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QUAKING ASPEN SERIES

Populus tremuloides

POTR N = 33

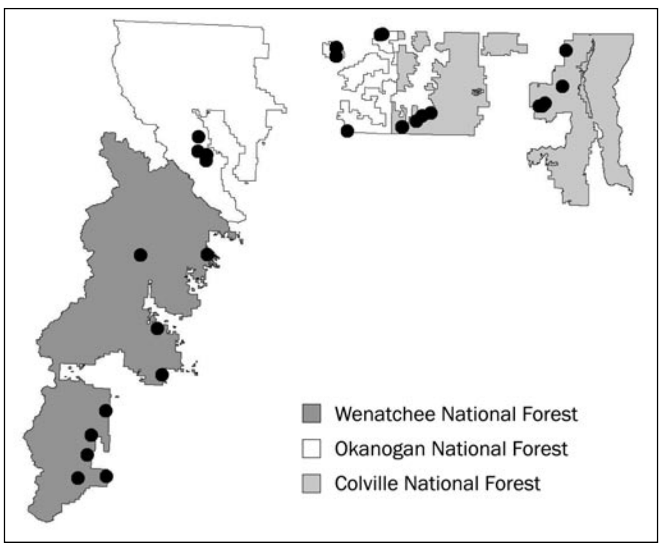


Figure 17—Plot locations for the quaking aspen series.

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.

	Elevation (feet)			
Forest	Minimum	Maximum	Average	N
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.

	Elevation (feet)			
Plant association	Minimum	Maximum	Average	N
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 gradient					
Valley width	Very low	Low	Moderate	Steep	Very steep	N
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

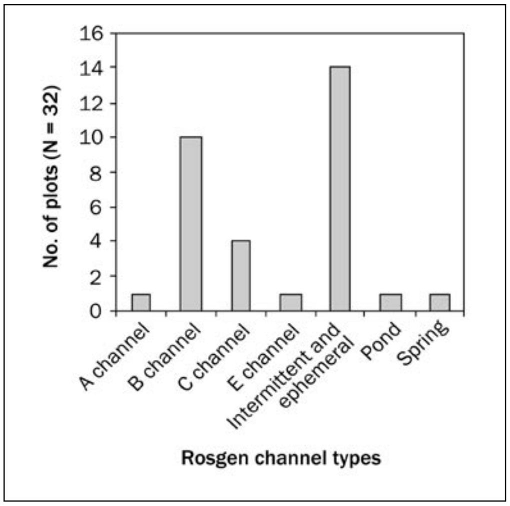
The differences between these two landform clusters justify examining individual associations in more detail. The wet POTR/CALA3 association favors broader valleys and flat, wet sites. The POTR/COST association generally favors moderately wide valleys and low valley gradients. The POTR/SYAL association, 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.

	Valley width					
Plant association	Very broad	Broad	Moderate	Narrow	Very narrow	N
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

	Valley gradient					
Plant association	Very low	Low	Moderate	Steep	Very steep	N
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 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.

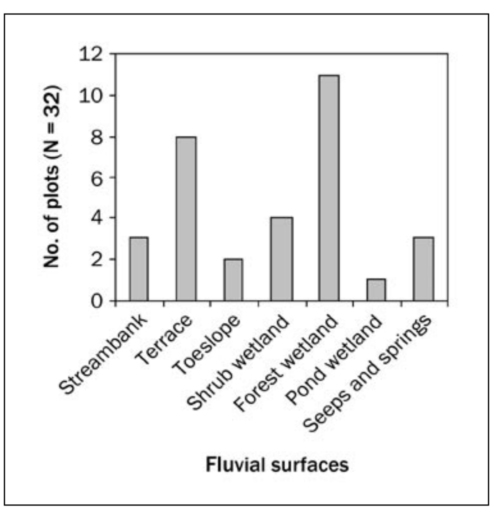
	Fluvial surfaces							
Plant association	Stream- bank	Terrace	Toe- slope	Shrub wetland	Forest wetland	Pond wetland	Seeps/ springs	N
POTR/CALA3	0	0	0	1	2	0	0	3
POTR/COST	1	3	1	2	6	0	1	14
POTR/SYAL	2	5	1	1	3	1	2	15
Series total	3	8	2	4	11	1	3	32

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.

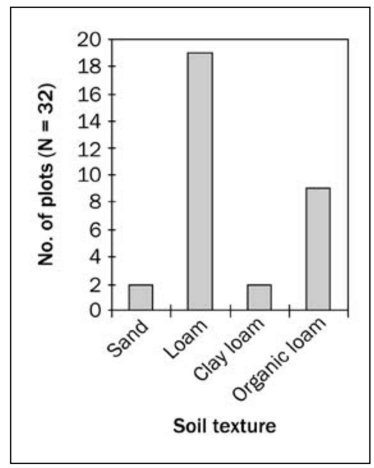
	Rosgen channel types							
Plant association	A	B	C	E	Intermittent and ephemeral	Pond	Spring	N
POTR/CALA3	0	0	0	0	3	0	0	3
POTR/COST	0	4	2	0	8	0	0	14
POTR/SYAL	1	6	2	1	3	1	1	15
Series total	1	10	4	1	14	1	1	32

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.



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 CON[a]	COV[b]	POTR/COST 14 plots CON	COV	POTR/SYAL 16 plots 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)

		POTR/CALA3 3 plots		POTR/COST 14 plots		POTR/SYAL 16 plots	
Species	**Code**	**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

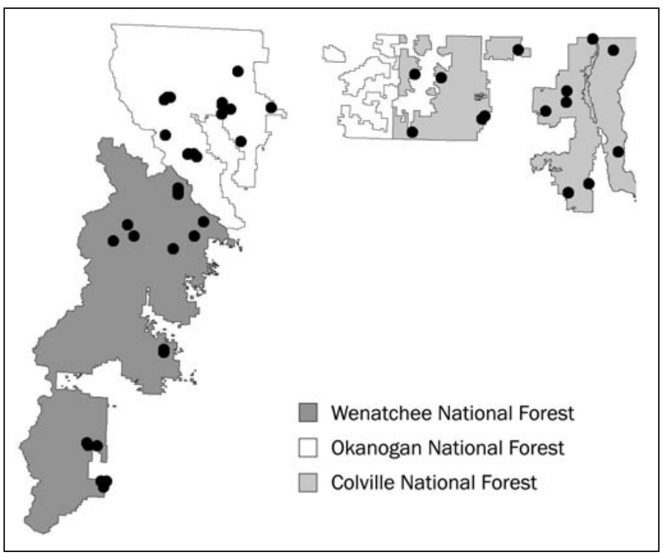


Figure 18—Plot locations for the black cottonwood series.

