Tackling Monitoring at the National Scale

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Introduction

The Peatland ACTION Monitoring Strategy was first developed in 2019 to assess the effectiveness of the work to restore Scotland's degraded peatlands. A reframed partnership version will be published shortly highlighting six priorities to ensure policy commitments are met and effective restoration is delivered. By recording indicators that measure both the general progress of peatland restoration and the effectiveness of specific techniques, the outputs can be used to inform future best practice.

Peatland ACTION has set more than 51,000 ha of peatland on the road to recovery since 2013 (meaning in total 71,000ha have been restored across Scotland when other restoration activity is included). Over 450 projects cover the length and breadth of Scotland, employing a wide variety of techniques from traditional drain blocking to novel bare peat stabilisation and forest to bog approaches.

Our Restoration Monitoring Network (RMN) and interferometric synthetic aperture radar (InSAR) bog breathing projects are at the forefront of our monitoring work.

Restoration Monitoring Network overview

The RMN was launched in 2023 and is an ongoing data collection system aiming to establish if restoration works are resulting in conditions favourable to the recovery of a functioning peatland habitat. It's an approach to applying standardised, repeatable, long-term monitoring across a representative sample of PA sites. The RMN will build to include about 40 sites covering different types of degraded peatlands from each of the following four categories:

a) Actively eroding blanket bog
b) Drained blanket bog
c) Drained raised bog
d) Forestry on bog

Figure 1. Map showing the 11 RMN sites, August 2024

RMN surveys are completed at several stages including pre-restoration, then at 1, 5 and 10 year post restoration intervals. The results will aid our understanding of timescales for change and the effectiveness of the combined restoration toolkit used in peatland recovery.

Twenty points are sampled within each site, including vegetation surveys, fixed point photography, area-based assessment and feature status assessments. The survey locations are aligned to the main degradation features (such as artificial drains, peat gullies, hags, bare peat and forestry blocks) and are randomly generated to remove bias.

For peat hags (Figure 2), the feature status assessment focuses on an area along the hag face and collects yes/no answers on the signs of active erosion and trampling damage, alongside estimates of the hag face angle. Data collected from the feature status assessments can then be used to produce descriptive statistics which complements the main statistical analysis of the vegetation survey quadrat data.

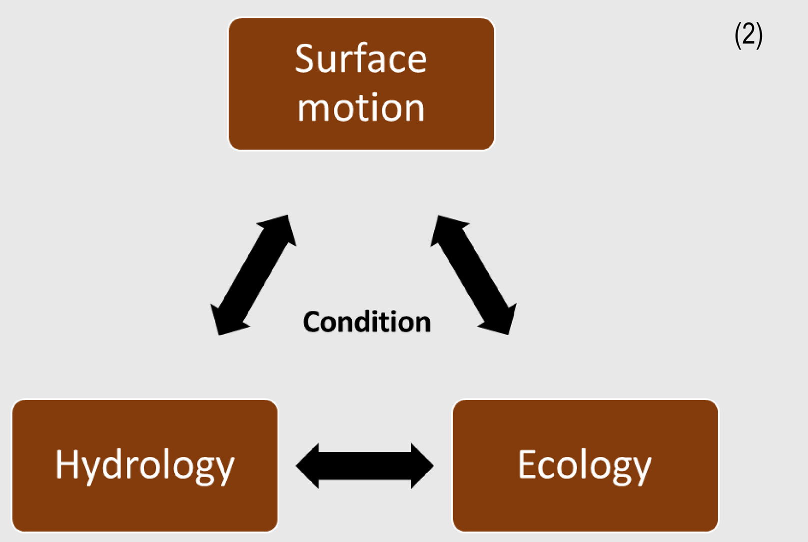
Figure 2. Photograph of a 1 by 4m quadrat used for vegetation surveys on a hag face. Vegetation cover of all plant species and bare peat is estimated within the quadrat.

The network is still in the early stages, focusing on pre-restoration surveys and some 1 year post restoration surveys. The RMN aims to be cost-effective, repeatable, long-term and open access – making the data publicly available and communicating outcomes following the 1, 5 and 10 year post restoration analyses.

Bog breathing overview

In recent times the use of InSAR radar remote sensing to monitor land surface motion has progressed to a point where peatland surface motion can now be monitored precisely from satellites. Given that the satellites provide global coverage of radar data irrespective of cloud cover, and revisit each area between 6 and 12 days, there is now scope for monitoring surface motion and hence peat condition at landscape to national scales.

The phenomenon of "bog breathing" was first described by Weber in 1902 [(1)] and relates to the surface motion of a peatland surface in response to changes in the water and gas content of a peat body.



