


TABLE 4.1. (Concluded) Subzone/variant names, tree species and elevation

| Biogeoclimatic zone | Climate region | Map symbol  | Subzone/variant | Tree species ^a | Elevation ranges S=South aspect N=North aspect |
|------------------------|-----------------------|---|-----------------|---------------------------|--|
| AT Alpine Tundra | Dry, Moist, Wet | AT | | | Min. Elev. 2600 m in Dry Region; 2400 m in Moist Region; 2300 m in Wet Region |

- ^a Species in bold type are zonal climax, other species are seral or non-zonal species.
- ^b () Bracketted species are rare species.
- ^c [-] Square brackets and minus sign denote diagnostic absence of species.
- ^d Please refer to Kamloops Forest Region Fieldguide (Lloyd *et al.*, 1990) for site identification and management interpretations for the IDFxh1, ICHmw3, and ESSFwc2. These variants are of limited extent in the Nelson Region.
- ^e The southern portion of this variant is found above the ICHdw, i.e., at elevations of 1200-1550 m.
- ^f These species occur in the lower elevations of the subzone/variant.

TABLE 4. Climatic characteristics for the biogeoclimatic zones of British Columbia

| Zone | Range and reference station | Lat. (°′) | Long. (°′) | Elevation (m) | Mean annual precip. (mm) | Mean summer precip. (May-Sept) (mm) | Mean precip. of driest month (mm) | Mean precip. of wettest month (mm) | Driest month | Wettest month |
|------|-----------------------------|-----------|------------|---------------|--------------------------|-------------------------------------|-----------------------------------|------------------------------------|--------------|---------------|
| AT | Old Glory Mtn. | 49 09 | 117 55 | 2347 | 755.5 | 287.0 | 40.0 | 84.1 | Jul | Dec |
| BG | Max | | | 588 | 335.7 | 174.5 | 17.3 | 55.4 | | |
| | Min | | | 297 | 205.6 | 98.0 | 8.0 | 27.3 | | |
| | Kamloops | 50 40 | 120 20 | 379 | 241.7 | 111.4 | 8.0 | 36.1 | Mar | Jan |
| BWBS | Max | | | 840 | 503.7 | 305.3 | 24.3 | 879.0 | | |
| | Min | | | 382 | 327.1 | 144.7 | 8.3 | 41.1 | | |
| | Fort Nelson A | 58 50 | 122 35 | 382 | 451.8 | 297.9 | 16.7 | 84.3 | Apr | Jul |
| CDF | Max | | | 223 | 1262.6 | 238.3 | 38.6 | 232.9 | | |
| | Min | | | 8 | 647.2 | 107.3 | 13.4 | 119.2 | | |
| | Victoria Int'l A | 48 39 | 123 26 | 19 | 872.9 | 141.9 | 18.1 | 157.3 | Jul | Dec |
| CWH | Max | | | 671 | 4386.8 | 1162.0 | 151.0 | 625.4 | | |
| | Min | | | 0 | 990.2 | 159.3 | 16.8 | 145.7 | | |
| | Haney UBC RF Admin | 49 16 | 122 34 | 143 | 2140.1 | 467.8 | 65.5 | 331.7 | Jul | Dec |
| ESSF | Max | | | 1862 | 1995.4 | 424.5 | 64.8 | 297.4 | | |
| | Min | | | 863 | 514.1 | 204.6 | 26.6 | 57.4 | | |
| | Boss Mountain | 52 06 | 120 53 | 1532 | 1177.1 | 401.6 | 63.5 | 140.6 | May | Dec |
| ICH | Max | | | 1085 | 1419.0 | 439.3 | 57.2 | 224.3 | | |
| | Min | | | 314 | 497.7 | 199.9 | 21.4 | 57.8 | | |
| | Revelstoke | 51 00 | 118 12 | 456 | 1063.7 | 325.0 | 51.4 | 177.0 | Apr | Jan |
| IDF | Max | | | 1128 | 1198.9 | 290.7 | 37.6 | 208.8 | | |
| | Min | | | 122 | 295.1 | 107.5 | 13.5 | 34.8 | | |
| | 150 Mile House | 52 07 | 121 56 | 738 | 414.2 | 214.0 | 15.8 | 60.7 | Apr | Jun |
| MH | Hollyburn Ridge | 49 23 | 123 12 | 930 | 2954.3 | 694.4 | 106.9 | 434.8 | Jul | Dec |
| MS | Max | | | 1554 | 663.8 | 252.1 | 38.5 | 108.1 | | |
| | Min | | | 1128 | 380.8 | 158.2 | 17.9 | 45.2 | | |
| | Peachland Brenda Mines | 49 52 | 120 00 | 1520 | 638.3 | 197.0 | 29.3 | 89.1 | Apr | Dec |
| PP | Max | | | 939 | 604.5 | 270.3 | 30.7 | 77.6 | | |
| | Min | | | 244 | 319.5 | 86.3 | 11.0 | 34.5 | | |
| | Kelowna | 49 54 | 119 28 | 354 | 332.2 | 136.3 | 15.3 | 45.1 | Apr | Dec |
| SBPS | Max | | | 1219 | 517.8 | 299.8 | 21.1 | 86.5 | | |
| | Min | | | 914 | 464.1 | 242.6 | 20.8 | 36.4 | | |
| | Alexis Creek Tautri Creek | 52 33 | 123 11 | 1219 | 464.1 | 242.6 | 20.8 | 57.6 | Apr | Jun |
| SBS | Max | | | 1245 | 1588.2 | 352.6 | 36.8 | 278.7 | | |
| | Min | | | 488 | 438.9 | 188.9 | 15.2 | 49.8 | | |
| | Prince George A | 53 63 | 122 40 | 676 | 628.3 | 300.8 | 27.4 | 68.2 | Apr | Aug |
| SWB | Cassiar | 59 17 | 129 50 | 1078 | 699.5 | 275.1 | 25.7 | 84.2 | Apr | Oct |

