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Land resource inventory of Mill and Woodfibre creeks, British Columbia

Report No. 84-01 British Columbia Soil Survey 1988

Canada

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D.E. MOON and J.A. BRIERLEY

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Land Resource Research Centre
Vancouver Research Station
Agriculture Canada
6660 N.W. Marine Drive
Vancouver, B.C.
V6T 1X2

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Cover illustration:
View of watersheds of Mill and Woodfibre creeks

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PREFACE

Work on the Mill and Woodfibre creeks map area was initiated in 1978 at the request of the British Columbia Ministry of Forests. The folio was used at the subunit (watershed) level of planning, defined in the Forest Planning Handbook (British Columbia Ministry of Forests 1979) in 1980.

The resource folio consists of a series of maps, each having the same base, on which specific resource inventories are presented. The following agencies participated in the project: British Columbia Ministry of Forests, Planning and Recreation divisions and Inventory and Research branches; British Columbia Ministry of Environment, Fish and Wildlife Branch; and Agriculture Canada, Land Resource Research Centre.

The resource map folio contains the following basic information:

Topic	Scale
General soil associations	1:50 000
Terrain inventory	1:31 680
Forest cover inventory	1:15 840
Detailed soil and vegetation	1:15 840
Fish, wildlife, and recreation	1:15 840
Slopes and configuration	1:15 840

In addition to the basic resource information, the following interpretive maps were derived from the 1:15 840 soil and vegetation map: recommended tree species to be established following harvesting; potential for mass movement following road construction; potential for yielding sediments following disturbance; potential problems associated with road construction; and road maintenance, to ensure drainage integrity.

SUMMARY

The watersheds of the Mill and Woodfibre creeks are typical of many south coast British Columbia watersheds. The area is dominated by steep slopes with shallow soils over impermeable bedrock or high bulk density glacial till. These characteristics, together with periods of intense rainfall, present a hydrologic system that is sensitive to disruption by road construction. The watersheds do not, however, present any unusual biophysical limitations to forestry operations.

Wildlife populations are generally low, as is recreational use. Although fisheries values could be significant, the strict water quality requirements of a pulp mill, which uses the two watersheds for is water supply, impose the most serious limitations to development. Sediment production as a result of road construction is the most serious immediate problem; accelerated mass wasting, also as a result of road construction, and timber removal are a more long-term threat to water quality. The possible influence of timber harvesting on water yields is not considered important.

Judicious road location, scheduling of construction, and erosion control should allow for the development of the watershed without serious deterioration of water quality. Some periods of reduced water quality during the first rainy season following road construction should, however, be expected.

The interpretive maps presented in the map folio delineate the areas sensitive to sediment production and mass wasting. Road locations and harvesting plans should not be approved for those areas without an on-site inspection.

RÉSUMÉ

Les bassins versants de Mill Creek et de Woodfibre Creek sont caractéristiques de nombreux bassins versants de la côte méridionale de la Colombie-Britannique. La région présente un relief à pentes abruptes et au sol peu profond qui recouvre une assise rocheuse relativement imperméable ou un till à forte densité apparente. Ces caractéristiques font que le système hydrologique est sensible aux perturbations causées par la construction routière, surtout en périodes de précipitations relativement abondantes. Les bassins versants n'affichent toutefois pas de limites bio-physiques inhabituelles aux opérations forestières.

Ces bassins sont en règle générale peu propices à la faune et à des utilisations récréatives. Bien qu'ils se prêtent aux activités halieutiques (la pêche), leur aménagement se bute à des obstacles de taille en raison des exigences strictes de qualité de l'eau qu'impose l'usine de pâtes à papier, qui s'alimente à même les cours d'eau des deux versants. Dans l'immédiat, c'est la production des sédiments due à la construction routière qui constitue le problème le plus grave; cependant, à long terme, les déperditions de sol accentuées par la construction routière et, éventuellement, le déboisement menacent davantage de détériorer la qualité de l'eau. Par ailleurs, on n'estime pas importantes les répercussions éventuelles du déboisement sur les rendements en eau.

Pour aménager les bassins versants sans nuire gravement à la qualité de l'eau, il faudra arrêter judicieusement le tracé des routes, bien échelonner leur construction et lutter efficacement contre l'érosion. On devra toutefois s'attendre à ce que l'eau soit de moindre qualité pendant une partie de la période de construction des routes et la première année qui suit leur aménagement.

Les zones sensibles à la production de sédiments et aux déperditions de sol sont clairement délimitées sur les cartes géographiques contenues dans le cahier. Il importe d'inspecter les emplacements visés avant d'approuver le tracé des routes et les plans de déboisement de ces zones.

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DESCRIPTION OF AREA

LOCATION

The Mill and Woodfibre creeks watersheds lie between latitudes 49°38' and 49°45' north and longitudes 123°14' and 123°23' west. Located approximately 48 km north of Vancouver, on the west side of Howe Sound, the combined watershed area of 6483 ha supplies water to a pulp mill.

ACCESS

Access to the watersheds is by a British Columbia Department of Highways ferry from Darrell Bay. A summer road extend two-thirds of the way up Woodfibre Creek to an elevation of approximately 600 m. Another road extends approximately 1.6 km up Mill Creek. The rest of the map area can be reached only by foot or helicopter.

RELIEF

Elevations in the watersheds range from 0 to 2076 m above mean sea level. Slopes are generally steep. Thirty-four percent of the area is dominated by slopes steeper than 35°, an additional 29% of the area is dominated by slopes ranging from 25 to 35°, and strongly hummocky terrain with slopes ranging from 0 to 40° over short distances occupies another 27% of the area. This leaves only 10% of the area with slopes that are less than 25° and only 1% that are less than 16°.

BIOGEOCLIMATE

The folio area crosses two biogeoclimatic zones, the Coastal Western Hemlock and the Mountain Hemlock zones. The 900-m contour is said to mark the approximate boundary between the two zones (K. Klinka, personal communication). However, plot data and field reconnaissance gave ambiguous classifications as low as 700 m and confirmed changes as low as 790 m. Because aerial verification between 700 and 800 m was problematic but did show tree cover elements in common with the Mountain Hemlock zone, ambiguous areas were classed as Mountain Hemlock zone. Since the maps were completed, the British Columbia Ministry of Forests has recognized a montane variant of the Coastal Western Hemlock Wet subzone (Klinka et al. 1979) that seems to fit this ambiguous zone. Areas below 800 m, which were mapped as the Mountain Hemlock Forested subzone, may be considered the montane variant of the Wetter Maritime Coastal Western Hemlock subzone of the Coastal Western Hemlock zone. The reported differentiating characteristic used to separate these variants is a difference in soil development. The presence of yellow cedar (*Chamaecyparis nootkatensis* (D. Don) Spach) is considered to be only an accessory characteristic (Klinka et al. 1979). Yellow cedar was a consistent species in the ambiguous area, but the differentiating soil characteristics did not support the proposed break and could not be used to resolve the boundary.

Two subzones of the Mountain Hemlock zone are present above 800 m. The distribution of the Forested and Parkland subzones appears to be controlled by depth or duration of the snow pack, or both. Low slopes at elevations as low as 800 m showed differentiating characteristics of the Parkland subzone, and characteristics of the Forested subzone were found as high as 1190 m.

RECREATION

Recreational use of the folio area is low, although areas above 900 m have high recreation capability. There is some potential use for hiking, cross-country skiing, and fishing in Henriette Lake, but access is difficult.

FISHERIES

Resident fish in the Mill Creek are abundant. Steelhead trout and coho salmon use the lower reaches of the creek. They have been observed holding in the first two pools above tidewater. However, the areas they use for spawning are unknown. Anadromous cutthroat trout may also spawn within the lower reaches. Their contribution to the Howe Sound cutthroat fishery could be significant.

Woodfibre Creek does not contain anadromous fish stocks. Resident sport fish populations may exist in the middle to upper reaches of the creek.

WILDLIFE

These watersheds offer very little potential for the maintenance of ungulate populations.

Mountain goats may occasionally take advantage of ranges at higher elevations located on the west side of Mount Murchison (Scott Lake area) and the south side of Mount Conybeare. It is doubtful that these areas provide sufficient habitat for the maintenance of a mountain goat population on a permanent basis. A small population of black-tailed deer inhabit the watershed, but deer habitat is severely limited. It is doubtful that the areas are important enough to warrant special attention.

CLIMATE

The drainages of the Mill and Woodfibre creeks are characterized by warm dry summers and cool wet winters. Only 17% of the precipitation falls from May to September, and the remaining 83% is distributed throughout the year, with a peak in November-December and declining through to the summer. Snowfall, which makes up approximately 5% of the precipitation at sea level and approximately 30% at 1000 m, is generally restricted to December through May. Climate data presented in Table 1 are from climate stations of the Atmospheric Environment Services, Environment Canada, in or near the survey area. Data are presented for the period 1960-1970.

HYDROLOGY

General characteristics

Water yields west of the Coastal Mountains (Holland 1976) are controlled primarily by precipitation patterns. The influence of timber removal on water yield is likely to be insignificant when compared with natural, year-to-year variations. Peak streamflow is a response to the movement of storm water through subsurface pathways on watershed slopes (Cheng 1975). The shallow soils overlying either bedrock or highly compacted glacial till suggest that these pathways are close to the surface and susceptible to disturbance through road construction and, to a lesser extent, yarding.

Streamflow characteristics

Extrapolation of data from the Rainy River watershed--considered to be representative of the Mill and Woodfibre creeks drainages (Cheng 1975)--to the resource folio area give the water yield estimates reported in Table 2. Reported mill requirements are 84 hL/h. Without the reserve water impound of Henriette Lake, both watersheds together could not meet mill requirements for the month of August. Mill Creek would be unreliable as a water supply for July, August, and September. Without increasing the water in the impound, Woodfibre Creek would fail to meet requirements for 3 months and would be unreliable as a water supply for 3 months.

Based on the Rainy River watershed, estimated flood flow frequency and low flow frequency are presented in Table 3.

RELEVANT POINTS

Neither Mill Creek nor Woodfibre Creek is capable, on its own, of meeting the water requirements of the pulp mill. Water quality is of primary importance. The rapid response to storm flow, the generally shallow soils over bedrock or highly compacted till, and the generally steep slopes indicate a sensitive hydrologic system. Road construction and some yarding systems could seriously disrupt established hydrologic pathways. Diversion of water pathways from subsurface to surface routes could lead to serious erosion and subsequent loss in water quality. Seasonal precipitation patterns indicate that October through January is the most sensitive period, although maximum daily precipitation values in August and September can also be very high.

Table I. Mean daily climate values

Precipitation	J	F	M	A	M	J	J	A	S	O	N	D	Annual
Mean monthly rain (mm)	340	269	236	216	114	86	69	84	155	409	432	447	2858
Mean monthly snow (mm)	58	30	15	0.1	0	0	0	0	0	0	7	34	147
Mean monthly precip. (mm)	399	300	251	218	114	86	69	84	155	409	439	483	3002
Max. daily precip. (mm)	198	109	79	74	89	58	48	112	112	114	132	124	198
Mean daily values													
Monthly max. (°C)	3.4	7.2	9.4	13.1	17.4	19.5	22.0	21.6	18.9	13.4	7.9	5.0	13.3
Monthly min. (°C)	-2.7	-0.04	0.7	3.7	6.6	9.4	11.4	11.3	8.6	5.8	1.8	-0.5	4.7

Precipitation: Woodfibre latitude 49°40' north, longitude 123°16' west, elevation 3.2 m.

Temperature: Squamish latitude 49°41' north, longitude 123°09' west, elevation 1.5 m.

Table 2. Estimated watershed characteristics

Areas	J	F	M	A	M	J	J	A	S	O	N	D	Annual
Per hectare	43	48	29	41	62	52	23	10	26	52	52	64	43
Woodfibre (10^3)	99	110	67	94	142	120	53	23	60	120	120	147	99
Mill (10^3)	177	198	120	169	255	214	95	41	107	214	214	267	177
Total (10^3)	276	308	186	263	398	334	148	64	167	334	334	114	276

Note: Yield given in hectolitres per hour.

Table 3. Estimated flood flow frequency and low flow frequency

Areas	Annual maximum daily flow (hL/h) Return period (yr)						Annual minimum 7-day flow (hL/h) Return period (yr)	
	5	10	25	50	100		5	10
Woodfibre (10^6)	1.57	2.40	3.10	3.54	3.89	(10^3)	1.2	0.08
Mill (10^6)	2.81	4.29	5.55	6.35	6.98	(10^3)	2.2	0.15

CLASSIFICATION AND MAPPING METHODS

BIOGEOCLIMATIC ZONES

Biogeoclimate has been discussed in the section entitled "Description of the area". The following classification criteria were used in delineating zones from the air.

