THE UNIVERSITY of York

Defra-BESS Collaboration: supporting innovation in mapping ecosystem services

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1. Non-technical summary

Ecosystem services are the services that ecosystems provide to maintain a healthy and productive environment for life on earth, in particular, human beings. Examples include the provision of clean air, removal of pollutants from water, maintenance of a healthy climate, provision of food, fuel and building materials, and landscapes that people enjoy.

We need to understand more about how these services are provided and where they occur, so we can manage the landscape in such a way to sustain or enhance the associated benefits that we receive from the natural world. Developing better ways of mapping the distribution of these services is an important part of this process.

The aim of this project was to review current projects that are mapping ecosystem services in England, the methods they are using, how effective they are and how these methods might be applied more widely.

We found that approaches to mapping ecosystem services vary greatly, not only in the way that the maps are constructed but also in terms of stakeholder engagement. However, there are a large number of different groups and organisations benefiting from the mapping of ecosystem services, and these benefits are occurring at national, regional and local level.

The challenges for current mapping projects centre largely on data availability and quality. Future development of ecosystem service mapping will be enhanced by the provision of further guidance on techniques and improved integration and availability of relevant datasets.

2. Report summary

The importance of biodiversity in underpinning a broad range of benefits that the environment provides to society (ecosystem services) is now widely recognized at the policy level. These benefits are not just in terms of the benefits of biodiversity per se, but extend to the role of biodiversity in ecosystem services such as the prevention of flooding by wetlands, the storage of carbon by peatlands and the production of food in agriculture.

Mapping has a fundamental role to play in supporting decision-making for implementing the ecosystem approach at a landscape level. There are a number of existing initiatives establishing projects to map the distribution of ecosystem services in different areas, both nationally and locally. There is now a need to bring together the knowledge and understanding gained through these activities so that best practice can be shared and common approaches established.

The key objective for this project was to investigate the approaches that a number of local initiatives are taking to develop spatially explicit maps of ecosystem services, including what datasets, data standards and data models they are using, and how they involve stakeholders and end users in the process.

To address this objective, the Ecosystem Service Mapping Gateway (http://www.nerc-bess.net/ne-ess/) set up by the NERC Biodiversity and Ecosystem Service Sustainability (BESS) programme Directorate was further developed to include additional ecosystem service mapping projects. Some of these projects were investigated in more detail, using in-depth interviews, to provide case studies of how ecosystem service mapping has been conducted.

Our in-depth interviews showed that projects often differed greatly in terms of their methodological approach, end-users and even purpose and objectives. Some projects were driven by stakeholder input from the beginning whereas others involved stakeholders at the very end in order to verify and refine map outputs. The main purposes of the mapping projects included:

- To quantify and map ecosystem services
- To quantify and map ecosystem services in relation to management
- To map ecosystem services for land-use planning
- To establish management interventions for ecosystem services
- To develop green infrastructure maps
- To map connectivity of habitats

Impacts have been demonstrated at both the national and the local level but challenges and barriers were common for the case study mapping projects, in particular, those relating to data availability and quality. Other barriers included:

- Data licensing and ownership
- Technical and skills-based barriers
- Restrictions of time and funding
- Translational and communication difficulties

A follow-up workshop was held to discuss some of the key challenges regarding data availability to ecosystem service mapping, and to identify some possible means of overcoming existing barriers, including

new frameworks for data collation and provision. Key factors for enhancing success in mapping of ecosystem services included: building wider awareness through publicising a project; establishing 'buy-in' early on from stakeholders; and having access to wider support to facilitate project development. Some of the perceived barriers were: limits to availability of data, including licensing and ownership problems; limits to data quality and resolution; limited relevance of existing data to ecosystem services, especially in terms of measuring flows rather than stocks of services; a lack of access to technical expertise; and restrictions of time and funding.

It was considered that a new framework for data collection and dissemination would be beneficial, perhaps involving the creation of a new national centre or partnership. This would have responsibility for providing easier access to data and helping to ensure better coordination in data collection. A coordinating data centre or partnership would provide a direct link between data users and data providers, to promote the more effective use of existing data resources and ensure a better match between data provision and need, and could also serve as a source of advice on dataset availability and compatibility.

