Report on Maxent model for *Erica tetralix L*.

Introduction

I chose the perennial subshrub *Erica tetralix L*. for my investigation into the impacts of climate change on a plant species. This heathland plant is found extensively in the British Isles(Bannister, 1966) as well as being fairly common along the western coast of Europe, ranging from Iberian Peninsula up to Norway(Bakker & Berendse, 1999). It requires plenty of precipitation and a high water table in the, often nutrient-poor, bogs, heaths and forests it inhabits(Lars Fröberg, 2011)(Bannister, 1966). For this reason it is expected that changes in moisture levels will have a more detrimental impact on *Erica teralix L*. than temperature changes.

Methodology

The variables for this model were aimed towards moisture levels as this species is particularly dependent on high levels of precipitation. To account for this fact the Precipitation of Wettest Month and Precipitation of Driest Month were chosen for two variables as this gives an indication of the extremes that the species would endure. The other variables chosen for this investigation looked into general temperature levels with the Annual Mean Temperature and Temperature Annual Range chosen as well as investigating the Mean Temperature of Wettest Quarter.

Model output

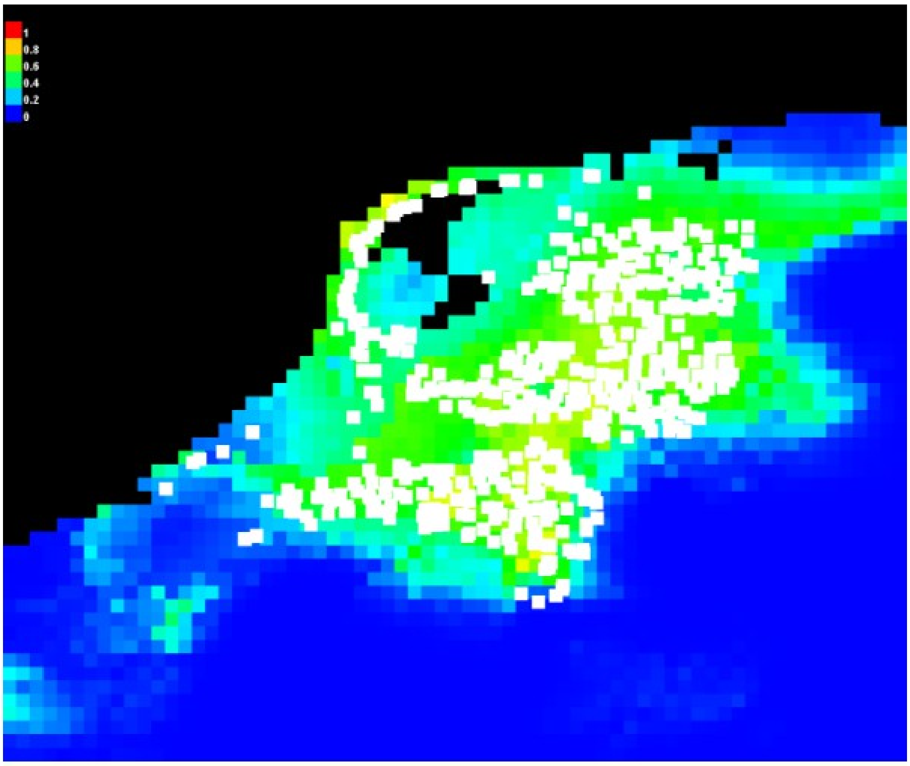

Figure 1: Current distribution and suitability for Erica tetralix L. in the Netherlands. Warmer colours show areas with better predicted conditions. White dots show the presence locations.

Figure 1 shows the current distribution of *Erica tetralix L.* and the suitability in the Netherlands. It illustrates that *Erica tetralix L.* is a common species in the region with a wide ranging distribution across the country. It clearly avoids urban zones and is more prominent in areas with the suitable variable levels as predicted by Maxent, which is to be expected.

