



RSPB Cymru Additional Information to Sustainability Committee Inquiry into Land Management and Carbon Emission Reduction.

Summary

- Current understanding of the net Carbon budget from landscapes is relatively poor, even without taking into account changing land management or climate change. A key constraint in identifying the most appropriate management for Carbon is the lack of understanding of the production, cycling and fate of methane from peatlands.
- Without advances in this area and a better understanding of other losses of Carbon from the uplands as Dissolved Organic Carbon or Particulate Organic Carbon it may not be possible to properly assess the impact of changes in land management on Carbon budgets
- A range of research activities are currently underway at Lake Vyrnwy, the majority of these aim to further our understanding of the processes underlying greenhouse gasses fluxes and other forms of Carbon loss from the uplands. The impact of land management and climate change upon these process is a key component of the these research projects.
- Initial results from Lake Vyrnwy suggest that, in the short term, blocking drains, which results in a flush of methane emissions may not be counter-balanced by the reduction in carbon dioxide production that occurs. However, in the longer term maintenance of open drains may result in much greater Carbon loss through erosion and oxidation of peat. There is also likely to be an increased potential for peatlands to sequester Carbon from the atmosphere (and actively form peat) in areas where drains and other inappropriate management has been removed.
- Whilst we believe the evidence is lacking at present to identify the most appropriate management of the uplands purely with a focus on Carbon, we do believe that by managing the uplands as functioning ecosystems the potential for delivery of Carbon, biodiversity, water quality and other ecosystem goods and services would be maximised.
- We also believe that the knowledge, experience and expertise to manage for these wider gains currently exists. Resources for the delivery of these are currently insufficient. It would be helpful if the committee were to recommend in its final report that the Welsh Assembly Government should prioritise this issue and create a specific climate change budget to fund this type of work and help deliver the One Wales emission reduction target.

Upland Carbon Fluxes

The majority of work carried out on Carbon fluxes from the uplands have been over a small temporal or spatial scale or have looked at only a part of the complex set of processes involved in Carbon emissions or sequestration. This has resulted in a relatively poor understanding of the net Carbon budget from landscapes, even without the impacts of changing land management or climate change being taken into account. In particular, our poor understanding of the production, cycling and fate of methane from peatlands (the worlds' largest natural source of this potent greenhouse gas) is a key constraint in identifying the most appropriate management for Carbon. Alongside carbon dioxide and methane, it is also clear that without a better understanding of losses of carbon from the uplands as Dissolved Organic Carbon (DOC) or Particulate Organic Carbon (POC), it may not be possible to properly assess the impacts of changing land management upon Carbon budgets.

Whilst everyone agrees that the peat present in the uplands (80% of which is Carbon by dry weight) should be conserved, there is a relatively poor understanding of the variation in 'naturally' occurring greenhouse gas emissions. This may be at least partly due to the apparent presence of 'hotspots' across landscapes. Understanding the scale, distribution and importance of these hotspots is an essential first step in properly managing our uplands for Carbon.

A range of research activities are currently underway at Lake Vyrnwy under the umbrella of UKPopNet, a network of institutions funded by NERC (www.UKPopNet.org). At Lake Vyrnwy, the majority of these projects have relevance to our understanding of the processes underlying greenhouse gasses fluxes and other forms of Carbon loss from the uplands. The impact of land management and climate change upon these process is a key component of the these research projects.

The experimental design established at Lake Vyrnwy allows simultaneous comparisons between areas where management (ditch blocking) has been carried out with areas where such management has not been carried out. This allows the impact of land management to be separated from other larger scale changes such as climate change. The Lake Vyrnwy site provides one of the largest replicated experimental design sites in the world, a hugely valuable resource that has already attracted researchers from across the UK. One of the key outputs form the research being carried out at Lake Vyrnwy is the incorporation of the various components being studied into a model that will allow an assessment of the likely impacts of changes in land management (and future climate change) upon Carbon budgets. This model would be tested on other sites to ensure its validity, allowing its use across Wales and the rest of the UK. Additional information on this work is contained in Appendix 1.

Initial results from Lake Vyrnwy suggest that, in the short term, restoring water table levels by blocking moorland drains results in an increase of methane producing soil organisms, and that the resultant flush in methane emissions may not be counter-balanced by the reduction in carbon dioxide production that occurs. This has potential implications on our ability to effect a net reduction in greenhouse gas emissions through land management over the short term. However, in the longer term maintenance of open drains may result in much greater C loss through erosion and oxidation of peat. There is also likely to be an increased potential for peatlands to sequester Carbon from the atmosphere (and actively form peat) in areas where drains and other inappropriate management has been removed.