On the basis of the results from the interviews and workshop, a set of brief 'guidelines' was developed to highlight good practice in ecosystem service mapping. These guidelines are given in full in this report but a summary is provided here:

1. Consider fitness for purpose
2. Use available data where possible
3. Involve stakeholders from the outset
4. Use an iterative and flexible, but well-documented approach
5. Learn from other projects
6. Update as new data become available
7. Maps are only one tool in the Ecosystem Approach

The full guidelines, as well as the detailed case studies, are accessible through the Ecosystem Service Mapping Gateway. The Gateway will be maintained under the auspices of the NERC Biodiversity and Ecosystem Service Sustainability (BESS) Directorate until at least 2017.

3. Introduction and objectives

3.1 Project background

In the UK, the National Ecosystem Assessment Report (UK NEA 2011a), the Lawton Report (Lawton *et al.*. 2010), and the Natural Environment White Paper (NEWP; HM Government 2011) have all emphasised the importance of a more integrated, landscape-orientated and integrated approach to some of the key policy challenges such as climate change adaptation, flood regulation, water quality regulation and food production.

There have been a number of landscape-level activities driven by government agencies such as Natural England's Upland Ecosystem pilot projects, Natural England's Green Infrastructure programme, JNCC's spatial mapping projects and various ecosystem-based projects promoted by the Marine Management Organisation. At a national level, 12 Nature Improvement Areas (NIAs) have been established, and at a local level, there are now 48 Local Nature Partnerships (LNPs) established, all seeking to implement an ecosystem approach to management at the landscape level.

Mapping has a fundamental role to play in supporting decision-making for implementing the ecosystem approach at a landscape level. Mapping of ecosystem services and benefits can help decision-makers understand how different ecosystem services are delivered across a landscape and hence inform strategic planning. It is also useful as a means of visualising and communicating information on ecosystem services in an accessible way, in particular in relation to potential impacts as a result of management or environmental change.

There are a growing number of projects which contain a significant mapping component for representing ecosystem service delivery across the landscape. Many of these projects (48 in total) have been captured in a previous project conducted for Natural England and disseminated using a web-based interactive resource (The BESS Ecosystem Service Mapping Gateway: http://www.nerc-bess.net/ne-ess/). These projects include a study undertaken for the Joint Nature Conservation Committee (JNCC) that develops the use of spatially-based biodiversity data for the delivery of work on ecosystem services (Medcalf and others 2012), as well as the Eco-Serv project being developed by Durham Wildlife Trust to generate maps for a range of ecosystem services (http://www.durhamwt.co.uk/what-we-do/current-projects/ecoserv-project/).

Ecosystem service mapping is therefore a rapidly-expanding area, but it poses significant challenges, both technical and practical. Projects aiming to map ecosystem services have often developed according to local needs and resources and are often shaped by the availability and quality of the data used. They may be conducted for a number of different purposes and use different approaches. There is still much that can be learned and shared regarding the methods that projects are using (data, models, end-users), the barriers to mapping ecosystem services and how these barriers can be overcome.

There is therefore a need to discover more about these existing projects, construct frameworks to address common barriers, and bring together the knowledge and understanding gained through these activities so that best practice can be shared and common approaches established.

3.2 Project aims

The key objectives for this part of the project were therefore to investigate the approaches that a number of local initiatives are taking to develop maps of ecosystem services. Specifically, this project aimed to:

1. Investigate the approaches that a number of local initiatives are taking to develop spatially explicit maps of ecosystem services, including what datasets, data standards and data models they are using, and how they involve stakeholders and end users in the process.

2. Investigate the rationale behind the representation of stocks of natural capital and flows of ecosystem services in map form and how this affects the perception and use of this information by users.

3. Identify any common issues that local initiatives face in getting the evidence and data into a form that can be shown on maps, interactive maps and GIS.

4. Identify any impacts and common success factors in analysis and presentation of data that have led to demonstrable changes in public perception and decision making processes.

