# Mountain zones

With increasing elevation, winter snows deepen and growing seasons contract. Plant communities change in response to these climatic controls. Above the coastal forest dominated by western hemlock, a sequence of elevational zones includes: small-tree subalpine forest; subalpine parkland; and alpine tundra. Wildlife values change accordingly.

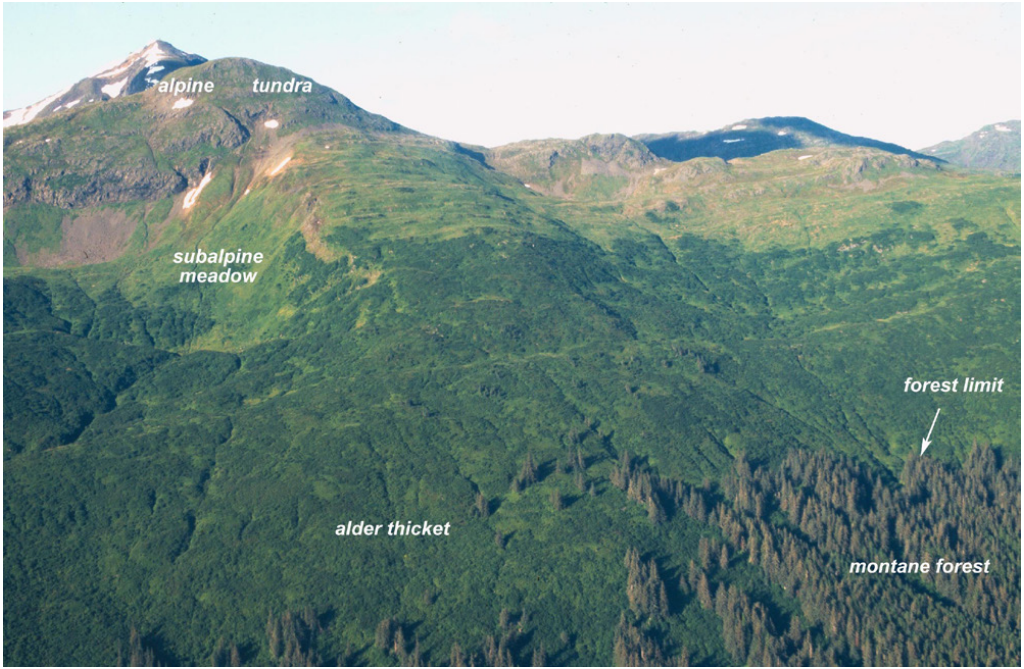
**Forest limit** refers to the upper limit of closed subalpine forest. Conifers above this line occur as scattered clumps of stunted **elfinwood**. The highest of these dwarf conifers at **tree limit** can reach 3,500–4,000 ft on some mountains.

High elevation habitats of Southeast have received very little scientific study. This report follows the elevational zones described by Brooke *et al* (1970) for southwestern British Columbia.