Coastal Western Hemlock Wet subzone (Submontane): *Abies amabilis* (Pacific silver fir) is present on mid to lower slope positions and moderate to deep soils; *Chamaecyparis nootkatensis* (yellow cedar) and *Tsuga mertensiana* (mountain hemlock) are absent under the same conditions.

Mountain Hemlock Forested subzone: The presence of yellow cedar and mountain hemlock in significant numbers on any site marked the lowest limit of elevation. Aerial verification of the presence of yellow cedar was used to link the lower limits of elevation as determined by ground verification of mountain hemlock. It is possible that the lower portions of the areas designated as the Mountain Hemlock Forested subzone represent the montane variant of the Coastal Western Hemlock Wet subzone (Klinka et al. 1979).

Mountain Hemlock Parkland subzone: Areas of discontinuous forest cover with openings of sedge- or heather-dominated vegetation, or both, and areas of tree islands surrounded by shrub-dominated areas were mapped as Mountain Hemlock Parkland subzone. The strong influence of slope, aspect, and snow pack distribution precluded the definition of a limit in elevation.

GENERAL SOIL ASSOCIATIONS: CLASSIFICATION AND MAPPING

Classification was based on an initial 3-day reconnaissance. Biogeoclimatic zoning was presumed to be a meaningful stratification criterion for soil characteristics and was used at the first level.

Zoning can be inferred from a relationship between elevation and forest cover, tied to major landform characteristics (primarily slope and surface expression). Within these broad zones, landscape position, surface expression, and slope provide a reasonable estimate of mode of material deposition. The addition of forest cover and slope position can provide estimates of soil drainage.

Field reconnaissance supported the general relationships used, but the distinction between much of the colluvial and morainal materials could not be supported. Where the distinction could be supported it was not mappable at the 1:50 000 scale. Soil drainage, on the other hand, could be mapped in the form of relatively homogeneous units at the chosen scale. For these reasons the next level of stratification recognized two material types: fluvial deposits and morainal-colluvial deposits derived primarily from granitic bedrock. These two material types were then subdivided into classes based on dominant and subdominant drainage. Soil boundaries were drawn on 1:63 360 panchromatic, black-and-white aerial photos using air photo interpretation of the field-tested relationships.

TERRAIN CLASSIFICATION AND MAPPING

For terrain classification and mapping, the system used in Environmental Land Use Committee Secretariat 1978 was followed. Mapping was based on a 5-day reconnaissance, by foot, to verify air photo interpretation. Although differentiating between morainal and moraine-derived colluvial deposits was still considered problematic, a distinction was attempted.[1]

SOIL AND VEGETATION CLASSIFICATION AND MAPPING

Sampling design

The vegetation and soil classifications were based on 66 plot descriptions. Data collection followed procedures outlined in Walmsley et al. (1980). Two sampling strategies were used. Thirty plots were sampled using interval sampling, with random offsets from a randomly chosen transect. The transcet followed a north bearing from elevation 370 m on Woodfibre Creek to elevation 775 m. At each 30 m of slope distance, a random offset, within a 60-m corridor, was taken at 90° to the transect

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[1]It should be noted that these maps were not updated in light of further information gathered during the course of the project. The intent was to compare the various information bases when gathered in a manner consistent with routine application.

line and a 0.04-ha plot was centred on the location point. An additional 36 plots were located on traverses chosen to cross a range of terrain-cover types as inferred from aerial photographs. Plots were chosen to represent areas of approximately uniform vegetation cover of mappable size. The sample plot was required to show a single species area curve over a 0.04-ha area and was located at least 30 m from any apparent boundary.

Vegetation classification

Vegetation analysis was conducted using a computer-adapted version of tabular analysis (Ceska and Roemer 1971). Classification is based on the species group, which is formed using rules dictated by the classifier. Two sets of criteria are dictated. The level of occurrence for the exclusion of a species from analysis is based on the minimum proportion of plots in which a species must occur and the maximum proportion of plots in which a species may occur before it is used in the analysis. These criteria exclude both ubiquitous and rare species from analysis, if desired. The other set of criteria is used in establishing species groups. The species group provides the basis for the classification and consists of species that tend to occur together more frequently than they do separately. Inside and outside rules are dictated. The inside rule specifies the proportion of the species in a species group that must occur on a plot before that species group is considered present. The outside rule specifies the proportion of plots in which a species may occur without the presence of the species group to which it belongs. For example, a 60/10 rule set requires that any plot having a species group present will contain at least 60% of the species listed for the group and that none of the species listed as belonging to the group will occur in more than 10% of the plots where the group is not present. This approach recognizes species that tend to associate together more often than not, the degree of association being dictated by the stringency of the rule set.

Classification of community types is based on the species groups that are present in a plot. Since each species group is restricted to a different ecological range, a classification based on these groups should produce ecologically distinct community types. Further discussion on the interpretation of species groups can be found in the description of vegetation community types. The application of defined rule sets to species group definition and the establishment of diagnostic species groups for community types allow for the unambiguous, consistent, and reproducible classification of vegetation communities in the study area. Consult the tables in Appendix II for the diagnostic species and rule requirements used to define species groups and the diagnostic combination of species groups used to define vegetation community types.

Soil classification

The soil classification used was in large part dictated by the interpretive needs of the requesting agency. Silvicultural interpretations were to be based on existing procedures of the British Columbia Ministry of Forests (Klinka 1977), and since these could be based largely on the interpretation of the vegetation types, the soil classification was designed to provide interpretations relevant to water quality concerns. These concerns relate primarily to sediment production as a result of mass movements, road construction, road maintenance, and surface disturbance. Information on the following parameters was considered essential in making the required interpretations: slope, texture, competence and angularity of coarse fragments, drainage, configuration (surface geometry), and active processes. Of these only drainage, texture, and competence and angularity of coarse fragments could be considered soil properties, the remainder being site or landscape properties.

Soil classes were defined on the basis of drainage (as inferred from soil morphology), texture of the fine earth fraction, and origin and angularity of the coarse fragments.

Drainage class

Field criteria were used to recognize five drainage classes.

1. Rapid to well drained; no prominent or distinct mottles and no gleyed colors within 100 cm, except in highly compacted morainal deposits.
2. Moderately well drained; distinct mottles within 100 cm of the surface or prominent mottles between 50 and 100 cm of the surface. Gley colors absent within 100 cm, except within highly compacted morainal deposits.
3. Imperfectly drained; prominent mottles within 50 cm of the surface. Gley colors absent within 100 cm, unless the materials are highly compacted morainal deposits.
4. Poorly drained; gley colors absent within 50 cm of the surface and present between 50 and 100 cm, unless the material is a highly compacted till.
5. Very poorly drained; gley colors within 50 cm of the surface, unless the material is a highly compacted morainal deposit. Strongly hydrophytic vegetation or wetland humus forms were also considered adequate evidence for very poorly drained soils.

Parent material

Five parent material classes were recognized.

1. Granitic till or colluvium; materials are derived primarily from granitic rock types, although some gneissic or basaltic materials may be present.
2. Sedimentary colluvium; materials are derived from moderately competent sandstone bedrock with an admixture of material derived from granitic till.
3. Fragmental colluvium; materials are angular, coarse fragments with insufficient fine-earth material to fill the interstices of the coarse-fragment fabric. Generally granitic but may be gneissic or sedimentary rock types.
4. Fluvial; materials are highly rounded gravelly to very gravelly sandy materials deposited by running water. Fluvial origin is inferred from landform and texture.
5. Rock outcrop or organic; mineral soil is less than 10 cm to bedrock and may have a shallow (less than 30 cm) layer of well-drained organic material overlying the bedrock.

Texture

Field estimates and laboratory analysis indicated five mappable texture and coarse-fragment classes:

1. 20-90% angular coarse fragments in a sandy loam to loamy sand matrix.
2. 20-90% rounded coarse fragments in a coarse silt loam to loamy sand matrix.
3. 20-50% rounded coarse fragments in a loam to sandy loam matrix.
4. 0-50% rounded coarse fragments in a silt loam matrix.
5. 20-90% rounded coarse fragments in a sand matrix.

Landscape characteristics

Slope

Slope classes were based on an evaluation of slopes within the watershed. Classes were chosen to give the narrowest possible range of mappable slopes within each class.

1. Excessively steep, 80% or greater.
2. Very steep, 70-79%.
3. Steep, 46-70%.
4. Moderate, 30-45%.
5. Low, 0-29%.

Configuration

Configuration refers to the shape of the landscape as it influences the pattern of vegetation and soil distribution. The categories are as follows:

1. Random (R); an area that shows no predictable pattern or surface features.
2. Dissected (D); an area crossed by frequent ephemeral drainage lines showing low slopes and generally less than 1 m deep. Topography is generally subdued.
3. Gullied (V); an area crossed by steep-sided and deep-erosion gullies. They may be active or stable, they are deeper than 1 m, and they are generally deeper than 1.5 m.
4. Hummocky (H); a complex sequence of slopes, irregular depressions, and knobs. On steep slopes closed depressions may not occur.
5. Terraced (T); a sequence of nearly level steps broken by steep (more than 70% slope) scarp faces.
6. Mass wasting (M); applied to areas showing active mass movements of a nature likely to be aggravated by forest harvesting or road construction.
7. Avalanching (A); applied to areas showing evidence of periodic avalanches.

Mapping

The procedure followed in mapping the soils and vegetation is described below. Following an initial reconnaissance, during which the 1:50 000 soil mapping and the 1:31 680 terrain mapping were completed, provisional vegetation, soil, slope, and configuration classes were defined. Air photo interpretation of 1:15 840 panchromatic, black and white photos was used to delineate areas that were predicted to be relatively homogeneous in terms of the provisional classes. Delineations were verified using foot traverses. Site, soil, and vegetation information was collected for the dominant and subdominant components of each delineation traversed. This consisted of the information necessary to establish soil, vegetation, landscape, and biogeoclimatic classes, and in some cases included soil profile descriptions and complete vegetation descriptions. Boundaries that did not reduce the range of classes between units separated were deleted, and boundaries that could be tied to air photo features and reduced the range of classes within a delineation were added.

Following completion of the fieldwork, all relevant data were analyzed to establish limits and definitions for soil and vegetation classes. Units that had been ground-checked were updated if necessary. A map symbol was devised to label delineations by their dominant and subdominant classes. For each polygon, the map symbol identified the following: biogeoclimatic subzone, dominant and subdominant soil drainage, parent material, texture, and vegetation community types supported. In addition, the symbol identifies the slopes, configuration, and active processes associated with each delineation. Delineations that were not ground-checked were labeled using air photo interpretation. The criteria used for photo interpretation are given with the description of the soil and vegetation map units in Appendixes I and II.

INTERPRETATIONS

INTERPRETIVE PROCEDURES

A number of methods for interpreting site-specific soils information are well developed. The use of erosion nomographs (Wischmeier et al. 1971), the calculation of factors of safety (O'Loughlin 1974, Swanston 1970), and the use of interpretive tables (Soil Conservation Service 1971) are examples. The application of these interpretive methods to soil maps, however, presents at least three serious problems. The first is that of how well the site-specific evaluation used to derive the interpretation represents the areas to which the interpretation is being extrapolated. Work on the variability of specific soil properties both within and between map units (Wang 1980) suggests that our confidence in the extrapolation of interpretations may be optimistic. The second problem is that in compound map units (map units that contain at least two different soils) a single interpretive rating may be misleading. The third problem is that landscape features that are not part of the soil definition or a specific combination of soil types may alter the interpretive ratings of the individual soils that make up the map units. For example, the Db soil is imperfectly drained, gravelly to very gravelly, coarse loamy till or till-derived colluvium. Slopes in excess of 46% might be considered potentially unstable, and slopes in excess of 70% would almost certainly be considered unstable. The Db soil, however, when found on map units with 70-80% slopes presents few problems if the terrain is strongly bedrock-controlled with numerous outcroppings of lower slope bedrock that break the continuity of debris movement. The same soil on a relatively uniform slope, when incised by frequent gullies, could present serious water-quality problems on map units with slopes as low as 46%.

In addition to the problem of applying existing methods of soil interpretation to soil maps, we are confronted with the need to make interpretations for which there are no established methods or for areas in which established methods have not been tested.

The approach taken in the map area was one of combining observation with existing methods of interpretation where possible. Where existing methods were not available or applicable, empirical observations were combined with a basic physical model. As discussed in the section on classification methods, the class limits used in mapping were chosen to represent naturally occurring distributions where possible. A 2-week reconnaissance of managed areas in the Howe Sound area was conducted to establish critical parameter classes, or combinations of them, which were associated with management problems. This reconnaissance was used to evaluate existing procedures and provided the basis for subsequent interpretations.