5. Develop through a participatory process a range of possible actions that the public, private or voluntary sectors could take to overcome any issues defined in Objective 3.

6. Report on findings in a way that is easily accessible to local initiatives, data holders, land managers and business users, NGOs, government agencies and relevant academics.

4. Methods

We conducted stakeholder interviews in order to obtain the data to address objectives 1 through 4 and held a stakeholder workshop to address objective 5. Objective 6 was achieved by promoting our case study findings on the existing Ecosystem Service Mapping Gateway database (http://www.nerc-bess.net/ne-ess/). All results are reported here, including a set of guidelines for best practice that we have compiled from our findings.

4.1 Interviews with project representatives

Data on projects were collected using an online survey and posted onto the Ecosystem Service Mapping Gateway. The online survey was advertised using professional networks and also via social media such as the BESS twitter feed.

Some projects featured on the Ecosystem Service Mapping Gateway were subsequently approached and requested to take part in an in-depth interview, either in person or on the phone, to provide further information on their mapping project. The interviews focused on the use of data and data standards, the involvement of stakeholders and end users, the representation of stocks and flows, challenges in the translation of data into map form and the impacts of the project so far. The topic guide used during the semi-structured stakeholder interviews, including specific questions asked, is provided as Appendix 1. Interviewees were also sent some information prior to interview providing a summary of the project's aims, a list of interview topics and some key definitions. All interviews were recorded and transcribed with the permission of the interviewee. The results from all of the projects are reported here, with the exception of one where the interview recording failed. A further three cases studies have been omitted from the Ecosystem Service Mapping Gateway due to a lack of approved consent. Therefore, of a total of 19 interviews, we discuss 18 cases studies in this report and showcase 15 case studies on the Ecosystem Service Mapping Gateway.

4.2 Workshop on data management and ecosystem service mapping

A workshop was held with representatives from key organisations focussed on data management. The overarching aim of the workshop was to identify a range of possible actions that the public, private or voluntary sectors could take to overcome any problems relating to the availability of data for ecosystem service mapping.

The workshop was structured around two themes. The first theme was data quality and availability. Within this theme, participants discussed data-related barriers preventing more effective mapping of ecosystem services, the roles and responsibilities of different organisations in potentially enhancing the availability of data for ecosystem service mapping, and potential future opportunities in terms of new data. The second theme was data management. Within this theme, participants were encouraged to develop new frameworks for data management that might offer solutions to some of the problems of accessibility.

5. Results: Interviews with project representatives

A total of 19 stakeholder interviews were conducted. The projects that were covered by these interviews represent a full range of stages from those still planning the methodology right through to completion with reports already published. The key findings from these interviews are summarised below and in Table 1.

Table 1. A summary of case study projects including the title, organisation, main purpose, objectives, approach, stakeholder participation and end-users and impacts. The projects are grouped according to purpose.

Case study project title	Organisation	Purpose	Objectives	Approach	Stakeholder participation	End-users and impacts
Mapping Ecosystem Services	Natural England	To quantify and map ecosystem services	To map key ecosystem services at an England level. The outputs are maps of services based on proxies of underlying habitat type and the assessment of each habitat type's ability to provide a particular service.	A total of 10 ecosystem services have been mapped based on the potential of areas to deliver services based on the NEA assessments described in the Synthesis Report. Relationships between habitat and ecosystem service have been converted into a simple scoring system based on the importance of the habitat in delivering the ecosystem service in question.	The maps and the methodology have been shared with two of the Nature Improvement Areas, specifically Morecambe Bay and the South Downs, who have given feedback.	Large scale partnerships and people who are doing practical action on the ground to maintain and deliver outcomes of ecosystem services and biodiversity. This includes all of the Nature Improvement Areas, the AONBs and the National Parks.
The Social, Economic and Environmental Research (SEER) project into Multi-Objective Land Use Decision Making	CSERGE at University of East Anglia	To quantify and map ecosystem services	To apply advanced analysis techniques to highly detailed datasets comprising spatially detailed information to produce ecosystem service maps.	Economic values were calculated using separate models and then integrated to form a spatial output of economic values for each ecosystem service and good. Different scenarios were applied to a baseline to show the spatial distribution of changes in ecosystem service value if that scenario were to occur.	Main stakeholders include national partners and national interest decision-makers, although there have been local presentations given of mapping output to decision-makers in and around Norfolk.	The outcomes have fed into the Natural Environment white paper. The project has also contributed to the Natural Capital report and some high profile scientific publications. The project has also provided guidance to the Office for National Statistics.

