General enquiries on this form should be made to:
Defra, Procurements and Contracts Division (Science R&D Team)
Telephone No. 0207 238 5734
E-mail: research.competitions@defra.gsi.gov.uk

Department for Environment Food and Rural Affairs

SID 5 Research Project Final Report

- **Note**
  In line with the Freedom of Information Act 2000, Defra aims to place the results of its completed research projects in the public domain wherever possible. The SID 5 (Research Project Final Report) is designed to capture the information on the results and outputs of Defra-funded research in a format that is easily publishable through the Defra website. A SID 5 must be completed for all projects.
- This form is in Word format and the boxes may be expanded or reduced, as appropriate.
- **ACCESS TO INFORMATION**
  The information collected on this form will be stored electronically and may be sent to any part of Defra, or to individual researchers or organisations outside Defra for the purposes of reviewing the project. Defra may also disclose the information to any outside organisation acting as an agent authorised by Defra to process final research reports on its behalf. Defra intends to publish this form on its website, unless there are strong reasons not to, which fully comply with exemptions under the Environmental Information Regulations or the Freedom of Information Act 2000.
  Defra may be required to release information, including personal data and commercial information, on request under the Environmental Information Regulations or the Freedom of Information Act 2000. However, Defra will not permit any unwarranted breach of confidentiality or act in contravention of its obligations under the Data Protection Act 1998. Defra or its appointed agents may use the name, address or other details on your form to contact you in connection with occasional customer research aimed at improving the processes through which Defra works with its contractors.

Project identification

1. Defra Project code: SP0572
2. Project title: Ecosystem Services of Peat - Phase 1
3. Contractor organisation(s): Peak District National Park Authority
4. Total Defra project costs (agreed fixed price): £ 99,978
5. Project: start date .... 21 November 2008
   end date .... 20 November 2009

6. It is Defra's intention to publish this form.
Please confirm your agreement to do so..**YES** ☒ **NO** ☐

(a) When preparing SID 5s contractors should bear in mind that Defra intends that they be made public. They should be written in a clear and concise manner and represent a full account of the research project which someone not closely associated with the project can follow.
Defra recognises that in a small minority of cases there may be information, such as intellectual property or commercially confidential data, used in or generated by the research project, which should not be disclosed. In these cases, such information should be detailed in a separate annex (not to be published) so that the SID 5 can be placed in the public domain. Where it is impossible to complete the Final Report without including references to any sensitive or confidential data, the information should be included and section (b) completed. NB: only in exceptional circumstances will Defra expect contractors to give a "No" answer.
In all cases, reasons for withholding information must be fully in line with exemptions under the Environmental Information Regulations or the Freedom of Information Act 2000.

(b) If you have answered NO, please explain why the Final report should not be released into public domain

Executive Summary

7. The executive summary must not exceed 2 sides in total of A4 and should be understandable to the intelligent non-scientist. It should cover the main objectives, methods and findings of the research, together with any other significant events and options for new work.

There is now wide recognition of the importance to human well-being of services delivered by the peatland environment. Despite this, there remains little ecological understanding of ecosystem services, particularly in terms of how and where they are supplied and consumed at a regional or national scale. The new cross government Natural Environment PSA28 target aims 'to secure a diverse, healthy and resilient natural environment, which provides the basis for everyone's well-being, health and prosperity now and in the future; and where the values of the services provided by the natural environment are reflected in decision-making'. Therefore, when taking action in peatlands, management should strive to achieve multiple benefits and not implement action to promote one service to the detriment of other vital services. This project is a scoping study to a bigger project, which will inform the Defra Ecosystem Approach framework in light of the Millennium Ecosystem Assessment. It is novel and visionary work, bringing key stakeholders for peatlands together for strategic mapping and spatial analysis of public benefits.

The overall aim of this project was to identify the distribution of different ecosystem services in upland and lowland peatlands and assess cost-benefit flows. As a scoping study this project assessed the availability of data and scientific evidence on peatland ecosystem service provision as well as the transferability of the evidence base using detailed case studies. The project investigated representative case study sites, which include upland and lowland peatlands in different states of degradation, namely the Peak District moorlands, Migneint and Thorne & Hatfield moors as main case study sites and Somerset Levels as an additional case study with less intensive analysis (Table 1).

