Table 69. Environmental and structural characteristics of the TSHE/RUPE Association.

	Mean	S.D.	Min	Max
Environment[1]				
Elevation	4500	293	3750	4920
Aspect[2]	348	55		
Slope	20	9	3	35
Topographic Moisture	6.27	0.65	5.0	7.0
Soil Surface[3]				
Exposed soil	33	27	3	90
Gravel	16	11	12	38
Rock	2	2	0	5
Bedrock	0	0	0	0
Moss	10	10	3	30
Lichen	1	1	0	2
Litter	55	19	35	85
Diversity[4]				
Richness	23.9	4.7	19	34
N2	7.4	2.6	4	12

' Values for environmental variables were generated using both classification plot and mapping plot data (n=18).
[2] The mean and standard deviation values for aspect are calculated using statistical formulae for circular data (Batschlet 1981).
[3] Soil surface characteristics in percent cover.
[4] Richness and heterogeneity, N2, are expressed as average number of species per plot.

Early serai (<100 years old) stands are dominated by western larch, lodgepole pine or Engelmann spruce. Western white pine and Douglas-fir are part of the sere only if most of the raw humus layer is lost (Bell 1964). This may be the reason that Douglas-fir is so poorly represented in these data.

The shrub and herb layers are often sparse in old, heavily shaded stands. Dwarf bramble characterizes these moist, cold sites. Other shrubs are low in stature and relatively inconspicuous, especially in late serai stands. Shrubs such as beargrass and big huckleberry increase after disturbance and may be abundant in early serai stands. Oak-fern, coolwort foamflower, trillium, claspleaf twisted-stalk, round-leaved violet and queencup beadlily are the most common herbs. Moist site indicators such as rusty menziesia, devil's club, lady-fem and claspleaf twisted-stalk may be present in stands close to streams or seepage areas. Mosses and lichens typically cover much of the forest floor and the many old and large logs.

Figure 111. Photo of the TSHE/RUPE Association.

MANAGEMENT IMPLICATIONS

Wildlife/Range- Complex canopy structures are common with two or more tree layers in the canopy. Stands with more than one tree canopy layer provide more and higher quality habitat for arboreal mammals and birds than do those with a single canopy layer. Deer and elk use these cool, shaded areas in summer for browse and thermal and hiding cover. Elk use some of the wetter sites for wallows. Most of the stands sampled are in late serai or old-growth stages, representing high value to old-growth dependent species due to their stand structures. Mature stands may represent winter range for woodland caribou, their principal forage being epidendric lichens covering many of the older trees. Old-growth stands are important winter habitat for martin (Koehler and Homocker 1977). Herbage for livestock is low in natural stands and livestock grazing has little potential except for shade and water.

Silviculture- High basal area and stand density index values (appendix 2) reflect moist, sheltered growing conditions as well as the relative old ages of the sample stands. Site index interpretations are weak because most trees were rotten and too old for the tables or equations. Streamside habitats make erosion potential an important consideration. Frost pockets from cold air drainage may also cause reforestation difficulties.

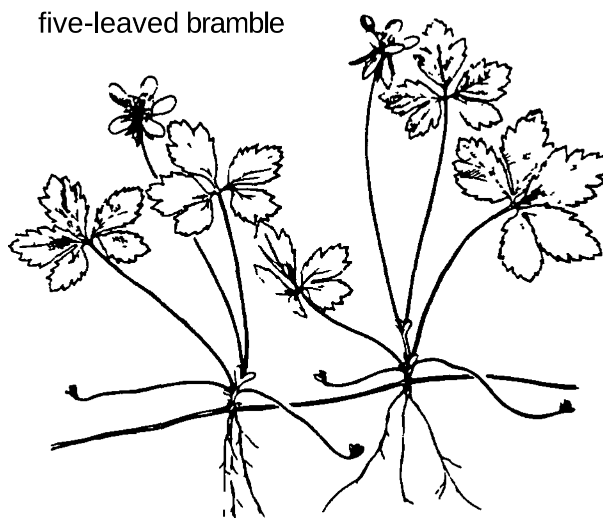
Lodgepole pine, Engelmann spruce and western larch are the best adapted species for reforestation. Shrub and herb competition is low Natural regeneration should be easily achieved with the proper species and treatment. Western larch should respond well to shelterwoods, though this technique may lead to windthrow problems. Individual and group selection cutting works well on these sites for promoting western hemlock, western redcedar, subalpine fir and Engelmann spruce. Douglas-fir is apparently not well adapted to the cool, frosty conditions characteristic of the association. Efforts to plant Douglas-fir on TSHE/RUPE sites should be viewed as experimental rather than meeting reforestation targets.

Mature stands are cool and shady, often with large trees, gentle topography and near streams. However, stands in the TSHE/RUPE Association are poor choices for campgrounds because the natural vegetation does not tolerate trampling and heavy use. Additionally, the soils are quite moist much of the spring and early summer. Old trees in dense, shady stands over a layer of mosses, lichens, delicate ferns, subshrubs and herbs are visually attractive and make good trail and nature walk areas. Visitors should be restricted to paths. Big huckleberry provides recreational berrying in more open stands. Huckleberries are easily eliminated if their shallow rhizomes are damaged by excessive foot traffic or heavy equipment.

COMPARISONS

Braumandl and Curran (1992) describe a Western Redcedar-Western Hemlock/Oak Fern-Foamflower Site Association for the southern interior of British Columbia. Many of those sites would key to the TSHE/RUPE Association, though they contain less subalpine fir. Bell's (1965) Slope Aralia Oakfern Association - Degraded Aralia Oakfern Forest Type, also in southern British Columbia, is very similar to the TSHE/RUPE Association. Other authors in the northern Rocky Mountains have not described a TSHE/RUPE Association. Some Colville N.F. stands will key out to the TSHE/GYDR Habitat Type of Cooper *et al.* (1991) from northern Idaho or the TSHE/CLUN Habitat Type-ARNU3 Phase of Pfister *et al.* (1977) from Montana

Rubus pedatus
five-leaved bramble



TSHE/XETE ASSOCIATION CHF5 21
Tsuga heterophylla/Xerophyllum tenax
western hemlock/beargrass

DISTRIBUTION AND ENVIRONMENT

The TSHE/XETE Association is a minor type primarily limited to the Sullivan Lake Ranger District in the northeast comer of the Forest (Figure 112). It typically occupies mid- to upper-slope positions on southeast to southwest aspects, but can occur on other aspects (Figure 113). Approximately 90% of the plots are located between 4,000 and 5,000 ft. (Figure 113) and average 4,639 ft. (Table 71).

Soils are formed in volcanic ash deposited over colluvium, glacial till or outwash. Bedrock geology tends to be granitic. Coarse fragments increase with depth and compacted layers were found in some soil profiles. Hummocks, slumps, rootwads and windthrown trees suggest unstable soils even on gentle to moderate slopes (< 40%). Humus and duff layers ranged between 1 and 6 in. (2.5 -16 cm.). The TSHE/XETE Association generally grades into the TSHE/MEFE Association on more northerly aspects or concave sites as effective soil moisture increases. It grades into the TSHE/CLUN Association on warmer habitats within the Hemlock Series. The ABLA2/XETE Association is found at higher elevations (above 5,000 ft.) on colder and somewhat drier sites. Some overlap between the ABLA2/XETE and TSHE/XETE Associations occurs and differentiation between the two types is

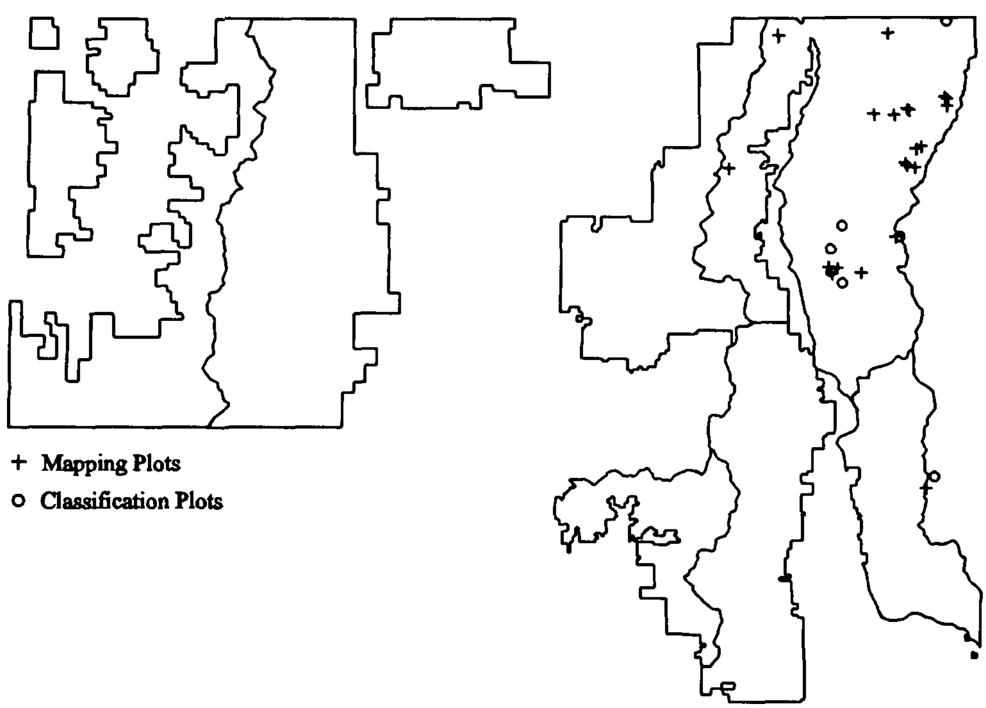


Figure 112. Plot locations of the TSHE/XETE Association (n=29).

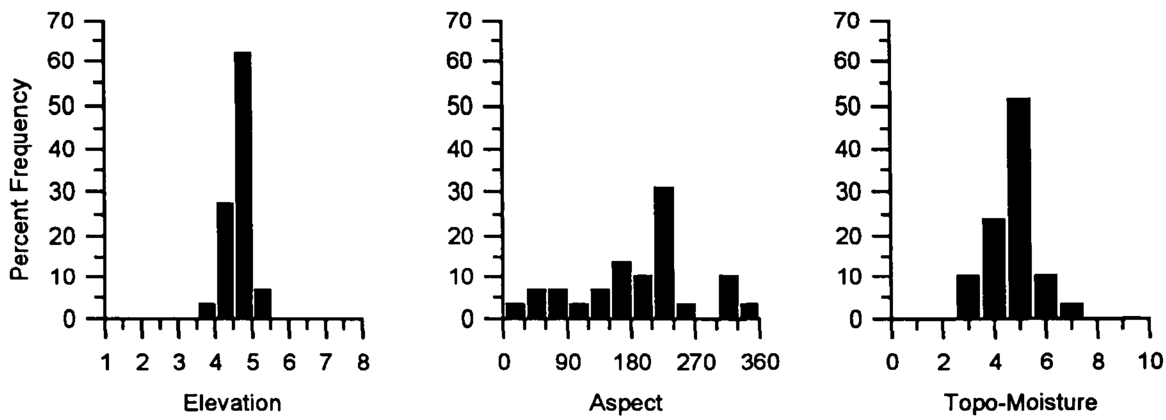


Figure 113. Frequency ofTSHE/XETE plots by elevation (1000 ft.), aspect, and topographic moisture.

based on the reproductive success of western hemlock.

VEGETATION

Late serai and climax stands are characterized by western hemlock dominance in all tree layers and an open, park-like undergrowth (Figure 114). The TSHE/XETE Association contains some of the oldest trees sampled. One western larch was 570 years old at breast height. Douglas-fir and western white pine are minor serai species occurring only on warmer portions ofthe type. Western larch or western white pine may form a sparse, emergent layer over a shorter main canopy comprised of western hemlock, Engelmann spruce, subalpine fir and/or western redcedar. Grand fir and ponderosa pine were absent from the data. Early serai stands (<100 years old) may closely resemble the THPL/VAME Community Type. Lodgepole pine or western larch often dominate these early-seral stands.

Table 70. Common plants of the TSHE/XETE Association (n=8).

		CON	COVER
TREE QVERSTQRY LAYER			
TSHE	western hemlock	88	46
THPL	western redcedar	88	16
PIEN	Engelmann spruce	75	6
ABLA2	subalpine fir	63	5
PICO	lodgepole pine	13	60
TREE UNDERSTQRY LAYER			
TSHE	western hemlock	100	10
THPL	western redcedar	75	8
ABLA2	subalpine fir	63	2
SHRUBS AND SUBSHRUBS			
XETE	beargrass	100	9
PAMY	pachisdma	100	5
LOUT2	Utah honeysuckle	100	3
VAME	big huckleberry	88	8
PYSE	sidebells pyrola	88	3
LIBOL	twinflower	75	9
CHUM	western prince'spine	75	5
MEFE	rusty menziesia	50	3
HERBS			
CLUN	queencup beadlily	100	6
TIUN	coolwort foamflower	88	5
VIOR2	round-leaved violet	88	3
GOOB	western rattlesnake plantain	75	2

Table 71. Environmental and structural characteristics of the TSHE/XETE Association.

	Mean	S.D.	Min	Max
Environment[1]				
Elevation	4639	294	4000	5280
Aspect[2]	347	79		
Slope	33	16	2	69
Topographic Moisture	4.72	0.92	3.0	7.0
Soil Surface[3]				
Exposed soil	20	20	1	40
Gravel	62	0	62	62
Rock	10	14	0	38
Bedrock	0	0	0	0
Moss	8	5	2	15
Lichen	1	1	0	2
Litter	70	14	50	80
Diversity[4]				
Richness	26.3	5.5	21	35
N2	7.1	3.7	2	12

' Values for environmental variables were generated using both classification plot and mapping plot data (n=29).
[2] The mean and standard deviation values for aspect are calculated using statistical formulae for circular data (Batschlet 1981).
[3] Soil surface characteristics in percent cover.
[4] Richness and heterogeneity, N3, are expressed as average number of species per plot.

A wide variety of shrubs are typical of the association. Only Utah honeysuckle, pachistima, twinflower, sidebells pyrola, big huckleberry and beargrass have more than 75% constancy. Russet buffaloberry may be abundant in relatively young stands dominated by lodgepole pine but is absent from sampled stands over 100 years old. Rusty menziesia. Cascades azalea and alpine pyrola are often present in small amounts. Herb cover is normally low but a variety of species may be present. Queencup beadlily occurred on all the plots and coolwort foamflower, trillium, western rattlesnake plantain and round-leaved violet are common associates. Mosses cover much of the ground in mature stands.

MANAGEMENT IMPLICATIONS

Wildlife/Range- Moderate sites may produce abundant wildlife forage in early and mid-seral stages. Utah honeysuckle, pachistima, big huckleberry and russet buffaloberry provide wildlife forage. Big huckleberry is frequently browsed and the flowering heads of beargrass are used by ungulates and

Figure 114. Photo of the TSHE/XETE Association.

small mammals such as chipmunks and squirrels. Some of these stands are in late serai or old-growth stages and are important to old-growth-dependent species due to their stand structures. Mature, open stands may serve as winter range for woodland caribou, their principal forage being epidendric lichens covering many of the older trees. Old-growth stands may be important winter habitat for martin (Koehler and Homocker 1977). Stands with more than one tree canopy layer provide habitat for arboreal mammals and birds. The TSHE/XETE Association provides little herbage for domestic livestock because of low herb production and unpalatable species.

Silviculture- Timber productivity is generally good on these sites. Shrub and herb competition and soil compaction are the main limitations to intensive timber management. Competition from beargrass and other shrubs may hinder tree regeneration. In addition, tree seedling stress caused by strong diurnal fluctuations in temperature is common in the upper slope positions characteristic of the type. Tree top damage, presumably from ice or snow, is common. Stands on west aspects are especially subject to rapid snowmelt and to ice damage to conifer crowns. The unstable soils merit special attention to avoid slumps and slides. Protection of soil organic matter and nutrients is essential to maintain site productivity.

Selection and shelterwood cuts favor shade-tolerant species such as western redcedar, western hemlock and subalpine fir. More open cutting techniques may predispose these species to blowdown. Group selection cutting may be the best alternative to prevent blowdown and avoid the problems associated with larger clearcuts (snow accumulation, temperature changes, etc.). Clearcuts followed by broadcast burns may be difficult to reforest because of greater temperature ranges and insolation rates. Blackened soil surfaces may raise temperatures at the soil-air interface enough to kill seedlings.