EcoServ-GIS	Durham Wildlife Trust	To quantify and map ecosystem services	Produce fine resolution, county scale ecosystem service maps using widely available data.	The approach used ArcGIS Modelbuilder software to develop spatial models of ecosystem service provision and demand based on a set of rules devised from literature and expert knowledge. Habitat data was linked to a set of ecosystem service 'indicators' in order to map provision, while socio-economic data was used to map potential areas of demand for ecosystem services.	The project steering group consisted of members from Natural England, the Environment Agency and several universities and this has been the main form of stakeholder engagement so far in the project.	The main beneficiaries for the toolkit are the Wildlife Trusts across the country but also Local Nature Partnerships or Local Authorities who may want to produce ecosystem service maps. Natural England is also using the toolkit in order to produce maps for an Integrated Biodiversity Delivery Area (IBDA).
New Project (name to be decided)	The National Forest Company	To quantify and map ecosystem services	To identify, map and quantify the ecosystem services that result from the creation of the new forest created as part of the National Forest Initiative.	Ordnance Survey Mastermap data and Mapinfo GIS software was used to construct the species network models and the maps. The initial outputs are mapped corridors across the whole of the forest. Workshops were held to refine the approach to consider factors such as habitat block size, habitat management and other factors such as the influence of water courses.	Forest Research and Natural England but local stakeholders, local Wildlife Trusts and County Councils have also contributed to developing the model.	The maps have already been used to work on planning issues with the Highways Agency. The project has worked closely with colleagues in Nottinghamshire who used the same approach for Sherwood Forest.

Ecosystem services for economic characterisation of the Scottish water environment	Scottish Environment Protection Agency (SEPA)	To quantify and map ecosystem services	This project maps ecosystem service provision by the water environment. Services are mapped at a water body level to show the relative importance of each water body in terms of service delivery.	The project identified the ecosystem services associated with the water environment and then mapped the provision of each ecosystem service by each water body. Initially this was a straightforward 'yes' or 'no' regarding whether or not each water body provides the service. A score was then applied to indicate the significance of the provision of each service by each water body, relative to other water bodies in the country, on a scale of high, to medium, to low.	Future consultation with stakeholder groups will include: local authorities, hydroelectric power companies, whisky distilleries, Scottish Water, members of SEPA responsible for flood management, Historic Scotland and possibly fish farmers. Their feedback (and expertise) will be used to refine the data and/or maps.	It is hoped that the data, stories and maps will feed into subsequent work but its main purpose is for assisting implementation of the Water Framework Directive (WFD).
Nene Valley Nature Improvement Area Project	University of Northampton	To quantify and map ecosystem services	To map and model ecosystem services and biodiversity across the Nene Valley Nature Improvement Area (NIA) and to better understand the thresholds for those services and their current health.	The project is using several techniques, one of which is the ecosystem service mapping tool developed by Durham Wildlife Trust as part of their EcoServ-GIS project. The first stage of the project has been a data-gathering exercise and then the models will be run using ArcGIS software.	Stakeholders will include the local Wildlife Trust, the County Council, the RSPB, Natural England and the Environment Agency. The Nene Valley Regional Park which coordinates development activity will also be consulted.	The project will be using the maps to identify some of the best areas in which to pursue payments for ecosystems services and to influence planning policies. The project is also planning on using the maps to interact with local groups.