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

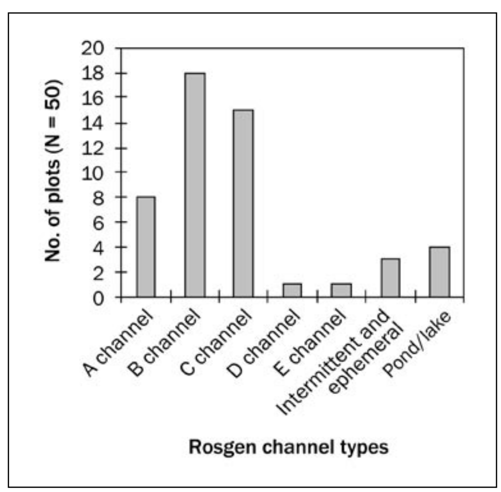
Plant association	Valley width Very broad	Broad	Moderate	Narrow	Very narrow	N
POTR2/ALIN	0	5	8	0	0	13
POTR2/ALIN-COST	1	2	2	2	0	7
POTR2/ALLUVIAL BAR	0	0	2	2	0	4
POTR2/COST	5	3	7	2	0	17
POTR2/OPHO	0	0	0	0	2	2
POTR/SYAL	2	2	2	1	0	7
Series total	8	12	21	7	2	50

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.

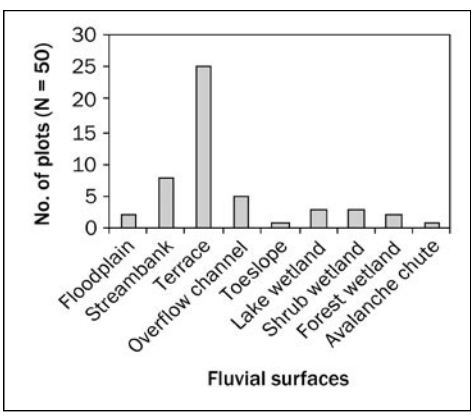


Additional insight is gained by looking at individual associations. All six associations are variably located along Rosgen A, B, and C channels in riparian zones. The POTR2/ALIN-COST and POTR2 ALLUVIAL BAR are the most frequent associations along A channels. In addition, POTR2/ALIN and POTR2/COST are 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.

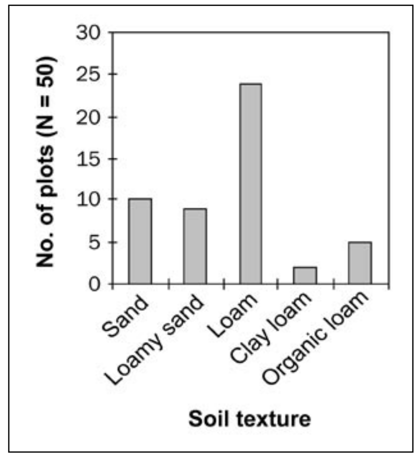


Additional insight is gained by looking at the distribution of POTR2 associations by fluvial surface. All plots in the POTR2/ALLUVIAL BAR, POTR2/COST, POTR2/SYAL, and POTR2/OPHO associations are located in riparian zones. The POTR2/ALIN and POTR2/COST associations are mostly riparian but also include 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.

Plant association	Water table (inches)			N
	Minimum	Maximum	Average	
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.

Plant association	Soil temperature (°F)			N
	Minimum	Maximum	Average	
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

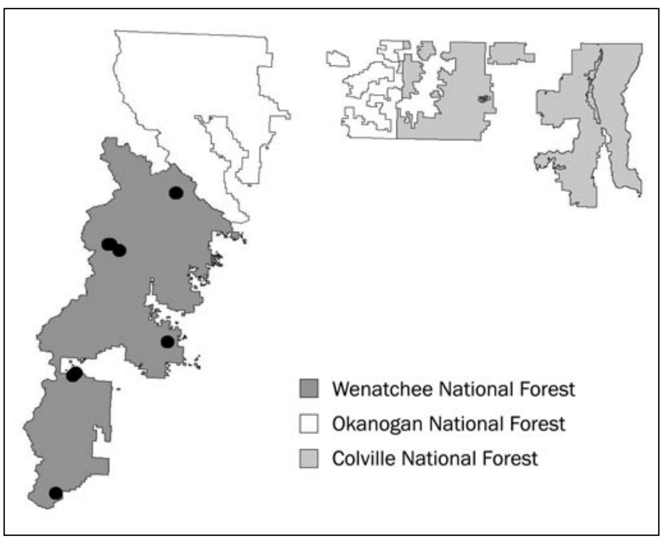


Figure 19—Plot locations for the red alder series.

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.

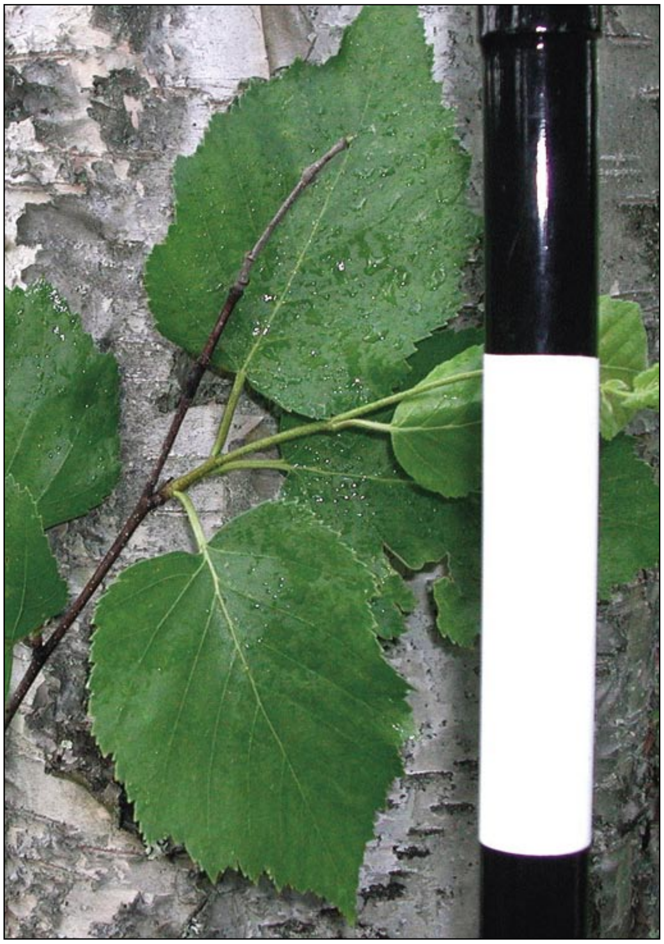
RELATIONSHIPS TO OTHER CLASSIFICATIONS

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



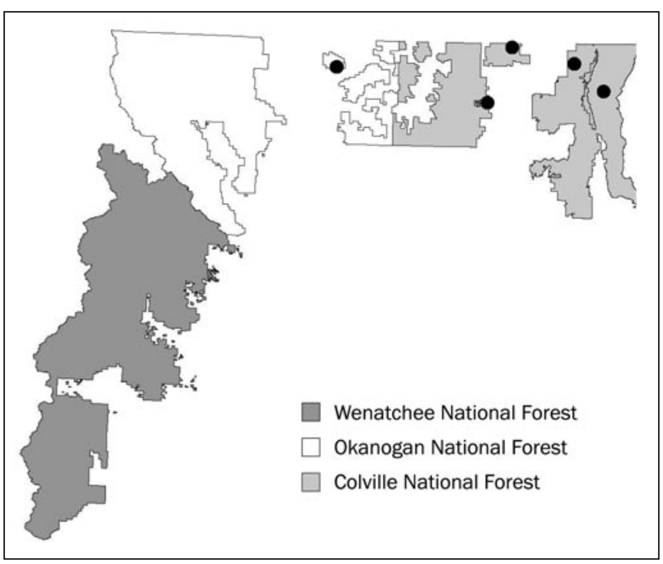


Figure 20—Plot locations for the paper birch series.