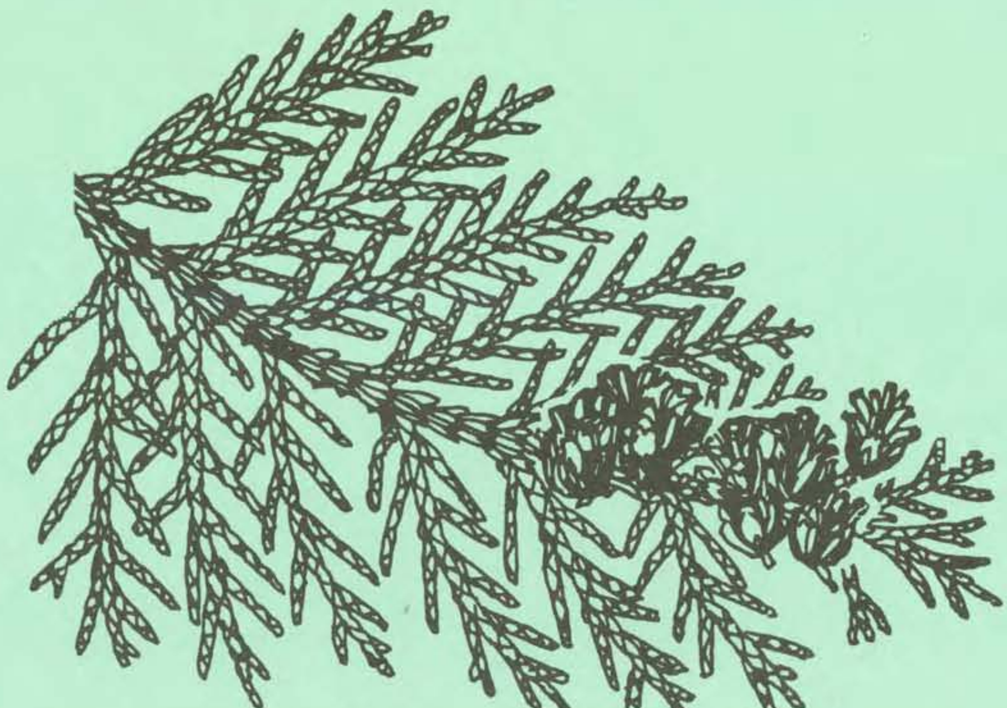
Broadcast burning also stimulates beargrass development and increases shrub competition. Moderate natural regeneration of serai western larch and Douglas-fir should result from seedtree and shelterwood treatments if adequate seed sources are present. Cool fires appear to stimulate both beargrass and big huckleberry growth while hot fires reduce huckleberry growth more than beargrass growth. Mechanical scarification decreases growth of both species. Lodgepole pine may be the most suitable species for timber management (when good seed sources are present) because the species is adapted well to the harsh growing conditions existing on some TSHE/XETE sites. In general, shelter in the form of standing trees or by logs left on site is essential for successful reforestation.

Bench habitats in the association are often good choices for campgrounds because beargrass is quite resistant to foot traffic. TSHE/XETE sites also make good locations for trails. Big or low huckleberries are easily damaged but these stands remain well vegetated longer than most other associations because of beargrass[1] resistance to trampling. Extensive areas of beargrass in flower are visually attractive. Huckleberry picking may also attract forest visitors to these sites. Good air and soil drainage are also typical of these stands.

COMPARISONS

Cooper *et al.* (1991) describe a beargrass phase of their TSHE/CLUN Habitat Type that resembles the TSHE/XETE Association. However, their environmental conditions and successional patterns differ. Other workers in the Rocky Mountains have not recognized a TSHE/XETE Association.

WESTERN REDCEDAR SERIES



WESTERN REDCEDAR SERIES

Thuja plicata

THPL

DISTRIBUTION AND ENVIRONMENT

Western redcedar is a long-lived conifer which can reach ages as old as 800 to 1,000 years. The species has two separate coastal and interior distributions. The interior distribution is correlated with the Inland Maritime climatic regime which includes northeast Washington, northern Idaho, northwest Montana and southeast British Columbia. Western redcedar ranks second only to western hemlock as the most shade tolerant and environmentally restricted conifer on the Colville N. F. Compared to western hemlock, western redcedar is more tolerant of high soil moisture, summer drought and temperature extremes (Minore 1979). The Western Redcedar Series (where redcedar is the indicated climax dominant) occurs only on that part of the species' range beyond the environmental or geographic range of western hemlock, and western redcedar regeneration without hemlock indicates the Western Redcedar Series. Only minor amounts of western hemlock (confined to moist microsites) are acceptable in the Western Redcedar Series. The one exception is where western hemlock can be a significant stand component in the wet THPL/OPHO Association.

The Western Redcedar Series is widespread over the eastern two-thirds of the Colville N.F. (Figure 115). Other than the Lone Ranch Creek drainage in the north, with only small and isolated stands

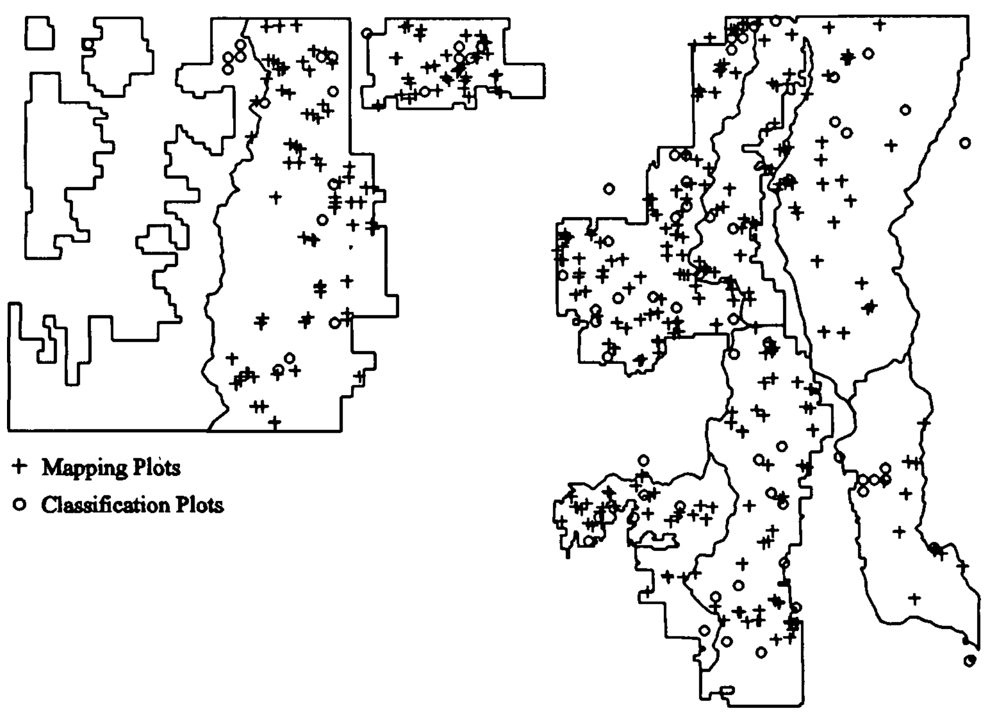


Figure 115. Plot locations for the Western Redcedar Series on the Colville N. F. (n=463).

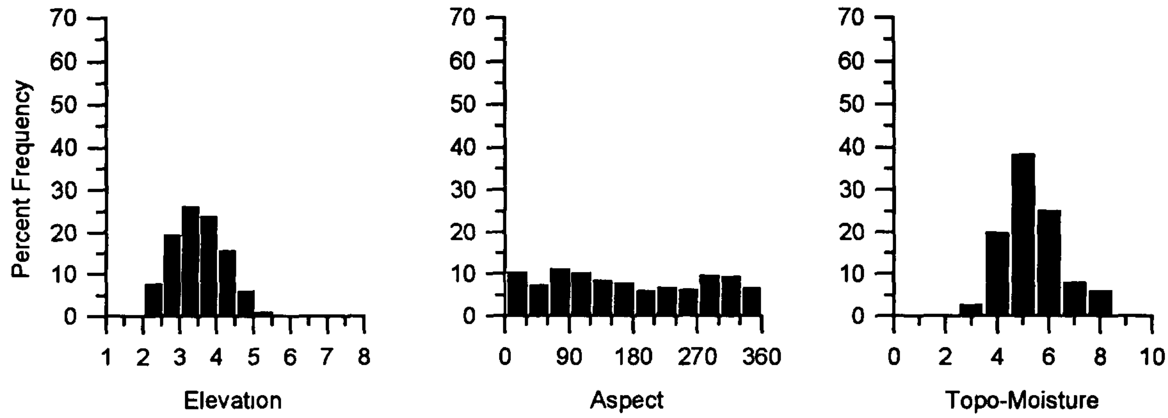


Figure 116. Frequency of Western Redcedar Series plots by elevation (1000 ft.), aspect, and topographic moisture.

occur west of the Kettle Mountain Crest. The Western Redcedar Series occupies a variety of aspects and elevations (Figure 116). Most stands occur between 2,500 and 4,500 ft. elevation. However, the Western Redcedar Series can extend down to lower elevations in moist stream bottoms with cold air drainage. It is not uncommon to find western redcedar as low as 1,700 or 1,800 ft. in certain localities. In addition, local distribution patterns of western recedar differ depending upon aspect, geology and precipitation levels. Western redcedar is generally restricted to moist stream bottoms and northern aspects in the southwest area of it's distribution on the Colville N.F. and gradually expands to a wider range of slope positions and landforms as one progresses to the northeast. Differences in aspect of the Western Redcedar Series on the Colville and Sullivan Lake Ranger Districts is illustrated in Figure 117. Low temperatures also limit western redcedar distribution within it's range, since it is not resistant to frost.

The Series has a bimodal moisture distribution. At one end it characterizes sites too dry to support the Western Hemlock Series but somewhat more moist than the Grand Fir Series. Root penetration of western redcedar is better than that of western hemlock, perhaps allowing it to survive in somewhat drier locations (Bums and Honkala 1990). The Western Redcedar Series also occurs on very wet sites where western hemlock is usually, but not always, a climax co-dominant. We follow Daubenmire and Daubenmire (1968) and Pfister *et al.* (1977) in assigning these wet habitats to the THPL/OPHO Association which is part of the Western Redcedar Series. However, a pure floristic separation from the Western Hemlock Series based on tree reproductive success is questionable.

Three associations and one community type are described for the Series. These include the THPL/OPHO, THPL/ARNU3, THPL/CLUN Associations and the THPL/VAME Community Type. Swampy sites resembling the THPL/ATFI Association of Daubenmire and Daubenmire (1968) were seen, but were either too small or too poorly developed to sample. Additionally, these fragments were found within the range of western hemlock which contradicts the observations of Daubenmire

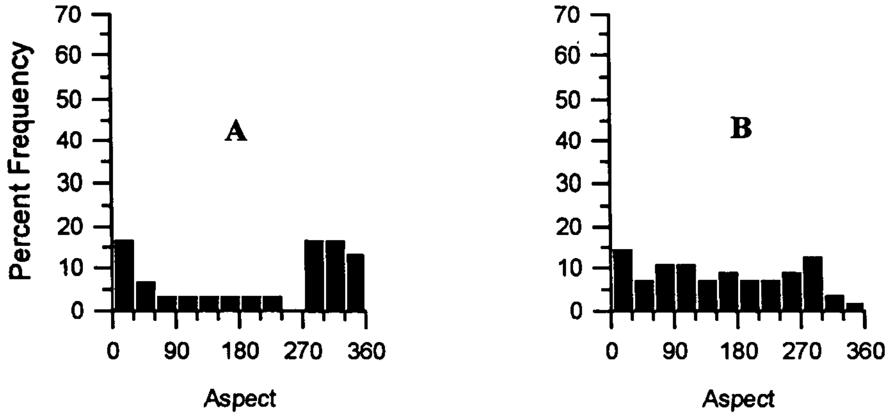


Figure 117. Frequency of western redcedar plots by aspect from the south-half of Colville (A) and Sullivan Lake (B) Ranger Districts.

and Daubenmire (1968). Riparian plant associations in the Western Redcedar Series (such as THPL/ATFI) are described in riparian classifications for eastern Washington (Kovalchik 1993).

VEGETATION

All tree species occurring on the Colville N.F. (except whitebark pine) may be found within the Western Redcedar Series depending on association and stand history. Western larch, Douglas-fir, lodgepole pine and grand fir are the most important serai trees. Western white pine was a major serai species prior to the introduction and spread of white pine blister rust. Subalpine fir and Engelmann spruce are locally abundant as serai species within some of the cooler stands, particularly in stream bottoms with cold air drainage. However, both of these species are more common in the Western Hemlock Series. Ponderosa pine is a minor serai species except on very warm, well-drained habitats. Western hemlock, as described above, may co-dominate on wet THPL/OPHO sites. Western hemlock is an accidental species located on favorable microsites in the remaining three western redcedar plant associations

Western redcedar influences soil development and undergrowth composition much differently than western hemlock. Mineral soil next to redcedar trees in mixed-species stands has higher extractable calcium, base saturation, ph and nitrification potential compared to soils under neighboring hemlocks (Turner and Franz 1986). Also, undergrowth under western redcedar has more species and larger individuals compared to undergrowth under western hemlock (Turner and Franz 1986). The tree regeneration layers follow a pattern similar to the overstory. Western redcedar is usually present, along with lesser amounts of grand fir. Douglas-fir may be a significant regeneration component under certain serai conditions, such as beneath decadent lodgepole pine, but disappears as the secondary canopy of Douglas-fir, grand fir and western redcedar assumes dominance. Small amounts

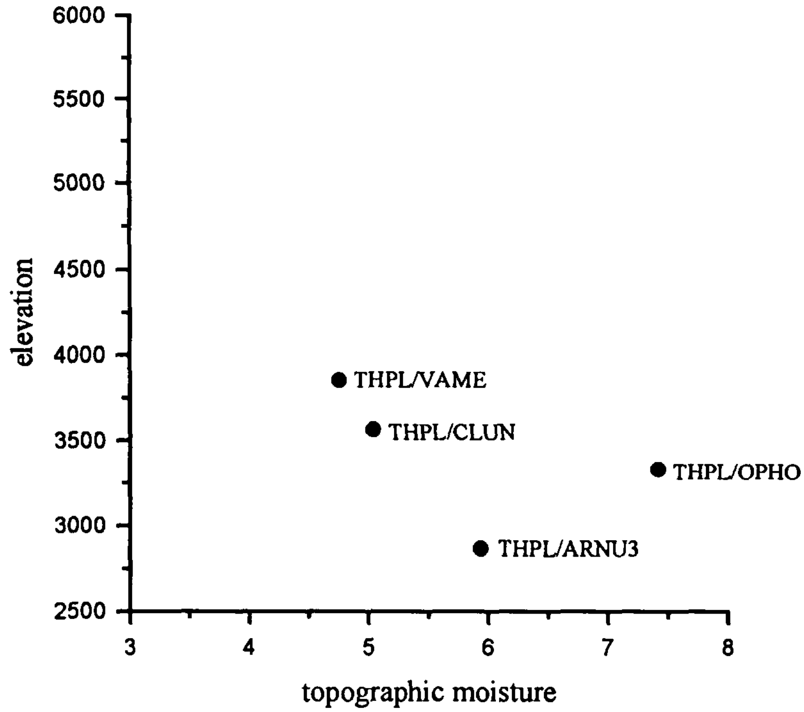


Figure 118. Ordination of western redcedar plant associations by elevation and topographic moisture.

ofsubalpine fir and/or Engelmann spruce regeneration may also be found in cooler stands. Successful western hemlock regeneration is found only in the THPL/OPHO Association.