Honeybee pollination service supply-demand mapping	CAER, University of Reading	To quantify and map ecosystem services	To examine the capacity of national honeybee stocks to provide pollination services to national insect pollinated agriculture over 41 European countries.	For each country, the approach took the sum area of insect pollinated crops, the number of honey bees in the country, and multiplied the area of each crop by a series stocking factors. These were the number of honey bee colonies per hectare required to provide pollination services to those crops. This was then summed and then compared to twice the number of honey bees. The number of honey bees were doubled on the assumption that you can move honey bees between two different crops in a year.	The Department of Agriculture of Cyprus were involved as stakeholders as they provided data for the project. In the future, the project may involve stakeholders further by asking for feedback from beekeepers in the different countries.	EU policy-makers are the main intended beneficiary of the work. It is hoped that the work will highlight changes in the supply and demand of pollination as an ecosystem service in-line with changes that have been implemented in the Common Agricultural policy. It may also be of benefit to both beekeepers and farmers by encouraging access to wider pollination service markets.
Mapping of Ecosystems and their Services in the EU and its Member States (MESEU)	NERC Centre for Ecology and Hydrology	To quantify and map ecosystem services	To provide assistance on behalf of and in cooperation with the EU Commission to the Member States in the context of action 5 of the EU 2020 biodiversity strategy, on the mapping and assessment of the state of ecosystems and their services.	The project has constructed a matrix which shows the extent to which ecosystem services have been mapped in each European state and the levels of expertise, the gaps in knowledge and whether it's involving stakeholder partnerships or not. The project leaders at Alterra have then taken this matrix and started to develop it into a framework which can be used to look at how we would map it across the whole of Europe.	Consultation workshops with stakeholders will be used for identifying gaps in the mapping process and also providing a structured set of recommendations. These include, mapping professionals, representatives from the member states, nature directors and policy practitioners.	The EU will be the main end-user but the data will be made available to all member states.

Does environmental stewardship deliver ecosystem services that support agricultural production?	The Food and Environment Research Agency (Fera)	To quantify and map ecosystem services in relation to management	To produce a review of the ecosystem services provided by Environmental Stewardship (ES), the main agri-environmental scheme in England. It is particularly concerned with those that are of benefit to agricultural (especially crop).	The approach involved calculating the number of stewardship options that were taken up on each land holding and the different levels of benefit that they provided for each of the ecosystem services. These benefits were scored on a scale of -1 to 3 using expert opinion. Scores were apportioned and presented using a 5km grid for each map at a national scale. The maps and an accompanying report were produced in August 2012.	Natural England has been the main stakeholder and beneficiary of the project.	It is likely that the report and results of this project have contributed to the evidence base for the next round of the Common Agricultural Policy.
Land Use and Ecosystem Services (LUES)	Forest Research	To map ecosystem services for land-use planning	To understand, and spatially map the links between forests, woodland and trees and the ecosystems services they provide to better inform sustainable forest management, and wider land-use planning.	Using a series of workshops, a key list of initial ecosystem services has been devised. The method for the mapping will then be developed, with further feedback from stakeholders. At the final stage, this approach will be applied to some cases studies, including the Dearne Valley Yorkshire and the South Downs National Park.	Forest Research and Forestry Commission colleagues were involved in the methodology using workshops.	Policy practitioners, strategic decision-makers, but also planners and regional staff such as district foresters will use the outputs.

SCCAN	Natural Resources Wales	To map ecosystem services for land-use planning	The project aims to deliver an ecosystem service mapping system that could assist people in taking an ecosystems approach in their decision making.	The approach uses existing datasets such as Phase 1 Survey data, Landmap Landscape Character data, social data, soil data and Ordnance Survey data. At the local level, the project maps operate at a 10 meter grid scale. Within each square, a rule base was used to gain an overall score in terms of ecosystem service potential.	The main stakeholders which have involved in the project are two Local Authorities: Bridgend and Torfaen.	The Local Authority of Bridgend is using the maps regarding their planning department and countryside division. In addition, the Local Authority of Torfaen has used the maps regarding evidence of flooding and may also start using them as part of their climate change strategy.
Ecosystem services review for the Ministry of Defence	Smiths Gore	To map ecosystem services for land-use planning	To produce a concise assessment of what the priority ecosystem services are on the MoD estate and how its managers can reduce any risks and exploit any opportunities.	The approach involved constructing a matrix of the different ecosystem services provided by the estate and then a workshop was held with internal stakeholders to rank them in order of importance and discuss appropriate metrics for measuring them. Further workshops are planned to confirm the metrics and assessments and the project use ArcGIS to construct the maps.	An internal stakeholder workshop was used to rank ecosystem services in terms of importance. Further consultation will take place with external stakeholders such as environmental protection agencies.	MoD managers will have access to the ArcGIS maps and be able to use them in their management activities. The MOD may also use the maps as part of their stakeholder engagement with consultees and in future planning policies.

