

Understanding peatland restoration costs and contractor capacity

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1 Executive summary

1.1 Aims

Degraded peatlands are one of the largest sources of greenhouse gas emissions in Scotland. The Scottish Government has a budget of £250m to spend towards peatland restoration efforts through the Peatland ACTION (PA) programme up to 2030.

This research explored the evidence for peatland restoration costs in Scotland and examined emerging trends. It also investigated opportunities and challenges for contractors delivering peatland restoration services. We reviewed existing literature and analysed cost data compiled by SRUC from the PA programme projects supported by NatureScot funding between 2018 and 2023. We also carried out interviews with contractors. Data from other PA delivery partners post 2021 was not examined in this project phase due to time constraints.

1.2 Key findings

- Observed peatland restoration costs per hectare vary significantly. This reflects a range of influencing factors, including:
 - project-specific factors (e.g. site characteristics, project length)
 - contractor-specific factors (e.g. firm size and history)
 - background commercial conditions (e.g. inflation, funding availability, tendering processes)
 - site location, baseline condition and environmental designation status.
- Approximately half of the variation in unit costs between sites could not be explained by the statistical analysis, often due to noise in the data, for example:

- Differences in data recording on restoration processes, project characteristics and costs across projects within the study period
- Wider economic factors such as regional variations in labour and material costs, poor transport networks and local competition for scarce resources (see the recent [SRUC Rural and Islands Insights report](#) for evidence of this at a local scale)
- Limited local competition due to barriers to entry to the market.
- There is some evidence for economies of scale i.e. larger projects have lower unit costs. The extent of such economies of scales is difficult to determine due to other differences across projects.
- Statistically speaking, costs of restoration have not changed over time. The absence of such an observed time trend in restoration unit costs may simplify the use of unit costs as predicted by the model to future years.
- Interview data highlighted the impact of other factors, confirming the influence of complexities and uncertainties, both real and perceived, in the tendering process. These include:
 - perceived uncertainty in long-term commitment to government support for peatland restoration
 - challenging tendering processes
 - environmental and market conditions that add risk to a business engaged in restoration.
- This is largely independent of site characteristics but impairs value for money directly by increasing the overhead costs of tendering, and indirectly by constraining the pool of willing contractors.

1.3 Improving operational delivery of peatland restoration

- Estimates for restoration costs from our analysis could be useful for costings of large-scale policy programmes; the spatial approach to estimating variation in unit costs allows extrapolation at larger scale, although further work is needed to understand complex issues.
- Further research into the extent to which economies of scale are present would be helpful, as would steps to improve confidence in the accuracy of reported costs and associated site characteristics.
- Regional differences imply that uniform national benchmarking rates might be inappropriate, with large residual uncertainty of unit costs potentially increasing the risk of falsely rejecting projects that may deliver restoration cost-effectively.
- Using standardised costs to assess projects is also problematic because a large part of variation in costs remains unexplained. Either of the options below can improve this situation.
 - Give greater attention in the tendering process, in particular how that may be improved on both the demand and supply side. This would draw out true context-specific costs in a competitive market.

- Seek greater transparency around individual cost elements for an individual project bid, including overhead charges and profit margins e.g. open-book tendering with agreed percentage markups.
- Supply of restoration services might be strengthened and value for money in peatland restoration increased through consideration of the following:
 - Include contingency costings as part of the tendering process, to address contractors' cost risks regarding e.g. inflation spikes in key inputs (e.g. fuel) or unforeseen site complexities.
 - Commit to long-term funding of a pipeline of restoration projects. This will provide reassurance to existing and potential contractors that their investment in staff and machinery is merited.
 - Ensure prompt payment upon project completion with provision for at least part payment when final inspection is delayed due, for example, to weather conditions.
 - Simplify tendering procedures to stimulate supplier interest in peatland restoration work through rationalisation of information required, improved guidance and support for those tendering the work to provide better feedback.
 - Continue with (well received) training support plus opportunities for mutual knowledge exchange between funders and contractors. A specific area for training is in data collection for contractors.

1.4 Strengthening future analysis

Challenges and limitations of the analysis presented in this report could be addressed by:

- Exploring potential systemic differences across Peatland ACTION delivery partners by comparing the results derived from the NatureScot Peatland ACTION database with estimates generated by, for example the Cairngorms National Park and Forestry and Land Scotland.
- Confirming that the process of recording spatial location and recording of restoration area based on site outlines is standardised and consistently allows linking area and location with records of restoration costs and activities over time. Verification of reported area estimates through digitization in GIS can reveal important discrepancies. Re-recording of samples of outlines for restored areas, known as restoration footprint, on the ground should be considered for comparison.

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2 Glossary / Abbreviations table

Abbreviations

CCP	Climate Change Plan
CEDA	Centre for Environmental Data Analysis
CEH	Centre for Ecology & Hydrology
CNPA	Cairngorms National Park Authority
FLS	Forestry and Land Scotland
GHG	Greenhouse Gas
GIS	Geographic Information System
JHI	The James Hutton Institute
LULUCF	Land Use, Land Use Change and Forestry
NNR	National Nature Reserves
NSA	National Scenic Areas
OS	Ordnance Survey
PA	Peatland ACTION
PCS	Public Contracts Scotland
SAC	Special Areas of Conservation
SEPA	Scottish Environment Protection Agency
SG	Scottish Government
SPA	Special Protection Area
SRUC	Scotland's Rural College
SSE	SSE plc (formerly Scottish and Southern Energy plc) is a multinational energy company
SSSI	Site(s) of Special Scientific Interest

Glossary

Bidding	Process thorough which contractors respond to the tender by offering a budget and scale of activities they are capable of delivering within the defined scope of the project.
Complexity	Aggregate account of extent and effort required to restore a particular site. A combination of site's location, topographic features, accessibility, peatland condition and land cover that determine the overall scales of restoration operations and thus represents a proxy for the resources (costs) required.
Contractor	Private company directly engaged in restoration activities.
Cost Database	Also: SRUC (peatland restoration) cost database; Peat restoration cost database collated by SRUC capturing main activities and costs during restoration collected as part of the NatureScot administered delivery of the Peatland ACTION Programme.
Cost-Effectiveness	A ratio of unit costs of restoration and a metric used for measurement of restoration success such as area restored or GHG abated. High cost-effectiveness means low cost for high level of benefit delivered and thus is a common way to measure value for money.
Degraded Peatland	A peatland is considered degraded if it is a source, rather than a sink of GHGs. This is due to a combination of peat draining and surface damage due to use, extraction or propagation of plant species that hinder the natural process of growth of peat moss (sphagnum).
Feasibility study	Process of determining whether it is practically possible to deliver sufficient levels of improvement in quality of a particular stretch of degraded peatland. Required prerequisite for any implementation activities.
Heterogeneity	Account of patchiness/variability of land cover on a particular peatland site. It is measured as a total length of outline of individual land cover features, i.e. water bodies, patches of forest or grasslands. Land cover heterogeneity is assumed to be linked with high site complexity from the perspective of peatland restoration.
Maintenance	Any work required on a site post-restoration such as repairs to installed features.
Monitoring	Regular assessment of a post-restoration site to collect information on the current status of peatland recovery and any evidence of success of implemented measures. Includes inspection of installed features and sampling of peat condition.

NatureScot	Previously Scottish Natural Heritage; public body responsible for advising Scottish Ministers on all matters relating to the natural heritage.
Peatland Code	Voluntary standard for UK peatland projects wishing to market the climate benefit of restoration.
Peatland Condition	Classification of current state of degraded peatlands. Classes consist of a combination of drainage status and surface cover i.e. drained grassland. Peat condition classes are used to calculate annual emission from degraded peatlands.
Peatland Restoration	A set of activities required to undertake to return a degraded peatland to its (near) natural state.
Peatland	Land is classified as peatland if within the measured boundary the peat soil profile is at least 50cm deep.
Remoteness	Remoteness of a site is an aggregate measure of its distance from population centres, access infrastructure and topographic features such as elevation.
Restoration Cost	For the purpose of this analysis, the costs of restoring a particular site represent all the labour, machinery, fuel, equipment, material and other resources used during the measure implementation phase.
Restoration measures	Individual activities undertaken on a restoration site during the project implementation phase such as installation of peat dams, bunding, moss planting or shrub removal.
Restoration Project	A complete set of activities funded within a single grant allocation. Each restoration project can consist of restoration of a single or several sites. The implementation of restoration activities can be undertaken in several subsequent or overlapping phases.
Restoration Site	A discrete patch of land on which the restoration activities take place. The area defined as a restoration site is thus equal to the area restored after the project implementation phase is concluded.
Rewetting	A collection of activities aimed at restoring the natural water content of required peatland. One of the key steps to reduce excess emissions from degraded peatlands.
Tendering	Process of publishing a call for contractors to apply for a delivery of a specific peatland restoration project and subsequently choosing a winning bid based on the set of defined criteria.

3 Background

A high proportion of Scottish peatlands are in a degraded state and the Scottish Government has been setting ambitious targets for peatland restoration¹. These reflect various overlapping policy objectives, notably reductions in greenhouse gas emissions (GHG) but also biodiversity enhancement and water management. Primarily via the Peatland ACTION (PA) programme supported by Scottish Government and administered by Scottish Natural Heritage (now NatureScot), Forestry and Land Scotland, and the National Park authorities, in excess of [52,000 hectares](#) have been restored since 2012.

In February 2020, [the Scottish Government](#) announced an increase in investment in peatland restoration of more than £250 million over 10 years, aiming to support the restoration of 250,000 hectares of degraded peat by 2030, as part of the [Scottish Government's Climate Change Plan](#) for net zero. In the [Update of the Climate Change Plan](#), the restoration target is upheld, and it is emphasised that “[t]o deliver on the 2032 emissions reduction envelope annual peatland restoration needs to be far higher than the current 20,000 hectare annual target”.²

Scottish Government funding for peatland restoration is managed via the Peatland ACTION (PA) programme. This has five delivery partners: NatureScot, Forestry and Land Scotland, Cairngorms National Park Authority, Loch Lomond and The Trossachs National Park Authority and Scottish Water. **This research examined only NatureScot projects.** Harmonising data from all delivery partners was an initial ambition but considered out of scope within the time and budget available in the project. Nevertheless, cost data collated from NatureScot PA administered projects has wide coverage, geographically and in terms of restoration activities and **accounts for c.70% of PA restoration.**

Over 10,000 ha of Scottish peatlands were restored under PA in 2023/24, an increase in annual restoration area of 40% compared to the previous year. Despite this increase, meeting the policy ambition for peatland restoration will require significant upscaling of restoration efforts over coming years at times of continued pressure on public budgets. Value-for-money and scale of policy ambition imply a need for targeting restoration efforts where it is most cost effective, taking single (GHG emission reduction) or multiple social and environmental outcomes into account. Determining such cost-effective pathways, requires an in-depth understanding of the costs that currently underpin peatland restoration in Scotland. However, whilst variation in restoration costs across different projects are reported (Glenk et al., 2022), the causes of such variation have yet to be investigated systematically. Furthermore, despite the key role that contractors have in peatland restoration delivery (and therefore associated costs), their perceptions of the tendering and restoration process has not yet been sufficiently studied.

¹ Restoration and rewetting are used interchangeably in this report. In doing so, we do not imply that it is likely that peatlands will be restored to their historic undisturbed state, but emphasise the aim of restoring the functioning of the area as a wetland. This is done through raising water tables, i.e. rewetting.

² Although the 2032 emission targets have now been acknowledged as unachievable, the peatland restoration target remains in place.

This report examines variation of costs of implementing restoration,³ factors affecting contractors ability and willingness to engage in restoration, and explores barriers to scaling restoration efforts related to costs and the supply of restoration services by contractors.

The project had three main aims:

1. Which factors affect restoration costs? ([Section 4](#))

We take a broad perspective to offer an overview that considers environmental and site conditions, factors affecting bidding of contractors and actual restoration work. The synthesis is based on a rapid review of literature discussing bidding behaviour and cost of implementing nature restoration, combined with the joint expertise of the research team. Where possible, we discuss interactions between factors and how they have been evolving over time.

2. Which factors explain variation in restoration cost? ([Section 5](#))

We provide a data driven quantification of relationships between restoration cost and environmental and site characteristics. The analysis draws on cost data collected via the NatureScot PA funded programme⁴, which is matched with spatial information on environmental and site characteristics for statistical analysis. This provides insight into any systematic variation of restoration cost to support restoration budgeting and planning.

3. What are the opportunities and challenges for contractors in engaging with restoration? ([Section 6](#))

We draw on interviews with contractors of restoration services selected to represent a mix of size and geographical spread. Interview notes and transcripts were reviewed to provide perspectives on prospects and difficulties faced by contractors as crucial actors for scaling of restoration efforts.

4 Factors affecting restoration – an overview

4.1 A brief synthesis of related literature

To identify factors affecting restoration cost, we screened relevant literature related to costs of ecosystem restoration and nature-based solutions⁵; and the factors affecting bidding behaviour of contractors.

³ Unless noted otherwise, we will refer to restoration costs as the capital requirements to implement restoration on site. This does not include certain transaction (program administration and monitoring) costs borne by funders, the opportunity costs of restoration related to income forgone (see [Moxey et al. 2016](#)), or any private financial benefits of restoration e.g. related to carbon scheme participation or transfer payments. Such costs can make up a considerable amount of total cost of investing in nature based solutions ([Kang et al. 2023](#)).

⁴ Forestry and Land Scotland and the Cairngorms National Park Authority also hold data on restoration costs (as do Loch Lomond and Trossachs National Park), but these databases were beyond the scope of this project.

⁵ For further insights, the search goes beyond peatland and peatland restoration only, including habitat (e.g. wetlands, grassland) restoration more generally but also other land-based sectors requiring similar contracted land management services (e.g. forestry, landscape gardening civil engineering).

4.1.1. Cost of conservation efforts, including ecosystem restoration

There is consensus in conservation literature that costs should play an important role for conservation planning, management and evaluation; they affect 'value for money' considerations. The efficiency of conservation spending is enhanced if funding is allocated based on considerations of cost-effectiveness, i.e., the benefit achieved relative to cost (e.g., Babcock et al., 1997; Naidoo et al., 2006; Perhans et al., 2008; Burkhalter et al., 2016; Rodewald et al., 2019; Field and Elphick, 2019). How benefits are measured is of relevance, too: counting benefits simply in terms of area or number of conservation units is associated with less efficient allocation of resources compared to measures that better reflected actual intended outcomes (e.g., biodiversity) (Engert and Laurance., 2019).

The efficiency gains of considering costs depend on the accuracy of cost predictions. This requires the development of cost projections that reflect the (spatial) variability in cost of conservation action (Burkhalter et al., 2016; Van Deynze et al., 2022), also allowing the identification of potential economies of scale (Cho et al., 2017; Armsworth et al., 2018).

Ecosystem restoration projects of all types are generally considered to be high cost, often requiring significant up-front capital investment (Sewell et al., 2016). However, costs of restoration vary greatly across contexts and locations (de Groot et al., 2013; Sewell et al., 2016; Van Deynze et al., 2022). Factors quoted to influence cost variation include the baseline level of ecosystem degradation, local infrastructure availability, type and scale of restoration, population pressure and density, the legal framework, existing land use and tenure arrangements, land value, labour costs and method of measurement (Sewell et al. 2016,). We found studies referring to complexity of restoration works, managing and protecting safe access to sites, access to labour and supplies, and other project characteristics including land cover, slope, elevation, number of sites in a project and distance between sites (Van Deynze et al., 2022).