Stands with "depauperate" shrub and herb layers are often encountered in dense stands of western redcedar with a thick layer of litter. Such stands have few or no shrubs and herbs or very low cover for the species present. Presently we key many of these sites to the THPL/CLUN Association; viewing the paucity of shrubs and herbs as transitory and more related to tree canopy densities and litter accumulations than to intrinsic site factors. The undergrowth of mature stands varies from lush devil's club and ferns to carpets ofpachistima and twinflower to virtually nothing under very dense overstory conditions. Tall shrubs over 3.5 ft. (1 m) rarely seem to dominate except for devil's club or in early serai conditions. Likewise, herbaceous species seldom dominate. The typical upland undergrowth is characterized by an abundance of species from the *"Pachistima myrsinites* union" of Daubenmire and Daubenmire (1968). Common species often include pachistima, queencup beadlily, twinflower, pyrola spp. and common brome.

Of the five major conifer series found on the Forest, the Western Redcedar Series ranks in the middle regarding diversity components. A total of 154 vascular plant species were found on the 74 plots (as of August 1991) used to describe the Series and associations (Table 72). However, a graph of richness against sample size (not shown) shows a rising curve without any plateau. This suggests that

Table 72. Diversity components of the Western Redcedar Series.

	Mean	S.E.[2]
Richness'	154	
Number of associations	3	
Expected richness[3]	186.6	7.6
Expected N2"	18.4	1.9
Average richness per plot	27.5	0.9
Average N2 per plot	8.7	0.5

' Total number of vascular plant species in the Western Redcedar *Series* data.
[2] Standard error of the estimate.
[3] Jackknife estimate of richness given a sample size of 74 plots.
[4] Jackknife estimate of N2 given a sample size of 74 plots.

richness, at least, has been poorly characterized by existing data and that the Jackknife estimate of richness is unreliable. However, the other species diversity components are reliable even with small sample sizes and they also rank in the middle. The only exception to this middle ranking of diversity is the number of associations which ties for lowest among the major conifer series. This low number of associations occurs despite the bimodal moisture distribution of the series. This indicates that the series encompasses little habitat variation except for the contrast between the two extremes (wet and dry).

Age data are available for 116 western redcedar trees. Fifty are from stands in the Western Redcedar Series and 66 from the Western Hemlock Series. These 116 trees are grouped into the following age classes: 32 were less than 100 years old, 39 were between 100 and 200 years, 22 between 200 and 300 years, 18 between 300 and 400 years, 4 between 400 and 500 years, and 1 was over 500 years old. All ages are at breast height at time of sampling (1982 or 1983). All trees over 400 years old were from stands in the TSHE/RUPE or TSHE/GYDR Associations. The oldest western redcedar in the Western Redcedar Series was 345 years old and was found on a THPL/OPHO site that also contained a 550 year old western hemlock. In the Western Redcedar Series, only three western redcedars over 200 years old are from types other than the THPL/OPHO Association. The paucity of old trees is attributable to a combination of recent fire history and that old stands were often the first entered by loggers.

Dense shrub fields are characteristic of early serai stages after logging or wildfire. Redstem ceanothus, pachistima, sticky currant, thimbleberry, snowberry, Douglas maple, shiny-leaf spirea and Scouler willow are important shrubfield components. Ninebark is not normally as prolific in the Western Redcedar Series as in the Grand Fir or Douglas-fir Series and normally occurs only on drier and warmer sites within either the THPL/CLUN or THPL/ARNU3 Associations. Appendix 1 lists the reproductive strategies of selected species. Species that regenerate from seed after intense fire include both redstem and snowbrush ceanothus, thimbleberry, pachistima and sticky currant. Seeds of these species remain viable in the forest soil or duff layer for many years. Douglas maple, Scouler willow, common snowberry and shiny-leaf spirea generally regenerate from buried roots, root crowns, rhizomes or by seeds from outside the burned area. Seeds of these latter species remain viable in the soil for relatively short periods of time.

FIRE ECOLOGY

Fire return intervals are not well documented for the Western Redcedar Series, though most sites show some evidence of past fire such as buried charcoal and fire-scarred trees. Fire has certainly been a major influence within the Series on the Forest. Most of the stand data (except THPL/OPHO stands) are comprised of stands less than 200 years and often near 100 years old. In north Idaho, a typical fire-return interval for low- to moderate-severity fires is 50-100 years; a stand-replacement interval is 150-500 years. However, fire regimes and intensities can be quite variable in this Series. The drier western redcedar associations found on uplands are more at risk of burning than the wetter types located in stream bottoms, seeps, and benches. Redcedar communities south of Interstate 90 in Montana are typically riparian in nature, and bum much less frequently than the drier adjacent uplands (Agee 1994). This results in a pattern of late successional cedar forests surrounded by younger forests on the drier uplands. This pattern is commonly observed on many areas of the Colville N.F., particularly in the drier areas on southern exposures. Thus, in many instances, these riparian "stringers" of western recedar can form natural firebreaks on the landscape (Fisher and Bradley 1987). However, even these very moist redcedar sites can bum, particularly under severe drought conditions when crown fires spread from the drier neighboring stands. Thus, when these narrow cedar "stringers" are located in the midst of large stands of drier plant associations such as PSME/PHMA or ABGR/PHMA, the risk of burning is greater. Many riparian cedar stands on the Colville N.F. reflect this situation.

On the wetter portions of the forest, such as the Sullivan Lake area, redcedar and hemlock stands tend to be more widespread and continuous and have longer fire-return intervals, allowing the development of older forests However, fire has also been a major type of disturbance in these areas, particularly in stands on steep mid-slopes. These mid-slope stands are generally warmer, drier, and more wind-exposed, and may form a "thermal belt" which burns more intensely than lower slope positions (Amo and Davis 1980). Most of these stands are either THPL/CLUN or THPL/VAME types. When fire occurs in these stands, the patch size can be very large. Some very large and intense fires have burned in the cedar/hemlock forests of northeast Washington, north Idaho, and northwestern Montana and include the 20,000 hectare Sundance Fire in north Idaho in 1967 (Anderson 1968). Cooper *et al.* (1991) note other extensive fires in the area in 1889, 1919, 1926, and 1934. Barrows (1952) states that 400,000 hectares burned in north Idaho in 1910 alone. The Colville N.F. was no exception, with a similar history of intense fires in the cedar and hemlock forests. These past fires account for many of the young and dense cedar-hemlock "doghair" stands found on the Forest.

Subalpine fir, Engelmann spruce, lodgepole pine, grand fir, and western hemlock all have naturally low resistance to fire, and are easily killed by moderate severity fires. Species such as Douglas-fir, western larch, ponderosa pine, and western redcedar often survive as residuals due to their higher tolerance to fire. Quite often, western redcedar will survive fires if any portion of the bole and cambium survived and also due to its large size (Smith and Fischer 1995). Fire-scarred redcedar are common on the ColvilleN.F. After stand-replacing fires, western redcedar usually enters most sites early in succession due to its prolific seed production. Burned, exposed mineral soil provides good germination for redcedar, though the faster growing serai species (grand fir and Douglas-fir) usually overtop the seedlings and saplings (Smith and Fischer 1995). Western redcedar usually dominates the mid-to late-successional stages on most sites and continues this trend to climax.

INSECTS AND DISEASE

Generally, western redcedar is free of major problems associated with insects and diseases. Redcedar seems to suffer little damage from most insects. Western redcedar is less susceptible than it's associates to most damaging agents, but damaged trees are common due to its longevity. Redcedar are often windthrown in wet environments and are not resistant to windthrow on the moist sites where growth and yield are highest. More than 200 species of fungi are found on redcedar, and hollow old trees are common. The most common root and butt rots include *Phellinus weiri, Armillaria mellea* and *Poria asiatica.* These rots are most evident in old stands, where much of the standing volume is often defective and unmerchantable. In addition, redcedar pencil rot may be of concern for managers on developed sites.

Armillaria root rot is present in virtually all stands of the Western Redcedar Series in the northern Rocky Mountains (McDonald *etal.* 1987b). However, the infection rate is low in undisturbed stands. In addition, more productive sites have lower infection rates compared to less productive stands. Apparently, the total environmental and biological stress on productive sites does not exceed the tree's tolerance. Infection rates increase threefold after man-caused disturbance *{i.e.* logging or road building). Less productive sites, such as those in the Douglas-fir or Subalpine Fir Series, have much higher infection rates but as whole these series have a lower overall incidence of the pathogen (McDonald *et al.* 1987a).

MANAGEMENT IMPLICATIONS

The Western Redcedar Series is second only to the Western Hemlock Series in productivity. High water tables and shrub competition are the greatest timber management hazards in most stands. Most western redcedar have been harvested traditionally by clearcutting the mixed-species stands in which they grow. Because of the often steep terrain, wood decay, and breakage, redcedar harvesting costs are usually high and lumber recovery is usually low (Burns and Honkala 1990). Western redcedars should not be left as scattered seed trees; even those individuals along clearcut margins may be lost to windthrow or exposure.

Knowledge of shrub and herb composition can be used to tailor treatments to achieve desired post-treatment condition. As an example, Morgan and Neuenschwander (1988) studied post-clearcut shrub response to high and low intensity burns on Western Redcedar Series sites in north Idaho. Extracts from their results follow. Bum intensity after clearcutting greatly affects resulting undergrowth species composition and abundance. Low intensity fire favors species with rhizomatous sprouts or buried root crowns while high intensity fire favors shrub establishment from seed. Multiple entries before a clearcut and bum modify the response as well. Multiple entries open the canopy and provide disturbed soils allowing establishment of shade-intolerant shrubs, and these shrubs then resprout vigorously after the clearcut and bum. Clearcutting followed by broadcast burning especially favors redstem ceanothus (Irwin and Peek 1979) if an adequate seed source is present. Shrub production usually peaks between 10 and 14 years after treatment although tall shrubs *(i.e.* Scouler willow and Douglas maple) may continue to increase in cover over a longer time period (Irwin and Peek 1979).

Ashy soils are easily compacted or displaced by heavy equipment thereby reducing site productivity and hindering tree regeneration. Harvesting practices that minimize soil compaction and organic matter loss have been suggested by Page-Dumroese (1993). Preserving the rich but somewhat fragile soils on found on many western redcedar sites must be considered during any harvesting or site preparation planning (Smith and Fischer 1995). Soil organic matter content and porosity are both very important soil properties to consider during planning. Soil water-holding capacity is increased by organic matter from duff, roots and plant debris (Smith and Fischer 1995). Harvey (1982) reports that soil wood is an excellent seedbed for regeneration because 1) it retains moisture, 2) reduces non-conifer competition and decay fungi and 3) hosts more mycorrhizae than humus. Soil wood and soil organic matter can be increased from logging debris (Page-Dumroese *et al.* 1994). Slash decays rapidly on these moist sites. Decay of slash can be accelerated and the potential threat of wildfire can be minimized on sites by lopping and scattering slash (Smith and Fischer 1995). Piling fuels with heavy equipment may cause soil compaction and the intense heat generated by burning large slash piles drastically alters soil structure and removes essential nutrients and organic matter. Cool broadcast burns should provide adequate fuel reduction.

Mature stands in most associations provide little forage for domestic livestock or wild ungulates. Early serai stages produce more forage and have higher cover values in most canopy layers (except the tree canopy). Wildlife, including elk, deer, and snowshoe hares (as well as livestock) consume much of the cedar reproduction in closed stands (Cooper *et al.* 1991). Redcedar seedlings and saplings are often severely browsed by deer, elk or rodents and browse damage may be an important stand-establishment problem. Production of shingles and shakes constitute perhaps the most important special use of redcedar wood.

COMPARISONS

The Western Redcedar Series (or analogs to it) has been well described for the northern Rocky Mountains. Daubenmire and Daubenmire (1968) incorporated climax western redcedar associations into the Western Hemlock Series and did not explicitly recognize a Western Redcedar Series. Otherwise, the Western Redcedar Series has been described for western Montana (Pfister *et al.* 1977), northern Idaho (Cooper *et al.* 1991) and the adjacent southern interior of British Columbia (Braumandl and Curran 1992). Western redcedar stands occurring along the west and east slopes of the Cascade Range are typically included within the Western Hemlock Series (Henderson *et al.* 1992, Lillybridge *et al.* 1995, respectively). The only possible exception is in the southern Oregon

Cascades and coast ranges where western hemlock has a restricted distribution. Preliminary classifications recognize a Western Redcedar Series in these areas (Atzet and McCrimmon 1990, Atzet and Wheeler 1984).

KEY TO PLANT ASSOCIATIONS IN THE WESTERN REDCEDAR SERIES

Before using the key, the field form in Appendix 4 should be completed. Refer to the "USING THE KEYS" section in the introduction for more specific information on using the key, particularly if the stand in question does not key properly.

Devils club ≥ 5% . . . . THPL/OPHO Association p. 251

Wild sarsaparilla, baneberry, wild ginger, and/or bunchberry dogwood ≥ 5% . . . . THPL/ARNU3 Association p. 240

Big huckleberry ≥ 5% . . . . THPL/VAME Community Type p. 256

Queencup beadlily and/or round-leaved violet ≥ 1% . . . . . . THPL/CLUN Association p. 246

THPL/ARNU3 ASSOCIATION CCF2 22
Thuja plicata/Aralia nudicaulis
western redcedar/wild sarsaparilla

DISTRIBUTION AND ENVIRONMENT

The THPL/ARNU3 Association is found on all ranger districts on the Colville N.F., though is primarily limited to sites east of the Kettle Mountain Crest (Figure 119). It is very limited on the Republic Ranger District, with the only sites sampled located in the Lone Ranch Creek drainage. This association typically occupies moist, gentle to moderate lower-slopes, benches or bottoms. These sites represent warm, moist xero-riparian conditions when next to streams or on stream terraces, though sites are occasionally found on subimgated mid-slopes. Most sites are below 3,500 ft. (Figure 120). Aspects are variable due to the sheltered topographic positions of most stands.

The regolith is volcanic ash deposited over coarse textured alluvium or glacial outwash. Only soils from the Lone Ranch Creek drainage are without significant ash. Litter covers much of the soil surface and humus layers are well developed. Nutrient cycling from breakdown of litter appears relatively rapid on these moist, warm sites. The THPL/ARNU3 type is typically replaced by the TSHE/ARNU3 Association on similar but cooler sites and by the THPL/CLUN or ABGR/CLUN Associations on more exposed slopes. Adjacent upland sites are often in the Douglas-Fir or Grand

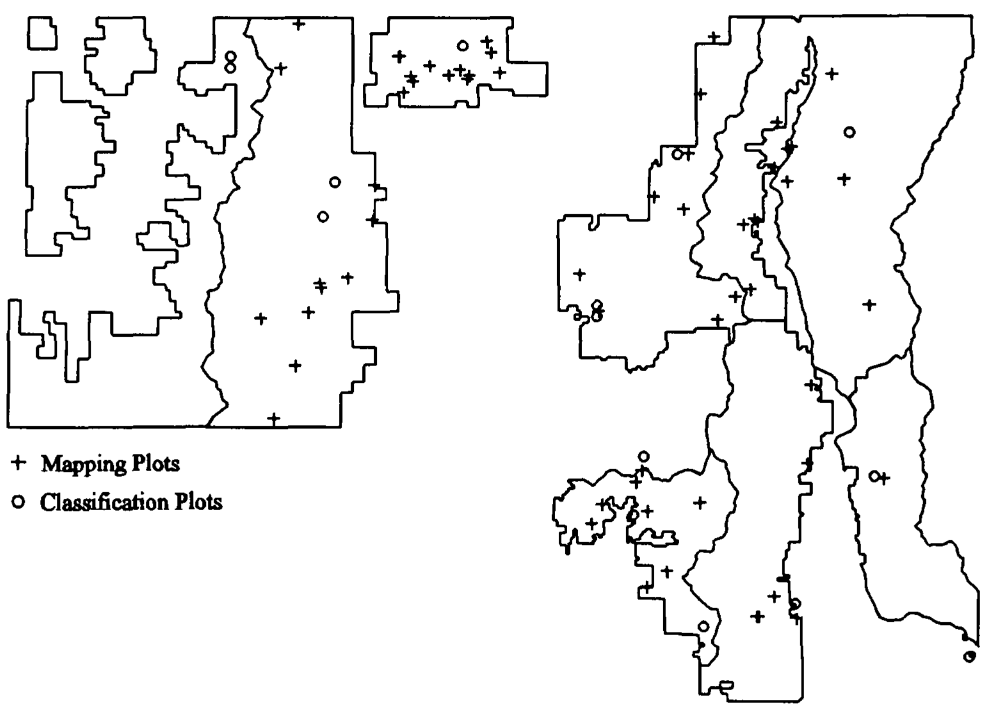


Figure 119. Plot locations for the THPL/ARNU3 Association (n=84).