The concept of ecosystem services is interdisciplinary and critically linked to human welfare and societal choice. Therefore, an interdisciplinary approach was chosen to combine biophysical and socio-economic science expertise in partnership with stakeholder expertise. To promote the most effective knowledge transfer and collation of expertise, the project held stakeholder start-up meetings in the case study sites and an end of project conference with case study partners and national peatland experts from policy, practice and science.

The project objectives were:
1) Assess the information available on the provision and quantification of peatland ecosystem services for each site.
2) For each case study identify and map ecosystem services provided by peat.
3) Determine suitable valuation data required to undertake peatland ecosystem service valuation based on peatland maintenance and restoration.
4) Determine the flows of costs and benefits for each site.

5) Assess the capacity of each site to increase its ecosystem service provision and assess the case for restoration, outline conflicts between service provisions and compare differences in ecosystem service provision between sites.
6) Assess the transferability of results from each case study to other areas.
7) Determine a feasible programme of work that could be carried out over the next 2 to 5 years to collect additional information required on peatland ecosystem services, valuation data to be used in cost-benefit analyses and prioritisation of management and restoration actions.
8) Produce a list of the top 10 criteria for assessing peatland ecosystem service provision that allows monitoring the health of ecosystems and which could be built in to future monitoring.

Table.1: Basic characteristics of case study sites

Study Site	Peatland classification	Area (km2)	Peatland degradation and restoration issues
Migneint	Upland blanket bog	198.5	Peatland of relatively good condition despite some areas of gripping and erosion. Recent uncontrolled burns. Remote with low recreational pressure in comparison to the Peak District.
Peak District	Upland blanket bog	453.2	History of degradation through overgrazing, heather burning, wildfire, atmospheric deposition, erosion and drainage. Restoration attempts by re-vegetating, drain blocking and footpath improvement. 16 million people within 1 hour drive increase recreational pressure on the landscape.
Thorne and Hatfield Moors	Lowland raised bog	33.4	History of drainage to improve agricultural productivity. History of peat cutting for fuel and horticulture. Re-wetting since the acquisition of the site by English Nature in the 1970s. Restoration intensified since 2002.
Somerset Levels	Fen	63.9	History of drainage to improve agricultural productivity. Restoration projects include raising the water table in drained pasture, and reed planting in a former peat-extraction site to provide habitat for rare birds and improve water quality.

Below we describe some of the main outcomes.

As available data and their copyright was spread across organisations a transparent and high quality database for the case study sites was pivotal. Hence a peat geonetwork was developed. The geonetwork can be accessed at www.ukpeatgeonetwork.org.uk and complies with the EU INSPIRE Directive regulations. All 110 datasets, their custodians, points of contact (from 27 organisations) and spatial coverage are described in the peat geonetwork. Thus there is now a web based data portal in place that can be used in Phase II of the work and which is available for practitioners and academics to use. Data are typically available at 1 square km resolution and this was the basis of the overall assessment in this scoping study. However, many of the individual ecosystem service assessments could be adopted for higher resolutions if required. There are several areas with inadequate information for assessment and some of these are highlighted at the end of this Executive Summary.

The full report is richly illustrated with maps and figures to highlight the key ecosystem services and their flows. Using a GIS approach the project mapped and quantified the spatially explicit distribution of ecosystem services. In order to inform the valuation the mapping has been supplemented with the development of scenarios to understand how ecosystem service provision might change. These scenarios were business as usual, restoration of water table, restoration of vegetation, conservation-led rewilding, food security (e.g. increased grazing), arable (cultivation), economy (grouse economy for uplands, peat extraction for lowlands), and maximise carbon sequestration. Several new approaches were trialled in the project providing Defra with ways of taking ecosystem service assessments forward. These involved modelling to produce spatial service maps and using spatial data modelled for different land management scenarios to determine service provision, synergies and trade-offs under those scenarios.