More specific peatland restoration cost estimates for the UK and Scotland also show great variability. For example, costs per hectare vary greatly by restoration technique used (Artz et al 2018; Okumah et al., 2019; Glenk et al., 2020, 2021, 2022). A previous CXC study (Artz et al., 2019) investigated physical limitations to access to restoration sites. They focused on several factors – physical infrastructure (road network), snow days, rainfall, elevation, peat condition, drainage status and a NatureScot remoteness index. Further, Aitkenhead et al., (2021), in their mapping of peatland emission categories, provided evidence for strong regional variation in peatland conditions and levels of degradation. In an outline of a national peatland monitoring strategy, Artz et al. (2023) proposed features such as bare peat extent, topographic and hydrological connectivity, soil erosion levels, microclimatic proxies water table stabilisation such as rainfall or windspeed and changes to vegetation cover among others, as essential dimensions to monitor the potential success of restoration efforts. Previously, Artz et al., (2019) had also identified strong geographic divide in peatland conditions across Scotland and that high site fragmentation levels introduce substantial error into the estimation process.

Other studies confirm the relevance of factors including altitude and distance from roads (remoteness) (Okumah et al., 2019), and site condition (Glenk et al., 2020, 2021, 2022), pre-restoration site use and land-cover.

The conservation and restoration literature emphasises the importance of reporting cost elements (e.g. fixed & variable, capital, labour cost) instead of simply total cost (Cook et al., 2017; Artz et al., 2018). Knowledge of cost elements, ideally collected in a standardised way (Iacona et al., 2018; Artz et al., 2018), facilitates the transfer of cost estimates across sites and contexts, enhances their potential to enter decision support tools, and improves understanding of the relationship between cost and conservation outcome as spending increases or decreases (Cook et al., 2017). Lack of standardising how costs are accounted for adds to an already large variation in reported cost across projects (Sewell et al., 2016; Glenk et al., 2020).

4.1.2. Synthesis of papers investigating contractors' decisions to bid

Peatland restoration is primarily undertaken by private-sector contractors who are invited to tender competitively for work. However, little research appears to have been undertaken specifically in relation to peatland contractors' business models and factors influencing their decisions to bid for restoration projects. Nonetheless, some possible insights are offered by findings for other land-based sectors (e.g. forestry, landscaping, and civil engineering).⁶ Although the analogies are not perfect, they are sufficient to identify relevant types of issues.

Common factors identified in this broader literature fall into various risk categories: client-related, project-related, contractor-related, and other (Cohan, 2018; Oo et al., 2022; Olatunji et al., 2023). The latter relate to background market conditions and government policies which apply across all contractors and projects, for example, wage and price inflation or regulatory obligations. All other things being equal, uncertainty about relative costs and/or future regulatory requirements dampen contractors' willingness to bid for projects and/or increase quoted bid prices (Oo et al., 2022; Binshakir et al., 2023; Olatunji et al., 2023).

Client-related factors include financial and organisational reputation plus willingness to foster longer-term relationships. For example, promptness in paying, openness of administrative processes, and degree of mutual trust. All other things being equal, a reliable client with simple(r) bidding processes and a willingness to share project information plus commit to a pipeline of work is more likely to receive bids, and at lower prices (Spencer, 1989; Oo et al., 2022; Binshakir et al., 2023; Olatunji et al., 2023).

Project-related factors essentially relate to the size and complexity of projects (and hence overlap with the site-specific factors noted above). For example, larger projects generally benefit from economies of scale and simpler projects have less risk of encountering unforeseen problems. Hence, all other things being equal, simpler and larger projects are more likely to attract bids, and at lower unit prices (Oo et al., 2022; Binshakir et al., 2023; Johansson et al., 2023; Kronholm et al., 2023; Olatunji et al., 2023).

Contractor-related factors relate to the capabilities and confidence of individual firms. For example, prior experience with similar projects, availability of relevant staff and machinery, and sufficient cash-flow. All other things being equal, a contractor is more likely to bid for a given project if they are familiar with the type of work required and either already have the necessary staff and machinery or are sufficiently confident to invest in additional capacity (e.g. perceive a good chance of follow-on work). Confidence to bid may also reflect the anticipated degree of

⁶ For example, Spencer (1989), Cohan (2018), Benjaminsson et al. (2019), Kronholm et al. (2021), Oo et al. (2022), Binshakir et al. (2023), Johansson et al. (2023), Olatunji et al. (2023).

competition from other contractors and perceived fairness of (client-related) bidding processes. For example, the likelihood of a rival bid by a competitor being viewed as strong and/or favoured may discourage bidding (Cohan, 2018; Spencer, 1989; Oo et al., 2022; Binshakir et al., 2023; Johansson et al., 2023; Kronholm et al., 2023; Olatunji et al., 2023).

4.1.3. Implications for costs

Given that all factors identified above are likely to vary across different projects, clients (e.g. funding bodies), contractors and time-periods, it would be expected that observed unit costs (e.g. per ha) will display significant variation. This is confirmed by previous analysis of peatland restoration costs across Scotland (Okumah et al., 2019; Glenk et al., 2020, 2021, 2022). For example, Glenk et al. (2022) report overall median costs of £1025/ha across 158 completed projects but with a standard deviation of £4328/ha, and also show that medians for different types of projects vary between £939/ha and £1778/ha.

Reported costs for other types of ecosystem restoration also show significant (>40%) variation. This is largely attributed to differences in project scales and complexity, including administrative processes, but also to a lack of standardisation in cost reporting. Econometric analysis of the determinants of cost variation typically struggle to explain all such variation (King and Bohlen, 1995; Keating et al., 2015; Knight et al., 2021; Van Deynze et al., 2022).

4.2 Likely factors affecting peatland restoration cost

The findings from the available literature are consistent with anecdotal evidence gleaned previously by members of the research team and of the Steering Group. As such, it is possible to hypothesise the types of factors likely to affect peatland restoration costs, to guide (but not dictate) issues to explore through statistical analysis of secondary data and through discussions with contractors.

We identified a wide overview of potential factors affecting restoration costs across sites and at a given point in time ([Appendix Table A4.2](#)). There are potential relationships between factors and restoration costs, for example, costs per hectare are likely to fall as project size increases and overhead cost elements can be spread more thinly. However, costs per hectare are likely to increase with severity of baseline degradation (e.g. proportion of site with eroded or bare peat) as the restoration effort required increases. Similarly, more remote sites and sites with more complex mosaics of features may also be relatively more expensive per hectare.

The issue is complex and factors may confound each other. For example, economies of scale effects may not be immediately apparent if larger sites also happen to be more remote and/or more degraded.

The statistical analysis relied on the cost data already collated by researchers of SRUC into a suitable database from PA NatureScot data, although inconsistencies in reporting over projects and the study period (2018-2023) presented challenges. Specific metrics for characterising projects may include various biophysical indicators (e.g. area, location, topography) as well as baseline condition and access conditions affecting which type and density of restoration techniques is cost-effective.

We understand that PA delivery partners differ in their approach to profiling projects for tendering with potential implications for a full analysis of reported cost. For example, the Cairngorms www.climatexchange.org.uk

National Park Authority (CNPA) has a model to translate complexity into labour and machinery days necessary for restoration, providing options for adjustments of typical rates in the process. This approach makes intuitive sense given that many site-specific factors affecting cost are related to complexity ([Appendix Table A4.2](#)). However, pre-characterization of complexity of restoration via aerial photography is time consuming and may be challenging to apply at scale. This may change in the future, for example employing machine learning mapping tools to assess drainage and erosion features that provide indication for restoration complexity (Macfarlane et al., 2024).

In addition, background changes over time may affect all projects, including advances in restoration techniques ([Appendix Table A4.3](#)). For example, inflation increasing the costs of key inputs (e.g. fuel) but also, potentially, innovation and experience reducing unit costs. Dynamics of supply and demand for restoration services may affect unit cost of restoration and also change over time. For example, contractors of restoration services may become more experienced and thus efficient over time. However, whether this impacts on unit costs depends, among other things, also on the level of competition that contractors face.

In addition to the statistical analysis of reported cost data, more qualitative insights can be gained through interviews with contractors undertaking restoration activities on-the-ground. This offers an opportunity to confirm the relevance of factors identified for statistical analysis. It also offers an opportunity to explore other factors not included in the cost database.

For example, contractors' willingness to bid and quoted prices for particular projects may be affected by their capacity and experience (e.g. number of diggers, work on similar sites previously), but also by alternative income-generating opportunities (e.g. other civil-engineering work). Moreover, it may also be affected by (perceived) complexity and fairness of tendering processes, including the (perceived) likelihood of bidding successfully (i.e., whether tendering is worth the effort).

Such issues can be explored through discussion with contractors using semi-structured interviews. Whilst a range of different types of contractors (e.g. varying by size, location and experience) can be interviewed, results should not be treated as statistically representative but rather as illustrative cases of the types of factors influencing contractors' engagement with peatland restoration.

4.3 Conclusion

Peatland restoration costs are influenced by a range of factors, including:

- project-specific factors (e.g., site characteristics, project length),
- contractor-specific factors (e.g. firm size and history), and
- background commercial conditions (e.g. inflation, funding availability, tendering processes).

These factors vary across different projects, clients (e.g. funding bodies), contractors and time periods, leading to great variation in observed unit (e.g. per ha) costs. Lack of standardising how costs are accounted for further adds to this already large variation in reported cost across projects. Systematic analysis of the factors to identify variation and evidence collected directly from contractors are needed to gain in-depth understanding.

5 Explaining variation in restoration cost

In this section we use information entailed in the SRUC cost database, which is compiled from NatureScot Peatland ACTION grant application and final reporting forms (see Section 5.1). We combine data in the SRUC cost database with publicly available spatial data to determine how geography, climate, peat condition, land use and site designation (SSSI etc.) are associated with restoration costs. The main output of the work reported in this section is a statistical model which attempts to explain variation in the restoration cost per hectare across completed projects.

The model results can be used to understand systematic relationships between restoration costs and site characteristics (e.g. access, topography, land use) that vary spatially. Findings may provide answers to questions such as ‘typically, is restoring peatland under grassland or forested land more or less expensive?’; or ‘is there a trend for restoration to be more expensive in one region compared to another?’. Answers to such questions may provide insights on how peatland restoration in Scotland could be delivered more cost-effectively. The model may also be used for to derive estimates of costs associated with expanding restoration across Scotland, for example as part of a cost-benefit analysis. We also highlight gaps in knowledge and highlight areas for review and further research that could make this type of analysis more accurate.

5.1 Methodological approach: cost data analysis

The SRUC cost database (see Glenk et al., 2022 for an overview) contains detailed information on project costs and activities, and in its most recent form originates from 289 final project report forms of NatureScot PA administered restoration projects covering a period from April 2016 to March 2023. Due to issues with unreliable historic data contained in the forms (see [5.2.4](#)), only 229 of the 289 final observations for a period between April 2017 to March 2023 were complete and sufficiently reliable to be used in the analysis. Full details of the methodology, including limitations of the SRUC database, are given in [Appendix A5](#).

Cost of restoration of a particular peatland site is here defined as the sum of all expenses within the project implementation phase. This includes all the measure-related costs (labour, material, fuel, equipment/machinery), mobilisation costs, project management and monitoring costs (within implementation phase) and other necessary work not directly attributable to restoration measures, such as changes to access infrastructure, site boundaries/fences, location-specific biodiversity protection measures or livestock/wildlife management/exclusion. Cost estimates exclude costs associated with feasibility studies, bidding and grant application process, any pre-restoration site-specific expenses, post-restoration monitoring and maintenance or loss of income due to limited use of the site post-restoration. These non-implementation costs are excluded because they are not part of the contractor tendering process and relate to a different set of activities. In addition, many sites do not yet have a lengthy period of reporting of post-implementation costs.

A statistical model to infer the cost per hectare of a site in the SRUC cost database based on 37 explanatory variables was developed to determine which variables significantly impact on cost. Spatial variables were extracted from several maps based on the location of the restoration project under the assumption that the sites were perfect circles of an area equal to that reported in the SRUC cost database. Spatial variables used to infer cost include rainfall, peat condition, peat

depth, pooled-biogeographical-zones. Various configurations of the model were tested (i.e., different explanatory variables, different units of measurement), but the model presented is the best in terms of statistical test performance (see [Appendix A5](#) for more details). A full list of variables used in the model can be seen in the Appendix Table A5.1. and a more detailed description of the data extraction and statistical model can be found in [Appendix A5](#).

Figure 5.1 displays the geographical distribution of projects considered in the analysis across what we refer to as ‘restoration zones’ ([Appendix Table A5.4](#)). It is important to note that Figure 5.1 is not a representative map of PA restoration activity. The eight restoration zones were created by pooling the original 21 ‘biogeographical zones’ for the ease of interpretation. The original biogeographical zones, also referred to as ‘[Natural Heritage Zones](#)’ represent discrete regions based on similarities in topography, climate and the composition of biological community. Sites within a restoration zone are expected to have similar environmental and geographical features and thus a similar foundation for peatland restoration.

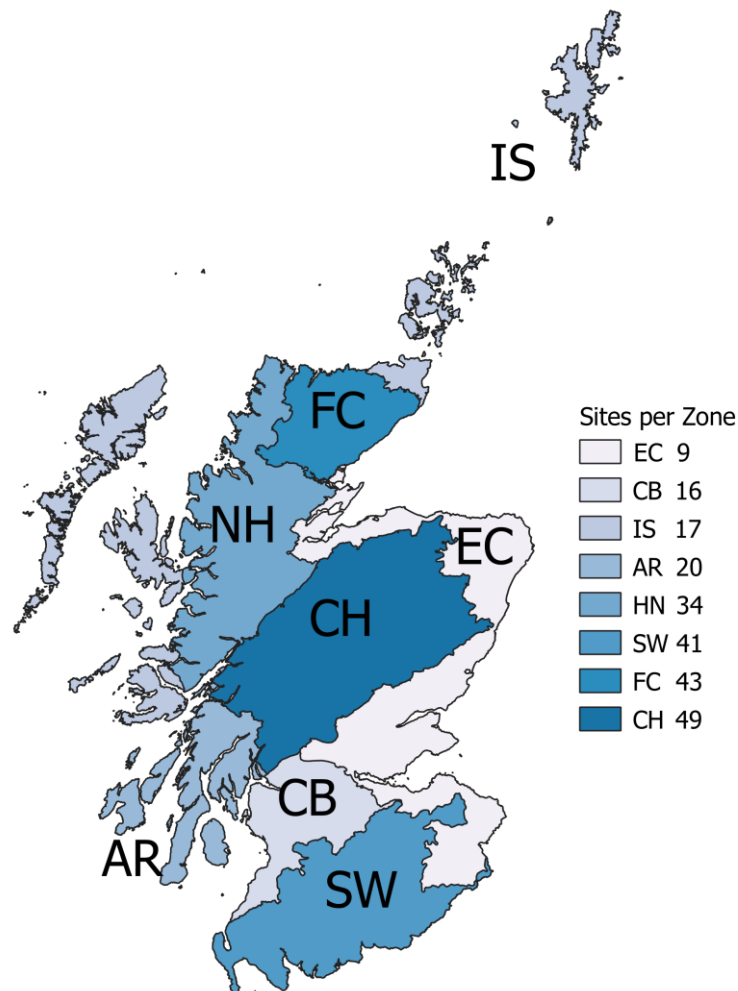


Figure 5.1: Number of sites per restoration zone. FC) Flow Country; AR) Argyll; CH) Central Highlands; NH) Northern Highlands; EC) East Coast; IS) Isles (Shetland, Orkney, Hebrides except for Argyll); CB) Central Belt; SW) Southwest.

5.2 Results of cost data analysis

5.2.1. Descriptive data overview

After removing entries with obvious reporting errors (totalling 60 entries), the average cost per hectare (2020-£/ha) of restoration is £1,550/ha. However, there is a large variation in unit cost. To illustrate this: the unit cost at the 5th percentile is £191/ha, while the unit cost at the 95th percentile is £4,483/ha, [Appendix Table A5.6](#).

Therefore, using an overall average cost per hectare to estimate costs of future restoration projects is not advised and further information about the site is required to infer variation in cost per hectare. The average restoration cost per hectare in each restoration zone shows that, all else equal, restoration in the Flow Country was least costly while restoration in the Central Belt was most expensive (Figure 5.2).