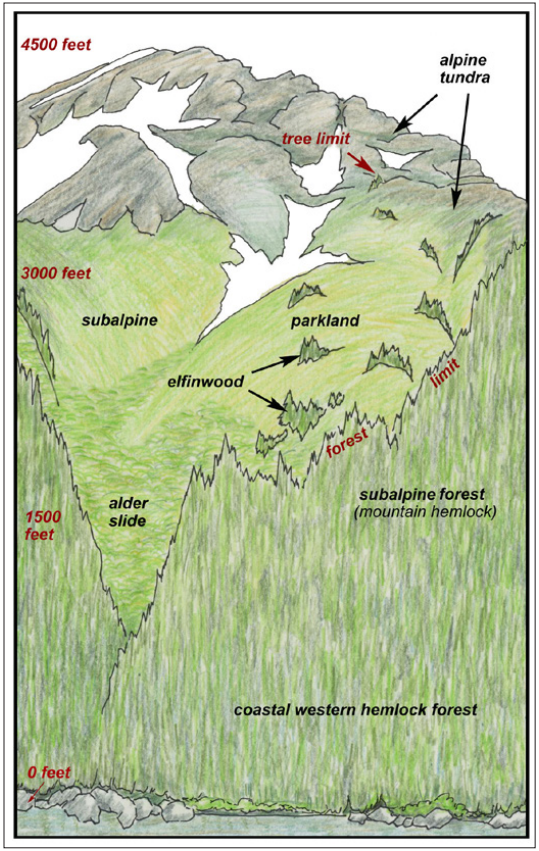
## Subalpine forest subzone

The subalpine zone or belt is defined as "*the forest tundra ecotone*," with dwarfed tree growth and subalpine meadows (Löve 1970). Brooke *et al* (1970) have subdivided this zone into **subalpine forest** and **subalpine parkland** subzones. The lower limit of the subalpine is a subtle and easily missed transition that occurs about halfway from sea level to tree limit throughout most of our region. Here, western hemlock-dominated forests grade into stands of smaller mountain hemlock, the conifer best adapted to cool summers and deep, wet, winter snow conditions.

The transition to this subalpine forest zone usually occurs at about 1,500 ft above sea level, but can be as low as 1,000 ft in places like Sít' Eeti Geeyí, *bay in*




Elevational belts on shoulder of Mount Hawthorne [*noTN?*], southern Séet ka, *canyon strait* (Gastineau Channel). In this location the belt of Sitka alder thicket is very wide, perhaps as a result of Taku winds that bring severe interior weather conditions in winter, depressing forest limit.




*place of the glacier* (Glacier Bay), where all elevational zones were depressed during colder, snowier winters of the Little Ice Age.

On the climb upward, trees become shorter and often more widely spaced. In response, shrubs like blueberry and salmonberry become more abundant. Because winter snow depths usually exclude **deer** from the subalpine forest subzone, browsing pressure on blueberries is reduced, a further encouragement to proliferation of the shrub layer. Depending on topography and soil drainage, this subalpine coniferous forest gradually breaks up into small, ferny openings that are excellent summer habitat for herbivores and insectivores. False hellebore appears in these subalpine glades.

**Sooty grouse** broods are especially common at these upper forest limits, probably because lush shrub and herbaceous thickets offer a high abundance of insects and good hiding cover for the growing chicks. High densities of grouse in turn attract **northern goshawks** to the subalpine elevations; young sooties are a favored prey species for these forest-hunting raptors. Likewise, early summer song intensity of breeding birds like **darkeyed juncos, ruby-crowned kinglets,** and **Wilson's warblers** can be very high. In spite of the late green-up relative to sea level, these birds manage to quickly fledge

**Above:** Heavily used deer trails in montane opening at 1,800 feet elevation. • **Left:** Sequence of elevational belts on a typical Southeast mountainside. Communities also respond to topography; transitions are lower in valleys and higher on convex slopes.

broods in the productive timberline forests.

In winter, tracks of **marten** and **short-tailed weasel** are abundant in the high subalpine forests. Their key prey species—**Keen's mouse, red-backed voles,** and **long-tailed voles**—respond favorably to the rich subalpine herb and shrub layers. For these small rodents, the deep snows that exclude deer in winter may actually be a positive factor, providing thermal cover and partial protection from predators.

Although **deer** are forced down from the high country in fall and early winter, the subalpine forest and parkland subzones are seasonally very important to them. In portions of Southeast, some deer seem to spend their annual cycle following the snow line up and down the mountainsides. After heavy fall rains that briefly remove snow, deer climb again, staying as high as snow conditions allow, indicating greater food availability at these higher elevations. There may also be less predation from wolves in the high country (Person 2001)

Some **mountain goats** take cover from winter storms by retreating from ridge-top habitat into cliffy sections of subalpine forest where snow is partially intercepted by the hemlock canopy (Fox *et al* 1989). Telemetry studies of **brown bears** indicate that most denning takes place within the subalpine forest subzone. Mean den elevation for 120 collared bears was 2,100 ft and slope averaged 35°. Dens were found in caves or excavated in the root structure of large old-growth trees. Genuine old-growth trees can occur at any elevation from sea level to tree limit. Ancient stands of spruce and mountain hemlock may stand only 30 ft tall, with trunks no thicker than a person's waist. Yet their tightly packed rings indicate that some of these trees were already old at the peak of the Little Ice Age about 250 years ago. Even the stunted elfinwood patches at tree limit, scarcely tall enough to hide a deer, may contain old-growth trees.

Mother sooty grouse takes to a low spruce branch, attempting to distract the photographer from half-grown chicks. Grouse broods are common at montane elevations.