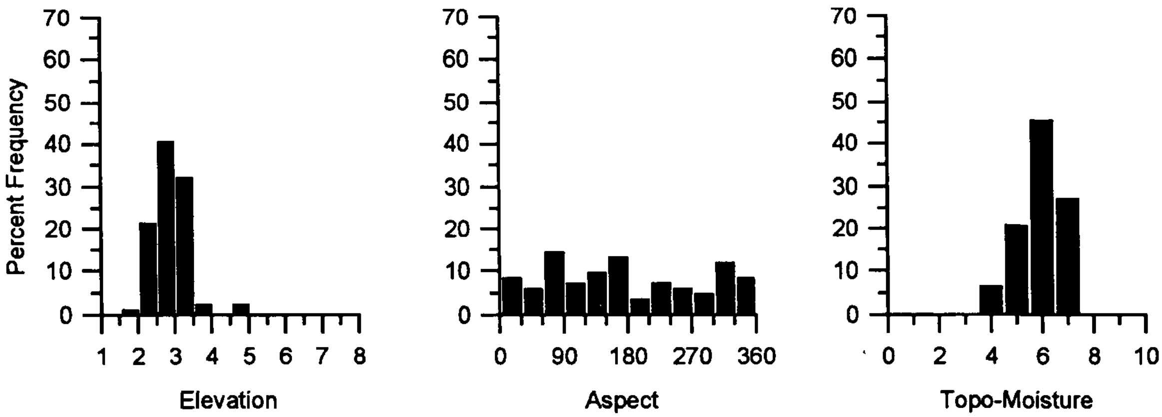


Figure 120. Frequency of THPL/ARNU3 plots by elevation (1000 ft.), aspect, and topographic moisture.

Fir Series. West of the Kettle Mountain Crest the type appears to be replaced the ABLA2/COCA Association which is found on apparently frostier sites or where the climate is less maritime in character.

Some stands in the PICO/SHCA Community Type appear to be on sites similar to those supporting the THPL/ARNU3 Association. We speculate that such areas may have burned intensely one or more times with subsequent reductions of nutrient pools and organic matter levels such that the sites have not yet fully recovered. Similar vegetation patterns exist on sites that were cleared and used as fields. Gentle slopes, low elevations and relatively deep soils make areas supporting the THPL/ARNU3 Association attractive for homesteads or other kinds of intensive land use. Abandoned homesteads and fields are usually dominated by lodgepole pine and a wide variety of weedy forbs and grasses, including many introduced species. Several decades to a century or more may be required before species composition on

Table 73. Common plants of the THPL/ARNU3 Association (n=16).

		CON	COVER
TREE OVERSTORY LAYER			
PSME	Douglas-fir	100	18
THPL	western redcedar	94	24
ABGR	grand fir	75	13
LAOC	western larch	75	8
PIEN	Engelmann spruce	56	14
BEPA	paper birch	50	6
TREE I'INDERSTORY LAYER			
^HPL	astern redcedar	94	4
ABGR	grand fir	56	5
SHRUBS AND SUBSHRUBS			
LIBOL	twinflower	94	6
ACGLD	Douglas maple	94	4
ROGY	baldhip rose	88	4
BEAQ	Oregon grape	75	3
RUPA	thimbleberry	69	5
COCA	bunchberry dogwood	63	6
TJ'ppnc ^'m			
ARNU3	wild sarsapanlla	81	12
^LUN	queencup beadlily	81	4
g^ST	starry solomonplume	75	5
QATR	sweetscented bedstraw	69	3
OSCH	sweetroot	63	3

Table 74. Environmental and structural characteristics of the THPL/ARNU3 Association.

	Mean	S.D.	Min	Max
Environment[1]				
Elevation	2864	490	2000	4860
Aspect[2]	82	70		
Slope	15	19	1	87
Topographic Moisture	5.94	0.86	4.0	7.0
Soil Surface[3]				
Exposed soil	42	43	1	95
Gravel	14	10	1	38
Rock	9	16	0	38
Bedrock	0	0	0	0
Moss	3	5	0	15
Lichen	0	1	0	3
Litter	68	25	30	95
Diversity[4]				
Richness	29.3	5.4	19	37
N2	8.2	3.4	4	15

[1] Values for environmental variables were generated using both classification plot and mapping plot data (n=49).
[2] The mean and standard deviation values for aspect are calculated using statistical formulae for circular data (Batschletl981).
[3] Soil surface characteristics in percent cover.
[4] Richness and heterogeneity, N3, are expressed as average number of species per plot.

profoundly disturbed sites approximates that of the THPL/ARNU3 Association.

VEGETATION

Late serai conditions are difficult to find and have to be inferred from composition of the tree regeneration layers. Mature stands are likely comprised of large western redcedar and scattered remnants of serai species such as Engelmann spruce, grand fir and Douglas-fir. Most conifer species except western hemlock, subalpine fir and whitebark pine can occur as serai species on THPL/ARNU3 sites. Composition ofmid-seral stands depends on the type, intensity, and frequency of disturbance, and on prior stand composition. Douglas-fir, western larch, grand fir, and western redcedar typically dominate the overstory of mid-seral stands. Engelmann spruce may be an important overstory component, especially where cold air ponds during stand establishment periods. Lodgepole pine can dominate early-seral stages. Ponderosa pine is unusual but may occur on warm, well-drained, mid-slope habitats where repeated underbums are common.

Western white pine is poorly represented in the data, but was undoubtedly more common in this type

Figure 121. Photo of the THPL/ARNU3 association

before the spread of white pine blister rust. Paper birch and/or quaking aspen are especially important serai species on sites where fire removed much of the humus. These rapid growing, short lived, intolerant species may be very important in nutrient cycling on sites that have been intensely burned. Black cottonwood is a minor serai species on alluvial terraces close to water. Western redcedar and grand fir dominate the regeneration layers ofmid-seral stands, and Engelmann spruce regeneration may also be found in colder stands.

The undergrowth is comprised of scattered tall shrubs and a relatively rich ground layer ofmesophytic subshrubs and herbs. Douglas maple and baldhip rose are the most common tall shrubs. Thimbleberry and common snowberry may be abundant, especially where Engelmann spruce also occurs. Oregon grape and serviceberry are also common. These shrubs all decline in cover with the formation of dense canopies of western redcedar or grand fir.

Typical herbs include Twinflower, bunchberry dogwood, wild sarsaparilla, queencup beadlily and starry solomonplume. Coolwort foamflower, wartbeny fairybells, baneberry, round-leaved violet and Columbia brome are other common species. Wild ginger can be locally abundant and represents an alternate indicator species for this type. Wild ginger also indicates habitats transitional to the THPL/ASCA3 Habitat Type described for northern Idaho (Cooper *et al.* 1991). THPL/ARNU3 has the highest average species richness of the three associations in the Series (Table 74), second only to the THPL/VAME Community Type. Average dominance is equal with the THPL/OPHO as the highest of the associations in the Series. Average dominance of just the undergrowth species is the highest overall. Not only is average richness above both Forest and Series averages, these figures also indicate that more species have relatively higher proportional abundances than average.

MANAGEMENT IMPLICATIONS

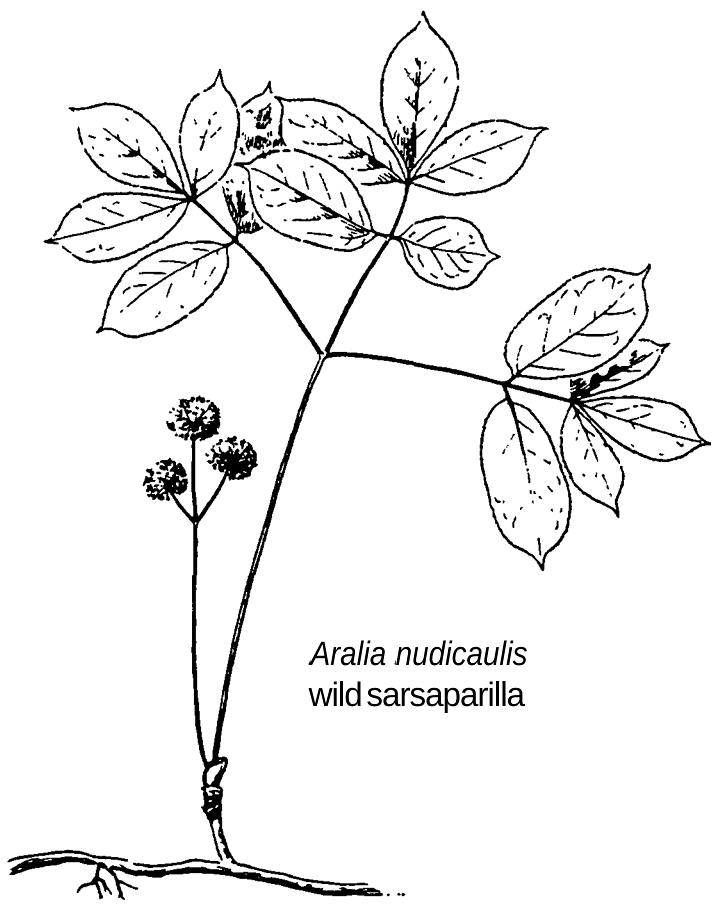
Wildlife/Range- Sheltered, relatively warm sites, proximity to streams and rich shrub and herb layers make the association highly valuable for wildlife and domestic livestock. Stands with multiple tree canopies provide good habitat for arboreal mammals and birds. Early successional stages may contain important browse species such as redstem ceanothus. Fire may enhance deer and elk habitat, particularly if ceanothus seeds are present. Pacific yew, if present, provides good winter browse for moose. Herbage for livestock is only moderate and continued overgrazing, combined with overstory removal, can result in large increases in weedy species on these sites.

Silviculture- These are highly productive timber sites Many conifers are suitable for management and species selection for reforestation is more dependent on management objectives than on site characteristics. Serai shrubs and herbs may hinder reforestation, especially after fall broadcast bums. Pre-treatment species composition and serai characteristics (appendix 1) are important in determining vegetation responses after treatment. However, organic matter, soil nitrogen and other nutrients are easily lost (Harvey *etal.* 1987). Follow the guidelines of Harvey *et al.* (1987) to protect site quality. Ashy soils are easily compacted or displaced by heavy equipment, thereby reducing site productivity and hindering tree regeneration. The needs for soil protection, fuel reduction, and mineral soil exposure for regeneration all need to be balanced during the planning stages of proposed management activities.

Both even- and uneven-aged management techniques can be applied on these sites due to the moderate environment and serai species which are often present. Barrett (1982) recommends even-aged management with broadcast burning when western larch is the dominant serai species on north-facing slopes. Regeneration on drier aspects is enhanced by shelter from residual overstory trees (Ferguson *et al.* 1986). Serai species such as ponderosa pine, western larch or Douglas-fir may be enhanced by underbuming in combination with shelterwood or selection cutting techniques (Amo and Davis 1980). In general, burning seems to enhance regeneration of serai species, particularly on clearcuts (Smith and Fischer 1995). Burning may also increase the potential for natural regeneration on these sites by reducing seed-destroying insects for 1-2 years after fire (Fellin and Kennedy 1972). Moeur (1992, 1994) reports that selective cutting could be used to alter the structure of late serai or old-growth stands by opening the canopy and encouraging reproduction by the shade-tolerant species. Ninebark and other warm-site shrubs such as thimbleberry, Oregon grape, and Douglas maple may become abundant after a fire either from stored seed or from buried roots, rootcrowns or rhizomes. Periodic disturbance favors species such as ninebark.

COMPARISONS

Several researchers have described plant associations in the Pacific Northwest which are similar to the THPL/ARNU3 Association. Variations have been reported for Montana (Pfister *et al.* 1977), eastern Washington and northern Idaho (Daubenmire and Daubenmire 1968), northern Idaho (Cooper *etal.* 1991), northcentral Washington (Clausnitzer and Zamora 1987), and southern British Columbia (Braumandle and Curran 1992). Kovalchik (1993) describes a nearly identical riparian THPL/ARNU3 Association for eastern Washington The THPL/ARNU3 Association is a part of the THPL/PAMY Habitat Type of Daubenmire and Daubenmire (1968). Pfister *et al.* (1977) describe a THPL/CLUN Habitat Type-ARNU3 Phase that closely resembles the THPL/ARNU3 Association. Cooper *etal.* (1991) have a broadly defined THPL/ASCA3 Habitat Type. Part of the THPL/ASCA3 Habitat Type-ASCA3 Phase is similar to the THPL/ARNU3 Association. Clausnitzer and Zamora (1987) describe a THPL/ARNU3 Habitat Type on the Colville Indian Reservation that appears to be the same as the THPL/ARNU3 Association. The Hybrid White Spruce-Douglas-Fir/Gooseberry/Wild Sarsaparilla Site Association described for the southern interior of British Columbia (Braumandle and Curran 1992) is also a similar type. However, this type contains more spruce and subalpine fir than the THPL/ARNU3 Association described for the Colville N.F.



Aralia nudicaulis
wild sarsaparilla

THPL/CLUN ASSOCIATION CCF2 21
Thuja plicata/Clintonia uniflora
western redcedar/queencup beadlily

DISTRIBUTION AND ENVIRONMENT

The THPL/CLUN Association is the most common and widely distributed western redcedar association on the Colville N.F. It occurs on all districts (Figure 122) and encompasses a broad range of habitat conditions within its geographic range. It is especially common on the Kettle Falls and Colville Ranger Districts. Aspects are variable and most sites are between 2,500 and 4,500 ft. (Figure 123). Elevations of plots range as high as 5,280 ft. (Table 76). This association indicates some of the driest sites normally capable of supporting western redcedar as a climax dominant. When within the geographic range of western hemlock, this community is restricted to relatively warm and dry sites.

The regolith is volcanic ash deposits overlying glacial till or outwash. The glacial deposits are comprised of a variety of bedrock types including both calcium rich and granitic rock types. Humus depths range between 2 and 10 in. (5-25 cm) in depth. Many of these stands are in early stages of succession because of the stand-replacement fires which burned much of the Forest earlier this century. This factor, combined with the relatively dry nature of these sites, makes further

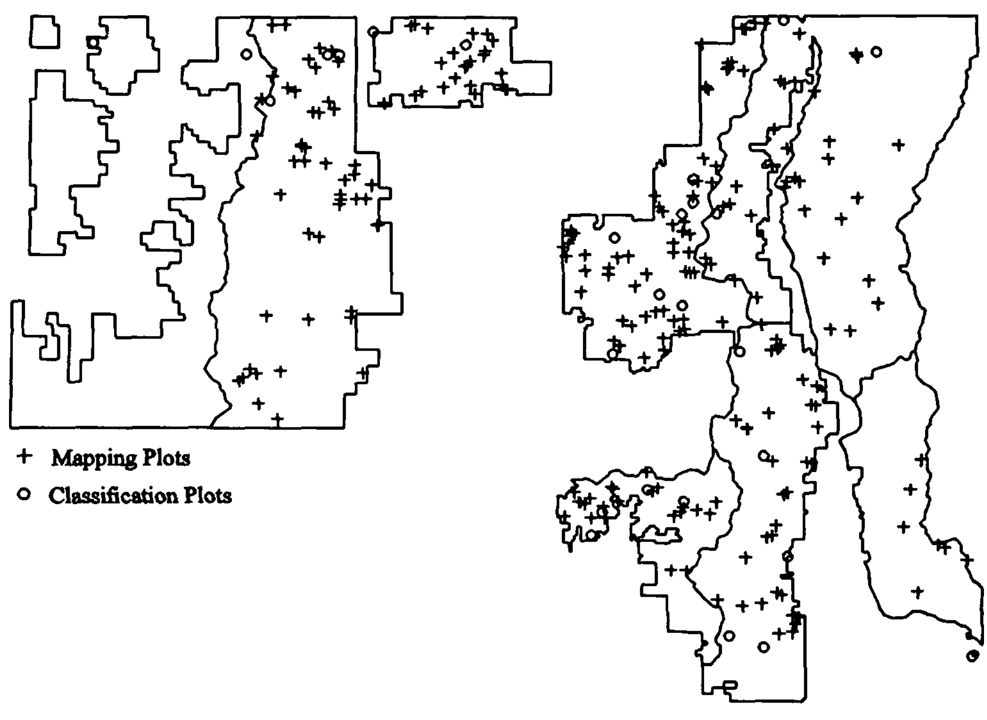


Figure 122. Plot locations for the THPL/CLUN Association (n=270).

