Cairngorms National Park Authority



Peatland Science & Monitoring Strategy 2026–2030

Contents

Overview **4**

Vision **4**

Background **4**

Cairngorms Peatland ACTION 4

Strategic context 5

Monitoring priorities & rationale **9**

Strategic linkages **10**

Delivering the Monitoring Strategy **12**

Who will deliver the Strategy? 12

Funding for monitoring work 12

Reporting and knowledge sharing 13

Annual reporting of peatland restoration delivery 13

Peatland ACTION Partnership 13

Conferences and events 14

Objectives **15**

1. Eligibility and compliance 15

1.1 Baseline surveys 15

1.2 Drone surveys 17

1.3 Fixed point photography 17

1.4 Review visits 17

1.5 Grant compliance monitoring 17

1.6 Peatland Code 18

1.7 Roles and responsibilities 19

1.8 Proposed delivery timeline 19

1.9 Delivery of Peatland ACTION monitoring priorities 19

2. Determining success 20

2.1 Process monitoring 20

2.2 Process monitoring + ... 21

2.3 Roles and responsibilities 24

2.4 Proposed delivery timeline 24

2.5 Delivery of Peatland ACTION monitoring priorities 25

3. Optimising ways of working 25

3.1 Technological advances 26

3.2 Technique development 26

3.3 Future-proofing restoration practices 28

3.4 Proposed delivery timeline. 30

3.5 Delivery of Peatland ACTION monitoring priorities 31
4. The bigger picture 31
4.1 Biodiversity impacts 31
4.2 Catchment health and water quality 34
4.3 Socio-economic impacts 34
4.4 Proposed delivery timeline. 35
4.5 Delivery of Peatland ACTION monitoring priorities 36
5. Data quality 36
5.1 Review/revise survey protocols 36
5.2 Develop digital data recording procedures and templates 37
5.3 Data storage and sharing 37
5.4 Proposed delivery timeline 38
5.5 Delivery of Peatland ACTION monitoring priorities 38
6. Collaboration 39
6.1 Facilitate and maintain collaborations 39
6.2 Delivery of Peatland ACTION monitoring priorities 41
Exemplary site monitoring schedule 41
Acronyms 42
Definitions 43
References 43
Appendices 45

Overview

This strategy intends to outline current and future monitoring activities and research undertaken in the Cairngorms National Park ('The Park') by the Cairngorms National Park Authority's ('Park Authority') Cairngorms Peatland ACTION team. The strategy is designed to align with strategic linkages, facilitate the monitoring of outcomes and provide transparency on Park activities. We have identified six monitoring priority themes. Broad timelines are provided for their delivery within the 5-year delivery period of this strategy. Specific delivery timelines are provided in the Monitoring Plan, which is maintained internally to track progress and facilitates flexibility in project delivery where necessary. The Monitoring Plan can be accessed by Park Authority staff here - Monitoring plan.xlsx - and is available on request. Key definitions and acronyms are referenced at the end of this document.

Vision

By 2031, the Cairngorms Peatland Action Monitoring Strategy will generate the evidence and insight needed to advance peatland restoration across the Cairngorms National Park and make valuable contributions to the wider peatland sector. Through rigorous monitoring and clear communication of results, we will empower public and private partners to deliver more resilient peatlands, adopt efficient and environmentally responsible restoration practices, and maximise the climate, nature, and community benefits of peatland recovery.

Background

Cairngorms Peatland ACTION

The Park Authority is one of the five delivery partners of Peatland ACTION, alongside NatureScot, Loch Lomond and the Trossachs National Park Authority Forestry and Land Scotland and Scottish Water. Peatland ACTION is a nationwide peatland restoration programme funded by the Scottish Government and implemented by these delivery partners. The Cairngorms Peatland ACTION team works collaboratively with landowners and managers, technical experts and consultants to deliver and fund peatland restoration at scale in the Cairngorms National Park. The team comprises of a Programme Manager (PM), Operations

Manager (OM), Project Officers (PO), a GIS Officer (GO), Project Assistant (PA) and a Peatland Science and Monitoring Officer (PSMO).

Strategic context

Scotland's Climate Change Plan 2026–2040

Under Scotland's Climate Change Act 2019, there are targets to reach net zero emissions by 2045. The main routeways to achieving this are set out in Scotland's Climate Change Plan (2026-2040). Specific targets applicable to the peatland sector include:

- **Restoration scale:** Restoring a minimum 400,000 ha of degraded peatlands by 2040 by accelerating annual peatland restoration targets by 10 % from 2026 to 2030 and subsequently maintaining annual restoration rates
- **Preventing deterioration:** protecting peatlands in good condition
- **Deer management:** preventing further deterioration of degraded sites via promoting deer management, including incentivising control of deer numbers
- **Controlling muirburn:** implementing new muirburn licensing measures in the Wildlife Management and Muirburn (Scotland) Act 2024.

Scottish Biodiversity Strategy to 2045

This strategy aims to accelerate ecosystem restoration and regeneration, protect valuable species and habitats, and promote biodiversity. Specific objectives for the peatland sector in the 2024-2030 delivery plan include:

- **Restoration scale:** restore 250,000 ha of degraded peatland by 2030
- **Deer management:** reduce deer numbers to 5-8 deer per km^2 in each Deer Management Group in the Cairngorms National Park.
- **Water catchments:** enhance water and air quality via peatland restoration, and undertake water management measures to enhance biodiversity and reduce negative impacts.

National Peatland Plan (2015)

Scotland's National Peatland Plan intends to '*protect, manage and restore peatlands to maintain their natural functions, biodiversity and benefits*' (NatureScot, 2015). Additional aims are as follows:

- **Protect** peatlands in good condition and their ecosystem functions

- **Enhance resilience** of peatland ecosystem via appropriate management
- **Restore** peatland ecosystem functions and biodiversity, and understanding of such to help inform future decisions
- **Build capacity:** secure greater peatland restoration capabilities and knowledge sharing between land managers, practitioners and the public
- **Support growth**: ensure peatland values are reflected in the support given to peatland managers and practitioners
- **Knowledge sharing:** demonstrate and communicate the wider public benefits of healthy peatland landscapes and peatland restoration.

Peatland ACTION Five-year Partnership Plan 2025 –2030

Peatland ACTION has iterative 5-year plans to achieve Scotland's long-term peatland restoration vision. Priorities for 2025-2030 are:

- **Further**: Expand peatland restoration in Scotland
- **Fairer:** Support a just transition through restoration
- **Better**: Improve how we work and solve technical challenges

Peatland ACTION Restoration Monitoring Strategy 2024–2030

Peatland ACTION's monitoring strategy reviews the effectiveness of peatland restoration by the Peatland ACTION partnership. This is achieved collaboratively by Peatland ACTION partners via the monitoring priorities in figure 1. These priorities intend to monitor the progress of peatland restoration (priority 1), inform best practice (priority 2), monitor the effectiveness of restoration techniques (priorities 3-4), communicate results effectively (priority 5) and develop novel monitoring techniques (priority 6). The alignment between our monitoring strategy and Peatland ACTION's is highlighted in the objectives of each monitoring priority (pages 15-41).

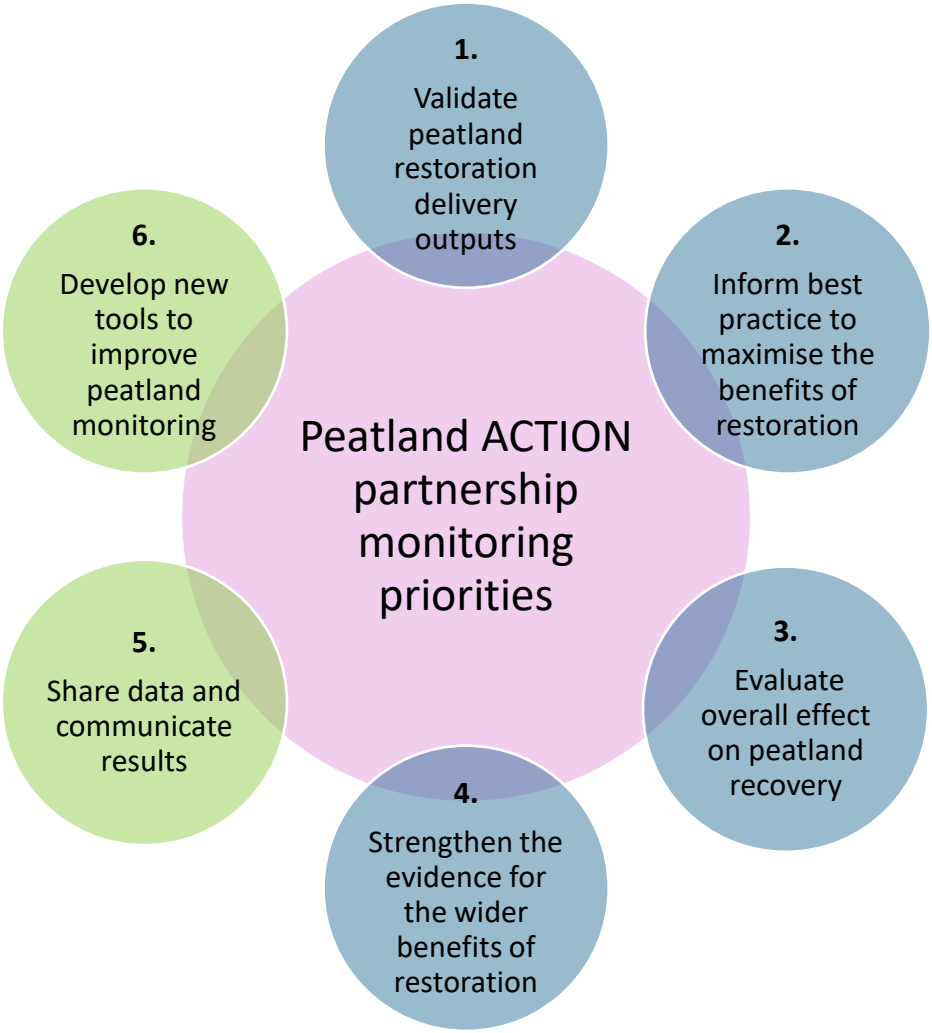


Figure 1. Peatland ACTION partnership monitoring key (blue) and supporting (green) priorities.

