Module 5: Biodiversity

The most species-rich mountain region in the world is the Northern Andes. Why are mountains known as biodiversity-hotspots? They cover just 27% of the Earth's surface, and yet contribute a disproportionate amount of biodiversity.

No one knows for sure, but there are several theories. One explanation is that mountains have many different ecosystems in a relatively small area. Ascending in altitude, the changing climate brings changing ecosystems. Therefore, it could be that microclimates play a role.

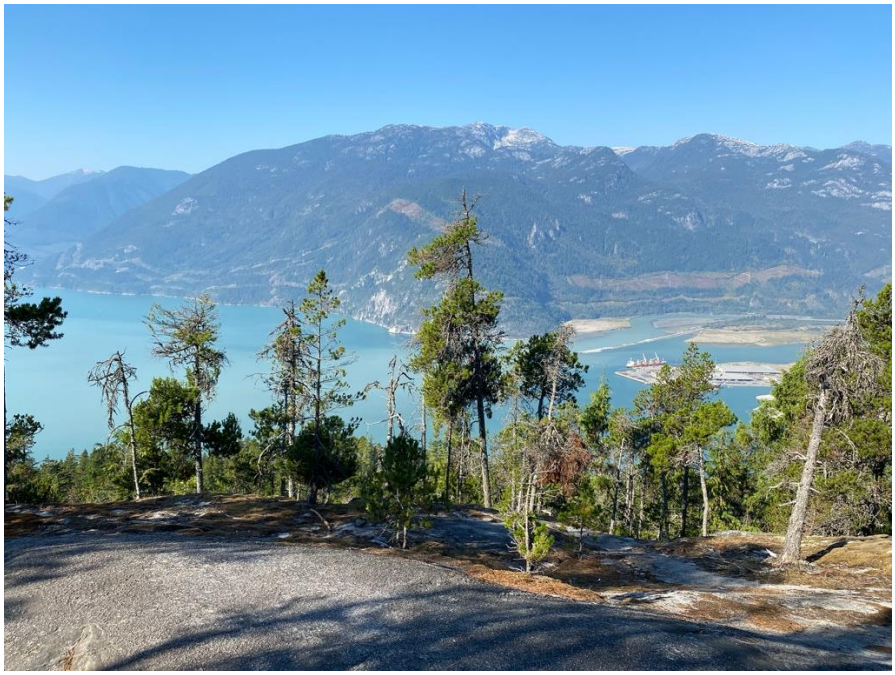
Another theory is that a link exists between mountain biodiversity, especially tropical mountains, and bedrock geology. It's been speculated that mountains originating from oceanic bedrock provide positive growing conditions for plants, so they can better adapt to challenging soils. It follows that if this impacts the plants, it also impacts the varieties of species of animals that can live off the plants and each other.

When **Charles Darwin** studied Galapagos Finches, he discovered that when bad weather affected plant growth and there were fewer seeds to eat, the finches had to eat larger seeds not normally a part of their diet to survive. Only the birds with beaks large enough to eat the larger seeds survived. These survivors had offspring with large beaks, and this inherited trait was passed on through reproduction. The species thereby evolved to have larger beaks than before, and this **adaptation** to environment is **natural selection**.

Consider the different plant and animal adaptations required for to montane, subalpine and alpine mountain areas.

The sub-alpine forest, for example, is a transition zone from dense forest below to alpine tundra above treeline. Sub-alpine areas can be buffeted by hurricane force winds, scoured by ice crystals, and weighted down by heavy snow—life can be a challenge for mountain trees. As a transition zone from dense forest below to alpine tundra above treeline, the treeline is not really a line, but rather a zone where trees gradually get smaller and more stunted until conditions are too challenging for tree growth. The plants that grow in these soils must be very hardy. One often sees the following:

- **Krummholz** = stunted or deformed vegetation in the subalpine
- **Flagging** = where you have growth on only one side of a tree due to winds
- Vegetation growing directly out of rock.



Subalpine tree growth.
Squamish, British Columbia
Photo by Martha Warren

How have animals adapted to live in the mountains?

The Red Breasted Sapsucker get their name from how they eat. These woodpeckers drill rows of holes into tree trunks and then return to those holes later to feed on the running sap and the insects attracted to it. Hummingbirds also use the Sapsucker feeding holes. The Rufous Hummingbird will follow the Sapsucker, feeding at the wells of sap that the Sapsucker keeps flowing.

Sapsucker holes, Sea to Sky Gondola, Squamish, British Columbia.
Photo by Andrea Andres.

Cougars use the th o stalk their prey. Cougars are active throughout the year and are elusive animals that prefer to avoid contact with humans.

Chipmunks live in trees and gather food on the ground in areas with underbrush, rocks, and logs, where they can hide from predators like hawks, foxes, coyotes, weasels, and snakes. They have striped bodies for camouflage, claws, and are able climbers. They feed on insects, nuts, berries, seeds, fruit, and grain which they stuff into their cheek pouches and carry to their burrow or nest to store. Chipmunks hibernate, but instead of eating a lot and fattening up before they sleep, they keep a store of nuts and seeds to eat throughout the winter. They can reduce their respiration and heart rate when food is scarce and reduce their overall body temperature. Chipmunks have litters of 2-8 pups, once or twice per year – a useful adaptation for survival of the species considering they have so many predators.

