Mapping Potential Mountain Woodland Vegetation of the Western Highlands through a Study of Western Norway

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Recipient of BSBI Plant Study Grant, 2023

Introduction

Scottish mountain woodland habitat consists of a few scattered relic communities and locations where restoration has occurred [1]. However, in Norway, *fjellskog,* composed of the "birch belt" and "willow zone", is a ubiquitous component of the country's biogeography [2,3]. Comparisons of climate and geology suggest the contrasting landscapes of the Western Highlands of Scotland and Western Norway primarily reflect differences in land management between the two countries [2]. This dissertation takes a quantitative ecological approach to apply and validate these comparisons. "Climatic analogue models" are proposed as a tool for developing detailed future natural scenarios for upland Scotland.

Characteristic	Corrour Estate	Kjerrringafjellet
Max elevation (m)	1133	1136
Mean July T at ~1000m	9.26C	9.4
Mean July T at ~400m	12.26C	12.9C
Mean rainfall	2400-3300mm	1900-2970mm
Geology	Psammite, Granite	Phyllite

Table 1. Characteristics of Corrour Estate and Kjerringafjellet, Norway. *Climate characteristics extracted from 1km grid square data.*

Fieldwork

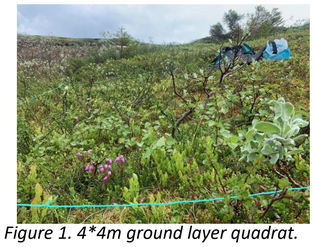

*Figure 1. 4*4m ground layer quadrat.*

16 days of fieldwork

21 30*30m & 4*4m plots

377 trees and shrubs measured

Four transects were walked in full and boundaries between different vegetation communities recorded. A representative area was selected in each zone for 30*30 and 2*2m plots. Domin scores, *Betula pubescens* characteristics and tree and shrub characteristics were recorded in each plot.

Figure 2. Atlantic pinewood vegetation qualitatively appears similar to Caledonian Pinewood. *Photographed here 505m asl.*

Figure 3. The highest recorded Betula pubescens and Pinus sylvestris, 810m asl.

Figure 4. Betula pubescens growing amongst heath vegetation with abundant Cladonia. 905m asl.

Figure 5. Sorbus aucuparia seedling at summit cairn of Kvasshovden, 1056m asl.

Figure 9. Betula nana and Salix lanata. Both rare in Scotland and abundant in localised areas at the survey site. Here 890m asl.

Figure 6. Stunted Betula pubescens and bog vegetation form open islands amongst the woodland. *Here 545m asl.*

Figure 7. Betula pubescens growing near horizontal on steep ground*. 510m asl.*

Figure 8. Tall Betula pubescens in a sheltered corrie*. 990m asl.*

Data Analysis

Cluster analysis was carried out on Domin score data to identify distinct groups (see Figure 10). Species boxplots were plotted to understand these communities. They were identified as four distinct groups with two outliers:

- Atlantic Pinewood
- Birch-Willow Scrub (wide range of vegetation)
- Alpine
- Bog

The topographic data for each quadrat was supplemented by adding intermediate points within the zone of homogenous vegetation. The occurrence of alpine and birch and willow scrub plots could be explained; though explaining the presence of BWS/APW in low altitude, low slope areas was more complicated (Figure 11). Bog vegetation was limited to areas of deep peat.

Species	Maximum Recorded Altitude (m)			
	Timberline	Krummholz	Tree	Species Limit
Pinus sylvestris	545	Domin <5	810	≥1020
Betula pubescens	735	870	810	≥1020
Sorbus aucuparia	Domin <5	NA	735	925*
Picea abies	Domin <5	Domin <5	510*	925
Alnus incana	Domin <5	735	480	735
Populus tremula	Domin <5	NA	600	600
Prunus padus	Domin <5	NA	450	450
Salix caprea	Domin <5	NA	805	805
Salix shrub spp.	NA	NA	NA	925
Juniperus communis	NA	NA	NA	≥1020
Betula nana	NA	NA	NA	925

*<- Table 2. Maximum recorded altitude for trees and shrubs at Kjerringafjellet. *observed at higher altitude outside of plots.*

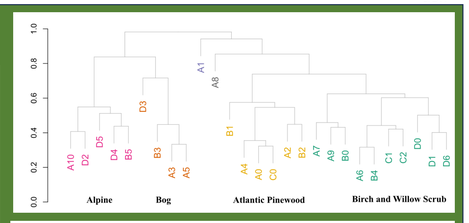

Figure 10. Cluster Dendrogram of Surveyed Plots. Domin scores for plots on transect B were identified using images.