Zone key

| | | | |
|------|----------------------------------|------|--------------------------|
| AT | Alpine Tundra | IDF | Interior Douglas-fir |
| BG | Bunchgrass | MH | Mountain Hemlock |
| BWBS | Boreal White and Black Spruce | MS | Montane Spruce |
| CDF | Coastal Douglas-fir | PP | Ponderosa Pine |
| CWH | Coastal Western Hemlock | SBPS | Sub-Boreal Pine — Spruce |
| ESSF | Engelmann Spruce — Subalpine Fir | SBS | Sub-Boreal Spruce |
| ICH | Interior Cedar — Hemlock | SWB | Spruce — Willow — Birch |

TABLE 5. Occurrence^a of trees in the biogeoclimatic zones of British Columbia

| Gymnosperms | BG | PP | IDF | ICH | MS | SBPS | SBS | BWBS | SWB | MH | CDF | CWH | ESSF | AT ^b |
|---|-----|-----|-----|-----|-----|------|-----|------|-----|-----|-----|-----|------|-----------------|
| <i>Abies amabilis</i> (amabilis fir) | - | - | - | + | - | - | - | - | - | +++ | - | +++ | (+) | - |
| <i>A. grandis</i> (grand fir) | - | - | ++ | ++ | + | - | - | - | - | - | ++ | + | - | - |
| <i>A. lasiocarpa</i> (subalpine fir) | - | - | - | ++ | +++ | (+) | +++ | ++ | +++ | ++ | - | + | +++ | - |
| <i>Chamaecyparis</i> <i>nootkatensis</i> (yellow-cedar) | - | - | - | - | - | - | - | - | - | +++ | - | ++ | (+) | - |
| <i>Juniperus scopulorum</i> (Rocky Mountain juniper) | + | + | ++ | - | - | - | + | (+) | - | - | ++ | (+) | - | - |
| <i>Larix laricina</i> (tamarack) | - | - | - | - | - | - | (+) | ++ | - | - | - | - | - | - |
| <i>L. lyallii</i> (alpine larch) | - | - | - | - | - | - | - | - | - | - | - | - | ++ | - |
| <i>L. occidentalis</i> (western larch) | - | + | +++ | ++ | +++ | - | - | - | - | - | - | - | + | - |
| <i>Picea engelmannii</i> (Engelmann spruce) | - | - | + | ++ | +++ | - | - | - | - | + | - | - | +++ | - |
| <i>P. engelmannii</i> <i>x glauca</i> (hybrid white spruce) | - | (+) | ++ | ++ | +++ | + | +++ | - | - | - | - | - | ++ | - |
| <i>P. glauca</i> (white spruce) | - | (+) | + | - | + | +++ | ++ | +++ | +++ | - | - | - | + | - |
| <i>P. glauca</i> <i>x sitchensis</i> (Roche spruce) | - | - | - | ++ | - | - | - | - | - | (+) | - | ++ | - | - |
| <i>P. mariana</i> (black spruce) | - | - | - | + | - | - | ++ | +++ | + | - | - | - | - | - |
| <i>P. sitchensis</i> (Sitka spruce) | - | - | - | - | - | - | - | - | - | + | + | +++ | - | - |
| <i>Pinus albicaulis</i> (whitebark pine) | - | - | - | - | - | - | - | - | - | + | - | - | ++ | - |
| <i>P. banksiana</i> (jack pine) | - | - | - | - | - | - | - | (+) | - | - | - | - | - | - |
| <i>P. contorta</i> (lodgepole pine) | (+) | - | +++ | ++ | +++ | +++ | +++ | +++ | ++ | + | ++ | ++ | +++ | - |
| <i>P. flexilis</i> (limber pine) | - | - | (+) | - | - | - | - | - | - | - | - | - | (+) | - |
| <i>P. monticola</i> (western white pine) | - | - | + | ++ | + | - | - | - | - | + | + | ++ | + | - |
| <i>P. ponderosa</i> (ponderosa pine) | + | +++ | +++ | + | - | - | - | - | - | - | - | - | - | - |
| <i>Pseudotsuga menziesii</i> (Douglas-fir) | + | ++ | +++ | ++ | +++ | + | ++ | - | - | (+) | +++ | +++ | + | - |
| <i>Taxus brevifolia</i> (western yew) | - | - | + | ++ | - | - | - | - | - | - | ++ | ++ | - | - |
| <i>Thuja plicata</i> (western redcedar) | - | (+) | ++ | +++ | + | - | + | - | - | + | ++ | +++ | + | - |
| <i>Tsuga heterophylla</i> (western hemlock) | - | - | + | +++ | + | - | (+) | - | - | ++ | + | +++ | + | - |
| <i>T. mertensiana</i> (mountain hemlock) | - | - | - | + | - | - | - | - | - | +++ | - | + | ++ | - |