For many of the provisioning services it was relatively straightforward to map ecosystem service provision (e.g. food production, timber provision, wool etc). However, for some provisioning services it is necessary to understand potential service provision under different scenarios, or tackle more difficult conceptual issues. For example, if freshwater is abstracted from an aquifer that is below the peat there is a question around whether this is a service provided by the peatland or simply by the landscape below the peat. In some instances the data are clear on where the peat contributes water to the aquifer but in others (e.g. Thorne and Hatfield) this is less clear. Another example is the mapping of the current distribution of renewable energy sources across peatlands. This does not provide information on the full potential for renewable energy generation and hence the potential ecosystem service provision (i.e. Objective 5 of this project was to assess the potential of the peatland case study sites to increase their ecosystem service provision). Taking wind energy as an example the project showed how this potential needs to be modelled using information such as turbine specification, available wind resource, physical constraints (e.g. scheduled monuments, accessibility, slope, watercourses, residential dwellings), radar and military designations and statutory designations. Maps can then be produced showing suitable locations. However, it is then necessary to consider conflicts between wind energy production and other services such as impacts on hydrological flows, water quality, biodiversity, landscape character and aesthetics.

To map regulating services requires more sophisticated modelling approaches as data are not simply available from a primary source. For example, the climate regulation service provided by different peatlands must be modelled using parameters formed from best available data from scientific studies. However, these models often require assumptions to be made about peat whereby some of the features or process rates are assumed to be the same from site to site because there is a lack of measurements at each site. Hence uncertainty analysis has to be performed alongside the modelling. Nevertheless, this project developed maps for climate regulation for each of the study sites based on the scenarios listed above. Similarly, more sophisticated modelling is required to map the flood risk mitigation service of peatlands. This project developed a new modelling tool for mapping the flood risk mitigation service under different scenarios using as its core recently acquired data on rates of surface water movement across the peatland landscape for different vegetation covers (e.g. bare peat versus Sphagnum covered peat). A clear conclusion is that not all peatland types should be considered to have the same flood mitigation service. However, for the upland sites it was possible to estimate the difference in flood peak that might be expected under extreme conditions such as if the peatland was bare compared to if it was fully covered in Sphagnum (and scenarios in between). The work showed that eliminating bare areas should be a priority and any return to a more pristine Sphagnum cover elsewhere would be beneficial in terms of delaying flow.

For water quality (drinking water provision, pollutant retention and dilution) peatlands provide a clear and quantifiable ecosystem service. In other ways (notably dissolved organic carbon production) the presence of peat is arguably detrimental to water quality, at least in relation to drinking water treatment. Peat condition and management can influence water quality including particulate organic carbon loss, nitrate and sulphate retention and dissolved organic carbon production. The Migneint, although affected by extensive ditching and atmospheric deposition, appears to retain important functions of sulphate and nitrate retention, and there is little evidence that dissolved organic carbon loss has been substantially increased by management. In the Peak District, on the other hand, severe acidification has been exacerbated by the loss of sulphate and nitrate retention functions. Dissolved organic carbon loss may have been increased by burning, but also appears to have been suppressed by past acidification, with a part of the recent increases therefore linked to subsequent ecosystem recovery rather than degradation. However, the exact relationships are not always clear cut and further scientific work is required to understand a number of management impacts on water quality derived from peatlands.

Cultural services encompass those that are traditionally valued as ‘public goods’ such as opportunities for recreation and enjoyment in nature as well as spiritual, aesthetic and educational services. There are also cultural heritage conservation services provided by peatlands which can be very significant since peat often preserves the historic environment. There may be considerable economies associated with peatland cultural services such as field sports and tourism. The scoping study focussed on the case of recreation services, although several other cultural services were also described and mapped. The value of the ecosystem service provided by recreation is difficult to measure and so services were modelled in three ways; opportunity mapping (e.g. footpath density, car park density etc), accessibility mapping (e.g. rivers, lakes, footpaths, land cover roads, maximum travel time, elevation, start point etc) and assessing realised demand by observed visitor numbers. While population maps and travel time are useful to understand the leisure services offered by peatlands such as the Peak District (large surrounding population with 16 million people living within 1 hour’s drive and 10 million day visits per year) and the Migneint (sparse surrounding population and few visitor numbers) this may not be always a transferable and reliable indicator. For example, 5 million people live within an hour’s drive of Thorne & Hatfield and yet this site receives very few visitors. Active recreation management through provision of visitor facilities (interpretation, visitor centres, etc) and transport opportunities (car parks, roads, public transport) plays a major role in visitor attraction. Furthermore, the sense of place is much stronger developed in the Peak District compared with Thorne & Hatfield Moors which have until recently been industrial sites of peat extraction. Regarding demand, the good correlation of the observed visitor usage pattern and this study’s cost surface model suggests that access is the main predictor for recreation. Scenic beauty and tranquillity relative to home are important factors for demand, too. Peatland restoration and management actions, as selected in this study may have little effect on visitor patterns. Active recreation management, through access improvement with footpaths, board walks, bird hides, visitor centres etc will have much stronger effects, along with development of built infrastructure.