## Subalpine parkland subzone

Above the closed subalpine forests, several possible transitions to higher communities occur. The sequence depends on topography, drainage, and snow dynamics. Studies in southern coastal British Columbia (Brooks *et al* 1970), where mountain climate is similar to that of Southeast, show that on an elevational transect, winter snow depth peaks in the subalpine zone and declines thereafter into the alpine. The coastal snow pack is much denser and wetter than in the cold interior mountains, and it creeps slowly downslope in late winter and spring ('snowcreep'), eliminating woody-stemmed vegetation from many microhabitats. Saturated soils also slip downhill at much slower rates, inhibiting growth of trees and even shrubs.

The result is a mosaic of lush subalpine meadows and increasingly dispersed stands of dwarfed conifers, a distinctively maritime herbaceous mountain community. Because the meadow plants die back to their roots in the fall, they are immune to the snowcreep that removes blueberries, alders, and conifers. The deep snow pack

protects subalpine herbs from the harsh winter wind and cold that make higher alpine habitats a place of stress and desiccation.

Although the growing season is short in the subalpine subzone, daylight hours at Southeast latitudes are almost unending at the time of summer solstice. The plants best able to take advantage of the combination of prolonged summer sunlight but brief growing season are those that can grow to full height in a few short weeks. These include many species described previously in coastal uplift meadows such as fireweed, lupine, cow parsnip, bluejoint, and flowers in the sunflower family. Species more distinctively subalpine in distribution are narcissus-flowered anemone, various louseworts, and broad-petalled gentian.

Subalpine meadows also resemble coastal uplift meadows in their attraction to grazers. Rapidly growing herb communities are the most desirable of all foraging places for most herbivores. In Southeast mountains, these herbivores include **deer, bear, mountain goat,** and **hoary marmot,** and **mature grouse** & **ptarmigan**. The young birds are insectivorous but also find abundant prey in these communities. Although Sitka black-tailed deer are eclectic feeders, deer cabbage is probably the most important summer food for altitudinally migratory deer. Deer cabbage is the dominant plant of many subalpine bowls in places such as Xutsnoowú, *bear fortress* (Admiralty Is).

Radio telemetry studies of **deer** on Xutsnoowú show that as snow pack recedes in late spring, deer move out of old-growth forests into scrub stands and moist subalpine meadows, gradually making greater use of north faces. Highly dissected relief creates microsite diversity and selection for various growth stages. In September, deer cabbage and other summer herbs wilt and lie down, turning the mountain meadows a lovely (but slippery) gold. At that point, herbivores focus their feeding in subalpine forests.

**Left**: Common flowers of the lush subalpine meadows. From top to bottom: broad-petalled gentian (*Gentiana platypetala*) and fir clubmoss (*Lycopodium selago*); whorled lousewort (*Pedicularis verticillata*) and monkshood (*Aconitum delfinifolium*); narcissusflowered anemone (*Anemone narcissiflora*). Rapid summer growth in the subalpine meadows makes this belt important to grazing **deer, bear** and **mountain goats**. ● **Below**: Hoary marmot (*Marmota calligata*) in damp subalpine sedge meadow. Marmots can't range as widely as deer, so exert more intensive and localized effects on favored forage plants.

**Left**: Yearling buck in subalpine meadow. In complex mountain topography some meadows are available to grazers in May, while other places retain snow into August. This means that deer can always find tender, freshly uncovered greens, following spring-like conditions throughout the summer. ● **Inset**: small-flowered paintbrush (*Castilleja parviflora*) and deer cabbage (*Fauria crista-galli*). ● **Right**: Sitka alder invasion of subalpine meadow over 55-year interval at 1,900 feet, Wooshkeenax̲ Deiyí, *trails above each other* (Roberts Trail above the State Capital)



Although most **brown bears** concentrate on lowland salmon streams in late summer, a smaller fraction of the population, mostly sows with cubs, stay in the high country throughout the snow-free season (Ben-David *et al* 2004). These bears, and others making shorter visits to the mountains, forage primarily in the subalpine zone.