TABLE 5. Continued

| Angiosperms | BG | PP | IDF | ICH | MS | SBPS | SBS | BWBS | SWB | MH | CDF | CWH | ESSF | AT ^b |
|--|----|----|----------------|-----------------|----|------|----------------|------|-----|----|-----|-----|------|-----------------|
| <i>Acer macrophyllum</i> (bigleaf maple) | - | - | + | - | - | - | - | - | - | - | ++ | ++ | - | - |
| <i>Alnus rubra</i> (red alder) | - | - | - | - | - | - | - | - | - | - | +++ | +++ | - | - |
| <i>Arbutus menziesii</i> (arbutus) | - | - | - | - | - | - | - | - | - | - | ++ | + | - | - |
| <i>Betula neoalaskana</i> (Alaska paper birch) | - | - | - | - | - | - | - | ++ | - | - | - | - | - | - |
| <i>B. occidentalis</i> (water birch) | + | + | + | (+) | - | - | (+) | + | - | - | - | - | - | - |
| <i>B. papyrifera</i> (paper birch) | + | + | ++ | ++ | + | - | ++ | ++ | - | - | + | + | - | - |
| <i>Cornus nuttallii</i> (western flowering dogwood) | - | - | + | - | - | - | - | - | - | - | ++ | ++ | - | - |
| <i>Populus balsamifera</i> ssp. <i>balsamifera</i> (balsam poplar) | - | - | - | - | - | - | + | ++ | + | - | - | - | - | - |
| <i>P. balsamifera</i> ssp. <i>trichocarpa</i> (black cottonwood) | + | + | + | ++ | + | + | ++ | + | - | - | ++ | ++ | + | - |
| <i>P. tremuloides</i> (trembling aspen) | + | ++ | +++ | ++ | ++ | + | +++ | +++ | + | - | + | + | + | - |
| <i>Prunus emarginata</i> (bitter cherry) | - | - | + ^c | ++ ^c | - | - | + ^c | - | - | - | ++ | + | - | - |
| <i>Quercus garryana</i> (Garry oak) | - | - | - | - | - | - | - | - | - | - | ++ | (+) | - | - |
| <i>Rhamnus purshiana</i> (cascara) | - | - | - | ++ ^d | - | - | - | - | - | - | ++ | + | - | - |

^a Occurrence classes: +++(abundant); ++(common); +(present but uncommon); (+)(very rare); -(absent).

^b Tree species occur only in krummholz form in the Alpine Tundra zone.

^c *P. emarginata* occurs in these zones, but only rarely as a (small) tree.

^d Rarely as a small tree.

Chapter 18: Alpine Tundra Zone

by

J. Pojar and A.C. Stewart

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LOCATION AND DISTRIBUTION

The Alpine Tundra zone (AT) occurs on high mountains throughout the province (Figure 65). In southeastern British Columbia, the AT occurs at elevations above approximately 2250 m; in the southwest, above 1650 m; in the northeast, above 1400 m; in the northwest, above 1000 m. The zone is concentrated along the coastal mountains and in the northern and southeastern parts of the province and occurs above all three subalpine zones. The AT extends beyond British Columbia on the high mountains to the north, east, and south.

ECOLOGICAL CONDITIONS

The harsh alpine climate is cold, windy, and snowy, and characterized by low growing season temperatures and a very short frost-free period (Table 4). British Columbia has only two long-term, alpine climate stations: Old Glory Mountain, near Trail (Figure 66) and Mt. Fidelity in Glacier National Park. Available short- and long-term data indicate that the mean annual temperature ranges from -4 to 0°C. The average temperature remains below 0°C for 7-11 months. Frost can occur at any time. The AT is the only zone in the province where the mean temperature of the warmest month is less than 10°C. Mean annual precipitation is 700-3000 mm, most of which (70-80%) falls as snow.

Alpine ecosystems in British Columbia have received relatively little attention from scientists and land managers. Furthermore, most of the studies that have been done remain unpublished and poorly available in thesis or report form (see Hamilton¹²). However, some general features of the AT can be derived from the available information.

The alpine zone is, by definition, treeless, but tree species are common at lower elevations, although in stunted or krummholz form.¹³ The most common krummholz species are subalpine fir, Engelmann spruce, white spruce, mountain hemlock, and whitebark pine. Krummholz is usually not widespread, however. Alpine vegetation is dominated by shrubs, herbs, bryophytes, and lichens. Of course, much of the alpine landscape lacks vegetation and is the domain of rock, ice, and snow.

Alpine scrub or shrubfield vegetation of low deciduous shrubs often dominates lower alpine subzones, especially in the northern part of the province. Common shrubs are willows (e.g., *Salix arctica* [arctic willow], *S. barclayi* [Barclay's willow], *S. barrattiana* [Barratt's willow], *S. glauca* [grey-leaved willow], *S. planifolia* [tea-leaved willow]), and *Betula glandulosa* (scrub birch).

¹² Hamilton, E. 1983. A problem analysis of the classification of Alpine Tundra and subalpine parkland subzones within the British Columbia Ministry of Forests Ecosystem Classification program. B.C. Min. For., Res. Br., Victoria, B.C. Draft report.

¹³ Some ecologists include krummholz within the subalpine zone; others, within the alpine zone.

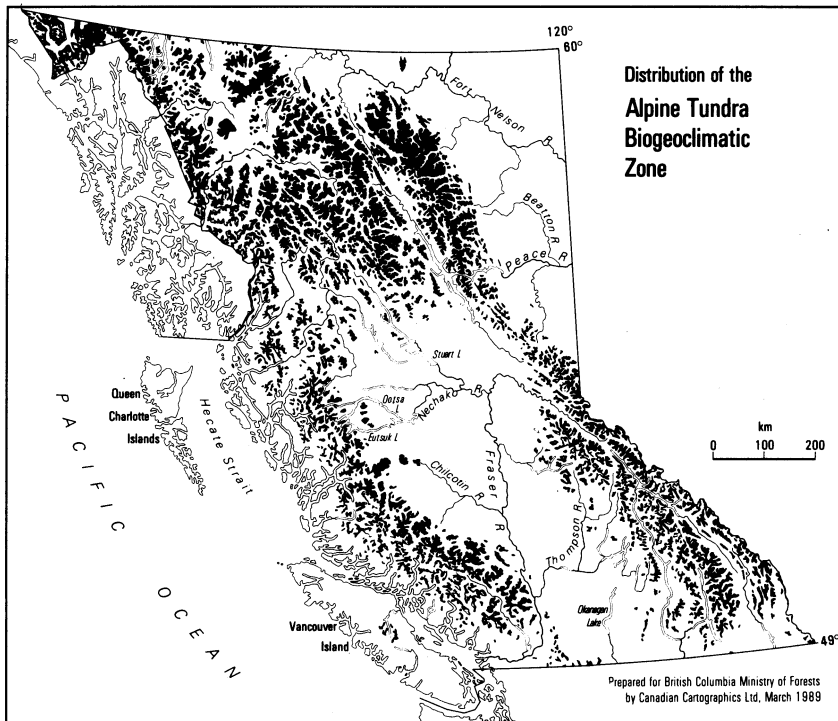


FIGURE 65. Alpine Tundra zone.