Biodiversity is not defined as an ecosystem service in the Millennium and National Ecosystem

Assessments, but underpins the rest of the services. Therefore this project examined abiotic and biotic indicators for assessing biodiversity and the impacts of change scenarios. Changes in soil and vegetation under the different land use scenarios had differential effects on different species. The habitat suitability for one positive blanket bog indicator species, Dryopteris dilatata, increased with the decreased sward height and soil moisture content in the food security scenario, but in general negative indicator species showed a greater increase in habitat suitability under this scenario. Habitat suitability for positive indicator species did not change appreciably under the business as usual scenario, but increased considerably under the re-wetting and conservation led rewilding scenarios. Effects on positive and negative common standard monitoring indicator species were summarised into a habitat quality index. This proved to be a useful way of mapping and summarising the impacts of scenarios on multiple plant species. The index was most sensitive to changes in water content; thus the largest decline in habitat quality was observed under the food security scenario and there was little difference between the business as usual scenario and the grouse economy scenario or the rewetting and conservation-led rewilding scenarios. The habitat quality index was also sensitive to changes in soil pH and nitrate content.

The project examined whether existing environmental valuation studies can be applied to strengthen the policy advice related to peatland restoration. The focus of the valuation was on i) carbon flows, ii) biodiversity, iii) water quality indicators and iv) run-off potential in order to reflect the most significant changes in the ecosystem services that are likely to be influenced by peatland management as determined by the mapping and scenario modelling work. Furthermore, the choice reflected data availability and status of scientific understanding. Peatlands provide a wide range of complex direct and indirect ecosystem services. This is not in itself an economic rationale for peatland restoration. In order to assess the economic case for restoration it is essential to determine whether specific management actions have an impact on the ecosystem services provided by peat. The required steps were determined to be: a) to identify the baseline situation for each site; b) to identify management changes under different scenarios; c) to identify existing data on the costs associated with each management change; d) to link management changes to changes in ecosystem services; e) to identify biophysical trade-offs in relation to management intervention; f) to identify existing data on the economic values of the change in ecosystem service provision; and g) to identify existing data on variations economic values associated with ecosystem changes across stakeholders.

Results indicated that at the local level it was not possible to identify consistent and systematic relationships between the magnitudes of change in individual ecosystem services. In the assessment of spatial targeting it is important to assess the nature of the consumption of the environmental good and service. Where location is important to demand this clearly plays a role in the economic assessment of restoration initiatives. The project conference revealed that individual ecosystem services were not considered equally important in the different sites. Only carbon storage was always ranked within the top three most important services for all sites. For example, most important services in the Peak District were freshwater provision, carbon storage and water quality, while for Thorne & Hatfield Moors carbon storage, wildlife watching and landscape aesthetics were judged the three most important services. For the Migneint, the three most important services were biodiversity, carbon and freshwater provision. Each group of stakeholders had also re-named and merged services based on their opinions. This information was useful and helped understanding of which services are important to different groups of stakeholders. Furthermore, the sites are situated in entirely different socio-demographic landscapes, which can potentially have very significant implications for economic valuation results as cost and benefit estimates are weighted by the number of affected individuals. This is of particular relevance for flood mitigation evaluations, as only a restricted part of the surrounding areas are likely to be affected by land use change in peatlands. The importance of the spatial distribution of people around peatland sites is also particularly relevant for recreational values.