Interpretations were developed in two stages. In the first stage, soil characteristics were evaluated to provide relative sensitivity ratings for each soil type. These soils were grouped into four or five groups (response classes) with similar expected responses. The actual groups and number of classes changed from one interpretation to the other. The second stage was the modification of these basic soil response classes on the basis of site and landscape features, specifically slope and configuration. Two points need to be emphasized: interpretations were made only on the basis of information recoverable from the map symbol, and therefore factors that may be important but were not mappable are ignored; and interpretations generally indicate the worst, rather than the most probable, impact.

The reliability of the interpretations provided will depend on the validity of the interpretive method used and on the accuracy of the mapping, neither of which should be considered good enough to eliminate the need for site-specific evaluations in critical areas. Finally, the interpretive ratings supplied here are relative and apply only to areas in the general vicinity of the watershed; extrapolation to areas outside the Howe Sound area, without testing, is not advisable.

POTENTIAL FOR MASS MOVEMENT FOLLOWING ROAD CONSTRUCTION

Mass movements in this discussion are restricted to either relatively shallow planar failures or rotational failures in noncohesive granular materials. They are of a type likely to be affected by forestry practices and do not refer to deep-seated instability. The chief concern is one of potential impact on bodies of water, as a source of erodible material and as an added road maintenance cost. Potential loss of productive area is minimal.

Development of interpretive procedures

An evaluation of slopes in the Howe Sound area produced the five major slope classes used in Table 4. Breaks between classes were the least frequently occurring slope values, and the most frequently occurring slope values were generally well within the class limits. Slopes below 46% were frequently related to water-involved depositional processes. Slopes between 46 and 70% showed a bimodel distribution, with the major peak being skewed to 70%. The peak at 70% is strongly related to desposition as a result of rock fall. Slopes between 70 and 80% were rock, highly compacted glacial till, or actively failing scarp faces. Slopes exceeding 80% were nearly all rock.

A survey of slope failures in the area supported the results of O'Loughlin (1974) in which no failures were found on slopes below 45%. Slope failures on slopes of between 46 and 70% were associated with imperfectly to poorly drained soils or, where found in well-drained areas, with road construction. Natural and road-associated failures were found even under well-drained conditions on slopes between 70 and 80%. Soils on slopes in excess of 80%, although uncommon, invariably showed some evidence of mass movement.

Confirmation of these empirical results can be found in the model used to calculate the factor of safety (FS) for noncohesive, infinite slopes. Taken from O'Loughlin (1974) the factor of safety (FS) is calculated as:

$$FS = \frac{Ca + zWb \cos^2 \alpha \tan \phi}{Ws \cos \alpha \sin \alpha}$$

which reduces to $FS = \dfrac{Ca + Wb \cos \alpha \tan \phi}{Ws \sin \alpha}$

where Ca = apparent soil cohesion
Wb = buoyant unit weight of soil
z = depth to shear plane
α = slope angle of shear plane
ϕ = angle of internal friction
Ws = saturated unit weight of soil

Using a number of reasonable assumptions, the critical slope limits below which soils should not be expected to fail can be derived for saturated (poorly drained) and unsaturated (well-drained) soils. Taking the extreme case of completely saturated (water at the surface) soils lacking any apparent cohesion, using the low end of the bulk density range found (1.15), estimating particle density of 2.65, and using the 35° average angle at which road fill and talus slopes stand in the area as an estimate of the angle of internal friction, the equation is solved as follows:

Wb = weight of saturated soil minus the bouyancy to saturation

Ws = weight of dry soil plus the weight of water. For a saturated soil the weight of water is equal to the proportion of the soil occupied by pores or 1 minus (bulk density/particle density) = 0.57

Therefore

Ws = bulk density plus [1 minus (bulk density/particle density)]

= 1.15 + 0.57 = 1.72

Solving for a 29% (16°) completely saturated slope, the factor of safety

$$FS = \frac{0 + .72 \cos 16.2 \tan 35}{1.72 \sin 16.2} = 1$$

indicates that even under extreme conditions slopes less than 29% would not be expected to fail. A similar calculation for well-drained soils at 70% slopes also produces a factor of safety of one (it is at the angle of repose). Since soils with a factor of safety of less than one are considered unstable and soils with a factor of safety greater than one are considered stable, the results of the survey are supported by the model.

The above discussion can be used to establish three interpretive classes for sites: no hazard (slopes less than 29%); low to moderate hazard (slopes between 29% and 70%, where only soils subjected to periodic saturation are expected to fail); and high hazard (slopes greater than 70%, where any soil might be expected to fail).

The classes do, however, presume a lack of apparent cohesion and complete saturation; both are unlikely events. The classes ignore landscape features that produce a range of site conditions within a given map unit or delineation. They also disregard features that would mitigate or aggravate the impact of a site-specific failure. Finally, the middle class groups soils that range from virtually no hazard to very high hazard. In an attempt to improve the usefulness of the interpretive classes, a four-class system was developed.

Information used in assigning hazard classes had to be recoverable from the map symbol. The parameters used and their relative effect on stability are shown in Table 4. Of the four parameters listed, drainage and texture are diagnostic soil criteria; the defined soil types were therefore grouped into classes (response classes) that would be expected to show similar responses to changes in slope and surface geometry (configuration).

Table 4. Slope stability

	Classes (increasing hazard)				
Property	Lowest				Highest
Slope (%)	0-30	30-46	46-70	70-80	>80%
Drainage	rapid	well	moderately well	imperfect	poorly to very poorly
Texture	fragmental	coarse loamy angular	coarse loamy rounded	sandy to loamy rounded*	silt loam*
Configuration	hummocky	random	dissected	gullied	

*These soil textures showed evidence of sorting.

Table 5. Ratings for potential mass movement following road construction

Rating	Slope (%)	Reponse class	Configuration*
High	80+	1, 2, 3, 4	H, R, L, V
	70-79	4	H, R, L, V
		3	R, L, V
		2	V
	46-69	4	R, L, V
		3	V
Moderate	70-79	3	H
		2	R, L
		1	R, L, V
	46-69	4	H
		3	R, L
Low	70-79	2, 1	H
	46-69	3	H
		2, 1	H, R, L, V
	30-45	4, 3	V
Very low	30-45	4, 3	H, R, L
	0-29	1, 2, 3, 4	H, R, L, V

*Configuration: H, hummocky; R, random; L, dissected; V, gullied.

Soil response classes

In assigning soils to response classes, an attempt was made to balance the stabilizing influence of increased angularity and interlocking of coarse fragments, lower void space, and lack of particle-sized sorting (increasing the angle of internal friction) against the destabilizing influence of soil saturation, which causes increased pore-water pressure. The following soils were assigned to the classes, ranked in order of increasing sensitivity, as follows:

Class 1	Ja, Ka, Ba, Ga
Class 2	Ca, Ha, Bb, Le, Da, Ia, Cb, Me
Class 3	Ea, Db, Dc, Ne, Fa
Class 4	Eb, Ec, Ye, Dd, Fb, Fc, Ed, Fd

Hazard ratings

The response classes were then rated for stability based on the average slope of the map delineation. All soils on slopes in excess of 70% were considered high hazard; soils on slopes between 46 and 70% were considered high hazard if they were in response class 4 and moderate if in class 1 or 2. Soils on slopes less than 46% were considered very low hazard for all response classes. The potentially stabilizing or destabilizing influence of surface geometry (configuration) was then used to modify the hazard ratings. Gullied terrain was expected to show areas of local oversteeping and potentially long-distance movement of debris if a failure occurred. Hazard ratings were therefore increased by one class on gullied units. Ephemeral drainages, characteristic of dissected units, were generally identified as more poorly drained soils in the unit and therefore were accounted for in the response class. Random or regular configurations were presumed to have no influence, and hummocky configurations were presumed to have a stabilizing influence by limiting any failures to small size and short distances of movement. Hazard ratings on hummocky terrain were therefore generally reduced by one class. Table 5 presents ratings used and the combinations of slope, response class, and configuration assigned to each rating.

Ratings for potential mass movement following timber removal may be determined by downgrading each road-related rating by one class. The following remain unchanged: soil response classes 3 and 4 on 70-80% slopes and random-dissected or gullied configurations; response class 3 on gullied 70-80% slopes; and response class 4 on gullied 46-70% slopes.

The interpretive map was produced by rating the most limiting soil type, prefixing the rating with a 1 for dominant or a 2 for subdominant soil, and using the symbol denominator to indicate the most seriously limiting features.

POTENTIAL FOR YIELDING SEDIMENTS

The potential for yielding sediments provides relative ratings of a map unit's potential to deliver sediments to the main stream channel. The rating assumes that mineral soil has been exposed, since significant erosion is unlikely where ground cover and forest floors are continuous and intact. Two aspects were considered in assigning interpretive values: the inherent erodibility of the soil and the influence of site and landscape features, because they influence both erosion and sediment transport.

Four of the mapping parameters were used in assigning classes. Table 6 presents the parameters used and ranks the classes in increasing order of susceptibility.

Mappable ranges of texture and drainage were combined to produce four response classes. Texture ranges and an assumed constant organic-matter content were used to estimate relative susceptibility to erosion (Wischmeier et al. 1971). The ratings were modified slightly, using drainage as an estimate of possible suprasaturation (run-off as a result of soil saturation to above the soil surface). Suprasaturation was considered possible on poorly drained soils and probable on very poorly drained soils. The soils were grouped into four response classes, ranked in order of increasing susceptibility:

Class 1 Ba, Bb, Ca, Cb, Ga, Ha, Ka, Le, Me, Ne
Class 2 Da, Db, Ia, Ye
Class 3 Ea, Eb, Fa, Fb
Class 4 Dc, Dd, Ec, Ed, Fc, Fd, Nc

Soil response classes were then ranked in order of increasing sensitivity based on slope. They were then modified by site features, which might influence erosion, and landscape features, which might influence the probability of delivery to stream water. For example, hummocky terrain is generally less susceptible to local erosion than smoother terrain, and delivery to streams is less likely. Gullied terrain is more erodible because of localized steep slopes, and delivery is more assured because of the presence of streams in the gullies. Table 7 presents the response, slope, and configuration classes assigned to each rating.

Table 6. Potential sediment yield, assuming exposed mineral soil

Factor	Class (increasing susceptibility)			
Texture	fragmental	gravelly or rubbly sandy loam to sand	gravelly loam to sandy loam	gravelly silt loam
Slope	5	4	3	1, 2
Drainage	rapid to imperfect	poor	very poor	–
Configuration	hummocky, random	dissected	gullied	–

Table 7. Ratings for potential to yield sediments*

Response class	Slope	Configuration†	Potential sediment yield
1	1, 2	H, L, R, V	low
	3, 4, 5	H, L, R, V	very low
2	1, 2	H, L, R, V	low
		V	moderate
	3, 4	H, L, R	very low
		V	low
	5	H, L, R, V	very low
3	1, 2	H, R	moderate
		L, V	high
	3, 4	H, L, R	low
		V	moderate
	5	H, L, R, V	very low
4	1, 2, 3	H, L, R, V	high
	4	H, R	moderate
		L, V	high
	5	H, R	low
		L, V	moderate

*Sediment yield from road construction is strongly dependent on such features as grade, drainage maintenance, and construction practices, which cannot be evaluated until road plans are available. Road construction is the single most important source of sediment in the watershed. Ratings for road construction should be increased by one level but should stabilize within 1-2 years following construction, provided that roads are adequately maintained.

†H, hummocky; L, dissected; R, random; V, gullied.

The interpretive map rates the most limiting soil in the map unit and identifies whether the rated soil is dominant or subdominant.

A cautionary note is in order. These are relative ratings within the map area only. Interpretations do not in any way estimate the magnitude of potential sediment yield.

ROAD MAINTENANCE REQUIREMENTS

Relative road maintenance refers to two features: cut banks, which are evaluated for stability (minor rotational or planar upslope failures resulting from a loss of toeslope support) and dry ravelling (minor sloughing and surface creep), which tends to block drainage ditches and possibly culverts. Fill slopes are evaluated for possible side-cast migration, and sliver fills increase the total erodible surface or possibly encroach on streams.[1]

The rating of cut banks and fill-slope stability depends in large part on road design. However, a relative ranking of map areas based on slope, configuration, and response class is possible.

Fill slopes

Fill slope migration, for any given road design, is dependent primarily on slope and configuration, and secondly on soil characteristics that influence the angle of repose and volume expansion as a result of excavation. The use of a geometry table for road prisms (Megahan 1976) can provide estimates of excavation volume and road prism characteristics for uniform slopes. As with most interpretive methods it is, however, very site-specific. The approach used in the Mill and Woodfibre creeks map area was more landscape oriented and far less precise.