For deer and bear, lower portions of the subalpine zone offer not only exceptional forage but often an ideal interspersion of open grazing areas with small stands of spruce and hemlock for hiding and



Late snowbed surrounded by alpine heather. Gastineau Peak in background [*noTN?*] is 3,666 feet elevation. Microtopography influences where snow collects and how long it persists. Combined with short growing season this results in a distinctive mosaic of plant associations with sharp boundaries. • **Inset**: Cooley buttercup (*Ranunculus cooleyae*), an alpine species first discovered here, restricted to our moist coast range mountains.

thermal cover. With increasing elevation, the conifers grow more stunted; extensive elfinwood copses occur on convex topography free of winter snowcreep. These shelter not only mammals but also nesting songbirds like **American robin** and **fox sparrow**.

Because **mountain goats** cannot outrun their predators, they are restricted to proximity of cliffy escape habitat >50°. But they take advantage of subalpine meadows wherever these occur close to bedrock faces. Sitka alder thickets are common on steeper subalpine slopes. On some especially active mountainsides, these avalanche-induced thickets may extend from summit to sea level.

Subalpine is the most sensitive of elevational zones to climate change. Since the ending of the Little Ice Age, warmer, longer summers and earlier snow melt have promoted shrub invasion of subalpine meadows. This changing vegetation will affect foraging habitat for many herbivores, and will alter nesting habitat for songbirds.

## Alpine tundra zone

Arctic and alpine ecologists throughout the world have noted that trees are generally unable to grow where the mean temperature for the warmest summer month is cooler than 50°F. Above (or northward from) this 50°F isotherm lies a slow-growing, very conservative community called **tundra**. In many places, the highest (or most northerly) trees grade directly into tundra.

The list of truly alpine-adapted fauna in Southeast is short. Most successful are—from top to bottom—mountain goat (*Oreamnos americana*), rock ptarmigan (*Lagopus mutus*), and American pipit (*Anthus rubescens*).

In Southeast, however, these elevational zones are more typically separated by lush subalpine meadow communities. The reason appears to be that conifers of Lingít Aaní rarely reach the 50°F summer isotherm line. Tree limits and forest limits are depressed here from such causes as snowcreep, frequent avalanches, and recent influences of the Little Ice Age. In place of highest subalpine forest, rich herbaceous meadows grow.

The true alpine zone is higher, at elevations where winter snows are colder, drier, and more easily redistributed into massive drifts and cornices. As this snow melts in spring and summer, it uncovers convexities first and concavities last. An intricate patchwork of distinctive microcommunities results from staggered timing of plant maturity and associated variations in drainage.

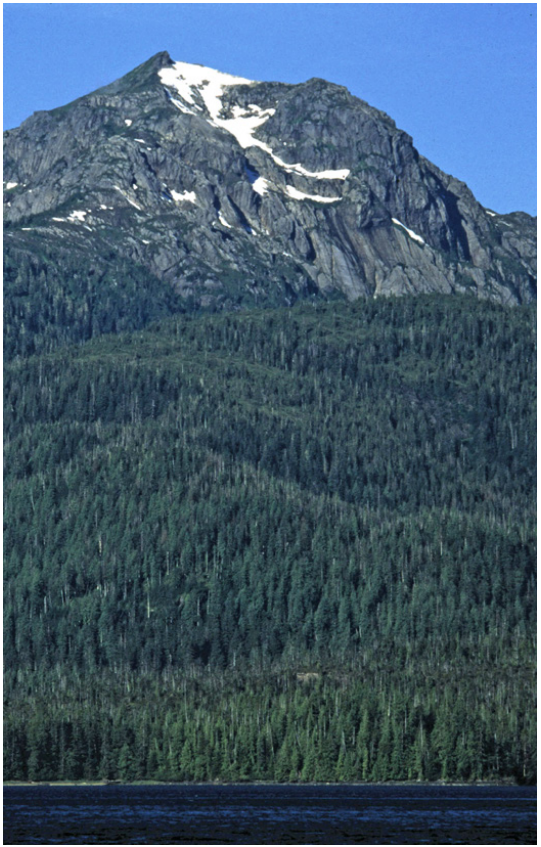
On windy sites, little knobs and ridges are blown clear of snow even in mid-winter. These are the harshest terrestrial microsites in Lingít Aaní. Plants here must be able to endure severe desiccation—ground-huggers only a few inches tall, generally with small, leathery leaves. In summer, flowers of these microsites seem huge by comparison to their foliage. During winter, **mountain goats** may forage on these windblown ridges, in habitat similar to that of bighorn sheep. [1]