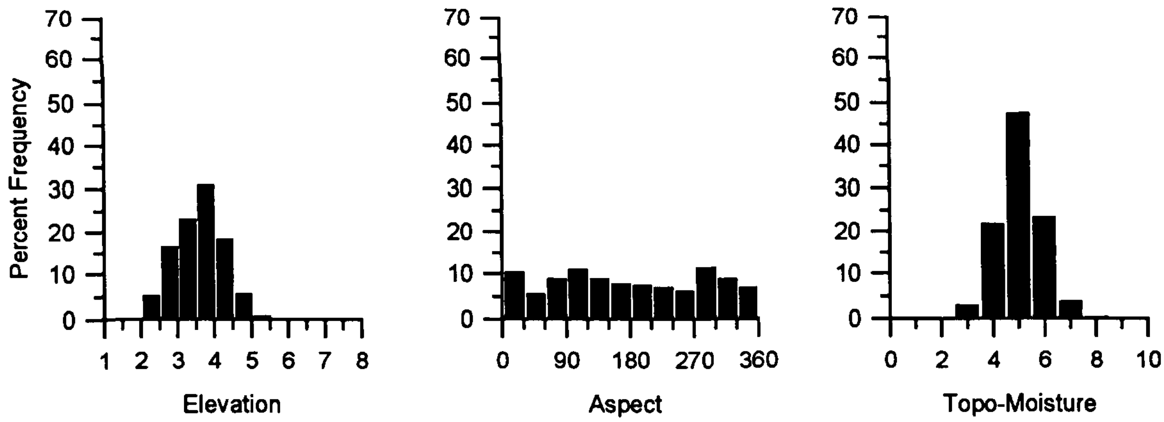


Figure 123. Frequency ofTHPL/CLUN plots by elevation (1000 ft.), aspect, and topographic moisture.

successional or classification interpretations of these sites difficult. The THPL/CLUN type grades into the TSHE/CLUN or THPL/ARNU3 Association with increasing site moisture and into Douglas-fir or Grand Fir Series associations with decreasing site moisture.

VEGETATION

Douglas-fir, western larch and (occasionally), ponderosa pine dominate the overstory of most early to nud-seral stands. Lodgepole pine may dominate young stands (< 100 yrs). Grand fir and western redcedar comprise a subordinate sub-canopy in mid-serai stands that gradually increases in dominance as stands age. Grand fir often establishes in a stand at nearly the same time as Douglas-fir or western larch. However, slow early growth keeps it subordinate until superior shade tolerance and vigorous later growth give it more prominence. Grand fir often seems to peak m prominence near the 150 year mark in stand development. Western redcedar establishment will often be delayed several decades past stand initiation. Late serai and climax stands are

Table 75. Common plants of the THPL/CLUN Association (n=31).

		CON	COVER
TRRR DVERSTORY LAYER			
LAOC	western larch	90	12
PSME	O0''^_1''	o7	21
THPL	western redcedar	68	34
TREE IJNDERSTORY LAYER			
^HPL	western redcedar	90	6
ABGR	grand fir	71	4
SHRUBS AND SUBSHRUBS			
PAMY	pachistima	84	10
LIBOL	twinflower	81	12
CHUM	w. prince's pine	77	5
ROGY	baldhiprose	77	5
ACGLD	Douglas maple	71	4
BEAQ	Oregon grape	68	4
LOUT2	Utah honeysuckle	65	2
ironiio Hr'.KH'^			
^^	round-leaved violet	68	2
cLUN	queencup beadlily	65	4
QQOB	w. rattlesnake plantain	61	2
SMST	starry solomonplume	58	4

Table 76. Environmental and structural characteristics of the THPL/CLUN Association.

	Mean	S.D.	Min	Max
Environment'				
Elevation	3565	630	2240	5280
Aspect[2]	29	71	1	360
Slope	26	16	1	85
Topographic Moisture	5.04	0.87	3.0	8.0
Soil Surface[3]				
Exposed soil	44	35	0	98
Gravel	14	10	1	38
Rock	5	9	0	38
Bedrock	0	0	0	0
Moss	3	2	1	10
Lichen	1	1	0	2
Litter	53	34	0	98
Diversity"				
Richness	25.2	10.0	7	50
N2	7.5	4.1	2	18

' Values for environmental variables were generated using both classification plot and mapping plot data (n=273).
[2] The mean and standard deviation values for aspect are calculated using statistical formulae for circular data (Batschletl981).
[3] Soil surface characteristics in percent cover.
[4] Richness and heterogeneity, N^, are expressed as average number of species per plot.

assumed to be dominated by western redcedar. Grand fir and Douglas-fir will persist late in the sere and grand fir may be co-climax on the driest sites within the type.

Western redcedar clearly dominates reproduction in older stands while grand fir exhibits a decline in reproductive success in stands over 100 years old. Abundant Douglas-fir regeneration occurs only in early serai stands where lodgepole pine and/or ponderosa pine are prominent in the overstory. Ponderosa pine may be common on warm, well-drained sites where there has been a pattern of repeated underbums. Such sites are often associated with ninebark and oceanspray. Western white pine is poorly represented in the data, though prior to the introduction of white pine blister rust, it was a major serai species well adapted to occasional intense fires.

Shrub cover and composition is highly variable. Twinflower, pachistima, baldhip rose, Douglas maple, Utah honeysuckle, and shiny-leaf spirea are all likely to occur. Snowbrush ceanothus, redstem ceanothus, serviceberry, thimbleberry, common snowberry and ninebark may be locally well represented depending on stand structure, age and disturbance history. The herb layer is also variable in composition and cover dependent on stand history, density and age. No herbs exceed 75% constancy and only "Pachistima union" indicators such as queencup beadlily, round-leaved violet and

Figure 124. Photo of the THPL/CLUN Association.

starry solomonplume are relatively common.

THPL/CLUN has the lowest average overall species diversity of all types in the Series (Table 76). This low average diversity is undoubtedly related to the number of depauperate stands in the data for the type. Both richness and dominance rank at the bottom, although these figures are close to average for the Forest as a whole. Stands with "depauperate" shrub and herb layers are often encountered. Such stands have few or no shrubs and herbs or very low cover for the species present. Presently we retain most such sites in the THPL/CLUN Association; viewing the paucity of shrubs and herbs as transitory and more related to tree canopy densities and litter accumulations than to intrinsic site factors.

MANAGEMENT IMPLICATIONS

Wildlife/Range- Stands with multiple tree canopies provide excellent habitat for arboreal mammals and birds. Multiple tree and shrub canopies common in mid-seral (100-200 year) stands provide considerable forage and shelter for a wide variety of wildlife species. A large variety of bird and mammal species utilize these stands for either thermal and hiding cover or forage. This is due in part to their extensive distribution across the landscape. Palatable domestic livestock herbage is lacking in most stands but early serai stages may provide moderate herbage.

Silviculture- Tree productivity is good on these sites. Shrub and herb competition and soil compaction are the main limitations to intensive timber management. Avoid soil compaction and nutrient and organic matter depletion by following the guidelines of Harvey *et al.* (1987). Soil organic matter content and porosity are both very important soil properties to consider during planning.

Both even- and uneven-aged management techniques can be used on these sites due to the moderate environment and variety of serai species which are present. Individual and group selection techniques should favor western redcedar and grand fir. Adequate natural regeneration of western larch and Douglas-fir should result from seedtree or shelterwood treatments. Regeneration on drier aspects is enhanced by shelter from residual overstory trees (Ferguson *et al.* 1986). Serai species such as ponderosa pine, western larch, or Douglas-fir may be enhanced by underbuming in combination with shelterwood or selection cutting techniques (Amo and Davis 1980). In general, prescribed burning seems to enhance regeneration of serai species, particularly on clearcuts (Smith and Fischer 1995). Burning may also increase the potential for natural regeneration on these sites by reducing seed-destroying insects for 1-2 years after fire (Fellin and Kennedy 1972). However, both burning and bulldozer activity resulted in significant increases in the bulk density of soil samples taken 10-12" below the surface.

COMPAMSONS

The THPL/CLUN Association is part of the THPL/PAMY Association of Daubenmire and Daubenmire (1968). They identified the THPL/PAMY type as the only upland western redcedar association. The THPL/CLUN Habitat Type-CLUN Phase described for Montana (Pfister *et al.* 1977) and northern Idaho (Cooper *et al.* 1991) includes the THPL/CLUN Association as described for the Colville N.F. Clausnitzer and Zamora (1987) describe a THPL/LIB02 Habitat Type on the Colville Indian Reservation which appears to have significant overlap in environment with the THPL/CLUN type. Several of those plots would have keyed to the THPL/CLUN Association. Likewise, Braumandl and Curran (1992) describe a Western Redcedar-Hybrid Spruce/Falsebox Site Association for the southern interior of British Columbia which contains environments representative of the THPL/CLUN Association. However, the type contains more subalpine fir and Engelmann spruce than the THPL/CLUN Association described for the Colville N.F.

THPL/OPHO ASSOCIATION CCS2 11
Thuja plicata/Oplopanax horridum
western redcedar/devil's club

DISTRIBUTION AND ENVIRONMENT

The THPL/OPHO Association is a minor but distinctive meso-riparian plant community on the Colville N.F. It is found on the four ranger districts east of the Kettle Mountain Crest (Figure 125), but is most common on the Newport and Sullivan Lake Ranger Districts. Aspects and elevations are variable. The majority of sites are at elevations between 2,500 and 4,500 ft. (Figure 126). The THPL/OPHO Association occurs on wet bottomlands, benches or seep areas on side slopes, usually as narrow and sometimes intermittent "stringers". These stands are often small and fragmented, making it difficult to find uniform areas large enough to sample. Hummocky ground next to or between stream channels or associated with old root-wads combined with large downed woody material are common characteristics of these sites.

The regolith is alluvium derived from a variety of rock types. Volcanic ash is often present in the upper profile and sometimes forms an "ash cap". Soils are dark in color, high in organic matter, and poorly drained. Litter cover is commonly high but humus layers were only 2 to 5 in. (5-13 cm) in depth. Apparently the relatively thin humus layers are due to rapid decay on these wet sites. High

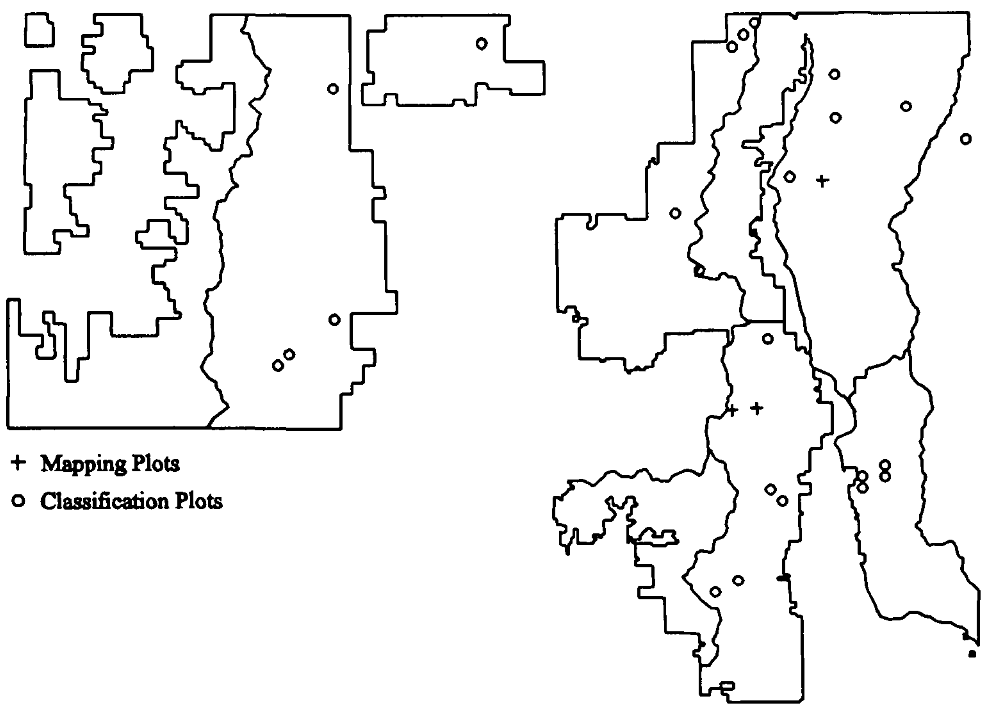


Figure 125. Plot locations for the THPL/OPHO Association (n=31).

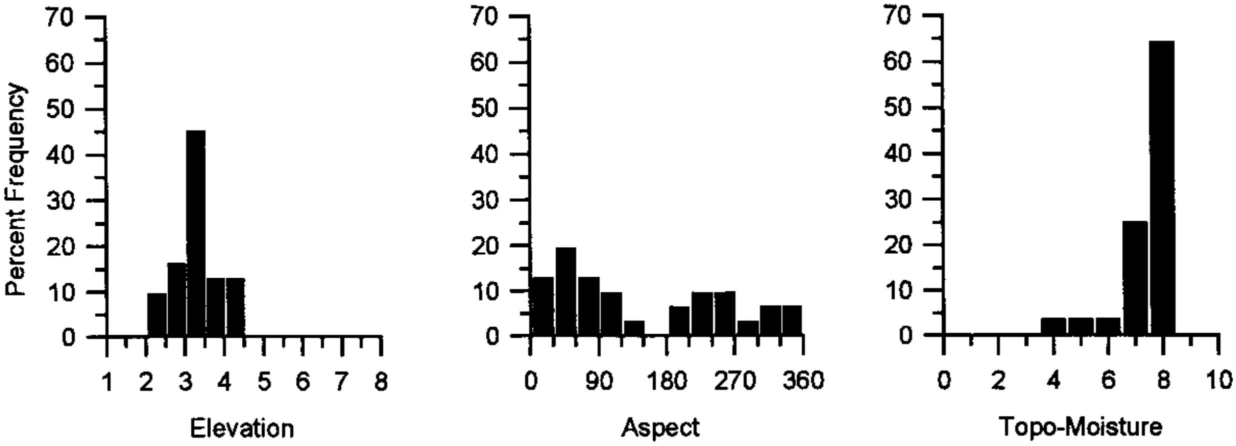


Figure 126. Frequency of THPL/OPHO plots by elevation (1000 ft.), aspect, and topographic moisture.

water tables with standing surface water in old stream channels and holes created by windthrown trees are characteristic features. Exposed rock or gravel at the soil surface is common, especially next to flowing water or in abandoned stream channels. Somewhat drier sites with better drained soils are typically in the TSHE/GYDR Association.

VEGETATION

The THPL/OPHO Association characterizes one of the wettest sites that normally support conifers on the Forest. The overstory of mature stands typically contains two or more layers. Western redcedar usually forms a lower canopy while Douglas-fir, grand fir or western hemlock comprise the open, emergent layer. Western hemlock is commonly restricted to drier microsites such as old root-wads, stumps, short snags and logs. Engelmann spruce or white spruce did not occur in the sample plots, but either of these species

Table 77. Common plants of the THPL/OPHO Association (n=6).

		CON	COVER
TREE OVERSTORY LAYER			
THPL	western redcedar	100	35
TSHE	western hemlock	100	23
ABGR	grand fir	100	13
TREE UNDERSTORY LAYER			
TSHE	western hemlock	100	2
THPL	western redcedar	67	4
SHKLJB&AND SUBSHRUBS			
OPHO	devil's club	100	9
ACGLD	Douglas maple	83	3
RILA	prickly currant	67	2
HEKB,S			
ATFI	lady-fern	100	29
GYDR	oak-fern	100	23
ASCA3	wild ginger	100	7
TIUN	coolwort foamflower	100	7
CLUN	queencup beadlily	100	4
ACRU	baneberry	100	4
CIAL	circaea	100	2
GATR	sweetscented bedstraw	100	2
SMST	starry solomonplume	83	9
STAM	claspleaf twisted-stalk	83	3
DIHO	Hooker fairybells	83	3
ADBI	pathfinder	83	2

Table 78. Environmental and structural characteristics of the THPL/OPHO Association.

