

## Short Visit Application

### Microbial community structure and function along a natural soil warming gradient

James Weedon

Understanding the effects of climate change on ecosystem function requires knowledge about how soil processes respond to altered temperature and moisture regimes. In particular, changes to heterotrophic respiration and cycling of nutrients such as nitrogen and phosphorous have the potential to feedback to the climate system by modifying the emission of greenhouse gases from soils, and/or altering the conditions which determine ecosystem primary productivity. Most important soil processes are carried out by the soil microbial community, the vast phylogenetic and functional diversity of which has come to be appreciated in the last two decades with the development of cultivation-independent molecular methods. Mechanistic understanding of the response of terrestrial ecosystems to climate change will have to be based on knowledge of the response of microbial community structure and function to changes in temperature and moisture. This knowledge is still limited, but essential e.g. to interpret the outcomes of climate manipulation experiments.

My PhD research (since 2006) focuses on addressing these issues in the context of a long term climate manipulation experiment in an ombrotrophic peatland in Abisko, North Sweden (Weedon *et al.*, in press) My collaborators and I have adapted molecular microbial ecology and soil enzymology methods to test for the effects of seasonal climate manipulations on microbial community structure and function, with a particular focus on the soil organic nitrogen cycle. To date we have found that increased summer temperatures lead to higher rates of organic nitrogen accumulation, but we saw no detectable change in the size of soil enzyme pools or the microbial community that produces them. We are currently continuing the work to separate the direct and indirect effects of temperature on soil processes, and using more sensitive molecular methods to measure the effects of climate changes on the soil microbial community at higher temporal and taxonomic resolution.

Our current work is limited to one climate manipulation experiment in Northern Sweden. There is therefore a need to make similar measurements in other high latitude systems to explore the generality of our findings. An experimental site currently being established by scientists at the Agricultural University of Iceland (Landbúnaðarháskóli Íslands) provides an excellent opportunity for us to make comparative measurements of the response of microbial community structure and function to soil warming. An earthquake on 29 May 2008 near the study site has created a “natural warming gradient” of +45 °C to 0 °C in a previously undisturbed Sitka spruce plantation at Reykir (see Figure). Such a strong warming gradient in an otherwise homogenous environment provides a unique and excellent opportunity to study the

response of a wide range of ecosystem properties and processes to soil warming. We propose to organize a sampling expedition to this site in Spring 2012 to take samples for the analysis of soil enzyme pools (soil enzyme assays) and microbial community structure (based on DNA and RNA markers, taxon specific qPCR and DGGE) using our previously established protocols (Weedon *et al.*, in press). Generating data on soil microbial structure and function contributes to a larger project at this site coordinated by AUI and can be integrated with planned measurements of ecosystem respiration, primary production, phenology and a range of abiotic variables. In this way we create synergies between the expertise of both the host and visiting research groups. In addition, the measurements we will make will allow us to make a comparison with our previous measurements from Abisko and therefore increase our understanding of larger scale patterns in the response of soil processes to warming in high latitude systems. The proposed action would therefore meet the ClimMani objectives by:

- Facilitating synergistic interaction between researchers from two different ClimMani countries (Iceland and The Netherlands)
- contributing to a synthesis of observational data about soil microbial community responses to warming in different high latitude systems by comparing the results from standardized measurement protocols taken across different warming gradients

The expected results of the proposed action would be contribution to at least one scientific article based on the larger project at Reykir, as well as a stand-alone publication comparing the results to those obtained from the Abisko work and work in other high-latitude systems.

### **Work plan and Time schedule**

Measurements of soil microbial community structure are best made on DNA/RNA extracts taken from freshly sampled material. We therefore plan to conduct the extractions from samples on-site at UAI. The visit will therefore involve four main activities: a) meeting with hosts and orientation/set up at lab facilities and field site, b) sampling of soil samples from field site, c) extraction of nucleic acids in laboratory and d) preparation of soil and nucleic acid samples for transport to Amsterdam for further analyses.

Sampling is planned for Spring 2012. Our previous work has shown that the period immediately following winter soil thaw is critical for the soil nutrient economy for the rest of the year, and is likely to be a period when the contrasts between the different parts of the soil warming gradient will be greatest. Samples will be taken from a transect that is currently being established by researchers at AUI. This will allow sampling along a broad soil temperature gradient, as well as direct integration with a range of measurements of other ecosystem properties (ecosystem gas exchange, soil temperature and moisture, plant phenology) which

will be conducted by the AUI group. Soil samples will be processed as quickly as practicable using lab facilities provided by AUI. Additional samples will be transported back to Amsterdam for further analyses.