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

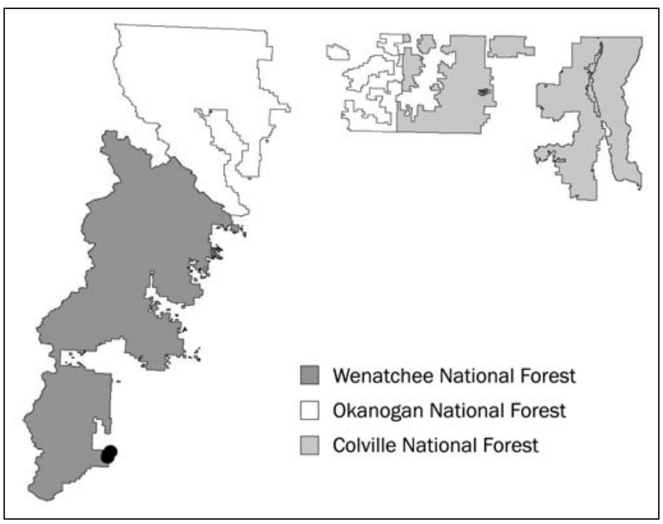


Figure 21—Plot locations for the Oregon white oak series.

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

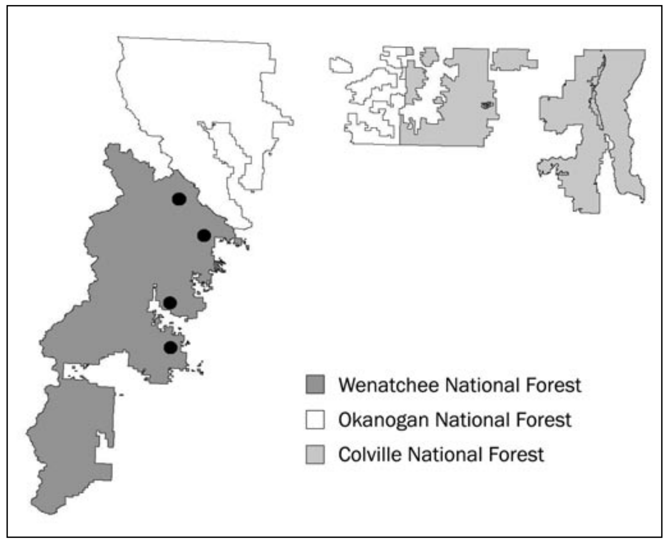


Figure 22—Plot locations for the bigleaf maple series.

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

		ACMA 4 plots		ALRU 13 plots		BEPA 7 plots		QUGA/COC2-SYAL 6 plots	
Species	Code	CON[a]	COV[b]	CON	COV	CON	COV	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

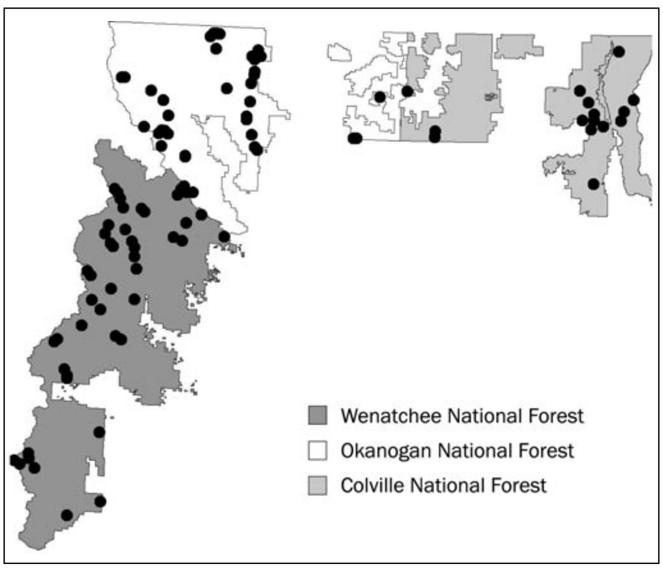


Figure 23—Plot locations for the willow series.

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.

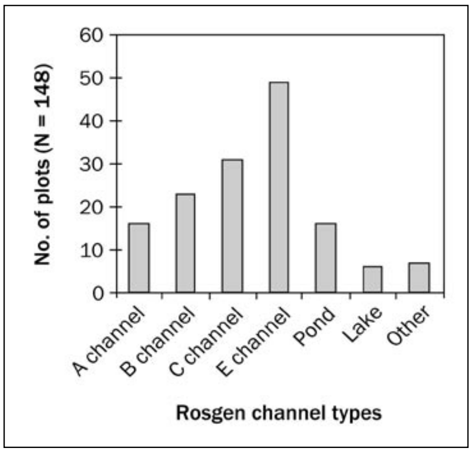
Plant association	Valley gradient Very low	Low	Moderate	Steep	Very steep	N
SACO2/CASCB-CASP	1	2	1	0	1	5
SACO2/MESIC FORB	0	1	1	1	2	5
SAFA/CANI2	0	2	0	0	0	2
SAFA/CASCB-CASP	5	1	0	0	0	6
SAFA/CASCP2	1	9	2	1	1	14
SAFA/CAUT	10	0	0	0	0	10
SAFA/DAIN	0	2	0	0	0	2
SAFA/ELPA2-ERPO2	6	0	0	0	0	6
SALIX/ALLUVIAL BAR	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.

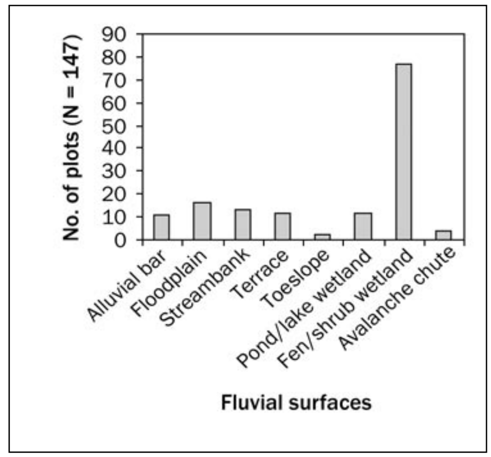


As with valley width and gradient classes, additional insight can be gained by looking at the distribution of channel classes for each plant association. With some exceptions, the first seven associations in the following table largely occur on riparian sites where A, B, and C channels predominate. The 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.