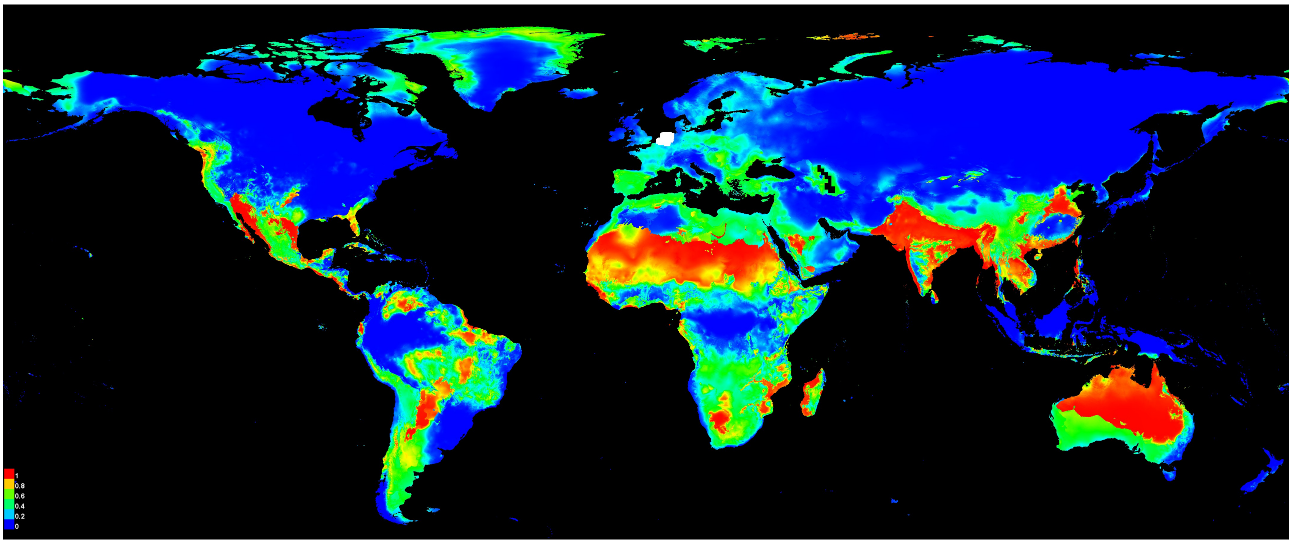

Figure 2: Current suitability for Erica tetralix L. across the world. Warmer colours show areas with better predicted conditions. White dots show the presence locations in the Netherlands.

Figure 2 indicates the suitability for Erica tetralix L. on a global scale with the current distribution in the Netherlands also shown.

This figure is unusual as it shows the majority of western Europe is only partly suitable for the species, with other areas of the globe being preferable, which is not what is currently observed in species surveys (Bakker & Berendse, 1999). Regions such as India, Australia and Northern Africa are presented as being better suited. This could be due to the model only taking into account certain variables or, more likely, an issue coming up in the production of the model. If we regard the model as correct this results is likely down to the isolation of western Europe with the mountain ranges such as the Alps and water bodies such as the Mediterranean separating *Erica Tetralix L.* from other areas. Some evidence to support this is the fact that invasive specimens in Central America have been found and this is supported by this figure with these areas being apparently more suitable than the native environments

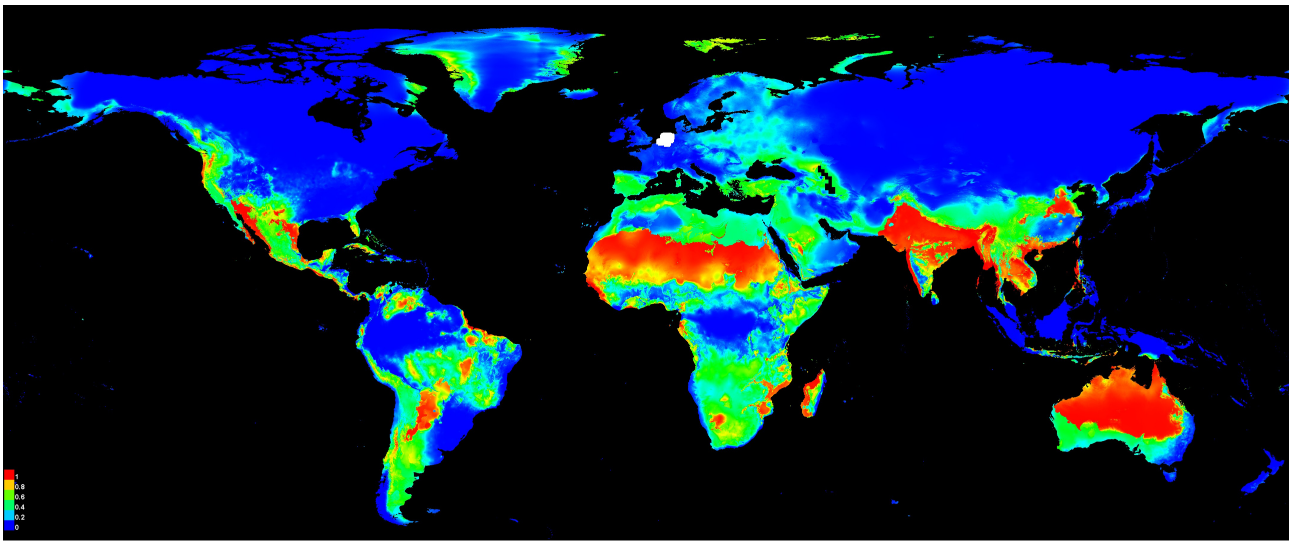

Figure 3: Future suitability for Erica tetralix L. across the world. Warmer colours show areas with better predicted conditions. White dots show the presence locations in the Netherlands.

This figure continues with the trend shown in figure 2 with Northern and Central Western Europe being shown to be completely unsuitable for *Erica Tetralix L.* in the future scenarios. Areas in India, Australia and other regions are observed to be more suitable than the previous figure indicated that increased rainfall in the Himalayas could lead to a perfect environment for the species. Of course once again this disregards the huge distances between the native habitat and the proposed environments.