	Mean	S.D.	Min	Max
Environment[1]				
Elevation	3332	559	2320	4400
Aspect[2]	38	67		
Slope	11	12	2	67
Topographic Moisture	7.42	0.99	4.0	8.0
Soil Surface[3]				
Exposed soil	15	13	1	30
Gravel	9	5	3	12
Rock	10	19	0	38
Bedrock	0	0	0	0
Moss	5	0	1	5
Lichen	0	0	0	0
Litter	28	13	15	40
Diversity[4]				
Richness	26.5	1.6	24	29
N2	8.0	2.8	5	13

[1] Values for environmental variables were generated using both classification plot and mapping plot data (n=31).
[2] The mean and standard deviation values for aspect are calculated using statistical formulae for circular data (Batschlet 1981).
[3] Soil surface characteristics in percent cover.
[4] Richness and heterogeneity, N2, are expressed as average number of species per plot.

may be present as minor serai components. Analogs of this type described for Montana (Pfister *et al.* 1977) and northern Idaho (Cooper *et al.* 1991) both have one or the other of the above species in their plots. Western redcedar and/or western hemlock dominate the regeneration layers in late serai or climax stands.

Grand fir and Douglas-fir are common in early to mid-seral stands but are restricted to drier microsites. Microsite variation strongly affects vegetation composition. Species that grow best on mounds require better drainage than that available in the wet swales between hummocks.

The undergrowth is characterized by a rich variety of shrubs, herbs and ferns beneath a layer of devil's club. Devil's club is the most constant and abundant shrub and is diagnostic of the association (if well represented). Other common shrubs include Douglas maple, twinflower, prickly currant and Pacific yew. Lady-fem is usually abundant, and has higher cover than devil's club in most stands. Oak-fem forms a nearly continuous layer under the lady-fern and devil's club. Wild ginger, arrowleaf groundsel, claspleaf twisted-stalk, Hooker fairybells, pathfinder, coolwort foamflower, queencup beadlily, wild sarsaparilla, and baneberry are other common herbs that indicate wet to moist habitats.

Figure 127. Photo of the THPL/OPHO association

This association ranks third of the four types in the Series in both richness and dominance (Table 78) and close to average for the Forest as a whole. Although very moist to wet habitats support lush vegetation, they seldom have the highest concentrations of species. Wet soils and competition by meso- or hydrophytic obligates exceeds the ability of many species to survive.

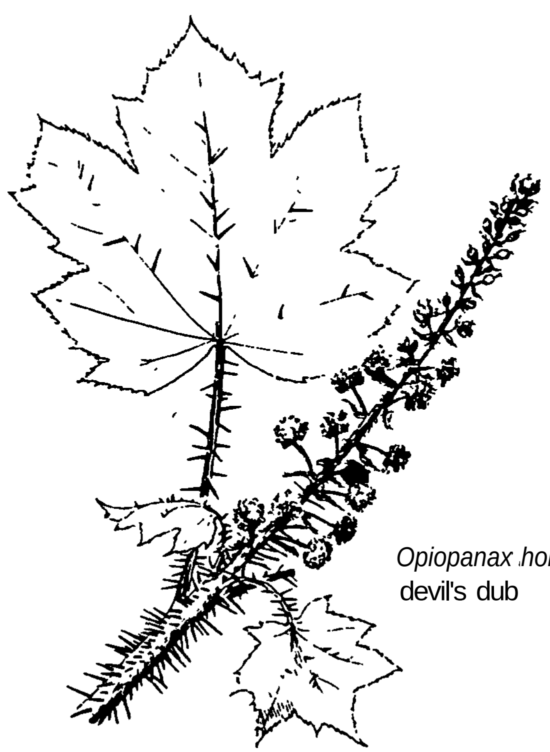
MANAGEMENT IMPLICATIONS

WUdlife/Range- Despite limited acreage, the type is an important landscape element. Wet forests are important for species diversity, water, shelter and refagia during major fires. The association is valuable riparian habitat for many species of wildlife, offering water, cover and forage. Big game may seek out the lush forbs and use these sites for wallows, and elk relish the spiny leaves of devil's club. In addition, due to the large size many of the cedar or hemlock attain in this type, these sites may represent important habitat for species dependent upon old-growth stand structures. Sites in these "cedar-hemlock bottoms" may represent the only remaining old-growth in some areas of the forest where most of the surrounding uplands have burned. The humid conditions also attract a large variety of insects, which in turn attract avian species. Domestic livestock use in the type is low except as access to water and for shade. As with many types of riparian plant communities, concentrated cattle use can destroy the plant cover of these sites, so use should be monitored very closely.

Silviculture- Timber productivity as estimated by basal area and SDI is high (appendix 2), but good site index estimates are difficult to obtain because of the high proportion of defective and diseased trees present in most natural stands. High water tables and riparian conditions severely limit silvicultural options. The association is not well suited to intensive timber management. Managers should consider other values when managing these stands because of high wildlife and watershed values and the difficulty of assuring regeneration after harvest. Soils are subject to compaction and flooding, making harvesting and road building very difficult. Natural stands normally have a high percentage of "cull" trees from rot, multiple tops or dead tops. Opening the overstory canopy often results in windthrow. The type is poorly suited to recreation developments and trails because of the swampy conditions. The type is biologically rich but sensitive to disturbance.

COMPARISONS

The THPL/OPHO association has been previously described first for northern Idaho and eastern Washington (Daubenmire and Daubenmire 1968) and, subsequently, Montana (Pfister *etal.* 1977) and northern Idaho (Cooper *et al.* 1991). Kovalchik (1993) describes an identical THPL/OPHO Association for riparian sites in eastern Washington. Braumandl and Curran (1992) also describe a very similar Western Redcedar-Hemlock/Devils Club/Lady Fem Site Association for the southern interior of British Columbia. The type is also comparable to the Opiopanaceton (Devil's Club) Association described by Bell (1965) for central British Columbia.



Opiopanax horridum
devil's dub

THPL/VAME COMMUNITY TYPE CCS3 11

Thuja plicata/Vaccmium membranaceum
western redcedar/big huckleberry

DISTRIBUTION AND ENVIRONMENT

The THPL/VAME Community Type is found on all districts east of the Kettle Mountain Crest (Figure 128). This type typically occupies mid- to upper-slope positions on west to east (northerly) aspects. Stands are usually between 3,000 and 5,000 ft. (Figure 129). This plant community is very heterogeneous as it occurs across a broad range of habitat conditions. This type generally occupies the highest elevations within the Western Redcedar Series (considering modal sites). Stand structures and presence of western redcedar and big huckleberry are presently the main unifying characteristics for this type.

The regolith is volcanic ash deposited over glacial outwash and till. Surface soil textures are usually sandy. Nearly half of the soil profiles used for this description have a compacted subsoil. Roots do not penetrate the compacted layers and become concentrated in the upper soil horizons. Humus and duff depths show considerable variation, ranging between 2 and 12 in. (5-30 cm). Only one of six soil profiles had humus and duff over 5 in. (13 cm). This site supported a dense stand of thimbleberry, perhaps indicating the site was more moist than normal.

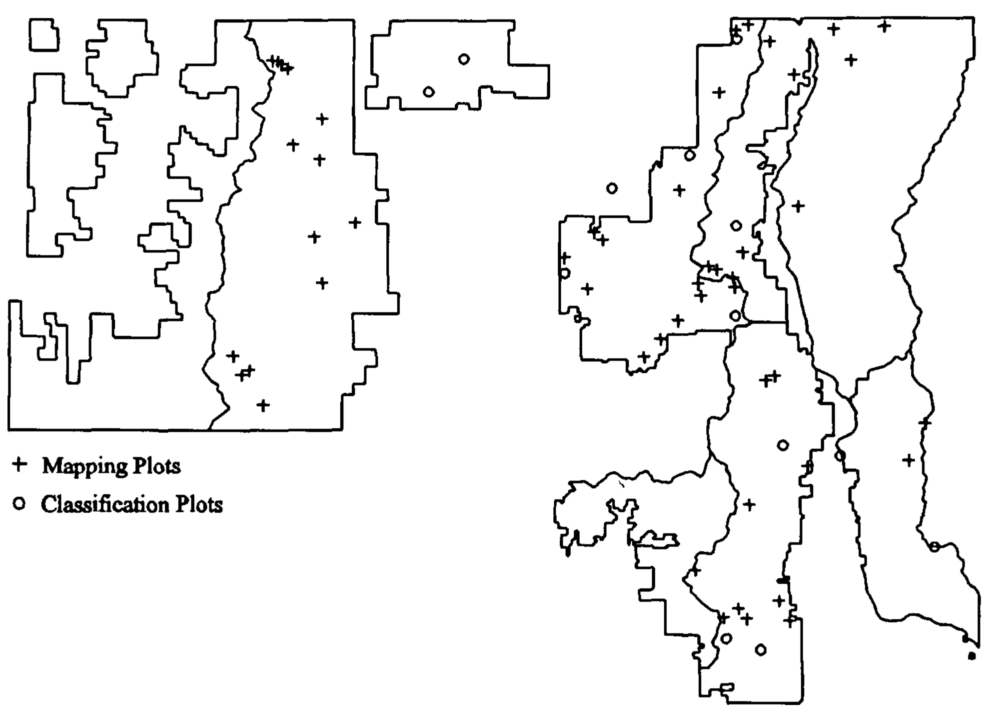


Figure 128. Plot locations for the THPL/VAME Community Type (n=72).

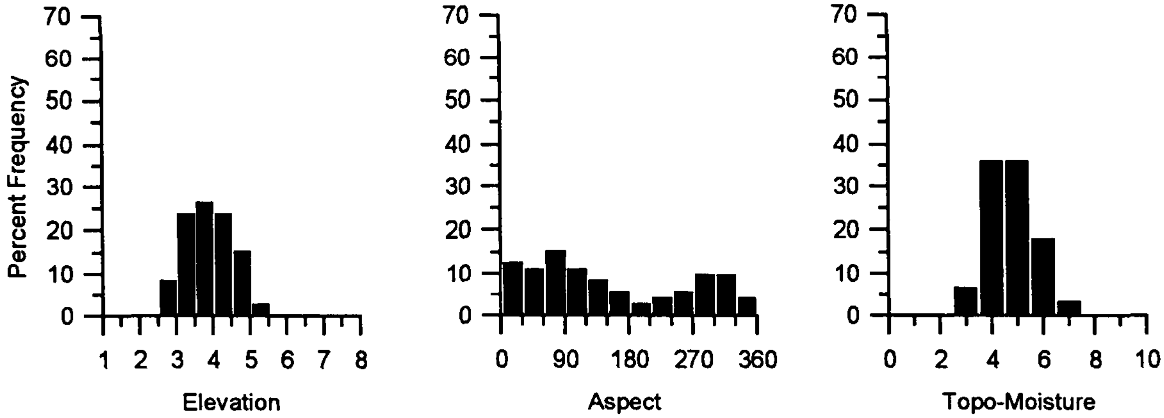


Figure 129. Frequency of THPL/VAME plots by elevation (1000 ft.), aspect, and topographic moisture.

Very hot, large fires appear to be the originating factors in at least some stands but repeated underburning may be important on other sites. Fire evidence in the form of snags, charred stumps, charcoal and scarred trees is common. We speculate that relatively recent intense fires or activities related to homesteading removed much of the soil organic materials and nutrients such that species compositions are not yet adjusted to the local climate and soil potential.

VEGETATION

Western larch, Douglas-fir, lodgepole pine or a mixture of these three species dominates the overstory of this community type. Grand fir and western redcedar occasionally form significant components of the overstory. Western redcedar and grand fir will increase in dominance as stands age. Succession is slow to the more shade tolerant and environmentally restricted

Table 79. Common plants of the THPL/VAME Community Type (n=20).

		CON	COVER
TREE OVERSTORY LAYER			
PSME	Douglas-fir	95	19
LAOC	western larch	95	15
ABGR	grand fir	70	8
PICO	lodgepole pine	65	19
THPL	western redcedar	55	11
TREE UNDERSTORY LAYER			
THPL	western redcedar	100	4
PSME	Douglas-fir	80	4
ABGR	grand fir	65	4
SHRUBS AND SUBSHRUBS			
VAME	big huckleberry	95	14
PAMY	pachistima	95	7
ROGY	baldhip rose	95	4
LOUT2	Utah honeysuckle	80	4
BEAQ	Oregon grape	80	3
CHUM	w. prince's pine	75	5
LIBOL	twinflower	70	16
SPBEL	shiny-leaf spirea	70	5
ARUV	bearberry	55	4
HERBS			
VIOR2	round-leaved violet	90	4
CLUN	queencup beadlily	85	4
SMST	starry solomonplume	65	4

Table 80. Environmental and structural characteristics of the THPL/VAME Community Type.

	Mean	S.D.	Min	Max
Environment[1]				
Elevation	3852	638	2640	5180
Aspect[2]	63	60		
Slope	24	15	2	67
Topographic Moisture	4.75	0.94	3.0	7.0
Soil Surface[3]				
Exposed soil	25	13	10	50
Gravel	22	13	12	38
Rock	15	18	0	38
Bedrock	0	0	0	0
Moss	2	1	1	5
Lichen	0	1	0	2
Litter	37	18	20	70
Diversity[4]				
Richness	30.1	4.6	20	37
N2	11.3	3.5	6	18

[1] Values for environmental variables were generated using both classification plot and mapping plot data (n=72).
[2] The mean and standard deviation values for aspect are calculated using statistical formulae for circular data (Batschlet 1981).
[3] Soil surface characteristics in percent cover.
[4] Richness and heterogeneity, N3, are expressed as average number of species per plot.

western redcedar.

Some sites may be successional to western hemlock. Many plots in the type are within the geographic range of western hemlock with suitably deep soils and maritime climate. It is possible that intense conflagrations preceding the current stands removed seed sources and destroyed essential organic seed beds. A century or more may be required to restore organic matter and nutrients after a severe disturbance to pre-disturbance levels (Harvey *et al.* 1987).

The shrub layer is floristically variable but high in total cover. The open nature of these stands may account for much of the shrub vigor. Big huckleberry, pachistima and baldhip rose are present on nearly all plots. Other common shrubs include bearberry, twinflower, Utah honeysuckle, mountain ash, shiny-leaf spirea and thimbleberry. Low huckleberry is abundant in some stands and may be the only huckleberry present on some sites.

Herbs are variable in occurrence and cover. Queencup beadlily is present in most plots but the presence of other herbs appears dependent on shrub density, microsite variation and disturbance history. Starry solomonplume and round-leaved violet are the only herbs other than queencup

Figure 130. Photo of the THPL/VAME Community Type.

beadlily with more than 50% constancy. False bugbane, pinegrass and western meadowrue may be well represented, but are present in only a few stands. THPL/VAME has highest average overall diversity in the Series, including both species richness and dominance (Table 80). This is to be expected from sample plots that include only early-seral stands where diversity is often high. As such stands mature, species richness will begin to decline. Structural diversity (not measured) will likely tend to increase as canopy structure becomes more complex.

Some stands in the THPL/VAME Community Type appear to be on sites similar to those supporting both the PICO/SHCA Community Type and the THPL/ARNU3 Association. We speculate that such areas may have burned intensely one or more times with subsequent reductions of nutrient pools and organic matter levels such that the sites have not yet fully recovered. Similar vegetation patterns exist on sites that were cleared and used as fields.

MANAGEMENT IMPLICATIONS

Wildlife/Range- These sites have obvious wildlife forage value due to the presence of big huckleberry in the stands. Big huckleberry provides food and cover for a variety of big game, small mammal, and avian species. Wildlife values for thermal cover are high because of the mix of shrub species and the relatively warm sites that become snow-free earlier than most sites in the Subalpine Fir or Western Hemlock Series. Dense pole-size stands may be valuable for wildlife cover. Early successional stands may be more useful to wildlife, especially if shrub cover is high. Mature stands provide low to moderate amounts of herbage for livestock but early serai stages may provide considerable herbage. There was little evidence of livestock use in the sample plots.