Scotland's Peatland Standard [consultation draft]

The draft Scotland's Peatland Standard is being developed by NatureScot and Peatland ACTION partners to provide a consistent technical framework for protecting, managing and restoring peatlands across Scotland. The consultation draft sets out objectives, outcomes, success indicators, principles, legal requirements, essential good practice and supporting guidance. Following consultation, publication of the Peatland Standard is intended for December 2026. For this monitoring strategy, the Standard is particularly relevant because it promotes consistent decision-making, clearer evidence requirements and outcome-based assessment of restoration progress, including use of success indicators and

recovery trajectories to judge whether peatlands are moving towards healthier, more resilient condition.

Cairngorms National Park Partnership Plan 4 2022-2027

Focusing on people, nature and place The Park's plan aims to:

1. Conserve and enhance natural and cultural heritage (priority aim).
2. Promote sustainable use of natural resources.
3. Promote public engagement with special qualities of The Park.
4. Promote sustainable economic and social development for local communities.

Specific to peatland restoration, this plan includes objectives to reduce carbon emissions and improve biodiversity:

- **Restoration scale:** restore a minimum of 6500 ha of degraded peatland
- **Skills and training**: increase contractor and estate capacity via upskilling and work opportunities
- **Integrating trees and peatland**: develop guidance on integrating peatland and woodland restoration
- **Deer management**: explore approaches to protecting peatland restoration from herbivores
- **Carbon and biodiversity**: work towards becoming carbon negative and biodiversity rich, including long-term monitoring of species, habitats and ecosystems (including peatlands) in the Cairngorms Nature Index.

These deliverables align with a long-term vision to have a minimum of 38,000 ha of peatland under restoration management by 2045. Under Heritage Horizons: Cairngorms 2030, there are also targets to restore around 3,500 ha of degraded peatland over 5-years by 2030. Progress towards delivery of The Park's plan will be evidenced by the Cairngorms Nature Index (CNI), an indicator-based monitoring programme of The Park's species, habitats and ecosystems aims to evidence, our monitoring strategy intends to contribute to CNI where feasible.

Cairngorms Peatland ACTION Programme Plan 2026-2030

Additional to achieving hectare-based restoration delivery targets, we have specific programme themes. These are:

- **Herbivore impact** – the impact of (mainly) red deer on restoration outcomes.

- **Restoration at altitude** – reviewing the effectiveness of peatland restoration techniques at high altitudes, where extreme weather and short growing seasons are constraining factors.
- **Peatland restoration and trees** – exploring the integration of woodland creation and peatland restoration, and restoring of bog woodland.
- **Holistic land management -** including integrating peatland restoration on traditional sporting estates.
- **Innovation -** developing innovative approaches to restoration techniques, approaches to delivery, science and monitoring, and people engagement.
- **Blended finance** - exploring options for reducing demands for public money.
- Furthering the "New Entrants to peatland restoration" training scheme to increase workforce **skills and capacity**.

Monitoring priorities & rationale

1. Eligibility and compliance

   Monitoring that is essential for project delivery, determining grant funding eligibility and ensuring projects are legally compliant to grant conditions and best practice guidance. Some projects may also be registered for Peatland Code requiring additional surveys to validate marketable carbon credits.

2. Determining success

   By establishing standardised monitoring protocols we want to evidence whether restoration efforts are progressing peatland sites along the road to recovery, in alignment with the recovery trajectory indicators described in Scotland's Peatland Standard. Using specialised surveys of sites representative of environmental conditions of interest, we will better understand the resilience of restoration activities to factors that might influence restoration success.

3. Optimising ways of working

   We strive to take a leading role in the development of innovative tools, techniques and technologies in the peatland sector, and to better understand the effectiveness of approaches to improve and monitor peatland condition. This includes assessing the outcomes of established techniques and processes in varied environmental conditions (e.g. altitude and extreme weather events) and herbivore tolerances. We encourage collaborators to

utilise the Park as a living lab to test novel ways of working, particularly where projects are of relevance to our programme and monitoring themes.

4. The bigger picture
   We want to better understand how peatland restoration may facilitate nature recovery and biodiversity uplift, which includes contributing to the Cairngorms Nature Index. We want to consider how peatland restoration might impact water catchment health, particularly water quality, and help support people who live and work in these landscapes. By improving our understanding of the socio-environmental impacts of peatland restoration, we can strive to maximise the climate, nature, and community benefits of peatland recovery.

5. Data quality and sharing
   We will review and improve our monitoring protocols, including field methodologies and data collection techniques. We will streamline and standardise data collection, storage and processing by adopting digital data collection tools where feasible. We intend to share survey protocols and results with relevant stakeholders. This priority overarches many aspects of our other monitoring priorities.

6. Collaboration
   The Park has a wealth of resources available for land-users, managers and stakeholders. We wish to facilitate knowledge exchange and promote The Park as a site for high-quality scientific research, and support others where values are aligned to our monitoring priorities.

Strategic linkages

Table 1 outlines how our monitoring priorities are strategically aligned with national, peatland sector and organisational policies. Alignment between The Park's monitoring strategy and Peatland Action's monitoring priorities will be highlighted in the introductory sections of our monitoring priority objectives.

Table 1. Strategic linkages to our monitoring strategy. Short-hand refers to Strategic Context themes in bold.

Park Authority			Peatland ACTION	National (Scotland)		
Monitoring strategy	**Programme themes**	**Partnership plan**	**Partnership Plan**	**Climate Change Plan**	**Biodiversity Strategy**	**Peatland Plan**
Eligibility & compliance	Herbivore impacts	Restoration scale Carbon & biodiversity Deer management	Further Fairer Better	Restoration scale Deer management Prevent deterioration Controlling muirburn	Restoration scale Deer management Species & habitats	Restore Resilience Protect
Determining success	Restore at altitude Herbivore impacts	Restoration scale Carbon & biodiversity Deer management	Further Better	Restoration scale Deer management Prevent deterioration Controlling muirburn	Restoration scale Deer management	Restore Resilience
Optimising ways of working	Restore at altitude Peatlands & trees Innovation Herbivore impacts	Restoration scale Carbon & biodiversity Deer management	Further Better	Restoration scale Deer management Prevent deterioration Controlling muirburn	Restoration scale Deer management Species & habitats	Restore Resilience
The bigger picture	Peatlands & trees Blended finance Land management	Carbon & biodiversity	Fairer Better	Prevent deterioration	Water catchments Species & habitats	Restore Resilience Protect
Data quality and sharing	Innovation		Fairer Better			Capacity
Collaboration	Skills & training Blended finance	Skills & training	Fairer Better			Capacity Growth Share

Delivering the Monitoring Strategy

Who will deliver the Strategy?

The Peatland Science and Monitoring Officer role supports the Cairngorms Peatland ACTION programme by leading the scientific monitoring, data collection, analysis and reporting needed to guide and evidence peatland restoration across The Park. The post holder is responsible for developing the Monitoring Strategy and survey methodologies, managing and carrying out site surveys, coordinating research and contractor input, improving data and GIS systems, and working closely with colleagues, land managers, partners and the wider scientific community to ensure restoration projects are well evidenced, efficiently delivered, and aligned with climate, biodiversity and habitat restoration objectives.

The Monitoring Strategy will be overseen by the Peatland Science and Monitoring Officer and implemented as a collective effort by Cairngorms National Park Authority staff, contractors, project owners, agents, volunteers and the wider scientific community. Information on key responsibilities and which parties are responsible for delivering each priority within the Strategy is detailed in the sections below.

The Strategy has been developed in consultation with Cairngorms National Park Authority colleagues, the Cairngorms Peatland Restoration Developers' Group, Peatland ACTION partners, and other wider stakeholders.

Funding for monitoring work

Funding for monitoring should be considered at the earliest stage of project development so that survey requirements, strategic alignment and potential funding routes can be identified before work begins. Essential surveys needed to support a peatland restoration funding application, project design or pre-works due diligence may be eligible for support through Cairngorms Peatland ACTION funding. This can include surveys required to establish baseline conditions, confirm eligibility, inform restoration plans or meet legal and grant compliance requirements. Project owners, agents or collaborators should contact peatlandaction@cairngorms.co.uk for advice on whether proposed survey work can be supported.