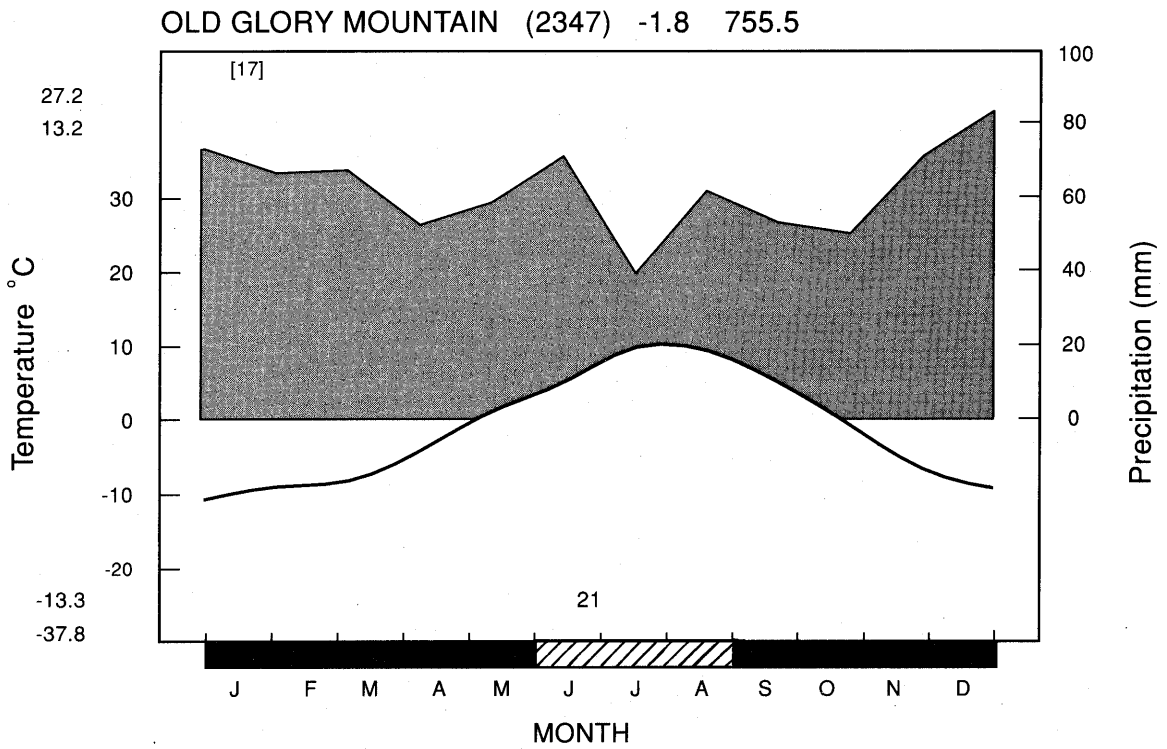


FIGURE 66. Representative climatic diagram for the Alpine Tundra zone.

A dwarf scrub of prostrate woody plants is the most common form of vegetation in the AT as a whole. Dwarf scrub generally is most abundant in the middle elevations of the zone. This scrub is especially widespread in moister, snowier regions; in drier regions it tends to be restricted to areas of snow accumulation. However, some scrub types (e.g., the *Dryas octopetala* [white mountain-avens] association) are restricted to windswept, largely snow-free ridgecrests. Important dwarf shrubs include evergreen-leaved species such as *Cassiope* spp. and *Phyllodoce* spp. (mountain-heathers), *Luetkea pectinata* (partridgefoot), *Arctostaphylos uva-ursi* (kinnikinnick), *Empetrum nigrum* (crowberry), *Vaccinium vitis-idaea* (lingonberry), *Loiseleuria procumbens* (alpine azalea), and *Dryas* spp., as well as deciduous species such as *Salix cascadiensis* (Cascade willow), *S. polaris* (polar willow), *S. reticulata* (netted willow), *S. reticulata* ssp. *nivalis* (snow willow), *Vaccinium uliginosum* (bog blueberry), and *Arctostaphylos rubra* (red bearberry).

Alpine grass vegetation is also widespread. It becomes dominant in drier regions, as in higher elevations of the south central Interior, the Chilcotin district and elsewhere on the leeward slopes of the Coast Mountains, and along the leeward side of the Rocky Mountains. Elsewhere, grass vegetation tends to be more localized and often is restricted to steep south-facing slopes or convex, windswept ridges. Dominant grasses and sedges vary from south to north, but some important species of drier alpine communities are *Festuca altaica* (Altai fescue), *F. brachyphylla* (alpine fescue), *F. scabrella* (rough fescue), *F. viridula* (green fescue), *Elymus innovatus* (fuzzy-spiked wildrye), *Agropyron violaceum* (broad-glumed wheatgrass), *Poa rupicola* (timberline bluegrass), *Hierochloe alpina* (alpine sweetgrass), *Calamagrostis purpurascens* (purple reedgrass), *Danthonia intermedia* (timber oatgrass), *Carex nardina* (spikenard sedge), *C. microchaeta* (small-awned sedge), *C. phaeocephala* (dunhead sedge), *C. scirpoidea* ssp. *pseudoscirpoidea* (single-spiked sedge), and *Kobresia myosuroides* (Bellard's kobresia). Grass vegetation also dominates some seepage or snowbed ecosystems. Some common graminoid species of wetter alpine communities are *Calamagrostis lapponica* (Lapland reedgrass), *Arctagrostis latifolia* (polargrass), *Poa arctica* (arctic bluegrass), *Carex* spp. (e.g., *Carex aquatilis* [water sedge], *C. enanderi* [Enander's sedge], *C. nigricans* [black alpine sedge], *C. podocarpa* [short-stalked sedge], *C. spectabilis* [showy sedge], *C. capitata* [capitate sedge]), *Eriophorum* spp. (cotton-grasses), *Juncus drummondii* (Drummond's rush), *J. parryi* (Parry's rush), *Luzula arcuata* (curved alpine woodrush), and *L. wahlenbergii* (Wahlenberg's woodrush).

