Treeline project

The boundary between high-elevation treeline and treeless alpine environments is ‘fuzzy’ and can be difficult to delineate. The transition between closed and continuous forest and treeless alpine can be divided by three boundaries [@Figure]:

1. Forestline. This boundary delineates the upper boundary of closed subalpine forest. This is subalpine forest, and in British Columbia, this is often mapped as high-elevation biogeoclimatic units such as ESSF or MH, including woodland subzones. This boundary may be abrupt or diffuse.

2. Treeline. This boundary delineates the uppermost boundary of upright trees with a minimum height of 2m [@Holtmeier2003] or 3m [@Korner]. Trees growing between the forestline and treeline boundaries are distributed as scattered individuals or in clumps. Clumped distributions of trees can be in fingers, islands, or hedges. This area may be mapped in BC as parkland variant of the ESSF.

3. Tree-species line. This boundary delineates the uppermost boundary of tree species occurrence, regardless of their form. Trees growing between the treeline and tree-species line can appear in a multitude of forms, including krummholz, cushions, mats, wedges, and prostrate.

Below, we discuss these three boundaries and their zones in more detail:

![A screenshot of a cell phone

Description automatically generated]()

Figure . From Kim and Lee (2015).

![A large green landscape

Description automatically generated]()

Figure . Example of three treeline boundaries on McBride (Teare) Peak. Google Earth photo.

The boundary between treeline and alpine at high-elevations is fuzzy and can be difficult to ascertain. The following issues must be considered:

1. The definition of a tree at high-elevations. At their upper elevation limits, trees can take several forms: upright individual stems of varying heights, prostrate stems, and krummholz (multiple stems with severe deformation and damage from climatic extremes such as wind and snow abrasion). Several authors have proposed that only upright stems over 2m or 3m be considered a tree, as the crowns of these individuals will be exposed to the atmosphere and prevailing climate. Trees below this height may be considered to be more “shrub-like” and may be protected during portions of the year from deep snowpacks that will shelter the tree from extreme low temperatures and wind, or surface features such as boulders, shrubs and other trees that block wind, riming, and snow abrasion. Thus, we may want to consider two treelines: a boundary defined by tree heights >2m, and a boundary defined by the presence of seedlings.

2. The treeline. The boundary between forest and alpine ecosystems can be difficult to ascertain because this boundary has a number of characteristics:

The presence of trees is controlled by a suite of nested environmental factors. At a coarse scale, low growing season temperatures control the upper limit of tree presence. At regional scales, climatic factors such as prevailing wind and snowfall accumulation can further control treeline, and at local scales, factors such as soils, topography, and biological interactions will all further modulate the treeline. In theory, low growing season temperatures will control the upper limit of trees (the fundamental niche). Other factors will further control the presence of trees, resulting in the presence of trees below the theoretical growing season isotherm.

3. The treeline form is not distinct in many cases. For the reasons listed above, the delineation of the treeline is not distinct in many cases. The treeline can take on multiple forms, including diffuse, abrupt, island and krummholz. Island treelines can be further subdivided (@reference). This is important to consider

Pathways for theoretical treeline expansion

The potential for trees to expand upwards with climate change will be controlled by available substrates and conditions. Alpine ecosystems characterized by high vascular cover, such as alpine meadows, heath, tundra, and grasslands may support seedling establishment, whereas alpine ecosystems that have lower vascular plant cover such as fellfields, nivation, and wetlands will have lower potential for treeline expansion.

Below the treeline, tree expansion may occur in sites characterized by cold soil and cold air ponding, such as krummholz and shrub-carr ecosystems in subalpine environments.