Monitoring projects that go beyond essential pre-application or pre-works requirements may be eligible for NatureScot Peatland ACTION monitoring project

funding. Eligible projects should help evidence the outcomes of restoration and support better, bigger delivery on the ground; they may relate to a single restoration project or take a regional approach, and there are no geographical restrictions or target areas for this funding. Applications are assessed against the fund's requirements, including eligibility, fit with outcomes and priorities, procurement requirements, reporting obligations, final reporting, and grant terms and conditions.

NatureScot operates different application routes depending on project value. Monitoring projects under £30,000 are invited to complete the application forms provided by NatureScot, while projects over £30,000 should submit an expression of interest and allow additional time for wider consultation with NatureScot, the Peatland ACTION delivery partnership and Scottish Government. NatureScot recommends allowing around 12 weeks before the intended start date for projects under £30,000, and around 16 weeks for projects over £30,000. Multi-year offers may be considered for large-scale projects where appropriate.

All proposals for monitoring that may contribute to this Strategy should be shared with the Cairngorms Peatland ACTION team at an early stage by emailing peatlandaction@cairngorms.co.uk. Early discussion will help identify the most appropriate route for support, avoid duplication with existing monitoring, ensure proposals are aligned with the Strategy's priorities, and signpost applicants to potential sources of funding, including Cairngorms Peatland ACTION and NatureScot Peatland ACTION where relevant.

Reporting and knowledge sharing

Annual reporting of peatland restoration delivery

Cairngorms Peatland ACTION will report interim and final hectares of peatland restoration delivery, and any associated project spatial data, to NatureScot's Peatland ACTION data team on an annual basis by agreed deadlines and using agreed templates. This data feeds into the Scottish Government Peatland Programme's Nationwide annual reporting of peatland restoration efforts.

Peatland ACTION Partnership

Cairngorms Peatland ACTION staff are members of working groups hosted by Scottish Government and Nature Scot on behalf of the partnership, including the Monitoring and Data (MaD) group, and Technical Advisory Group. These groups will be key forums for discussion, collaboration and information sharing. Any reports or

papers produced resulting from this Strategy will be shared with Peatland ACTION partners. The Peatland ACTION Partnership will work together to develop protocols and methodologies for surveying and monitoring peatlands wherever possible.

Cairngorms Peatland Restoration Developers' Group

This group was set up in 2025 and meets quarterly. Its membership is open to anyone involved in designing, developing and delivering peatland restoration projects in the Cairngorms National Park. Its purpose is to provide a forum for optimising programme delivery in the Cairngorms National Park by facilitating discussion and collaboration.

Conferences and events

The Peatland Science and Monitoring Officer and other staff members will attend conferences and events of relevance to peatland science. Opportunities will be taken to present, lead site visits, take part in workshops, or exhibit posters relating to the Monitoring Strategy and its outcomes.

Objectives

This section outlines deliverables associated with the objectives of our six monitoring priorities. Established projects associated with these deliverables are outlined where available and we intend to be flexible, inviting innovation and collaboration to opportunities that might arise throughout this 5-year delivery period. Here we highlight roles and responsibilities associated with established monitoring activities and outline delivery timelines. Detailed delivery timelines will be maintained internally to allow for dynamic review and are available on request.

1. Eligibility and compliance

1.1 Baseline surveys

1.1.1 Pre-application surveys

Pre-application surveys are essential to determining project areas, funding eligibility and informing project design. Centred on a 100 m grid over a proposed project site, these assessments include peatland condition, vegetation surveys and herbivore impact assessments (HIA). Vegetation and HIA are undertaken on a subsample of 100 m grid locations, with sample number determined by project area (ha). Georeferenced data is produced from each survey type. Summaries of each survey are outlined below; full details are available on request:

i. **Standard assessment (Peat depth and condition)**

Peat depth is assessed on a 100 m grid across the project site and a 50 m buffer around the site edge. Where projects are to be submitted for Peatland Code and peat depth is variable, an additional 50 m grid is surveyed. If depth is < 50 cm on the 100 m grid, the 50 m grid is triggered until a depth of > 50 cm is recorded (triggering return to 100 m grid) or the edge of the project site has been reached.

Peatland condition records whether 100 m grid locations are (1) near-natural, (2) modified/ micro-erosion, (3) drained - artificial, (4) drained - hagg/gully, (5) actively eroding - hagg/ gully, (6) actively eroding – bare peat, (7) forested, (8) previously forested or (9) bog woodland. Any evidence of burning, turf quality, secondary condition classes and substrate-type where exposed is also recorded.

ii. **Vegetation**

Quadrat based surveys are used to record the percentage cover of vegetation, bare peat, mineral and/or standing water.

iii. **Herbivore impact assessment (HIA)**

HIA considers potential impacts of deer, hare and sheep on project sites based on review of the vegetation present and evidence of herbivore utilisation. Where sites are scored as having high herbivore impact, a project may be designed in consideration of such impacts, or terminated.

1.1.2 Heritage surveys

Scoping for heritage features includes consulting available online records (i.e. Historic Environment Records, historic maps and aerial imagery) and walkover surveys to identify and record the location of any previously unrecorded features. Where heritage features are identified advice must be sought from local authority archaeologists prior to project continuation. Further details can be found in Mann (2022).

1.1.3 Ecological constraint surveys

Prior to works commencing, the potential presence of priority species and habitats is reviewed by consulting existing Park Authority data, relevant Park Authority staff, estate staff and key consultees. Priority species or habitats are those protected or considered vulnerable to peatland restoration activities. Available species records (in project areas and their access routes) are reviewed against our priority species list which includes breeding birds, the Scottish Biodiversity List and Cairngorms Rare Plant List. Collated records are used to tailor walkover surveys by competent Park Authority staff or contractors which verify continued presence and identifies any additional priority species or habitats.
Survey results are used to generate ecological constraints maps for restoration plans and species-specific protection plans to minimise potential disturbances. Where deemed necessary, a licence may be sought.

1.2 Drone surveys

Drone surveys can provide high-resolution imagery, useful for image classification, and digital surface models to provide insights into peatland conditions prior and post restoration. These surveys can contribute to Peatland Code applications (discussed further in Section 1.6) and can be requested where aerial imagery is of insufficient quality for restoration planning. The Park Authority approach is that surveys are not required for solely drain blocking projects where there is minimal erosion, elsewhere they are recommended for restoration planning. Standard flights are flown at 100m above ground level with a 70 % image overlap in both directions. This may be reviewed on a site-by-site basis. Drone surveys may be conducted in-house or commissioned.

1.3 Fixed point photography

Fixed point photography (FPP) is used to visually capture geotagged before and after treatment photos of a range of site conditions and restoration techniques. Each photograph is assigned a unique ID with further practical guidance available in Boyce and Elliff (2023). FPP is conducted by POs or the PA, and 10-15 photos are taken per site.

1.4 Review visits

Sites are inspected within 5-years after restoration via desk and field-based reviews. Desk-based reviews compile information regarding techniques applied, monitoring/ survey results and assess differences between pre-works and recent drone or aerial imagery. This is used to help plan field visits. Field-based reviews aim to assess the progress of ~10 % of each restoration-type on the 'road to recovery', aiming for a total of 30-40 sample locations. Surveyors review any damage to or failures of features; recovery of borrow pits/ mulch harvesting areas and, where appropriate, whether mitigation is required[1]. These reviews are undertaken by POs or contractors.

1.5 Grant compliance monitoring

The Park Authority has offered grant funding to peatland restoration projects under Peatland ACTION since 2021. These grants have a 10-year contract period within which recipients must adhere to grant conditions. Compliance monitoring is a desk-

[1] Peatland ACTION does not fund maintenance or monitoring required for Peatland Code projects.

based and field visit in year eight after works completion to assess whether grant conditions have been adhered to. This involves a review of site details, spatial data and recent aerial imagery, and walk-over surveys to assess any damage to restoration works resulting from breaches of grant conditions. These assessments can be undertaken by Park Authority staff or contractors. Further details are available on request.

1.6 Peatland Code

Peatland Code requires surveys to establish (1) baseline conditions and (2) verify projects 5-years after the date restoration works ended and at subsequent minimum 10-year intervals.

1. Baseline surveys
    - Condition categories and peat depth as collected during pre-works assessments (see Section 1.1).
    - Fixed-point photos (~ every 4th 100 m grid point) OR drone survey to gather an orthorectified map (min. 1 m resolution) AND fixed-point photos of key restoration features where conditions may be abnormal for the site.
2. Pre-verification surveys (conducted by third-party Code agents)
    - Post-restoration condition change monitoring revisit survey locations on the pre-works 100 m grid survey (see Section 1.1). These define the condition of restoration features within 5 m of each survey point as either revegetated bare peat, modified bog, rewetted modified bog or near natural bog. The grid point is then assigned the average condition category.
    - Fixed point photos collected during baseline surveys are repeated.
    - Best practice recommends utilising drone surveys to assess the condition of bare peat.

Further details regarding this process can be found at IUCN (2023; 2024).

1.7 Roles and responsibilities

Table 2. Responsible party for survey delivery in Park Authority-led and agent-led peatland restoration projects. * means survey not required to follow Park Authority protocols.

Survey-type	Park Authority-led	Agent-led
Pre-application	Park Authority (PSMO)	Agent*
Heritage	Park Authority (PA)	Agent
Ecological constraints	Park Authority (PA)	Agent*
Drone	Park Authority (PSMO)	Agent
Fixed point photography	Park Authority (PO)	Agent*
Review	Park Authority	Park Authority
Compliance	Park Authority	Park Authority
Peatland Code	Project owner	Agent

1.8 Proposed delivery timeline

The proposed delivery timeline is provided in The Monitoring Plan, which can be accessed by Park Authority staff here - Monitoring plan.xlsx - and is available on request.

