The management of wild reindeer (*Rangifer tarandus*) in Hardangervidda National Park, Norway

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Keywords

hunting, climate, tourism

Summary

Hardangervidda is the largest mountain plateau in northern Europe, and is home to the largest wild reindeer (*Rangifer tarandus*) population on the european continent. Wild reindeer are often considered keystone species of the circumpolar region, because they influence ecosystem processes such as nutrient cycling and primary production (e.g. OLOFSSON et al, 2004). The reindeer population on the Hardangervidda plateau is important for its ecological value, and for its economical and recreational value for hunters, hikers and landowners (BJERKETVEDT et al, 2014). A loss of this herd would have a negative impact not only for the ecosystem, but also for the people that depend on it for their livelihood. The protection of the largest population of wild reindeer in Europe was one of the main reasons to designate Hardangervidda National Park. Hardangervidda's wild reindeer population has had frequent and extreme fluctuations in harvest numbers over the last six decades because data on herd size is unreliable, there is a lack of data on recruitment and other life stage characteristics, and because there is a high variation in hunting success (BJERKETVEDT et al, 2014; STRAND et al, 2004). Thus, more reliable population data is sorely needed.

There are a number of factors that are known to affect reindeer populations. For example, human infrastructure has been shown to affect reindeer migration and movement corridors (PANZACCHI et al, 2013). Population fluctuations of reindeer are also affected by climatic variation; Snow quantity and quality is one of the most important natural factors determining winter grazing of wild reindeer, as it affects both access to and quantity of lichens, which are their main food source in the winter (ODLAND et al, 2014; SKOGLAND, 1978). As reindeer depend greatly on lichens as a food source in the winter, the estimation of lichen biomass is an important factor in the study of reindeer populations. An appropriate grazing regime and management by people has the potential to maintain reindeer grazing grounds. However, in order to inform the management of reindeer migration, more reliable information must be gathered on the distribution of lichen biomass which provides superior winter grazing areas for wild reindeer. It is of the utmost importance not only that mapping efforts are improved, but also the ability to predict changes in lichen cover, and determine what changes have already occurred. A recently developed lichen biomass estimator may be helpful in assisting with this type of monitoring (FALLDORF et al, 2014).

Wild reindeer are also highly dependent on good summer pastures to be able to feed their calves, but also to fatten up before the long winter. This is particularly important in an environment where winters are relatively long, and calving occurs in late May, where there is often still snow cover (REIMERS, 2002; REIMERS et al, 1983). Changes in vegetation and availability of summer grazing areas therefore have a great potential to affect the reindeer population. Such changes are particularly likely in the face of climate change, and therefore warrant further investigation. A warming climate can also increase the prevalence of disease and insect harassment, which reindeer suffer from increasingly in the summer. Ordinarily, reindeer seek refuge on snow patches to avoid insects on warm and windless days. However, reductions in snow patches are likely to restrict this insect avoidance behavior. As the reindeer population on Hardangervidda is at the southern end of its range, it is to be expected that these problems are more likely to be exacerbated when compared with northern populations.

The combination of human and natural factors affecting reindeer movements and survival in this vulnerable population pose many interesting questions related to the future of wild reindeer management. As a part of the ECOPOTENTIAL project (http://www.ecopotential-project.eu/), we aim to quantify and map the availability of summer and winter grazing pastures for wild reindeer on Hardangervidda over time, using satellite imagery and data gathered in the field. We ask why reindeer are absent from summer grazing pastures they have consistently used in the past, and whether tourism has had an influence on this change. The reduction in the presence of snow patches in the summer may also play a role in the locations that the animals choose in the summer months. We also try to explain what climatic factors are most important in controlling fluctuations in this population over time. Human factors certainly play a role in population control. Particularly because, in the absence of predators, the population is managed by hunting, an activity that attracts tourism in addition to what is already present in the park through other outdoor activities. However, as tourism and hunting are integral parts of the park management, and the reindeer population is more or less confined to its present range by roads and other human infrastructure, climate variables ultimately have the potential to be the determining factors for the control of the population.

We tested growing degree-days, various temperature and snow cover variables for their effect on fluctuations in the reindeer population over the last two decades. Our preliminary findings suggest that colder temperatures tend to have a positive effect on the reindeer population. Colder winter temperatures are beneficial, possibly due to a reduction in the incidence of icing i.e. melting of the snow and subsequent freezing, which makes the snow pack impenetrable by reindeer. The Hardangervidda wild reindeer population is at the southern end of its range, and as such, this finding has particular consequences under future climate change, and may require a re-thinking of the management of reindeer migration. For example, the Hardangervidda herd should have the possibility to migrate northwards. However, this is a problem in the light of the recent findings of Chronic Wasting Disease, as there are plans to cull the population just north of Hardangervidda quite extensively, and mixing of these populations is not currently desirable (NORWEGIAN INSTITUTE FOR NATURE RESEARCH, 2017). Out of those considered, the only other variable that may be informative in predicting the population is the number of growing degree-days. The data suggests that fewer growing degree-days have a positive effect on the population. This relationship is not significant at any reasonable level, however, though these results may motivate further investigation. Nevertheless, this relationship may be particularly critical for reindeer because of the already short growing season, and the fact that they calve relatively early compared with other ungulates. Warming has also been shown to reduce the variability in plant phenology, which in turn, has been shown to result in a decline in calf production (POST et al, 2008).

These findings have the potential to be used to predict changes and to inform the management of this important reindeer population, and need to be considered particularly in conjunction with the effects of anthropogenic factors which control their seasonal movements in Hardangervidda National Park.

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