We are applying for funding for a visit of 12 days in May of 2012. With the following provisional time schedule:

Day 1: Arrival and orientation

Day 2: Set up lab and plan field sampling

Days 3 – 7: Field sampling and RNA/DNA extraction (the latter step can be time consuming depending on availability of specialized equipment, a recent field campaign at Abisko resulted in ~ 30 extractions per 12 hour work day)

Days 8 - 9 : Extra time available for sampling, rest days, solving eventual problems with lab work etc

Days 10 - 11: Preparation of samples for transport, lab clean up. Meeting with hosts to plan scientific outputs

Day 12: Departure

**Requested funding:**

Return air travel from Amsterdam to Reykjavik (approx. €400)

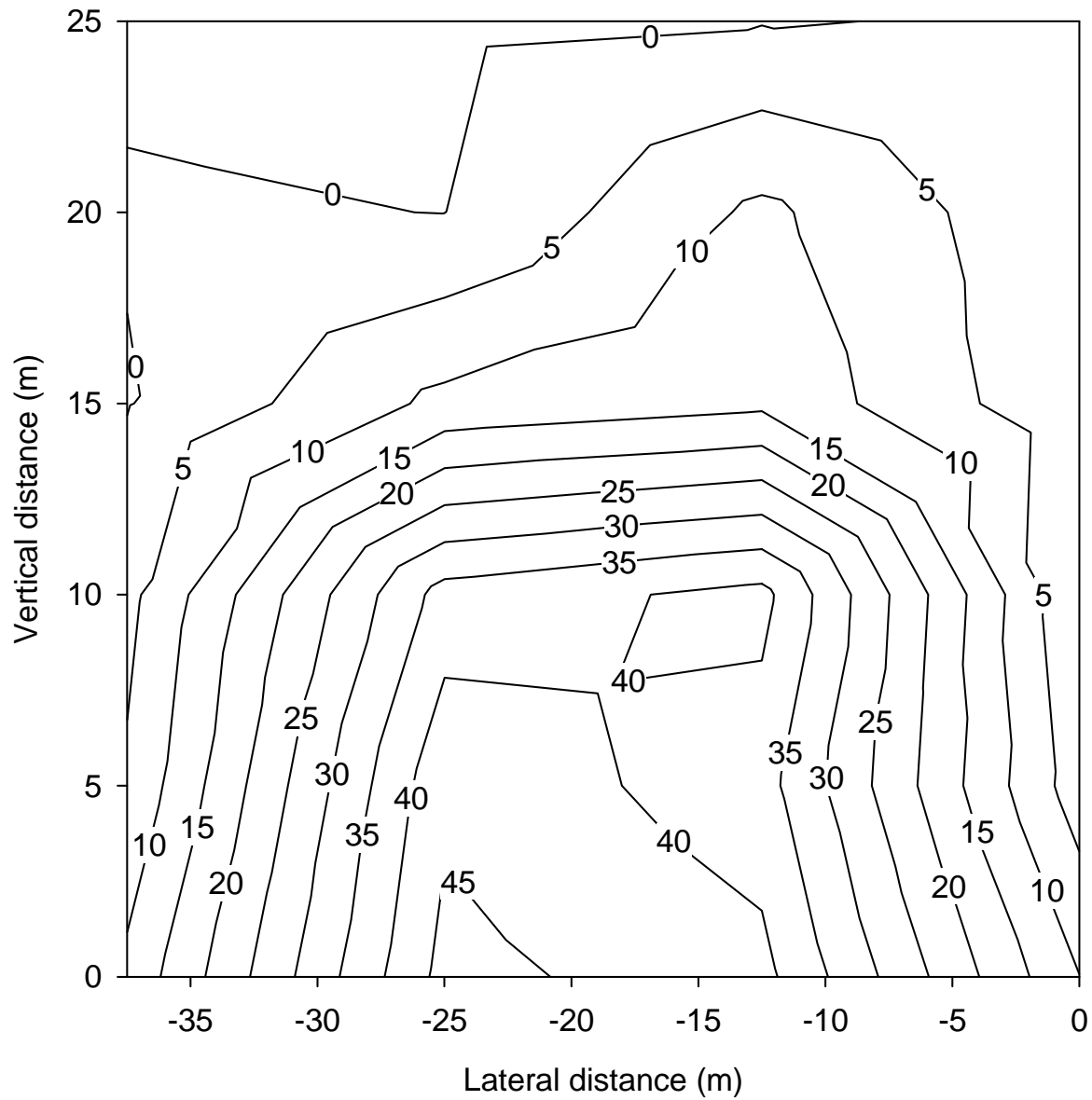
12 x €85 per diem (accommodation and meals) = €1020

Costs associated with lab materials and consumables will be covered by my PhD project.