On average, 22% of sites were classified as ‘Near Natural Bog’ in the [UK LULUCF Inventory](#) ([Appendix Table A5.5](#)), and the largest area of restored peatland was classified as ‘Near Natural Bog’ at 32% of the area restored, for the sites considered in this study ([Appendix Table A5.5](#)). However, according to information provided by the NatureScot Peatland ACTION team only 3.8% of restored peat bog is near natural bog. It is likely that the ‘circle method’ ([Appendix Figure A5.1](#)) for calculating the area of restored peatland and/or the inaccuracy of the peat condition map used in the inventory may cause errors in our calculations.

Size class	Interval (ha)	Average cost (2020£/ha)
1	[0-10]	2375.773
2	[10-25]	1478.852
3	[25-40]	1,344.1
4	[40-85]	1,487.4
5	[85-578]	933.5

Table 5.2: Sites categorised into area classes of equal number of observations (N=46 and N=45 for Size class 5) and their average restoration cost per hectare.

To analyse the relationship between site area on costs per hectare, the sites were distributed equally to size-classes based on spatial area. The average unit costs for sites in the smallest area category were approximately three times as high as the ones in the largest area category, Table 5.2, pointing to the possibility of economies of scale (see [Appendix A5.3](#) for an explanation and illustrative example related to peatland restoration).

These averages, however, need to be interpreted with caution due to the nature of calculation of costs per hectare (total site costs divided by total site area) and confounding factors, i.e., other factors co-vary (in our data) with size. The suggestion that decreased unit cost associated with larger site size in the data is due entirely to economies of scale could therefore be misleading. For example, a high proportion of larger sites are grassland sites rather than bare peat sites, meaning that their lower per ha costs may partly reflect their scale but may also partly reflect the relative ease of restoring grassland rather than restoring bare peat.

This was evident in the cost database, where we find that the largest sites (N=6 representing 17% of the restored area; site area >380ha) had none of the complex restoration activities such as mulching, stabilisation, felling and sphagnum transplanting (one notion of site-complexity). Therefore, it was difficult to determine if a large site was cheaper per hectare due to economies of scale, or because it required less complex restoration activities; both explanations are likely responsible for the observed decrease in cost per hectare with increased site area.

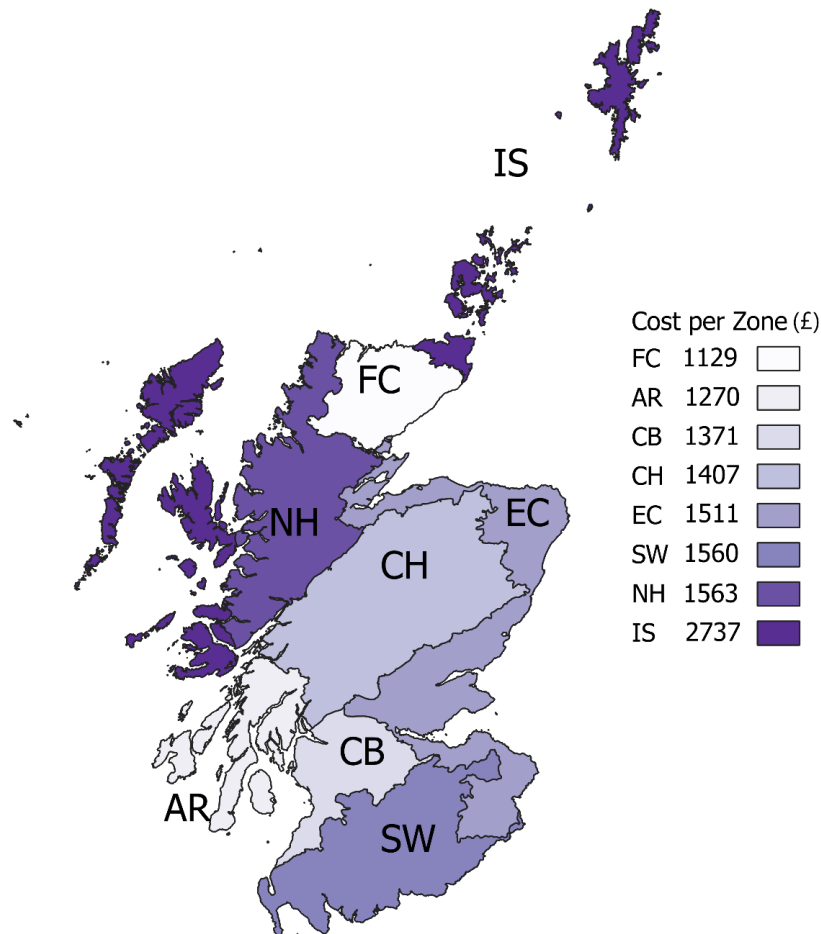


Figure 5.2: Average restoration cost per hectare for each restoration zone. Zones: FC) Flow Country; AR) Argyll; CH) Central Highlands; NH) Northern Highlands; EC) East Coast; IS) Isles (Shetland, Orkney, Hebrides except for Argyll); CB) Central Belt; SW) Southwest.

5.2.2. Statistical model results: drivers of spatial variation in cost per hectare

The results provide a good overview of the spatial drivers of restoration cost but may mask any interactions between variables. The statistical model (log-linear) helps us unpick all the variables that are driving cost for a site and determine features that are making sites more or less expensive ([Appendix Table A5.7](#)). The model explained 52.0% of the variation in cost per hectare amongst the 229 sites used in this study. After accounting for the number of variables (37) used in the www.climatexchange.org.uk

model relative to the number observations (Adjusted R-squared), the explained variation was 42.4%, which compares favourably to other studies (Van Deynze et al., 2022). The unexplained part is attributed partly to noise in the reported data (e.g. errors in forms and in data entry) and to unobserved influences on costs – both of which reflect some of the limitations of the data collection process. However, it should be noted that it is unrealistic to expect 100% explanatory power on any statistical model: neither is the underlying relationship between different factors often known sufficiently to specify it perfectly in modelling terms nor are all possible data available to populate a perfect model.

Figure 5.3 displays all the variables considered as having an influence on cost per hectare, and the amount that they are predicted by the statistical model to change costs per hectare⁷. Variables right of the red dashed line increase costs and those left of the dashed line decrease costs. Here we discuss variables which we are almost certain ('significantly') to affect cost per hectare according to the available data, i.e. those in green in Figure 5.3 as well as variables we initially expected to drive unit cost.

5.2.2.1 Year of funding

We expected that cost per hectare would vary across time ([Appendix Table A4.3](#)). However, the year in which the funding was granted is not statistically significantly explaining variation in costs. Since the costs are deflated, the data suggests that peatland restoration costs have changed over time in line with inflation. However, most data points were unreliable before 2017 and the reliability of data increased after 2019, which leaves only a six-year time period to be investigated here. This then limits conclusions in regards of time trends.

Nevertheless, those interested in time trends may inspect a descriptive analysis of area of restoration sites, restoration measures, land cover and regions over time for the study time period (2018-2023, [Appendix 5.4](#)).

5.2.2.2 Regions

For the pooled biogeographical zones, the lowest restoration unit costs, once all other factors such as forestry land use are controlled for, are reported for the Flow Country (which is used as a reference point in the statistical model and hence does not show up in Figure 5.3). Costs per hectare are significantly greater for sites in all other regions. Note that this applies after controlling for all other factors considered in the model. The restoration zones with the greatest restoration costs per hectare are:

1. The Isles: On average, log-cost per hectare is 2.1 times greater to restore a site in this region than in Flow Country. The high costs may reflect a mix of greater costs (e.g. fuel and haulage costs) on islands. Furthermore, the limited supply of contractor services on specific islands and their need to travel long distances and potentially transport the heavy machinery by ferry are potentially important factors.
2. Argyll: On average, log-cost per hectare is 1.4 times greater than for the Flow Country. The complexity of terrain and remoteness to some extent overlaps with The Isles, and thus similar challenges might be expected.

⁷ We note that the magnitudes of the factors cannot be compared (see Appendix Figure A5.3 for a version of the Figure where magnitudes can be compared).

3. Central & Northern Highlands: log-cost per hectare restored is 1.3 times higher than in the Flow Country. The hilly terrain adds complexity due to more difficult access and environmental conditions in which the restoration needs to take place.

The availability of contractors in different restoration zones may also explain the regional differences (see Section 6 and factors related to demand and supply of contractors in Appendix Table A4.3.)⁸.

5.2.2.3 Peatland condition classification

The proportion of peatland in certain condition categories affects restoration costs. In general, sites with lots of peat classified as 'grassland' are cheaper to restore, Figure 5.3. We hypothesize that this is because the land is more homogenous and because the grass is protecting the underlying peat from erosion. Therefore, it is more likely that the restoration activities required will be cheaper, such as drain blocking. It may also be that grassland areas have more favourable access conditions that reduce costs.

In contrast, sites with large proportions classified as 'eroded bog' increase the restoration cost. This is likely due to the complexity and raised cost of restoration activities to restore eroded bogs, e.g., hag reprofiling and sphagnum moss transplants. The proportion of the site with peat classified as 'forest' has the greatest positive effect on cost per hectare amongst Inventory peatland condition categories. We expect that this is due to the cost of felling, and the associated removal of stumps and possibly mulching, before restoration activities can begin. This finding is in line with earlier analysis presented in Glenk et al., (2022).

5.2.2.4 Site designation

Each site designation is self-reported and model results can be interpreted as the effect of a particular reported site designation, keeping all other designations the same. If a site reports SSSI designation, the log-costs per hectare are 80% higher than without it, Figure 5.3. This could be tied to careful operation on-site and risk of downtime through presence of important wildlife. The national scenic area (NSA) designation has the opposite effect on costs. If a site falls into this category, the log-costs per hectare are 69% lower. This effect might be the result of better access to scenic areas and overall better pre-restoration site conditions and management. Further work is required to understand the influence of this factor.

5.2.2.5 Site use

Like site designation, site use is a self-reported category, and each site could have several reported uses. The model results for each site use are interpreted as the effect of a particular reported site use, keeping all other reported site uses the same. Forestry reported as a site use dramatically increases restoration costs per hectare. On a hectare basis, sites that are used for grazing are cheaper to restore than those that are not used for this purpose, Figure 5.3. This is in line with 'forest' and 'grassland' peat condition categories discussed above (5.2.2.3). Although the effect is less certain (i.e., not significant), costs per hectare of sites self-reported as 'field sports' (i.e., shooting grouse) tend to be lower. We expect this is due to the good access on such sites.

⁸ Potentially contributing to relatively lower restoration costs, earlier projects especially in the Flow Country may have been subject to sequencing of restoration measures at the same site over several years; with yearly progress entered as new projects into the SRUC cost database. The extent to which such sequencing might have taken place is, however, unclear.

5.2.2.6 Average rainfall

In general, sites with a greater average yearly rainfall rate are associated with lower cost per hectare. This could be due to various reasons, such as comparatively higher water tables that might imply healthier peatland and thus less complex restoration activities.

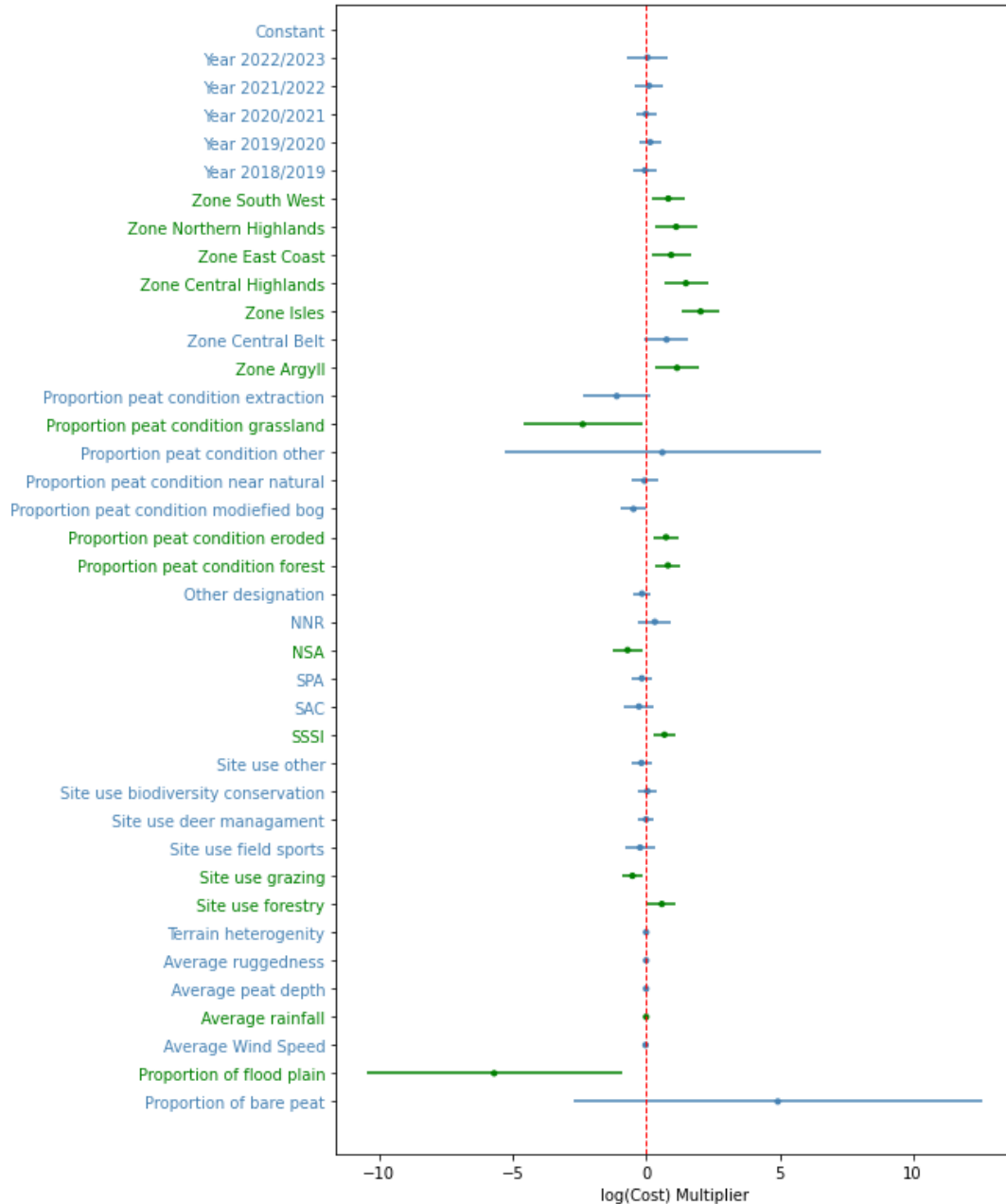


Figure 5.3: Factors and how they affect the costs of restoration.

5.2.3. Statistical model results: summary

- The statistical model allows us to explain c.52% of the variation on per hectare peatland restoration costs.

- Site location within restoration zones and specific categories of peat condition, site use and site designation are significant predictors of variation of costs per hectare of peatland restoration.
- Of these factors, the geographical area that the site is in is the largest driver of cost per hectare with significantly greater values on the Isles, and significantly lower values for the Flow Country, after accounting for other factors.
- Forestry, both as a site use and a peat condition category, has a strong effect on overall costs due to complexity of activities related to forest removal⁹.
- High levels of peatland erosion are linked with greater per hectare restoration costs.
- Presence of floodplains/surface water on site, NSA designation and grazing, or peat covered by grassland all significantly reduce site restoration costs per hectare.
- On average, larger sites have lower unit costs (£/ha) than smaller sites. We attribute this to a combination of economies of scale and a tendency for larger sites to be associated with relatively less complex and thus cheaper restoration activities.

