Climate Change Effects on Biodiversity and Species Richness in the Kilpisjärvi Biological Research Station

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Research Questions and Hypotheses:

- How will the effects of climate change affect the abundance and richness of biodiversity in plants in the Kilpisjärvi area?
- We hypothesize that as the growing season begins earlier and temperatures rise you will see a decrease in birch and an increase in shrubs.

Introduction:

Climate projections generally point to a warming earth. Here we investigate the local impact of climate change on fauna in Kilpisjärvi, Finland. At a latitude of 69°N, Kilpisjärvi experiences a mean winter low climate of -16.7°C and summer high of 13°C. A rising climate may reduce the arable land for plant species which local animal populations primarily consume. In this study we:

- Document the current state of grazing plant populations that reindeer consume.
- Apply current climate projections to consider a future outcome of continually rising global temperatures.

Figure 1. Wash near research station where transects were measured. This location represented the typical area in terms of plant density and variety.

Methods:

We estimate the population density of grazing plants near the Kilpisjärvi Biological Station in Lapland, Finland. We selected three locations along the border of a wash (fig. 1), where we expect the density of plants to be near the maximum possible. Fig. 2 shows the test locations. Population density is estimated by:

- Counting species along 25 meter transects spaced 5 meters apart
- Take the average of each species as the local population density
- Species counted include: *Betula pubescens, Betula nana* and *Salix* and *Juniperus* species.
- Only plants that were rooted within a meter of the line were recorded.

With the data as our current baseline, we model the future population based on climate projections and species susceptibility in warmer climates.

- Current literature suggests a possible warmer climate in these areas within the next 50 years.
- Warmer temperatures will contribute to increased soil aridity which reduces arable land.

Figure 2. Example of test areas. Each line represents a transects. Transects are spaced 5 m apart.

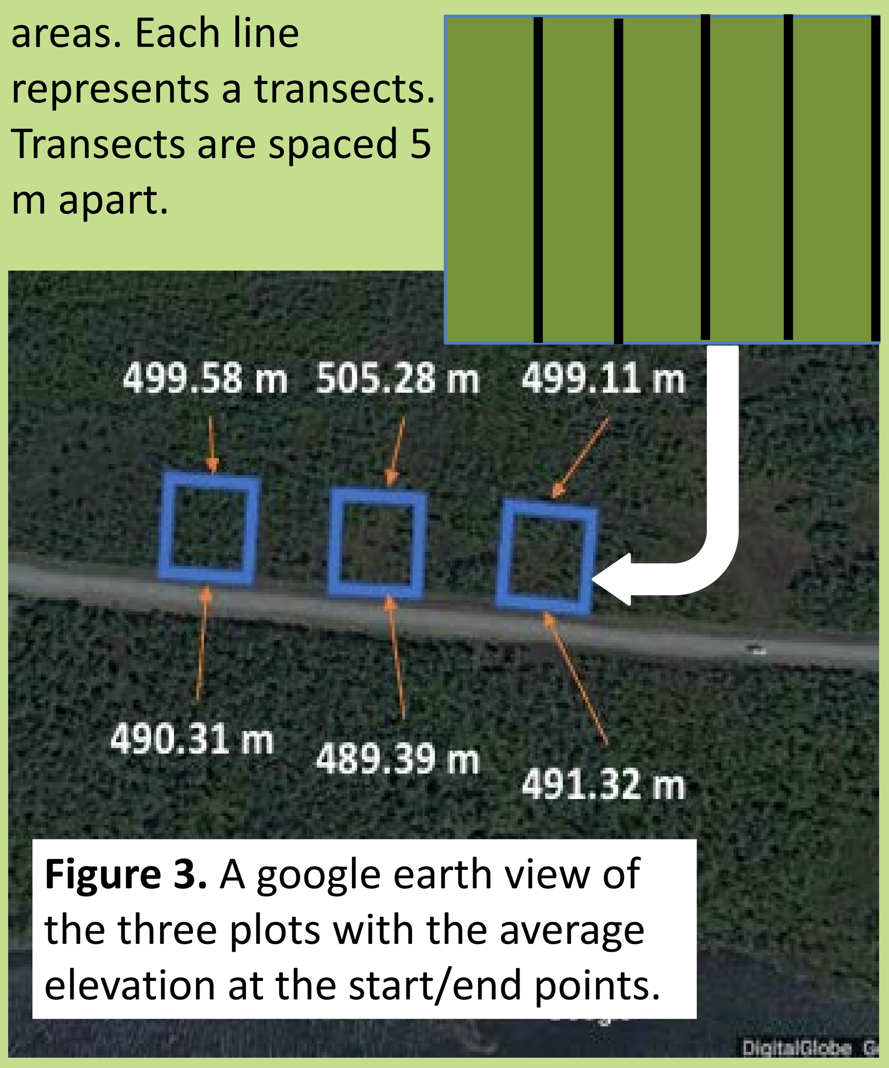


Figure 3. A google earth view of the three plots with the average elevation at the start/end points.

Projections:

With a current baseline to work from, we predict future populations. Our model includes:

- Temperature projections based on a suggested 5 degree global climate warming by 2100. We assume a linear increase to estimate the temperature in 2050.
- Warmer winters may lead to an enhancement in precipitation while summers will experience more effective soil drying.
- We considered the susceptibility of each plant to predators and weather-driven population change.

Our model results in a percentage change in population density.

Results:

Our data were condensed into an estimate of each species population density over 50 m^2 plots of land.

- The 15 transects were averaged by species and projected along the 50 m^2 plot of land.
- A sum of the total of the plants encountered was taken and were separated via species.
- We projected to see a major decrease in the *Betula pubescens* and an increase in the willows, junipers and *B. nana*. This would change the area into a different forest with more shrubby plants and an increase in the moss and lichen species, providing more food for the reindeer if they can adapt to the weather changes.