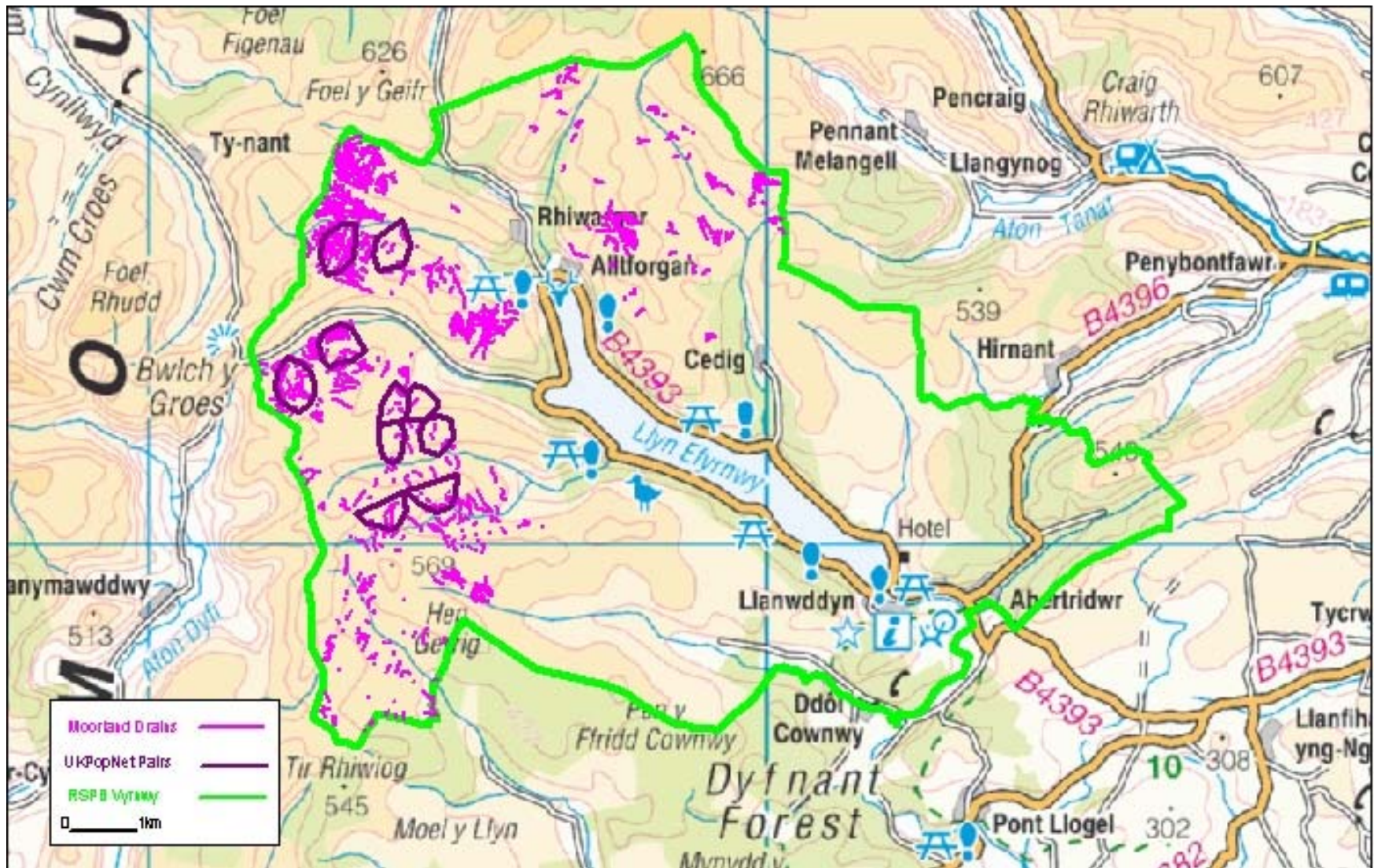
The summary of UKPopNet research activities at Lake Vyrnwy contained in Table 1 indicates that initial results from the majority of work would not be available until mid 2010 onwards. Publication of results and conclusions from this work is likely to take place in the 6-12 months following completion of the work. This should provide a much better understanding of the current state of Carbon budgets in the uplands of Wales and beyond, and the short to medium term impacts land management may have. However, we believe that longer term monitoring of the impacts of land management and climate change upon a range of ecosystem services including Carbon management is essential to fully understand the implications of such changes. As discussed above, the experimental design and baseline data available from Lake Vyrnwy make the site ideal for such longer term monitoring and the Welsh Assembly Government (WAG) should prioritise funds for this essential work to continue.