5.2.4. Main limitations of the analysis

While the explanatory power of our analysis lies within expectations for this type of study, it is important to note sources of ‘noise’ and data uncertainty. Apart from potential issues with data entry and collation into the SRUC cost database, a major source of uncertainty is related to large variation in detail and rigour of reporting of the restoration process via application and reporting forms. Several reports are missing crucial details making them invalid for further analysis. It is important to point out that such issues primarily arise for older sites in the SRUC cost database, and that reporting forms have been adapted several times over the study period to accommodate insights as the PA program evolved within NatureScot.

Each PA project that has been granted funding by NatureScot can be identified via a grant reference number. Thus, the sites that have been restored within the same restoration grant share the same reference number. However, throughout the duration of restoration, the definitions of sites often change, in part reflecting adjustments to initial restoration plans made throughout a project. Differences concern both the number of sites within a grant, and the area of identified sites can both increase or decrease based on what is currently considered feasible/priority. Therefore, the information detailed in project application forms can only be compared to final forms if these changes were sufficiently documented. Likewise, it was sometimes not possible to link past restoration grants to more recent grants on a specific area of peat. We recommend using the same grant reference codes for additional funding or encoding previous grant codes into new grant reference codes so that previous funding can easily be traced back to new funding for the same overall restoration area.

Inconsistencies of grant reference numbers and site IDs between the SRUC cost database and PA spatial data meant that it was impossible to easily link spatial site outlines to the cost data base. Consequently, we manually “triangulated” matches between sites in the SRUC cost database and

⁹ Note that the analysis only includes forest-to-bog restoration by NatureScot PA projects (and not forest-to-bog restoration through, for example, FLS).

sites in the spatial data for restoration from NatureScot PA, which was both time consuming and without guarantee of being free of error.

Due to unavailability of geospatial data for all sites in the SRUC cost database considered for analysis, we assumed that each site was a circle of the reported restoration area around a central point which reduces accuracy. According to NatureScot, spatial data has now a site ID field and the final report document has also this site ID field with cost associated, which should facilitate similar analysis of variation in restoration cost per hectare in the future. Furthermore, moving to digital reporting so that spatial information and cost data can be entered into the same data portal may reduce errors in site identification and matching of cost and spatial data. Due to a lack of a standardised methodology for the calculation of a total area of a restoration site, over time of study (2018-2023) and across restoration sites in the SRUC cost database, the account of area restored provided in the reporting form can be only treated as approximate.

Sites for which the reported areas were missing, unclear or otherwise impossible to work with were removed from the analysis. The format in which the type, unit and (unit or total) cost of restoration measures is reported also varies as reporting forms were updated over the years; and depended on preferences and reporting efforts invested by grantees. For example, the installation of wave dams has been reported either as the total number of individual dams, the total length of all the drains that were dammed, or the total area covered by the specific type of dams. Wave dams also feature only in later editions of application and reporting forms. Such issues with reporting complicate measure-specific analysis of restoration cost. For example, differences in units in which measures are reported make judgment on measure intensity in a restoration site challenging if not impossible. A more technical description of the limitations in the analysis can be found in the [Appendix A5.1.5](#). An account of challenges regarding information used for collating an earlier version of the SRUC cost database is also included in Glenk et al. (2022).

5.3 Conclusions

- For costings of large-scale policy programmes, and in the absence of more robust alternatives, our model might be used **to provide upper and lower bounds for restoration costs**. The use of mostly spatially explicit variables in the statistical **model facilitates extrapolation at larger scale**. Accepting **important caveats** regarding the analysis (related e.g. to consistency of recording of cost within SRUC cost database and the proximate approach to deriving spatial variables from reported area), information on variation in unit cost could be combined with spatially explicit restoration pathways to **derive baseline estimates of expected costs of large-scale policy implementation and related uncertainty**. Such estimates could for example be combined with benefit estimates of peatland restoration in a cost-benefit analysis.
- Statistically speaking, costs of restoration have not changed over time. The absence of such an observed time trend in restoration unit costs may simplify the use of unit costs as predicted by the model to future years.
- Prior to extrapolation of unit cost estimates for large scale policy appraisal, **further research is needed to assess the extent to which economies of scale** are present. This could be combined with further **efforts to improve confidence in the accuracy of reported costs and associated site characteristics**.

- Because of the great degree of variation and the relatively large degree of unexplained variation in unit costs, the statistical model should not be used for appraisal of individual projects (as opposed to large scale policy programmes). However, there are potential implications of the unexplained variability for the practice of **using standardised costs to assessing projects and benchmarking**. Given the large degree of unexplained variability, greater flexibility in appraisals of cost should be offered. In this regard, for example, our model points to a need for **accommodating for larger costs on the Isles**.
- There has been great progress in **harmonising cost and area reporting for projects**, especially since 2019. Based on challenges in linking the SRUC cost database with spatial data on NatureScot Peatland ACTION administered projects for the study period, **a review of the methodology for recording** of the following data may prove useful. This recognises that much of the points below may already be in hand:
 - **Costs:** clear, separate categories for measure-related expenses and project management; costs identifiable at a site level and over time.
 - **Site outlines:** precise recording of site location and dimensions. [Guidance for recording outlines and areas](#) (e.g. distance buffers around areas where restoration measures are implemented) to record area impacted by restoration has been developed. It might be worth to review that guidance is implemented consistently and enforced for all projects by Peatland ACTION delivery partners.
 - **Applied measures:** unified accounting of units (i.e. length vs. number of dams).
 - **Common and unified project and site identification:** ensure that the system in place allows tracking of sites throughout project lifetime and beyond.
- Also, compare the statistical results derived from NatureScot Peatland ACTION projects within the SRUC cost database to the estimates generated for projects administered by other delivery partners.
 - For example, CNPA uses a bottom-up approach that classifies peatland restoration needs and associated costs by complexity mapping based on aerial photography. A more detailed analysis of costs of delivery by Forestry and Land Scotland could provide **additional insights into the economics of forest to bog restoration**.
- **Verify reported area estimates in spatial data provided by NatureScot Peatland ACTION.** Re-recording of site outlines (area restored/restoration footprint) on the ground should be considered and could be incentivised and/or organised via Peatland ACTION officers.

6 Opportunities and challenges for contractors delivering peatland restoration services

The rapid literature review (see [4.1.2](#)) points to a knowledge gap about service providers implementing nature-based solutions. Our research partly addresses this gap with a focus on contractors of peatland restoration and their views and perceptions regarding business models, factors influencing decisions to tender and costing within tenders, and barriers and opportunities to scale business operations in the peatland restoration domain.

6.1 Methodological approach: contractor views

Eight interviews were conducted with contractors providing peatland restoration services in Scotland, primarily funded through NatureScot as the PA delivery partner (Table 6.1). Here, we define contractors as the company or individual enacting the peatland restoration. Details of the approach are given in [Appendix B6](#), including the interview protocol (Table B6.2).

Interview notes and transcripts were reviewed to identify commonalities and points of difference in contractor perspectives of the tender process and wider factors affecting the industry. Findings are presented here around nine main themes: factors affecting tendering, alterations to tendering, costs, importance of business diversity to create resilience, consistency of funding and workflow, geographical area of work, recruitment and skills, training and increasing the restoration area.

Participants								
Size	Medium	Large	Small	Medium	Small	Large	Medium	New Entrant
Region	Main-land National	Main-land National	Main-land NE	Main-land NW	Island	Main-land National	Main-land NW	Main-land NE
Number of Operators	9	28	5	8	5	No data	8	1
Number of Machines	9	25	11	9	6	No data	6	2

Table 6.1: Study participant overview. To maintain anonymity, we remove identifiers and randomise order of appearance in this table

6.2 Results of interview analysis

6.2.1. Factors affecting tendering

A wide range of considerations affecting the decision to tender were mentioned by participants, including

- Ease of tendering, which determined whether contractors would tender or not. This applied mainly to smaller contractors
- Current workload
- Capacity, although this is increased by machinery hire or sub-contracting
- The accessibility of site
- Whether the operations matched their machinery portfolio
- One large contractor does their own formal value for money assessment to decide whether it is worth tendering

Experience of the tendering process was commonly raised as an important factor affecting the decision to tender, in line with findings from the literature ([Section 4.1.2](#)). Contractors further highlighted a number of issues with the tendering process that were leading to frustration and

could pose a barrier to expanding the industry. Decision makers in administrations involved in implementing peatland restoration have some control over shaping the tendering process, thus offering potential for operational adjustments.

- Transparency of the process: Contractors highlighted a need for substantiated and clear feedback.
- Timeframes: knowing what is happening when and sufficiently in advance.
- Content of tenders was too involved.
- Public contracts tendering was perceived by smaller contractors as onerous and not always concomitant to the scale of project.
- Tendering is a non-productive aspect of a business that does not favour micro and small businesses. Several contractors perceived that the complexity of tendering is a barrier to smaller contractors entering the industry.

The time spent on tendering ranged from one to five days. Most contractors indicated that they spent several days working on each tender highlighting that tendering is a significant cost to be absorbed by businesses. Where contractors were very keen on a project, they would visit the site, therefore increasing their investment in, and commitment to, the site.

Tendering success was highly variable with smaller contractors often doing jobs not requiring a full tender process. Several contractors reported low success rates with a perception of time being wasted. One large contractor reported that their success rate was around one third. Two further (well experienced) contractors related that they had not won any “Peatland ACTION” work in the last year although they did work for SSE and FLS and had won PA contracts in the past. Contrastingly, one island-based contractor related that their success rate was near 100%. For those reporting low levels of success, this was understandably leading to frustration.

“Do I want to put good money and time toward chasing peatland action work? Right now we will dabble where we think it's appropriate, but I'd rather put time and effort into chasing work that will actually go somewhere.” (A4)

Contractors generally regarded the tendering process as overly complex and inefficient, requiring a level of information which could be out of proportion to the value of contracts. A particular problem raised was a lack of standardisation in both the information requested and the format required between different organisations, which increased the amount of time required to respond to each. Even those contractors who had built capacity in tendering through dedicated staff perceived that the tendering process was unnecessarily complex; one highlighted that lack of standardisation was a problem as it increased the risk that key information would be missed; another considered that complexity was a barrier to smaller contractors wishing to enter the industry. Adding to frustration around low tendering success, some contractors perceived that there was insufficient feedback provided on why tenders had been unsuccessful. While feedback on relative pricing was provided, other factors used to discriminate between tenders were rarely communicated.

“You don't even get feedback that you can work off because everybody just goes, [the winning bidder's] technical submission was better, and you go well, what was better about it? And they go, I'll need to get back to you. It's not like there's a matrix and they go well, here's where the other person's scored higher.” (A5)

A perceived lack of transparency in how tenders were awarded was a key concern for one contractor in particular who considered that tendering had become “closed book” and that “it seems to be a small handful of main players who will all the contracts”. Providing an example of where a contract had been awarded to a company closely connected to the commissioning organisation they also voiced concern that contracts appeared to be being awarded without being listed on [Public Contracts Scotland](#) (PCS).¹⁰ These points were raised as breaches in what they considered should be a fair and transparent process to ensure fair allocation of public funds.

Contractors further related that the planning and timeframes for tenders were too often uncertain, which could lead to a “feast or famine” outcome. It was further highlighted that the current funding year had been particularly unusual.

“Due to the way in which projects are being assessed and funded by Scottish Government and Peatland Action, there has been a glut of tenders recently, so I've probably done in the space of two months, probably submitted about 24 jobs. And you know never in the history of my working life [have I] ever seen anything quite like it, you know, in terms of a glut of workload, of a single thing.” (A8)

Some contractors also indicated that they had begun bidding strategically to account for the risk that projects ultimately would not go ahead due to funding constraints. One larger contractor related that they ran their own value for money assessment to determine whether it was worth tendering. Another mid-sized contractor similarly indicated that they were starting to consider expected cost per hectare as a factor in their decision to bid for work.

6.2.2. Contractor views on alterations to tendering

Framework agreements were discussed as a potential means to reduce the volume of information in tender submissions. Although easier for the commissioning organisation as they only deal with one contractor, it was considered that the approach favours contractors who have the resources to tender well. One participant raised concern that this would lead to the dominance of larger contractors, leaving the smaller, less lucrative and active part of the contract to be subcontracted to smaller contractors. Although the framework provides a simplified approach, they considered that work could be done at lower cost by directly contracting smaller contractors.

A common view amongst contractors was that restoration work should support the local economy.

“I think it's only right if the Lewis people get the Lewis work and the Skye people get the Skye work providing they're doing it at competitive rates” (A7)

Linked to this, one mid-sized contractor questioned whether smaller contracts could be tendered on a different basis, and offered to local contractors first as a means of developing local capacity.

“I know when we were starting up these small jobs were great for us and we even picked up a lot of like ten, twenty grand AECS schemes and they were brilliant for us and they helped us get our feet and learning how to tender for bigger work.” (A4)

¹⁰ At the time of interviewing, interviewees may not have been aware that listing on PCS had recently been made compulsory rather than simply preferable.

A similar view was given by a larger contractor who questioned whether it may be possible to differentiate tenders and make it easier for smaller contractors to bid for the smaller jobs and allow the larger contractors to take larger jobs.

Wishing to highlight a positive example, one contractor pointed to Bidwells as an example of an efficient tender process that was easy to understand and provided a good mapping system. Another contractor similarly praised Bidwells' efforts to streamline the tender process by maintaining key contractor information on file, reducing the volume of information that must be submitted with each tender.

6.2.3. Risk factors and costs

The key risk factors affecting cost quoted by participants were:

- Difficulty and distance of site access: distance and accessibility affect costs in terms of additional travel time, machinery breakages and increased risk.
- Winter risk, flooding and snow restrict access to sites, potentially stranding machines or requiring premature mobilisation from sites.
- Activities: damming and ditch blocking were assessed as relatively straightforward to estimate, whereas hag- reprofiling was considered to be more variable.
- Contractors further referred to rising costs of machinery, and wages as future drivers of costs.

6.2.4. Importance of business diversity to create resilience

To survive in what potentially is an uncertain environment of peatland restoration and funding, most businesses had a reasonably diversified business model, not relying too heavily on peatland restoration. Two contractors indicated that they were quite specialised, with peatland restoration accounting for more than 80% of their turnover. In some cases, they reviewed their exposure to risk and considered reducing reliance on peatland restoration. Reducing the exposure to risk from peatland contracts included working with utilities, civil engineering (dualling of the A9), estate access, hydro-schemes, footpaths, fencing, dykeing and tree planting. Many of these alternatives are easier to implement, provide more certain longer-term work, reduced risk, with less travelling and reduced ongoing costs.

6.2.5. Consistency of funding and workflow

Consistency of commitment to funding was important for all the contractors. Prior blips in funding reduced confidence in the industry and ultimately the amount of time committed to peatland restoration. Planning, timelines and long-term contracts could all be improved to provide a more continuous flow of work. Multiyear funding was appreciated but it was felt this needed to be more co-ordinated to create a rolling programme of work for both large and small sites.

Although progress has been made in some areas with more summer restoration, the summer gap and down time reduces the amount of restoration completed. Some contractors considered the summer gap as positive, as it gave operators a break and change of scene to alleviate the monotony of peatland restoration.

Improving the diversity of funding was considered a good idea to reduce reliance on Government funding. If Government funding was to be reduced in the future it was suggested to apply gradual

tapering rather than the sudden drop that many contractors experienced when the renewable obligation was suddenly stopped for windfarm construction.

Although a few years away, an early indication of the Scottish Governments long term strategy for funding restoration post 2030 would be appreciated to signal long-term commitment to the sector.

6.2.6. Geographical area of work

Most contractors were willing to travel, with some Scotland based contractors working in Ireland and England. The reasons for the travel were partially to diversify the business and provide new experiences for the business and operators. Most businesses preferred to work in their local area, but inevitably not all operatives could find housing near the business base and had to travel anyway. In some cases, contractors may drive up to an hour from their home base, followed by another ½ hour transiting to the sites via an access track. Finding suitable accommodation for staff is an issue in some cases.