1.9 Delivery of Peatland ACTION monitoring priorities

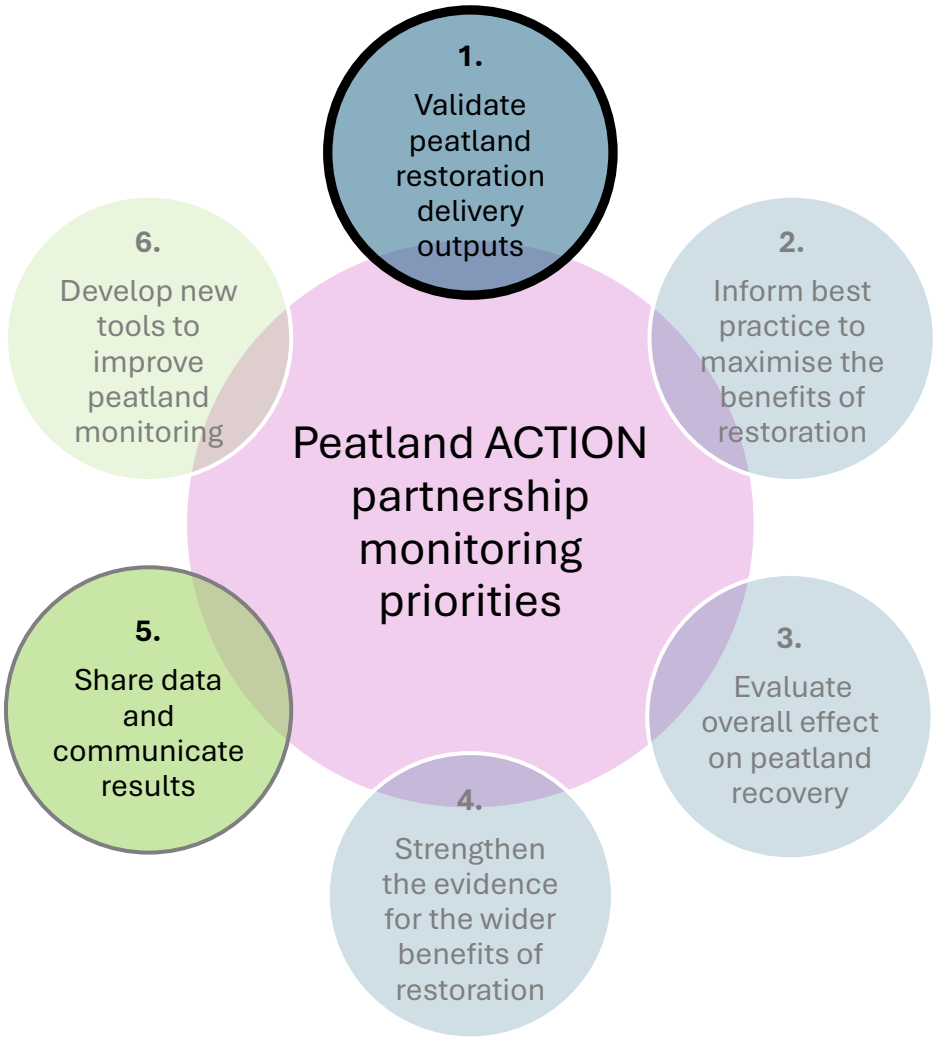


Figure 2. Linkages between monitoring priority and Peatland ACTION's restoration monitoring strategy. Linkages are highlighted and key contributions are in bold. Peatland ACTION priorities are faded out where there is no linkage with our objective.

2. Determining success

2.1 Process monitoring

Process monitoring aims to collect standardised data to estimate site recovery statuses. This helps evidence whether sites are on the whole progressing on a positive trajectory. Process monitoring results will also help inform compliance monitoring and compliments review visits. The survey strategy is outlined in Table 3. Process monitoring includes repeating elements of pre-application assessments

(vegetation and HIA) and drone surveys in year 5 and 10 (same specification as in Section 1.2). Vegetation surveys can indicate changes in site conditions over time based on species-specific ecological tolerances. For example, rises in hydrophilic species (e.g. *Sphagnum*) can infer wetter site conditions. Sites can also be monitored more quantitatively by using Ellenberg Indicator Values (EIV). EIV is a numerical system which scores species-specific plant tolerances for a range of environmental factors (e.g. light, temperature, moisture, soil pH, soil moisture and nitrogen) and by calculating the average indicator scores per plot, can be used to monitor site trajectories on these environmental gradients (Hill et al., 1999).

Table 3. Outline of process monitoring strategy.

Survey-type	Method	Purpose of survey
Pre-restoration	Pre-works assessment	Peat depth, condition, vegetation composition and HIA.
Year 1	Vegetation and HIA & drone	Changes in vegetation composition and herbivore utilisation.
Year 5	Vegetation, HIA & drone	Changes in vegetation composition and herbivore utilisation.
Year 10	Vegetation, HIA & drone	Changes in vegetation composition and herbivore utilisation.

2.2 Process monitoring +

"Process monitoring +" is a more detailed assessment than standard process monitoring which targets sites representative of environmental conditions of interest to better understanding the resilience of restoration activities to factors that might influence restoration success. Additional to site-wide monitoring (HIA and vegetation), process monitoring + includes focused feature assessments of a minimum 18 fixed locations. Feature assessments are tailored to feature-types (e.g. dam, bund or baffle; upstream zone or pool; reprofiled and revegetated slope; donor or damage site) but includes review of feature composition, functioning, key vegetation-types present, and evidence of herbivore-feature interactions. These surveys are repeated at post restoration at years 0, 1, 3 and 10. Priorities for Process Monitoring + are outlined in Table 4 and the survey strategy is summarised in Table 5.

Table 4. Priorities for process monitoring + and preliminary site selection.

Priority	Rationale
Deer impacts	Trampling and grazing by deer may impact the recovery of peatland restoration sites. We wish to better understand deer impacts on site recovery, considering where deer pressures are high and absent/ negligible. Monitoring for this priority commenced in 2023 and is discussed further in Section 3.3.
Altitude	Our peatland team typically works on sites at 400-800 m a.s.l. however we want to better understand the feasibility of working at higher altitudes where the restoration of degraded peatlands may be impeded by shorter growing seasons, higher exposure and (often) reduced accessibility. As the peatland sector continues to grow, we are expecting to transition beyond focusing on 'low hanging fruit' of more accessible, lower elevation restoration sites in future and we wish to establish best practice in such environmental conditions.
Other herbivore impacts	In the National Park, we typically focus on the impact of deer populations on restoration outcomes, however other herbivores, such as sheep or mountain hare may also affect restoration outcomes.
East-west climate envelopes	Climate change is predicted to impact the frequency of extreme weather events, including droughts and flood events. The Park covers a broad climate gradient from the drier east to relatively wetter north-west. Geographical climate divergence may impact recovery rates and trajectories.

Table 5. Survey strategy for process monitoring + (v2). The high deer pressure monitoring strategy (process monitoring + v1) is provided in appendix 1.

Survey-type	Schedule	Method	Purpose of survey
Pre-restoration	Before works	Pre-works assessment	**Site-wide:** peat depth, condition, vegetation composition and HIA.
Post-restoration baseline	Within 1 month	Feature assessment	**Feature-specific:** whether restoration features are functioning as intended, vegetation establishment/ turnover and any herbivore interactions
Year 1 post-restoration	1 growing season	Vegetation, HIA, drone & feature assessment	**Site-wide:** immediate changes in vegetation composition and HIA. **Feature-specific:** whether restoration features are functioning as intended, vegetation establishment/ turnover and any herbivore interactions
Year 3	3 growing seasons	Vegetation, HIA & feature assessment	**Site-wide:** changes in vegetation composition and HIA. **Feature-specific:** whether restoration features are functioning as intended, vegetation establishment/ turnover and any herbivore interactions
Year 5	5 growing seasons	Vegetation, HIA & drone survey	**Site-wide:** changes in vegetation composition, HIA and landscape.
Year 10	10 growing seasons	Vegetation, HIA, drone & feature assessment	**Site-wide:** changes in vegetation composition and HIA. **Feature-specific:** whether restoration features are functioning as intended, vegetation establishment/ turnover and any herbivore interactions

2.3 Roles and responsibilities

Survey-type	Park Authority-led	Agent-led
Process monitoring	Park Authority	NA
Process monitoring +	Park Authority	NA

2.4 Proposed delivery timeline

A provisional timeline for the delivery of process monitoring or process monitoring + is provided in Table 6.

Table 6. Provisional timeline for process monitoring + for priority themes.