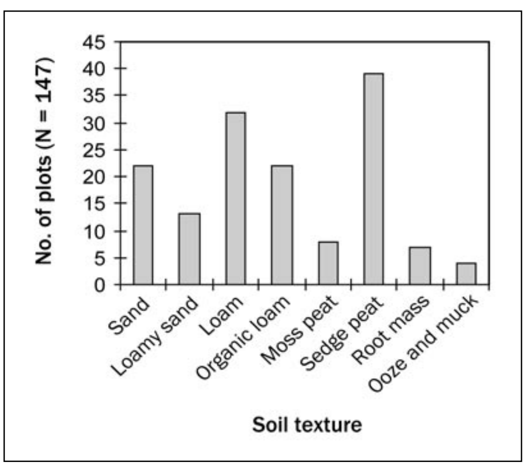


The distribution of the SALIX series by fluvial surface is clearer when looking at individual plant associations that may have strong affinities for riparian versus wetland zones. The first seven plant associations occur largely in riparian zones on alluvial bars (which include point bars), floodplains, 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	Alluvial bar	Flood-plain	Stream-bank	Wet terrace	Toe-slope	N	Pond/lake wetland	Fen/shrub wetland	Avalanche chute	N
	Riparian fluvial surfaces						Wetland fluvial surfaces			
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	Sand	Loamy sand	Loam	Organic loam	Moss peat	Sedge peat	Root mass	Ooze/ muck	N
	Soil texture								
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.

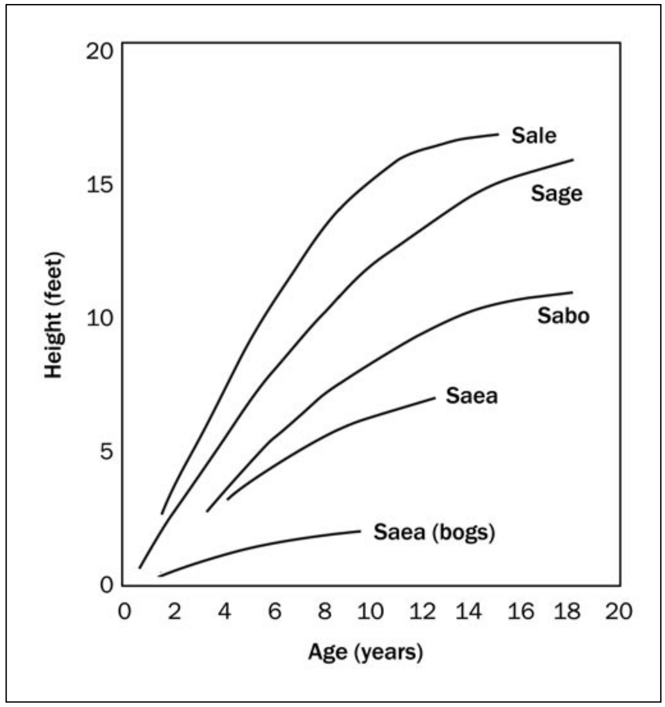


Figure 24—Height/age comparisons for some important willows in central Oregon (Kovalchik 1991a).

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).

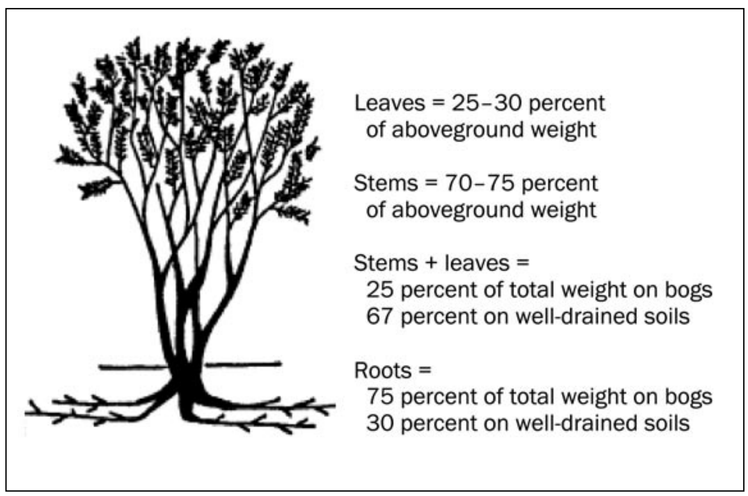


Figure 25—Biomass distribution on shrubby willows (Kovalchik 1991b).

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.

	Down log attributes				
Log condition	Tons/ acre	Cu. ft./ acre	Linear ft./ acre	Sq. ft./ acre	% ground cover
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.)

	Sensitive species															
Plant association	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

Species	Code	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	
		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		SACO2/ MESIC FORB 5 plots		SAFA/ CANI2 2 plots		SAFA/ CASCB-CASP 10 plots		SAFA/ CASCP2 14 plots		SAFA/ CAUT 10 plots	
		CON	COV	CON	COV	CON	COV	CON	COV	CON	COV	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		SAFA/ ELPA2-ERPO2 6 plots		SALIX/ ALLUVIAL BAR 16 plots		SALIX/ EQUIS 3 plots		SALIX/ GLEL 4 plots		SALIX/ MESIC FORB 16 plots	
		CON[a]	COV[b]	CON	COV	CON	COV	CON	COV	CON	COV	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)

Species	Code	SALIX/SPDO 3 plots		SALIX/CACA 8 plots		SALIX/CALA4 2 plots		SALIX/CASCP2 14 plots		SALIX/CAUT 26 plots		SASC-PAMY 6 plots	
		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

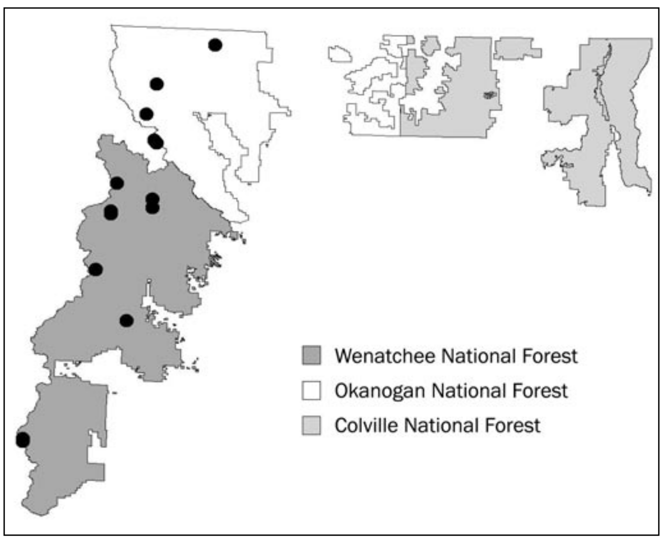


Figure 26—Plot locations for the HEATH series.