**Reference**

Weedon J.T., Kowalchuk G.A., Aerts R., van Hal J., Van Logtestijn R.K.S.P., Tas N., Røling W. & Van Bodegom P. (in press). Seasonal climate manipulations in a sub-arctic peat bog accelerate nitrogen cycling without changing soil peptidase pools or microbial community structure. *Global Change Biol*, DOI: 10.1111/j.1365-2486.2011.02548.x.

Temperature elevation in 1000 m<sup>2</sup> in the Reykir Sitka spruce forest



Soil temperature elevation (°C) on 27th of September 2011 in a 1000 m<sup>2</sup> area within a 45 year old Sitka spruce stand at Reykir, S-Iceland. The trees found at higher T-elevation than ca. 35 °C have died.

## ACADEMIC CURRICULUM VITAE – James Taylor Weedon

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**Date of Birth:** 28<sup>th</sup> January 1981 (Adelaide, Australia)

**Research Interests:** Microbial ecology, soil-plant interactions, ecosystem ecology and biogeochemistry. Ecological statistics.

### Education:

2008 - current **PhD** *Vrije Universiteit, Amsterdam, The Netherlands*  
Institute of Ecological Science  
Supervisors: Peter van Bodegom, Rien Aerts, George Kowalchuk

2006 – 2008 **MSc.– Ecology** *Vrije Universiteit, Amsterdam, The Netherlands*

2004 **BSc.(Honours)** – Environmental Biology *University of Adelaide, Australia*

1999-2002 **BSc.-** majors in Botany and Environmental Biology  
**Dip. Lang.** (Italian)  
*University of Adelaide, Australia.*

### Peer-reviewed Publications:

**Weedon JT**, Kowalchuk GA, Aerts, R, van Hal J, van Logtestijn R, Röling W, Tas N, van Bodegom, P (in press) Summer warming accelerates sub-arctic peatland nitrogen cycling without changing enzyme pools or microbial community structure *Global Change Biology* DOI: 10.1111/j.1365-2486.2011.02548.x

Freschet GT, **Weedon JT**, Aerts R, van Hal JR, Cornelissen JHC (in press) Interspecific differences in wood decay rates and dynamics: insights from a new short-term method to study long-term wood decomposition *Journal of Ecology* DOI: 10.1111/j.1365-2745.2011.01896.x

**Weedon JT**, Aerts R, Kowalchuk GA, van Bodegom PM (2011) Enzymology under global change: organic nitrogen turnover in alpine and sub-arctic soils. *Biochemical Society Transactions*, 39, 309 - 314.

Cornwell, W.K., Cornelissen, J.H.C., Allison, S.D., Bauhus, J., Eggleton, P., Preston, C., Scarff, F., **Weedon, J.T.**, Wirth, C., Zanne, A. (2009) Plant traits and wood fates across the globe – rotted, burned or consumed? *Global Change Biology* **15**, 2431-2449

**Weedon, J.T.**, Cornwell, W.K., Cornelissen, J.H.C., Zanne, A., Wirth, C. and Coomes, D. (2009) Global meta-analysis of wood decomposition rates:

a role for trait variation among tree species? *Ecology Letters*, **12**, 45-56

**Weedon, J.T.** and J.M. Facelli (2008) Desert shrubs have negative or neutral effects on annuals at two levels of water availability in arid lands of South Australia. *Journal of Ecology*, **96**, 1230-1236

### **Academic Awards:**

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|-----------|---|
| 2006-2008 | Huygens Scholarship Program, International Scholar<br>(Netherlands Ministry of Science, Education and Culture)                                    |
| 2004      | John Bagot Medal (Best Honours project in Botany)<br>South Australian Conservation Biology Grant , Nature Conservation Society of South Australia |
| 1999-2001 | Adelaide Science Scholarship<br>(University of Adelaide undergraduate scholarship program)  |

### **Professional Presentations and Workshops:**

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|------|---|
| 2010 | Oral presentation. Enzymology and ecology of the nitrogen cycle, Birmingham, UK.  |
| 2008 | Invited participant in ARC-NZ Research Network for Vegetation Function. Working Group 35 “Global Wood Litter” – Macquarie University, Sydney, Australia |
| 2006 | Oral presentation. 27 <sup>th</sup> International Conference of the Society of Wetland Scientists, Cairns, Australia.                                   |
| 2004 | Oral presentation. Meeting of the Ecological Society of Australia. Adelaide, Australia  |

### **Scientific Service and Employment**

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|-------------|---|
| 2008 -      | Manuscript reviewer for <i>Functional Ecology</i> , <i>Geoderma</i> , <i>Arid Land Research and Management</i>  |
| 2005 - 2006 | Employed as Research Officer – Riparian and Wetland Plant Ecology. Inland Waters Program, South Australian Research and Development Institute – Aquatic Sciences Division |