Mountain heathers, along with other tough-leaved plants like arctic willow, crowberry, and partridgefoot, dominate most of the Southeast alpine tundra. Few of the true alpine plants are very palatable to the large herbivores of Lingít Aaní, who tend to prefer more succulent subalpine 'gardens.' Heather tundra is laced with game trails, however. Mountain ridges are favored thoroughfares not only for **deer, goat,** and **bear**, but also for wide-ranging Southeast predators, the **wolf** and **wolverine**. The latter is largely restricted to alpine and subalpine habitats in Lingít Aaní, where it hunts mostly for **marmots** and **ptarmigan**.

Alpine tundra feels like paradise on a warm, still summer day. But even in summer, wind, rain,

1 Winter ridgetop use varies regionally within Lingít Aaní. In upper Chilkat Valley, colder drier snow is more easily moved by wind, and those goats often stay high. Goats we watch all winter in Áak'w Aaní typically descend to a band from 500 to 1,500 feet above sea level.

Left: Common alpine plants - clockwise from upper left: alpine azalea (*Loiseleuria procumbens*) and rose-root (*Sedum integrifolium*); purple mountain saxifrage (*Saxifraga oppositifolia*); Alaskan moss heather (*Cassiope stelleriana*) and reindeer lichen (*Cladonia sp*); moss campion (*Silene acaulis*).

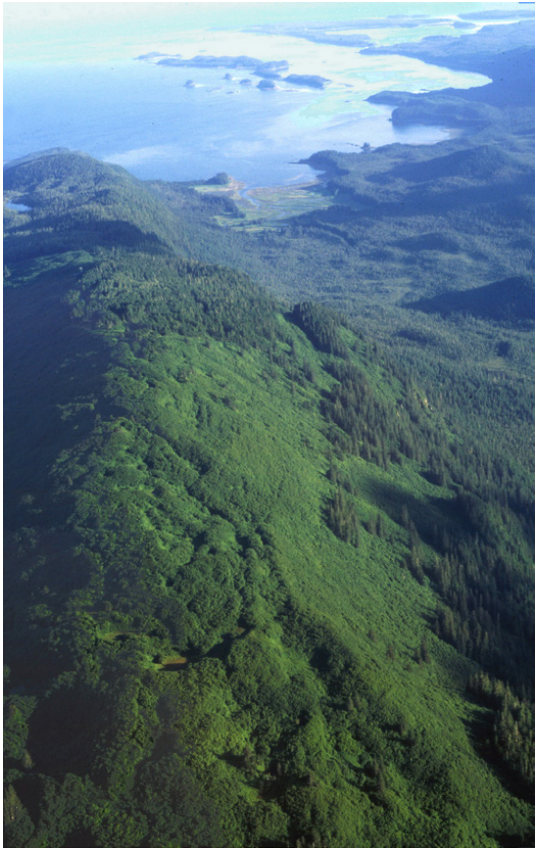


**Right**: Mount Etolin, 3,270 feet, highest summit in South Etolin Island Wilderness. Like most Wilderness designations in Lingít Aaní (Xutsnoowú excepted) this one is predominantly on granite, and has low-productive forests of little interest to the timber industry. High-country communities are relatively spartan, and ridgetops are almost entirely lacking in lush subalpine meadows.

and overcast skies are the norm in the Southeast high country. Few birds nest here. The 2 most successful species are **rock ptarmigan** and **American pipit**.

## Regional variation in mountain habitats

Preceding descriptions of elevational zones portray a 'generic' Southeast mountain environment, based mostly on experience in Áak'w Aaní. Plant distributions and community ecology of Lingít Aaní's mountain habitats are poorly documented, however. Regional variation can be striking, and depends on such factors as bedrock type, maritime versus interior climate,



**Left**: Southward toward Couverden Islands in the southern Chilkat Range [*noTNs?*]. Dimpled topography at 2,000 feet in foreground is from dissolution of Silurian limestone bedrock causing sinkholes overgrown with rich alder/salmonberry thickets. ● **Right**: Karst summit at 2200-feet on Táas' Daa, *double-headed tide around it* (Lemesurier Is) at mouth of Sít' Eeti Ḡeeyí, *bay in place of the glacier* (Glacier Bay). Soils thin and dominated by heather species unpalatable to wildlife. Subalpine meadows are almost non-existent. Crevices under heath mats in foreground descend into the dissolving limestone.

deer herbivory, and response to warming conditions since the recent Little Ice Age, which was most pronounced in northern Lingít Aaní and near large mainland icefields.