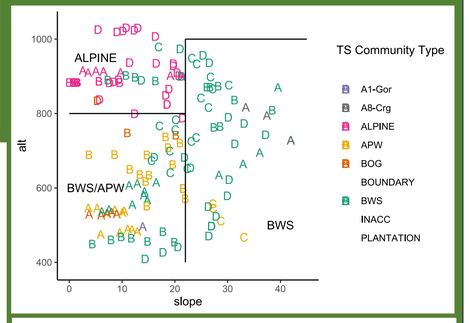

Figure 11. Clusters by slope and altitude. APW: Atlantic Pinewood. BWS: Birch/Willow Scrub

Preliminary Results

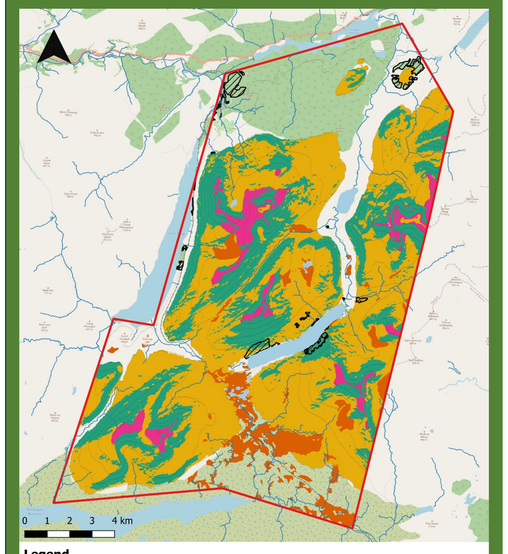

Figure 12. Modelled extent of woodland in Corrour Estate, Western Highlands

Mapping Potential Woodland at Corrour

A rule-based classification system was created by combining the results of Figure 11, with an additional layer of deep peat. The classification was applied to a digital elevation model of Corrour Estate. The resulting map shows the potential distribution of mountain woodland vegetation types according to the model (Figure 12).

The results were verified by comparison with the native woodland model [4]. The model outputs were found to be in general agreement. Adding elevational constraints on tree forms of *Pinus sylvestris* and *Betula pubescens* improved the agreement of the models.

These results provide further evidence that the Western Highlands could support a large area of montane woodland, including montane willows, dwarf birch and more extensive distribution of pine and downy birch.

Limitations

The initial vegetation dataset is limited by its low spatial spread and low sample size. Geological differences and minor variations in climate are not included in this primitive model. There is also a lack of detail in the vegetation dataset, especially in the case of montane willows which I was largely unable to identify to a species level in the absence of leaves.

Nevertheless, this study suggests there is substantial scope for detailed "climatic analogue modelling" which could greatly improve understandings of potential mountain woodland in Scotland.

Conclusion

This study demonstrates that a new climatic analogue model approach could make a substantial contribution to understanding of the potential mountain woodland of the Western Highlands. Data from Western Norway suggests large areas of the Western Highlands could support mountain woodland vegetation. Distinctive krummholz trees could add a significant new ecosystem component. This study also supports efforts to encourage a wider distribution of montane shrubs such as *Salix lanata and Betula nana*.

This research was made possible by the BSBI Plant Studies Grant and RGS Henrietta Hutton Research Grant.

With thanks also to Miss Julia Stewart, Dr. Ian Lawson and Miss Sarah Watts.

REFERENCES

1. Tipping, R. (1995, November). The form and the fate of Scotland's woodlands. In *Proceedings of the Society of Antiquaries of Scotland* (Vol. 124, pp. 1-54).
2. Halley, D. (2017). Woodland History in South West Norway – Comparative Insights From A Parallel Universe. *Scottish Woodland History Conference*
3. Moen A (1998) *National Atlas of Norway: Vegetation:* Statens kartverk
4. Towers, W., Hall, J., Hester A., Malcolm, A, Stone D. (2004). *The Native Woodland Model.* Scottish Natural Heritage