Demonstration Project Case Study

Project title: Trialling methods for rapid establishment of Sphagnum moss to restore an area of degraded bog at Cors Fochno

Description

Wide scale drainage of peatland habitats for agricultural and forestry activities has damaged and led to the deterioration of a significant proportion of UK peatlands. Peatlands on the Natural Resources Wales (NRW) estate are currently estimated to be a net source of greenhouse gas emissions (Williamson *et al*., 2016). Within the Cors Fochno SSSI and NNR is an area of degraded bog subjected to past drainage for agricultural use, including a season of potato growing and subsequent conversion to grazed grassland. This area of improved / semi-improved grassland was identified as a candidate site for restoration for reasons including that surrounding field margin ditches have been blocked, that the site has shallow surface gradients to aid surface water logging and that its restoration may also improve the condition of an adjacent re-wetted area. The project sought to promote rapid colonisation and growth of Sphagnum bog moss carpets on bare peat once stripped of turf, aiming to restore the degraded bog, reducing carbon dioxide emissions and improving habitat quality. Three different bog moss establishment techniques were trialled, with their successes in terms of rapidity and extent of colonisation to be monitored over time, with the objective of informing future restoration and sustainable Sphagnum harvesting projects at Cors Fochno and elsewhere.

Method

The project was designed to investigate the pros and cons of a number of treatment methods for establishing bog moss, whilst restoring areas of the former bog subjected to drainage reclamation. The first step of the project was to create trail plots for different treatments, as follows:

- The project area was grazed, mown and the cuttings removed.
- A total of 16 individual plots measuring 20m x 8m were laid out on a grid, aligned with their long axes parallel to the contour.
- A baseline survey of the plots was conducted measuring key variables including water table levels and vegetation composition.
- A tracked excavator (7 ton Hymac) removed the turf and scraped off the near-surface degraded peat of all trial plot areas to a depth of c.10cm.
- Plots were levelled to the horizontal where possible, and uncut strips of at least 2m were left between plots.
- Given the significant possibility of undesirable re-growth of deep rooted competitive higher plants, notably *Juncus effusus*, the upper 0.5-0.75m of the peat profile was overturned in half of the plots to assess efficacy of preventing re-growth.
- The turf and peat excavated from the plots were loaded into a tracked dumper machine and used to infill areas of deep former drains close to the work areas where possible.

0.32 ha of peatland replanted with the aim of restoring >0.42 ha of degraded bog

Emissions avoided through restoration: 2.2 tCO_2e /year

Existing carbon stocks protected

Total project cost: £25,292

Techniques for rapid Sphagnum establishment trialled including novel BeadaGel inoculation

Staff involved:
NRW reserve staff and manager
NRW peatland specialists
NRW staff volunteers from Bangor and Aberystwyth offices to help with planting

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- Three small drainage channels (c. 20cm wide) were excavated parallel to the long axes of the plots and linked into the plots with additional short channels, to drain excess surface water.
- All plots were thoroughly wetted before planting.

After plot preparation, three different propagation or planting techniques for moss establishment were applied. The principal technique, applied to 12 of the plots, was inoculation with BeadaGel (laboratory produced micropropagated Sphagnum plants mixed prior to spreading with a gel to aid dispersion and contact with substrate). This method of establishing Sphagnum propagules has the advantages of: avoiding donor site impact/damage; excellent control of species composition; no transfer of alien biota or weed species; and proven rapid productivity results. Within the 12 BeadaGel plots, the influence of a number of variables likely to impact establishment and growth were also explored, including month of application (March vs. May), rate of application (0.5 litres per square metre (l/m^2) vs. 0.33 l/m^2), and application of a straw mulch to avoid desiccation vs. no straw mulch. The species composition of the BeadaGel was: *Sphagnum palustre* 50%; *S. papillosum* 20%; *S. capillifolium* 20%; *S. fallax*, *S. cuspidatum* & S. subnitens 10% (c.3.3% each).

This range of BeadaGel treatments will be compared with the two others establishment techniques applied to the remaining 4 plots. These were i) sowing of Sphagnum plant plugs i.e. 'BeadaHumok' grown under controlled conditions, and ii) sowing with Sphagnum plants collected and transplanted from an adjacent area of bog on Cors Fochno. Plugs were planted at densities of 9 per m^2 and 16 per m^2. The species composition of BeadaHumok plugs was as the BeadGel, whilst the transplanted material consisted primarily of S. *palustre* with smaller proportions of S. *subnitens*, S. *papillosum* and S. *fallax*. All plots were mulched with straw after plug planting.

Outcomes

The project will restore 3200 m^2 of degraded raised bog within trial plots, and a potentially larger, adjacent re-wetted area, in addition to c.1000 m^2 of infilled ditch.

