Restoring Active Raised Bog in Ireland’s SAC Network 2016 – 2020 (LIFE14 NAT/IE/000032)

D5 An Assessment of Ecosystem functions of restoration

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Introduction

Today, the value of intact raised bogs and natural (and semi-natural ecosystems in general) and their role in providing ecosystem services is much more widely appreciated (de Groot et al., 2002). In addition to their unique biodiversity and their role in carbon sequestration and storage (Renou-Wilson et al., 2019) intact peatlands also contribute to flood alleviation, water storage and purification and the protection of past environmental archives among other services. Furthermore, Anderson et al, (2017) highlight that damaged peatlands cannot sustain these services and thus bear a cost to society, which can be alleviated by restoration measures. This has led to growing interest in the concept of natural capital (Bonn et al., 2014; Science for Environment Policy, 2017.

The National Raised Bogs Special Areas of Conservation management plan identifies the following Ecosystem Service Functions associated with Raised Bogs:

1. Climate change mitigation through peat formation;

2. Water quality and flood mitigation;

4. Support of habitat and species biodiversity;

1. Climate Change mitigation

The reduction in greenhouse gas emissions from the high bog areas restored during the Living Bog project was estimated by referring to ecotope emission factors developed by Regan et al., 2020. In the Regan et al study, two raised bog sites, similar to those managed in the Living Bog, were monitored for CO2 and CH4 emissions/exchange over two years using the flux-chamber measurement. Ecotope 'emission factors' were subsequently developed and have been hitherto applied to estimate the 'savings' accrued by restoration management in this project.

A summary of 1) the reduction in CO2 emissions from ecotopes that are generally sources of C to the atmosphere (facebank, marginal and sub-marginal) and 2) an increase in net CO2 sequestration from ecotopes that are typically peat-forming (central and sub-central) is presented in Table 1 for 5 of the Living Bog sites that had baseline ecotope mapping and subsequent ecotope mapping completed towards the end of the project. It is estimated that CO2 emissions were reduced by c. 426 tonnes, or 32%, over the timeline of the project, due to the reduction in the area of otherwise 'dry' ecotope. This has also resulted in an increase in 'wet' ecotope and c. 80 tonnes, or an increase of 32%, in the project period. This situation will continue to improve as the hydrological conditions of the sites stabilise. There is a lag time between water table response and ecological recovery, meaning the savings made with respect to CO2 will continue to improve.

Table 1. Estimated reduction and sequestration of CO2 at mapped high bog ecotopes at the beginning and end of the Living Bog project for 5 sites

Site Name	**Baseline CO_2 Emission**	**Post-Restoration CO_2 Emission**	**% Decrease**	**Baseline CO_2 Sequestration**	**Post-Restoration CO_2 Sequestration**	**% Increase**
	$t\ CO_2\ ha^{-1}\ yr^{-1}$	$t\ CO_2\ ha^{-1}\ yr^{-1}$		$t\ CO_2\ ha^{-1}\ yr^{-1}$	$t\ CO_2\ ha^{-1}\ yr^{-1}$	
Ferbane Bog	177	129	27%	50	59	17%
Moyclare Bog	108	76	30%	40	43	8%
Garriskil Bog	195	189	3%	93	126	35%
Carrownagappul Bog	752	446	41%	51	83	62%
Ardagullion Bog	117	84	29%	13	17	28%
TOTAL (FROM FIVE SITES)	**1350**	**924**	**32%**	**248**	**328**	**32%**

Reference:

Regan, S., et al. *Ecohydrology, Greenhouse Gas Dynamics and Restoration Guidelines for Degraded Raised Bogs*. No. 342. EPA Research Report, 2020.

Greenhouse Gas emissions study on cutover bog

A significant proportion of the Living Bog area is composed of cutover bog. No classification scheme was available at the start of the project on which to develop emission factors similar to those developed by Regan et al (2020). However, the new classification scheme developed as part of the Living Bog now makes this possible and a GHG monitoring study using static flux chambers has commenced at one of the Living Bog sites, Killyconny Bog. This study is being managed by NPWS and will be used to develop emission factors for the main ecotypes identified and mapped across the Living Bog network, and more accurately estimate the full climate change benefit of rewetting these sites. These factors can be used to retrospectively assign appropriate factors to the cutover bog habitats and used to monitor their changes as part of the AfterLIFE monitoring plan.