Whilst we believe the evidence is lacking at present to identify the most appropriate management of the uplands purely from a Carbon perspective, we do believe that by managing the uplands as functioning ecosystems the potential for delivery of Carbon, biodiversity, water quality and other ecosystem goods and services would be maximised. We also believe that the knowledge, experience and expertise to manage for these wider gains currently exists. Resources for the delivery of these are currently insufficient however, and increased funding should be a priority for WAG. RSPB Cymru suggest that WAG should create a specific climate change budget to help deliver the One Wales emission reduction target.

Table 1: Timetable of LIFE Active Blanket Bog in Wales Monitoring and UKPopNet Research at the RSPB Cymru Lake Vyrnwy Reserve

Activity	Principal Institut	Year																											
		2006				2007				2008				2009				2010				2011				2012			
		1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
<u>LIFE Blanket Bog Project</u>	RSPB	[Shaded bar from Q1 2006 to Q4 2011]																											
<u>UKPopNet Large Projects</u>																													
1) <i>Bug to Big</i>	<i>Aberdeen & York Uni's</i>	[Shaded bar from Q3 2007 to Q4 2009]																											
2) <i>Scaling</i>	<i>Aberdeen & York Uni's</i>	[Shaded bar from Q1 2008 to Q4 2009]																											
<u>UKPopNet Small Projects</u>																													
3) <i>Management Change</i>	<i>CPB</i>	[Shaded bar from Q3 2007 to Q4 2008]																											
4) <i>Hydrological Controls</i>	<i>Cranfield Uni</i>	[Shaded bar from Q1 2008 to Q4 2008]																											
5) <i>Soil Carbon</i>	<i>Aberdeen Uni</i>	[Shaded bar from Q1 2008 to Q4 2008]																											
6) <i>Breathing in?</i>	<i>York Uni</i>	[Shaded bar from Q3 2008 to Q4 2009]																											
7) <i>Microbial Methane</i>	<i>York Uni</i>	[Shaded bar from Q3 2008 to Q4 2009]																											
8) <i>Airbourne data gathering</i>	<i>Edinburgh Uni</i>	[Shaded bar from Q3 2008 to Q4 2009]																											
9) <i>Remote Sensing</i>	<i>Aberystwyth Uni</i>	[Shaded bar from Q3 2008 to Q4 2009]																											
10) <i>Ebolition</i>	<i>St Andrews Uni</i>	[Shaded bar from Q3 2009 to Q4 2010]																											
<u>UKPopNet PhD Studentships</u>																													
11) <i>Microclimate</i>	<i>York Uni</i>	[Shaded bar from Q1 2007 to Q4 2009]																											
12) <i>Vegetation modelling</i>	<i>UCL</i>	[Shaded bar from Q1 2008 to Q4 2010]																											
13) <i>Gas Fluxes</i>	<i>York Uni</i>	[Shaded bar from Q1 2008 to Q4 2010]																											
14) <i>Soil Processes</i>	<i>Aberdeen Uni</i>	[Shaded bar from Q1 2007 to Q4 2009]																											

Figure 1: The RSPB Reserve at Lake Vyrnwy with moorland drains and UKPopNet Treatment-Control Catchments Pairs



Appendix 1: UKPopNet Activities at Lake Vyrnwy

2008 was the second major field season for UKPopNet's two main projects and two original studentships (Pippa Gillingham and Sarah Richardson) taking place at RSPB's Lake Vyrnwy reserve. Two more PhD students (Natasha MacBean and James Stockdale) jointly funded by NERC Centre for Terrestrial Carbon Dynamics began their studies in October '07. These projects bring in remote sensing expertise and will contribute invaluable insight into our ability to scale-up. In Spring '08 a further six small projects were granted funding for research at Lake Vyrnwy. Representatives of most of these projects attended a knowledge exchange event with RSPB on the 3rd October 2008 and presented their initial findings.

Details on the progress of each individual project is given below.