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 licorice-root, 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

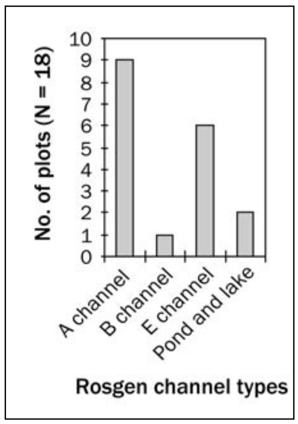
Differences between the two plant associations are more apparent. CAME-PHEM appears to be more common in low to very low gradient valleys, whereas PHEM-VADE is most common in very steep valleys. However, they are still present in other valley gradient classes. Site variation is probably due to the high 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					N
	Very broad	Broad	Moderate	Narrow	Very narrow	
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					N
	Very low	Low	Moderate	Steep	Very steep	
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.



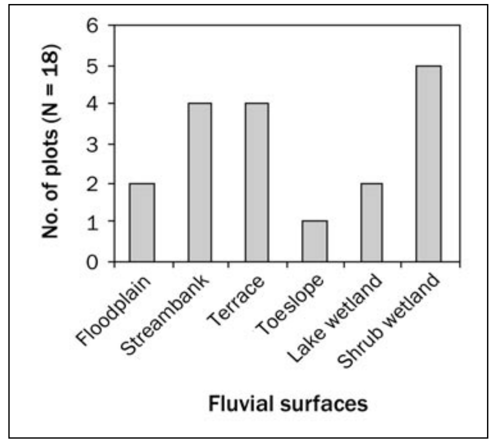
This apparent dichotomy for the HEATH series can be explained by looking at the distribution of the plant associations across channel classes. Five of the seven plots in the CAME-PHEM association occur along E channels, and one occurs by a lake. These channel classes are indicative of relatively broad, 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				N
	A	B	E	Pond/lake	
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

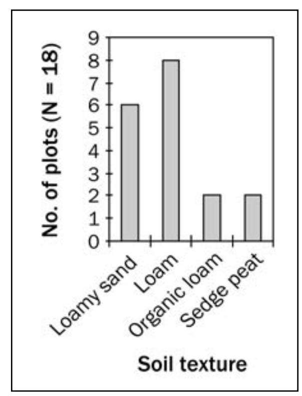


three plots (43 percent) occur within well-drained portions of riparian zones. The previous information on valley configuration and fluvial surfaces support the fact that the HEATH series occurs on a variety of transitional fluvial surfaces along high-elevation streams, lakes, and wetlands. Differences only occur when comparing the associations.

Plant association	Fluvial surfaces						N
	Flood-plain	Stream-bank	Terrace	Toe-slope	Lake wetland	Shrub wetland	
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				N
	Loamy sand	Loam	Organic loam	Sedge peat	
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

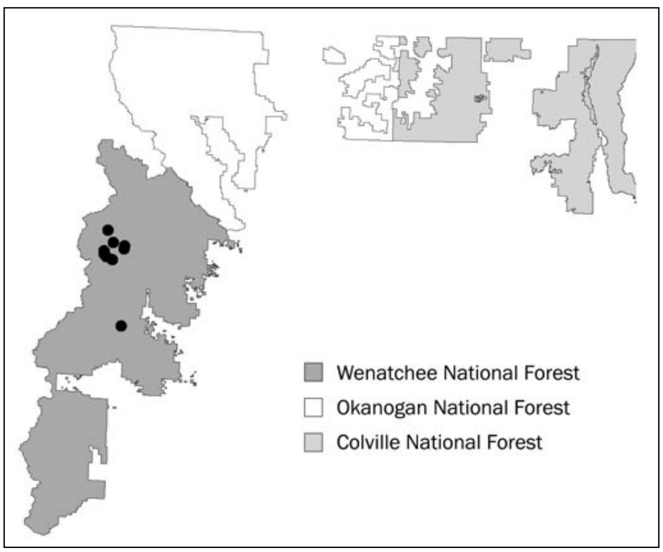


Figure 27—Plot locations for the vine maple series.

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.

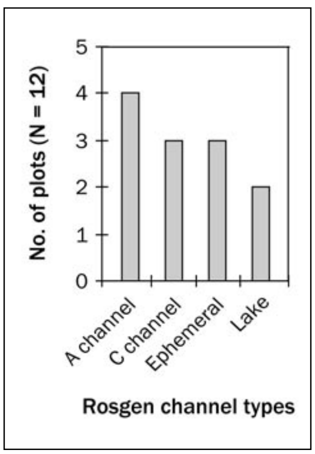
Plant association	Valley width					N
	Very broad	Broad	Moderate	Narrow	Very narrow	
ACCI	4	2	0	0	0	6
ACCI-OPHO/ATFI	1	1	0	4	0	6
Series total	5	3	0	4	0	12

Plant association	Valley gradient					N
	Very low	Low	Moderate	Steep	Very steep	
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.

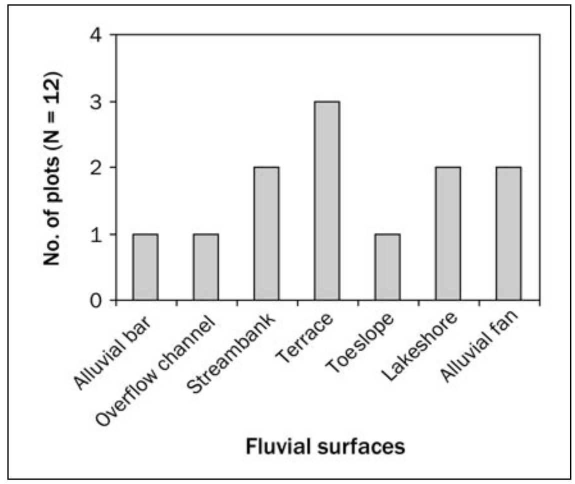


The distribution of stream types varies by plant association. The narrow, steep valleys most prominent in the ACCI-OPHO/ATFI association support high-energy A channels, although one lady fern dominated plot is along a C channel and another along an ephemeral channel (again, dominated by lady fern). The 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				N
	A	C	Ephemeral	Lake	
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.

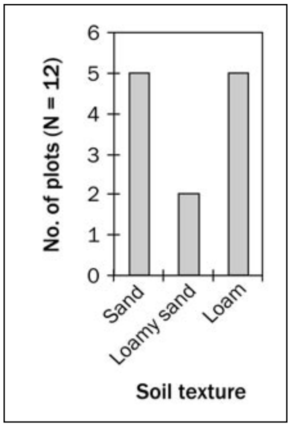


Some differences are apparent when looking at individual associations. Two ACCI association plots are located on an alluvial fan where an ephemeral stream is entering a lake. Two are on relatively similar toeslope sites that are transitional to lakeshores. The other two ACCI association plots are found 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							N
	Alluvial bar	Overflow channel	Stream-bank	Terrace	Toe-slope	Lake-shore	Alluvial fan	
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 pre-burn 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

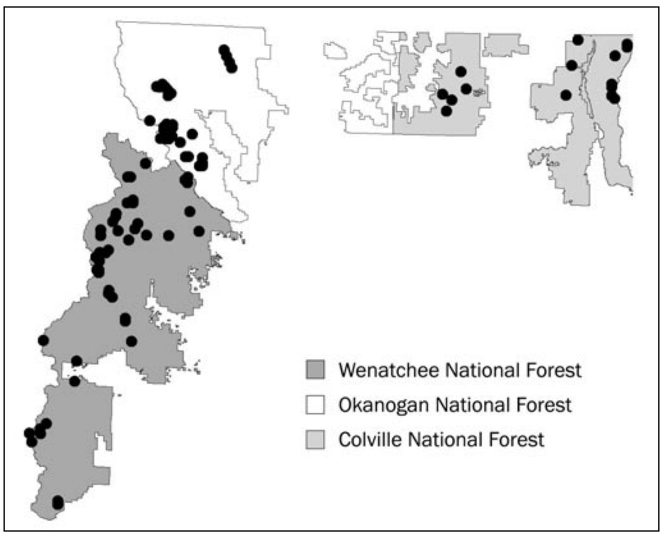


Figure 28—Plot locations for the Sitka alder series.