Theme	Details	Year 0	Year 10
Deer impacts	High	2023	2033
	Low/ negligible	TBC	
Altitude	High	2027/28	2037/38
	Average	2026/27	2036/37
Other herbivore impacts	Sheep	2027/28	2037/38
East-west climate envelopes	East	2026/27	2036/37
	NW	TBC	

2.5 Delivery of Peatland ACTION monitoring priorities

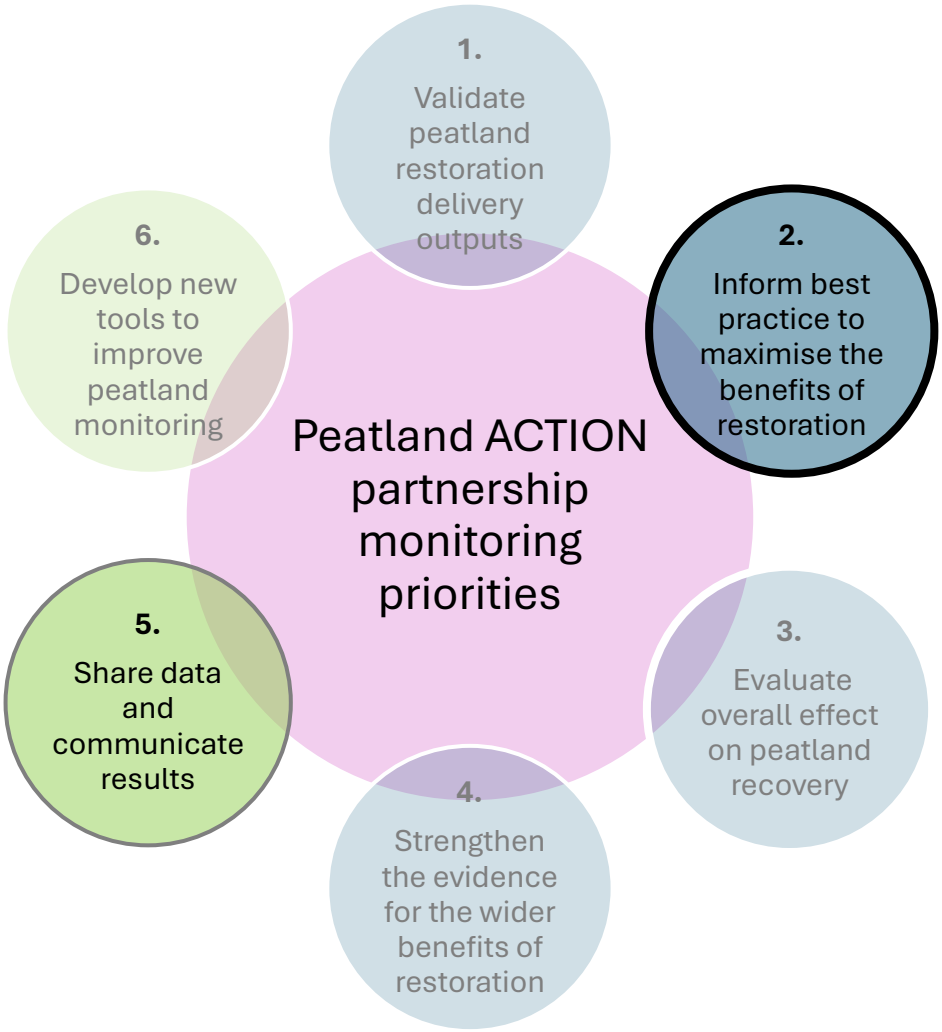


Figure 2. Linkages between monitoring priority and Peatland ACTION's restoration monitoring strategy. Linkages are highlighted and key contributions are in bold. Peatland ACTION priorities are faded out where there is no linkage with our objective.

3. Optimising ways of working

Our team invites the application and development of innovative technologies in The Park, and we will seek opportunities relevant to our monitoring themes during the 5-year phase of our monitoring strategy. Currently established projects are outlined below.

3.1 Technological advances

3.1.1 SensorSticks

Innovative water table and soil temperature monitoring devices developed by Plant-2 have been deployed to monitor water table dynamics in remote upland peatlands. Powered by plant-soil interactions and solar cells these devices provide a green technological solution to monitoring water table dynamics at remote upland peatland sites, where regular visits to change batteries and download data is unfeasible for long-term data collection. Four devices have been deployed for long-term monitoring of water table dynamics pre-and-post peatland restoration works at high altitude sites.

3.1.2 Deer deterrent devices

Managing deer populations is vital to successful peatland restoration, as they can damage peatland sites via trampling and grazing. We are exploring novel approaches to managing deer impacts on peatland restoration sites, to supplement the current deer management toolbox (conventional stalking and fencing). This project aims to review the effectiveness of novel approaches to deterring Red Deer in peatland settings and their associated environmental conditions (e.g. variable weather, remote).

3.1.3 Remote sensing tools

We intend to explore opportunities to develop UAV-based methodologies for monitoring peatland condition and herbivore activity.

3.2 Technique development

3.2.1 Reseeding bare peat

One aspect of peatland restoration is restabilising and revegetating bare peat. In 2024 we established trials of different approaches to reseeding:

a) Native seed mix
   A mix of native peatland species seeds (forbs and *Calluna vulgaris*) applied with lime and fertiliser on bare exposed peat (~3.5 ha). The seed mix included Sheep's Fescue (*Festuca ovina*), Purple Moorgrass (*Molinia caerulea*), Mat Grass (*Nardus stricta*), Wavy Hair-grass (*Avenella flexuosa*), Common Bent (*Agrostis capillaris*) and Brown Bent (*A. vinealis*), Application was a single season, with follow-up visits to review establishment using quadrat-based surveys.

b) Non-native seed mix
A fast-growing nurse crop of non-peatland-native seed including Sheep's fescues (*F. ovina* and *F. longifolia*), Perennial Rye Grass (*Lolium perenne*), Browntop Bentgrass (*A. castellana*) and Wavy Hair-grass was applied as a medium for native species to establish. Seed was applied with lime and fertiliser (~3.5 ha) and there will be follow-up applications of lime and fertiliser for 3years (until 2027). Exclusion areas are established to compare whether re-application promotes establishment rate. Follow up visits will review establishment and species turnover success using quadrat-based surveys.

3.2.2 Alternative materials in peatland restoration.

Imported coir products are frequently used for stabilising erosion, revegetating bare peat and surface bunding. While effective as a restoration tool, these products have a relatively high carbon footprint. We will explore potentially locally sourced thus potentially more sustainable, alternative materials and their effectiveness in peatland restoration.

a) Sheep wool
A trial established in 2024 is reviewing the effectiveness of wool logs as bunds in micro-erosion features, and mats and raw fleece for stablishing erosion, and as a revegetation medium on a site with sheep presence. This trial also considers potential chemical leaching from the wool products (to be discussed in Section 4.2.1). We intend to establish a second trial using wool products to further review their effectiveness in a different environmental setting.

b) Hemp
We will explore the potential for needle-punch hemp products produced in Scotland to be applied in peatland restoration via product testing and establishing field trials where appropriate.

3.2.3 Minimising impacts and recovery of access routes

Accessing peatland restoration sites frequently requires repeated cross-tracking of established or newly created tracks in peatlands areas, potentially causing damage. Whilst damage can be mitigated via sensitive driving techniques and low ground pressure machines, damage may still arise, requiring additional protections, monitoring and/or additional restoration works. We intend to explore strategies to restore and minimise damage incurred by site access. Monitoring is to be reactive to

mitigation measures applied, but may consider ground protection and re-vegetation techniques.

3.3 Future-proofing restoration practices

3.3.1 Recovery and resilience of peatland restoration sites from fire

In a changing climate where wildfire events may become more prevalent, it is important to understand how such events interact with peatland restoration techniques. One such approach is to monitor the recovery of peatland restoration sites affected by fire, to better understand the resistance of sites which are on the road to recovery.

Our fire recovery monitoring protocol explores how peatlands recover from fire, considering burn intensity, time since sites have been treated with restoration techniques and the recovery of vegetation, biodiversity (with birds as indicator species) and specific restoration features. This protocol utilises qualitative and quantitative surveying techniques including UAVs, vegetation quadrats, passive acoustic monitoring (PAM) of birds, fixed point photography, repeat breeding bird surveys (where applicable) and feature recovery assessments. Controls of unburnt and untreated peatland sites are applied and surveys are to be repeated for a minimum of 10-years with surveys in yr-1, yr-2, yr-5 and yr-10 following a baseline survey. This approach has been applied on sites affected by wildfire in 2025 (monitoring commencing 2026) and can be applied to new sites as they might arise.

3.3.2 Working with herbivore impacts

The Park Authority have specifically funded a restoration project where herbivore utilisation is known to be high to explore the interaction between herbivore activities and restoration outcomes. 'Process monitoring +' was established in 2023 (pre and post restoration baseline surveys) with repeat monitoring in 2024 (1 yr post-restoration) and scheduled for 2026, 2028 and 2030. The methodology for this Process monitoring + v1 is outlined in appendix 1. This differs from Process Monitoring + v2 as described in Section 2.2 in that it includes site condition monitoring (yr-0, yr-3, yr-10). Additionally, an array of trail cameras were deployed in year 0 (12months following works completion) to assess herbivore utilisation of the site, to compare with process monitoring results. Process monitoring + will also be implemented on a site where deer numbers are negligible.

3.3.3 Working at altitude

Process monitoring + (see Section 2.2) will be implemented to explore the effectiveness and impacts of restoration treatments at high altitude (> 600 m a.s.l.).

To better understand hydrological dynamics of such sites, we will monitor water table dynamics. SensorSticks (Section 3.1.1) these will be deployed to collect baseline data for 1-year prior to restoration treatment and left *in situ* for long term monitoring of the potential impacts of restoration activities on water table height. Two devices will be deployed per site. Two sites have been identified for water table monitoring: devices on site 1 (610-845 m) were deployed in summer 2025, with treatments scheduled for 2026, and devices on site 2 (900-950m a.s.l.) will be deployed in 2026.