Weather Stations

Three automatic weather stations were put in place across the RSPB reserve at Lake Vyrnwy during May 2008, one in the Eunant Fawr, one at Creigiau'r Llyn (at the top of the Hafod track) and one at Cefn Glas. A fourth weather station was setup just beyond the river crossing on route to Cefn Glas in December '08. All were sited after consultation with RSPB staff and are continuously monitoring air temperature, humidity, wind direction & speed, radiation and rainfall. Soil temperature, Photosynthetically Active Radiation (PAR) and water table depth are also being monitored at these locations. The data from these are a valuable asset to all research being conducted at Lake Vyrnwy.

Major Projects

1) Linking microbial biodiversity and trace gas fluxes at the landscape scale: the Bug-to-Big Project
Jim Prosser, Ken Killham, Thomas Freitag (all Aberdeen) & Phil Ineson (York)
Project duration: August '07 to end September '09

This project aims to (i) determine the influence of changes in management on the abundance, diversity and activities of populations of soil organisms and (ii) quantify trace gas fluxes at the site and scale-up measurements to the landscape scale.

Extensive gas flux sampling took place during July and August trying out various techniques of measuring gas flux at different scales. This complements data gathered in August and November '07. Analysis of results is underway and will guide microbial analysis of soil samples during '09.

2) Scaling in interdisciplinary upland research: from plots to catchments to regions
Justin Travis, Steve Redpath, Steve Palmer (all Aberdeen) & Jon Pitchford (York)
Project duration: April '07 to end March '09

This study aims to test the ability to scale up and make interdisciplinary predictions for an upland ecosystem. It will test the accuracy of catchment scale predictions and determine which (if any) processes can be successfully up-scaled from plot size experiments and inform the debate on the appropriate scale for manipulation experiments.

An international working group associated with this project will meet twice during the coming six month period to refine approaches used to scale up data.

Small Projects

3) Can small scale controlled experiments predict the impacts of landscape scale management changes?

Martin Lukac (CPB) et al.

Project duration February '08 to end March '09

The initial phase of this project is now coming to an end. Large and small mesocosms were taken from an agreed area in the Afon Eiddew in March '08 with the assistance of Al Evans. These were taken to the Ecotron controlled environment facility at the Centre for Population Biology in Ascot. The mesocosms have been subjected to either a high or low water table treatment with monthly samples of gas flux and soil water measured. Light reflectance has also been measured.

Results obtained to date have been encouraging. The project team have secured a six-month extension to explore the impacts of water table change in greater detail. This next phase will monitor CH₄ and CO₂ fluxes and their underlying processes in detail at two scales of mesocosms during a cycle of wet (raising the water table) and dry (lowering the water table) conditions.

4) Hydrological controls on site- to landscape-scale ecosystems in upland environments

Nicholas Howden (Cranfield) et al.

Project duration: July '08 to end March '09

This project aims to produce the initial stages of a hydrological model for the experiment at the RSPB Lake Vyrnwy reserve. This will provide an understanding of induced and observed water table fluctuations such that potential responses of upland hydrological systems to future climate change and alternative management regimes can be identified.

The project began in June '08. Thus far the basics of the model along with the relevant data to support it have been assembled and put together. Some preliminary hydrological modelling of the lake water balance has also been carried out.

5) How does hydrologically induced environmental change mobilise soil carbon? Use of lead isotopes as a marker for organic soil matter mobilisation

Doerthe Tetzlaff (Aberdeen) et al.

Project duration: July '08 to end March '09.

This project aims to validate the use of naturally occurring lead isotopes as organic matter (OM) tracers through soil and soil pore-waters to surface waters.

Surface water and soil pore water samples were taken on three separate occasions from the Eunant Fawr catchment in July, August and September '08 (to provide hydrological contrasts) from the vicinity of moorland drains that have been blocked as part of habitat restoration activities and a comparable 'control' area where drains have remained un-blocked. In September '08, a soil core was taken to ascertain the lead isotopic ratio in the soil profile which provides a tool to ascertain the provenance of soil OM in fluvial exports. Analysis is underway.

6) Uplands breathing in or out? Linking land management, hydrology and carbon footprints

Andreas Heinemeyer (York) et al.

