Care-Peat restoration of degraded peat in NW England

Interreg North-West Europe Care-Peat
European Regional Development Fund
EUROPEAN UNION

EU funding: €4.22 m | Total budget €7.03 m | Timeline: 2019-2023

https://www.nweurope.eu/projects/project-search/care-peat-carbon-loss-reduction-from-peatlands-an-integrated-approach/

Anna Keightley, Simon Caporn, Chris Field: Manchester Metropolitan University
Mike Longden, Sarah Johnson, Jo Kennedy: Lancashire Wildlife Trust

Introduction

The Care-Peat Project aims to restore the carbon storage capacity of peatlands, using a range of innovative techniques in diverse scenarios, across five countries in NW Europe (Belgium, France, Ireland, Netherlands, UK). The two UK pilot sites in NW England (Figure 1) use techniques based on established restoration practices of re-wetting and re-vegetating, incorporating conversion from agriculture.

Figure 1: Location of UK pilots.

Methods

Pilot 1: Little Woolden Moss, Greater Manchester

Little Woolden Moss is a 107-ha site owned by Lancashire Wildlife Trust since 2012. Industrial peat harvesting ceased in two phases, in 2012 and 2017. The 2-ha pilot is within the 2nd phase area, enclosed with bunding (Figure 2).

Clusters of *Eriophorum* species (3 *E. angustifolium* to 1 *E. vaginatum*, supplied by BeadaMoss®) were planted 1-2 m apart in March 2020 and 3 BeadaHumok® *Sphagnum* plugs (BeadaMoss® 5-species mix) introduced into each cluster 6 months later. This arrangement was termed 'companion planting'. Carbon Greenhouse Gas (CGHG) monitoring collars were inserted in wetter and drier areas, 6 in each of vegetated (restoration) and bare (control) areas. Collars were monitored for 12 months until vegetation became too dense (due to *E. vaginatum* expansion) to be representative of the pilot. Collars were then relocated to adjacent natural stands of *E. angustifolium* and monitoring resumed after a 6-month gap.

Figure 2: Little Woolden Moss companion planting GHG monitoring area, May 2020 and July 2021, 2 months and 16 months after planting, respectively.

Pilot 2: Winmarleigh Moss, Lancashire

Lancashire Wildlife Trust own Winmarleigh Moss SSSI and purchased adjacent areas of degraded bog and grazed pasture, where the 4-ha pilot (Figure 3) is situated, in 2019. The top 10 cm surface was stripped to remove plant material, nutrients and the invasive seed bank. The area was bunded into cells, and a series of main and sub-ditches connected to a rainwater collection sump provided irrigation that was automatically pumped, controlled and solar-powered. Cells were mainly planted with 150,000 BeadaHumok® *Sphagnum* plugs (BeadaMoss® 5-species mix) at 20 cm spacing in September 2020 (Figure 4). CGHG monitoring collars were inserted in areas with a likely range of moisture levels: 6 in the carbon farm (restoration) and 6 on an adjoining drained, grazed pasture (control).

Figure 3: Winmarleigh Carbon farm immediately after *Sphagnum* plug planting (September 2020). Image: M. Longden.

Figure 4: Examples of *Sphagnum* plugs within a CGHG monitoring collar in September 2020 (at planting) and August 2022 (light straw cover applied post-planting to protect plugs during establishment).

Carbon Greenhouse Gas (CGHG) flux monitoring and modelling

CGHGs were measured monthly using a Los Gatos Ultraportable Analyser (Figure 5), using readings in the dark, semi-light and full light to obtain Ecosystem Respiration (RECO), methane flux (FCH_4) and Net Ecosystem Exchange (NEE) in a range of light conditions, from which Gross Primary Productivity (GPP) could be calculated (NEE = RECO + GPP). FCH_4 was converted to CO_2 equivalents using GWP_{100} = 28. Peat temperature, photosynthetically active radiation (PAR), water table depth (via dipwells) and CGHGs were measured concurrently at each monitoring collar. Water table depth was also logged every 15 minutes in one dipwell in each restoration and control area. A meteorological station at each site measured air and peat temperatures, rainfall, and PAR on a 15-minute basis. Thereby, measured CGHG fluxes and environmental variables were modelled and the annual CGHG budget calculated.

Note: CGHG uptake by the ecosystem is expressed as a negative value, and emission as a positive value.

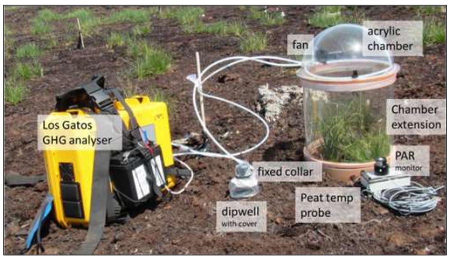

Figure 5: Typical Greenhouse Gas monitoring set-up, here shown on the Little Woolden Moss pilot.

