

NatureScot Research Report 1306 - Pilot study to find potential new sites for genetic conservation units for native trees in Scotland

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Keywords

trees, forest genetic resources, genetic diversity, climate change, conservation

Summary

Gene Conservation Units (GCUs) are a Europe-wide network of sites recognised for their protection of genetic diversity and natural processes in forest trees. The first GCU in the UK was declared for Beinn Eighe National Nature Reserve (NNR), Wester Ross in 2019. There are now five GCUs in Scotland, representing four species of tree (*Pinus sylvestris*,

Betula pendula, *Quercus petraea* and *Sorbus aucuparia*). This report proposes a further 98 GCUs, adding seven species. These proposed GCUs are on sites owned and managed by a range of public, private and non-governmental organisations. It is a core principle of the GCU process that sites are put forward by their owners. The GCU is a recognition of sound sustainable management of genetic diversity, and is compatible with commercial land use.

Background

The initiative to identify and declare Genetic Conservation Units (GCUs) is part of the pan-European effort coordinated by [European Forest Genetic Resources Network \(EUFORGEN\)](#), with declared GCUs compiled in the [EUFGIS database](#). At UK level, declaration of new GCUs is being coordinated by members of the steering group of the Strategy for the UK's Forest Genetic Resources, and collated at [UK Genetic resources website](#).

UK contacts for EUFORGEN:

- National Coordinator: David White, Forestry Commission, David.White@forestrycommission.gov.uk
- EUFGIS National Focal Point: Dr Richard Whittet, Forest Research, Richard.Whittet@forestresearch.gov.uk

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Design of the Environmental Coverage plots follows that used in Benavides et al (2021), and we received guidance in their preparation from Dr. Elisabet Martinez-Sancho.

Introduction

Genetic diversity is one of the three strands of biodiversity recognised in the Convention on Biological Diversity, and is key to nature's resilience. To date however, conservation of genetic diversity has lagged behind that of the other two strands: species and ecosystems. Gene Conservation Units (GCUs) offer a means of allowing biodiversity to adapt to changing conditions, whether caused by climate change, novel pests and pathogens or other pressures.

GCUs protect functioning (reproducing, demographically dynamic) populations as an explicit goal within their management plans. GCUs meet the IUCN criteria for [Other Effective area-based Conservation Measures](#) (OECM). As of Jan 2021, the UK's first 16 GCUs for tree species have been declared and registered with the European EUFGIS database; these cover 6 species across 12 sites (four sites are registered as GCUs for more than one species) and are owned by NatureScot or The Woodland Trust. Five of these, representing four species, are within Scotland (see [UK Genetic resources website](#) for further information). A major task remains to increase declaration of GCUs for the full environmental range for those species for which GCUs have been declared, and

to declare GCUs for those species without any. A first step would be to prepare a list of potential GCU sites for all tree species, with ownership identified, and mapped against all available genetic data and proxy information (e.g. climatic, edaphic variables) to allow prioritisation of sites representing the full environmental niche space for each species. Subsequent work to complete declaration of the GCUs could then proceed systematically and rapidly. A key target group will be private landowners as they represent the majority of landholdings in Scotland. Potential partners, including Scottish Land & Estates and a number of SELink members, have expressed considerable interest in the GCU concept.

This report summarises the outcomes of a pilot exercise to identify a list of potential populations to be declared as Genetic Conservation Units (GCUs) following the protocol of Hubert & Cottrell (2014) and Lefèvre *et al.* (2013), and for inclusion on the EUFORGEN database of GCUs of European native tree species. The aims were:

1. Extract and map environmental variables for Scotland.
2. Map populations of known ownership for major tree species in Scotland.
3. Generate list of potential GCU sites, with ownership and current management regime.

Ownership information for sites not owned or managed by NatureScot has been redacted in this published version of the report while discussions are held with landowners.

Methods

Following the EUFORGEN approach we assumed that, in the absence of data allowing explicit testing for genetic differences among populations (e.g. molecular or phenotypic/common garden data), climatic data form a reasonable proxy with which to identify populations likely to be differently adapted. In addition, EUFORGEN uses a European-scale stratification (Metzger 2018), and has a requirement for one GCU per stratum, to set a minimum number of GCUs per species; the outcome for Scotland would be a requirement for no more than one or two GCUs per species. Here, in the light of good data indicating local adaptation within tree species at finer scales and working on the principle that a larger number of populations would be required adequately to protect the national genetic resource within a species, we target a higher number of up to 10 GCUs per species.

The following approach was used:

1. For each species, extract global distributional data from the [EU-Forest database](#).
2. Identify a series of potential GCUs for each species, with priority given to sites under existing conservation protection, those sampled for the Native Tree Seed Project (RBG Kew) and with ex situ seed collections already in the Millennium Seed Bank, or those of known genetic distinctiveness from prior molecular or quantitative genetic studies.
3. Using a compiled dataset of locations from 1) and 2), extract climatic data from the [CHELSA database](#); Karger et al 2017).