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					N
	Very low	Low	Moderate	Steep	Very steep	
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

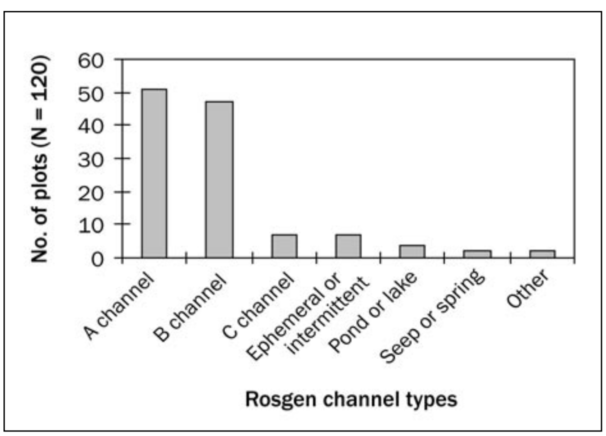
The distribution of the ALSI series by valley configuration may become clearer when considering individual plant associations. ALSI/OPHO, ALSI-RILA, ALSI/ATFI, ALSI/GYDR, and ALSI/SETR appear to favor narrower, steeper valleys. However, most associations occur in a variety of valley configurations, and other factors may better explain the distribution of the various ALSI associations.

Plant association	Valley width					N
	Very broad	Broad	Moderate	Narrow	Very narrow	
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					N
	Very low	Low	Moderate	Steep	Very steep	
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

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.



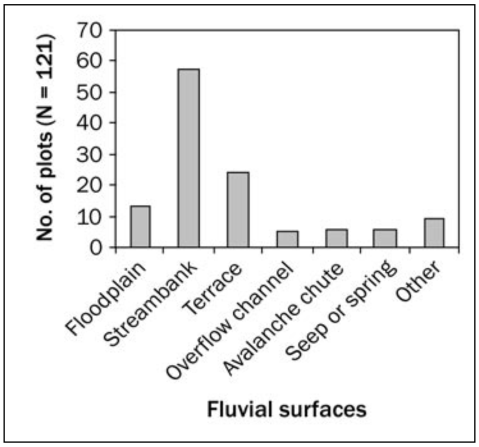
The same pattern holds with the individual ALSI plant associations. Only the ALSI/ATFI and ALSI/COST associations break the pattern of dominance by Rosgen A and B channels by perhaps being located on wetter sites along ephemeral or C channel types.

Plant association	Rosgen channel types							N
	A	B	C	Ephemeral/ intermittent	Pond/ lake	Seep/ spring	Other	
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—

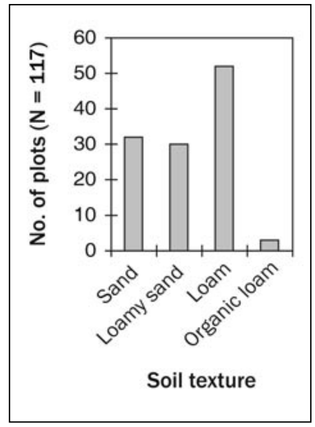
The ALSI series is usually found on fluvial surfaces that are well aerated, well drained, and moist. These conditions most often exist in riparian zones on floodplains or streambanks (including dikes) and the immediate terrace. Ninety-five of 121 plots (80 percent) are on these three fluvial surfaces; 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

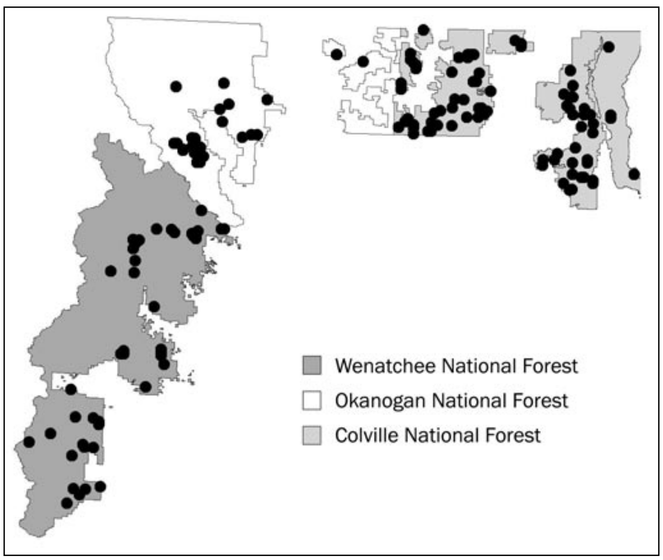


Figure 29—Plot locations for the mountain alder series.

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.

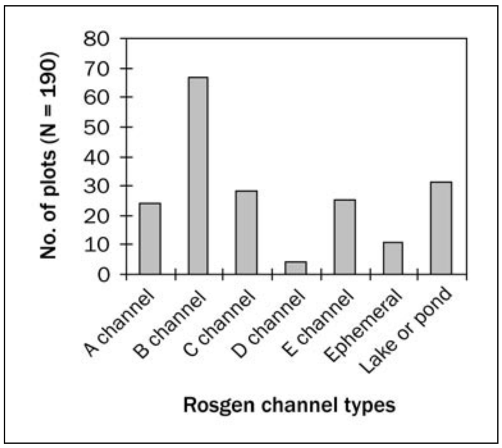
	Valley width					
Plant association	**Very broad**	**Broad**	**Moderate**	**Narrow**	**Very narrow**	**N**
ALIN/CASCP2	2	0	0	0	0	2
ALIN/LYAM	2	0	4	2	0	8
ALIN/CAUT	4	4	4	0	0	12
ALIN/SCMI	2	1	0	0	0	3
ALIN/EQUIS	4	8	10	6	1	29
ALIN/PHAR	1	0	1	0	0	2
ALIN/CACA	1	3	1	0	0	5
ALIN/ATFI	1	7	10	8	2	28
ALIN/GLEL	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.