Model Performance

The AUC of the model was 0.867 which is a fairly high level and seems to show the model was a good fit. This seems to suggest that the issues with the predictions seem to be more to do with the building process of the model, perhaps something going wrong early on, as the system seems to believe this is a good fit for the species which we know isn't true(Lars Fröberg, 2011)(Bannister, 1966). I would conclude from this that although the AUC states the model is good I would argue the opposite.

Variable Importance Table

Variable	Percent contribution	Permutation importance
bio7	51.2	47.2
bio14	24.3	22.6
bio1	15.9	7.7
bio8	4.7	12.8
bio13	3.9	9.6

The table above is the Variable Importance Table which indicates which variables were determined to be most influential in the distribution patterns shown in the model. This gives some insight into the outcome of the model as it shows that Temperature Annual Range had, by far, the largest contribution. This is not ideal as this is more of a minor component for the species with moisture levels being far more important.

Response to future scenario

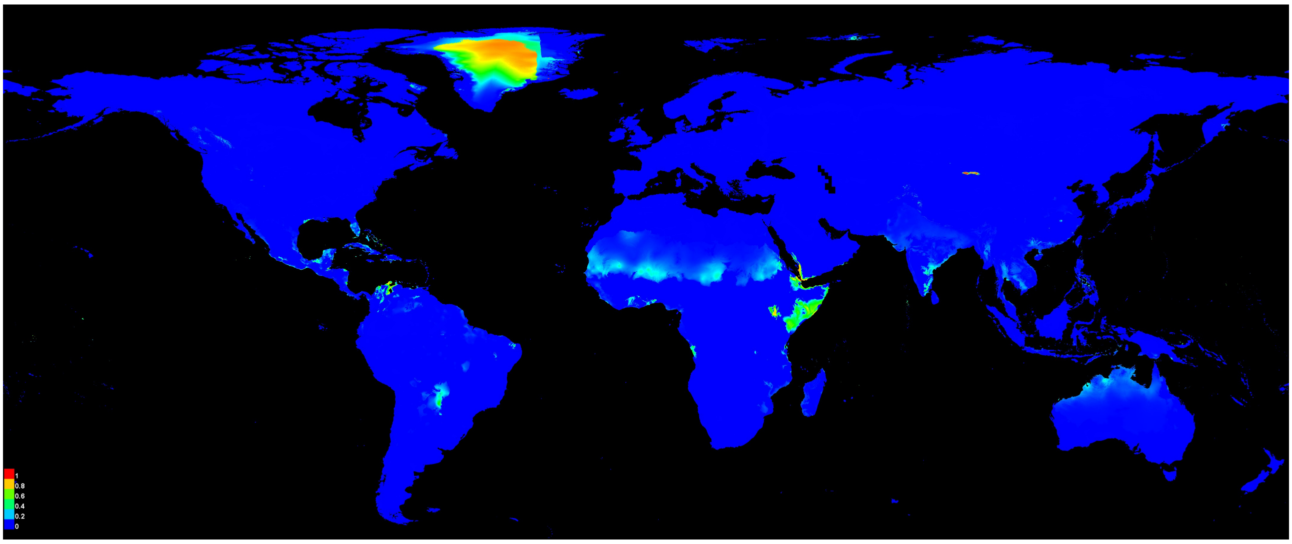

Figure 4: Future distribution change for Erica tetralix L. across the world. Warmer colours show areas with better predicted conditions.

This figure seems to be one of the main issues with the model with no clear trend being shown and it shows no link to the other figures. This further supports my claim that an issue with the model building took place.

Biological interpretation

The Maxent model has concluded that the distribution of Erica Tetralix L. would be better suited in warmer drier regions such as Australia and Northern Africa. It continues with this theme with it's future predictions showing an increased range in these areas as temperatures continue to rise. This is most unusual and is the complete opposite scenario to what is expected for the species in the future as it depends on moisture extensively. I believe the model has a flaw in it and so this model must be studied with caution. It is far more likely that we will observe Erica Tetralix L. migrate further north in Europe and move away from drier regions such as Spain and Portugal. This could mean that the species adapts to these new, harsher environments and becomes a more hardy species than it already is.

This model has been very difficult to analyse as it seems to have so many problems. I think an issue is that the priority of the model can be incorrect and it can focus on a variable that isn't as important as others. Also the model doesn't take distance or other constraints on species' spreading to other regions. In conclusion I don't think this model is useful and the species and its future distribution must be investigated further.

References

Bakker, JP & Berendse, F 1999, 'Constraints in the restoration of ecological diversity in grassland and heathland communities' Trends in Ecology and Evolution, vol 14, no. 2, pp. 63-68.

Lars Fröberg, 2011, New Flora of the British Isles, third edition, *Systematic Biology*, Volume 60, Issue 1, 1, pp 112–113

Bannister, P. 1966. Erica Tetralix L. *Journal of Ecology, 54*(3), 795-813. doi:10.2307/2257818