The BIG experiment: MOORCO – Moorland colonisation

We assess the impact of grazing and different tree species on changes in the carbon budget when woodland establishes on moorland.

Background

Originally set up as a joint project between the former Macaulay Institute and CEH Banchory as part of the MOORCO [1] project this experiment aims to identify mechanisms and rates of change as well as the role of herbivores in driving changes during succession from moorland to woodland. In addition this experiment includes *Pinus sylvestris* as well as *Betula pubescens* trees. The experiment was established in 2005 and our data collection so far has focused on changes in CO_2, DOC and soil carbon dynamics during the early stages of tree colonisation.

The experiment is called the BIG experiment because it is established at 3 sites: **B**allogie, **I**nvercauld and **G**lensaugh.

Key results

The results from this experiment will help detect how trees affect soil organic matter dynamics. The influences of physical parameters on these dynamics have to be understood and mechanistically quantified first. This requires the parameterisation of temperature and moisture models describing gaseous and dissolved exports. As climate change will alter these parameters, scenario calculations would greatly benefit from these parameterisations stemming from a specific Scottish moorland soil context.

Results will help understand the impact of changing land cover. The appearance of native trees on Scotland's heather-moorland is an unbroken trend, both in planted schemes as well as through natural regeneration following reduced grazing pressure. In the future, climate change will increasingly determine which areas are suitable for regeneration of

native tree species. Our work will give important insights into how soil organic matter dynamics of these areas will be influenced.

Results will inform on the preservation of soil carbon stocks (through losses from land-use): Scotland's soils contain a carbon stock of national and international importance, predominantly in the form of upland and blanket peat. Preservation of that carbon stock is mandatory to reduce contributions through land-use induced losses to national emissions and feeding back to atmospheric CO_2 levels.

The initial five years of tree planting with birch and pine at the Invercauld field site has shown little impact on CO_2 and DOC but that the variation in response of CO_2 and DOC is related to time of season and soil type.

See Publications [2] for further details of results.

Sites

Site Name	Grid reference
Glensaugh	NO675801
Invercauld	NO170950
Ballogie	NO550930

Experimental design

Treatments

Within each block were the following treatments:

- Grazing by large herbivores - unfenced
- No grazing by large herbivore – fenced

Within each fence or unfence plot were the treatments below:

- Planted birch (1m spacing)
- Planted pine (1m spacing)
- Heather control
- Low density birch (single trees planted)
- Clumped birch (clumps of 4 trees – only at Glensaugh)

Sub-plot treatments

- Litter addition – birch and pine litter added annually to birch, pine and control plots to assess if tree litter is driving below ground changes
- Weeding - removal of a) moorland species, b) early successional species c) late successional species, carried out annually to test the role of understorey species in driving changes.

Replication

- 4 blocks at Invercauld and Glensaugh, 3 blocks at Ballogie
- Each treatment listed above within each block

Data collected

Data type	Date	Details
Vegetation	2005-baseline	Species composition (% cover)
Soil chemistry[1]	2005 - baseline	Al, C, C:N, Ca, Ca, Fe, K, LOI, Mg, Mn, moisture, N, Na, N-mineralization, P, pH. Data for organic and mineral horizons
Soil seedbank	2005 - baseline	
Soil physical properties	2005 - baseline	LFH depth, O depth, bulk density
Soil respiration	2008-2011	Continuous at Invercauld from 2008-2001, but not all plots measured. Once a quarter at the other sites in 2010& 2011
Soil water chemistry (DOC) plus other chemical content	2006-2010	Only collected at Invercauld, once every 6 weeks
Root growth	2007-2009	Only collected at Invercauld, root growth, new roots and roots lost
Root chemical content	2005	Only collected at Invercauld
Soil temperature	2007-onwards	Only collected at Invercauld, continuous monitoring
Soil moisture	2007-onwards	Only collected at Invercauld continuous monitoring
Weather data	2007-onwards	Only collected at Invercauld. Rainfall, temperature, sunshine hours on daily basis

Soil carbon

During 2005 we established long-term monitoring of gaseous carbon exports from the soils by means of continuous-flow soil respiration chambers attached to infrared gas analysers in ungrazed tree and control plots at Invercauld. We also established zero-tension lysimeters to collect dissolved carbon and nitrogen exports from all plots and mini-rhizotron tubes were installed on all main plot treatments, adjacent to the respiration chambers, to monitor root production and root disappearance. Soil cores are also taken from the plots to determine standing root biomass and C and N inputs.

We continuously monitor gaseous and dissolved losses of carbon from these experimental plots. We also quantify soil carbon inputs by measuring both aboveground and belowground plant litter production. Detailed measures of the soil environment, such as temperature and moisture, as well as climatic parameters obtained from a dedicated weather station will create the necessary framework to interpret our findings. Soil climate data are continuously taken and recorded in order to differentiate between environment and treatment drivers of exports. An automatic weather station was established in 2008 and provides a live feed [3] available for the general public.

Contact

MOORCO [1] is a collaborative project across several groups and themes within the James Hutton Institute and with many different staff involved. In the first instance please contact Dr

Ruth Mitchell [4] for further details.

Related Staff

Related staff

Ruth Mitchell [5]

Links:
[1] http://www.hutton.ac.uk/research/groups/ecological-sciences/community-ecology/moorco
[2] http://www.hutton.ac.uk/research/groups/ecological-sciences/community-ecology/moorco/publications
[3] http://www.macaulay.ac.uk/ECN/invercauld_livedata/index.php
[4] mailto:ruth.mitchell@hutton.ac.uk?subject=Enquiry%20about%20MOORCO
[5] https://www.webarchive.hutton.ac.uk/staff/ruth-mitchell