Slope is the major limiting criterion. In the folio area, well-drained fill slopes stand at approximately a 70% angle, so that slopes approaching that angle are considered subject to sliver fill or side-cast migration. Slopes below 46% present few problems. When slopes are between 46 and 80%, the effect of surface configuration is important. Hummocky terrain has a strong mitigating effect, whereas gullied terrain produces areas of localized oversteeping and relatively smooth slopes,

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[1]The problems of fill-slope failure are discussed under interpretations for mass movement.

thereby increasing the hazard. Response classes are the same as those listed below for cut banks.

Cut banks

Slope, drainage, texture, and configuration were used to evaluate maintenance problems. The influence of drainage class is presumed to be one of increasing soil cohesion as a result of adhesive and cohesive forces of capillary water and a loss of cohesive strength at saturation.

Texture is evaluated for its contribution to internal friction. Five soil response classes, based on texture and drainage, were ranked in increasing order of susceptibility for the first year or two following construction:

Class 1 Ba, Bb, Ca, Cb, Da, Ga, Ha, Ia, Ja, Ka
Class 2 Db, Ea, Fa
Class 3 Dc, Dd, Eb, Fb, Nc
Class 4 Ec, Ed, Fc, Fd
Class 5 Le, Me, Ne, Ye

The response classes will probably require redefinition for subsequent years. Following initial cut-bank slumps resulting from local saturation, the roads create artificial drainage, making soil saturation unlikely. The effect of soil water is then one of increasing soil cohesion rather than a loss of cohesive strength at saturation.

As with fill-slope interpretations, map unit slope is of major importance. However, soil properties play a more significant role, and the influence of configuration is interpreted somewhat differently. Slope influences the height of the cut bank, the slope length of the cut bank, and the smallest possible angle of the cut bank. Soil drainage influences the possibility of loss of cohesive strength at saturation and an increase in cohesive strength for unsaturated soils. When soils dry, the cohesion resulting from water films is reduced, and dry ravelling becomes a greater problem. Hummocky, random, and dissected configurations are presumed to have no mitigating effect, and gullied configurations are presumed to increase the problem. Table 8 presents the mapping classes used and the interpretations assigned.

Cut-bank stability and fill-slope migration are evaluated for both the dominant and subdominant soils on the interpretive map, which shows the relative road maintenance required to ensure drainage integrity.

Table 8. Maintenance problems of cut banks and fill slopes

Slope (%)	Configuration*	Soil response class	Rating: Cut banks	Rating: Fill slopes
80	H, L, R, V	1, 2, 3, 4, 5	high	high
70-79	H	1, 2	high	moderate
		3, 4, 5	high	high
	L, R, V	1, 2, 3, 4, 5	high	high
46-70	H	1, 2, 5	moderate	low
		3	high	low
		4	high	moderate
	L, R	1, 2, 5	moderate	low
		3, 4	high	moderate
	V	1, 2, 5	high	moderate
		3, 4	high	high
30-45	H, L, R, V	1, 2, 5	low	low
		3, 4	moderate	low
0-29	H, L, R, V	1, 2, 3, 4, 5	low	low

*H, hummocky; L, dissected; R, random; V, gullied.

ROAD-ASSOCIATED PROBLEMS

The interpretive map illustrating road-associated problems is simply a summary of interpretive maps on potential mass movement, potential to yield sediments, and road maintenance. It outlines in map form the areas that present the most serious concerns for road construction. More specific information or interpretive criteria can be recovered from the appropriate map or section of this report.

RECOMMENDED TREE SPECIES

The recommendations for tree species to be established following logging were taken with some modification from Klinka (1977). It should be emphasized that the ratings of soil and vegetation units for the moisture and nutrient regimes used in the guide required a large measure of subjectivity.

The evaluation of the moisture regime proved problematic. Klinka (1977) gives direct equivalence of soil drainage class and ecological moisture regime. This equivalence is not valid because the concentration of precipitation during fall, winter, and spring produces soil morphology and drainage characteristics that are often more indicative of dormancy-season water regime than of growing-season water regime. In addition, many soils with prolonged saturation do not exhibit characteristic morphology either because of high dissolved oxygen in the water or organic material, masking the morphological properties characteristic of prolonged saturation. Descriptions of soils, soil map units, and vegetation that follow report general relationships between soil and vegetation. The number of cases in which these relationships did not hold was large enough to warrant the separate classification and mapping of soil and vegetation types rather than ecosystem units. This was necessary if soil drainage is to be used to make valid geotechnical interpretations. Because of this discrepancy, the moisture regime was determined by ranking the defined community types according to the inferred status of the soil water during the growing season. The equivalents in community type and water regime are as follows:

Coastal Western Hemlock wet subzone	Mountan Hemlock forested subzone
Pipsissewa, subxeric	Red Mountain-Heather, subxeric to submesic
Salal, submesic Twinflower, mesic	Yellow Cedar, mesic to subhygric

Foamflower, subhygric

False Hellebore, hygric to subhydric

Lady Fern, hygric

American Skunk-Cabbage, subhydric

The determination of nutrient regime was based on the following criteria: since all mapped soils were derived from generally acidic rock types, rapid to moderately well drained soils were classed as oligotrophic to mesotrophic. In the Coastal Western Hemlock wet subzone, species used to infer more eutrophic nutrient regimes (Klinka 1977) were generally found on the same plots as more oligotrophic indicators of nutrient regime but were more frequently associated with subhygric sites. Because of this, imperfectly to very poorly drained soils were classed as mesotrophic to permesotrophic if they supported subhygric to hygric vegetation and as submesotrophic to mesotrophic if they supported submesic or mesic vegetation. In the Mountain Hemlock zone, all soils were classed as submesotrophic to mesotrophic.

Despite recommendations to plant Sitka spruce on subhygric and hygric sites in this area (Klinka 1977), the general absence of Sitka spruce from these and similar sites in the general vicinity of the survey area would argue against its being planted except on a trial basis. Other than this, recommendations following Klinka (1977) are unlikely to produce serious problems in regeneration or productivity.

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APPENDIX I
SOILS OF THE MILL AND WOODFIBRE CREEKS MAP AREA

Ba SOILS

Diagnostic criteria

Rapid to well-drained, rubbly to very rubbly, coarse loamy colluvium derived from granitic or, less frequently, gneissic or schistosic bedrock.

Accessory characteristics

IBa soils[1] are mapped in the Coastal Western Hemlock wet subzone and are generally Orthic Humo-Ferric Podzols supporting Fibri-humimor forest floors (0-10 cm thick) and Pipsissewa or Salal community types.[2]

IIBa soils are mapped in the Mountain Hemlock forested subzone and are generally Orthic Humo-Ferric Podzols supporting Red Mountain-Heather community types.

Bb SOILS

Diagnostic criteria

Rapidly to well-drained, gravelly to very gravelly, coarse loamy till or colluvium derived from till. Lithology is dominantly granitic but may show an occasional admixture of other rock types. Water-washed or fluvial deposits meeting the requirements of drainage, texture, coarse fragments, and lithology are also recognized as Bb soils.

Accessory characteristics

IBb soils are mapped in the Coastal Western Hemlock wet subzone and are generally Orthic Humo-Ferric Podzols supporting Humi-fibrimor forest floors (less than 10 cm thick) and Pipsissewa or Salal community types.

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[1]The Roman numeral identifies the biogeoclimate subzone in which the accessory characteristics apply: I, Coastal Western Hemlock wet subzone; II, Mountain Hemlock forested subzone; III, Mountain Hemlock parkland subzone.

[2]Community types are described in Appendix II.

IIBb soils are mapped in the Mountain Hemlock forested subzone and are generally Orthic Humo-Ferric Podzols supporting Red Mountain-Heather or Avalanche community types.

Ca SOILS

Diagnostic criteria

Moderately well-drained, rubbly to very rubbly, coarse loamy colluvium derived from granitic or, less frequently, gneissic or schistosic bedrock.

Accessory characteristics

ICa soils are mapped in the Coastal Western Hemlock wet subzone and are generally Orthic Humo-Ferric Podzols supporting Fibri-humimor forest floors (0-20 cm thick) and Salal or Twinflower community types.

IICa soils are mapped in the Mountain Hemlock forested subzone and are generally Orthic Humo-Ferric or Orthic Ferro-Humic Podzols. IICa soils support Red Mountain-Heather and Yellow Cedar community types.

IIICa soils are mapped in the Mountain Hemlock parkland subzone and generally support the Forested physiognomic type.

Cb SOILS

Diagnostic criteria

Moderately well-drained, gravelly to very gravelly, coarse loamy till or colluvium derived from till. Lithology is dominantly granitic but may show an admixture of other rock types.

Accessory characteristics

ICb soils are mapped in the Coastal Western Hemlock wet subzone and are generally Orthic Humo-Ferric Podzols supporting Humi-fibrimor forest floors (less than 10 cm thick) and Salal or Twinflower community types.

IICb soils are mapped in the Mountain Hemlock subzone and are generally Orthic Ferro-Humic Podzols supporting Red Mountain-Heather or Yellow Cedar community types.

IIICb soils are mapped in the Mountain Hemlock parkland subzone and are generally Orthic Ferro-Humic Podzols supporting Heather, Forested, or Tree Island physiognomic types.

Da SOILS

Diagnostic criteria

Imperfectly drained, rubbly to very rubbly, coarse loamy colluvium derived from granitic or, less frequently, gneissic or schistosic bedrock.

Accessory characteristics

IDa soils are mapped in the Coastal Western Hemlock wet subzone and are generally Orthic Humo-Ferric Podzols or Orthic Ferro-Humic Podzols. IDa soils support Fibri-humimor forest floors (0-10 cm thick) and the Foamflower or Lady Fern community types.

IIDa soils are mapped in the Mountain Hemlock forested subzone and are generally Orthic Ferro-Humic Podzols supporting the Yellow Cedar or Avalanche community types.

IIIDa soils are mapped in the Mountain Hemlock parkland subzone, are generally Orthic Ferro-Humic Podzols and support the Forested physiognomic type.

Db SOILS

Diagnostic criteria

Imperfectly drained, gravelly to very gravelly, coarse loamy till or colluvium derived from till. Lithology is dominantly granitic but may show a significant admixture of other rock types. Water-washed or fluvial deposits that meet all criteria except mode of deposition are also classified as Db soils.

Accessory characteristics

IDb soils are mapped in the Coastal Western Hemlock wet subzone and are generally Orthic Ferro-Humic Podzols or Orthic Humo-Ferric Podzols. They support Fibri-humimor and Humi-fibrimor forest floors (less than 20 cm thick) and Twinflower, Foamflower, or Lady Fern community types.

IIDb soils are mapped in the Mountain Hemlock forested subzone and are generally Orthic Ferro-Humic Podzols supporting Red Mountain-Heather, Yellow Cedar, or Avalanche community types.

IIIDb soils are mapped in the Mountain Hemlock parkland subzone and are generally Orthic Humo-Ferric Podzols supporting Forested or Tree Island physiognomic types.

Dc SOILS

Diagnostic criteria

Imperfectly drained, gravelly, loam to sandy loam, till, or till-derived colluvium. Lithology is mixed but dominated by granitic rock types.

Accessory characteristics

IDc soils are mapped in the Coastal Western Hemlock wet subzone and are generally Orthic Ferro-Humic Podzols or Gleyed Ferro-Humic Podzols with Fibri-humimor forest floors (more than 10 cm thick) and supporting the Foamflower or Lady Fern community types.

IIDc soils are mapped in the Mountain Hemlock forested subzone and are generally Orthic Humo-Ferric Podzols supporting the Yellow Cedar community type.

Dd SOILS

Diagnostic criteria

Imperfectly drained, gravelly silt loam, till, or ice contact deposits of mixed but dominantly granitic lithology.

Accessory characteristics

Dd soils were mapped only in the Coastal Western Hemlock wet subzone and were generally Orthic Humo-Ferric Podzols supporting the Foamflower community type.

Ea SOILS

Diagnostic criteria

Poorly drained, rubbly to very rubbly, coarse loamy colluvium derived from granitic or, less frequently, schistosic or gneissic bedrock.

Accessory characteristics

IEa soils are mapped in the Coastal Western Hemlock wet subzone and are generally Gleyed Ferro-Humic Podzols or Gleyed Humo-Ferric Podzols. They support Fibri-humimor forest floors (0-20 cm thick) and the Lady Fern or Foamflower community types.

IIEa soils are mapped in the Mountain Hemlock forested subzone and are generally Gleyed Ferro-Humic Podzols supporting the Yellow Cedar or Avalanche community types.