6.2.7. Recruitment and skills

Contractors highlighted the importance of rural skills for working on peatlands efficiently. A key requirement voiced by contractors was the ability to ‘read the landscape and the conditions’. Technical skills in operating diggers and machinery were important, but not as critical as knowing how to move the machine on soft ground which was harder to come by and essential to avoid accidents and bogging. Ideal candidates for recruitment were those with hill experience; “farm kids” (A1) or “ex shepherds, stalkers and gamekeepers [who have] been on the hill most of their lives” (A3).

Fortunately, in terms of operator skills it was considered that due to the video gaming industry there were plenty of competent young people who could quickly learn how to operate diggers, and this aspect is not a problem for the businesses. The key issue requiring training was once on site and reading the landscape, which requires time and perseverance.

Retention of staff, particularly younger members present problems with staff leaving for less repetitive jobs or easier working conditions in civil engineering. Businesses try to combat this by offering variability of work and location, or through benefits such as a four- day week.

It was acknowledged that a wider range of skills is now requested of operators, principally mapping and GIS skills. In the case of smaller businesses this presented problems adding to workloads and need for upskilling. One large contractor questioned whether placing additional demands on operators was the most effective way to monitor work, believing that measurement could be undertaken more efficiently by a dedicated third party. Other (typically mid-sized and larger) contractors indicated that they had invested in IT and mapping capabilities.

Peatland ACTION funded training and apprenticeships were being used and appreciated.

6.2.8. Increasing and using restoration capacity

In circumstances where contractors perceived there to be a funding cut, they were not considering increasing their capacity. It was accepted that over time the amount of available work would increase. Using current capacity more efficiently was the approach being taken. Most contractors did not see evidence of additional work coming forward.¹¹ The issue for increasing the area restored was not related to capacity.

Current capacity is underutilised due to:

- Uncertainty of funding, leading to contractors looking for other work to reduce risk.

¹¹ It should be noted, however, that interviews were mostly undertaken before an announcement was made regarding funding for an additional 7000ha.

- Poor work stream planning that leads to uncertainty and reduces contractor ability to plan and expand operations.
- A hiatus in contract confirmation after end of March which leads to bunching of contracts, reducing capability to complete within a given timescale.
- Summer working with long daylight would utilise the current capacity to restore substantially more hectares. Breeding birds are the main factor reducing or stopping restoration through the summer. Generally, restrictions on estates regards stalking seasons is now less of a problem as it is understood that by good planning both operations can coexist.
- Some contractors were aware that the Peatland Code and collection of information was delaying contracts and made planning more difficult.

6.3 Conclusions

Combining the results from the data analysis and the interviews, we can draw the following conclusions on the questions posed by this research.

The interviews with contractors offer insight into the industry's views and perceptions regarding the tendering process and further engagement with peatland restoration as a business opportunity. Below is a synthesis of findings and options that may help address identified issues.

- Confidence in future funding is critical for contractors working in the industry. Unexpected reductions in funding reduce contractor confidence and may deter investment. Therefore, funding should ideally be consistent within years, based on a **long-term commitment to peatland restoration post 2030** that reflects the importance of restoration to address the twin climate and biodiversity crises. Interest and trust between funder and contractors may also be strengthened if information on how peatland restoration is funded post 2030 **involved contractors at a very early stage**.
- The tender process and its transparency were factors that concerned all contractors. Current tendering processes were considered to favour larger contractors with specific staff to respond to tenders. The amount of information required, whether the information was used and the ability to receive meaningful feedback were all factors affecting contractors' willingness to tender. **A review of tenders and information required** and how that is achieved would encourage a wider range of contractors to engage and tender. Such a review may focus on **simplification and proportionality**. Consideration might be given to whether basic tendering information could be submitted on an annual (rather than project) basis to stop repetition of effort. A review might also include **guidelines for providing substantiated post tender feedback**, as several respondents were unclear on how to improve future tenders. Improved feedback could lead to less contractor comeback and a greater willingness to tender.
- Underlying the contractor conversations was that they seek to provide good value for money whilst making a profit in a highly variable environment. All the contractors interviewed valued their reputation and wanted to produce quality restoration. Clearly, tendering requires a balance between bureaucracy and accountability. However, a degree of pragmatism is necessary in light of the urgency for action to counter the twin climate

and biodiversity crises. Consequently, the **amount of information required as part of the tendering process should ideally be concomitant to the scale of work.**

- Access to sites was seen as a key factor influencing the decision to tender (and also the cost of restoration). Poor and long-distance access increases both costs and risk. The purchase of specialised machinery to carry crews to the work site is required and the additional transit time reduces the length of the working day. In addition, poor and rough access results in machinery breakage and costly down time. To improve access conditions, in future any **access granted under planning permission could allow for neighbours to use the access for the purposes of land management.** There are cases of adjacent road standard tracks to sites that could not be used as they were on neighbouring land. Further considerations might include **improving affordable rural housing to increase rural workers and reduce unsustainable travelling.**
- Concerns were raised about consistency of funding and projects across the year. Peatland restoration generally has a short window of operation in the autumn, winter and early spring. This is further shortened due to heavy snow. Historical and current precedents of cuts in funding have made contractors very wary. Contractors suggested that diversified funding may help this situation. In response to this, options to assist contractors should be explored to **identify and pursue diversified funding sources to reduce risk and increase contractor confidence.**
- One opportunity to diversify funding sources lies in **improved coordination of environmental projects.** Currently there appears little or no coordination of environmental projects. With coordination, peatland restoration contracts could seamlessly run into river restoration contracts. Likewise, Scottish Water have many long-term infrastructure projects that could fill gaps in contractor work. Thus, **a more continuous flow of conservation work could be achieved through improved planning and coordination of work across the land-based sector** to better integrate peatland restoration contracts with, for example, river restoration and Scottish Water projects.
- Anecdotal evidence suggests that birds are less disturbed by consistent on-site presence than is recorded in scientific literature. A **review of bird disturbance policy** based on scientific evidence may thus help reducing down time and reducing uncertainty when tendering. To further reduce perceived uncertainty for contractors, low altitude contracts might be retained to cover periods of long-lasting snow.
- To stimulate investment, there is potential for interest free government backed loans for startups/early growth businesses. Consistency of projects would enable more assured payback of finance. In this regard, it might be worth to explore suitability of existing schemes and further **opportunities to ease access to interest free government backed loans for startups/early growth.**
- **Training and apprenticeships for delivery of restoration works** are of high value to individuals and businesses interested in entering the market, and **should continue to be financially supported.**

7 Conclusions

The research findings presented in this report reflect a rapid synthesis of the literature and our research team's own expertise plus statistical analysis of cost data compiled from NatureScot

administered Peatland ACTION (PA) projects and qualitative interviews with peatland restoration contractors. We have identified a multitude of factors affecting peatland restoration costs and contractors' decisions to tender for restoration work.

Whilst information on peatland restoration costs is available for NatureScot projects funded through the PA programme, the causes of apparent variation in costs have not yet been analysed systematically. Our statistical model, combining cost data with project site characteristics, is able to explain c.52% of observed variation. This is in-line with attempts to model cost variation in analogous sectors (e.g. other ecosystem restoration, landscaping).

Our analysis does not identify a time trend, but highlights that there are regional differences in cost, with higher costs to be expected for the Isles. Site features indicating greater complexity of restoration action, such as forest land cover and high levels of erosion, are associated with greater restoration cost. While restoration cost per hectare decreases as size of restored sites increases, our data does not allow us to fully and causally attribute this effect to economies of scale alone. This requires further investigation.

Overall, our analysis points to a need to recognise that there is large degree of unexplained variation in unit costs while unit costs vary considerably across sites in our data. This has implications for the relevance of standardisation in assessing projects and developing benchmarking of costings. For example, regional differences imply that uniform national rates might be inappropriate, while large residual uncertainty regarding unit costs would increase the risk of falsely rejecting projects that in fact deliver restoration cost-effectively.

However, although unexplained variation in costs may reflect genuine unobserved causes, our analysis was also hampered by several potential data imperfections. For example, the precise shape and size of individual projects is subject to some uncertainty, which may lead to errors in characterising sites. Equally, across the study period (2018-2023), categorisation of different types of cost is not necessarily consistent across all projects nor are different phases of the same project necessarily recorded consistently across different funding periods. Efforts to improve data quality have already been instigated. Nevertheless, it might be worth to clarify inconsistencies in older data, and confirm that harmonised data collection (site specific data on activities, cost, location, area, consistently recorded over time) is in place to improve the accuracy of future analysis.

Contractors are service providers who implement restoration work on the ground. The quality of their work is therefore key to restoration success. Despite their important role in the restoration process, there is a paucity of literature on motivations and barriers to contractors to tender for and enter ecosystem restoration work (including peatland restoration), and on factors that affect costs and long-term viability of restoration work to businesses. We interviewed contractors of different size and varying geographical range of operation. We identify recommendations that will affect cost and quality of delivery and thus enhance value for money of peatland restoration delivery in Scotland.

Specifically, we point to a need for a streamlined tendering process that is simplified and proportionate to scale of work, and that provides meaningful post-tender feedback. Fostering reliable and strong relationships with contractors is important, as is mitigation of short-term (e.g. mitigating risk of interruptions to work) and longer-term (e.g. related to funding situation) business risks. Cash flow availability might be improved through more efficient processing of payments to contractors, although delays may be caused by agents and not the funding

institutions (PA delivery partners). Business risk may also be reduced through offering opportunities to diversify funding sources, for example via improved planning and coordination of work across the land-based sector. Training opportunities are appreciated, but barriers to entering peatland restoration as a service provider would benefit from enhanced support for start-up, both in terms of e.g. interest free capital provision and tailored advisory support.

All of the above aspects affect costs and quality and thus value for money of peatland restoration delivery. A revision of the modus to deliver peatland restoration using public funds across Scotland should be embedded in a long-term commitment to peatland restoration post 2030 to attract investment and offer business perspective. Such a commitment to consistency of funding is needed to reflect the importance of peatland restoration to a world experiencing twin climate and biodiversity crises.

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10 Appendices

10.1 Appendix A4 Factors affecting restoration – review and synthesis

Web search terms concerning cost-effectiveness of peatland restoration	
("restoration" OR "nature-based solution*") AND ("cost-effectiveness" OR "cost*")	
Web of Science Search 1: broad peatland terms, contractor terms narrowed	
Peatland Terms	TS = (peat OR peatland OR bog OR restoration OR rewetting OR "ecosystem restoration" OR "nature-based" OR "nature based") AND
Contractor Terms	TS = (contractor OR supplier OR worker OR workforce) AND NOT
AND NOT (Non- OECD Countries)	TS = ("Afghanistan" OR "Albania" OR "Algeria" OR "American Samoa" OR "Angola" OR "Argentina" OR "Armenia" OR "Azerbaijan" OR "Bangladesh" OR "Barbados" OR "Belarus" OR "Belize" OR "Benin" OR "Bhutan" OR "Bolivia" OR "Bosnia and Herzegovina" OR "Botswana" OR "Brazil" OR "Bulgaria" OR "Burkina Faso" OR "Burundi" OR "Cambodia" OR "Cameroon" OR "Cape Verde" OR "Central African Republic" OR "Chad" OR "Chile" OR "China" OR "Colombia" OR "Comoros Congo" OR "Democratic Republic Congo" OR "Republic Costa Rica" OR "Côte d'Ivoire" OR "Croatia" OR "Cuba" OR "Czech Republic" OR "Djibouti Dominica" OR "Dominican Republic" OR "Ecuador" OR "Egypt" OR "Arab Republic" OR "El Salvador" OR "Equatorial Guinea" OR "Eritrea" OR "Estonia" OR "Ethiopia" OR "Fiji" OR "Gabon" OR "Gambia" OR "Georgia" OR "Ghana" OR "Grenada" OR "Guatemala" OR "Guinea" OR "Guinea-Bissau" OR "Guyana" OR "Haiti" OR "Honduras" OR "Hungary" OR "India" OR "Indonesia" OR "Iran" OR "Islamic Republic" OR "Iraq" OR "Jamaica" OR "Jordan" OR "Kazakhstan" OR "Kenya" OR "Kiribati" OR "Korea Democratic Republic" OR "Kyrgyz Republic" OR "Lao PDR" OR "Latvia" OR "Lebanon" OR "Lesotho" OR "Liberia" OR "Libya" OR "Lithuania" OR "Macedonia FYR" OR "Madagascar" OR "Malawi" OR "Malaysia" OR "Maldives" OR "Mali" OR "Marshall Islands" OR "Mauritania" OR "Mauritius" OR "Mayotte" OR "Mexico" OR "Micronesia" OR "Moldova" OR "Mongolia" OR "Morocco" OR "Mozambique" OR "Myanmar" OR "Namibia" OR "Nepal" OR "Nicaragua" OR "Niger" OR "Nigeria" OR "Mariana Islands" OR "Oman" OR "Pakistan" OR "Palau" OR "Panama" OR "Papua New Guinea" OR "Paraguay" OR "Peru" OR "Philippines" OR "Poland" OR "Romania" OR "Russia*" OR "Rwanda" OR "Samoa" OR "Sao Tome and Principe" OR "Senegal" OR "Serbia" OR "Montenegro" OR "Seychelles" OR "Sierra Leone" OR "Slovak Republic" OR "Solomon Islands" OR "Somalia" OR "South Africa" OR "Sri Lanka" OR "St. Kitts and Nevis" OR "St. Lucia" OR "St. Vincent and the Grenadines" OR "Sudan" OR "Suriname" OR "Swaziland" OR "Syrian Arab" OR "Republic Tajikistan" OR "Tanzania" OR "Thailand" OR "Timor-Leste" OR "Togo" OR "Tonga" OR "Trinidad and Tobago" OR "Tunisia" OR "Turkey" OR "Turkmenistan" OR "Uganda" OR "Ukraine" OR "Uruguay" OR "Uzbekistan" OR "Vanuatu" OR "Venezuela" OR "Vietnam" OR "West Bank" OR "Gaza" OR "Yemen" OR "Republic Zambia" OR "Zimbabwe")

Web of Science Search 2: broad contractor terms, peatland terms narrowed	
Peatland Terms	TS = (peat OR peatland OR bog OR rewetting) AND
Contractor Terms	TS = (contractor OR supplier OR worker OR workforce OR skill* OR labour OR training) AND NOT
AND NOT (Non- OECD Countries)	TS = ("Afghanistan" OR "Albania" OR "Algeria" OR "American Samoa" OR "Angola" OR "Argentina" OR "Armenia" OR "Azerbaijan" OR "Bangladesh" OR "Barbados" OR "Belarus" OR "Belize" OR "Benin" OR "Bhutan" OR "Bolivia" OR "Bosnia and Herzegovina" OR "Botswana" OR "Brazil" OR "Bulgaria" OR "Burkina Faso" OR "Burundi" OR "Cambodia" OR "Cameroon" OR "Cape Verde" OR "Central African Republic" OR "Chad" OR "Chile" OR "China" OR "Colombia" OR "Comoros Congo" OR "Democratic Republic Congo" OR "Republic Costa Rica" OR "Côte d'Ivoire" OR "Croatia" OR "Cuba" OR "Czech Republic" OR "Djibouti" OR "Dominica" OR "Dominican Republic" OR "Ecuador" OR "Egypt" OR "Arab Republic" OR "El Salvador" OR "Equatorial Guinea" OR "Eritrea" OR "Estonia" OR "Ethiopia" OR "Fiji" OR "Gabon" OR "Gambia" OR "Georgia" OR "Ghana" OR "Grenada" OR "Guatemala" OR "Guinea" OR "Guinea-Bissau" OR "Guyana" OR "Haiti" OR "Honduras" OR "Hungary" OR "India" OR "Indonesia" OR "Iran" OR "Islamic Republic" OR "Iraq" OR "Jamaica" OR "Jordan" OR "Kazakhstan" OR "Kenya" OR "Kiribati" OR "Korea Democratic Republic" OR "Kyrgyz Republic" OR "Lao PDR" OR "Latvia" OR "Lebanon" OR "Lesotho" OR "Liberia" OR "Libya" OR "Lithuania" OR "Macedonia FYR" OR "Madagascar" OR "Malawi" OR "Malaysia" OR "Maldives" OR "Mali" OR "Marshall Islands" OR "Mauritania" OR "Mauritius" OR "Mayotte" OR "Mexico" OR "Micronesia" OR "Moldova" OR "Mongolia" OR "Morocco" OR "Mozambique" OR "Myanmar" OR "Namibia" OR "Nepal" OR "Nicaragua" OR "Niger" OR "Nigeria" OR "Mariana Islands" OR "Oman" OR "Pakistan" OR "Palau" OR "Panama" OR "Papua New Guinea" OR "Paraguay" OR "Peru" OR "Philippines" OR "Poland" OR "Romania" OR "Russia*" OR "Rwanda" OR "Samoa" OR "Sao Tome and Principe" OR "Senegal" OR "Serbia" OR "Montenegro" OR "Seychelles" OR "Sierra Leone" OR "Slovak Republic" OR "Solomon Islands" OR "Somalia" OR "South Africa" OR "Sri Lanka" OR "St. Kitts and Nevis" OR "St. Lucia" OR "St. Vincent and the Grenadines" OR "Sudan" OR "Suriname" OR "Swaziland" OR "Syrian Arab" OR "Republic Tajikistan" OR "Tanzania" OR "Thailand" OR "Timor-Leste" OR "Togo" OR "Tonga" OR "Trinidad and Tobago" OR "Tunisia" OR "Turkey" OR "Turkmenistan" OR "Uganda" OR "Ukraine" OR "Uruguay" OR "Uzbekistan" OR "Vanuatu" OR "Venezuela" OR "Vietnam" OR "West Bank" OR "Gaza" OR "Yemen" OR "Republic Zambia" OR "Zimbabwe")

Table A4.1: Web of Science Search Terms. Results were supplemented by forward and backward tracing of citations plus the research team's prior knowledge of relevant references.