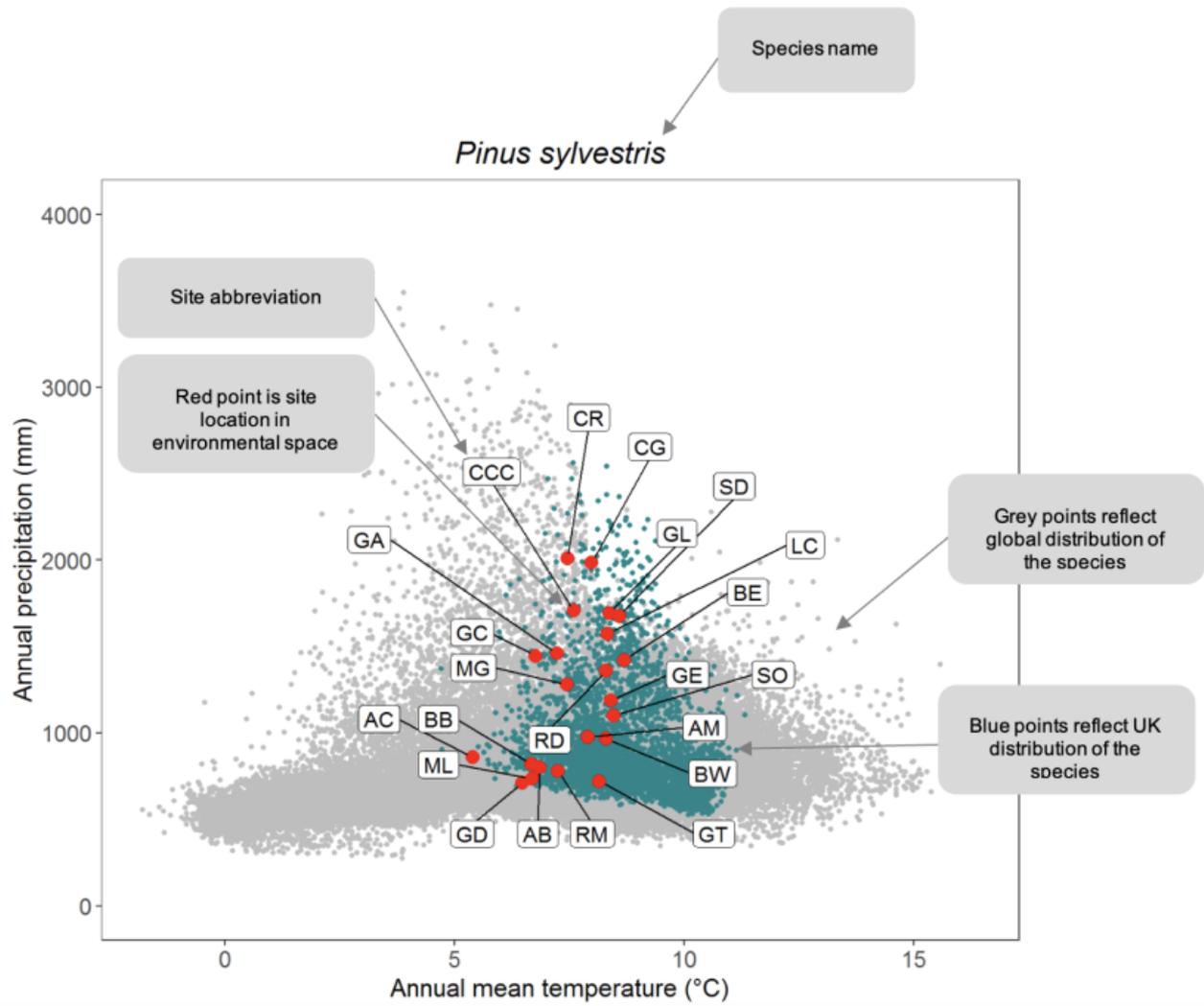
4. Plot 1) and 2) vs Mean Annual Temp and Mean Annual Precipitation, and 'Environmental Space Plot', as two of the principal factors shaping overall environmental variation across Scotland (Metzger et al 2005, Fig 4).

Results

Environmental Coverage plots and Proposed Site tables.

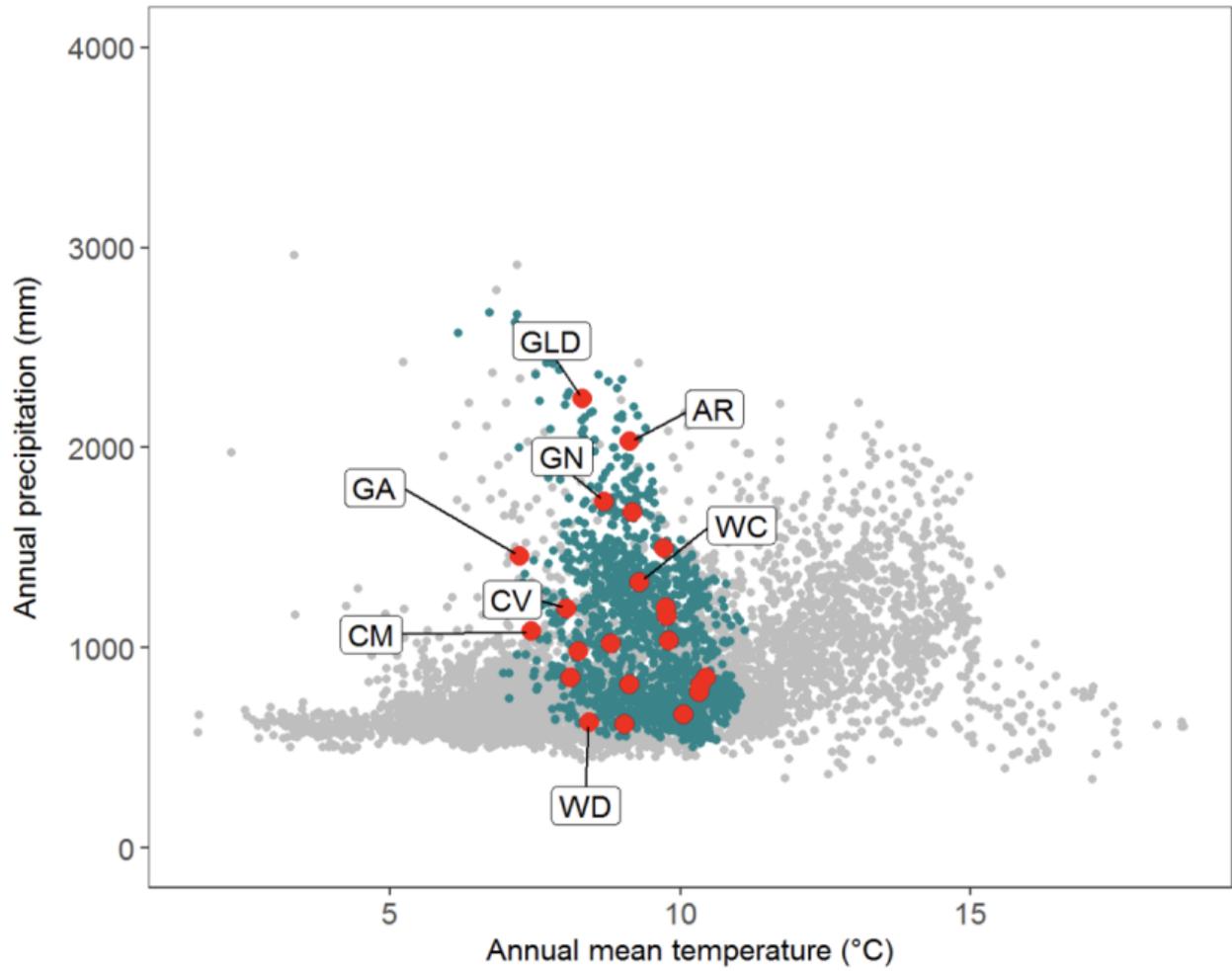
For each of following species, an environmental space plot was generated and the series of potential GCU sites was plotted against the overall environmental variation. Below follows an example of the plot and some guidance on how to read the plot, followed by plots and tables for each of the 11 species.