3.4 Proposed delivery timeline.

Activity	Project start	2026	2027	2028	2029	2030	Comments
Recovery from fire	2026						
SensorSticks	2025						
Deer deterrent	2026						
Remote sensing tools	2026						
Altitude – process +	2027						
Altitude - hydro	2025						
Re-seeding bare peat trial 1	2024						Bi-annual review
Re-seeding bare peat trial 2	2024						Treatment until 2027; Bi-annual review
Sheep wool trial1	2024						
Sheep wool trial2	2026						Process monitoring + candidate
Hemp trial	2026						
Access routes	2026						Bi-annual review where established

Figure 1. Gantt chart of monitoring schedule. Unconfirmed timelines are provided in lighter shadings.

3.5 Delivery of Peatland ACTION monitoring priorities

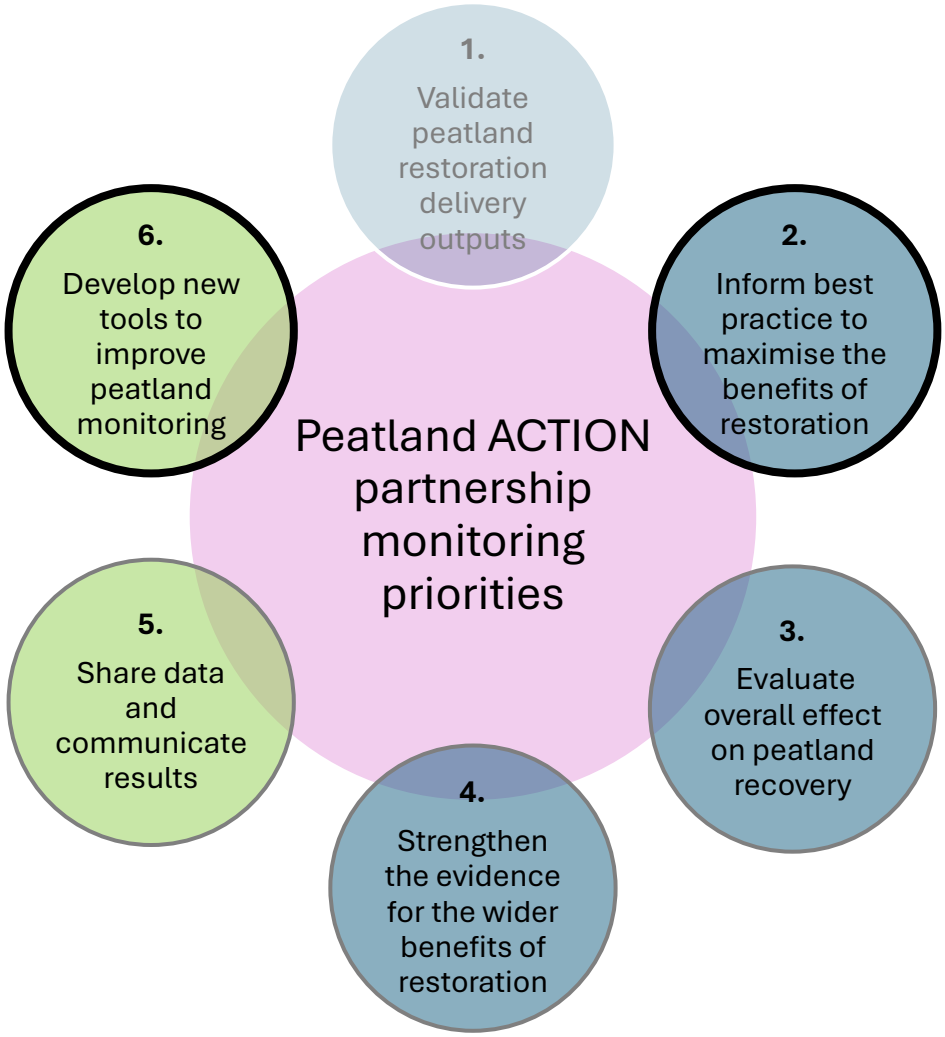


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4. The bigger picture

4.1 Biodiversity impacts

Species and habitat specific surveys repeated pre-and-post restoration can be used to indicate the impacts of peatland restoration on biodiversity. Here we define biodiversity as the number and abundance of species utilising peatland sites, and are particularly interested in species considered to be peatland specialists (where

peatland habitats are important to species-specific ecologies), rather than generalists (which can tolerate a range of habitats, including peatlands).

4.1.1 Dragonflies as freshwater biodiversity indicators

Peatland and bog-specialist dragonflies require healthy peatland and bog ecosystems for breeding and are sensitive to changes in water quality and availability. Dragonfly populations can indicate freshwater ecosystem 'health' and as top predators in these habitats, indicate where peatland restoration works may improve habitat conditions for wider invertebrate biodiversity. There is particular interest in how peatland restoration techniques may be tailored to create habitats for rare dragonfly species though the British Dragonfly Society's 'Dragonflies on the Bog' project, which focuses on sites in north-west Scotland. In The Park, we intend to investigate whether dragonflies are colonising habitats created during peatland restoration works, suggesting improved habitat conditions for freshwater invertebrates generally, and for rare specialist dragonfly species. We would focus on larvae surveys, which are less weather dependant than transect-based approaches to surveying adult populations. These works would focus on:

c) Identifying sites where adult dragonflies have been recorded (e.g. from NESBReC data or field observations) and determine whether pools are being used as breeding grounds (i.e. larvae present).
d) Pre and post restoration surveys to determine presence/ colonisation of pools created by restoration by dragonfly larvae. Post restoration surveys to be repeated in years 1 and 3 since restoration completion.
e) Survey a network of proximal peatland restoration sites to assess a space-for-time relationship between time since peatland restoration and colonisation.

4.1.2 Habitat improvements for breeding birds

Restoration works that might be undertaken in the breeding bird season (approximately March-August) require breeding bird surveys to establish whether species are present on site. Repeating breeding bird surveys may indicate that habitat improvements associated with peatland restoration activities can benefit breeding bird populations (Cosgrove et al., 2025). To explore potential impacts of our peatland restoration activities on breeding bird populations we aim to repeat breeding bird surveys 5-years after works completion.

4.1.3 Woodland-peatland integration

Bog woodland is an Annex 1 habitat in the EU Habitats Directive and a priority habitat in Scotland's Biodiversity Strategy due to its rare assemblage of bog species and trees, typically Scots Pine, Birch and/or Willow. Instead of these trees being considered invasive to peatland habitat, low tree densities and often stunted tree-forms are embedded within the peatland habitat, particularly where peat-depth and water table depth is heterogeneous. These habitats are important for species diversity and The Park is fortunate to contain good examples of bog woodland. We wish to explore the suitability of integrating trees into peatland restoration for biodiversity benefits in a way that would not reduce the integrity of peatland sites. Potential opportunities to explore are:

- Use of site-native trees to help stabilised peatlands, for example to 'lock-in' restoration features as 'living' dams or act as wind breaks to mitigate peatland erosion.
- Whether successful peatland restoration (rewetting and encouragement of peatland specialist species) can be achieved in parallel with appropriate levels (i.e. sensitive) of site-native tree regeneration or landscape enrichment, to enable restoration of ecologically functional woodland-peatland landscape mosaics.
- Impacts of peatland restoration on montane tree species.

4.1.4 Cairngorms Nature Index (CNI)

CNI is a long-term monitoring framework focused on species and habitats in five target ecosystems (woodland, managed uplands, managed lowland grasslands, freshwater, montane, and mires and wetlands) to evidence delivery of the Park Plan. We intend to contribute and collaborate on CNI monitoring where possible.

Specifically, we will collaborate with CNI in passive acoustic monitoring (PAM) of birds and bats on a range of peatland condition sites (e.g. degraded, treated and modified). Baselining is scheduled for 2027/2028 with monitoring repeated at approximately 5-year intervals. This data will also help inform us of peatland-specific biodiversity recovery associated with habitat restoration activities.

4.2 Catchment health and water quality

4.2.1. Impact of sheep wool products on water quality.

As outlined in Section 3.2.2 sheep wool may present an alternative and sustainable geotextile for peatland restoration. However, there are concerns regarding the impact that sheep-wool based products might have on the freshwater environment, with SEPA recommending a precautionary approach due to potential leaching of chemical residues from treatment of sheep for diseases and parasites (e.g. Cypermethrin and/or Diazinon) into water, impacting the water environment, particularly fresh water invertebrates, even when wool has been scoured (cleaned). We intend to contribute to the evidence gap on the interaction between sheep wool products and the water environment via two trials:

Trial 1: as outlined in Section 3.2.2, sheep wool products were used on a site in 2024. Working with Natural Dales Wool Products and ALS Laboratories (UK), we collected water samples from above and below wool logs to assess potential for chemical contaminants. The results of this experiment were inconclusive with marginal traceable elements either due to laboratory testing processes, or transportation of samples from site, and further complicated by presence of sheep on site. Lessons learnt will be built into a second trial.