Tamar Catchment Pilot project	Westcountry Rivers Trust	Establish management interventions for ecosystem services	To (1) characterise the current level of ecosystem service provision in the catchment, (2) define catchment management measures to enhance ecosystem services provision, (3) identify areas of the catchment where these interventions could take place (4) set out a framework for delivery.	The project established a 'working group' of stakeholders from the Tamar catchment. The working groups therefore led the process, helping to establish which areas play a role in the provision of each service within the catchment and which data sets were needed to map them. The working groups also established which interventions could be used to enhance ecosystem service provision.	Stakeholders included over 100 individuals and represented over 30 different interest groups, including representatives from each of the private, public and voluntary/community sectors in the catchment.	In the short term the project has had an impact on the management practice of county councillors and planners and farmers that have been part of the stakeholder process.
Liverpool City Region Green Infrastructure Framework	The Mersey Forest	Develop green infrastructure	To develop a green infrastructure framework for Liverpool City Region.	The framework is built upon a spatial evidence base covering 28 functions of green infrastructure. For each function, both provision and need for ecosystem services has been mapped. Together, these have been used to help generate a list of recommended actions.	Local Authorities, Government agencies, businesses, NGOs, and other organisations were involved at every stage via regular meetings.	The Local Nature Partnership for the area has agreed to accept the City Region Framework as one of its main guiding documents.
GIFT-T!	Greening the Gateway Kent and Medway	Develop green infrastructure	To develop Green Infrastructure Business Plan at a landscape scale. GGKM is working with Medway Council to map the ecosystem services of the Hoo Peninsula, Medway.	The approach used the same tool as the Mersey Forest Project (above). After consultation with stakeholders, 27 functions of green infrastructure were mapped for the area.	Stakeholders have been consulted throughout the project. They included: The National Farmers' Union, Environment Agency, representatives from NGOs, parish councils and the County Council.	The maps will be used and incorporated into the areas Green Infrastructure plan. Many of the stakeholders involved throughout the project will also be en-users.

Mapping landscape permeability	Dorset AONB	To map connectivity of habitats	To map four broad habitat types within the Dorset AONB and establish the ecological network that connects them. It is hoped that this approach will improve maps of ecosystem services in the area.	The project consisted of three parts. The first was to co-ordinate and pull together all the information that Dorset AONB had on habitats into one place. Second, to identify how species could move between those core habitats. The final stage was to take that data to land owners to try and help them make decisions about conservation management on a farm and landscape scale.	Stakeholder engagement took place with 17 landowners, using a set of generic maps for the landscape to explain the principles behind the project.	The project enabled four agri-environment schemes to be established on farms. In addition, Information provided to the Fire Service helped improve their fire management plan.
Ecological connectivity and terrestrial biodiversity prioritisation mapping	Natural Resources Wales	To map connectivity of habitats	To map habitat networks based on least-cost modelling for a range of terrestrial habitats to help understand ecosystem services within natural resource plans.	Phase One Habitat Survey data was used to determine the habitat type of land parcels. Each habitat then has a different cost associated to it according to the cost to the species between forest patches. The mapped outputs show the resulting habitat networks.	The project had a steering group consisting of members from the Forestry Commission, Woodland Trust, and other organisations which influenced the work at all stages, especially regarding the designation of priority areas.	The National Trust has been using the maps to plan current and future woodland management. In addition, the maps have been used to assess potential projects in terms of how they may benefit habitat connectivity when being assessed for funding from Natural Resources Wales. The maps have also been used to identify sites to comply with the Natura 2000 designations in Wales.