1. *Alnus glutinosa*
2. *Betula pendula*
3. *Betula pubescens*
4. *Corylus avellana*
5. *Fraxinus excelsior*
6. *Juniperus communis*
7. *Pinus sylvestris*
8. *Populus tremula*
9. *Quercus petraea*
10. *Quercus robur*
11. *Sorbus aucuparia*



Environmental Coverage plots - how to read the plot
[Click for a full description](#)

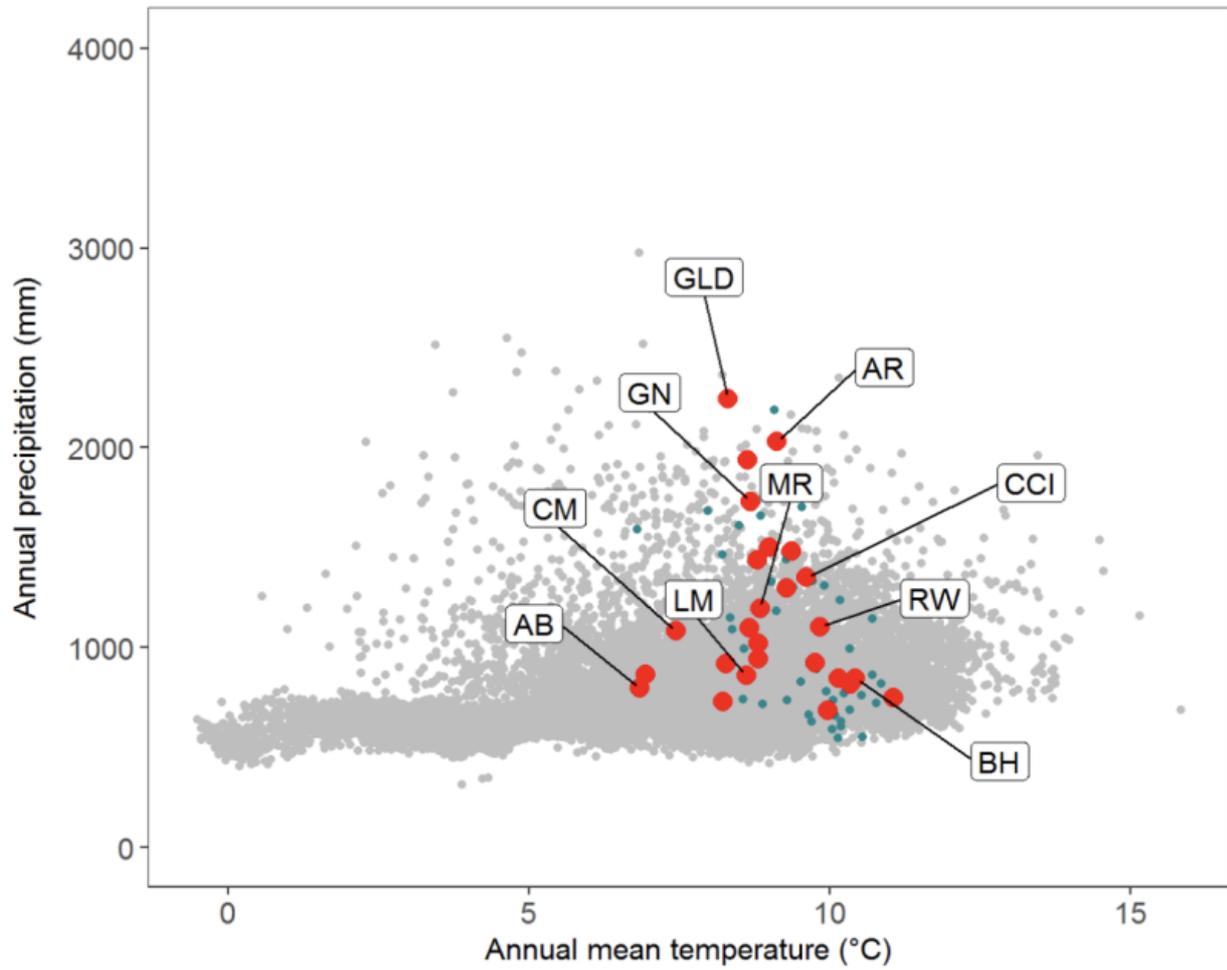
Alnus glutinosa



1. *Alnus glutinosa*

[Click for a full description](#)