The black bear's greatest adaptation to living on the mountain is its ability to eat many different things. From fruits and nuts, grasses, twigs, and honey, to grubs, insects, fish, and small mammals. Its molars are great for grinding up foods and its large canine teeth for ripping apart fish. Bears can smell food up to 20 miles away. Their sense of smell also helps them locate other bears and detect and avoid danger. Bears have huge, strong legs to move or bend large objects like rocks or tree trunks to get to food. They have large, padded feet and strong, curved claws to climb trees easily to get to fruit. Their long and sticky tongue can reach insects in trees. They can even separate and spit out unwanted nuts or berries without using their paws.

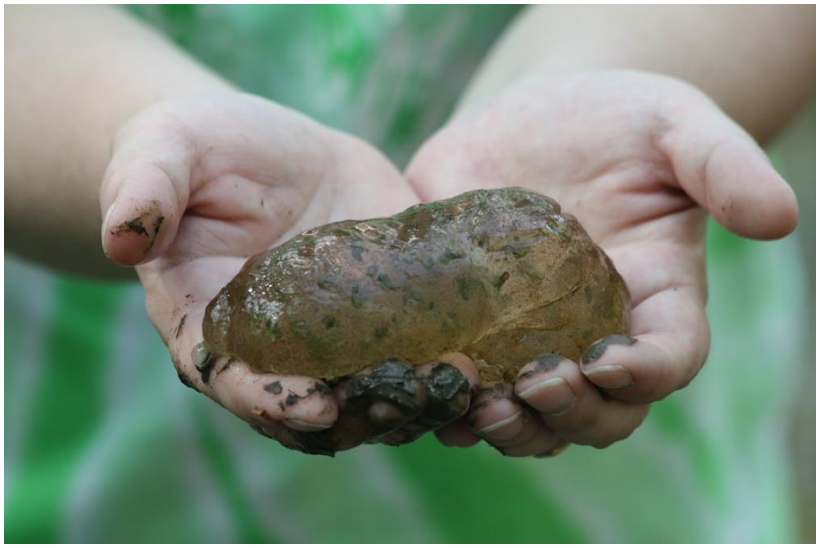
As in circumpolar regions, mountains are experiencing faster rates of climate-change, introducing major implications for humankind and the ecosystems on which we depend. This is due to mountains extending above the surface boundary layer into the free atmosphere and being more directly exposed to major incoming weather systems. The question is which plant and animal species will adapt as our mountains change? What will happen as our mountains become warmer?

Some species will move uphill due to climate change. Mountain goats will be affected by warmer winters. If trees start growing higher up the mountainside, then there will be less of the lichens, ferns, grasses, herbs, and shrubs that goats currently eat. They will also have to go higher up the mountain in the summer to stay cool.

For caribou in the Rocky Mountains' Jasper Park, it's difficult to dig through the deeper snowpack further up the mountain to find food. Instead, they stand on snow to eat lichen from trees. But if a snowpack is reduced or gone completely, the caribou are unable to reach arboreal lichens. Caribou also use high-elevation snow-patches for respite from summer heat and insects.

Yaks in Nepal can't live at the elevation they used to because it's too warm now for them. They are already moving further up the mountains to reach a cooler environment, forcing them into a smaller area where it's harder to find food and water.

Vernal pools/ephemeral wetlands only contain water for part of the year. These shallow ponds of water are full in the winter and spring and dry out to become mud and soil in the summer and fall. If there are longer droughts, species like frogs and salamanders won't continue to live there.



Salamander eggs, Squamish, British Columbia. Photo by Andrea Andres.

Measuring biodiversity is important so we can see how species are adapting to global climate change. Studying the Himalayan yak, for example, may tell us a lot about how cattle and other animals will be impacted by climate change.

Climate change increases mountain exposure to hazards such as storms, landslides, and avalanches and these will impact mountain plants and animals. But it is not just warmer air temperature that's the issue. Rather, it is the increased humidity coming from warm air holding more water vapour, and warming seas and land releasing more water into the atmosphere through evaporation. The result is more heat, more storms, and increased rainfall.

Anthropogenic disturbances such as mining, farming, development, and recreational hiking can also have an adverse effect on biodiversity. The significance of mountains to people is examined in Module 6 Mountains and People.

Questions for discussion:

Where a mountain was once, say, cold and dry, but is now warmer and more humid, how will the vegetation change?
How will our water availability from glaciers and snowpacks change?

How will natural hazards be different?
How will animals and humans adapt?

Suggested case studies:

- The use of habitat corridors in mountains to increase biodiversity: Conservation corridors are being used to preserve ecological connectivity. For example, the Albertine Rift is one of the most biodiverse regions on the African continent. The Rift is located within six countries: Burundi, the Democratic Republic of the Congo, Rwanda, Tanzania, Uganda, and Zambia. 500 species are found exclusively there. Scientists predict that by the end of this century, many species there will have moved to higher elevations as the climate warms, resulting in a 75% reduction in habitat.
- The survival of animals with seasonal phonologies: Animals such as the snowshoe hare in the Rocky Mountains will be disadvantaged if snow disappears before their white winter coat sheds.
- The impact of invasive species on mountain forests: In British Columbia, the Mountain Pine Beetle was previously limited to a small area, its numbers kept down by periodic very cold temperatures in late autumn and early spring. As these cold snaps have become less frequent, the beetle was able to expand enormously, into areas where such events are even less likely. This has had widespread impact on pine-dominated forests and associated ecosystems – exacerbated by intensive 'salvage-logging.'