The extent to which a peat body oscillates is also related to the condition of the peatland, with degraded peats showing little sign of seasonal cycles in the surface motion, whereas wetter, good condition peats show greater motion with a clear seasonal pattern.

Progressing InSAR analyses

Peatland ACTION has been working in partnership with the University of Nottingham, University of Highlands and Islands, and Forestry and Land Scotland to develop methods which maximise the use of InSAR in relation to understanding our peatlands.

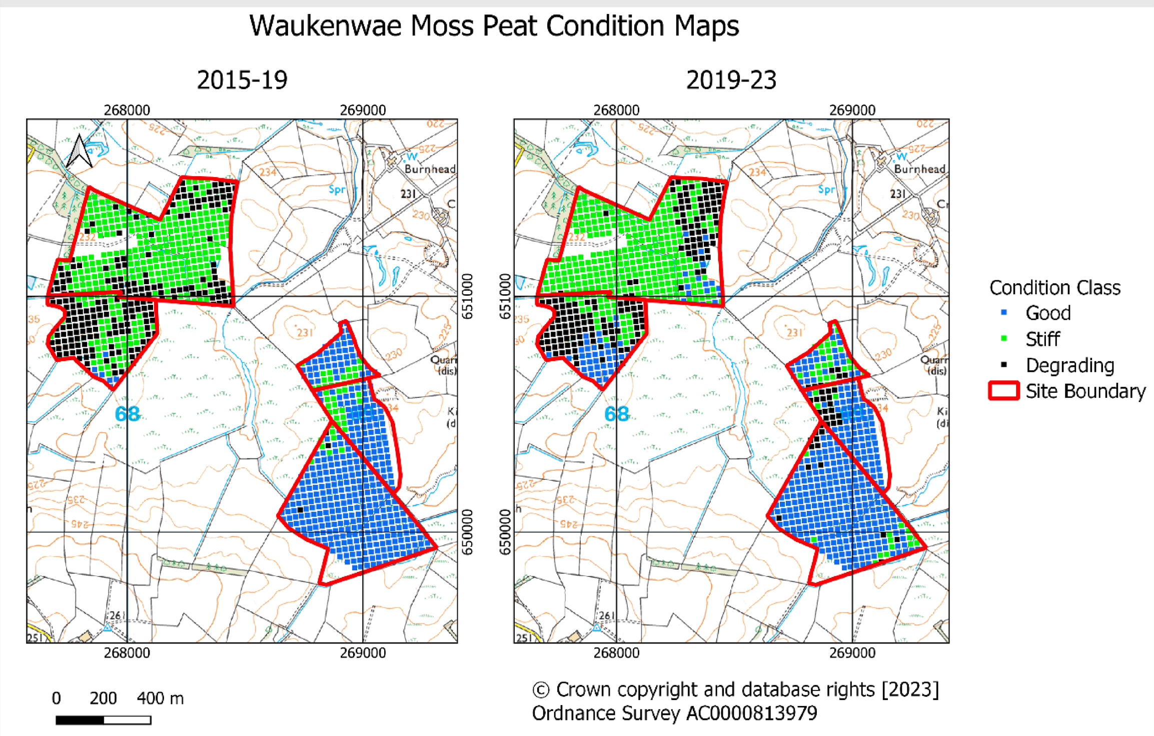


Fig 3. An example of condition mapping showing the difference in condition in some areas in the second time period [(3)].

The map in figure 3 shows the outputs for one of our case study sites where restoration work had taken place, and we could assess the outputs in relation to the work undertaken.

Work has progressed from initial manual classification techniques through to the development of automated classification techniques which currently classify the peat condition into 3 simple classes. More complex classification schemes could have been derived from the same radar data, but we were keen to have simple but meaningful outputs.

The outputs were not limited to case study sites but cover an area of over 400,000 ha of peatlands in Scotland, approximately a fifth of Scotland's peatlands. This landscape level of analyses data can contribute to a better estimate of the amount, condition and distribution of peat and the associated carbon inventories.

In addition, monitoring of the ongoing general trend of surface motion, be it stable, subsiding or rising, contributes to the identification of areas where significant positive or negative change is occurring on a peatland. This change detection can allow the impacts of restoration works or other land management practices on peatlands to be visualised and better understood.