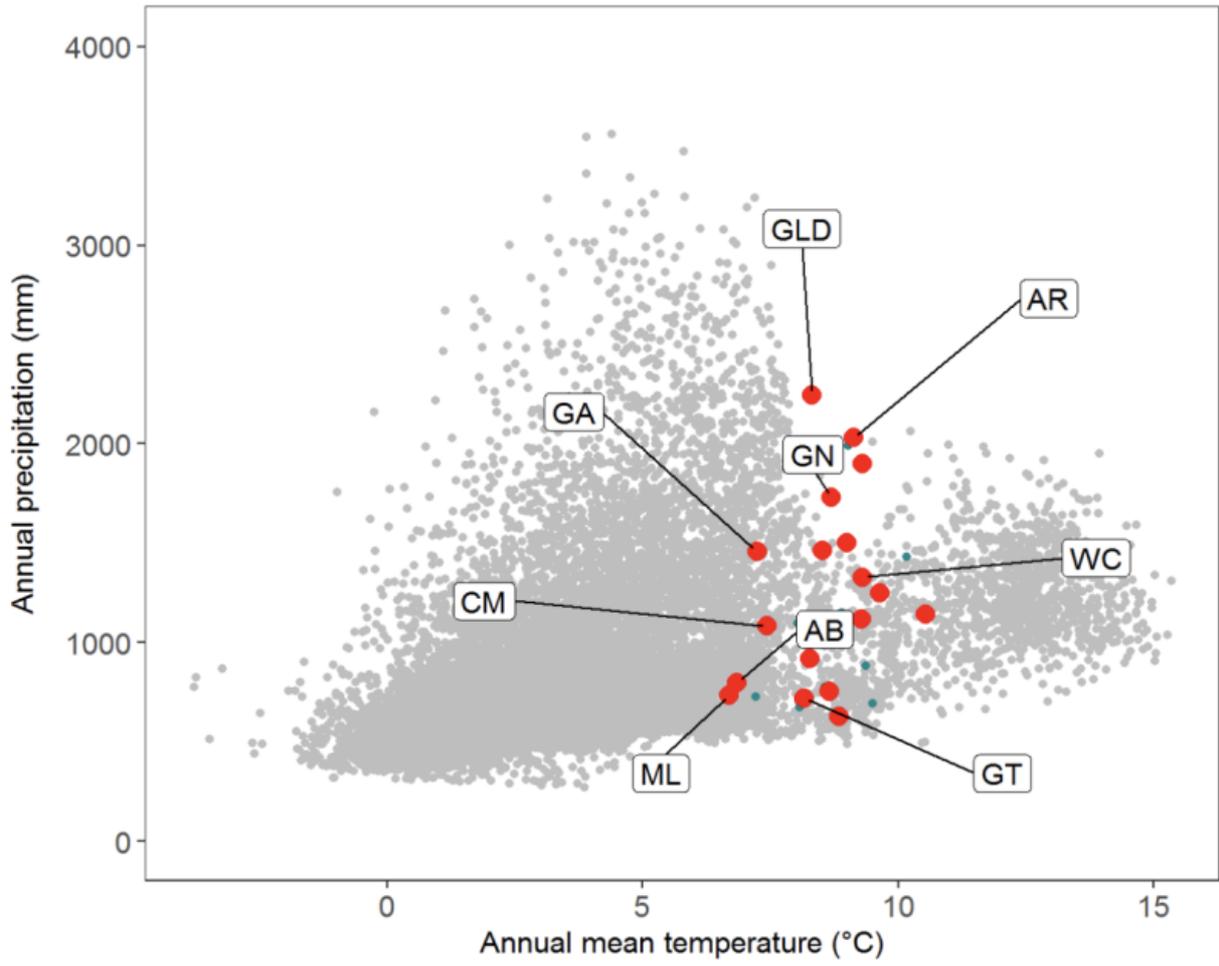
Betula pendula



2. *Betula pendula*

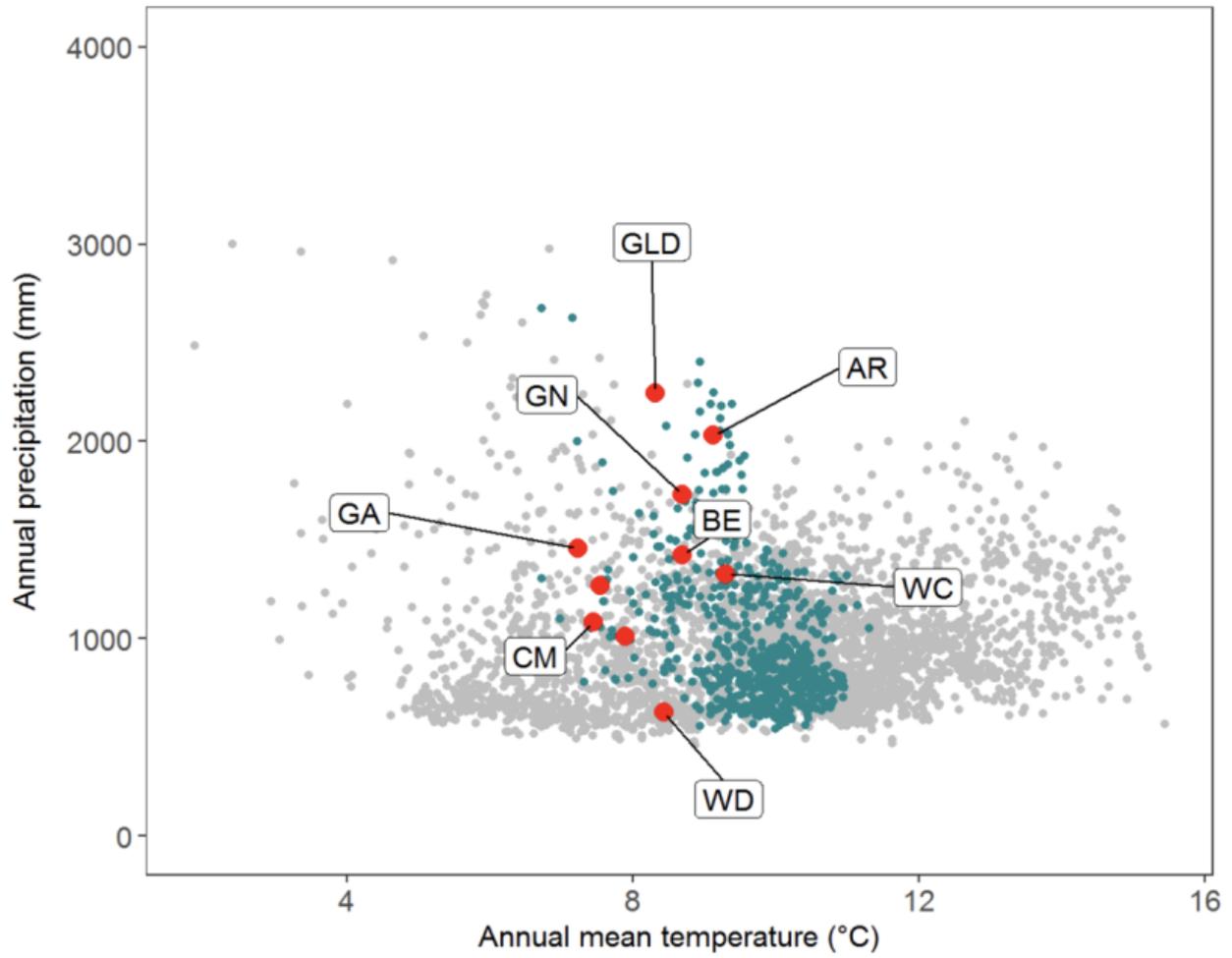
[Click for a full description](#)