Southeast-wide surveys of mountain habitats should be a conservation priority. [2] The available information permits

2 PS 2023: I wrote this more than a decade ago. From 2011 to 2014, a multidisciplinary team studied alpine and subalpine habitats of Southeast Alaska. Led by Karen Blejwas, the team studied mammals (Joe Cook), flora (Kitty LaBounty), birds (Catherine Pohl), and insects (Derek Sikes). 2013 sites were: Mahoney Mt. Revillagigedo Is ● Mt at head of Freshwater Bay,

a few initial observations about regional variation.

**Bedrock type** is important in mountain habitats. Granitic rock, for example, does not weather into soils suitable for rich subalpine meadows. Alpine plant diversity is relatively low, and forage for herbivores is minimal. For example, on Mud Bay Mountain, 3,015 ft, capping a Cretaceous batholith above Xákw Tlein, *huge sandbar* (Mud Bay), summer deer use of the high country is low compared to deer activity on nearby metamorphic and sedimentary ranges.

Mountain communities on highland karst are harder to characterize. In some places, especially where terrain is rolling and not too steep, extensive herbaceous meadows are found on solution-pitted karst. Deer summering in these karst meadows are some of the largest in Southeast (J. Baichtal, Geologist, USFS, Ketchikan, AK, *personal communication* 2001). In other mountain communities, the subalpine transition may be completely lacking, and cover of alpine plants is very sparse. Some karst species, however, are regionally rare **calcicoles**, like androsace.

Snow melts earlier and summer conditions are drier on limestone alpine habitats (Jacques 1973). On these porous, excessively drained surfaces, a dry spell of only a few weeks duration may kill all but the most drought-tolerant species. Comparing carbonate to noncarbonate rock habitats on the mountains of Tàan, *sea lion* (Prince of Wales Is), Jacques found strong differences in species composition.

Three species of limited distribution in the mountains of Lingít Aaní: ● **Top** Subalpine fir, 3,000 feet, at Áax'w Sáani Xoo, *among the little lakes* (Log Cabin, White Pass). A true fir, this interior species is found along the Canadian border, and on karst summits of Tàan and neighboring southern islands; ● **Middle** Sweet-flowered androsace (*Androsace lehmanniana*), a widespread boreal calcicole known in Lingít Aaní only from isolated karst mountaintops in the Chilkats and Tàan; ● **Bottom** Broad-leaved marsh marigold (*Caltha biflora*) restricted in our region to the southern islands, where it's an important deer forage species along with the similar-looking deer cabbage.

Another regionally uncommon bedrock type with distinctive flora is ultramafic rock, such as that found on Mount Burnett on the Cleveland Peninsula *[noTNs?]*. Kruckeberg's holly fern (*Polystichum kruckebergii*) is a rare endemic species known only on this rock type (USFS 1997).

**Climate** influences on mountain plant communities have received little attention in Southeast. Because these communities occupy a much more stressful climatic regime in both summer and winter than that of the lowland forests and wetlands, floristic gradients from north to south and from outer coast to mainland are stronger in the high country than at lower elevations. These climatic influences may be difficult to separate from others such as herbivory and post-glacial colonization patterns.

Chichagof Is ● Hawthorne Peak, mainland above Gastineau Channel ● Baturin Lake, Baranof Is

**Herbivory** is intensely focused on certain subalpine deer pastures in places like Xutsnoowú. Large basins there often support near monocultures of deer cabbage, densely laced with deer trails. These meadows are mowed, trampled, and fertilized. On a more localized scale, marmot grazing and digging can have pronounced effects on vegetation.