Based on modelling and literature future valuation studies should first focus on obtaining values (i.e. costs and benefits) for: 1) changes to water quality; 2) species population changes (species of conservation concern as well as recreation or economic concern, e.g. fish or grouse); 3) risk and frequency of flooding events; and 4) potential of greenhouse gas flux from specific peatland restoration activities. Valuation studies should be designed so that they focus on specific and geographically limited areas where the biophysical impacts of peatland restoration can be clearly linked to the impact on ecosystem services. This allows for the collection of more accurate and representative valuation data. The valuation methodology chosen should depend on objectives of the study, the population impacted and the geographical scale that is being considered. Once the requisite valuation data is collected it can then be inserted into cost-benefit analyses to determine the cost-effectiveness of investments in peatland restoration activities for specific sites.

Conference discussions gathered information on synergies and trade-offs between services. For Thorne & Hatfield and the Somerset Moors and Levels key synergies were seen between cultural heritage and carbon storage as well as biodiversity and carbon storage and recreation. Key conflicts were identified as peat extraction and carbon storage, greenhouse gas emissions, cultural heritage as well as biodiversity, peat extraction and arable land use. There were also a number of conflicts/synergies that depended on circumstances and points of view such as between biodiversity and recreation or flood risk and cultural heritage, which participants scored as both a synergy and a conflict. Services that were consistently seen to provide high trade-offs with other services were arable food production and peat extraction. Spatial and temporal scales of impact are also important (e.g. the scale of impact ranging from global in the case of greenhouse gases to local in the case of flood risk).

In the Somerset Moors and Levels most ecosystem services are positively based on the wetland having high water tables. The exceptions are flood storage and methane emissions which are negatively impacted by high water table (i.e. less flood storage, more methane emissions).

For the Migneint and Peak District, generally the conflicts were associated with different forms of land use for provisioning services (wind power, peat extraction). From the scoring matrix used, water quality and biodiversity were assumed to have excellent synergy. However, when the detail of this was discussed it was realised that the relationships are complex and attempts to aggregate might be difficult. It may in fact be that maintaining monocultures of a particular species (e.g. Molinia) could have synergies with water quality but trade-offs with aspects of biodiversity.

One of the issues raised at the project conference, was that many of the ecosystem service maps predominantly addressed ecosystem service supply, yet service demand was seen as equally important to assess service flows. Maps of freshwater provision or realised recreation indicate the demand. Equally important for economic valuation and practical decision making as well as targeting political instruments is the spatial aggregation of ecosystem service providers and beneficiaries. Peatland ecosystem service may be provided at different scales 1) in situ: providers and beneficiaries both live in the peatlands and may belong to the same community, (e.g. benefits of food provision accrue directly to the land manager or through local markets to the local community); 2) omni-directional: beneficiaries live (inside and) outside the peatlands (e.g. recreation opportunities may be maintained by land managers/ area wardens working in peatlands, but are taken up by people living within the peatland and in surrounding areas). Some cultural services such as health walks are provided predominantly for local participants. Conversely, climate mitigation benefits through carbon storage are globally important to all people; 3) directional: providers do not directly benefit from land management for services, as these occur elsewhere, such as clean drinking water provision or potential flood risk mitigation downstream through cumulative management for water quality or runoff attenuation.

Overall the ecosystem services approach developed is transferable between sites. However, the exact findings, nature of services and synergies and trade-offs between services vary between sites. For example, the magnitude of gains achieved from restoration work in the Peak District may not necessarily be realised at other less degraded sites. Broad questions have to take account of different types of peatland and local and national circumstances. This is also important for determining the best spatial configuration of services (e.g. can food production in one place be better achieved in other places?) One of the key findings was that local knowledge must be used to interpret national, regional or even local maps and datasets. When national or regional datasets are applied local interpretation of these should also obtained. For example, maps of car parks at Thorne & Hatfield do not actually indicate that car parking is considered an important issue at the site. Ecosystem service flows need to be assessed in detail; water abstraction may serve different purposes, either industry or public consumption; both will have different long-term impacts. There were clear differences between upland and lowland peatlands thereby affecting transferability.