Betula pubescens



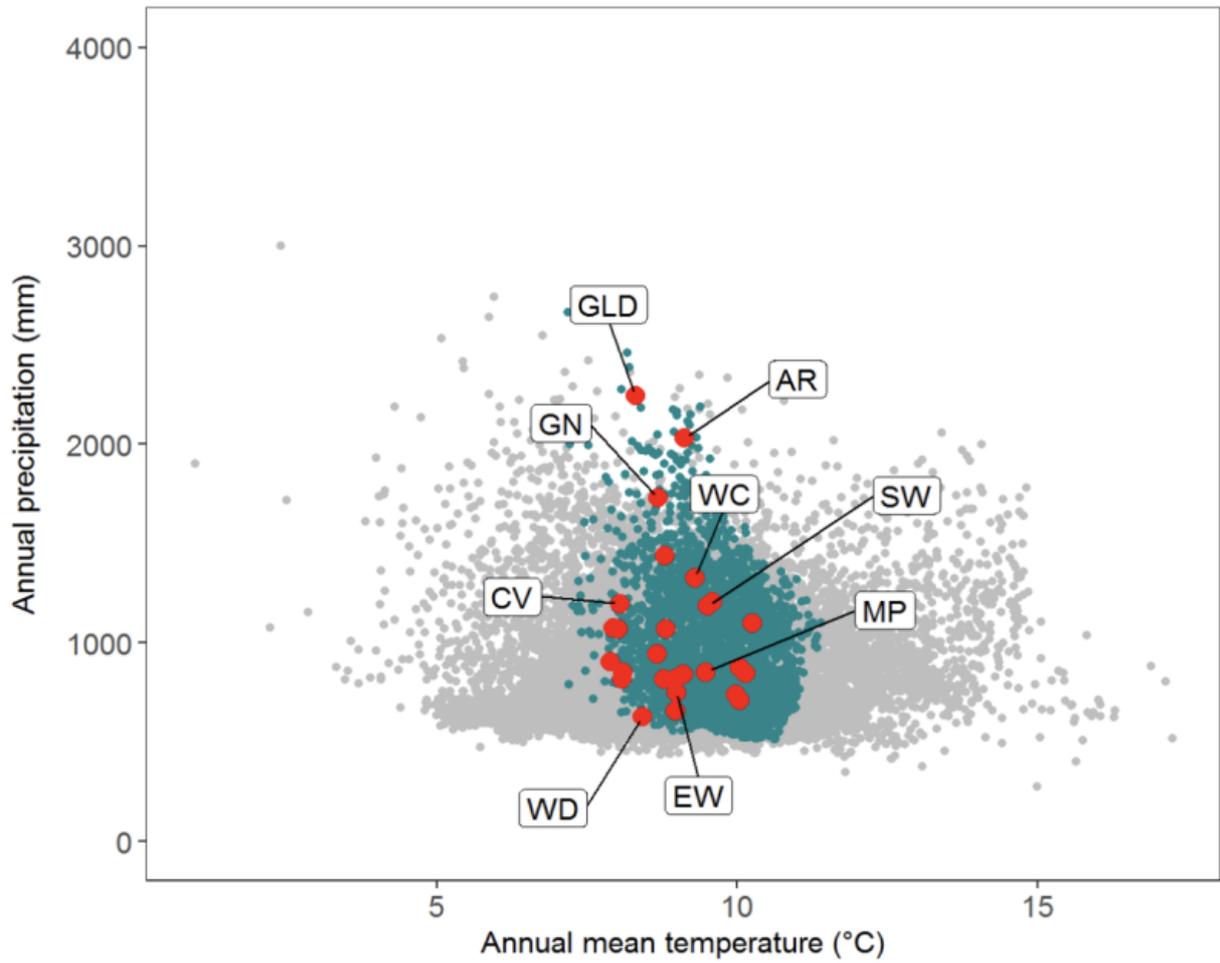
3. *Betula pubescens*
Click for a full description

Corylus avellana



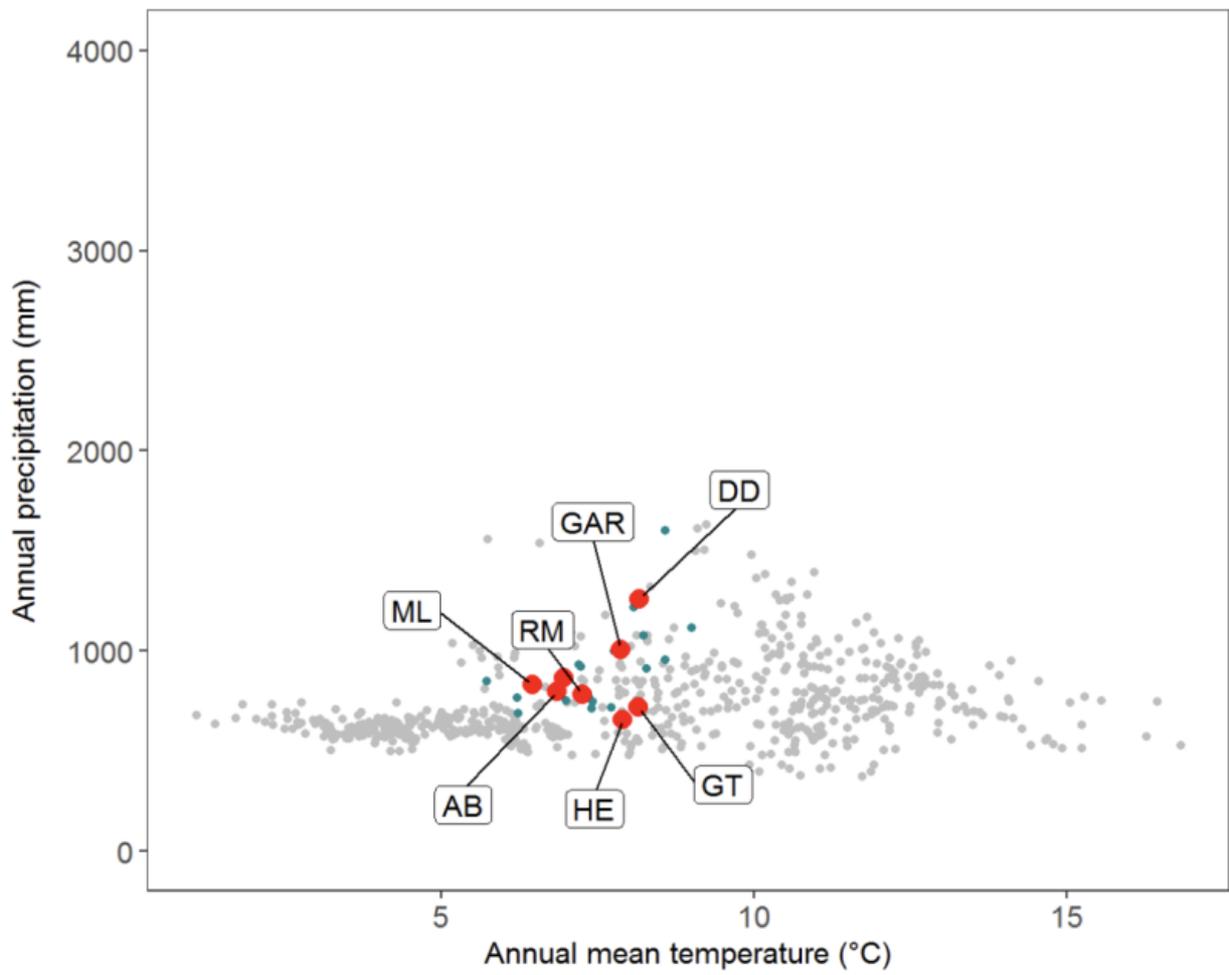
4. *Corylus avellana*
[Click for a full description](#)