Herb meadows or herbfields dominated by broad-leaved forbs are also common in the alpine, especially at middle and lower elevations. These meadows usually develop on well-drained sites with deep soils, in seepage areas, or along alpine rivulets and streams. Important species in British Columbia include *Lupinus arcticus* (arctic lupine), *Senecio triangularis* (arrow-leaved groundsel), *Erigeron peregrinus* (subalpine daisy), *Valeriana sitchensis* (Sitka valerian), *Veratrum viride* (Indian hellebore), *Arnica* spp. (arnicas), *Pedicularis* spp. (louseworts), *Castilleja* spp. (paintbrushes), *Antennaria lanata* (woolly pussytoes), *Anemone occidentalis* (western pasqueflower), *Caltha leptosepala* (white marsh-marigold), *Heracleum lanatum* (cow-parsnip),

Erythronium grandiflorum (glacier lily), *Ranunculus eschscholtzii* (subalpine buttercup), *R. nivalis* (snow buttercup), *Oxyria digyna* (mountain sorrel), and *Artemisia norvegica* ssp. *saxatilis* (mountain sagewort).

Few species of vascular plants (most of which are cushion- or mat-formers) have adapted to the extreme conditions in the highest parts of the alpine zone. However, a few mosses and liverworts and numerous lichens persist and even thrive at the upper limits of vegetation. Plant communities can occur over bedrock, in fellfield or boulderfield habitats, or as vegetation stripes on patterned or sorted ground. Species of the lichen genera *Cetraria*, *Alectoria*, *Umbilicaria*, *Parmelia*, *Rhizocarpon*, and *Lecanora*, as well as the lichens *Thamnolia subuliformis* and *Dactylina arctica*, and the mosses *Polytrichum piliferum* (awned haircap moss), *Rhacomitrium lanuginosum*, and *R. heterostichum*, typify the sparse, predominantly cryptogamic vegetation.

In alpine ecosystems the plants are typically small, close to the ground, and often widely separated by bare soil or rock. Unlike a forest, tundra does not modify microclimate very much, and the physical environment dictates the vegetation in the alpine zone. The terrain can be gentle or extremely rough, but in any case the effects of microenvironment are pronounced in such open and windy places. Even a few centimetres difference in microtopography makes a pronounced difference in soil temperature, depth of thaw, wind effects, snow drifting, and resultant protection to plants.

Alpine vegetation and soil typically occur in a complex mosaic of communities and polypedons. Major environmental factors are topographic exposure, wind, solar radiation, soil temperature, and the distribution of snow and its meltwater. These factors are all interrelated and also superimposed on patterns of bedrock, soil frost features, and sometimes permafrost as well.

The processes of frost shattering, colluviation, solifluction, nivation, cryoturbation, and permafrost development are all active. Soil development is often absent or weak, and is strongly affected by these processes that disrupt and dislocate horizons, displace and incorporate materials from other horizons, and mechanically sort soil particles. Such effects combine with the cold climate (which slows weathering) to greatly retard soil development.

Regosols (Orthic and Humic) are probably the most common soils overall in British Columbia's alpine zone. Constant churning of surface and subsoil particles results in poor horizon differentiation and frequent buried bands of organic-rich materials resembling former A horizons. Brunisols are also common and can dominate in drier alpine areas. Where graminoid sods have developed, organic matter incorporation in upper mineral horizons results in Melanic and Sombric Brunisols with turfy Ah horizons. Wet habitats commonly have Humic Gleysols or Organic soils. Turbic Cryosols and Organic Cryosols are common in northern regions or on north aspects where subsurface drainage is impeded. Ferro-Humic Podzols typically develop under krummholz, mountain-heather, and scrub birch vegetation.

Alpine humus forms have not been studied very much, but it appears that Rhizomulls are widespread in herb-dominated tundra ecosystems. Hemimors and Mormoders, however, may be expected beneath alpine scrub and heath vegetation.

SUBZONES

Ecologists have an incomplete understanding of the subzones of the AT in British Columbia, although they certainly appreciate the great diversity of alpine ecosystems in our extremely mountainous, climatically and edaphically complex province. There are three major divisions of the alpine zone in British Columbia:

- Maritime or Coastal
- Northern Interior (north of roughly 56° latitude)
- Southern Interior

Each of these regions can be further divided along climatic and elevational gradients, but no one has yet made ecological sense of the resulting matrix of possible subzones.

Maritime alpine tundra is dominated by alpine heath, a dwarf, evergreen scrub characterized by *Cassiope mertensiana* (white mountain-heather) and *Phyllodoce empetriformis* (pink mountain-heather). The zonal tundra of the northern Interior is characterized by dwarf willows (especially *Salix reticulata* and *S. polaris*), grasses (especially *Festuca altaica*), sedges, and lichens. Southern Interior tundra is more variable. *Dryas octopetala*, other dwarf willows (especially *Salix reticulata* ssp. *nivalis* and *S. cascadenis*), grasses, sedges, and lichens typify drier climates; alpine heath dominates in moister, snowier climates.