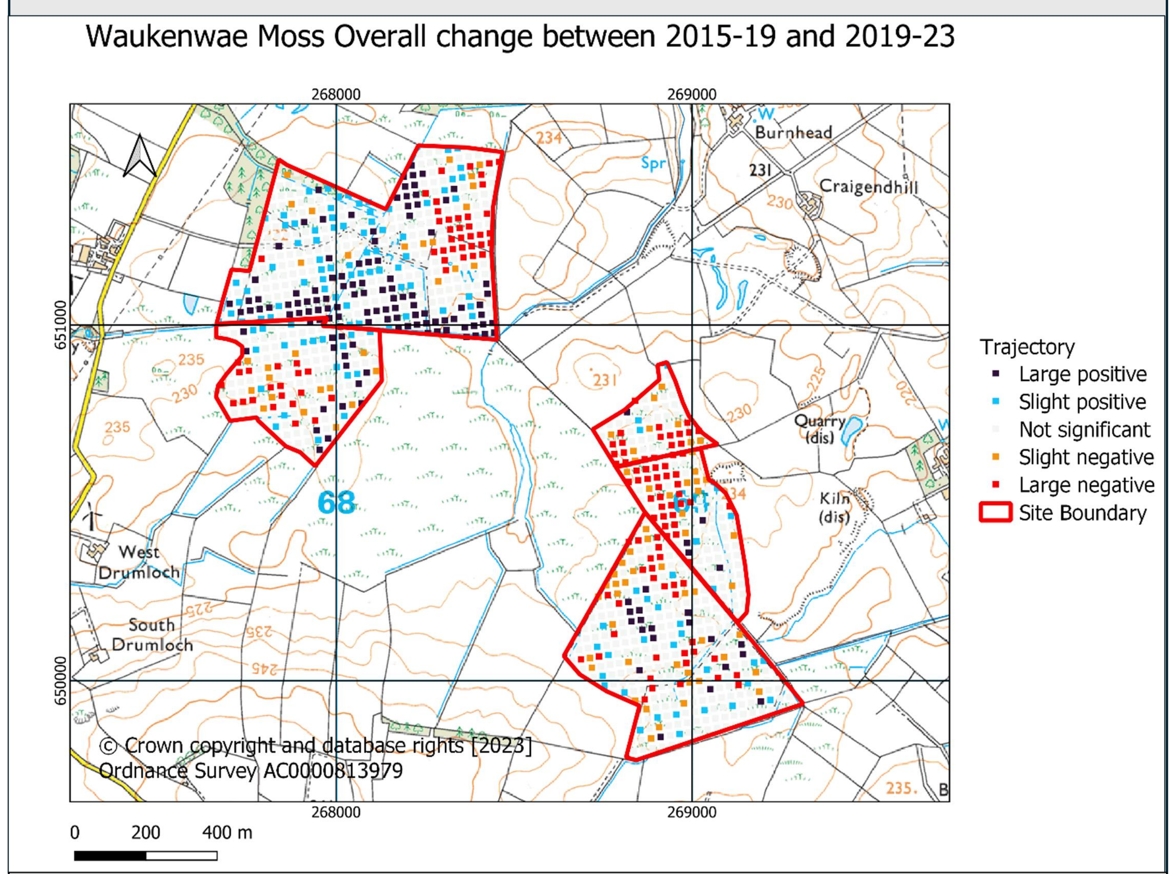


Fig 4. An example of change mapping that highlights areas of significant change [(3)].

The change detection method is particularly useful in assessing whether interventions are impacting peat behaviour, as changes in the condition class are expected to occur over a longer timeframe.

Conclusion

Whereas the RMN network can provide detailed ecological data on the response of sites to restoration works on a limited number of sites, the InSAR analyses has the potential to provide more general peat condition and change data but at a national level.

Neither method provides all the answers, but the information collected by both methods is complimentary. Information on vegetation structure, composition and cover provide information unavailable from the InSAR analysis so give a more detailed ecological picture. However, the InSAR work can give insights into early changes in the condition and behaviour of the peat which will likely precede any visible changes in the vegetation community of the site. Analysis at the landscape scale also allows understanding of how all our peatlands are responding to climate change and other factors that may influence their condition.

References

(1) Weber, C.A. (1902) Über die Vegetation und Entstehung des Hochmoors von Augstumal im Memeldelta. Berlin : Verlagsbuchhandlung Paul Parey. [Vegetation and Development of the Raised Bog of Augstumal in the Memel delta. : English transl. In: J. Couwenberg and H. Joosten (eds.) (2002) C.A. Weber and the Raised Bog of Augstumal. Tula, Russia : International Mire Conservation Group/PPE "Grif & K"].

(2) Marshall C., Bradley, A.V., Andersen, R., Large, D.J., 2021.Using peatland surface motion (bog breathing) to monitor Peatland Action sites. NatureScot Research Report 1269.

(3) Mitchell, E., Fallaize, C., Dryden, I., Bradley, A.V., Large, D.J., Andersen, R., Marshall C., (n.d.). Application of surface motion ("Bog Breathing") remote sensing to quantify change and the condition of peatland within an area of 10,800 km^2. NatureScot Research Report 1356.

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