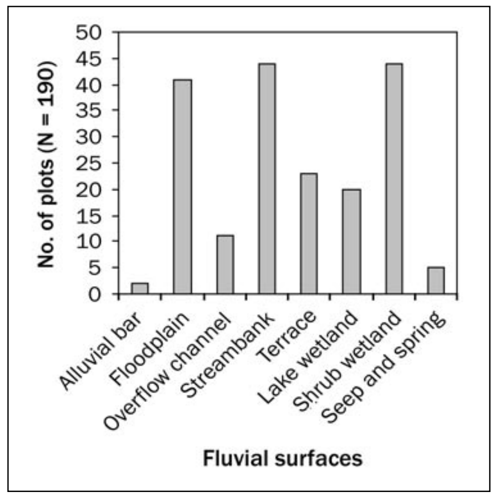


Additional insight is gained by looking at the distribution of Rosgen channel types by ALIN plant associations. For example, associations with wet site graminoids and herbs (such as ALIN/CACA, ALIN/CAUT, ALIN/CASCP2, ALIN/PHAR, ALIN/LYAM, and ALIN/SCMI) are more common on wetland sites along C and E 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.

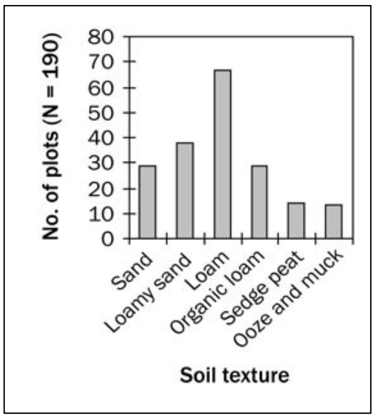


Additional insight is gained by looking at the distribution of fluvial surfaces by plant associations. For example, the wet ALIN/CACA, ALIN/CASCP2, ALIN/CAUT, and ALIN/LYAM associations are almost exclusively associated with wetlands. ALIN/ALLUVIAL BAR, ALIN/GYDR, ALIN/MESIC FORB, ALIN-COAST-SYAL, and 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)			N
	Minimum	Maximum	Average	
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)			N
	Minimum	Maximum	Average	
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

		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
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

		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[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

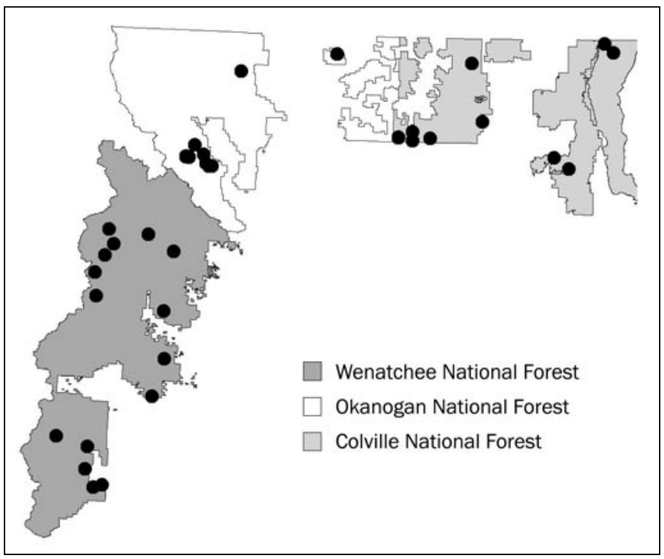


Figure 30—Plot locations for the red-osier dogwood series.

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

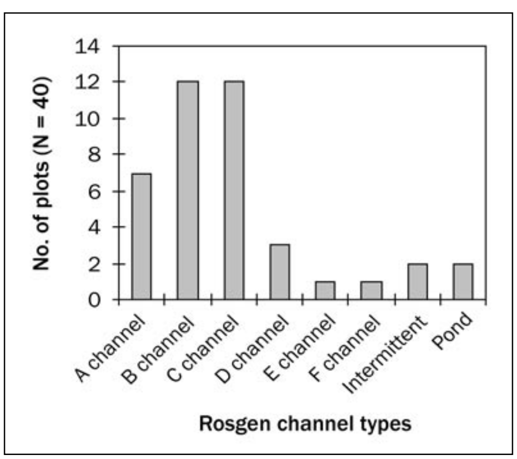
These generalities vary somewhat by association, where COST/ATFI prefers the cooler temperatures associated with narrower valley bottoms, whereas COST-SYAL and COST/MESIC FORB occur more often in relatively warmer broad, low-gradient valleys.

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.

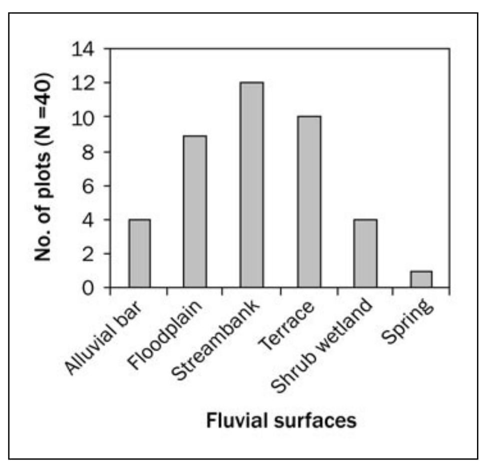


No meaningful patterns are evident when looking at individual associations except for the prominence of B and C channels along COST/EQUIS, COST/SYAL, and COST/MESIC FORB associations. COST/ATFI is usually located along A channels.

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.

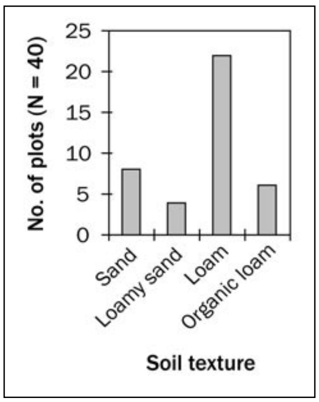


Additional insight is gained by looking at individual associations. As with the COST series as a whole, most stands in the COST/MESIC FORB and COST-SYAL associations are associated with streambanks and terraces. Plots also are found on alluvial bars, floodplains, and shrub wetlands. COST/ATFI, however, 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

Species	Code	COST-SYAL 11 plots		COST/ATFI 7 plots		COST/EQUIS 4 plots		COST/MESIC FORB 18 plots	
		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

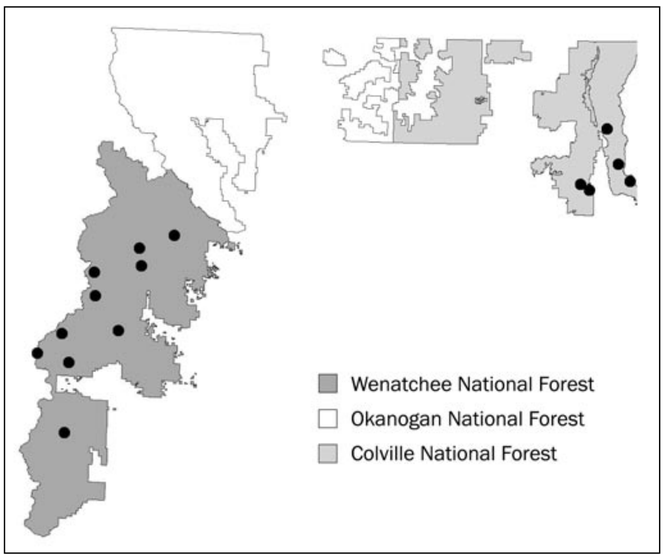


Figure 31—Plot locations for the Douglas spiraea series.