Results

Little Woolden Moss pilot

Eriophorum species (particularly *E. angustifolium*) rapidly covered the bare peat (approx. 50% of the area planted after 18 months), which promoted a higher GPP (Figure 6) than RECO in the first 12 months ('establishment' phase) as plants grew vigorously. Unfortunately, the *Sphagnum* was disturbed by crows immediately after planting, and there was widespread failure to thrive. CO_2 emissions were low but continuous from bare peat throughout the year. Mean measured CH_4 fluxes as CO_2 equivalents (using GWP_{100} = 28) were small compared to RECO values in vegetated plots: 0.16 ± 0.16 $gCO_2e\ m^{-2}\ h^{-1}$ and negligible in bare plots: $3.2^{-4} \pm 8.4^{-4}$ $gCO_2e\ m^{-2}\ h^{-1}$. The CO_2 budget (modelled data) for the establishment year was:

Vegetated: -33.25 $tCO_2e\ ha^{-1}\ yr^{-1}$ (i.e. large CO_2 uptake)

Bare peat: 4.25 $tCO_2e\ ha^{-1}\ yr^{-1}$ (i.e. CO_2 emission)

Mature stands of *E. angustifolium* (post-flowering) have a lower volume of plant material than in the establishment period, and there was early senescence of material during the 2022 summer drought. CGHG flux is variable, with a far lower GPP, likely to significantly reduce CO_2 uptake compared to the establishment year. Monitoring will continue for a further 3 months before modelling a CO_2 budget for the 2nd year.

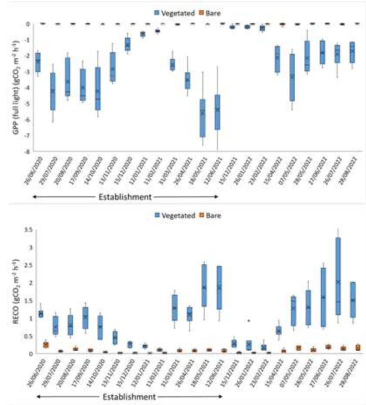

Figure 6: Measured Gross Primary Productivity (GPP) (in full light) and Ecosystem Respiration (RECO) fluxes on LWM pilot; *n* = 6. Establishment year from late June 2020 to early June 2021.

Winmarleigh Moss pilot

Creation of the 'carbon farm' through conversion from drained, grazed pasture to re-wetted peat with *Sphagnum* resulted in significantly higher water table depth (Figure 7) and an immediate annual reduction in CGHG emissions (86%) compared to the adjacent existing pasture. Although GPP (Figure 8) is high on the pasture, RECO is also high resulting in large emissions in low/zero light. Fluxes were very low throughout on the carbon farm. Mean measured CH_4 fluxes were very small and highly variable (i.e., negligible) overall: grazed pasture: $-4.1^{-4} \pm 1.4^{-3}$, carbon farm $7.9^{-6} \pm 2.1^{-4}$ $gCO_2e\ m^{-2}\ h^{-1}$.

However, very dry periods in spring and summer and occasional technical issues with the irrigation system reduced optimum moisture levels and slowed the potential *Sphagnum* growth rate (Figure 9). The CO_2 budget (modelled data) for the establishment year was:

Grazed pasture: 24.4 $tCO_2e\ ha^{-1}\ yr^{-1}$ (i.e. large CO_2 emission)

Carbon farm: 3.4 $tCO_2e\ ha^{-1}\ yr^{-1}$ (i.e. small CO_2 emission)

The 2022 summer drought has not been as intense in this area as elsewhere in the UK and, coupled with a lower grazing intensity, fluxes on the pasture have been less variable in the 2nd than the 1st year. The sump area on the carbon farm has been enlarged, providing a more reliable water supply which has promoted an improved increase in *Sphagnum* cover in the 2nd year (Figure 9). Monitoring will continue for a further 3 months before modelling a CO_2 budget for the 2nd year, when lower emissions on both restoration and control areas are expected. An overall small CO_2 uptake is expected once a full cover of *Sphagnum* has established.

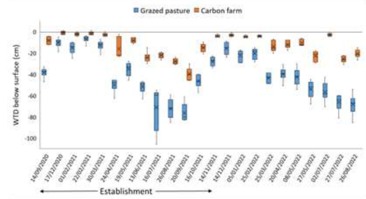

Figure 7: Water table depth (cm) below the surface during GHG measurements on the Winmarleigh site ; *n* = 6.

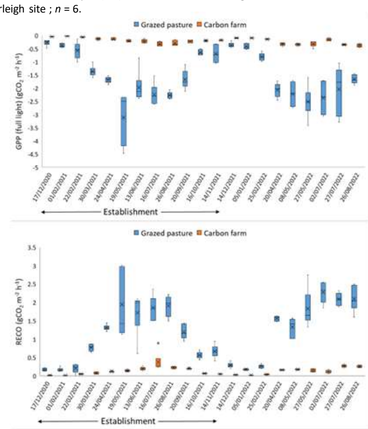

Figure 8: Measured Gross Primary Productivity (GPP) (in full light) and Ecosystem Respiration (RECO) fluxes on Winmarleigh pilot; *n* = 6. Establishment year from December 2020 to November 2021.

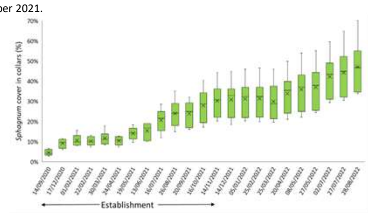

Figure 9: *Sphagnum* growth (% cover) in GHG monitoring collars, Winmarleigh site; *n* = 6

Conclusions

Conversion of drained, cutover peatland (Little Woolden Moss) and drained, grazed pasture (Winmarleigh carbon farm) to re-wetted bog has reduced emissions hugely and rapidly in the 1st year. Re-vegetation on the cutover site, even on shallow, poor-quality peat, was achieved quickly, but reliable CGHG benefits are not likely without consistently higher water table levels and *Sphagnum* establishment, although biodiversity gain will be rapid. Growing-season drought conditions over the project period hampered progress on both sites, and highlight the urgent need for improving resilience to climate change in peatland restoration projects.