric soil, (3) the substrate is nonsoil and is either saturated with or covered by shallow water at some time during the growing season.

wet meadow—A herbaceous wetland on mineral soil. Generally, wet meadows occur in seasonally flooded basins and flats, and are especially prominent on the margins (transition zone) of wetlands with organic soil. Soils are dry for part of the growing season.

wetland/riparian species—Plant species occurring within the wetland/riparian zone. Obligate species require the environmental conditions within the wetland zone. Facultive species tolerate the environmental conditions but may also occur away from the wetland zone.

wetland status—Refers to plant species that have exhibited an ability to develop to maturity and reproduce in an environment where all or portions of the soil within the root zone become, periodically or continually, saturated or inundated during the growing season. The ability to grow and reproduce in wetlands is due to morphological or physiological adaptations or reproductive strategies of the plant. These adaptations lead to the development of wetland communities that can be categorized as follows:

OBL (obligate wetland)—Plant species that occur almost always (estimated probability greater than 99 percent) under natural conditions in wetlands.

FACW (facultative wetland)—See p. 348.

FAC (facultative)—See p. 348.

valley gradient—The lengthwise slope of the valley floor expressed as a percentage. The following classes are used in this classification:

Very low	<1 percent
Low	1 to 3 percent
Moderate	4 to 5 percent
Steep	6 to 8 percent
Very steep	>8 percent

valley width—The width of the valley floor in feet (meters). The following classes are used in this classification:

Very broad	>984 feet (300 m)
Broad	328 to 984 feet (100.1 to 300 m)
Moderate	99 to 327 feet (30.1 to 100 m)
Narrow	33 to 98 feet (10 to 30 m)
Very narrow	33 feet (<10 m)

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