Silviculture- THPL/VAME sites have the lowest productivity in the Western Redcedar Series (appendix 2), though are still relatively productive. Past disturbance intensity, loss of nutrients and organic matter, and compacted soils may all contribute to lower productivity. Western larch and Douglas-fir have reasonably good site indexes. Grand fir was measured on only one plot but that stand had good growth rates. Basal areas in most stands are fairly low, so limitations to stocking apparently exist. Avoid further soil compaction, and nutrient and organic matter depletion by following the guidelines of Harvey *et al.* (1987). Soil organic matter content and porosity are both very important soil properties to consider during planning. Treatments such as whole tree harvest should be avoided so as to reduce nutrient and organic matter losses. Equipment should be restricted to the least amount of area as possible because of the danger of soil compaction.

Both even- and uneven-aged management techniques can be used due to the moderate moisture and temperature regimes and serai species which are present. When western larch is the dominant serai species on north-facing slopes, Barrett (1982) recommends even-aged management with broadcast burning. However, bothLarsen (1922) and Stickney (1982) report that clearcutting may create sites too harsh for adequate tree regeneration. Regeneration on drier southern aspects is enhanced by shelter from residual overstory trees (Ferguson *et al.* 1986).

Broadcast burning generally stimulates Douglas maple, russet buffaloberry, serviceberry and big huckleberry but will reduce soil nutrients and organic matter. Serai species such as ponderosa pine, western larch, or Douglas-fir may be enhanced by underbuming in combination with shelterwood or selection cutting techniques (Arno and Davis 1980). In general, burning seems to enhance regeneration of serai species, particularly on clearcuts (Smith and Fischer 1995). Burning may also increase the potential for natural regeneration on these sites by reducing seed-destroying insects for 1-2 years after fire (Fellin and Kennedy 1972).

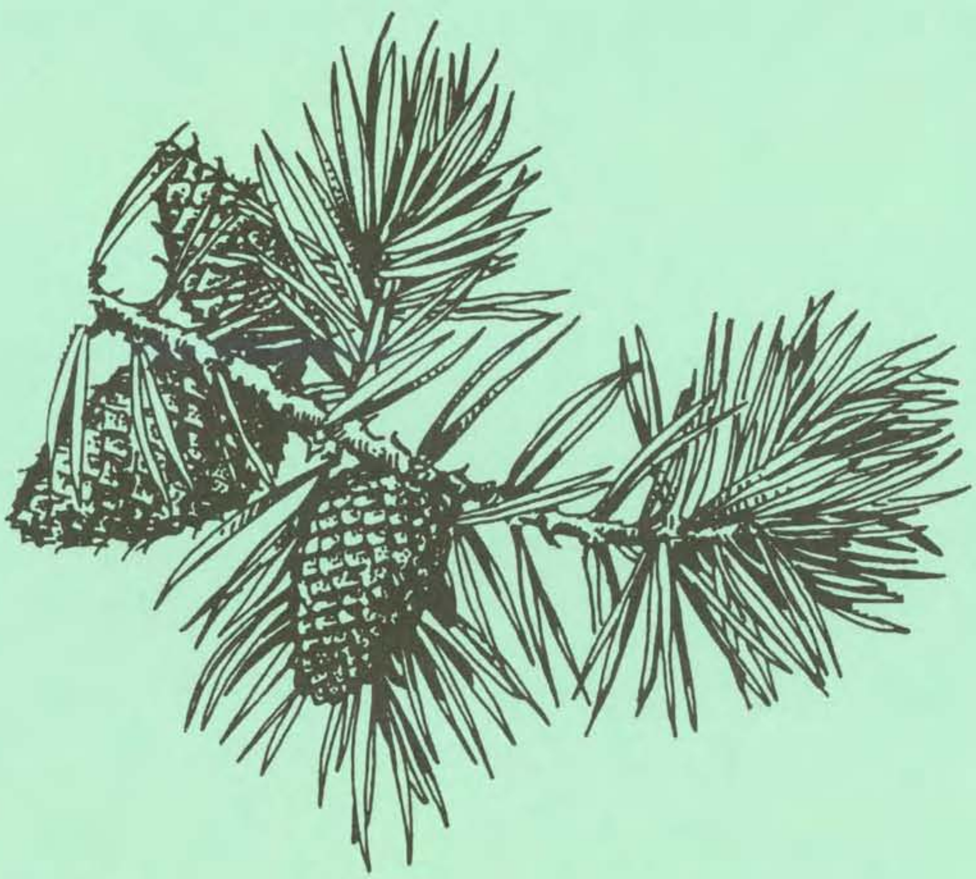
COMPARISONS

The THPL/VAME Community Type has not been described in the Pacific Northwest before. The THPL/CLUN Habitat Type-XETE Phase of Cooper *etal.* (1991) resembles some of our plots but beargrass is less common in northeast Washington compared to northern Idaho. Two stands sampled on the Colville N.F. have beargrass and would key to their type. The THPL/VAME Community Type is similar to the THPL/CLUN Habitat Type-VAGL Phase described in Montana (Pfister *et al.* 1977). It is also part of the THPL/PAMY Habitat Type described by Daubenmire and Daubenmire (1968) for eastern Washington and northern Idaho. Clausnitzer and Zamora (1987) describe a THPL/LIB02 Habitat Type on the Colville Indian Reservation which appears to have significant overlap in environment with the THPL/VAME type. Several of those plots would have keyed to the

THPL/VAME Community Type. Likewise, Braumandl and Curran (1992) describe a Lodgepole Pine-Douglas-Fir/Sitka Alder/Pinegrass Site Association for the southern interior of British Columbia which contains environments and species similar to the THPL/VAME Community Type. However, the type contains more Sitka alder and pinegrass and less big huckleberry than the THPL/VAME Community Type.

Vacclnium membranaceum
big huckleberry

OTHER VEGETATION TYPES



PIAL ASSOCIATIONS CAG112

Pinus albicaulis
whitebark pine

DISTRIBUTION AND ENVIRONMENT

Whitebark pine stands are generally limited to the higher peaks along the Kettle Mountain Crest and in the Salmo-Priest Wilderness (Figure 131). Whitebark pine occur on dry, windswept, southerly to westerly slopes near upper timberline, generally above 6,000 ft. (Figure 132). Severe insolation, winter desiccation and snow removal by wind are characteristic of the sites. Whitebark pine stands are so limited in extent and ravaged by wildfires and blister rust during the last century that we have little data other than observations. This type was not sampled on the Colville N.F. but stands have been observed and skeleton forests from fire, blister rust and insects are present on some of the higher peaks. Data from Okanogan N.F. plots are used to describe the type. Whitebark pine associations occurring on the Colville N.F. will be described in greater detail in future publications after adequate sampling. Whitebark pine types may be bounded by mountain big sagebrush, mountain snowberry or graminoid dominated communities which include such species as Idaho fescue or green fescue.

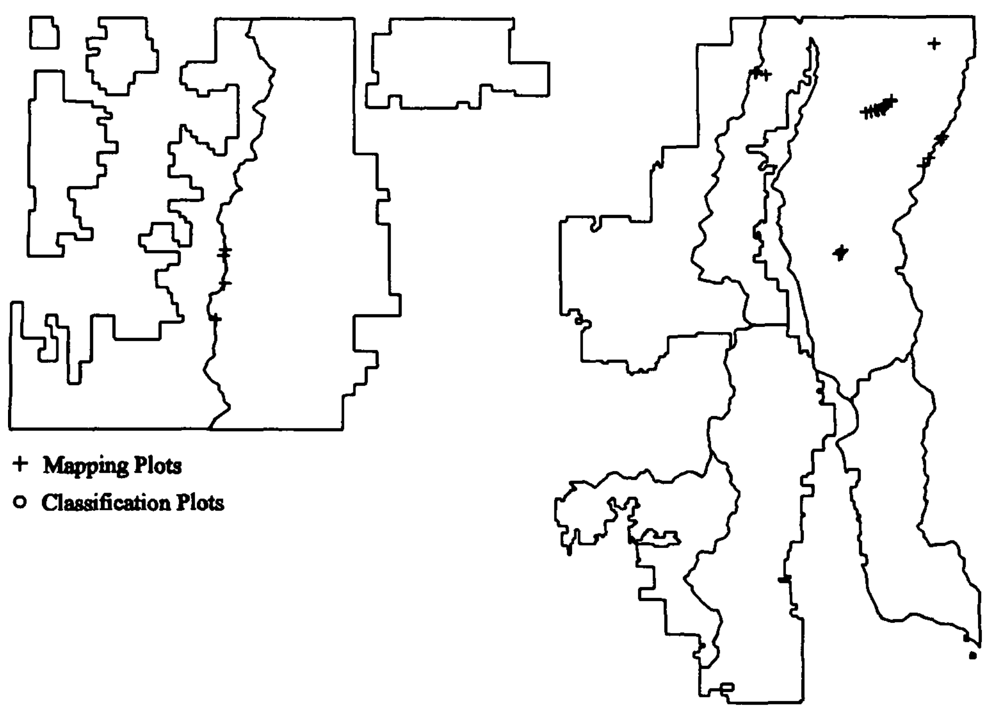


Figure 131. Plot locations for the Whitebark Pine Series on the Colville N. F. (n=28).

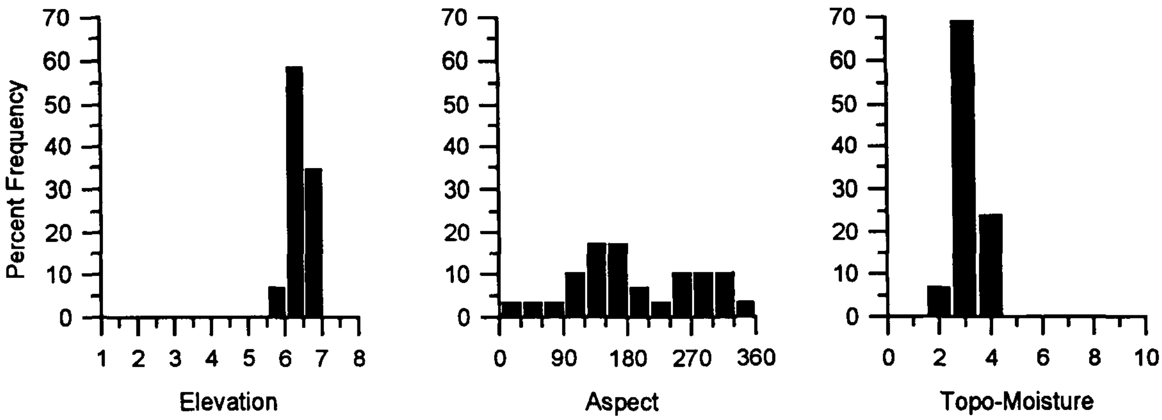


Figure 132. Frequency ofPIAL Series plots by elevation (1000 ft.), aspect, and topographic moisture.

VEGETATION

Sites dominated by whitebark pine are lumped into one type at present because of limited data. However, species composition and sites are sufficiently diverse that several associations could be described *(See* Lillybridge *et al.* 1995). Ongoing work in subalpine environments will add to our understanding of these complex systems. Late serai and climax stands on the Forest have not been seen because of widespread fires and infection by blister rust *(Cronartium ribicold).* Data from other areas and published descriptions of whitebark stands in Montana (Pfister *et al.* 1977, Williams and Lillybridge 1983) are used to help describe the type.

Stands rarely develop a closed canopy because of harsh environmental conditions. Multi-stemmed trees are common. Whitebark pine should dominate mature, natural stands. However, most Colville N.F. stands are now "ghost forests" of dead

Table 81. Common plants of the PIAL Series (n=6).

		CON	COVER
TREE OVERSTORY LAYER			
PIAL	whitebark pine	100	13
PSME	Douglas-fir	50	15
ABLA2	subalpine fir	50	7
TREE IJNDERSTORY LAYER			
PIAL	whitebark pine	83	2
SHRUBS AND SUBSHRUBS			
PAMY	pachistima	67	2
VASC	grouse huckleberry	50	3
JUC04	common juniper	17	30
HERBS			
CARU	pinegrass	100	10
ACMI	yarrow	100	5
ERIOG	buckwheat spp.	83	6
CARO	Ross sedge	67	6
CASTI	paintbrush spp.	67	2
FEID	Idaho fescue	50	6
ASTER	aster spp.	50	4
POA	bluegrass spp.	50	4
SENEC	groundsel spp.	50	3
HIERA	hawkweed	50	3
ANTEN	pussytoes spp.	50	3

Figure 133. Photo of the PIAL Series.

and down whitebark pine, composed of old burned or rust-killed skeletons on the tops of some of the higher peaks while living trees are scarce or absent. Although whitebark pine is the most common tree, subalpine fir, Engelmann spruce, Douglas-fir and lodgepole pine may be present depending on local conditions and elevations. Lodgepole pine and Douglas-fir are more common at lower elevations. Other tree species are usually limited to small, sheltered areas with more favorable microsites provided by the whitebark pine trees. Snow accumulations are greater and melting is delayed on the lee-side of existing whitebark trees, thereby creating more favorable microsites.

Extensive conflagration fires in the last 100 years killed most or all of the fire sensitive and highly flammable whitebark pines. These areas may remain virtually free of living trees for decades while old snags give mute evidence of former forested or wooded stands. Forest development on high elevation windswept slopes often requires hardy whitebark pines to form sheltered microsites for subalpine fir. High elevation habitats are often so severe that even climax stands of subalpine fir have fairly open canopies. At elevations where whitebark pine is a major stand component, individual subalpine firs are often stunted and distorted; reproducing mainly by layering. Shrubs have low coverages and most individuals are sheltered by rocks. Pinegrass is the most common and constant herb. Other herbs are variable in constancy and cover, though smooth woodrush and Drummond's rush *(Juncus drummondii)* have been observed to dominate some sites.

MANAGEMENT IMPLICATIONS

Wildlife/Range- Whitebark pines have edible seeds, "pine nuts", which serve as important forage for a wide variety ofwildlife including squirrels, grizzly bears and dark's nutcrackers, dark's nutcracker also plays an important ecological role in the seed dispersal ofwhitebark pine, with seed caches often germinating. In Wyoming, squirrels were the major seed predator ofwhitebark pine seeds (Hutchins 1994). These slopes are among the first to green up in the spring making them important forage areas for many wildlife species. Livestock often make heavy use of the grasses, sedges and herbs typical of the type. Sites are slow to recover from grazing because of shallow rocky soils, drought and short growing season.

Silviculture- Tree growth and stocking are low to very low. No techniques are known to assure reforestation. Overstory removal increases potential for severe frost heaving, winter desiccation and drought, and alters snow pack patterns and melting regimes. Whitebark pine wood is highly flammable even when green and the dry, windswept upper slope locations are predisposed to lighting strikes. Only the sparse, discontinuous cover typical of the habitat allows stands to reach maturity. Frost is possible any night of the year. Whitebark pine is host to mountain pinebeetle, and is often killed when the tree achieves a large size, particularly if there is an epidemic in progress in nearby lodgepole pine stands.

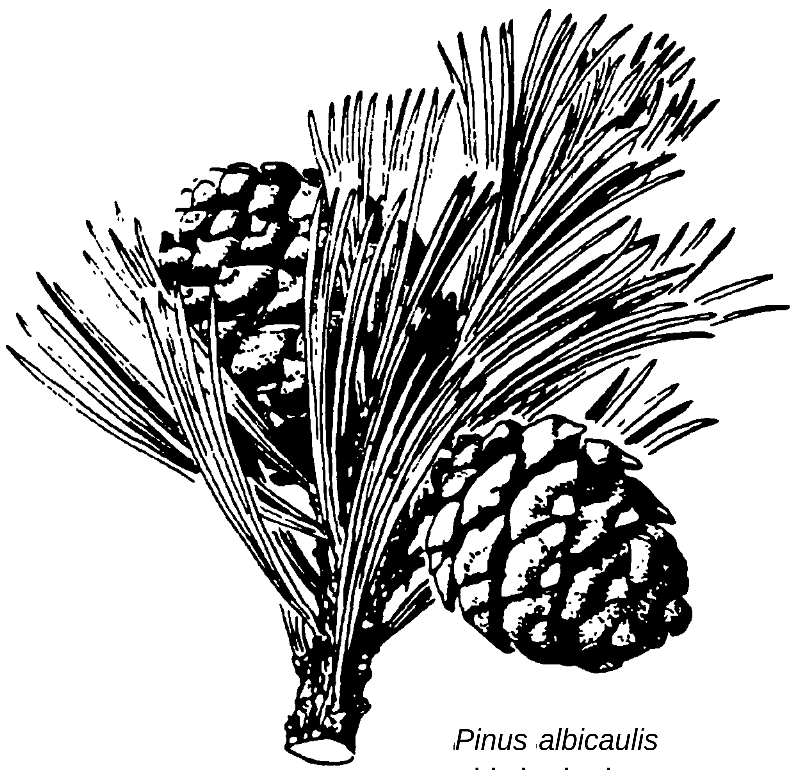
The continuing decline or loss ofwhitebark pine communities throughout the northwest has important ramifications regarding various community and landscape processes. The most obvious impacts are related to a decline in an important wildlife food source (seeds) and changes in plant community composition. These latter changes can result in the absence of reforestation after disturbances on these harsh sites, effectively lowering tree-line elevations. These changes in the landscape patterns of high-elevation communities may result in altered snow accumulations and subsequent changes in the hydrology of large areas (Kendall 1994).