Project duration: July '08 to end September '09

The aim of this proposal is to complement small scale research on net flux of CH₄ in response to land drainage and the blocking of peatland drains at Lake Vyrnwy by enabling continuous and non-intrusive measurements of net C-fluxes for both CO₂ and CH₄ at a larger scale (ha) using a combined state-of-the-art Eddy-TDL flux apparatus method at the same site. The flux measuring apparatus are due to be installed early in '09.

7) Direct measurement of microbial methane oxidation in peat soils in relation to vegetation cover

Jens Subke (York) et al.

Project duration: July '08 to end March '09

Work currently carried out by UKPopNet at Lake Vyrnwy indicates that certain vegetation types appear to be consistently net sources of methane (dominance of methanogenesis), whilst others are actually sites of net methane uptake (methanotrophy). The aim of this project is to compliment other UKPopNet research which will measure net methane flux by separating out the dominant component fluxes. This will be achieved by measuring directly the level of methane uptake across vegetation types at Lake Vyrnwy using stable isotopes.

Specialised chambers used to measure the net methane flux were constructed and fortnightly sampling began in August '08 and is ongoing. Gas samples are in the process of being analysed.

8) Trialling airborne data gathering approaches at Lake Vyrnwy

John Moncrieff & Tom Wade (both Edinburgh)

Project duration: April '08 to end March '09

Some high-resolution digital photography was taken using Edinburgh ECO-Dimona aircraft during an initial campaign in spring '08. Unfortunately technical problems meant that carbon flux at the landscape scale could not be measured. However it is hoped that further flights can be scheduled during spring '09.

9) Airborne measurements and remote sensing for validation and up-scaling models of ecological processes from experimental sites to geographic regions

Richard Lucas, Peter Dennis, Jamie Newbold (Aberystwyth), John Healey, Professor Davey Jones, (Bangor), Chris Thomas (Aberystwyth), Tim Hill, Caroline Nichol, Tom Wade (Edinburgh), Mathias Disney, Natasha Macbean (UCL).

Project duration: Oct '08 to end March '09

10) Biophysical drivers of methane ebullition in northern peatlands

Y.A. Teh (St Andrews), A.J. Baird (Leeds), E.R.C. Hornibrook (Bristol), P. Ineson K. Redeker (York), and J.-A. Subke (York)

Project duration: January '09 to end Septmeber '10

Studentships

11) The relative importance of microclimate and land use to biodiversity

Pippa Gillingham (York)

Project duration: October '06 to end September '09 (expected).

This PhD aims to assess the relative importance of climate versus management on biodiversity.

Summer fieldwork which involved collecting invertebrate samples from pitfall traps and downloading soil and vegetation height temperature data from across the RSPB reserve and other upland sites in England and Scotland were completed in late August '08. Invertebrate sorting, identification and analysis of environmental data are now being carried out.

12) Monitoring and modelling vegetations response under catchment-scale treatment regimes using Earth Observation data

Natasha MacBean (UCL)

Project duration: October '07 to end-September '10 (TBC).

This project uses Earth Observation data (both airborne and spaceborne) to monitor changes in vegetation that occurs as a result of management interventions

Four normalised difference vegetation index (NDVI) sensors were installed in the control (unblocked) area and one in treatment (blocked) area of both the Eiddew Fawr and Eunant Fawr in late June '08. These give a measure of vegetation amount and condition throughout the year and will help put satellite or aerial imagery into context. Week long repeat surveys of spectral measurements, leaf area index and vegetations cover were conducted from May to September '08.

13) Scaling up trace gas fluxes – case study in the UK uplands

James Stockdale (York)

Project duration: October '07 to end September '10 (TBC).

The aim of this PhD is to develop methodologies that can be applied to large scale flux studies to quantify the annual net flux of CO₂ and CH₄.

Several carbon flux sampling occasions in different vegetation types in close proximity to the three weather stations have been taking place since May '08. Analysis of gas samples is underway while high throughput field sampling technique is being perfected.

14) Does vegetation drive soil processes involved in global warming?

Sarah Richardson (Aberdeen)

Project duration: October '06 to end September '09 (TBC).

This studentship will examine the impact of water table and vegetation cover in upland ecosystems on methane oxidation rates and nitrous oxide (N₂O) emissions, and in turn the contributions of the microbial processes responsible for N₂O production.

During September '08, 48 ~20cm diameter cores were extracted from the agreed area in the Eiddew catchment to supplement those taken during '07. This will improve understanding of whether small (several cms) changes in the water table drive the observed rates of methane oxidation and identify strata where oxidation is occurring.