Long-term alterations in the water table significantly influence peatland function, and peatland hydrological properties, such as soil-water retention characteristics, are crucial for raised bog self-maintenance (Liu et al., 2022). Most GHG emissions from peatlands are closely correlated with water table, either directly or indirectly via the effects of water table (in semi-natural ecosystems) on species assemblage. These functional relationships have underpinned the development of the Greenhouse gas Emission Site Types (GEST) approach for continental Europe, which provides proxy estimates for GHG emissions from peatlands (Couwenberg et al., 2011).

2. Water quality and flood mitigation

The hydrology monitoring results presented in this report suggest that the restoration measures implemented as part of the Living Bog Project were successful in improving the supporting hydrological conditions across large areas of the twelve project sites. Critically water levels in most of these areas, have risen to within 20cm of the ground surface, which is the target level required for peat-forming vegetation to re-establish (Cushnan 2018). The limited variation observed in control plots highlights the fact that the positive results observed were as a direct result of the actions undertaken by the Living Bog Project and not as a result of climatic variables or seasonal/yearly variations.

Evidence from bogs in Ireland that have previously been the subject of restoration measures demonstrates that restoration measures typically reduce peak runoff rates and promote retention of more water within the bog, thus, reducing the frequency and magnitude of flood events by restoring a more natural hydrological regime along with an overserved improvement in water quality (Williams et al., 2014). Elsewhere, the restoration of peatland catchments in numerous sites across the UK, such as Exmoor National Park in Snowdonia, has demonstrated positive flood alleviation and water quality improvement as a result of restoration measures and monitoring has shown reduced runoff from the moorland as a result of increased storage in the peat. Restoration/rehabilitation has been successfully applied to numerous bogs throughout the Living Bog project as can be observed through the results presented in the hydrological/ecological reports reports. It is anticipated that the measures implemented during the Living Bog project have resulted in similar results and will continue to be monitored as part of the AfterLIFE project to quantify the impact of flood alleviation and water quality using longer term datasets.

3. **Support of habitat and species biodiversity**

The hydrological results from the Living Bog project suggest that the restoration measures were largely successful in restoring the supporting hydrological conditions required to promote the return of ARB/PFH across the project sites. The result presented in the project Vegetation Monitoring Final Report (Crowley & Smith 2022) supports the hydrological findings and suggests that the measures have been successful with an improvement in the percentage cover of Sphagnum observed on several project sites, indicating that the supporting hydrological conditions were improved.

Table 2 highlights the increase in Active Raised Bog (ARB) on five of the project sites as a result of restoration after approximately 1-3 years.

Table 2: Total extent (and type) of ARB in ha on the high bog across the five sites surveyed 1-3 years post-restoration.

Site Code/Name	Year of Survey	Sub-central	Central	Active Flush	Total ARB	Increase in ARB since baseline
000575 Ferbane Bog SAC	2021	34.6	2.3	0	36.9	4.3
000581 Moyclare Bog SAC	2021	18.2	4.6	0.6	23.4	1.7
000679 Garriskil Bog SAC	2021	52.7	15.8	0.4	68.9	18.0[1]
001242 Carrownagappul Bog SAC	2021	41.5	3.0	0.8	45.3	17.2[2]
002341 Ardagullion Bog SAC	2020	8.9	0.2	0.1	9.2	2.0
TOTAL						**43.0**

Improving habitat quality is also beneficial for species other than plants. A total of 62 bird species were recorded on the five raised bogs (across the high bog, cutover bog and surrounding scrub and woodland), of which 20 (32%) are listed on the Birds of conservation concern in Ireland (Gilbert et al., 2021); eight on the red list and 12 on the amber list. Twenty of these species are on the Red and Amber list of the Birds of Conservation Concern in Ireland, which emphasises the immense conservation value of these sites. Curlew were present on three raised bogs (Killyconny, Ferbane and Mongan) and Redshank on two sites (Mongan and Ardagullion), which given the perilous state of their populations, even these low numbers are of national significance. Snipe occurred on all sites and in higher breeding densities than reported for most other bogs, while Woodcock and Kestrel, two other red-listed birds of conservation concern were also found on all sites surveyed. Meadow Pipit and Skylark were the commonest birds encountered on the high bog, as is expected on relatively intact raised bogs, and both species occurred at breeding densities which compared well to other peatland sites.

References

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