#	Factors	Description
Tendering process		
1	Client	Type of client, payment attitude, history and reputation may impact cost and whether to bid for job
2	Ease of procurement process	Information availability and data recording requirements and length of process may impact cost and whether to bid for job
3	Expected competition	Depending on degree of (expected) competition and overall availability of (peatland or other substitute) work; can affect decision to opt out of tendering
4	Additional benefits to contractor	For example advertisement through open day, enhancing reputation and bringing in additional work through networking; may impact cost and willingness to tender
5	Amount of other (substitute) work available	May affect keenness to tender but also how challenges regarding scheduling and timing of work are costed
General project characteristics		
5	Project duration	Longer project durations offer income stability and are thus considered better; increased flexibility in allocating work may reduce cost
6	Scale of project	Larger projects offer greater, more reliable work and opportunities for reducing mobilisation costs if have machines and operators available
7	Type and size of land ownership (including crofts and common grazing)	Small land ownership may be associated with more costly implementation that are not easy to mitigate (e.g. access and need for taking apportionment to enable restoration on commons). However, usually if such projects advance to tender stage, most problems have been sorted out Larger land ownership (e.g. estates) may initially offer opportunities for restoring some land at no or low opportunity cost (in terms of income forgone). Depending on type of business and business objectives, scaling of restoration within large land ownerships may be associated with increasing opportunity costs. This may, however, not affect costs of implementing restoration action.

#	Factors	Description
8	Current land use on peatland to be restored and surrounding holding	Restoration costs can be affected if land use is in conflict with peatland restoration and thus there is a need for mitigation (e.g. keeping grazing activity at minimum). In some cases (e.g. grouse shooting) mitigation depends on timing of work
9	Stocking density of deer and livestock in area	Similar to #8, mitigation through keeping grazing at minimum may come at extra cost. Regarding livestock, this also depends on need for fencing and the availability of existing facilities to keep livestock off restoring land
Site location dependent factors		
	(i) facilities	
10	Need for overnight accommodation	Could instantly make tendering unviable if, for example, restoration is planned for an island location with an available onsite contractor; else can be mitigated easily in most cases and factored into higher costs
11	Distance from operator base	This may affect daily travel costs, and mobilisation cost; can be mitigated by longer daily hours (e.g. 10hr working days) though this may have cost implications (as #10 above)
12	Need for on-site welfare facilities	Costed in and usually quite consistent between contractors
	(ii) access conditions	
13	Challenges to access through presence of utilities, powerlines gas pipes and cables	More difficult access due to presence of utilities, powerlines gas pipes and cables can be associated with higher cost. However, typically not a problem, can be easily mitigated
14	Challenges to access through geographical location of site	If a site is very narrow, steep and/or cut off by watercourses, this complicates access; more difficult access can be associated with higher cost.
15	Challenges to access through site condition	Access to work location on a site, in terms of the length of the daily drive in to the work location, can be affected by overall site condition; more difficult access can be associated with higher cost
16	Site wetness	Special case of #15. If sites are very wet, this may imply a need for bog mats or more specialised LGP machines, adding to costs

#	Factors	Description
17	Potential flooding due to fords	Adds to risk of operation and may be added to tender cost
18	Challenges to access due to adverse weather conditions (snow, storm)	Adds to risk of operation and may be added to tender cost as contingency; length of snow free period may affect timing of operations and affect cost depending on availability of other work
19	Presence of (ground nesting) breeding birds and protected species	May delay implementation and complicate scheduling of work; could be added to tender as contingency
20	Challenges to access due to prevailing weather conditions	Depending on the conditions of a site, a contingency can be added to tender/costs to account for prevailing weather conditions (e.g. very wet conditions)
21	Site use by public (e.g. for recreation)	May affect access but typically not a problem
22	Archaeological Restrictions	May affect access but typically not a problem if considered at feasibility study or project approval stage
23	Concerns about security of site	Additional costs for security and potential loss
24	Health and Safety risk of bogging	This could be considered an added risk with contingency added to tender. However, it is in practice not considered a problem
25	Restrictions on Access: Stalking/Shooting	Similar to #8. Could affect timing of work and cost depending on availability of other work
26	Site designations	Could affect access cost but typically not a problem as agreements regarding site designations are usually sorted before tender
(iii) site characteristics		
27	Altitude	High altitude sites tend to be less easily accessible. This can affect cost, through impact on general accessibility, daily travel costs (see #11), mobilisation costs, but also #18: length of snow free periods
28	Slope	Restoration of sites on steep slopes may affect cost through additional time for restoration in challenging terrain
29	Exposure	May be linked to #18 (adverse weather conditions) and #20 (prevailing weather conditions)
Site peatland condition factors		
30	Complexity - Degree of erosion	May affect cost through additional time for restoration in challenging terrain; bare peat areas may require stabilisation which can be very time consuming

#	Factors	Description
31	Complexity - Density of drains and gullies	May affect cost through additional time for restoration for greater densities of drains and gullies
32	Complexity – Depth of hags	Relates to #30; may affect cost through additional time for restoration in challenging terrain
33	Availability of sphagnum for reseeded	Relates to #30; and the availability of sphagnum areas that can be used for reseeded (available on site or need to import to site); easier accessibility of sphagnum for reseeded is associated with <i>relatively</i> lower cost
34	Complexity - Slope and hydrological connectivity – required density of dams	Relates to #28 and #31; greater slopes may require a greater density of dams. Can affect cost through increased need for material (dams) and/or work/time to install dams
35	Vegetation cover - forest	Vegetation cover may have to be removed; for forests this implies harvesting of stands, and possibly removal of stumps and brush. Removal may come at a net cost. Biomass may be mulched which may add to costs
36	Vegetation cover - shrubs	Similar to #35; depends on height/thickness/density of shrub; mulching may add costs

Table A4.2: Potential factors affecting cost per hectare of peatland restoration across sites and at a given point in time.

#	Factor	Description
1	Inflation e.g. rising wages and fuel prices	Inflation increases nominal cost over time, that is, prices for goods and services paid in a market over time. However, theoretically inflation should per se not affect real costs over time if nominal prices are adjusted for inflation. In practice, companies might add a mark up to, for example, account for risks associated with inflation. Moreover, adjustments to costs and to funding are not necessarily simultaneous nor made on the same basis, meaning that they can become misaligned. Identifying the correct rate of adjustment may be challenging. Appropriate indices may be price indices for labour and energy use in agriculture and forestry, rather than more generic consumer price indices.
2	Technological Innovation: new technologies	Innovation can lead to solutions that allow providing the same service at lower cost, or more of a service for a given budget. In the case of peatland restoration, there have been improvements over time through learning-by-doing and research into materials and approaches. e.g. construction of dams, reprofiling techniques, revegetation methods
3	Overall contractor skills and experience	Peatland restoration undertaken with the aid of heavy machinery differs markedly in the requirements for the machine operators compared to other jobs involving earth movement. Typical digger/excavator jobs involve excavation and harmonisation across a certain area with little restrictions to force applied when operating the machine. Restoration requires careful adjustments using bucket movements in all directions. It can be expected that skills and expertise gained by operators enable them to work a larger area in a given time. Such efficiency gains may be expected to reduce unit costs of restoration; however, expertise may equally attract a price premium especially if competition for skilled workers is high.

#	Factor	Description
4	Conditions in related market spaces e.g. dualling of A9	Related markets offer opportunities for supplementing or substituting work on restoration projects. Work in related sectors, such as road construction or renewable energy site construction, vary across time and space and may thus affect the opportunity cost of contractors to tender for restoration with implications for cost.
5	Overall demand for peatland restoration	Increasing demand for restoration will, all else equal, increase costs, at least in the short run. However, an expected long-run increase in demand (via committed public budgets and/or private finance) may encourage an expanded supply of contracting services and exert downward pressure on costs.
6	Overall contractor capacity i.e. competition	The number of existing contractors actively tendering for the same jobs in restoration (and related markets) affects competition, with an expectation of greater competition driving costs down, all else equal.

Table A4.3: Factors affecting cost per hectare of peatland restoration over time

10.2 Appendix A5 Explaining variation in restoration costs

Appendix A5.1 Methodological approach (detailed) including data preparation and assumptions

Appendix A5.1.1 Factors included in analysis and spatial data sources

The analysis builds on the evidence review in Section 4 and previous work on understanding variation in site-specific restoration costs. For this study, the publicly available spatial data identified as potential predictors of variation in peatland restoration costs come from several sources listed in Appendix Table A5.1.

It is necessary to know location and dimensions (shape) of restored sites to be able to assign spatially explicit data to them. However, due to difficulty to reliably match many of the cost database sites with their [Peatland ACTION polygon](#) counterparts (5.2.4 'Main Limitations'), the site shape needed to be assumed. As all the sites selected for this analysis reported a UK National Grid location, representing a centroid for each site, and a restored site area (in hectares) was reported, **we assumed that all sites were a circle of “restored area” centred at the grid location**. This circle was then overlayed with the relevant spatial data and the data extracted. For example, to add the average number of ‘snow days’ expected on a site, we overlay the site circles on the [HADUK](#) grid of climate observations and extract the average snow days associated with the site. See Appendix A5.1.4 ‘Merging cost database with external data’ for full details of the methodology.

Appendix A5.1.2 Data modifications

For peatland conditions, land cover classes and biogeographical zones the variables taken from the original data sources were pooled into more general categories to increase the model’s ease of interpretation. For example, all land cover classes associated with forest were classified as one ‘forest’ category in the model, see Appendix table A5.2-A5.4 for more details.

For the costs to be comparable across all the sites, the total cost figure per site was divided by the total site area to arrive at a cost per hectare estimate. The costs have been deflated to 2020 levels using consumer price index (CPI) values from the [Office of National Statistics](#).

Appendix A5.1.3 Multi-linear regression

We developed a multi-linear model which estimates cost per hectare of the final restored area, C , based on the spatial variables described in Table A5.1. The distribution of Cost was right-skewed due to the existence of some notably expensive sites (see Figure A5.2). In such cases it is recommended to transform the dependent variable, for example by taking its natural logarithm. We thus develop a model to predict the natural logarithm of cost per hectare C of the restoration project:

$$\log(C) = A_0X_0 + \dots + A_nX_n + B_0D_0 + \dots + B_MD_M + \lambda$$

where the variables X_i are continuous, for example ‘Average annual rainfall’ and the variables D_i are dummy variables that take a value of one (else zero) if a condition applies, e.g. if Site Region ‘Argyll’ is associated with the site. Appendix Table A5.1 shows the list of continuous variables and dummy variables considered as well as their sources. Note that not all of the variables were included in the final statistical model (Table A5.7). Since the ‘Biogeographical zones’ are unique and cover every site (every site is in exactly one zone), we can remove one of these dummy variables from the regression and not lose any information. We choose to remove the ‘Flow Country’ and thus analysis of these results is relative to the cost of restoring sites in the Flow Country. Many prospective variables to be used in the log-linear model were likely to co-vary. To ensure there was acceptable levels of multi co-linearity in the variables used in the regression we ensured the variance inflation factors for each variable were less than 5, see [Appendix Table A5.8](#) for the variance inflation factors of the variables used in the model. To account for the fact that multiple observations (sites) can be associated with the same grant, clustered errors for all observations derived from the same grant were calculated.

In the results, we present the coefficients associated with the variables (X_i) and dummy variables (D_i) on a graph as ‘log Cost multipliers’, along with the 25% confidence interval as error bars (Figure 5.3). For continuous variables this can be interpreted as: For every one-unit change in the variable, by what factor would you expect the log cost per hectare to change. For dummy variables, this can be interpreted as the site having this property will cause this multiplication of the log cost per hectare. Since log is monotonic, we can translate this to how the variable multiplies cost. Each variable has different units and scales, so it is difficult to compare one multiplier to another. A statistically normalised version of the plot can be seen in Figure A5.3, where magnitudes between multipliers can be compared.

Category	Class	Variable	Source
Meteorological		Average wind speed per year (m/s)	Had-UK-Grid
		Average annual rainfall (mm)	Had-UK-Grid
		Average daily temperature per year (C)	Had-UK-Grid
		Minimum daily temperature per year (C)	Had-UK-Grid
Peat Quality	Peat Condition areas	Ratio of site that is bare peat	NatureScot
		Average peat depth(cm)	James Hutton Institute
		Forest (ha)	NAEI
		Cropland (ha)	NAEI
		Extraction (ha)	NAEI
		Eroded (ha)	NAEI
		Grassland (ha)	NAEI
		Modified Bog (ha)	NAEI
		Near Natural Bog (ha)	NAEI
Landscape		Settlement (ha)	NAEI
		Land cover heterogeneity (m)	NatureScot
		Ratio of site that is floodplain/surface water	Scottish Environment Protection Agency
		Terrain ruggedness (index)	Ordnance Survey
		Average slope (%)	Ordnance Survey
Site Characteristics	Site use (dummies)	Remoteness/wilderness (index)	NatureScot
		Rough Grazing	SRUC cost database
		Forestry	SRUC cost database
		Field Sports	SRUC cost database
		Deer Management	SRUC cost database
		Biodiversity Conservation	SRUC cost database
	Other	Other	SRUC cost database
	Site designation (dummies)	SSSI	SRUC cost database
		SAC	SRUC cost database
		SPA	SRUC cost database
		NSA	SRUC cost database
		NNR	SRUC cost database
		Other	SRUC cost database
	Biogeographical Zones (dummies)	Argyll	NatureScot
		Central Belt	NatureScot
		Isles	NatureScot
		Central Highlands	NatureScot
		East Coast	NatureScot
		Northern Highlands	NatureScot
		Southwest	NatureScot
		Flow Country	NatureScot

Table A5.1: List of variables and dummy variables used in the linear regression to estimate log cost per hectare. If the class of variables are dummy (i.e. binary) then this is indicated in the class column.

