

# Alpine mammals – will they survive the climate change?

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*Climate change is not something that's new and specific for the 19th century, rather something that's always been present. The reason why there is a discussion about the global warming is that the changes are occurring more rapidly today than before. Glaciers are melting, the sea level is rising and the tree line is moving upwards. The consequences of the climate change are estimated to be higher in the alpine region than others. Many alpine species can only be found in alpine regions and possess a poor capacity to adapt to changes in the environment. An earlier onset of vegetation as a response to higher temperatures might result in a prolonged season with green vegetation cover and more nutrient rich soil conditions. If there are more plants available during a longer time the grazers will be able to digest longer, which leads to a higher rate of survival of grazers during winter. There will also be a movement of the species, towards higher elevations. The resulting shift in species composition might lead to more competition between species and some species might even go extinct because of the loss of habitat due to invading species. Loss of genetic variation as a result of decreasing population sizes or more isolated populations might also lead to extinction of species. Most of the alpine species show negative trends when it comes to population sizes. The purpose of this paper is to give a glimpse of what might happen to the alpine ecosystem if the climate keeps on changing and how environmental changes affect the mammal species that live there.*

## The alpine biota

Alpine ecosystems are one of the few ecosystems that can be found all over the world and covers around 3 % of the earth's surface. There are many species that only can be found in alpine environments which makes the biota very specific. The ecosystems are distinguished by nutrient poor soils, harsh winter conditions and low temperatures. The alpine ecosystem can be divided into four sub-divisions; the sub-alpine region and low-, middle- and high alpine region (Table 1). Most of the vegetation constitutes of species with a low growth form. The climate in alpine regions varies a lot between seasons and it is therefore important for plants and animals that live there to be adaptable. The species richness is however surprisingly high even though the environmental conditions are relatively harsh. Only in the Alps there are around 80 mammal species, mostly shrews, mice and voles. There are also larger mammals such as different species of ibex or sheep or cat species (Table 2). On higher elevations there is less



Fig 1. Alps in Hunza, Pakistan.

Photo by: Johannea Petrone (2008).

variation in species composition and the proportion of larger carnivores (species that eat meat) is higher.

Sub-alpine region	Low alpine Region	Middle alpine Region	High alpine region
Lies below the tree line and are therefore not counted as real alpine environment. Birch- and pine forest are the dominating vegetation patterns.	The species diversity is higher than in the sub-alpine region and varies with the topography. Occupies larger areas then middle- and high alpine region.	The species diversity is decreasing. Meadows and small shrubs constitute to most of the vegetation cover and there is a frequent influx of melt water from the higher elevations.	Starts where there no longer is any continuous vegetation cover. The soil is extremely nutrient poor and the ground is often frozen. Lichens and bryophytes are the most common plant species.

**Table 1.** The alpine region can be divided into four sub-divisions depending on elevation and vegetation.

The species richness is highest on the mountain slopes since the incline prevent the water to freeze in the soil and more nutrients are available. This results in more nutrient rich plants and a profitable environment to grow large in. A higher vegetation cover makes the area more profitable for grazers which in turn make out the target for predators. During the last ice melt, that took place about 10 000 years ago, many species where forced to leave their normal territories as the conditions changed leading to a colder environment. The species where therefore re-distributed which indicate that not all species living together today have the same origin. Since the species that live in the same area today don't share the same history it's likely that they won't respond in the same way to changes in the environment, due to different adaptation abilities.

Carnivores	Smal grazers	Large grazers
Arctic fox ( <i>Alopex lagopus</i> )	Lemings ( <i>Lemmus</i> ssp)	Alpine ibex ( <i>Capra ibex</i> )
Brown bears ( <i>Ursus arctos</i> )	Marmots ( <i>Marmota</i> ssp)	Big horne sheep ( <i>Ovis canadensis</i> )
Cougar ( <i>Puma concolor</i> )	Pika ( <i>Ochotona</i> spp)	Blue sheep ( <i>Pseudois nayaur</i> )
Lynx ( <i>Lynx lynx</i> )		Red dears ( <i>Cervus elaphus</i> )
Snow leopard ( <i>Panthera unica</i> )		Snow goat ( <i>Oreamnos americanus</i> )
Wolfs ( <i>Canis lupus</i> )		
Wolverine ( <i>Gulo gulo</i> )		

**Table 2.** The table is describing typical alpine mammals.

## How global warming affect the alpine ecosystem

There have been many reports in media about the ongoing climate change and many researchers argue that the biggest alteration will occur in high mountain areas or at high latitudes, therefore affecting alpine ecosystems the most. Glaciers and permafrost are melting, trees and shrubs are taking over the open habitats and the sea levels are rising. The precipitation is changing as well and could go either towards more snowfall or more rainfall, which both affect the alpine ecosystem but in different ways.