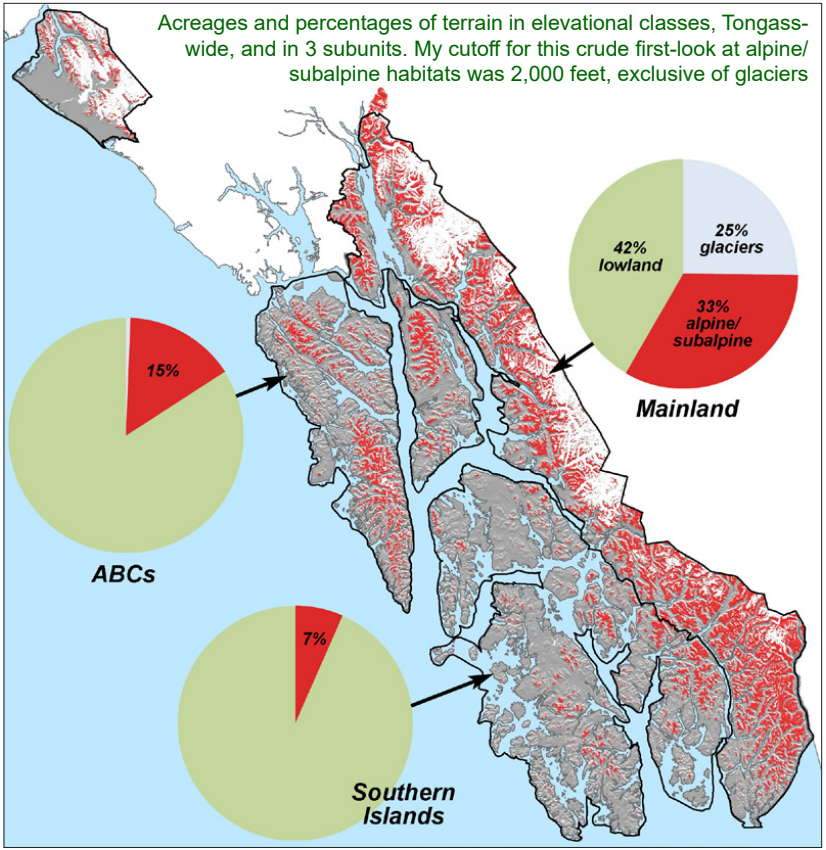
**Post-glacial colonization** rates and source areas have varied between species. As in the lowlands, certain mountain species are confined to southern Southeast. The broad-leaved marsh marigold, for example, is abundant in damp subalpine meadows on Prince of Wales. It probably could grow as well in similar high-country meadows of northern Southeast, but has simply not had time to colonize in the several millennia since deglaciation and warming climate created suitable subalpine habitat.

In southern Southeast, isolated mountainous areas were never overridden by ice during the last great ice age. These refugia may have supported subalpine fir and as many as 42 species of plants with discontinuous populations that have slowly expanded their ranges following deglaciation (Jacques 1973).

One result of these regional variations in habitat and history is the strong probability that as-yet undiscovered species and subspecies of flora and fauna exist in the mountains of Southeast. Only by thorough and wide-ranging surveys will the complexity of the Southeast mountainous archipelago be fully recognized.

## Implications for conservation

As climate warms, timberlines will rise throughout the world. But this effect will be especially pronounced along the northern Pacific coast where timber




High-country habitat is more abundant on mainland than islands.Because so much of that is glaciated north of the Stikine, our greatest concentration of alpine/subalpine is on the southern mainland.

lines are controlled not so much by temperatures as by heavy, long-lasting snow pack (Alaback and McClellan 1993). Global warming will also cause glacial retreat, not only at the snouts of lowland glaciers, but in mountainous cirques, where new terrain will be exposed to colonization by alpine plants. On other summits with limited acreage of alpine tundra, rare endemic species or subspecies may be 'pinched off' by invasion of conifer, shrub, or subalpine meadow vegetation. All of these climate-driven changes will affect wildlife habitat. Studies are needed to better anticipate when and where bottlenecks may occur for species at risk.

People so far have a limited footprint on mountain environments in Southeast. But those impacts have increased substantially in recent decades, especially with the growth in tourism in Southeast. A new aerial tramway on Mount Roberts above downtown Juneau brings hundreds of tourists per day into subalpine meadows and alpine tundra. These habitats are very slow to recover from trampling disturbances. Increased helicopter landings on mountain ridges have an unknown effect on wildlife and vegetation. Examples needing further study are displacement of mountain goats by helicopter traffic and introduction of invasive species through boots and clothing of globe-trotting visitors.