Appendix A5.1.4 Merging cost database with external data

The process of merging the SRUC cost database of NatureScot PA administered projects with other spatial data involved the following steps:

1. The site grid references in the cost database were converted to Easting-Northing coordinates (using standard UK coordinate reference system EPSG:27700) and converted to a GIS point shapefile (using QGIS software package version 3.16).
2. The circular polygon shapefiles with the centre point being the actual site centroids with a total area corresponding to the reported restored area (in NatureScot PA final reporting forms) were created within the GIS framework.
3. The maps containing spatial environmental information were overlaid over the circular polygon layer and cropped into the shape of the sites.
4. For the microclimatic variables (snow days, temperature, wind speed), topography (elevation, slope, ruggedness) and remoteness, an average value per site was calculated (for raster maps that means the total value of each variable for all raster cells in each site divided by the number of cells). For land cover categories, firstly the raster picture was converted into a vector polygon shapefile by smoothing the cell edges with a fineness down to 15 meters. A total area of each category per site was calculated and recorded as a separate variable (for all the land cover types that a specific site did not contain the variable values were zero). The areas of each category were divided by the total site area to arrive to a ratio of the site that has the particular land cover. The total length of outlines of individual land cover features was calculated to account for terrain heterogeneity (assuming that the more patchy the site is the longer the outline of the individual features). Similarly for the peatland condition map, a total area of each site that is peatland was calculated, individual peatland condition categories were recorded and ratios per site calculated. The bare peat ratio and floodplain/surface water area ratio were calculated as a ratio of the peatland per site rather than the total area of the site. Similarly, average peat depth was considered only for peatland area of each site. Finally, sites were assigned to a biogeographical region based on the centroids' precise location.
5. The data was downloaded from the GIS software into a spreadsheet and merged back into the cost database using a unique site identifier (concatenated from a unique site ID and a report type). The further steps of analysis/ model and figure construction were completed in Excel, STATA and Python packages, respectively.

Variable	Inventory categories
Forest	Forest
Cropland	Cropland
Eroded	Eroded
Modified	Modified bog
Near Natural	Near natural bog
Other	Other Peatland, Settlement
Grassland	Intensive Grassland, Extensive Grassland
Extraction	Industrial Extraction, Domestic Extraction

Table A5.2: Inventory peatland condition classes pooled into larger categories

Land Cover Categories	
Woodland	Woodland fringes and clearings and tall forb stands, Broadleaved deciduous woodland, Highly artificial coniferous plantations, Mixed deciduous and coniferous woodland, Lines of trees, small anthropogenic woodlands, early stage woodland and coppice, Coniferous Woodland
Shrub	Arctic, alpine and subalpine scrub, Temperate and mediterranean-montane scrub, Temperate shrub heathland, Riverine and fen scrubs
Blanket Bogs	Raised and blanket bogs
Other	Inland cliffs, rock pavements and outcrops, Arable land and market garden, Built-up, Bare field, Windthrow, Littoral sediment (predominantly saltmarsh), Coastal dunes and sandy shores, Coastal shingle, Rock cliffs, ledges and shores, Surface standing and running waters
Mires & Fens	Valley mires, poor fens and transition mires, Base-rich fens and calcareous spring mires
Grassland	Dry grasslands, Mesic grassland, Seasonally wet and wet grasslands, Alpine and subalpine grasslands

Table A5.3: Land cover classes pooled into larger categories

Restoration Zones	Biogeographical Zones
Argyll	Argyll West and Islands
Central Belt	West Central Belt
Isles	Coll, Tiree and the Western Isles, Orkney and North Caithness, Shetland, Western Seaboard
Central Highlands	Central Highlands, Cairngorms Massif, East Lochaber, Loch Lomond, The Trossachs and Breadalbane
East Coast	North East Coastal Plain, North East Glens, Eastern Lowlands
Northern Highlands	North West Seaboard, Northern Highlands, Western Highlands
Flow Country	The Peatlands of Caithness and Sutherland
Borders	Western Southern Uplands and Inner Solway, Border Hills

Table A5.4: Biogeographical zones pooled into larger Restoration zones

a) Peatland Condition	Area (ha)	Percent of restored peat area
Cropland	5	0%
Other	9	0%
Grassland	108	1%
Extraction	328	3%
Forest	1711	17%
Modified Bog	1764	18%
Eroded	2860	29%
Near Natural Bog	3171	32%
All	9956	100%
b) Site Designation	Count	Percent of sites
SPA	22	9%
SAC	27	11%
NSA	28	12%
NNR	39	16%
Other	54	23%
SSSI	56	23%
No Designation	103	43%
Multiple Designations	53	22%
c) Site Use	Count	Percent of sites
Rough Grazing	76	32%
Forestry	20	8%
Field Sports	45	19%
Deer Management	110	46%
Biodiversity Conservation	92	38%
Other Use	22	9%
No use	26	11%
Multiple uses	104	44%

Table A5.5: Percentage of total area of restored sites falling into each: a) peatland condition category as defined by the Inventory peat condition map; b) Site designation, and c) Land use as reported on the final report forms for NatureScot Peatland Action.

Appendix A5.1.5 Main limitations

A major source of uncertainty is related to large variation in detail and rigor of reporting of the restoration process via application and reporting forms. Several reports are missing crucial details that make them invalid for further analysis limiting the power of studies such as this.

Each project that has been granted funding by NatureScot can be identified via a grant reference number. Thus, the sites that have been restored within the same restoration grant share the same reference number. However, throughout the duration of projects, the definitions of sites often change. This includes both the number of sites within a grant, and the area of identified sites can both increase or decrease based on what is currently considered feasible/priority. Therefore, the information entailed in project application forms can only be compared to final forms if these changes were sufficiently documented.

For deriving site area and overlay with GIS information, the circular site outline approach was chosen due to difficulty to reliably link a substantial number of the sites from the cost database with spatial data from Peatland ACTION that contains both centroids and site outlines. The grant reference numbers are often inconsistent between cost database and spatial information, and the number, area, account of applied measures and grant amounts often do not match between the information sources. Consequently, we had to manually “triangulate” matches between sites in the cost database and sites in the spatial data from Peatland ACTION, which was both time consuming and without guarantee of being free of error.

Due to a lack of a unified methodology for calculation of a total area of a restoration site, over time and across sites in the database, the account of area restored provided in the reporting form can be only treated as approximate. Sites for which the reported areas were missing, unclear or otherwise impossible to work with were removed from the analysis. As mentioned above, the site areas were in some cases also pooled together within the same project, and thus arriving at a reliable area estimate for the individual sites was difficult.

The format in which the type, unit and (unit or total) cost of restoration measures is reported also varies as application and reporting forms were updated over the years, and depending on reporting efforts invested by grantees. For example, the installation of wave dams has been reported either as the total number of individual dams, the total length of all the dams combined, or the total area covered by the specific type of dams. Wave dams also feature only in later editions of application and reporting forms. Such issues with reporting complicate measure-specific analysis of restoration cost. For example, differences in units in which measures are reported make judgment on measure intensity in a restoration site challenging if not impossible.



Figure A5.1: An example of populating the circular polygons with the cropped spatial features (In this case different colours represent individual land cover classes).

Appendix A5.2 Supplementary results

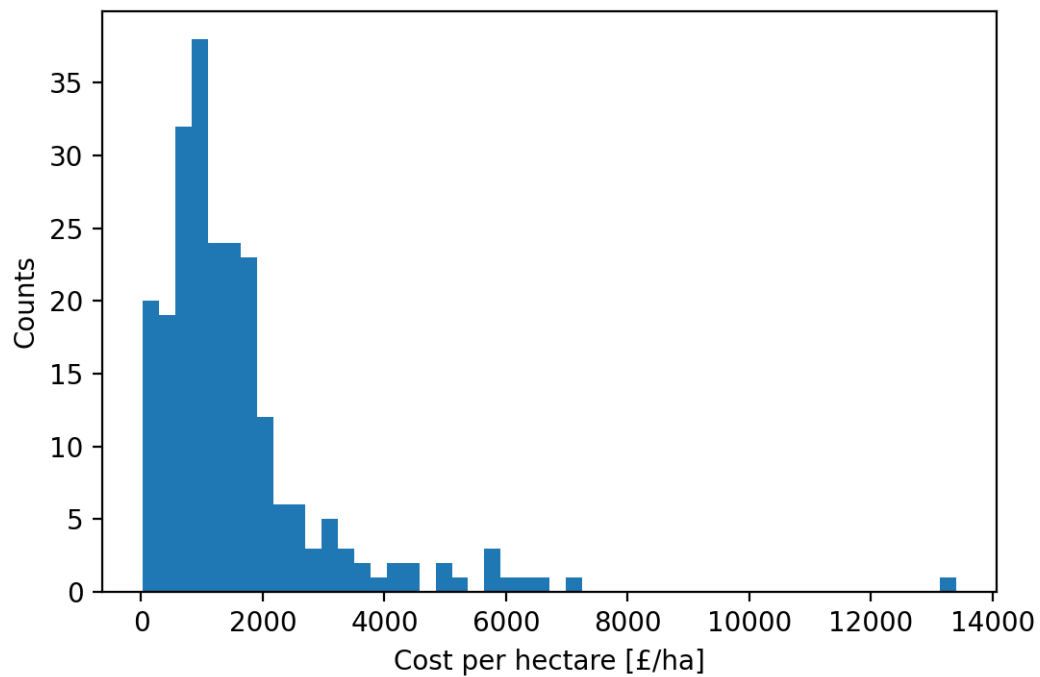


Figure A5.2: Distribution of costs considered in the analysis after deflation to 2020 levels.

Variable	Mean	Std. Dev.	5th percentile	95th percentile
Cost per hectare (£/ha)	1549.70	1500.49	190.54	4482.95
Ratio of bare peat	0.00	0.01	0	0.02
Ratio of floodplains/surface waters	0.00	0.01	0	0.01
Snow days per year	28.70	15.06	5.17	55.94
Average wind speed (m/s)	5.98	1.43	3.85	8.62
Annual rainfall (mm)	1679.70	543.40	978.93	2770.40
Average peat depth (cm)	83.11	37.15	25.00	151.18
Terrain ruggedness (index)	191.66	163.14	20.62	489.31
Site cover heterogeneity (m)	390.23	452.66	110.82	750.06
Peat condition (site ratio)				
Forest	0.19	0.34	0	1.00
Eroded	0.20	0.32	0	0.89
Modified	0.11	0.19	0	0.55
Near Natural	0.22	0.34	0	0.98
Other	0.00	0.01	0	0.00
Grassland	0.01	0.05	0	0.08
Extraction	0.02	0.11	0	0.11

Table A5.6: Descriptive statistics of explanatory variable data and cost per hectare of sites, N=229.

In Figure A5.3, we plot the same figure as Figure 5.3 in the main text, but we divide the multiplier by the standard deviation of the variable so that the magnitude of the multipliers can be compared between variables.

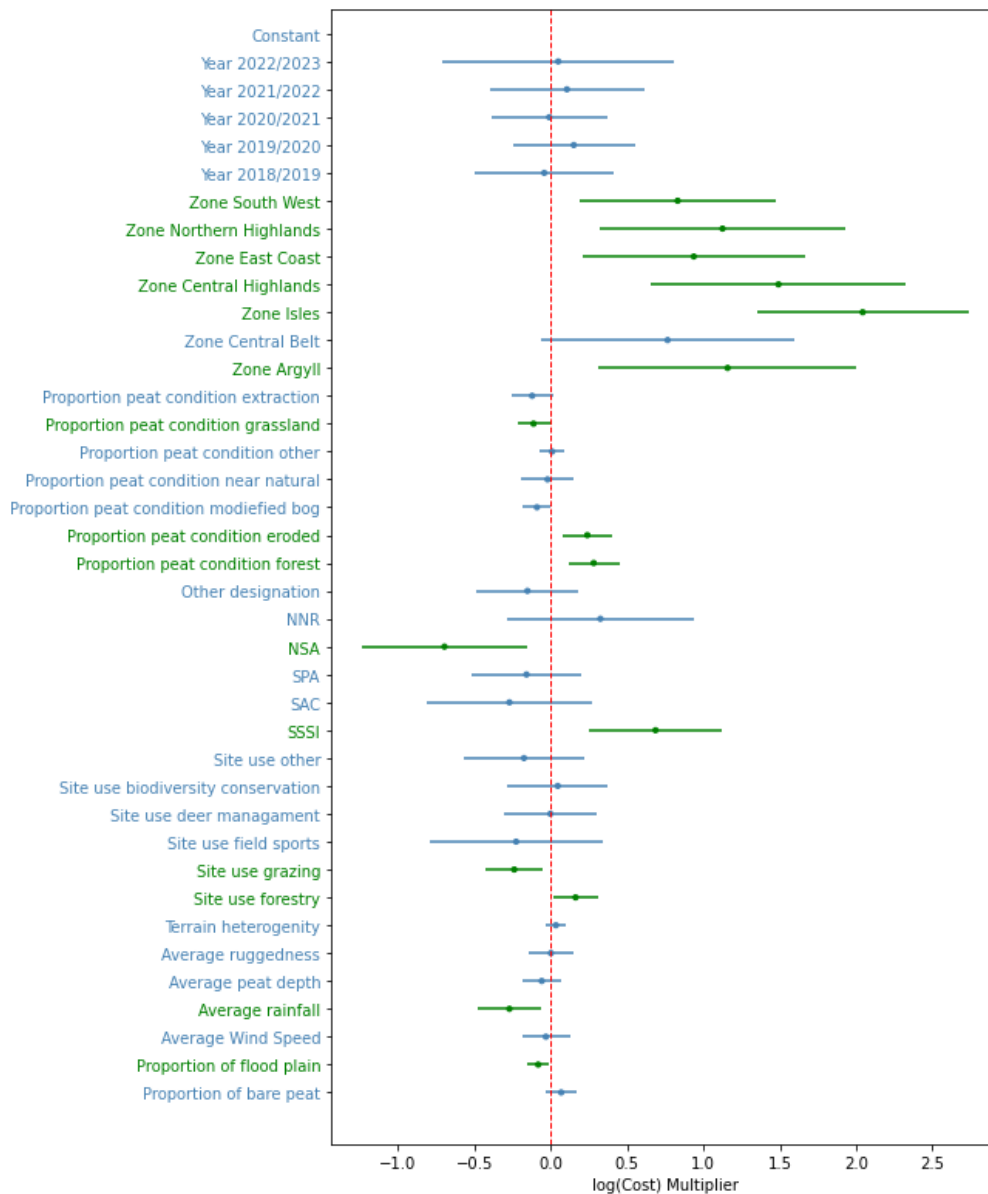


Figure A5.3: Normalised Log of the Cost per hectare multipliers (i.e. coefficients in the regression) according to the multi-linear model. For continuous variables, (e.g. average rainfall) this can be interpreted as for every one standard deviation, the log of the cost per hectare increases by the multiplier represented by the dot. For dummy (binary) variables (e.g. region), can be interpreted as the site having that property will increase the log cost per hectare by the multiplier. Positive log of the cost multipliers (right of the red line) implies increasing the variable increases the cost and vice-versa for negative log cost multipliers. If the entry is green, then the multiplier is significant ($p < 0.05$). In this case magnitude of multipliers can be compared.

