Atlantic woodland health: long-term interactions between climate, ecology and management (Ref IAP2-18-74)

Biological and Environmental Sciences, University of Stirling
In partnership with University of St Andrews and National Trust for Scotland.

Supervisory Team
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Overview

Forest health is a growing, international concern, with most attention focused on climatic drivers and regions with large tracts of forest cover. By contrast, relatively little is known about how climate change influences forest resilience in landscapes where woodland cover is limited and its composition is strongly influenced by cultural legacies. This gap in knowledge is exacerbated by current evaluation methods, since ecological time-series studies are too short to understand lagged responses and potential disequilibrium between woodland responses, climate shifts and management legacies. These issues are particularly relevant in long-settled landscapes, like Europe. This project will focus on temperate Atlantic woodland communities in NW Scotland to explore how climate change – particularly warmer and abrupt shifts – and human impacts interact to influence woodland health, measured through palaeoecological evidence for diversity, continuity and capacity to recover from perturbations.

Fig. 1. Small lochs provide a natural archive for studying long-term oak-birch woodland dynamics.

‘Temperate rainforest’ in NW Scotland is fragmented, as is our understanding of its sensitivity to environmental change and the level of continuity from prehistoric woodland communities. Palaeoecological evidence from coniferous woods further east suggest that deciduous taxa may be more competitive during phases of climatic warming, analogous to current conditions. However, the data are too limited to assess whether oceanic conditions near western range limits
deterioration, which undermines efforts to manage relict woods in a way that recognises and maintains both their cultural and conservation values.
provide microclimates suited to population recovery, or whether some forms of management disturbance are compatible with continuity and regeneration.

The relationship between climate change, catchment and vegetation can be complex. Therefore, the pollen records will be supported by lithostratigraphic analyses (organic content and micro-XRF geochemistry, supported by Dr Sarah Davies, University of Aberystwyth) to provide fine-scale evidence for the climatic induced changes in the water column and wider catchment. The palaeoenvironmental records will be constrained using radiocarbon dating (supported by NERC-RCF) and tephrochronology to understand change on ecological timescales. Analytical techniques to understand woodland responses will include rarefaction (pollen richness), turnover and regime shift analysis (supported by Dr Jane Bunting, University of Hull).

Palaeoecological datasets can be difficult for non-specialists to interpret. Inverewe is the focus of ongoing conservation management, archaeological and historical research, supported by the NTS. By working with them to develop a broader research-practitioner exchange network for this woodland ecosystem, the project will provide the student with opportunities to discuss common interests as part of research design and to explore alternative presentation formats that connect past and future dynamics, such as scenario planning and map-based representation of land cover change.

Collaboration with the NTS will provide training opportunities and increased insight into cultural impacts on the woodlands. In return, collaboration with NTS staff will ensure that future environmental management is framed by an understanding of long-term cultural and climatic impacts on this landscape. This participatory approach will provide a blueprint for future collaborations and ensure that research outcomes are relevant to the research users, both informing and informed by land and heritage management issues.

**Timeline**

Year 1: Training in pollen analysis and review of extant palaeoecological and palaeoclimate data for the region to identify useable datasets for regional timeseries analysis. First field coring campaign (Inverewe) during spring-summer, and first ‘researcher in residence’ stay. Geochemical analysis (XRF-ITRAX) followed by pollen and lithostratigraphic analyses, with first radiocarbon dating submission to NERC-RCF in the autumn.
Year 2: Data assembly for timeseries analysis and identification of key horizons to resample for higher-resolution analyses. Second field campaign to obtain cores for targeted palaeoecological sampling, pollen and lithological analyses. Second ‘researcher in residence’ collaboration. Second radiocarbon submission to NERC-RCF in autumn.

Year 3: Continuation and completion of labwork. Construction of Bayesian age models and timeseries analysis. Undertake combined analysis of completed project datasets and begin write-up. Third ‘researcher in residence’ collaboration.

Year 3.5 (6 months): Final data analysis, publication production and project dissemination.

Training & Skills

The PhD student will receive training in field techniques and lake sediment coring and will develop expertise in palaeoenvironmental reconstruction techniques, specifically pollen and timeseries analysis. The project also allows the student to develop skills in a range of lithostratigraphic and geochemical techniques, including XRF-ITRAX geochemical analysis and grain discrete electron microprobe analysis for tephra characterisation. The PhD student will also receive training in chronology construction, including Bayesian age-depth modelling. They will work alongside NTS land managers and archaeologists to gain insights into the human drivers of landscape change. The PhD student will also gain experience of archaeological approaches for investigating human/landscape interactions. The student will also work alongside the NTS to engage with the public through fieldwork collaboration and workshops. The NTS will provide a minimum 1 month residency at Inverewe during each summer as well as in the final year of the training. During these periods, the student will become the ‘researcher in residence’ at Inverewe.

The supervisory team will provide complementary expertise and deliver project-specific training in (1) high-temporal resolution pollen, fungal spore and charcoal analyses, and multivariate analysis of palaeoecological time-series (Davies), (2) sediment stratigraphic analyses and palaeoclimatic indicators (Tisdall), and (3) training in tephrochronology and statistical support (Streeter). The student will benefit from the vibrant conservation and woodland biogeography research community at Stirling and networking with current interdisciplinary projects in St Andrews on the social-ecological values attributed to tropical peatlands, and their implications for effective conservation.

Additional training and support in transferable skills will be available, including seminars/workshops on project management, oral and written communication, dealing with the Media, the Viva and troubleshooting. All students are expected to present their work annually at internal seminars and at external conferences. Students are also required to produce annual reports and undergo annual review meetings to ensure that they are progressing and receiving appropriate support for submission to a high standard. The student will also be encouraged to attend training and networking events within the IAPETUS2 DTP and offered via NERC.

References & Further Reading


Further Information

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