Figure 4. Average species number counted per meter squared at the Kilpisjärvi Biological Research Station.

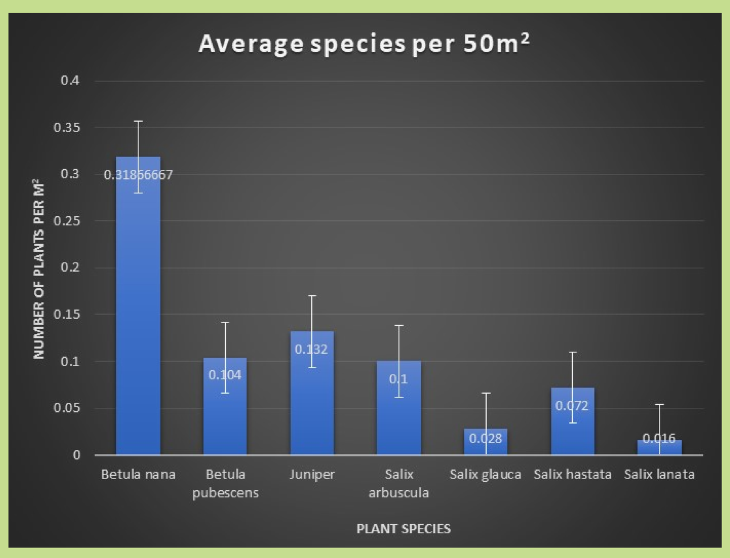
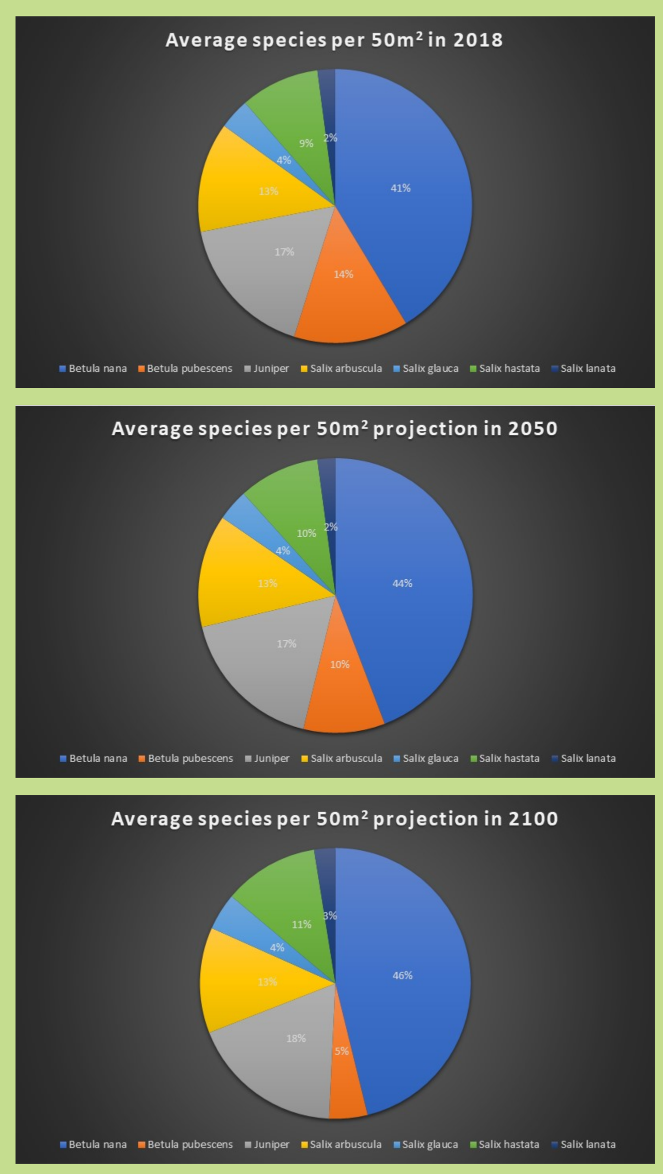


Figure 5. Projected outlook for 2050 & 2100 with a 5 degree temperature rise.

	Betula nana	Betula pubens	Juniper	Salix arbuscula	Salix glauca	Salix hastata	Salix lanata
2050	+20%	-20%	+15%	+15%	+15%	+15%	+15%

	Betula nana	Betula pubens	Juniper	Salix arbuscula	Salix glauca	Salix hastata	Salix lanata
2100	+10%	-50%	+10%	+25%	+25%	+25%	+25%

Figure 6. Percentage based view of the species average species abundance per 50 meters squared as of 2018.



Discussion:

- Our model suggests that the mean temperature in Northern Europe will increase.
- With a 5°C mean temperature increase by 2100 we predict that the climate change leads to more favorable conditions for grazing plants used in this study. Fig. 6 shows the relative abundance of each species currently, in 2050 and 2100. The relative change of each species is listed in figure 5.
- Higher temperatures provoke more rigorous precipitation during the winter months while the summer months will be warmer, leading to a longer growing season and possibly larger areas of arable land.
- The one species we predict to decline is the *Betula pubescens*, which is more at risk to beetle and insect infestation with the decrease in soil moisture and is expected to decrease in population at a lower elevation, but climb up the tree line in snow covered mountains.
- The *Salix* species are expected to increase population in the absence of birch as the dryer soil will lead a growth of smaller shrubs.
- Shrubby plants such as the willows, juniper, and *Betula nana* are predicted to overtake the area and outcompete slower growing species.

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