Similar peat scrapes excavated elsewhere at Cors Fochno in 1996 and 2008 (to lower the ground surface towards the water table) have achieved complete and moderate Sphagnum cover, even without Sphagnum introduction. It is expected that the spontaneous Sphagnum colonisation seen in the old plots will be greatly speeded up by the planned site preparation, introduction of propagules and treatments in the new plots. The enhanced control of surface water-logging is expected to be a crucial factor. Thus, it is expected that following trial treatments the best plots will achieve a 50%+ Sphagnum cover within 2 years. The project's main targets for establishment are:

- End of planting year: Water level in plots established and maintained at -15cm to +2cm.
- End of first growing season: Sphagnum propagules established in all plots.
- End of second growing season: Sphagnum cover of >20% in all plots, and cover of >40% in at least 50% of plots.

The project will, through trialling the treatments outlined, provide information on achieving more rapid establishment and luxuriant growth of Sphagnum on bare peat. This will be of value to those involved in bog restoration and in Sphagnum production for the marketplace. The project may itself potentially supply a marketable source of Sphagnum moss and plant propagules for other bog restoration or Sphagnum farming projects.

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The restoration will ultimately convert an area of greenhouse gas emitting degraded bog grassland to active bog, sequestering carbon. The turf and peat removed from the plots, will be protected from carbon release by being placed in water or below the water table. In this way areas of open deep ditch (and likely high emissions sources) will be converted into new substrates for mire vegetation growth and carbon uptake. It is estimated that restoring 0.42 ha of grass dominated modified bog to near natural bog will reduce greenhouse gas emissions by an estimated 2.2 tCO_2e / year[1].

[1]Estimates are annualised savings over 40 years, assuming that habitats would be in a restored condition for 10 years post restoration and a near natural condition for the next 30 years. Based on emission factors from Williamson *et al.* (2016) and calculations and assumptions in the Carbon Positive Project technical report "Evaluating NRW's Mitigation Options" (NRW, 2018).

Wider benefits

- The project will support the nature conservation values of the site, returning it to favourable condition. The new re-wetted habitat created at both the excavation and ditch infill sites will be beneficial to a range of bog and wetland specialist species, potentially including notable species e.g. *Rhyncospora fusca*, *Sphagnum pulchrum* and *Ceriagrion tenellum*.
- Results may inform the development of future Sphagnum farming projects. Trials such as those of Gaudig *et al*. (2014) have shown that Sphagnum farming could provide a "*sustainable high-quality alternative to fossil white peat as a raw material for horticultural growing media*".
- Restoration will enhance the resilience of the bog to climate change, including resilience to sea level rise through renewed peat growth.

Challenges and learning

- The precision with which the plots were excavated did not match up to the machine operators' assurances and in hindsight, the perimeter of each plot should have been accurately marked on the ground.
- Using the 7 ton Hymac to create the plots, the contractor was unable to achieve the desirable degree of surface levelling that may have been possible with more specialised turf cutting machinery. The levelling appeared to be hindered by the uneven, fibrous root mat underlying the surface. Scraped plots were therefore left with gently undulating and quite compact, smooth or slickened surfaces.
- The overturned plots by contrast appeared to be more level but more textured with minor surface irregularity and less compact or smooth. The action of overturning the upper peat profile increased rainfall infiltration markedly, such that rainwater which ponded on the surface of the scraped plots did not do so in the overturned plots.
- Conditions during plot excavation were wet and consequently quite difficult. Moving and relocating the excavated material required limiting the tracked dumper truck movements to avoid churning the field. This resulted in much of the material not being tipped where it could remain waterlogged below ditch level. Some subsequent relocation and relevelling of excavated peat was therefore necessary.
- As with plot construction, accurate cutting of the drains was hampered by the clumps of dense, fibrous roots alternating with softer peat. The drains, although performing an important function ideally needed to the engineered more precisely to work efficiently.
- It is likely that weather conditions after planting were an important factor in establishment success, and impact may have differed with establishment method, for example: torrential rain shortly after application caused surface inundation and re-distribution of straw in scraped plots, and may have washed a BedaGel surface film into low areas.

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Evidence & information

Gaudig, G., Fengler, F., Krebs, M., Prager, A., Schulz, J., Wichmann, S. & Joosten, H. (2014) Sphagnum farming in Germany – a review of progress. Mires and Peat 13: Art. 8. http://www.mires-and-peat.net/pages/volumes/map13/map1308.php

Natural Resources Wales (2018) Evaluating NRW's Mitigation Options. Technical Report. https://naturalresources.wales/about-us/corporate-information/carbon-positive-project/sharing-our-approach/?lang=en

Wichmann, S., Gaudig, G., Krebs, M., Joosten, H., Albrecht, K., Kumar, S. (2015) Sphagnum farming for replacing peat in horticultural substrates. Food and Agriculture Organization of the United Nations. www.fao.org/3/a-i4417e.pdf

Williamson, J.; Burden, A.; Evans, C. (2016) Condition based Estimate of Greenhouse Gas Emissions and Carbon Sequestration for NRW Peatland Habitats. CEH reference NEC05964, Centre for Ecology and Hydrology: Bangor.

Photographs of the project plots at Cors Fochno

Plot and drainage channel excavation:

Sphagnum planting and spraying: