# Rewilding the "great wood of Caledon": using remote sensing to understand natural forest regeneration in Scotland

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**Project summary:** How best can remote sensing support reforesting and rewilding in Scotland?

## Project background

*Fig 1. Scots pine regenerating in moorland in Glenfeshie after a major reduction in deer numbers over the last decade. The rate and extent of such regeneration is unknown, as are the factors that determine its success.*

Scotland and the UK are deforested countries. In recent years, the entwined ideas of rewilding and natural forest regeneration have influenced land use, particularly in upland Scotland. Landowners are increasingly managing land not for deer and grouse hunting, but for "wildness", ecological functioning and habitat for rare species. In many places this has involved an extensive deer cull or fencing to reduce browsing pressure on the trees, allowing trees to regenerate in areas that were open moorland. The results of this are starting to show (Fig. 1) and will have profound effects on a range of local ecosystem services as well as helping to meet national forest cover targets. However whilst the rate of new forest plantings is well known, natural regeneration is not currently quantified. This leads to important gaps in our knowledge of the ecological processes limiting regeneration and the effectiveness of different land management interventions.

Remote sensing is the ideal method to provide regular consistent information on forest regeneration over large inaccessible areas. However, most remote sensing to date focuses on distinguishing forest from non-forest, not looking at more subtle changes typical of natural forest regeneration. A new generation of radar and optical satellites (the European Space Agency's Copernicus constellation) provides frequent high resolution observations which can be used to construct time series of the land surface. These time series can reveal subtle changes in tree composition and density, due to the seasonal differences in leaf display between trees and the understory, and between different tree species. Alongside this, there is a new "golden age" in long wavelength radar remote sensing, with several new sensors ideally suited to measuring changes in tree cover and biomass[2].

This project will build on a suite of existing methods and tools developed at Edinburgh for monitoring landscape restoration, and adapt them to the specific case of natural woodland regeneration in upland Scotland. Once we are able to accurately map regeneration, we can use this data to address key ecological questions about the speed of regeneration and its environmental constraints, as well as the effectiveness of different land management interventions.

## Key research questions

a. Where is natural regeneration occurring in upland Scotland?
b. What factors determine the rate and location of regeneration?
c. How best can remote sensing inform management of natural regeneration?

## Methodology

Year 1. Identify and geolocate areas of natural forest regeneration across upland Scotland. Synthesise existing field data on regeneration areas and rates of regeneration and supplement where necessary with own fieldwork. Training in remote sensing to generate preliminary maps of regeneration for all upland Scotland.

Year 2. Evaluate the ability of existing methods that utilise radar and optical remote sensing data to provide information on landscape change, and see how this meets the needs of land managers in the restoration landscape. This will involve remote sensing analysis and discussion of results with land managers.

Year 3. Model the determinates of regeneration and the effectiveness of different land management approaches. Disseminate results through engagement with research users, online platforms, and publications.

## Training

Ongoing training will be provided by the supervisors in remote sensing methods, field data collection and data analysis. CR and his group have developed a set of methods for remote sensing of gradual changes in tree cover in complex landscapes. AK can provide expertise on statistical methods for impact analysis and change detection. JG will support the student in the policy context of forest regeneration in Scotland, and the needs of research users. In addition, a comprehensive training programme will be provided comprising both specialist scientific training and generic transferable and professional skills. Funding for this project will provide a stipend for 3.5 years, fees, and fieldwork and computing costs.

The student will be part of an interdisciplinary cohort of PhD students in the new Edinburgh Centre for Sustainable Forests and Landscapes, which offers new connections to a wide range of academic and non-academic organisations working in this field, through seminars, workshops and reading groups.

## Requirements

This project would suit a student with an interest in land management, forest restoration and rewilding. You will need to develop high level skills in data science as well as the ability to handle spatial data; all skills that are very much in demand in many research and applied contexts. You will also develop skills in communicating science to a wide range of audiences, and understanding how managers use scientific information. As such the PhD would suit students with a wide range of backgrounds, including but not limited to informatics and maths, as well as environmental science and physical geography. More important than past experience or existing knowledge is the ability to learn new methods and concepts.

## Further reading

Hobbs, R. Woodland restoration in Scotland: Ecology, history, culture, economics, politics and change. *J. Environ. Manage.* **90,** 2857–2865 (2009).

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