SOME REPRESENTATIVE SITE ASSOCIATIONS

The following descriptions pertain to a high alpine subzone studied in the rolling alplands of the Stikine Plateau, in north central British Columbia (see Figure 67).

Dwarf willow — Small-awned sedge

This association is widespread on all aspects over the exposed plateau surfaces and on the broad wind-swept ridges typical of the northern plateau terrain. Parent materials commonly have been derived from local bedrock, although thin morainal deposits also occur. Sloping sites with finer-textured parent materials tend to have solifluction lobes with Dystric and Sombric Brunisols. Cryic and Turbic Regosols are most common on flat or gently sloping sites that often have patterned ground features. The typical humus form is an alpine Rhizomull.

The tundra vegetation is dominated by dwarf willows, graminoid species, and lichens. *Salix polaris* and *S. reticulata* are the dominant dwarf willows. Prominent

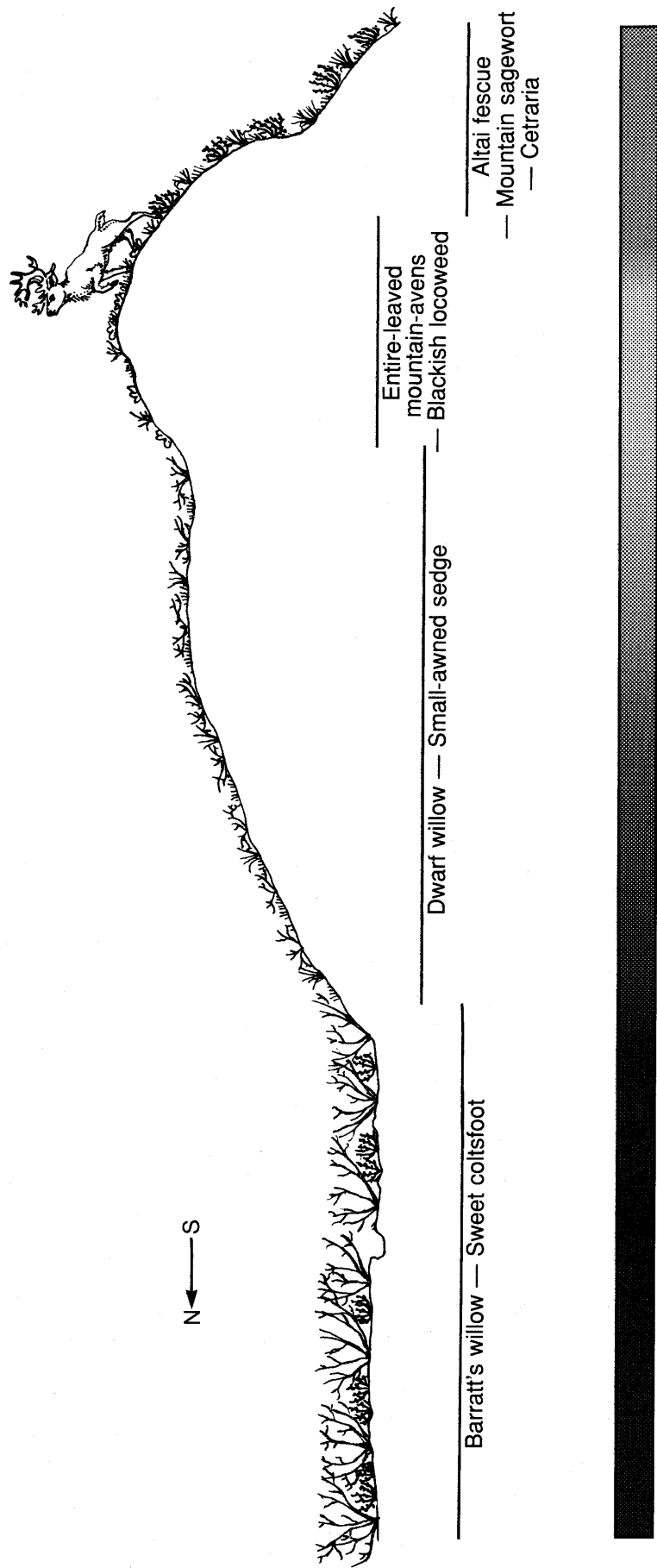


FIGURE 67. Simplified schematic diagram of topographic relationships among four common site associations of a northern subzone of the Alpine Tundra zone.

graminoid species include *Carex microchaeta* (small-awned sedge), *Hierochloe alpina*, *Festuca altaica*, *F. brachyphylla*, and *Luzula arctica* (arctic woodrush). Common forbs are *Polygonum viviparum* (alpine bistort), *Antennaria monocephala* (one-headed pussytoes), *Potentilla hyparctica* (arctic cinquefoil), *Silene acaulis* (moss campion), and *Stellaria longipes* (long-stalked starwort).

The cryptogamic layer is moderately to well developed. Important species include the lichens *Cetraria nivalis*, *C. delisei*, *C. cucullata*, *C. islandica*, *Stereocaulon paschale*, *Thamnolia subuliformis*, *Alectoria ochroleuca*, and *Dactylina arctica*, as well as the mosses *Polytrichum piliferum*, *Rhytidium rugosum*, *Distichium capillaceum*, and *Ditrichum flexicaule*.

Entire-leaved mountain-avens — Blackish locoweed

Cushion plant tundra occurs on dry, exposed, convex ridgecrests throughout northern British Columbia. These ecosystems occupy rapidly drained, gravelly or rubbly habitats. Parent materials have been derived from the local, usually somewhat calcareous, sedimentary bedrock. Stone-stripping is common; there is usually much bare ground between clumps of vegetation. Soils are typically Regosols, of Orthic, Humic, and Turbic subgroups. Typical humus forms are alpine Rhizomulls.