Most of the whitebark pine stands on the Colville N.F. are naturally small, isolated populations. This fact combined with their slow growing nature (50 to 100 years for significant cone crops) makes management and conservation of this species very difficult (Kendall and Amo 1990). However, the combination of using rust-resistant stock and/or introducing a natural fire regime offer some promise for future enhancement and conservation of whitebark pine communities. Kendall's (1994) recommendations for management ofwhitebark pine communities on National Park Service lands are quite applicable to most national forest lands. An important priority for areas with small, isolated populations (as on the Colville N.F.) should be to preserve the unique genotypic and phenotypic varieties by way of seed bank collections.

COMPARISONS

Many ecologists have described whitebark pine communities in the Pacific Northwest, though community descriptions tend to be quite variable. Various types have been described for Montana (Pfister *etal.* 1977), northeast Oregon (Johnson and Clausnitzer 1992), northeast and northcentral

Washington (Clausnitzer and Zamora 1987, Lillybridge *et al.* 1995, Williams and Lillybridge 1983), north Idaho (Cooper *et al.* 1991) and central Idaho (Steele *et al.* 1981). Additional types are described for the southern interior of British Columbia by Lloyd *et al.* (1990).



Pinus albicaulis
whitebark pine

PICO/SHCA COMMUNITY TYPE CLS521
Firms contorta/Shepherdia canadensis
lodgepole pine/russet buffaloberry

DISTRIBUTION AND ENVIRONMENT

The PICO/SHCA Community Type is most common east of the Kettle Mountain Crest (Figure 134). It is characteristic of gently sloping glacial outwash benches and terraces. The majority of sites are located on southern aspects (Figure 135). Most soil profiles have compacted subsoils and roots are concentrated in the surface ash horizons. Slopes are typically gentle and elevations moderate. Frost pockets are common. Some sites that are now dominated by lodgepole pine have been past homesteads and were used as fields. Historic soils were destroyed on many sites by burning and/or farming, the "A" horizon having been eliminated. Thus, the PICO/SHCA Association apparently reflectes many of these past disturbances.

VEGETATION

Lodgepole pine is the main overstory species except for a few stands that have a preponderance of western larch. Our oldest stand was about 150 years old and was dominated by western larch. Other plots were less than 50 years old and these are almost wholly dominated by lodgepole pine. Quaking

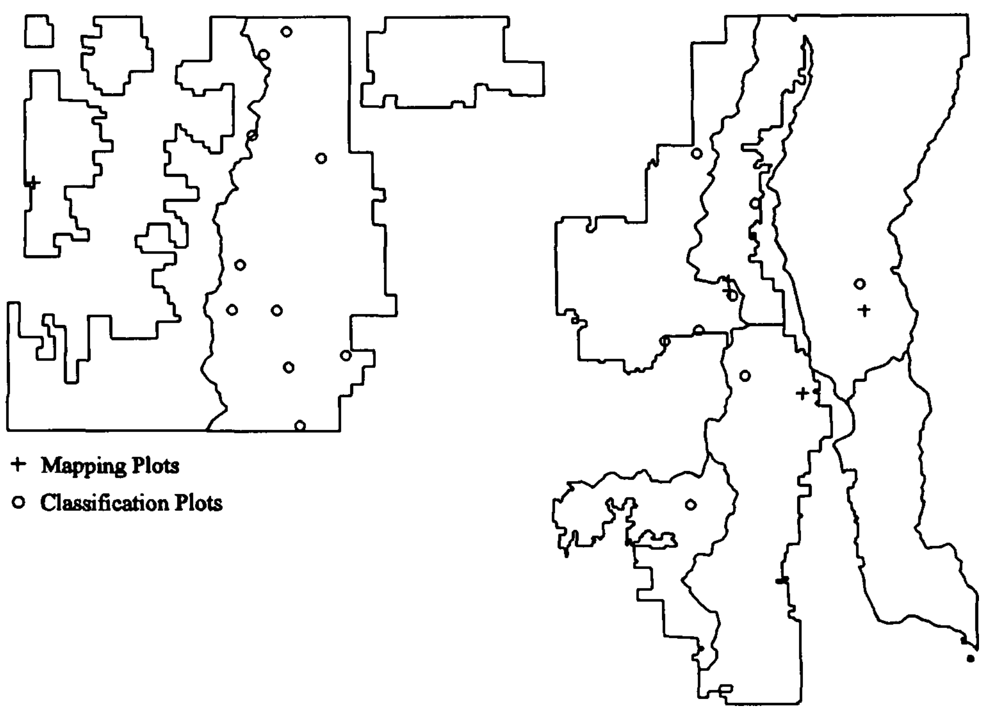


Figure 134. Plot locations for the PICO/SHCA Association (n=25).

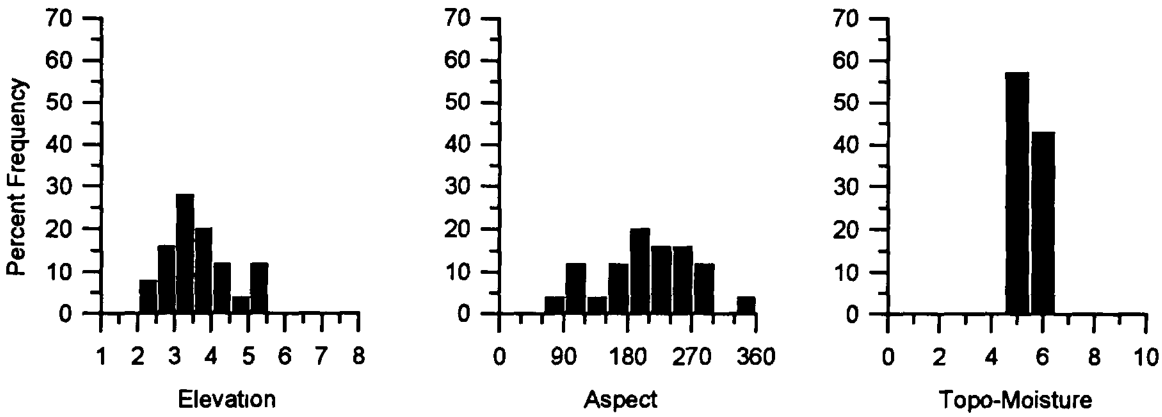


Figure 135. Frequency ofPICO/SHCA plots by elevation (1000 ft.), aspect, and topographic moisture.

aspen and perhaps paper birch may form part of the sere in some areas along with lodgepole pine or western larch. Other conifers are usually minor stand components if present. Evidence of climax tree composition is meager but judging from geographic location and site characteristics it appears the PICO/SHCA Community Type describes a relatively stable serai condition that may occur on ABLA2/VACA, ABGR/VACA, THPL/CLUN, THPL/ARNU3, TSHE/CLUN and TSHE/ARNU3 Association sites.

Russet buffaloberry, a nitrogen-fixing, early successional shrub, typifies the shrub layer but a variety of other species may be present depending on stand history and intensity of past perturbations. Common shrubs include western prince's pine, twinflower, pachistima, baldhip rose and shiny-leaf spirea. One or more huckleberry species are present in nearly all stands examined. Grouse huckleberry suggests sites with somewhat cooler temperatures. Dwarf huckleberry indicates sites with warm days

Table 82. Common plants of the PICO/SHCA Association (n=20).

		CON	COVER
IEEE. OYERSTORY LAYER			
PICO	lodgepole pine	100	46
LAOC	western larch	60	13
PSME	Douglas-fir	50	5
'TD 1-717 UNDERSTQRY1AYER			
PSME	Douglas-fir	65	4
SHRUBS AND SUBSHRUBS			
SPBEL	shiny-leaf spirea	95	7
PAMY	pachistima	90	5
CHUM	western prince's pine	90	5
LIBOL	twinflower	75	23
ROGY	baldhip rose	75	4
SHCA	russet buffaloberry	70	7
BEAQ	Oregon grape	70	4
SYAL	common snowberry	65	3
SASC	Scouler willow	60	4
AMAL	serviceberry	60	4
VAME	big huckleberry	55	11
HERB5			
CARU	pinegrass	90	19
HIAL	white hawkweed	75	2
FRAGA	strawberry spp.	70	3
VIOR2	round-leaved violet	60	3

Figure 136. Photo of the PICO/SHCA Association.

and cool nights. Pinegrass is normally the most abundant herbaceous species and may form a dense sward. Other herbs are variable in constancy and cover.

Very hot conflagration fires or intensive land use such as farming appear to be the originating factors for the stands but repeated underburning may be important at least on some sites. Fire evidence in the form of snags, charred stumps, and charcoal and scarred trees is abundant. Some plots between Colville and Tiger have fire-scarred lodgepole pines with up to three scars on living trees. We speculate that relatively recent intense fires destroyed much of the soil organic materials and nutrients, as did farming. The frost-prone topography and relatively shallow soils further hinder plant succession such that potential climax tree species are slow to establish.

MANAGEMENT IMPLICATIONS

Frost from cold air concentrations is a major factor in reforestation. Ash soils are easily compacted and naturally compacted layers deeper in the profile are common. Most roots are concentrated in the ash influenced soil horizons and these should be protected from displacement and compaction. Organic matter and nutrient capitals should be protected by following the guidelines of Harvey *et al.*

(1987) with care. Harvest methods and/or intensive slash treatments that compact the soils, remove tree crowns or essential organic matter should be avoided.

Livestock favor the type because of gentle slopes and abundant grasses and herbs. Intense grazing leads to an increase in strawberries, dandelions and other weedy herbs. Recreation developments are common and the sites are relatively resistant to damage because only very hardy species remain on these sites. However, huckleberries are easily damaged by trampling in recreation areas.

COMPARISONS

The PICO/SHCA Community Type has not been previously described in the Pacific Northwest.

Shepherdia canadensis
msset buffalobeny

POTR ASSOCIATIONS

Populus tremuloides
quaking aspen

Quaking aspen is found on all districts of the Colville N.F. It is rarely a major landscape component, normally occurring in small clumps of a few acres or less in size; or as scattered trees in conifer dominated stands. In most cases, the majority of areas with quaking aspen have enough conifer regeneration to indicate eventual conifer dominance. These areas are treated as conifer forest. However, some sites contain little or no conifers and evidence of eventual conifer dominance is lacking. This is especially true with aspen communities in riparian areas such as wet, poorly-drained basins and around springs and seeps. At least some of these riparian sites appear to be successionally stable or climax quaking aspen stands. Riparian aspen community types and plant associations will be described in further detail in later studies. Preliminary descriptions are available from Kovalchik (1993). Two broad aspen communities are discussed in this classification; quaking aspen/pinegrass and quaking aspen/snowberry. There are no aspen plots established on the Colville N.F. and these descriptions are derived from Okanogan N.F. data (10 plots). Therefore, the descriptions are brief until further data is available for the Colville N.F.

POTR/SYAL ASSOCIATION HQS2 11

Populus tremuloides/Symphoricarpos albus
quaking aspen/common snowberry

DISTRIBUTION AND ENVIRONMENT

The POTR/SYAL Association is a minor type observed on the Colville N.F. The three plots representing the type are from the Okanogan N.F. It's distribution on the Colville N.F. is not well understood, but it is probably more common in areas supporting the Douglas-fir and Subalpine Fir Vegetation Zones. The limited data suggests the type occurs on sites ranging from the edge of marshes and wet meadows to drainage depressions to mesic mid- and lower-slopes. The three sample plots occurred on gentle (3-28%) slopes located on various aspects. Elevations ranged from 3800 to 4500 ft.

Soils have a deep humus layer derived from the dead aspen and snowberry leaves. Most of the root biomass is located in this rich organic "sponge" layer. The moist, fme-textured mineral soil is often high in organic matter. Available water holding capacity is high and soils may be seasonally saturated, particularly during spring.

VEGETATION

As presently defined, POTR/SYAL sites support a wide range of vegetation. Quaking aspen dominated all plots while a variety of conifers (PSME, PICO, LAOC, PIPO, ABLA2 and PEEN) were subordinant. One xero-riparian plot was dominated by common snowberry with a rich mix of moist-site herbs underneath. The single upland plot was dominated by both common snowberry and pinegrass. Douglas-fir appeared to be the indicated climax on most sites based on understory composition. The POTR/SYAL type will probably be refined into upland and riparian variants with further study and analysis.

Table 83. Common plants of the POTR/SYAL Association (n=3).

	CON	COVER
TREE OVERSTORY LAYER		
POTR quaking aspen	100	77
PICO lodgepole pine	82	10
LAOC western larch	73	11
TREE UNDERSTORY LAYER		
POTR quaking aspen	100	10
PSME Douglas-fir	100	5
SHRUBS AND SUBSHRUBS		
SYAL Common snowberry	100	34
AMAL serviceberry	67	3
HERBS		
ACMI yarrow	67	1
TAOF dandelion	100	2
THOC meadowrue	100	2

MANAGEMENT IMPLICATIONS

Wildlife/Range- Many POTR/SYAL stands are near perennial water sources and provide important habitat for beaver, various bird species and other wildlife (Kovalchik 1987, Thomas *et al.* 1979). Beaver activity in conjunction with browsing by ungulates can severely damage or eliminate aspen stands. Common flickers, black-capped chickadees, hairy woodpeckers, yellow-bellied sapsuckers and many other species of birds nest in aspen. Deer, and ocassionally elk and moose, are observed feeding and bedding in aspen stands. Deer frequently use aspen stands for fawning areas (Kovalchik 1987). Although small in area, aspen stands provide a critical source of diversity across the landscape and should be managed with emphasis on providing habitat for wildlife (Kovalchik 1987).

Although measured herbage production was low (21 Ibs./acre), livestock can make considerable use of POTR/SYAL sites (Kovalchik 1987). The aspen suckers are readily eaten by livestock, which may prevent replacement of mature and dying trees. Snowberry is sensitive to trampling and its cover is drastically reduced in overgrazed allotments. Eventually, grazing may eliminate conifers as well as aspen and snowberry, converting such sites to herbaceous meadows.

Silviculture- Fire suppression has contributed to the conversion of aspen stands to conifers or meadows (Kovalchik 1987). Fire can be an important tool for stimulating aspen suckers and rejuvenating deteriorating stands. Protection from browsing may also be needed in order to enhance some decadent stands. Snowberry will resprout from stem bases following light to moderate-intensity fire.

Although many diseases affect aspen, relatively few kill or seriously injure living trees (Hinds 1985). Important fungal diseases of aspen leaves include black leaf spot, ink spot, shephards crook and other leaf rusts and powdery mildews. Many poorly understood viruses and systemic pathogens

Figure 137. Photo of the POTR/SYAL Association.

(mycoplasms, rickettsia, flagellates) also attack the leaves of aspen. Important decay fungi include tinder fungus, canker fungus and root and butt rots. The many bole cankers of aspen include sooty-bark canker, black canker and cytospora canker. Some defoliating insects include tent caterpillars, leaf miners and various leaf rollers.

COMPARISONS

Kovalchik (1987) describes a POTR/SYAL/ELGL Association in central Oregon that is similar to some of the wetter POTR/SYAL sites. It has been dewscribed on the Okanogan N.F. (Williams and Lillybridge 1983) and has been observed but not sampled on the Wenatchee N.F. in central Washington (Lillybridge *et al.* 1995).