The project produced key indicators for assessing peatland ecosystem service provision that allows monitoring the health of ecosystems and which could be built in to future monitoring. The overall assessment combined (i) the optimum combination of indicators of high relevance for peatlands and peatland services, (ii) the secondary score of other indicators of relevance, which identify the link to services or interest and the practicality of their immediate application in a monitoring scheme, and (iii) indicators which are indicative of several functions and services. Table 2 summarises the most promising indicators for a new monitoring scheme.

Table 2. Key indicators for a new monitoring scheme

Indicator	Service / Function
Common standard monitoring	Habitat / biodiversity
Appropriate plant diversity (e.g. CEH CS data)	Habitat / biodiversity
Bog-forming species	Habitat / biodiversity; regulating
National River Flow Archive (appropriate measurement for peatlands needs developing)	Provisioning

Water storage (modelled)	Provisioning; regulating
Water stress (modelled)	Provisioning; regulating
Presence of peatland ditches	Regulating
Area of bare peat	Regulating
Erosion (% area)	Regulating
% bare peat	Regulating
Dissolved and particulate losses of carbon	Regulating
Greenhouse gas flux measurements at all scales (chamber to landscape)	Regulating
National gamebag census / Red grouse populations and area of grouse moors	Cultural
Area of recreational facilities (e.g. Local footpath network)	Cultural
Area of designated land / national park	Cultural

The research provided suggestions that should be considered in a Phase II programme on the Ecosystem Services of Peat in order to provide critical guidance on peatland management actions to prioritise locations and actions of peat restoration in England and Wales. The following points were compiled based on lessons learnt from this scoping study combined with advice from workshops held at the project conference on 15/16 October 2009. In summary, there needs to be an improved evidence base, expanded spatial coverage, additional case studies for new peat types, inclusion of climate change scenarios in assessments, improved valuation including additional (e.g. non-use) services, and provision of practical / policy outputs.

1. There are a number of major research gaps that need to be filled before work can be rolled out to evaluate some of the major ecosystem services. It is therefore suggested that an integrated research programme is carried out over five years that results in ecosystem service plans for UK peatlands. Examples of major research gaps that have proven to be obstacles in this scoping study are:

- There is continuing controversy surrounding the impact of various remediation measures such as the blocking of grips on greenhouse gas emissions, as well as management measures such as burning. There remains a need to undertake monitoring and assessment of peatlands across uplands and lowlands in the UK, especially different fenland types, to establish all fluxes of both atmospheric and riverine fluxes of carbon and green house gases including the ultimate fate of losses in dissolved or particulate losses to rivers.
- The overall impact of gullying and ditch blocking not only on dissolved organic carbon, but also nitrogen, sulphur and acidity remains uncertain, as does the impact of water table on nitrogen retention.
- Research is needed to address the issue how rising trends of dissolved organic carbon (DOC) in streams can be halted or managed.
- Further work is required to quantify the impact of peat condition on the quantity and timing of runoff in relation to water supply, and to the dilution of diffuse and point-source pollution.
- Determining overland flow velocities for a wider range of peatland vegetation covers will aid assessment of flood risk attenuation benefits from peatland management.
- Understanding is needed how woodland clough planting impacts stream flow, water quality and carbon cycling.
- To address UK Climate Change goals, research is needed, on which renewable energy schemes are most efficient in their carbon balance, cost-effectiveness and have least impact on other ecosystem services and biodiversity and in what locations can they be best deployed.
- Targeted research is required to develop niche models for rarer species and build consensus on characteristic peat forming species.
- Major work is needed to identify additional indicators, especially for cultural services, to cover the full range of services peatlands deliver.
- More specific and in-depth valuation studies with regards to peatland restoration and management practices are required to inform cost benefit analyses.
- A greater understanding of the spatial (dis)aggregation of providers and beneficiaries of services is needed to assess ecosystem service flows.
- The links of ecosystem service provision to wellbeing and health are a pivotal area of research to be addressed.

2. Coupled to the above, an integrated research programme to assess effects of peatland management and restoration options on peatland ecosystem services, with a cost-benefit analysis to lead to spatial and temporal targeting of resources and efforts would be appropriate to address the research gaps.

3. A roadmap is needed to determine ecosystem research on peatlands with a timeline of how different research projects will feed in. There needs to be co-ordination of all current work on ecosystem services of peatlands (even if funding is from non-Defra sources).