Fraxinus excelsior



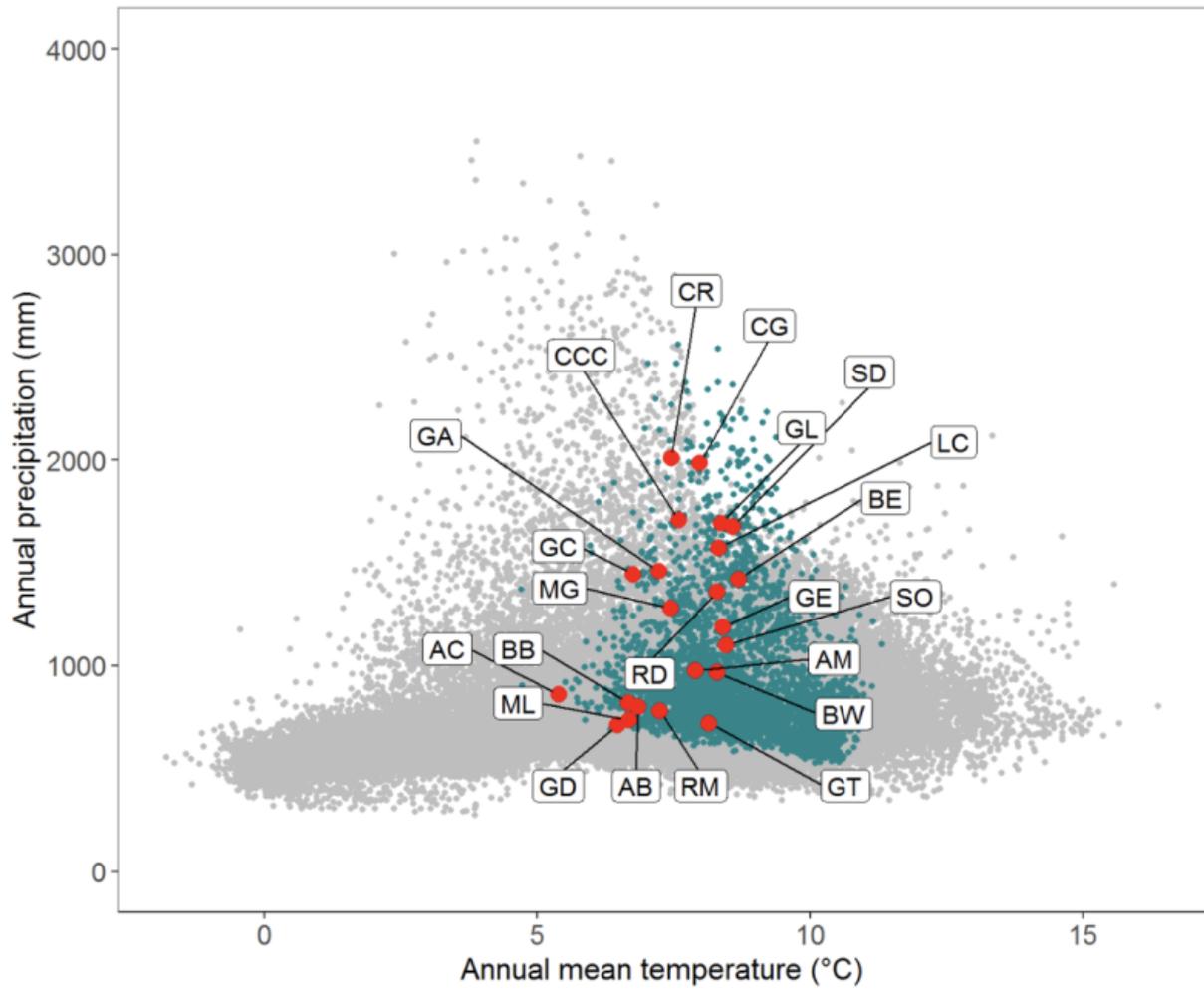
5. *Fraxinus excelsior*
Click for a full description

Juniperus communis



6. *Juniperus communis*
[Click for a full description](#)

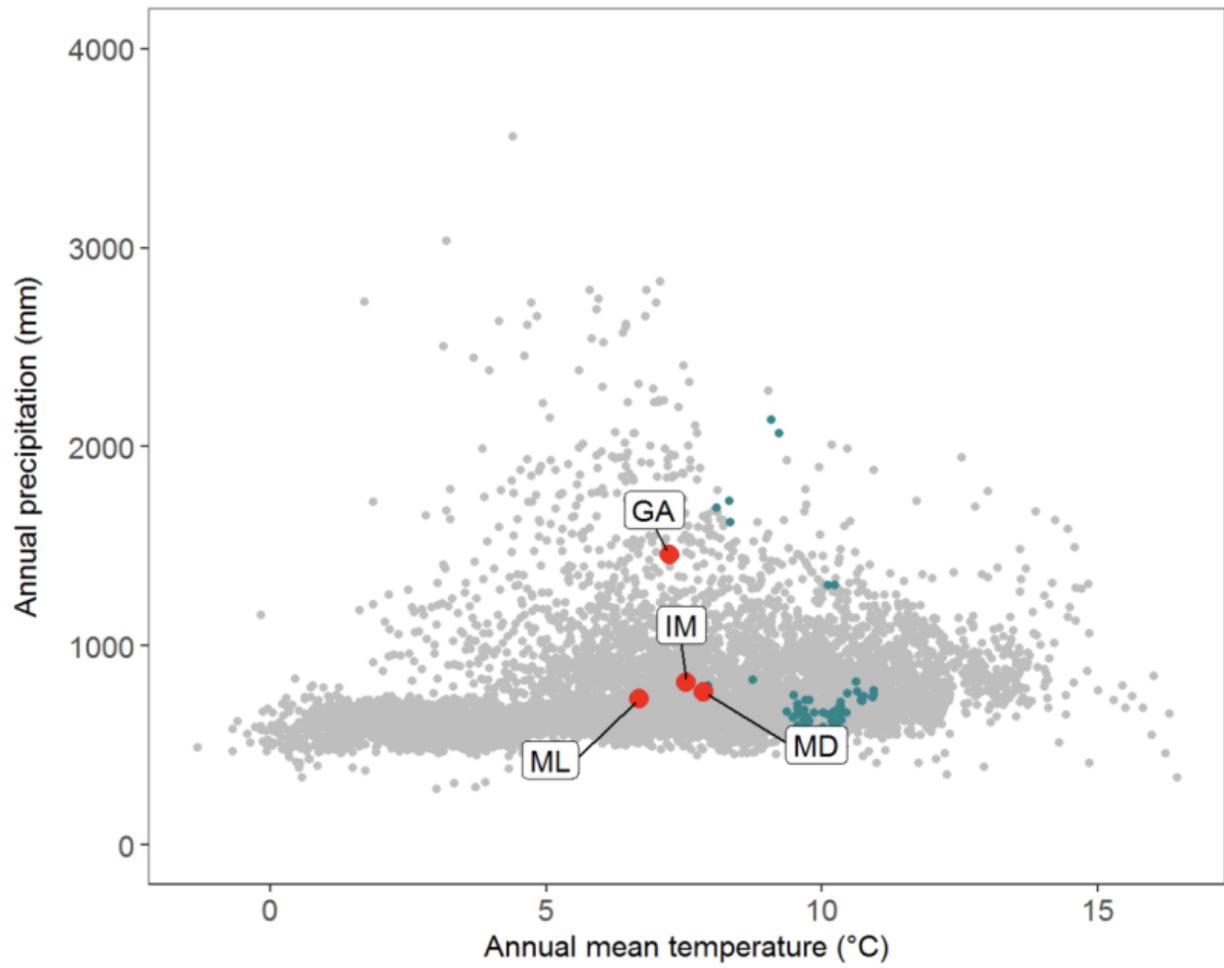
Pinus sylvestris



7. *Pinus sylvestris*

[Click for a full description](#)