IIIEa soils are mapped in the Mountain Hemlock parkland subzone and are generally Gleyed Ferro-Humic Podzols supporting Forested or Sedge physiognomic types.

Eb SOILS

Diagnostic criteria

Poorly drained, gravelly to very gravelly, coarse loamy till or colluvium derived from till. Lithology is dominantly granitic.

Accessory characteristics

IEb soils are mapped in the Coastal Western Hemlock wet subzone and are generally Gleyed Ferro-Humic Podzols supporting variable Mor humus forest floors and the Twinflower community type on forest floors thicker than 20 cm, or the Foamflower or Lady Fern community types on forest floors less than 20 cm thick.

IIEb soils are mapped in the Mountain Hemlock forested subzone and are generally Gleyed Ferro-Humic Podzols supporting the Yellow Cedar or False Hellebore community types.

IIIEb soils are mapped in the Mountain Hemlock parkland subzone and are generally Gleyed Ferro-Humic Podzols supporting the complete range of physiognomic types.

Ec SOILS

Diagnostic criteria

Poorly drained, gravelly, loam to sandy loam, till, or till-derived colluvium. Lithology is mixed but dominated by granitic rock types.

Accessory characteristics

IEc soils are mapped in the Coastal Western Hemlock wet subzone and are dominantly Gleyed Ferro-Humic Podzols with Mor humus form forest floors (less than 10 cm thick) and supporting the Foamflower community type.

IIEc soils are mapped in the Mountain Hemlock forested subzone and are generally Gleyed Ferro-Humic podzols supporting the Yellow Cedar community type.

Ed SOILS

Diagnostic criteria

Poorly drained, gravelly, silt loam, till, or ice contact deposits of mixed but dominantly granitic lithology.

Accessory characteristics

Ed soils were mapped only in the Coastal Western Hemlock wet subzone and were Gleyed Ferro-Humic Podzols supporting the American Skunk-Cabbage community type.

Fb SOILS

Diagnostic criteria

Very poorly drained, gravelly to very gravelly, coarse, loamy till or colluvium derived from till. Lithology is dominantly granitic but may show an occasional admixture of basaltic or sandstone rock fragments.

Accessory characteristics

IFb soils are mapped in the Coastal Western Hemlock wet subzone and are dominantly Gleyed Ferro-Humic Podzols supporting an upland Mor humus form and the Lady Fern community type or Orthic Gleysols supporting a transitional Hydromor humus form in the American Skunk-Cabbage community type.

IIFb soils are mapped in the Mountain Hemlock forested subzone and are dominantly Gleyed Ferro-Humic Podzols and Orthic Gleysols supporting the False Hellebore community type.

IIIFb soils are mapped in the Mountain Hemlock parkland subzone and are generally peaty phase Orthic Gleysols or Terric Mesisols supporting the Sedge physiognomic type.

Fc SOILS

Diagnostic criteria

Very poorly drained, gravelly, loam to sandy loam till or till-derived colluvium of mixed but dominantly granitic lithology.

Accessory characteristics

IFc soils are mapped in the Coastal Western Hemlock wet subzone and are generally Gleyed Ferro-Humic Podzols with deep (greater than 20 cm) Mor humus in the Lady Fern community type; or Orthic Gleysols or Humic Gleysols with thin Mor or Hydromor humus forms in the American Skunk-Cabbage community type.

IIFc soils are mapped in the Mountain Hemlock forested subzone and are generally Gleyed Ferro-Humic Podzols or Gleysols supporting the False Hellebore community type.

Ga SOILS

Diagnostic criteria

Well-drained, rubbly to very rubbly, coarse loamy colluvial material derived from moderately competent fine sandstone. Materials may have a significant admixture of granite-derived till.

Accessory characteristics

Generally Orthic Humo-Ferric Podzols supporting a range of thin (less than 10 cm thick) Mor humus forest floors and the Pipsissewa or Salal community type.

Ia SOILS

Diagnostic criteria

Imperfectly drained, rubbly to very rubbly, coarse loamy colluvial material derived from moderately competent fine sandstone. Materials may have a significant admixture of granite-derived till.

Accessory characteristics

Generally Orthic Humo-Ferric Podzols supporting Fibri-humimor forest floors and the Twinflower community type.

Ja SOILS

Diagnostic criteria

Well to moderately well drained, rubbly to very rubbly and fragmental surface (fine earth fraction is insufficient to fill the interstices of the coarse fragments) colluvial deposits. Coarse fragments are derived from granitic or infrequently gneissic bedrock.

Accessory characteristics

IJa soils are mapped in the Coastal Western Hemlock wet subzone and are generally Orthic Humo-Ferric Podzols supporting discontinuous Fibri-humimor forest floors and Twinflower or nonforested community types.

IIJa soils are mapped in the Mountain Hemlock forested subzone and are generally Podzolic soils supporting nonforested or Red Mountain-Heather community types.

IIIJa soils are mapped in the Mountain Hemlock parkland subzone and generally support nonvegetated or Forested physiognomic types.

Ka SOILS

Diagnostic criteria

Imperfectly drained, rubbly to very rubbly and fragmental (fine earth fraction does not completely fill interstices between the coarse fragments) colluvial deposits.

Accessory characteristics

IKa soils are mapped in the Coastal Western Hemlock wet subzone and are generally Orthic Humo-Ferric Podzols supporting Fibri-humimor forest floors (0-10 cm thick) and Lady Fern community types.

Le SOILS

Diagnostic criteria

Well-drained, gravelly to very gravelly, sandy fluvial deposits.

Accessory characteristics

Le soils were mapped only in the Coastal Western Hemlock wet subzone and were Orthic Humo-Ferric Podzols with Fibri-humimor forest floors and supported the Salal or Twinflower community type. Le soils were found on deep terraced deposits at the mouth of Mill Creek.

Me SOILS

Diagnostic criteria

Moderately well drained, gravelly to very gravelly, sandy fluvial deposits.

Accessory characteristics

Me soils were mapped only in the Coastal Western Hemlock wet subzone and ranged from Regosols to Orthic Humo-Ferric Podzols. Me soils were found on terraces immediately adjacent to the active floodplain and support early successional stages of the Twinflower community type.

Ne SOILS

Diagnostic criteria

Imperfectly drained, gravelly to very gravelly, sandy fluvial deposits.

Accessory characteristics

Ne soils were mapped only in the Coastal Western Hemlock wet subzone and were Orthic Humo-Ferric Podzols supporting Twinflower or Foamflower community types. Ne soils were found on bevelled morainal deposits, which impede drainage.

Ye SOILS

Diagnostic criteria

Poorly drained, gravelly to very gravelly, sandy fluvial deposits.

Accessory characteristics

Ye soils were mapped only in the Coastal Western Hemlock wet subzone and were Gleyed Regosols, Gleyed Podzols, or Gleysols. They occupy either the active floodplain and are unvegetated or are adjacent to the active floodplain and support Foamflower, Lady Fern, or American Skunk-Cabbage community types.

APPENDIX II
VEGETATION OF THE MILL AND WOODFIBRE CREEKS MAP AREA

INTRODUCTION

The vegetation community types defined in the Power River were based solely on vegetation characteristics, primarily the presence or absence of plant species. The vegetation data were analyzed following the procedure outlined in the section on classification and mapping methods. The basic unit in the resulting classification is the species group, which forms the basis for ecological interpretations.

The definition of vegetation community types[1] was based on the occurrence of diagnostic species groups,[2] which are groups of plant species that tend to occur together more frequently than with other species. For a species group to be considered present in a plot, a specified number of the total listed as belonging to the group must be present. Because the species belonging to a species group tend to occur in the same restricted number of plots, we infer that they tolerate approximately the same range and balance of ecological conditions and should therefore have some interpretive value. Table 9 presents the species groups and their member species.

Based on an evaluation of soil, site, and landscape characteristics associated with the occurrence of the species groups, the following ecological relationships are proposed.

Species groups

The *Chimaphila* species group is restricted to soils and sites that provide only a limited amount of plant-available water during the summer dry period. The group may be interpreted as drought-tolerant and shade-intolerant, since it is excluded from areas of better water supply and dense crown closure.

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[1]Vegetation community types are named and described using common names where possible, but are defined using Latin names. Appendix III lists the Latin names first.

[2]Species groups (used in defining vegetation community types) are named and defined using Latin names. Appendix IV lists common names first.

Table 9. Diagnostic species used to define species groups

Chimaphila species group, 2/5*
- *Chimaphila menziesia*
- *Chimaphila umbellata*
- *Viola orbiculata*
- *Goodyera oblongifolia*
- *Hypnum circinale*

Gaultheria species group, 1/2
- *Gaultheria shallon*
- *Hylocomium splendens*

Linnaea species group, 1/2
- *Linnaea borealis*
- *Thuja plicata*

Tiarella species group, 2/3
- *Tiarella trifoliata*
- *Rubus spectabilis*
- *Dryopteris assimilis*

Athyrium species group, 2/5
- *Athyrium felix-femina*
- *Streptopus amplexifolius*
- *Oplopanax horridus*
- *Rhizomnium glabrescens*
- *Viola glabella*

Lysichiton species group, 1/1
- *Lysichiton americanum*

Phyllodoce species group, 1/2
- *Phyllodoce empetriformis*
- *Cassiope mertensiana*

Chamaecyparis species group, 2/3
- *Chamaecyparis nootkatensis*
- *Tsuga mertensiana*
- *Vaccinium membranaceum*

Veratrum species group, 2/5
- *Veratrum viride*
- *Cladothamnus pyroliflorus*
- *Gaultheria humifusa*
- *Sphagnum spp.*
- *Vaccinium deliciosum*

*The top number represents the number of species that must be present on a plot for the diagnostic requirements to be met; the bottom number represents the total number of species listed.

The Gaultheria species group occupies an area that has a broad range of summer, plant-available water conditions, but it is best expressed on dry sites with relatively open crowns.

Its presence on wetter sites generally indicates nonsaturated microsite conditions and crown openings, since it does not seem to tolerate saturated soil, and its absence from areas of high canopy closure indicates shade intolerance.

The Linnaea species group is nearly ubiquitous in the Coastal Western Hemlock wet subzone but does not occur in the Mountain Hemlock forested subzone. Since it tolerates a broad range of soil-water and light conditions, we can assume that its distribution is controlled by one or more of the following macroclimate variables: length of growing season, heat units, and snow pack.

The Tiarella species group is excluded from sites where plant-available summer water is low and does best under conditions of medium canopy closure. It may be considered drought-intolerant, and because it occupies the better drained areas of wet sites, it may be saturation-intolerant.

The Athyrium species group is confined to areas of continuously moist soil. It has greater water requirements than the Tiarella species group and has a greater tolerance for soil saturation, so long as the water is not stagnant. With the exception of salmonberry, the group seems to require shade. Salmonberry, on the other hand, responds well to crown openings and can, with more light, move to somewhat drier conditions or can present a serious brush problem following logging on moister sites.

Lysichiton is a single-species species group. It is restricted to areas of prolonged summer soil saturation and tolerates stagnant water.

The Chamaecyparis species group is the Mountain Hemlock zone counterpart of the Linnaea species group, although it does extend into the higher elevations of the Coastal Western Hemlock wet subzone. It occurs on a wide range of soil and site conditions and therefore appears to be controlled by one or more of the following macroclimatic variables: longer snow pack duration, shorter growing season, and fewer heat units to which other species are not as tolerant.

The Phyllodoce species group is restricted to better drained, shallow upper slope positions. Soils are generally nutrient poor and have a lower water-holding capacity. The nutrient deficiency, or low summer-available water, or both, restrict forest growth and produce a relatively open canopy. The Phyllodoce species group appears to respond to high light intensity and possibly higher heat units and warmer soils. The group is intolerant of shade and summer soil saturation.

The Veratrum species group demands water and shade, and is tolerant of saturation.

Community types

Community types are defined on the basis of diagnostic species group combinations. Both the presence or absence of species groups may be significant in the definition of a community type. Table 10 gives the diagnostic requirements for defining community types based on the presence or absence of species groups. Of a total of 66 plots in the two forested subzones only three did not meet the requirements for any species group. The evaluation of 24 reconnaissance plots was consistent with the types defined.

VEGETATION OF THE COASTAL WESTERN HEMLOCK WET SUBZONE

Pipsissewa community type

Description

The tree layer is dominated by western hemlock, western red cedar, or coast Douglas fir. Each species occurs in more than 80% of the plots. Yellow cedar with cover values as high as 20% occurs on 20 of the plots and is generally associated with higher elevations.