Trial 2: Utilisation of wool products on a site with no sheep present and water quality testing following recommended laboratory procedures. This could be paired with pre-and-post restoration treatment sampling of freshwater invertebrates as additional indicators of water quality. Such sampling could follow the process outlined in Section 4.1.1 above and below wool logs, with below samples potentially vulnerable to chemical contamination. In future, we intend to explore alternative data collection techniques such as water-based passive acoustic monitoring devices ('HydroMoths') and environmental DNA (eDNA), both capable of detecting the presence of invertebrates.

4.3 Socio-economic impacts

4.3.1 New entrants into peatland restoration

Our programme aims to increase contractor capacity to deliver peatland restoration by providing opportunities for 'new entrants' to gain skills and experience. Annual workforce reviews will monitor uptake of this 'New Entrants to Peatland Restoration' opportunity.

4.3.2 Local skills and capacity

Annual workforce reviews will assess the localities of contractor teams working on Park Authority-led restoration projects to improve our understanding of local peatland sector skills and capacity.

4.4 Proposed delivery timeline.

Activity	2026	2027	2028	2029	2030	Comments
Dragonflies						Sites TBC
Breeding birds						See Table 10
Woodland-peatlands						TBC
Acoustic monitoring						
Sheep wool impacts						1 yr post treatment
New entrants						Annual reviews
Local skills & capacity						Annual reviews

Figure 2. Gantt chart of monitoring schedule. Unconfirmed timelines are provided in lighter shadings.

4.5 Delivery of Peatland ACTION monitoring priorities

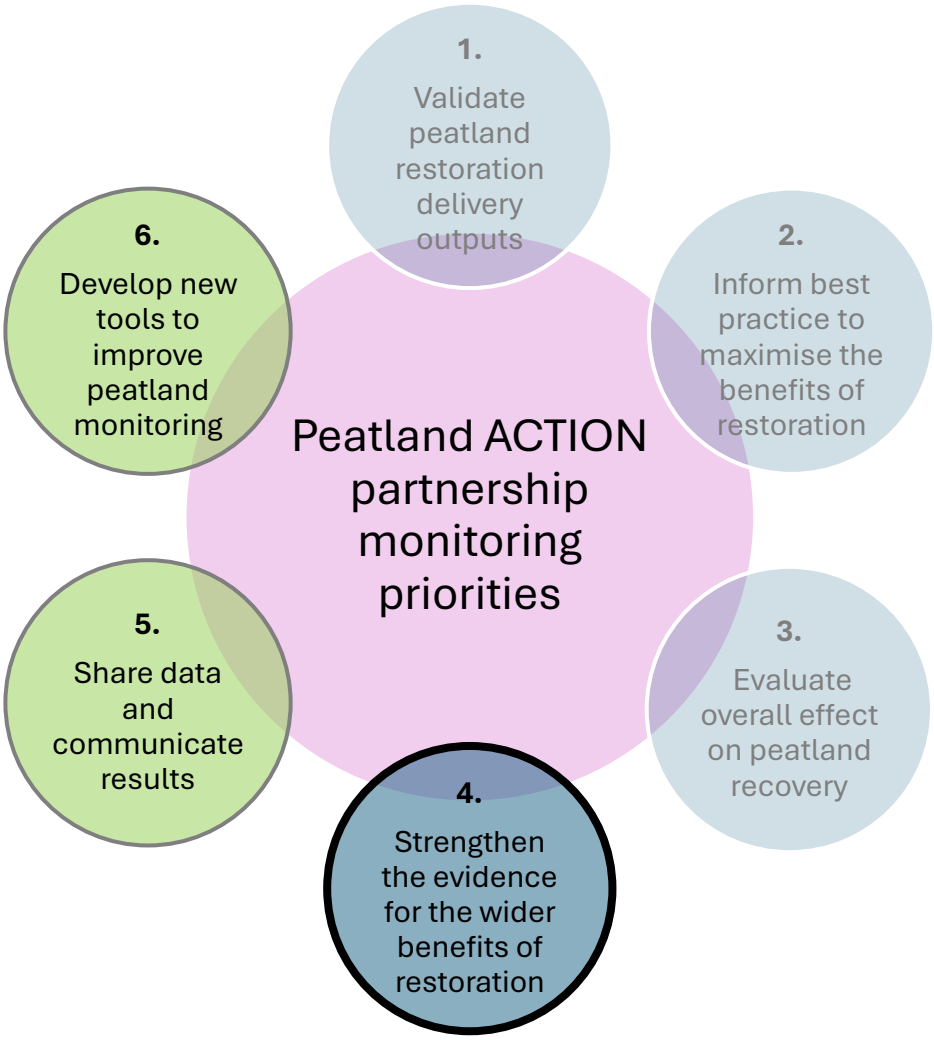


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5. Data quality

5.1 Review/revise survey protocols

We want to continuously review and improve our survey protocols, and are open to feedback from experts and peatland practitioners. Current revision processes include:

- Pre-application surveys

- Process monitoring + version 2
- Ecological constraint surveys

5.2 Develop digital data recording procedures and templates

Digital data recording can reduce recording errors in the field, data inconsistencies and post fieldwork data processing time (e.g. transcribing results). Additionally, this can help ensure data is appropriately stored for future use. Two approaches to digital data collection will be adopted during this monitoring strategy.

1. Field Apps

   Field apps such as QField and Mergin Maps are the mobile companions of QGIS which facilitate georeferenced data recording, navigation and mapping in the field. We will develop survey templates that can be used by Park Authority staff and contractors. Templates to be developed include, but are not limited to:

   - Pre-application surveys, including standard, detailed and habitat impact assessments (Section 1.1.1).
   - Ecological constraints surveys (Section 1.1.3)

2. Ad-Hoc Species Encounters

   Incidental encounters with flora and fauna in the field can provide valuable data for our peatland team and the wider ecological research community. QField is not considered appropriate in this circumstance since data is held within individual QField projects, and is not guaranteed to be synchronised with a wider data depositary. Options include applications such OTISS Path Survey or EpiCollect5 which can synchronise georeferenced field data (including photos) to a web-based interface, or developing our own.

5.3 Data storage and sharing

During this monitoring strategy period we will:

- Improve/formalise data storage processes, building clarity in data storage processes
- Contribute peat depth, condition and restoration footprints to NatureScot Peatland ACTION's data portal
- Share species records with NESBReC
- Contribute species records to the Cairngorms Nature Atlas.
- Share monitoring outcomes with relevant stakeholders in the form of verbal updates, media blogs and/or published research reports were appropriate

5.4 Proposed delivery timeline

We aim to implement these deliverables will in 2026 and protocols will be reviewed where deemed necessary.

5.5 Delivery of Peatland ACTION monitoring priorities

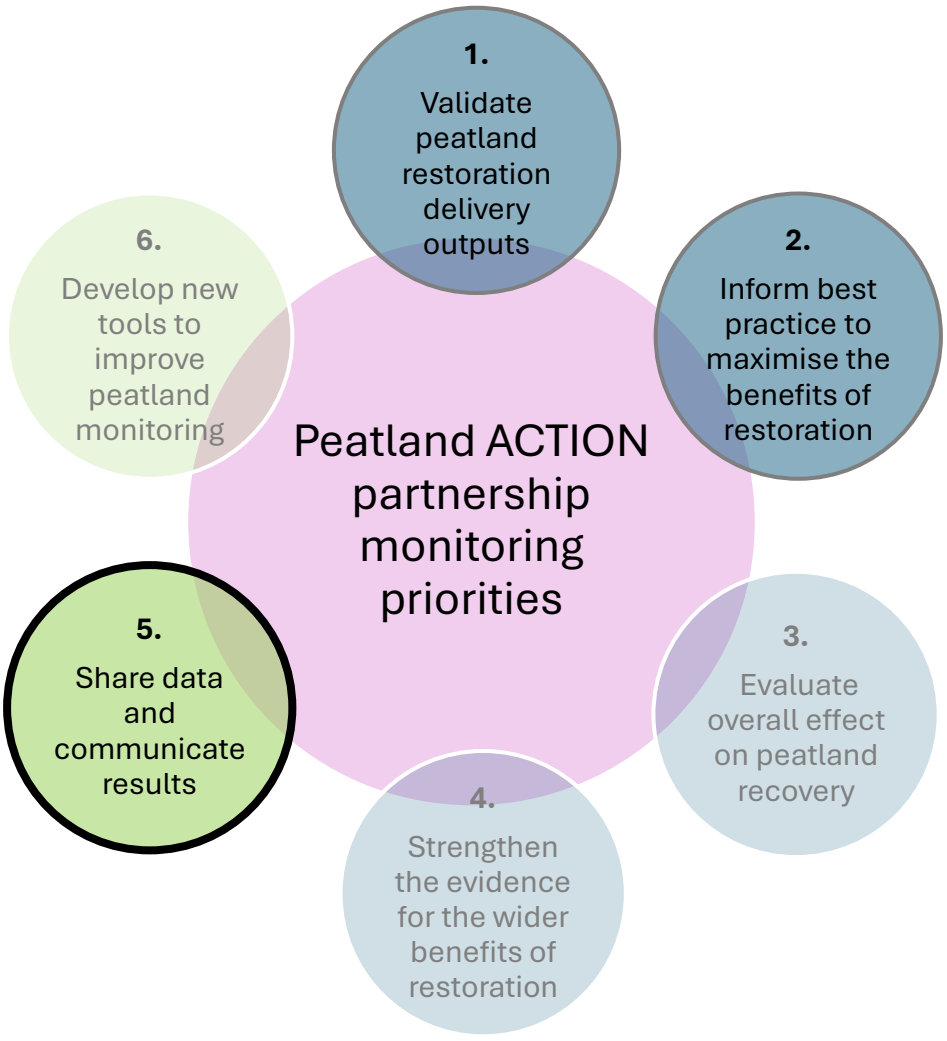


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6. Collaboration

6.1 Facilitate and maintain collaborations

We aim to facilitate collaborations by providing support, access, advice and/or funding. Current collaborations and partnerships are outlined in Table 7.