The poorly to moderately developed dwarf shrub/herb layer is dominated by cushion- or mat-forming plants. Important species include *Dryas integrifolia* (entire-leaved mountain-avens), *Oxytropis nigrescens* (blackish locoweed), *Silene acaulis*, *Potentilla uniflora* (one-flowered cinquefoil), *Lupinus arcticus*, *Salix reticulata*, *Draba nivalis* (snow draba), *Kobresia myosuroides*, *Hierochloe alpina*, *Calamagrostis purpurascens*, and *Carex microchaeta*.

The “moss” layer is moderately developed and dominated by lichens. Prominent species are *Cetraria nivalis*, *C. cucullata*, *C. nigricans*, *C. tilesii*, *Thamnolia subuliformis*, *Alectoria ochroleuca*, *Cornicularia divergens*, *C. aculeata*, and *Lecidea* spp.

Altai fescue — Mountain sagewort — Cetraria

Dry grassy tundra is common on steep, generally south-facing colluvial slopes. These habitats are well drained and typically have light, discontinuous, winter snow cover. Typical soils are alpine Eutric Brunisols, Orthic Humic Regosols, and Black Chernozem-like types. The prevailing humus form is an alpine Rhizomull.

Festuca altaica (Altai fescue) and *Artemisia norvegica* ssp. *saxatilis* (mountain sagewort) characterize the well-developed herb layer. Common associated species include *Hierochloe alpina*, *Carex microchaeta*, *Luzula spicata* (spiked woodrush), *Gentiana glauca* (glaucous gentian), *Potentilla diversifolia* (diverse-leaved cinquefoil), *Polygonum viviparum*, *Silene acaulis*, and *Campanula lasiocarpa* (mountain harebell).

The moderately developed moss layer is dominated by *Stereocaulon paschale*, *Cetraria nivalis*, *C. cucullata*, *Cladina alpestris*, and *Polytrichum piliferum*.

Barratt's willow — Sweet coltsfoot

Low thickets of *Salix barrattiana* (Barratt's willow) are common on wet sites in alpine valleys or swales, usually along low gradient streams, on gently sloping alluvial fans, or at the base of long slopes. Soils that have developed on the poorly drained, recent alluvium or colluvium are Cumulic Regosols or Rego Humic Gleysols. Typical humus forms are Hydromoders and Saprimulls. The snowpack of these ecosystems is deep, but usually melts several weeks earlier than in typical snowbed areas. This association is also common in the Canadian Rocky Mountains.

The dense, low shrub layer is dominated by *Salix barrattiana*, which is occasionally joined by *S. alaxensis* (Alaska willow), *S. glauca*, or *S. planifolia*.

The moderately developed herb layer can have numerous species, but *Petasites frigidus* var. *frigidus* (sweet coltsfoot), *Rubus arcticus* (dwarf nagoonberry), *Polemonium caeruleum* (tall Jacob's-ladder), and *Senecio lugens* (black-tipped groundsel) are most characteristic.

Prominent in the moderately to well-developed moss layer are *Tomenthypnum nitens* (golden fuzzy fen moss), *Drepanocladus revolvens*, *Aulacomnium palustre* (glow moss), *Mnium blyttii*, *Plagiomnium venustum*, *Brachythecium* spp., and *Hylocomium splendens* (step moss).

WILDLIFE HABITATS

Climate and rugged topography are the overwhelming factors influencing the assemblage of wildlife species in the Alpine Tundra zone (Table 36). The AT has the harshest climate of all the zones found in British Columbia. Rock and ice are among the most common features of the AT, ice being particularly common in the Coast Range. These areas, bereft of vegetation, generally have low value as wildlife habitat.

Wildlife species diversity and density are low in the AT. This is partly a result of severe conditions, but the isolated and scattered nature of alpine habitats also reduces species diversity. Despite these limiting factors, there are several wildlife species that are well adapted to the harsh environment. These include Mountain Goat, Gyrfalcon, White-tailed and Willow Ptarmigan, Water Pipit, and Rosy Finch.

For wildlife habitat purposes, the wide-ranging AT can be subdivided into three distinct areas, based on the underlying subalpine zone: Mountain Hemlock (MH), Engelmann Spruce — Subalpine Fir (ESSF), or Spruce — Willow — Birch (SWB) zones. These areas correspond to the maritime, southern Interior, and northern Interior subdivisions mentioned previously. Alpine tundra above the MH along the coast has exceptionally high snowfall and extensive icefields and glaciers. The snowpack does not melt away until well into summer and vegetation is sparse and includes primarily mountain-heathers. Even Mountain Goat, which are well adapted to wintering in the AT, generally descend to lower elevations along the coast in winter. Ungulates that winter in drier alpine regions, such as Caribou, California Bighorn Sheep, and Stone Sheep, are absent from the maritime alpine in winter. In the