The shrub layer is dominated by a relatively dense cover of western hemlock (20-70%), and coast Douglas fir is lacking. There is a low to moderate cover of red huckleberry and salal. Low covers of Alaskan blueberry and black blueberry are frequently found above 600 m.

Deer fern with low cover is a common associate, and other species are rare to infrequent.

The herb layer is poorly developed (cover less than 10%). Northern twinflower and Menzies' pipsissewa are frequent species. Common western pipsissewa and large-leaved rattlesnake orchid are common.

The moss layer is dominated by a constant occurrence of Hylocomium splendens (1-30% cover) and Rhytidiopsis robusta (1-50% cover). Dicranum fuscescens and Rhytidiadelphus loreus are frequent species, and Plagiothecium undulatum is common.

Diagnostic criteria

The Pipsissewa community type is defined by the presence of the Chimaphila and the Gaultheria species groups. The Twinflower species group, which separates the Coastal Western Hemlock from the Mountain Hemlock zone, is generally present but is not diagnostic. No other species group may occur. The Pipsissewa community is distinguished from the Salal type by the presence of the Chimaphila group.

Associated soils

The Pipsissewa community type is generally found on rapidly drained, coarse-textured, shallow (less than 1 m to bedrock or compacted till) deposits. The water-storage capacity of the rooting zone is low and, even when augmented by precipitation, does not meet the water requirements of the growing season.

Mapping criteria for map units dominated by the Pipsissewa type

The Pipsissewa - nonforested complex is mapped on moderate to steep (30-70%) hummocky ridge crests; steep to excessively steep (more than 46%) shoulder slopes; and very to excessively steep (more than 70%) gullied upper-slope positions.

The pure Pipsissewa type is mapped on steep (46-70%) convex shoulder slopes; very steep (more than 70%) upper slopes; and lower slope positions isolated from slope water by well-incised drainage lines.

Salal community type

Description

The tree layer is dominated by a constant, moderate to high cover of western hemlock or a frequent, low to moderate cover of coast Douglas fir. Western red cedar with a low to moderate cover is a constant species.

The shrub layer is well developed and generally dominated by western hemlock. Two variants are present: one, dominated by Vaccinium species, has 10-50% cover values of Vaccinium

Table 10. Diagnostic species groups used to define community types.

	Species groups								
Community types	Chimaphila	Gaultheria	Linnaea	Tiarella	Athyrium	Lysichiton	Phyllodoce	Chamaecyparis	Veratrum
Pipsissewa	*	*	+/-	-	-	-	-	-	-
Salal	-	*	+	-	-	-	-	-	-
Twinflower	-	-	+	-	-	-	-	-	-
Foamflower	-	+/-	+/-	*	-	-	-	-	-
Lady Fern	-	+/-	+/-	*	*	-	-	-	-
American Skunk-Cabbage	-	+/-	+/-	+/-	*	*	-	-	-
Red Mountain-Heather	-	-	-	-	-	-	+	*	-
Yellow Cedar	-	-	-	-	-	-	-	*	-
False Hellebore	-	-	-	+	+	+	+	*	*

* At least one of the groups so labeled must be present.
+/- May or may not be present.
\- Must be absent.

species and 0-20% cover values of salal, and the other has 1-10% Vaccinium cover and 60-70% salal cover. The two variants are similar in all other respects. Red huckleberry with low to moderate cover is a constant species. Alaskan blueberry and rusty Pacific menziesia are common, and other shrub species occur only infrequently or rarely. Black blueberry is common, and yellow cedar and mountain hemlock are rare above 600 m.

Fern cover is poorly developed (generally less than 10% cover). Deer fern is a constant species, western sword fern is infrequent, and spiny shield fern and oak fern are rare.

The herb layer is poorly developed or nonexistent, and total cover values are generally less than 10%. Canadian bunchberry and northern twinflower are common species. Other species are rarely or infrequently present, but as many as eight other species may occur as scattered individuals on any one plot.

The moss layer is moderately developed, and cover values are 5-70%. Rhytidiopsis robusta and Hylocomium splendens are constant species. Plagiothecium undulatum and Dicranum fuscescens are common low-cover species.

Diagnostic criteria

The Salal community type is defined by the presence of the Gaultheria and the Linnaea species groups. No other species groups may be present.

Associated soils

The Salal community type is associated with shallow (less than 1 m to compacted till or bedrock), well-drained to moderately well drained, coarse loamy deposits; well-drained, deep, sandy and gravelly fluvial deposits; and shallow (less than 1 m to bedrock), imperfectly drained soils on slopes of more than 70%, where the water-holding capacity of the rooting zone cannot meet the water requirements of the growing season. The imperfectly drained soils associated with this community type show local saturated conditions only in the fall, winter, or spring. No soil or site characteristics consistently differentiated the Vaccinium and Salal variants, nor could they be reliably mapped without ground verification.

Mapping criteria for map units dominated by the Salal type

The Salal - nonforested complex is mapped on hummocky ridge crests with moderate slopes (less than 46%); steep to excessively steep (more than 46%) shoulder slopes; and excessively steep (more than 80%) gullied upper slopes.

The pure Salal type is mapped on steep (46-70%) convex shoulder slopes; very steep to excessively steep (more than 70%) mid slopes; steep (46-70%), convex mid slopes; and deep, terraced, fluvial mantles.

The complexes of Salal and Twinflower are mapped on steep to very steep (46-70%) gullied upper slopes; moderate to steep (30-70%) upper shoulder slopes; steep to excessively steep (more than 70%) lower shoulder slopes; and where aprons or fans provide deeper rooting depths on mid-slope positions.

The complexes of Salal-Foamflower are mapped on very steep (70-80%) gullied mid-slopes and moderate to steep (30-70%) hummocky lower slopes, where the Foamflower type occurs in the gullies or depressions.

Twinflower community type

Description

The tree layer is dominated by western hemlock, which is a constant species, or coast Douglas fir, which is a frequent species. Western red cedar is constant, and Pacific silver fir is common but may be restricted to the understory.

The shrub layer is well developed and dominated by western hemlock or Pacific silver fir. Red huckleberry (as high as 50% cover) and rusty Pacific menzeisia (generally low cover) are constant species. Six other species each have rare to infrequent occurrences. Salal is generally absent.

Fern cover is poorly to well developed (0.1 to 60% cover). Deer fern is constant, spiny shield fern is common, and western sword fern is infrequent.

The herb layer is generally poorly developed (2-10% cover). Canadian bunchberry is a constant species, northern twinflower is common, and eight other species have rare to infrequent occurrences.

The moss layer is poorly to well developed (2-80% cover). *Plagiothecium undulatum* is a constant species and *Rhytidiopsis robusta* is common. Other mosses are infrequent to rare.

Diagnostic criteria

The presence of the *Linnaea* species group and the lack of any other species group except the *Gaultheria* are diagnostic for the Twinflower community type.

Associated soils

The Twinflower community type is associated with moderately well to imperfectly drained, relatively deep soils supporting thin (less than 15 cm) forest floors; imperfectly to poorly drained soils with moderate to thick (greater than 15 cm) forest floors; and fragmental gravels.

Mapping criteria for map units dominated by the Twinflower type

Complexes of Twinflower and Salal were mapped on hummocky crests and shoulder slopes with moderate slopes (30-40%) and on steep (46-70%) hummocky lower shoulder slopes where the Salal type occupies the hummocks.

Pure Twinflower units were mapped on steep (46-70%) mid slopes of main ridges; lower slope positions isolated from slope water by well-incised gullies; and deep, terraced fluvial mantles.

Complexes of Twinflower and Foamflower were mapped on steep (46-70%), gullied, and dissected lower mid slopes; moderate (30-40%), dissected lower shoulder slopes and till-glacial fluvial complexes; and steep to excessively steep (more than 46%) gullied scarp faces with a lower slope position, where the Foamflower type occupies the gullies or is marginal to the drainage lines.

Complexes of Twinflower and Lady Fern were mapped on steep to very steep (46-80%) gullied lower slopes; dissected, convex lower slopes; steep, gullied, and dissected mid to lower slopes subject to high snow pack; and veneers of fluvial gravels over beveled till. The Lady Fern type occupies the gullies, drainages, or depressional areas.

Foamflower community type

Description

The tree layer is generally dominated by constant western hemlock (10-50% cover), constant western red cedar (3-30% cover), or an equal mixture of these plus coast Douglas fir. Pacific silver fir is a common species but is only rarely dominant.

The shrub layer is well developed and dominated by western hemlock. Red huckleberry is subdominant and constant, rusty Pacific menziesia is common, but Alaskan blueberry, oval-leaved blueberry, and salmonberry are infrequent.

The fern layer is moderately well developed (5-30% cover). Deer fern is the dominant species, but spiny shield fern and western sword fern are also constant species. Common lady fern occurs only rarely.

The herb layer is poorly to moderately developed (1-25% cover). Canadian bunchberry, northern twinflower, or trifoliate-leaved foamflower are dominant. Foamflower is constant, as is either bunchberry or twinflower. Simple-stemmed twistedstalk is a common species.

The moss layer is generally poorly developed (less than 10% cover) but only rarely is as much as 30% cover. *Plagiothecium undulatum* is constant but not always dominant. *Rhytidiopsis robusta* is frequent and *Hylocomium splendens* is common.

Diagnostic criteria

The Foamflower community type is defined by the presence of the *Tiarella* species group and the absence of the *Athyrium*, *Lysichiton*, *Phyllodoce*, *Chamaecyparis*, and *Veratrum* species groups.

Associated soils

The Foamflower community type occurs on moderately well drained fragmental talus; imperfectly drained podzols of variable texture and depth with thin (less than 15 cm) forest floors; and poorly drained Gleyed Podzols with relatively thick (more than 15 cm) forest floors.

Mapping criteria for map units dominated by the Foamflower type

Complexes of Foamflower and Pipsissewa were mapped on steep, hummocky, lower shoulder slopes where the Pipsissewa type is confined to the hummocks.

Pure Foamflower units were mapped on steep (46-70%) lower slopes; moderate to steep dissected and gullied lower slopes; moderate- to gentle-slope (0-46%) lower shoulder slopes; and steep to excessively steep lower slope scarp faces.

Complexes of Foamflower and Lady Fern were mapped on moderate to steep lower slope positions of long, continuous slopes; moderate slope (30-46%) lower- and toe-slope positions with the Lady Fern type adjacent to ephemeral streams and occurring in local depressions; and steep (more than 46%), gullied, and mass-wasting lower slopes.

Complexes of Foamflower and American Skunk-Cabbage were mapped on gentle- to moderate-slope (0-46%) toe-slope positions with thick forest floors. The American Skunk-Cabbage type is generally confined to gullies or depressions.

Lady Fern community type

Description

The tree layer is generally dominated by either western hemlock (5-80% cover) or Pacific silver fir (5-70% cover), both of which are constant species. Western red cedar (0-10% cover) is a frequent associate, but coast Douglas fir (0-40% cover) is infrequent.

The shrub layer is generally very well developed (20-80% cover, rarely less than 20%). Regeneration is dominantly western hemlock, Pacific silver fir, and western red cedar, which make up a lesser component; coast Douglas fir is absent. Two variants strongly intergrade in the Lady Fern community type. A variant dominated by red huckleberry (0-30% cover) or Alaskan blueberry (0-20% cover), or both, grades to a variant dominated by salmonberry (0-80% cover) or devil's-club (0-90% cover). Salmonberry and devil's-club are constant species. No soil, site, or landscape features could be used to consistently separate the variants, nor could they be mapped without ground verification. Based on relative slope position, the Devil's-Club community type occupies wetter conditions. Rusty Pacific menziesia is a common associate, and at least one of four other species is commonly present. Salal occurs only rarely.

Fern cover is relatively well developed (4-30% cover, rarely less than 5%). Deer fern is generally dominant, and common lady fern is infrequently dominant or codominant with oak fern. Western sword fern is associated with the drier variant, and spiny shield fern is associated with the wetter variant.

The herb layer is poorly to moderately well developed (0.1-20% cover values). Cucumberroot twistedstalk and trifoliate-leaved foamflower, with occasional moderate to high covers, are constant species. Simple-stemmed twistedstalk, five-leaved creeping raspberry, and Canadian bunchberry are frequent associates. Two or more other herbs are frequently found, but their constancy is rare to infrequent.

The moss layer is generally moderately well developed (cover values 10-90%, seldom less than 10%). *Plagiothecium undulatum* is frequent and *Rhizomnium glabrescens* is common. Other mosses may have cover values as high as 30%, but their constancy is rare to infrequent.

Diagnostic criteria

The presence of the *Athyrium* species group and the absence of the *Lysichiton*, *Chamaecyparis*, *Veratrum*, and *Phylladoce* species groups is definitive for the Lady Fern community type.