## **Migrations towards higher alpine areas**

In the alpine environment the plants have a medium movement of 29 m per decade. The small grazers who feed on grass and shrubs are depending on the vegetation and a movement of plants should therefore also affect the rodents and grazing animals that probably would migrate as well. We can already see a trend with migrating species towards higher elevations, mostly from lower elevations. As the populations shift in their distribution they are doomed to invade on someone else's territory. We can see the effects of just such an example here in Sweden where the red fox are invading on the arctic fox territory, pushing it further up from the tree line and its old habitat. Above the tree line there aren't as much animals as further down since the vegetation is less abundant. The arctic fox become more dependent on the populations of lemmings in the north while the red fox have a higher variation of food supply.



**Figure 2.** The pictures are showing domestic sheep, lynx, wolverine and yellow bellied marmots.

Species have different responses to changes in the environment and some are more sensitive than others. For example the Pikas, a small grazer, are highly perceptive to high temperatures. They can be found in alpine ecosystems all over the world and most of them live in isolated populations on mountains slopes. The Pikas are known to be able to migrate but they move and reproduce slowly and might therefore be more likely to invade other populations rather than to migrate elsewhere. To be able to migrate at all they probably have to move from their high mountain tops and cold conditions, reaching warmer environments which might be too warm for them to survive. Carnivores like the Wolverine, also reproduce slowly and have problems with adapting to new conditions and will therefore also be affected of a climate change.

The movement of plant species into higher elevations has made it possible to have cattle management higher up in the mountains. Cattle are easy targets for predators such as the Snow leopard and combined with decreasing stocks of wild animals it's not a surprising fact that more domestic animals get killed. This is, of course, upsetting for the native farmers who earn their living on cattle management and need to protect their herds and as a consequence the illegal hunt of Snow leopards has increased.

## **A shift in vegetation patterns**

If the air temperature is rising, the ground temperature will also increase which leads to a higher rate of mineralization of the soil. Global warming is increasing the amount of carbon dioxide. Both the increasing carbon dioxide and the nutrient enrichment have positive effects on the vegetation, leading to longer vegetation seasons and more nutrient rich plants which are good for grazers.

Some hibernating species are known to leave their sleep earlier during the spring as a response on a warmer climate. As long as the growing season has started this isn't such a huge problem but if the plants haven't started to grow this will leave the animals without food and many might die.

### **Timing of onset of vegetation affects the reproduction**

Earlier onset of the vegetation could also have positive effects on the mammals. Large grazers are dependent on nutrient rich, high quality food, especially for their reproduction. The red deer are one example of a species that migrate during seasons and are therefore able to maximize their intake of nutrient rich plants. Since the vegetation seasons have shifted so has the optimal timing for reproduction. If the onset of vegetation starts earlier and there is more high quality food available the reproductive success might increase. The females have more time to feed which results in a larger body mass of their calves which then have a higher chance to survive during the cold season.

### **What can be done?**

There are clearly changes going on in the alpine region and much can be done to limit the negative effects of a climate change. Many species are threatened by the ongoing changes and uncertain weather conditions. What might be profitable for one species doesn't have to be good for all species. It is therefore quite hard to determine the consequences and responses of the alpine species to large scale environmental changes since the ability to adapt to changes might differ between species. A large number of factors are co-operating in the ecosystems and all need to be taking into account to create a successful management strategy for the alpine ecosystems and the animals that live there. Some important factors are the migration of species and the loss of suitable habitat. For example should the migrations of the species to higher elevation be taking into account when establishing nature reserves and should landowners be taught about sustainable development? More research needs to be conducted to fully understand what the consequences of climate change will be on the alpine region, but even so there is a unison picture of an environment that are changing and alpine species are becoming more threatened due to global warming.

### **Further reading**

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