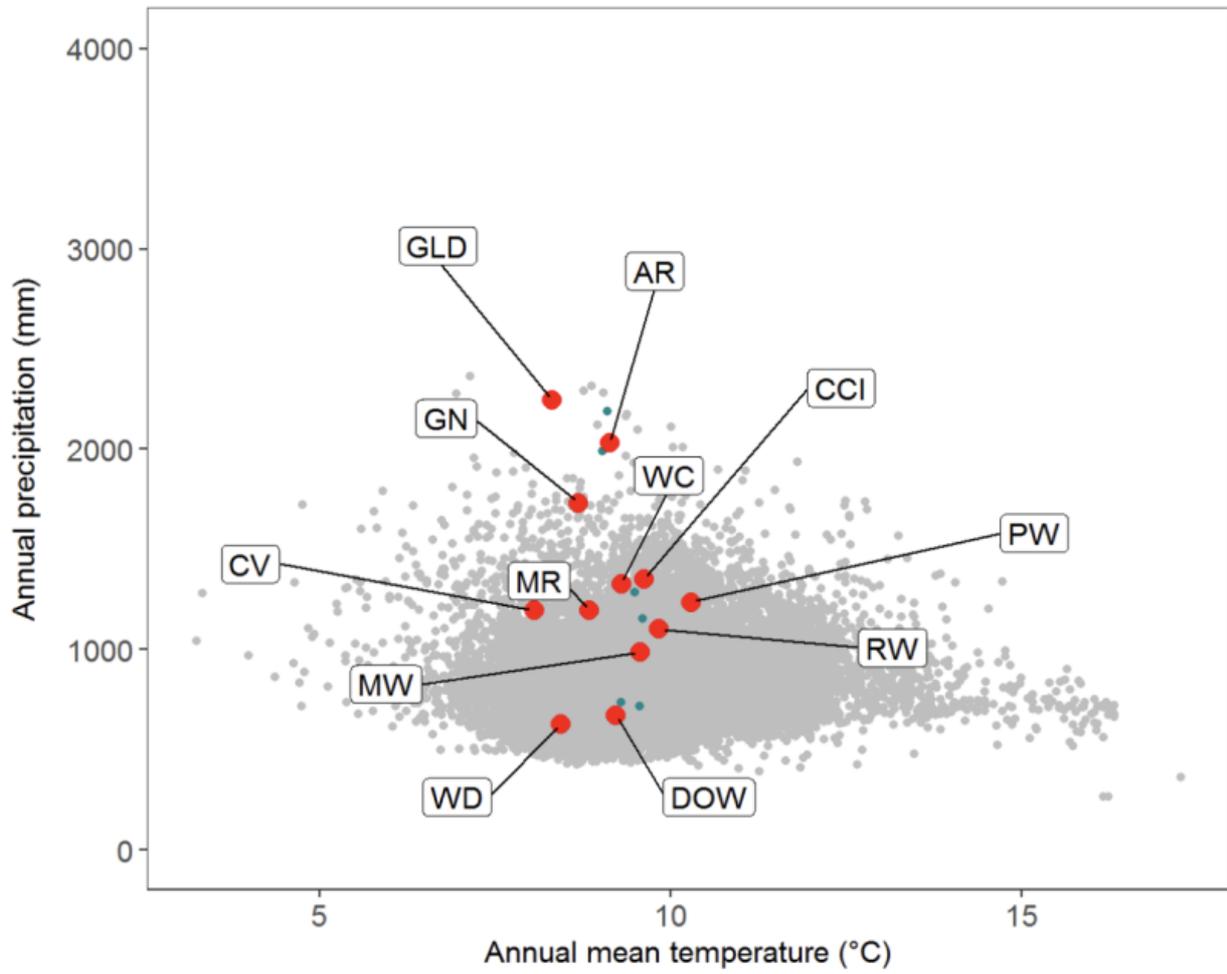
Populus tremula



8. *Populus tremula*

[Click for a full description](#)