Associated soils

The Lady Fern community type is associated with poorly drained soils of variable texture and depth and only infrequently with imperfectly drained soils.

Mapping Criteria for map units dominated by the Lady Fern type

Complexes of Lady Fern and Twinflower were mapped on channeled and raised fluvial deposits.

Complexes of Lady Fern and Foamflower were mapped on moderate to steep, (30-70%) gullied, lower slope positions, where the Foamflower type is restricted to intergully positions.

Pure Lady Fern units were mapped in moderate to steep (30-70%), lower slope positions.

Complexes of Lady Fern and American Skunk-Cabbage were mapped on moderate- to gentle-slope (0-46%) toe-slope positions. The Lady Fern type occurs on thick (more than 20 cm) forest floors, and the American Skunk-Cabbage type is restricted to drainage lines.

American Skunk-Cabbage community type

Description

The American Skunk-Cabbage community type is similar in nearly all respects to the Lady Fern community type and is separated from it solely by the presence of American skunk-cabbage. It represents the wettest end of the Lady Fern type and was recognized as distinct because, unlike the wetter variant of the Lady Fern type, it could be consistently differentiated by site, soil, and landscape features and was mappable without ground verification.

Associated soils

The American Skunk-Cabbage community type is associated with very poorly drained soils, showing hydromor humus forms. Depths and textures are highly variable.

Mapping criteria for map units dominated by the American Skunk-Cabbage type

Pure American skunk-cabbage units occurred only rarely. They were mapped on toe-slope positions having moderate to gentle slopes (less than 45%) at the base of long continuous slopes.

VEGETATION OF THE MOUNTAIN HEMLOCK FORESTED SUBZONE

Sampling in this subzone was limited to 20% of the sampling effort. The types recognized are therefore of a general nature. Six forested types were tentatively identified during ground traverses, but the data warranted only the definition of three general types. These are reported below.

Forested Red Mountain-Heather community type (two plots)

Description

The tree layer is dominated by yellow cedar and mountain hemlock. Pacific silver fir and western hemlock may also be present with significant cover.

The shrub layer is generally well developed (30-70% cover). Yellow cedar, Alaskan blueberry, or copperbush dominate the shrub layer, with black blueberry and cascade blueberry less dominant. White-flowered rhododendron is infrequently present. Although not conspicuous, red mountain-heather is a constant associate as is rusty Pacific menziesia. Alpine-wintergreen is frequent with low cover, and Mertens' cassiope is common with low cover values.

The herb layer is poorly developed (cover less than 10%). Five-leaved creeping raspberry is constant, and other species are rare to infrequent.

The moss layer is poorly developed but dominated by *Rhytidiopsis robusta* and *Dicranum fuscescens*. Sampling of this type was minimal, but the description given is consistent with field notes and with descriptions given by Brooke et al. (1969).

Diagnostic criteria

The presence of the *Phyllodoce* species group in a forested system is diagnostic for the Forested Red Mountain-Heather community type.

Associated soils

Soils associated with the Forested Red Mountain-Heather type are well to imperfectly drained. Imperfect drainage is a winter phenomenon, so that the soils show moisture stress in the summer. Soils are generally shallow to bedrock or fragmental talus.

Mapping criteria for map units dominated by the Forested Red Mountain-Heather type

Complexes of Nonforested and Forested Red Mountain-Heather were mapped on gullied, very steep to excessively steep (more than 70%) upper and crest slopes; and hummocky upper and crest slopes showing strong bedrock control.

Pure Forested Red Mountain-Heather was mapped on steep, gullied, or very steep upper slopes exhibiting strong bedrock control and scrubby, old-growth forest cover.

Complexes of Forested Red Mountain-Heather and Yellow Cedar were mapped on moderate to excessively steep (more than 46%) crest to mid-slope positions exhibiting strong bedrock control and dominated by low-stature forest cover.

Complexes of Forested Red Mountain-Heather and False Hellebore were mapped on moderate to steep (46-70%) lower- and mid-slope positions showing strong bedrock control or dominated by colluvial fans or aprons.

Yellow Cedar community type

Description

The tree layer is generally dominated by mountain hemlock, infrequently by western hemlock, and rarely by yellow cedar. Pacific silver fir with low to moderate cover is constant, and western red cedar is rare.

The shrub layer is moderately to well developed (covers 10-60%). Pacific silver fir is constant and frequently codominant wih red huckleberry at lower elevations (below 1100 m) and Alaskan blueberry at higher elevations. Rusty Pacific menziesia is a frequent associate. Black blueberry is infrequent, as is Sitka mountain-ash.

Fern cover is poorly developed (less than 10% cover). It is generally dominated by deer fern, although oak fern may dominate rarely.

The herb layer is poorly to well developed (cover 0.1-50%). Five-leaved creeping raspberry or blue-bead clintonia are dominant. Canadian bunchberry and simple-stemmed twistedstalk are common associates. A number of other species may be present but occur only rarely.

The moss layer is poorly to well developed (3-80% cover). _Rhytidiopsis robusta_ and _Dicranum scoparium_ are frequent.

Diagnostic criteria

The Yellow Cedar community type is defined by the presence of the _Chamaecyparis_ species group. No other species groups may be present.

Associated soils

The Yellow Cedar community type is generally associated with deeper (more than 60 cm to bedrock), moderately well to poorly drained soils. Although the soils may have prolonged saturation outside the growing season, they are well drained during the growing season. Soils are of variable texture and lithology.

Mapping criteria for map units dominated by the Yellow Cedar type

Complexes of Yellow Cedar and Nonforested were mapped on excessively steep (more than 80%) bedrock-controlled gullies, mass-wasting stream-cut gullies, and steep mid slopes with active talus deposits.

Complexes of Yellow Cedar and Forested Red Mountain-Heather were mapped on steep to very steep upper slopes with moderately expressed bedrock control and on mid slopes with areas of forested nonactive talus.

Pure Yellow Cedar units were mapped on moderate to very steep (30-70%) mid-slope and lower mid-slope positions showing only moderate evidence of bedrock control and uniform canopied forest cover.

Complexes of Yellow Cedar and False Hellebore were mapped on steep to very steep (46-70%) lower mid slopes and steep to very steep gullied lower slopes where false hellebore is confined to areas of drainage concentration; they were also mapped on moderate-slope and mid-slope positions.

False Hellebore community type

Description

The tree layer consists of yellow cedar, mountain hemlock, and Pacific silver fir. Western hemlock is commonly present.

The shrub layer is well developed (20-50% total cover). Alaskan blueberry is dominant. Pacific silver fir, yellow cedar, rusty Pacific menziesia, black blueberry, and oval-leaved blueberry are constant species.

Fern cover is poorly to moderately well developed (cover values 3-20%). Deer fern or oak fern are dominant. Common lady fern is a constant species.

The herb layer is moderately to well developed (10-30% cover). Five-leaved creeping raspberry is generally dominant. Simple-stemmed twistedstalk, trifoliate-leaved foamflower, and green false hellebore are constant species. Blue-bead clintonia, cucumberroot twistedstalk, and American skunk-cabbage are common associates.

The moss layer may be poorly to well developed and can support high covers of sphagnum moss. *Dicranum scoparium* is a constant species. Sampling of this type was minimal. However, the description given is consistent with field notes and comparable to similar types described in Brooke et al. (1969).

Diagnostic criteria

The presence of the *Chamaecyparis* species with the *Veratrum*, *Lysichiton*, or *Athyrium* species group is diagnostic for this unit.

Associated soils

The False Hellebore community type is associated with poorly and very poorly drained soils. It occurs on a wide range of other soil properties.

Mapping criteria for map units dominated by the False Hellebore type

Pure False Hellebore units were mapped on moderate-slope (30-46%) mid slopes, where crown openings result in high snow pack.

VEGETATION OF THE MOUNTAIN HEMLOCK PARKLAND SUBZONE

Four physiognomic types were mapped in the Mountain Hemlock parkland subzone. Ground traverses and sampling were minimal, and therefore the definition of community types was not justified. For an in-depth discussion of vegetation in this subzone the reader is referred to Brooke et al. (1969).

The Sedge physiognomic type is a sedge-dominated system that lacks trees or shrubs. It occurs in depressional or toe-slope positions, or the margins of streams. Soils are Gleysolic or Organic.

The Heather physiognomic type consists of nonforested low shrub cover on shallow soils in strongly shedding positions. It occurs in complexes with tree islands and sedge types on hummocky terrain of moderate slope and moderate to heavy snow pack.

The Forested physiognomic type has continuous forest cover. It occurs on steep to very steep slopes where snow pack is low.

The Tree Island type consists of isolated clumps of trees surrounded by tall shrubs. It generally occurs on the hummocks of hummocky terrain in complex with the Heather type and is confined to areas of lower snow pack.

APPENDIX III
LATIN AND COMMON NAMES OF PLANT SPECIES

VASCULAR PLANTS

Abies amabilis (D. Dougl. ex Loudon) J. Forbes	Pacific silver fir
Abies lasiocarpa (Hook.) Nutt. var. *lasiocarpa*	alpine fir
Adiantum pedatum L. subsp. *aleuticum* (Rupr.) Calder & Taylor	northern maidenhair fern
Alnus sinuata (Regel) Rydb.	Sitka mountain alder
Amelanchier alnifolia (Nutt.) Nutt. var. *alnifolia*	common saskatoon
Anaphalis margaritacea (L.) B. & H.	common pearly everlasting
Arctostaphylos uva-ursi (L.) K.P.J. Spreng. subsp. *ura-ursi*	kinnikinick
Aruncus dioicus (Walter) Fernald	sylvan goat's-beard
Athyrium felix-femina (L.) Roth subsp. *cyclosorum* (Rupr.) Christensen in Hult.	common lady fern
Blechnum spicant (L.) Roth	deer fern
Caltha leptosepala DC. var. *leptosepala*	alpine white marsh-marigold
Carex nigricans C.A. Meyer	black alpine sedge
Carex sp. L.	sedge
Cassiope mertensiana (Bong.) G. Don var. *mertensiana*	Mertens' cassiope
Chamaecyparis nootkatensis (D. Don) Spach	yellow cedar
Chimaphila menziesii (R. Br. ex D. Don) Spreng.	Menzies' pipsissewa
Chimaphila umbellata (L.) Bart. subsp. *occidentalis* (Rydb.) Hult.	common western pipsissewa
Circaea alpina L. subsp. *pacifica* (Asch. & Magnus) Raven in Calder & Taylor	alpine enchanter's-nightshade
Cladothamnus pyroliflorus Bong.	copperbush
Claytonia sibirica L. var. *sibirica*	Siberian spring beauty
Clintonia uniflora (J.A. Schult.) Kunth	blue-bead clintonia
Corallorhiza maculata Raf. subsp. *mertensiana* (Bong.) Calder & Taylor	western coralroot
Cornus canadensis L.	Canadian bunchberry

Dicentra formosa (Haw.) Walp. subsp. formosa	Pacific bleedingheart
Dryopteris assimilis S. Walker	spiny shield fern
Galium kamtschaticum Steller ex Schult. & Schult.	northern wild licorice
Galium triflorum Michx.	sweet-scented bedstraw
Gaultheria humifusa (Grah.) Rydb.	alpine-wintergreen
Gaultheria shallon Pursh	salal
Goodyera oblongifolia Raf.	large-leaved rattlesnake orchid
Gymnocarpium dryopteris (L.) Newman var. disjunctum (Rupr.) Ching	oak fern
Huperzia selago (L.) Bernh. ex Schrank & Martius var. selago	fir club-moss
Kalmia microphylla (Hook.) Heller subsp. microphylla	western swamp kalmia
Kalmia microphylla (Hook.) Heller subsp. occidentalis (Small) Taylor & MacBryde	western swamp kalmia
Linnaea borealis L. subsp. longiflora (Torr.) Hult.	northern twinflower
Listera caurina Piper	northwestern twayblade
Listera cordata (L.) R. Br. in W. Ait.	heart-leaved twayblade
Luetkea pectinata (Pursh) Kuntze	luetkea
Luzula parvifolia (Ehrh.) Desv.	
Lycopodium clavatum L.	running club-moss
Lycopodium sitchense Rupr. var. sitchense	Alaska club-moss
Lysichiton americanum Hult. & St. John	American skunk-cabbage
Mahonia nervosa (Pursh) Nutt.	dull Oregon-grape
Maianthemum dilatatum (A. Wood) Nels. & Macbr.	two-leaved false Solomon's-seal
Menziesia ferruginea J.E. Smith subsp. ferruginea	rusty Pacific menziesia
Moneses uniflora (L.) A. Gray var. uniflora	one-flowered wintergreen
Oplopanax horridus (J.E. Smith) Miq.	devil's-club
Orthilia secunda (L.) House subsp. secunda	few-flowered one-sided wintergreen
Osmorhiza chilensis Hook. & Arnott	mountain sweetcicely
Petasites sagittatus (Banks ex Pursh) Gray	arrow-leaved colt's-foot
Phyllodoce empetriformis (J.E. Smith) D. Don	red mountain-heather