	Coefficient	Standard error	z-value	P> z	[0.025	0.975]
Proportion of bare peat	0.0681	0.054	1.266	0.205	-0.037	0.174
Prop. of floodplain/surf. waters	-0.0827	0.035	-2.339	0.019	-0.152	-0.013
Average Wind Speed	-0.0324	0.081	-0.402	0.687	-0.19	0.125
Average rainfall	-0.2711	0.106	-2.564	0.01	-0.478	-0.064
Average peat depth	-0.0594	0.064	-0.926	0.354	-0.185	0.066
Average ruggedness	0.0006	0.075	0.008	0.993	-0.146	0.147
Terrain heterogeneity	0.0334	0.032	1.058	0.29	-0.029	0.095
Site use forestry	-0.2395	0.096	-2.504	0.012	-0.427	-0.052
Site use grazing	0.1622	0.075	2.168	0.03	0.016	0.309
Site use field sports	-0.2271	0.288	-0.788	0.431	-0.792	0.338
Site use deer management	-0.0029	0.154	-0.019	0.985	-0.304	0.298
Site use biodiversity cons.	0.0456	0.168	0.272	0.786	-0.283	0.374
Site use other	-0.1757	0.201	-0.873	0.383	-0.57	0.219
SSSI	0.686	0.223	3.078	0.002	0.249	1.123
SAC	-0.2711	0.277	-0.979	0.328	-0.814	0.272
SPA	-0.1592	0.185	-0.86	0.39	-0.522	0.204
NSA	-0.6967	0.277	-2.517	0.012	-1.239	-0.154
NNR	0.3248	0.311	1.045	0.296	-0.284	0.934
Other designation	-0.1531	0.171	-0.894	0.371	-0.489	0.183
Prop. peat cond. forest	0.2808	0.085	3.306	0.001	0.114	0.447
Prop. peat condition eroded	0.2391	0.081	2.949	0.003	0.08	0.398
Prop. peat cond. modified bog	-0.0908	0.047	-1.949	0.051	-0.182	0.001
Prop. peat cond. near natural	-0.0213	0.088	-0.242	0.809	-0.194	0.151
Prop. peat condition other	0.0083	0.042	0.2	0.841	-0.073	0.09
Prop. peat condition grassland	-0.1133	0.054	-2.09	0.037	-0.22	-0.007
Prop. peat condition extraction	-0.1224	0.07	-1.742	0.081	-0.26	0.015
Zone Argyll	1.158	0.431	2.689	0.007	0.314	2.002
Zone Central Belt	0.7648	0.422	1.811	0.07	-0.063	1.593
Zone Isles	2.0428	0.352	5.797	0	1.352	2.733
Zone Central Highlands	1.4913	0.426	3.503	0	0.657	2.326
Zone East Coast	0.9365	0.373	2.514	0.012	0.206	1.667
Zone Northern Highlands	1.1248	0.413	2.725	0.006	0.316	1.934
Zone South West	0.8308	0.327	2.54	0.011	0.19	1.472
Year 2018/2019	-0.043	0.232	-0.185	0.853	-0.499	0.413
Year 2019/2020	0.1503	0.203	0.74	0.459	-0.248	0.548
Year 2020/2021	-0.0105	0.192	-0.055	0.956	-0.387	0.366
Year 2021/2022	0.1056	0.258	0.409	0.683	-0.4	0.612
Year 2022/2023	0.0486	0.385	0.126	0.9	-0.707	0.804

Table A5.7: Ordinary least squared regression of log of the cost per hectare.

Variable	VIF
constant	123.1919
Proportion of bare peat	1.249553
Proportion of flood plain	1.186187
Average wind speed	2.363117
Average rainfall	4.79262
Average peat depth	1.935288
Average ruggedness	3.198891
Terrain heterogeneity	1.708854
Site use forestry	1.568768
Site use field sports	3.643887
Site use deer management	2.73706
Site use biodiversity conservation	1.934092
Site use other	1.549223
SSSI	2.682824
SAC	2.018384
SPA	1.462261
NSA	2.738603
NNR	3.915651
Other designation	1.476853
Proportion peat condition forest	4.666531
Proportion peat condition eroded	3.073554
Proportion peat condition modified bog	1.589749
Proportion peat condition near natural	3.936502
Proportion peat condition other	1.356258
Proportion peat condition grassland	1.679904
Proportion peat condition extraction	1.691232
Zone Argyll	3.050752
Zone Central Belt	2.479631
Zone Isles	2.778177
Zone Central Highlands	4.194155
Zone East Coast	1.638507
Zone Northern Highlands	4.0296
Zone Southwest	3.898588
Year 2018/2019	2.705031
Year 2019/2020	2.128802
Year 2020/2021	1.909482
Year 2021/2022	2.277006
Year 2022/2023	2.325957

Table A5.8: Variance inflation factors (VIF) of the variables used in the log-linear model demonstrating the level of multi-collinearity. Variables were only included in the main model if the $VIF < 5$.

Appendix A5.3 Additional information on economies of scale in peatland restoration with illustrative examples

Economies of scale arise at least partly from a contractor being able to spread fixed overhead costs for a project across a larger area. The literature review and interviews with contractors suggest that two main overhead costs are relevant: project tendering costs (i.e. the time and effort expended on submitting a bid) and project mobilization costs (i.e. the initial costs of getting equipment and materials on-site). Hence, whilst information on overhead costs was not sought explicitly through this research, some initial indicative analysis is possible.

To a first approximation, the costs of compiling and submitting a tender for a project are unrelated to its size since the effort required is determined by the tendering process rather than site size per se (although site complexity may increase required tendering effort). Similarly, again to a first approximation, haulage costs for equipment and materials relate primarily to the charge for moving a transporter carrying such items rather than carrying individual items themselves per se, implying that mobilization costs are likely to increase in a lumpy manner depending on how many haulage events are required rather than linearly with site size (e.g. if two diggers can be hauled on one transporter, mobilization costs will be the same for a small site requiring one digger and a larger site requiring two; only if more than two diggers are required will the larger site see an increase in mobilization costs - with scale still diluting the additional costs).

Contractor interviewees suggested that tendering takes two to three (eight hour) days. If contractors value their managerial time at £30/hour this equates to £480 to £720. If they value their time at £50/hour it equates to £800 to £1200. Online haulage costs suggest generic (i.e. not peatland) individual digger transportation costs mostly lie in the £400 to £500 range, depending on digger size and the distance moved ([UShip, 2024](#); [WHC, 2024](#)). Taken together, these imply project overhead costs of c.£900 to £1700. For a five-hectare site these equate to unit costs of c.£180/ha to c.£340/ha. For a 20-hectare site they equate to c.£45/ha to £85/ha. This highlights the potential magnitude of economies of scale effects. A better understanding could be established with further investigation, including how contractors value their managerial time, the effort devoted to tendering and actual mobilizations costs (including for multiple diggers and for items other than diggers).

Appendix A5.4 Additional analysis regarding temporal trends

Area

Year	Sites	Area (ha)	Std. dev.
2017/18	45	42.7	36.4
2018/19	57	64.4	97.3
2019/20	45	54.2	54.5
2020/21	48	65.7	114.8
2021/22	31	73	112.1
2022/23	3	72	66.7

Table A5.9: Summary statistics outlining the average areas (ha) of restored sites per each funding year.

Types of restoration measures

Year	A only	B only	C only	A & B	A & C	B & C	A,B & C	All
2017/18	1	3	3	10	6	3	9	45
2018/19	8	2	15	16	7	1	8	57
2019/20	10	2	9	9	7	0	8	45
2020/21	10	11	3	16	2	4	2	48
2021/22	6	6	0	13	1	2	3	31
2022/23	0	0	0	3	0	0	0	3
Total	35	34	30	67	23	10	30	229

Table A5.10: Number of sites restored using a measure category (A – dams & blocking, B – surface measures (bundling, mulching, replanting), C – forest & scrub removal) per funding year.

Land cover

Year	Shrub	Mires & Fens	Raised & Blanketed Bogs	Woodland	Grassland	Other
2017/18	357.2	2.4	1147.8	22.3	324.7	73.1
2018/19	195.0	60.7	1689.2	204.0	1265.6	162.3
2019/20	311.1	6.7	1354.9	101.8	357.3	289.6
2020/21	467.2	6.7	1569.1	53.8	668.4	238.6
2021/22	232.5	1.2	1644.7	15.7	121.5	48.4
2022/23	96.0	0.4	221.9	1.5	37.7	0.5

Table A5.11: Area (ha) of each pre-restoration land cover category restored per each year.

Regions

Year	Flow Country	Argyll	Central Belt	Isles	Central Highlands	East Coast	Northern Highlands	South- west	All
2017/18	10	0	4	3	17	3	3	5	45
2018/19	7	9	10	1	3	5	10	12	57
2019/20	14	10	2	5	5	1	6	2	45
2020/21	10	0	0	1	13	0	6	18	48
2021/22	2	1	0	7	11	0	7	3	31
2022/23	0	0	0	0	0	0	3	0	3
All	43	20	16	17	49	9	35	40	229

Table A5.10: Number of sites restored in each restoration zone per funding year.

10.3 Appendix B6 Opportunities and challenges for contractors

Appendix B6.1 Detailed methodological approach

Eight interviews were conducted with contractors providing peatland restoration services in Scotland. Interviews were conducted using an interview script (Appendix Table B6.1) to guide the conversation, yet allowing some flexibility for the discussion to move into other topics that were important to the participants. A semi-structured approach was selected because this is considered most appropriate where the topic of research is novel or under researched, as is the case for research concerning the experience of peatland restoration contractors.

Participants were selected for interview by purposive sampling, from a publicly available list of contractors willing to offer peatland restoration services (7), and from a list of new entrants to peatland restoration that was provided by NatureScot (1). A sampling frame was used to guide recruitment to ensure perspectives were obtained from contractors of different sizes and across geographic areas (Table 6.1).

Interviews were scheduled for thirty minutes, though ranged from 15 minutes to one hour and were conducted as video conference calls using Microsoft Teams (N=7), and by phone (N=1). Most interviews were conducted by interviewer 1 and 2 together (N=6), with interviewer 1 leading the interview. Two more were conducted by interviewer 2 alone.

An initial draft interview script was presented to the project steering group and revised to incorporate their feedback. With the consent of participants, interviews were recorded and later transcribed for analysis. Pre-approval for the overall approach and research instruments was received from the SRUC Ethics committee (Ref. 149 / 89056833).

Interview notes and transcripts were reviewed to identify commonalities and points of difference in contractor perspectives of the tender process and wider factors affecting the industry.

Pre-populated brief of contractor

Add here information collated e.g. from online sources on the contractor, if any
This may include – type of services offered, information on location, range of operation, experience & examples of past work, references, availability of machinery and staff capacity.

Contractor name:

Contact(s):

Website:

Useful info:

Type contractor (can be filled and/or revised after interview)

Experienced & active contractors focusing on restoration

Experienced & active contractors with wide range of business (e.g. forestry, estate management & road construction/maintenance)

Occasional contractors focusing on other business & who do not systematically look for restoration opportunities

Adjustments to questions needed if contractor falls into the following categories:

Tendering but unsuccessful

Not (yet) tendering

Introduction (to be tailored and aligned with contact emails and information provided therein)

We're conducting research on behalf of the Scottish Government and its Centre of Expertise on Climate Change, looking at peatland restoration undertaken by contractors.

We're interested in your views on peatland restoration – your experience as a contractor with the tendering process, how you approach costing bids for restoration work, and what influences restoration costs.

Your input will help with further development of funding schemes for restoration, for example by helping delivery partners and funders in having a better idea of the information that should be considered as relevant and make tendering easier for you.

Any information you provide will only be reported in anonymized form.

On this basis is this acceptable?

If not provided consent in email response, ask verbally for consent.

Table B6.1: Interview script.

Main questions	Instructions and Prompts	For context only: what we aim to learn from questions
Part 1 – business characterization		
Q.1 Can you please briefly explain your role in the business?		Helps contextualizing response
Q.2 How long have you been operating as a peatland restoration contractor?	From what background did your peat restoration business start? What prompted the move into peatland work? Was there anything that facilitated the process?	This is to get some sense of the contractors level of experience with delivering peatland projects, but also a sense how peatland restoration is seen as a business opportunity
Q.3 Is peatland restoration the main focus of the business?	1 Could you estimate the percentage that restoration is to your turnover? 2 What other services does business offer? 3 How many tenders per year and success rate? 4 Total Number of Ha restored per year 5 Do you work on restoration all year round? If not what do you do in the off season?	Get an idea of relative importance of peatland restoration relative to other activities and scale of operation.
Q.4 What is your capacity for peatland restoration?	Geographically, where do you operate i.e. offer restoration services? How many staff? How many of those are Operators? Machinery capacity: number of diggers and drivers? Could you do more Ha than currently? What stops you from doing more Ha?	Similar to Q.3 Get an idea of the scale and place of operation.
Part 2 – Tendering for projects		
Q.5 Where do you usually find out about new peatland restoration tenders?	How long do you usually spend on a tender?	Transition to topic of tendering

Main questions	Instructions and Prompts	For context only: what we aim to learn from questions
Q.6 What influences your decisions about whether or not to submit a bid?	Top three most important aspects affecting your decision to tender? For prompting, notes and coding - see list of related points below. Contractor business perspective • What is our capacity to do this work? • Do we have other more profitable work? • Does the project fit into the calendar? • Will this job fit in with other jobs in the area? • Is the work within our competence/machine capability? • How flexible is the contract? • Hassle factor and contingency required? • Can we make a reasonable profit? • Level of competition from other contractors? Overarching constraints • Distance – site too far/out of business range • No capacity in project timeframe Client • Client reputation & payment attitude • Good communication Tendering process • How complicated is the tendering process? • Opportunity for site visit. If not may need to add contingency	Obtain insights on tendering decisions –, i.e., key facilitating factors and barriers to preparing and submitting a tender. Response to Q.6 may lead naturally into Q.7 (appraisal of the tender information to arrive at a bid)

Main questions	Instructions and Prompts	For context only: what we aim to learn from questions
	• How much documentation is required? How much info (maps etc) is available • Are there other benefits of this contract....getting further contracts • Return date of tender Project characteristics • Duration of project...longer the better • Scale of the project....bigger better usually • Start date...too soon to fit in with other work? • How close is the finishing date • Is this an easy project or complex – how is complexity assessed? • Site condition/intensity of work • Access issues that can be mitigated or not	
Q.7 What makes for a good profitable project as opposed to a relatively difficult one?	Aspects may already emerge from elaboration on reasons for whether to tender (list above in Q.6). How do you arrive at estimates of staff and machinery days? Do you appraise complexity of a job for that, and if so, what are indicators for complexity you look for? Anything you specifically look out for that has significant cost implications?	This is about appraisal of the tender information to arrive at a bid – i.e. factors affecting contractor cost calculations.
Q.8 How could the tendering process be improved?	Would you prefer if the tenders were based on a number of digger days or specific lengths of ditches for example?	Opportunities for improving tendering process to facilitate (additional) restoration

Main questions	Instructions and Prompts	For context only: what we aim to learn from questions
Part 3 - outlook and trajectory for peatland business		
Q.9 Have you taken on additional staff to deliver peat restoration, or invested in machinery over past 2 years?	If yes to additional staff: Did you require additional training and if so how was this delivered? Have you taken advantage of any publicly-funded training courses? Would simulator training help encourage you to take on a member of staff? If yes to machinery: Have you found the additional investment worthwhile to your operation? What innovations will help you in the future? What are the future drivers of costs?	Learn about past investment as indicator of expected direction of business and willingness to expand
Q.10 Do you expect (the peatland restoration side of your) business to grow? In next 1-2 years or 3 to 5 years?	If yes, why? If no, what makes you think so?	Opportunities and barriers to growth
Q.11 What would encourage you to (further) expand capacity, or to bid for more projects?	E.g. - Changes in funding models, if there was bundling of projects? - Framework tenders, improving certainty over further income from restoration projects over several years? - Support e.g. interest free government loans for machinery - Certification indicating e.g. trained supplier of restoration services - Consistency of funding - ... [input from steering group?]	Mitigating barriers to growth and new models to encourage scaling of capacity
Q.12 What do you think keeps other contractors		Perceptions of other contractors – “themes”

Main questions	Instructions and Prompts	For context only: what we aim to learn from questions
from bidding for restoration projects?		emerging across contractors
Q.13 Are you able to suggest to us other contractors who could in theory deliver restoration but don't bid? Do you know of anyone who we could or should talk to? (and why should we talk to them)?		Help with identifying further interviewees (may or may not follow recommendations)
Wrap up		
Any questions to us?		
Note if they would like to see published CxC report		
Thanks and close		

Table B6.2: Final interview schedule for interviews with (potential) contractors of peatland restoration services.

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