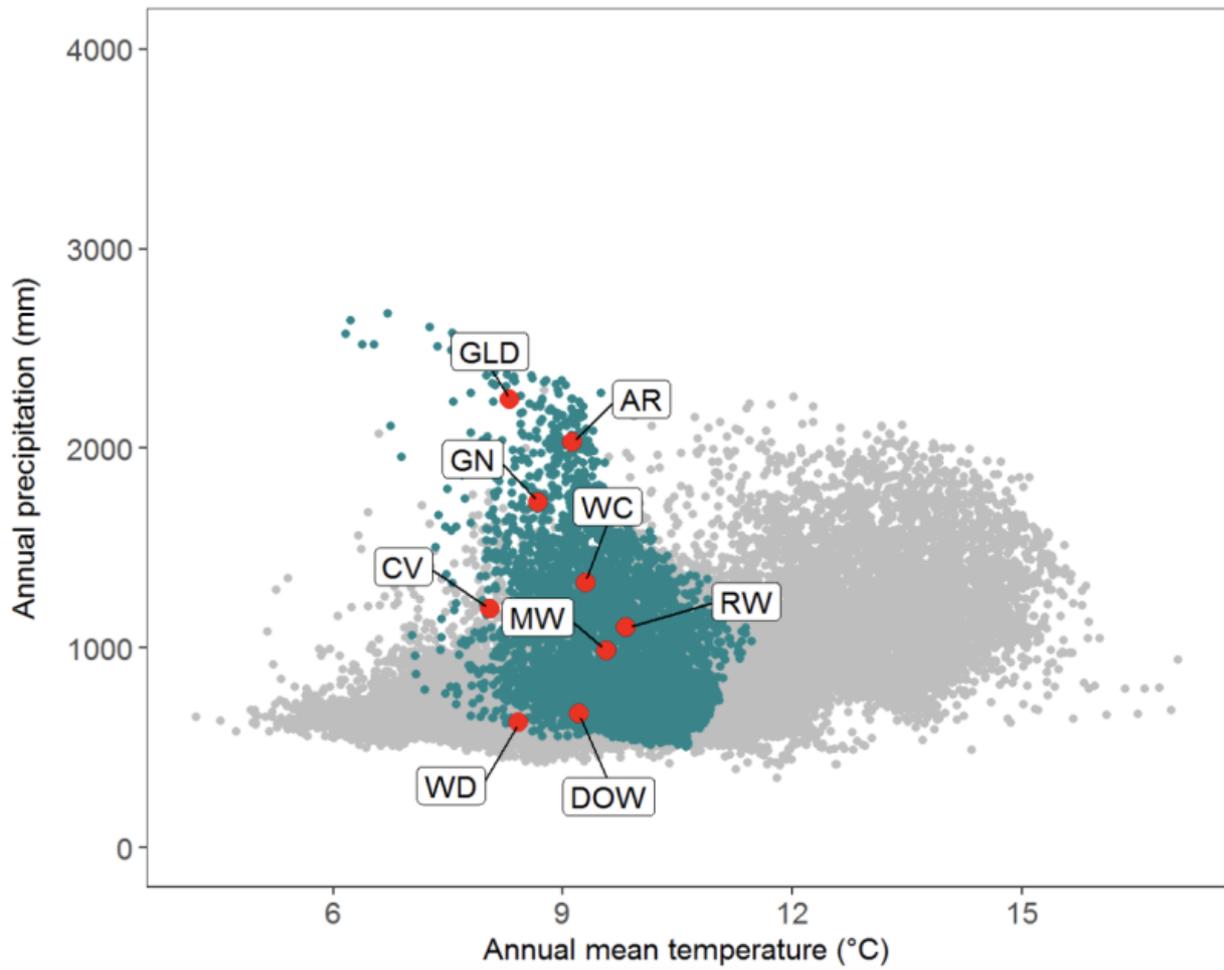
Quercus petraea



9. *Quercus petraea*

[Click for a full description](#)

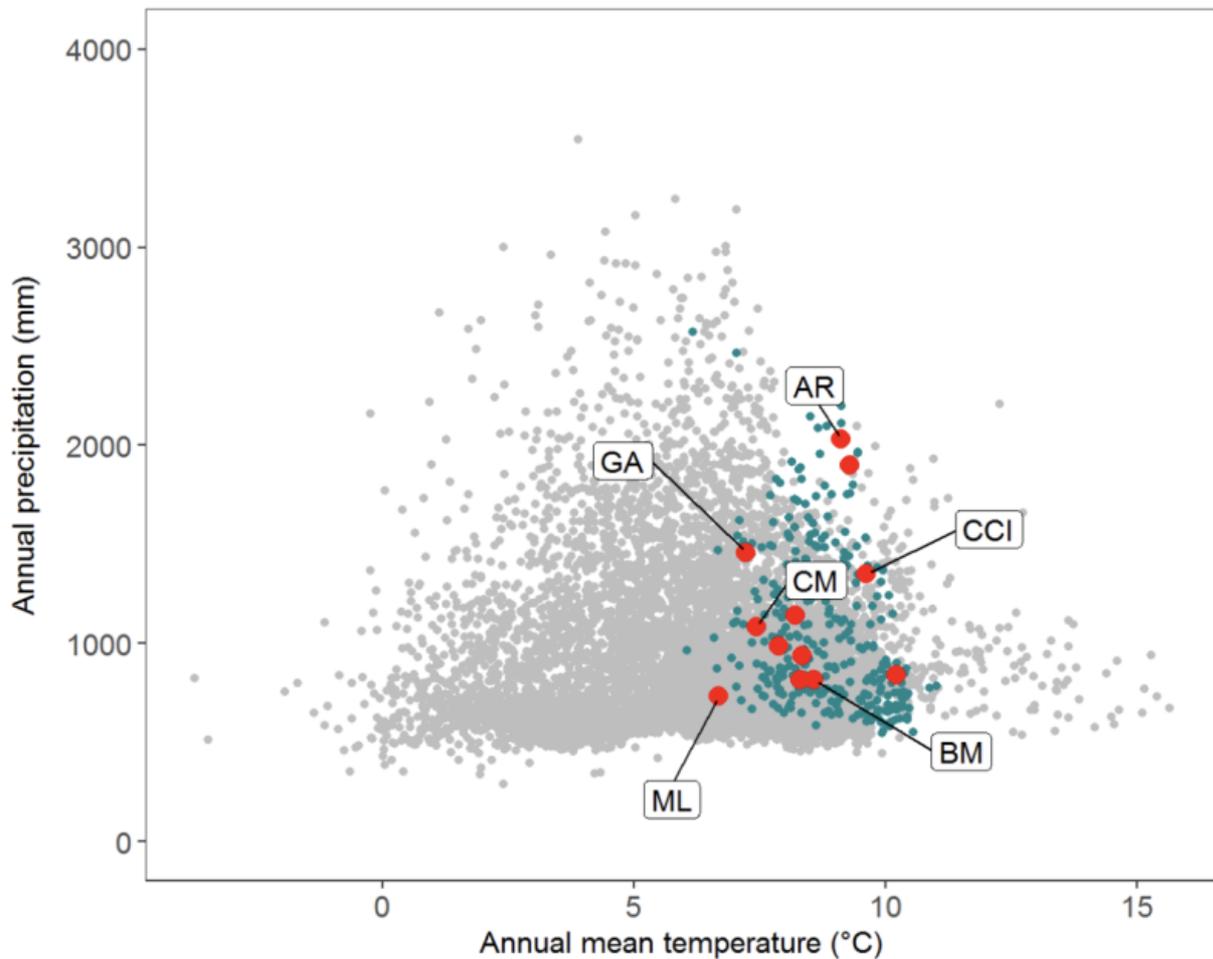
Quercus robur



10. *Quercus robur*

[Click for a full description](#)

Sorbus aucuparia



11. *Sorbus aucuparia*

[Click for a full description](#)

Discussion and key points

The Environmental coverage plots give an easy graphical representation of the distribution in environmental space of selected potential GCU sites. Currently the approach uses a simple bivariate plot of mean annual temperature vs mean annual precipitation. To elaborate further, a few immediate points of development would be:

- Deeper evaluation of environmental drivers, with a minimum objective to include an oceanicity / continentality index and make representation in 3 dimensions.
- Extend coverage of UK distribution where this is currently lacking (e.g. *Q. petraea*), and potentially distinguish the Scottish environmental space within that.
- Develop objective methods for identifying a distribution of sites in environmental space (e.g. maximum spacing estimation).

If the objective is to achieve a target minimum number of GCUs per species (say, 10) then the objective approach of identifying a set that provides maximum coverage of the selected environmental space could be used. However, the selection should be balanced

by expert review to identify obvious gaps, such as sites of known distinctiveness, sites with existing genetic data indicating distinctiveness etc. A suggested approach would be:

1. Prepare candidate list of sites (can be based on state of protection, management, botanical or other distinctiveness)
2. Plot sites within Environmental Coverage approach, generate list of sites giving best distribution within target environmental space.
3. Submit list of proposed sites to expert review to identify obvious gaps, known distinctive sites.
4. Open negotiations with site owners / managers.
5. Collate GCU data according to EUFGIS database requirements
6. Submit sites (can be batch submitted) to EUFGIS national contact point.

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