Table 7. Ongoing collaborations and partnerships

Scale	Activity	Partners	Description	Our role
The Park	Cairngorms Peatland Developers Group	Third party developers including agents, private landowners and eNGOs	Quarterly meetings between peatland practitioners working in The Park for knowledge exchange.	Lead
	Cairngorms Nature Index	Park Authority Nature Team	Long-term monitoring of a variety of indicators of ecosystem health in The Park.	Support
Peatland ACTION	Long-term hydrological monitoring	NatureScot	Water loggers to monitor hydrological changes following peatland restoration across a network of Peatland ACTION sites, including in the Park.	Support
	Restoration Monitoring Network	NatureScot	Long-term monitoring of a network of Peatland ACTION restoration sites, including in the Park.	Advisor
	Peatland ACTION Monitoring and Data Group	NatureScot, LLTNPA, FLS & Scottish Water	Quarterly meetings between Peatland ACTION partners for science and monitoring knowledge exchange	Support
	Herbivore impact working group	NatureScot	Working group to revise and test herbivore impact assessment protocols	Support
National	Scottish LiDAR Steering group	SEPA, NatureScot, ScotGov, FLS, Scottish Water, JHI, University of Edinburgh,	Steering group for the delivery, and generation of products, of the Scottish Land LiDAR Programme including those of relevance to the peatland sector	Support

		University of Cambridge		
	Sheep wool in peatland restoration working group	Regulatory bodies across the UK and Ireland, environmental NGOs, peatland practitioners and researchers	Explores the use of sheep's wool in peatland restoration, and potential socio-environmental impacts	Support
Project/ site	Mar Lodge Estate Monitoring Programme	National Trust for Scotland	Various ecological and hydrological surveys, including on peatland sites. Also monitoring trials of restoration techniques using sheep wool and stone dam re-vegetation	Funder/ support
	Dalnacardoch Estate Monitoring Programme	DWCT	Various ecological, hydrological and meteorological surveys, including on peatland sites	Support
	Greenhouse gas monitoring	JHI	Flux towers on Balmoral Estate	None
	Antheia	Leeds University and JHI	Academic research project utilising remote sensing techniques to monitor bog pool dynamics	Advisor

6.2 Delivery of Peatland ACTION monitoring priorities

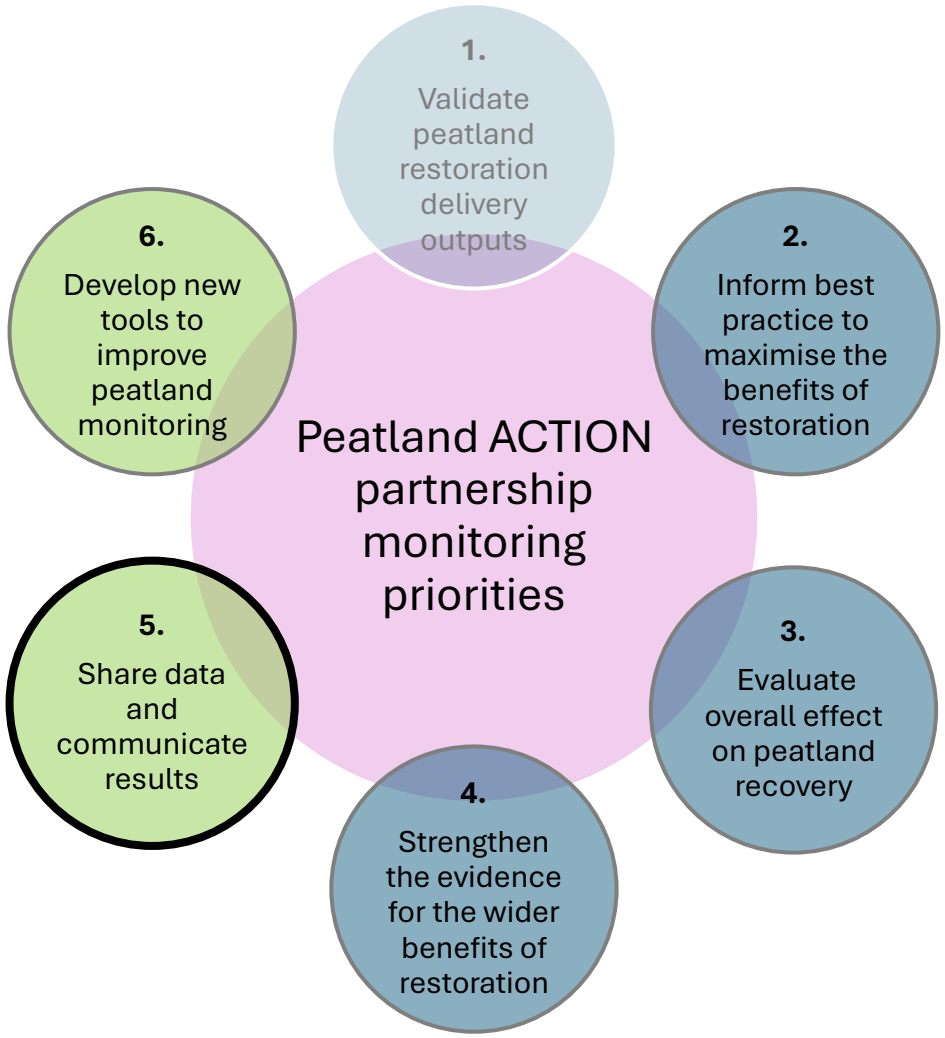


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Exemplary site monitoring schedule

The Gantt chart (Figure 3) outlines integration between standard monitoring activities. Site-specific trails as outlined in this strategy are additional to this minimum monitoring schedule.

Survey-type	pre	Yr 0	Yr 1	Yr 2	Yr 3	Yr 4	Yr 5	Yr 6	Yr 7	Yr 8	Yr 9	Yr 10
Pre-works												
Heritage												
Ecological constraints												
Drone												
Fixed Point Photos												
Review												
Compliance												
Peatland Code												
Process monitoring												
Process monitoring +												
Breeding birds												

Figure 3. Gantt chart of standard site monitoring schedule. Surveys in italics (and light shading may not be applicable and site-specific trials and projects are excluded as non-standard activities.

Acronyms

ADL – Angus Davidson Ltd
CC – Caledonian Climate
CNI – Conservation Nature Index
DWCT – Durrell Wildlife Conservation Trust
EIV – Ellenberg Indicator Values
FLS – Forestry and Land Scotland
FPP – Fixed Point Photography
GO – GIS Officer
HIA – Habitat Impact Assessment
JHI – James Hutton Institute
LiDAR – Light Detection and Ranging
LLTNP – Loch Lomond and the Trossachs National Park
OM - Operations Manager
PA – Project Assistant
PAM – Passive Acoustic Monitoring
PM – Programme Manager
PO – Peatland Officer

PSMO – Peatland Science and Monitoring Officer
RSPB – Royal Society for the Protection of Birds
SEPA – Scottish Environment Protection Agency
SWL – Scottish Woodlands Ltd
NBN – National Biodiversity Network
NESBReC – North East Scotland Biological Records Centre
NTS – National Trust for Scotland
3E – 3E Services

Definitions

Biodiversity – the number of individual species and their abundance

New entrant – contractors eligible for training in peatland restoration techniques and supervision by Cairngorms Peatland ACTION project officers. Companies are only eligible if they have **not** delivered ≥ two relevant projects, have ≤ two operators with experience in delivering drain blocking or where the company has **not** been involved in peatland restoration for more than two years.

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Appendices

Appendix 1. Original process monitoring protocol

Survey-type	Schedule	Method	Purpose of survey
Pre-restoration baseline	Before works	Pre-application assessment	**Site-wide:** peat depth, condition, vegetation composition and HIA.
Post-restoration baseline	Within 1 month	Vegetation, HIA & feature assessment	**Site-wide:** immediate changes in condition, vegetation composition and HIA. **Feature-specific:** whether restoration features are functioning as intended, vegetation establishment/ turnover and any herbivore interactions
Herbivore utilisation	12 months	Trail cameras	**Site wide:** recording herbivore utilisation (primarily deer).
Year 1 post-restoration	1 growing season	Feature assessment	**Feature-specific:** whether restoration features are functioning as intended, vegetation establishment/ turnover and any herbivore interactions
Year 3	3 growing seasons	Vegetation, HIA & feature assessment	**Site-wide:** changes condition, vegetation composition and HIA. **Feature-specific:** whether restoration features are functioning as intended, vegetation establishment/ turnover and any herbivore interactions
Year 5	5 growing seasons	Vegetation, HIA & drone survey	**Site-wide:** changes in vegetation composition, HIA and landscape.
Year 10	10 growing seasons	Vegetation, HIA & feature assessment	**Site-wide:** changes in vegetation composition and HIA. **Feature-specific:** whether restoration features are functioning as intended, vegetation establishment/ turnover and any herbivore interactions