TABLE 36. Selected wildlife habitats and species in the Alpine Tundra zone (adapted from Wildlife Branch 1989)

| Habitat | Habitat distribution | Representative wildlife species | Wildlife species at risk ^a |
|--|------------------------------|--|---|
| Alpine heath, grasslands, tundra, and scrub | Common | Mountain Goat, Stone Sheep, Mule Deer, Black Bear, Hoary Marmot, Arctic Ground Squirrel Golden Eagle, Red-necked Phalarope, Snow Bunting, White-tailed Ptarmigan, Rock Ptarmigan, Willow Ptarmigan, Water Pipit, Horned Lark, Rosy Finch | ◆ California Bighorn Sheep, Rocky Mountain Bighorn Sheep, Dall Sheep, Caribou, Grizzly Bear, Gyrfalcon, Least Sandpiper |
| Alpine meadows | Common, limited areal extent | Stone Sheep, Rocky Mountain Elk, Mule Deer, Black Bear, Hoary Marmot, Columbian Ground Squirrel, Arctic Ground Squirrel, Brown Lemming, Northern Bog Lemming, Meadow Vole, Water Vole Golden Eagle, Blue Grouse, White-tailed Ptarmigan, Willow Ptarmigan, Golden Plover, Rufous Hummingbird | ∇ Vancouver Island Marmot, Cascade Mantled Ground Squirrel ◆ California Bighorn Sheep, Rocky Mountain Bighorn Sheep, Dall Sheep, Caribou, Grizzly Bear |
| Windswept and south aspect alpine | Common in drier areas | Mountain Goat, Stone Sheep, Hoary Marmot Golden Eagle, Common Raven, Smith's Longspur, Snow Bunting, White-tailed Ptarmigan, Rock Ptarmigan | ◆ California Bighorn Sheep, Rocky Mountain Bighorn Sheep, Dall Sheep, Caribou, Gyrfalcon |
| Krummholz | Common, limited areal extent | Mountain Goat, Stone Sheep, Mule Deer, Rocky Mountain Elk, Black Bear, Red Fox, Wolverine, Marten, Snowshoe Hare, Hoary Marmot, Golden-mantled Ground Squirrel Sharp-shinned Hawk, Blue Grouse, White-tailed Ptarmigan, Willow Ptarmigan, American Robin, Dark-eyed Junco, American Tree Sparrow, Golden-crowned Sparrow Western Toad, Wood Frog, Spotted Frog | ◆ California Bighorn Sheep, Rocky Mountain Bighorn Sheep, Dall Sheep, Caribou, Grizzly Bear, Red-tailed Chipmunk |
| Rocky cliffs, talus, and sparsely vegetated rock | Extensive | Mountain Goat, Golden-mantled Ground Squirrel, Common Pika, Hoary Marmot, Least Chipmunk Golden Eagle, Rock Ptarmigan, Townsend's Solitaire, Say's Phoebe | ∇ Vancouver Island Marmot, Cascade Mantled Ground Squirrel ◆ Collared Pika |

^a Wildlife species and subspecies at risk are those on the preliminary Red and Blue Lists proposed in the Provincial Wildlife Strategy, B.C. Ministry of Environment (October 1989 draft).

∇ Red-listed wildlife species. These are being **considered** by the Wildlife Branch for designation as endangered or threatened in British Columbia.

◆ Blue-listed wildlife species. The Wildlife Branch considers these species "sensitive" and/or deserving of management attention. Population viability is a concern for these species because of (a) major declines in population numbers; or (b) major changes in habitat that will further reduce existing distribution. Species that are generally suspected of being vulnerable, but for which information is too limited to allow designation in another category, are included in this category.

summer, Roosevelt Elk, Black-tailed Deer, and Mule Deer forage in lower elevation krummholz and meadow habitats. Other species found in summer include the Golden Eagle, White-tailed Ptarmigan, Rock Ptarmigan, Wolverine, and Hoary Marmot. The endangered Vancouver Island Marmot also occurs in the Alpine Tundra zone.

The largest subdivision of Alpine Tundra occurs above the ESSF. Snow depths are variable, being least in the East Kootenays and lee of the Coast Mountains, and greatest in the Interior “wet belt.” In the driest areas, Rocky Mountain Bighorn Sheep, California Bighorn Sheep, Mountain Goat, and Caribou winter on steep south-facing habitats or on windswept vegetated ridges. Some of the densest populations of Mountain Goat in North America can be found in these drier areas. In snowier areas, only Mountain Goat are expected to occur during winter. Stone Sheep occur at the southern extreme of their range near the Williston Reservoir. Mule Deer, Rocky Mountain Elk, Grizzly Bear, and Black Bear are found in krummholz and lush meadow habitats during summer and fall. Other species include the Wolverine, Hoary Marmot, Columbian Ground Squirrel, Golden-mantled Ground Squirrel, and Common Pika. Characteristic birds include the Golden Eagle, White-tailed Ptarmigan, Rock Ptarmigan, Horned Lark, Water Pipit, and Rosy Finch.

The coldest and generally driest subdivision of Alpine Tundra lies above the SWB in northern British Columbia. Stone Sheep and Caribou are found throughout, particularly in the drier portions. Stone Sheep winter on steep, windswept, south-facing terrain while Caribou prefer windswept mountain plateau habitats. Mountain Goat are found wherever suitably rugged terrain occurs and are notably abundant in the transition areas in the lee of the Coast Range. Other mammals common to this northern subdivision include the Grizzly Bear, Gray Wolf, Red Fox, Wolverine, Hoary Marmot, Arctic Ground Squirrel, Siberian Lemming, and Least Chipmunk. The Collared Pika and Dall Sheep occur in the extreme northwest corner around and west of Atlin. Characteristic birds include the Golden Eagle, Gyrfalcon, White-tailed Ptarmigan, Willow Ptarmigan, Rock Ptarmigan, Horned Lark, Snow Bunting, Water Pipit, and Rosy Finch.

RESOURCE VALUES

Most resource use of the Alpine Tundra zone is based on its high recreational and wildlife values. Recreational pursuits include hiking, camping, skiing, snowmobiling, horseback-riding, and hunting. Such uses are only locally intensive, but certainly the AT is one of the major playgrounds of the province, especially where there is ready access from urban centres.

The AT also provides some locally significant summer range for domestic cattle and sheep, primarily in the drier alpine regions of south-central British Columbia.

LITERATURE CITED

Wildlife Branch. 1989. Regional wildlife habitat maps. B.C. Min. Environ., Victoria, B.C. 15 maps, 1:500000.