Pinguicula vulgaris L. subsp. *macroceras* (Link) Calder & Taylor	common butterwort
Pinus monticola D. Dougl. ex D. Don in Lambert	western white pine
Platanthera dilatata (Pursh) Lindl. ex. L. Beck var. *albiflora*	fragrant white rein orchid
Polypodium hesperium Maxon	western polypody
Polystichum munitum (Kaulf.) K. Presl f. *munitum*	western sword fern
Polytrichum commune Hedw.	
Polytrichum piliferum Hedw.	
Pseudoleskea atricha (Kindb. ex. Macoun & Kindb.) Kindb.	
Pseudotsuga menzeisii (Mirb.) Franco var. *menziesii*	coast Douglas fir
Pteridium aquilinum (L.) Kuhn in Decken subsp. *aquilinum* var. *pubescens* Underw.	western bracken
Pyrola asarifolia Michx. var. *asarifolia*	common pink pyrola
Rhododendron albiflorum Hook.	white-flowered rhododendron
Ribes bracteosum Dougl. ex Hook.	stink currant
Rubus parviflorus Nutt. subsp. *parviflorus*	western thimbleberry
Rubus pedatus J.E. Smith	five-leaved creeping raspberry
Rubus spectabilis Pursh	salmonberry
Sambucus racemosa L. subsp. *pubens* (Mich.) House var. *arborescens* (Torr. & Gray) A. Gray	coastal American red elder
Smilacina racemosa (L.) Desf. var. *racemosa*	false Solomon's-seal
Smilacina stellata (L.) Desf.	star-flowered false Solomon's-seal
Sorbus sitchensis M.J. Roem. subsp. *grayi* (Wenz.) Calder & Taylor	Sitka mountain-ash
Streptopus amplexifolius (L.) DC.	cucumberroot twistedstalk
Streptopus roseus Michx. var. *curvipes* (Vail) Fassett	simple-stemmed twistedstalk
Streptopus streptopoides (Ledeb.) Frye & Rigg var. *brevipes* (Bak.) Fassett	small twistedstalk
Taxus brevifolia Nutt.	western yew
Thelypteris phegopteris (L.) Sloss. in Rydb.	long beech fern

Thuja plicata Donn. ex D. Don in Lam.	western red cedar
Tiarella trifoliata L.	trifoliate-leaved foamflower
Tsuga heterophylla (Raf.) Sarg.	western hemlock
Tsuga mertensiana (Bong.) Carr.	mountain hemlock
Vaccinium alaskaense T.J. Howell	Alaskan blueberry
Vaccinium deliciosum Piper	cascade blueberry
Vaccinium membranaceum Dougl. ex Hook.	black blueberry
Vaccinium myrtillus L.	low bilberry
Vaccinium ovalifolium J.E. Smith in Rees	oval-leaved blueberry
Vaccinium parvifolium J.E. Smith in Rees	red huckleberry
Valeriana sitchensis Bong. subsp. *scouleri* Rydb. Piper	Scouler's sitka valeria
Veratrum viride Ait. subsp. *eschscholtzii* (A. Gray) Love & Love	green false hellebore
Viola glabella Nutt.	yellow wood violet
Viola orbiculata Geyer ex Hook.	evergreen yellow violet

BRYOPHYTES

Antitrichia curtipendula (Hedw.) Brid.	
Bartramia pomiformis Hedw.	
Cephalosia bicuspidata (L.) Dumort.	
Dicranum Hedw. sp.	
Dicranum fuscescens Turn.	
Dicranum pallidisetum (Bail. ex Holz.) Irel.	
Dicranum scoparium Hedw.	
Eurhynchium B.S.G. sp.	
Hylocomium splendens (Hedw.) B.S.G.	step moss
Hypnum circinale Hook.	
Isopterygium elegans (Brid.) Lindb.	
Isothecium spiculiferum (Mitt.) Ren & Card.	
Mnium glabrescens Kindb.	
Mnium insigne Mitt.	
Mnium punctatum Hedw.	
Mnium spinulosum B.S.G.	
Pellia neesiana (Gottsche) Limpr.	
Plagiochilia asplenioides (L.) Dumort.	

Plagiothecium undulatum (Hedw.) B.S.G.
Pleurozium schreberi (Brid.) Mitt.
Pogonatum alpinum (Hedw.) Rohl. var. *sylvaticum* (Hoppe) Lawt.
Pogonatum contortum (Brid.) Lesq.
Rhacomitrium Brid. sp.
Rhacomitrium heterostichum (Hedw.) Brid.
Rhacomitrium heterostichum var. *microcarpon* (Hedw.) Boul.
Rhizomnium glabrescens (Kindb.) Kop.
Rhytidiadelphus loreus (Hedw.) Warnst.
Rhytidiopsis robusta (Hedw.) Broth.
Scapania bolanderi Aust.
Sphagnum L.
Sphagnum nemoreum Scop.
Sphagnum russowii Warnst.
Sphagnum squarrosum Crome
Stokesiella oregana (Sull.) Robins.
Stokesiella praelonga (Hedw.) Robins.

APPENDIX IV
COMMON AND LATIN NAMES OF PLANT SPECIES

Alaska club-moss	Lycopodium sitchense Rupr. var. sitchense
Alaskan blueberry	Vaccinium alaskaense T.J. Howell
alpine enchanter's-nightshade	Circaea alpina L. subsp. pacifica (Asch. & Magnus) Raven in Calder & Taylor
alpine fir	Abies lasiocarpa (Hook.) Nutt. var. lasiocarpa
alpine white marsh-marigold	Caltha leptosepala DC. var. leptosepala
alpine-wintergreen	Gaultheria humifusa (Grah.) Rydb.
American skunk-cabbage	Lysichiton americanum Hult. & St. John
arrow-leaved colt's-foot	Petasites sagittatus (Banks ex Pursh) Gray
black alpine sedge	Carex nigricans C.A. Meyer
black blueberry	Vaccinium membranaceum Dougl. ex Hook.
blue-bead clintonia	Clintonia uniflora (J.A. Schult.) Kunth
Canadian bunchberry	Cornus canadensis L.
cascade blueberry	Vaccinium deliciosum Piper
coast Douglas fir	Pseudotsuga menzeisii (Mirb.) Franco var. menziesii
coastal American red elder	Sambucus racemosa L. subsp. pubens (Mich.) House var. arborescens (Torr. & Gray) A. Gray
common butterwort	Pinguicula vulgaris L. subsp. macroceras (Link) Calder & Taylor
common lady fern	Athyrium felix-femina (L.) Roth subsp. cyclosorum (Rupr.) Christensen in Hult.
common pearly everlasting	Anaphalis margaritacea (L.) B. & H.
common pink pyrola	Pyrola asarifolia Michx. var. asarifolia
common saskatoon	Amelanchier alnifolia (Nutt.) Nutt. var. alnifolia
common western pipsissewa	Chimaphila umbellata (L.) Bart. subsp. occidentalis (Rydb.) Hult.
copperbush	Cladothamnus pyroliflorus Bong.
cucumberroot twistedstalk	Streptopus amplexifolius (L.) DC.
deer fern	Blechnum spicant (L.) Roth
devil's-club	Oplopanax horridus (J.E. Smith) Mig.
dull Oregon-grape	Mahonia nervosa (Pursh) Nutt.

evergreen yellow violet	Viola orbiculata Geyer ex Hook.
false Solomon's-seal	Smilacina racemosa (L.) Desf. var. racemosa
few-flowered one-sided wintergreen	Orthilia secunda (L.) House subsp. secunda
fir club-moss	Huperzia selago (L.) Bernh. ex Schrank & Martius var. selago
five-leaved creeping raspberry	Rubus pedatus J.E. Smith
fragrant white rein orchid	Platanthera dilatata (Pursh) Lindl. ex. L. Beck var. albiflora
green false hellebore	Veratrum viride Ait. subsp. eschscholtzii (A. Gray) Love & Love
heart-leaved twayblade	Listera cordata (L.) R. Br. in W. Ait.
kinnikinick	Arctostaphylos uva-ursi (L.) K.P.J. Spreng. subsp. ura-ursi
large-leaved rattlesnake orchid	Goodyera longifolia Raf.
long beech fern	Thelypteris phegopteris (L.) Sloss. in Rydb.
low bilberry	Vaccinium myrtillus L.
luetkea	Luetkea pectinata (Pursh) Kuntze
many-flowered one-sided wintergreen	Pyrola secunda
Menzies' pipsissewa	Chimaphila menziesii (R. Br. ex D. Don) Spreng.
Mertens' cassiope	Cassiope mertensiana (Bong.) G. Don var. mertensiana
mountain hemlock	Tsuga mertensiana (Bong.) Carr.
mountain sweetcicely	Osmorhiza chilensis Hook. & Arnott
northern maidenhair fern	Adiantum pedatum L. subsp. aleuticum (Rupr.) Calder & Taylor
northern twinflower	Linnaea borealis L. subsp. longiflora (Torr.) Hult.
northern wild licorice	Galium kamtschaticum Steller ex Schult. & Schult.
northwestern twayblade	Listera caurina Piper
oak fern	Gymnocarpium dryopteris (L.) Newman var. disjunctum (Rupr.) Ching
one-flowered wintergreen	Moneses uniflora (L.) A. Gray var. uniflora
oval-leaved blueberry	Vaccinium ovalifolium J.E. Smith in Rees
Pacific bleedingheart	Dicentra formosa (Haw.) Walp. subsp. formosa
Pacific silver fir	Abies amabilis (D. Dougl. ex Loudon) J. Forbes

red huckleberry	Vaccinium parvifolium J.E. Smith in Rees
red mountain-heather	Phyllodoce empetriformis (J.E. Smith) D. Don
running club-moss	Lycopodium clavatum L.
rusty Pacific menziesia	Menziesia ferruginea J.E. Smith subsp. ferruginea
salal	Gaultheria shallon Pursh
salmonberry	Rubus spectabilis Pursh
Scouler's sitka valeria	Valeriana sitchensis Bong. subsp. scouleri Rydb. Piper
sedge	Carex sp. L.
Siberian spring beauty	Claytonia sibirica L. var. sibirica
simple-stemmed twistedstalk	Streptopus roseus Michx. var. curvipes (Vail) Fassett
Sitka mountain alder	Alnus sinuata (Regel) Rydb.
Sitka mountain-ash	Sorbus sitchensis M.J. Roem. subsp. grayi (Wenz.) Calder & Taylor
small twistedstalk	Streptopus streptopoides (Ledeb.) Frye & Rigg var. brevipes (Bak.) Fassett
spiny shield fern	Dryopteris assimilis S. Walker
star-flowered false Solomon's-seal	Smilacina stellata (L.) Desf.
step moss	Hylocomium splendens B.S.G.
stink currant	Ribes bracteosum Dougl. ex Hook.
sweet-scented bedstraw	Galium triflorum Michx.
sylvan goat's-beard	Aruncus dioicus (Walter) Fernald
trifoliate-leaved foamflower	Tiarella trifoliata L.
two-leaved false Solomon's-seal	Maianthemum dilatatum (A. Wood) Nels. & Macbr.
western bracken	Pteridium aquilinum (L.) Kuhn in Decken subsp. aquilinum var. pubescens Underw.
western coralroot	Corallorhiza maculata Raf. subsp. mertensiana (Bong.) Calder & Taylor
western hemlock	Tsuga heterophylla (Raf.) Sarg.
western polypody	Polypodium hesperium Maxon
western red cedar	Thuja plicata Donn. ex D. Don in Lam.
western swamp kalmia	Kalmia microphylla (Hook.) Heller subsp. microphylla
western swamp kalmia	Kalmia microphylla (Hook.) Heller subsp. occidentalis (Small) Taylor & MacBryde
western sword fern	Polystichum munitum (Kaulf.) K. Presl f. munitum

western thimbleberry	*Rubus parviflorus* Nutt. subsp. *parviflorus*
western white pine	*Pinus monticola* D. Dougl. ex D. Don in Lambert
western yew	*Taxus brevifolia* Nutt.
white-flowered rhododendron	*Rhododendron albiflorum* Hook.
yellow cedar	*Chamaecyparis nootkatensis* (D. Don) Spach
yellow wood violet	*Viola glabella* Nutt.