4. There should be a UK upland hub for peatlands, which forms one unitary platform for knowledge exchange between science, policy and practice and develops new integrated research. Such a platform has recently been proposed to the Living with Environmental Change (LWEC) Directors and steering group who are keen to see stakeholders and the policy community support this through funding and staffing. This would build on the many excellent, but currently disjointed and replicated initiatives, to align and integrate activities. It is crucial that representations from stakeholder organisations are used to co-ordinate and develop work for peatlands.

5. There should be support for strategic long-term monitoring. The lack of long-term datasets is a real hindrance for evaluating ecosystem services. Effective monitoring of landscape peatland restoration programmes, for example, would allow for adaptive management and addressing some of the major knowledge gaps. This should be standard requirement with any new funding for practical work. Another avenue would be to feed standardized peatland ecosystem service monitoring into the biological network sites of the ECBN network, and encourage and facilitate large landscape restoration projects to take part.

6. This research has shown that different types of peatland offer different ecosystem services and/or provide services in different ways (e.g. flood mitigation). Therefore, care must be taken in Phase II to ensure that peatlands are properly characterised when the work is rolled out to other peatland types. That said, blanket peat forms 87 % of the UK's peatland and research will necessarily need to be targeted proportionally.

7. Phase II should include all ecosystem services (beyond the ones that could be covered in this scoping study).

8. The scale of approach needs to be carefully considered. For example, for some services the focus is within the peatland itself, while for others the focus may be off-site and the scale of the off-site service provision must be appreciated. Additionally, while using the same scale of approach for all services allows some comparative maps to be produced (e.g. 1km2 grids), such scaling is not as appropriate to some services as it is to others.

9. The UK Peat Geonetwork www.ukpeatgeonetwork.org.uk should be used as a source of metadata and a way of managing datasets when the work is rolled out across England and Wales. The approach should encourage active sharing of information, facilitate collaboration between scientists and science users and ensure avoidance of duplication of efforts.

10. Climate change will need to factored into an ecosystem service approach to evaluate how the service provision may change and/or ways of i) taking advantage of climate change, ii) mitigating and adapting to negative impacts on ecosystem services, and iii) understand how land management and climate change will interact.

11. A key objective for Phase II would be to determine whether an optimal geographic configuration for managing different services in different areas that maximises overall benefits can be found. Thus, maps showing where and what restoration could be applied will be very useful.

12. Research is needed to establish how costs for (un)sustainable management can be internalised and stewardship for ecosystem services be rewarded, e.g. through payment for ecosystem services (PES) schemes), reform of environmentally harmful subsidies, regulation or new market options.

13. Clear policy advice is required at different levels (e.g. support/guidance for agri-environment schemes) along with information on the uncertainty present.

14. As ecosystem services are a matter of societal choice a participatory process with full engagement with landowners and managers is needed; this would be challenging at a national scale and therefore an integrated national, regional and local approach is required. As suggested in Section 6, local stakeholders are required to interpret national datasets covering their peatlands.

15. The work and approach needs to be communicated effectively to the public.

A full report is available as an appendix to this SID5 form, which outlines the methods, data sources, results, maps, ideas for future work and references.

Project Report to Defra

8. As a guide this report should be no longer than 20 sides of A4. This report is to provide Defra with details of the outputs of the research project for internal purposes; to meet the terms of the contract; and to allow Defra to publish details of the outputs to meet Environmental Information Regulation or Freedom of Information obligations. This short report to Defra does not preclude contractors from also seeking to publish a full, formal scientific report/paper in an appropriate scientific or other journal/publication. Indeed, Defra actively encourages such publications as part of the contract terms. The report to Defra should include:

- the scientific objectives as set out in the contract;
- the extent to which the objectives set out in the contract have been met;
- details of methods used and the results obtained, including statistical analysis (if appropriate);
- a discussion of the results and their reliability;
- the main implications of the findings;
- possible future work; and
- any action resulting from the research (e.g. IP, Knowledge Transfer).

See Appendix for full report

References to published material

9. This section should be used to record links (hypertext links where possible) or references to other published material generated by, or relating to this project.

See Appendix for full reference list