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 Very low	Low	Moderate	Steep	Very steep	N
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

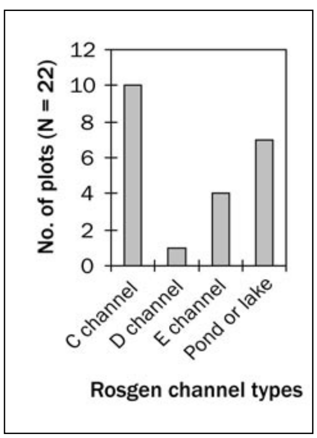
In addition, little difference in valley width and gradient classes is apparent among the three associations. All are located in valleys with moderate to very broad width. The wet SPDO/CACA association is most prominent in very broad valleys and is almost totally restricted to very low gradient valleys.

Plant association	Valley width Very broad	Broad	Moderate	Narrow	Very narrow	N
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 Very low	Low	Moderate	Steep	Very steep	N
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.

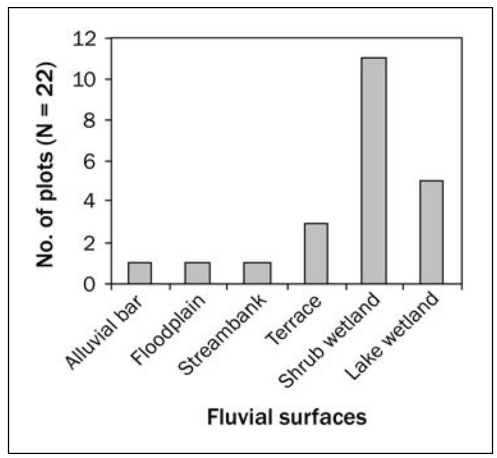


The data for individual associations support the above observations, as most associations are located near C and E channels. All three associations also can be found on wetlands bordering lakes and ponds.

Plant association	Rosgen channel types C	D	E	Pond/lake	N
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).



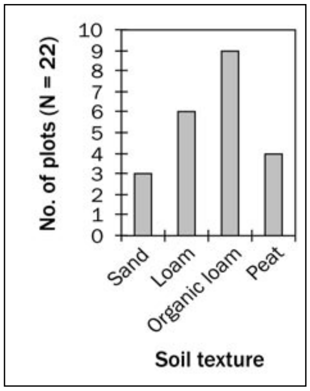
Similar patterns can be shown for individual plant associations. The majority of plots (15 of 22) in each association are located in wetlands. Four of six riparian zone plots (alluvial bars, floodplains, streambanks, and wet terraces) are associated with the SPDO association.

Plant association	Fluvial surfaces Alluvial bar	Flood-plain	Stream-bank	Terrace	Shrub wetland	Lake wetland	N
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.

	Soil texture				
Plant association	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.

	Water table (inches)			
Plant association	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.

	Soil temperature (°F)			
Plant association	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

		CRDO-SPDO 3 plots		SPDO 11 plots		SPDO/CACA 8 plots	
Species	Code	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

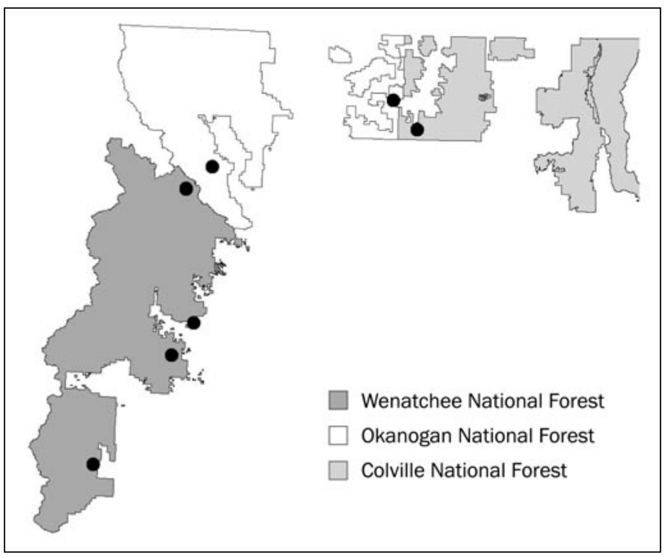


Figure 32—Plot locations for the Douglas maple series.

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 midsummer.

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

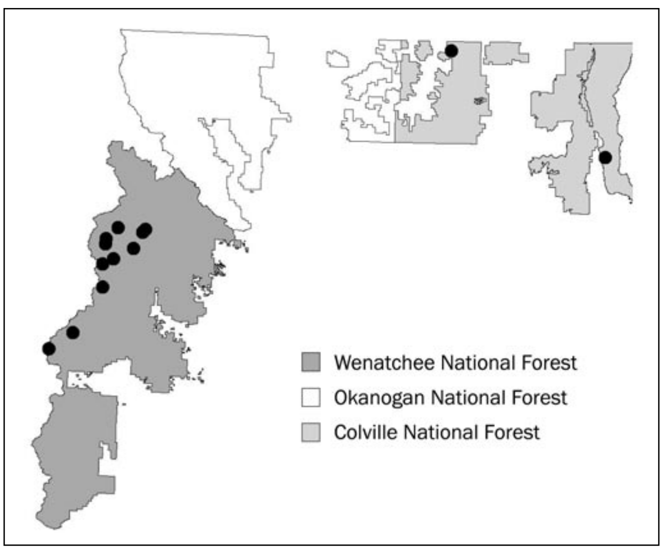


Figure 33—Plot locations for the devil's club series.

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

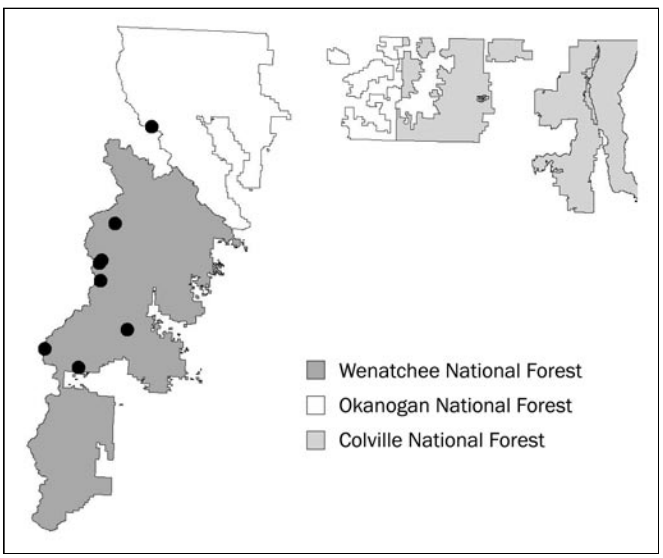


Figure 34—Plot locations for the salmonberry series.

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.