Liverpool City Region Ecological Framework	Merseyside Environmental Advisory Service	To map connectivity of habitats	To reduce the loss of and fragmentation of our important habitats; by improving the value of the core biodiversity resource and reconnecting our important habitats thus providing greater resilience for our natural assets.	The project identified where the habitat networks were and then identified strategically important habitats such as the River Alt corridor, the Mersey, the Dee estuary and the Sefton coast. Opportunities for enhancing those areas has been adopted by the local councils and current work looks at refining that and identifying locally determined nature improvement areas for Merseyside, and Halton.	The project had two targeted stakeholder consultations on methods for mapping the network and the buffer zones. That was targeted at local wildlife groups and trusts, the Environment Agency, Natural England and other statutory authorities, as well as the local planning authorities and individual local naturalists and experts.	End-users will be local planning authorities, statutory agencies, local Wildlife Trusts etc, but also developers.

5.1 Characteristics of ecosystem service mapping projects

i. Data and data standards

Depending on the funding available for the projects, both freely available and purchasable datasets have been utilised. Often a wide range of datasets will feed into the mapping system – although there were cases where data for only a couple of variables were required. Datasets used include:

- Land Cover Map
- Ordnance Survey MasterMap
- Phase One Habitat Classification surveys
- Agricultural Census data
- Biodiversity data (from NGOs, Biological Record Centres etc.).

Not all data sources were external to projects. Smiths Gore (contracted by the Ministry of Defence), for example, made extensive use of the MoD's own data along with the expertise of its land managers.

Our case studies provided a range of approaches to mapping ecosystem services – including the use of data models. However, whilst proxies were not uncommon for attributes that would otherwise be difficult to assess directly, some projects solely used empirically derived data.

ii. Involvement of stakeholders and end users

The stakeholder groups involved in our case studies come from across the spectrum and are summarised in Table 1. They ranged from local residents to local authorities, conservation-orientated organisations (e.g. Wildlife Trust, local nature partnerships) to representatives from industry (e.g. National Farmers' Union), both governmental and public bodies (e.g. Natural England) and sometimes only the stakeholder group who contracted the work.

The approaches taken to stakeholder involvement also varied widely. Some contracted projects only had external input from the client, in which case this occurred throughout the development process, whereas others produced a mapping system (perhaps consulting with specialist groups along the way) before bringing it to local people to be taken forward. At the other extreme were cases where stakeholders have been involved from the start and are very much given 'ownership' of the project, its direction and the maps. It was noted that the detail presented regarding how the system worked, depending on the complexity of the project, had to be tailored to the stakeholder group – with some organisations working on more of a 'need-to-know' basis leaving the intricate software (and often the terminology used in academia) to specialists.

Consultations in various forms were mentioned frequently by interviewees, from showing local residents the maps to presenting them to more official organisations such as local planning authorities, but although interactive mapping did occur within the case studies sampled, it appeared to be more common for input to be from specialists rather than representatives of local communities. In the case of the Nene Valley Nature Improvement Area Project, it is anticipated that

interactive mapping will provide a basis for mapping cultural services – using a website as a user interface rather than face-to-face consultations. We did not find any formal analysis of the perceptions of end-users but the mapping projects were generally said to have been met with interest and enthusiasm, at least whilst acknowledging the potential limitations of the systems used.

As with the stakeholder groups involved in developing the mapping systems, the actual end-users varied widely from one organisation (such as Natural England, who contracted the Food and Environment Research Agency to undertake a review of the ecosystem services provided by Environmental Stewardship schemes, and who may then take its outputs forward to other stakeholder groups as they choose) to many (e.g. anybody who would be interested in developments and planning), and from authorities to interested local individuals, according to the primary intentions of the project.

iii. Representation of stocks and flows

As a general rule, the concept of 'stocks and flows' was not specifically incorporated into the mapping projects. Many systems could be considered to have inadvertently mapped stocks (e.g. 'stocks' of timber mapped as woodland habitat) but fewer provided a representation of flows. In one example it was suggested that flows could be inferred from changes in stocks; in another, the interviewee considered her project (linked to another that effectively, but inadvertently, mapped 'stocks) to demonstrate flows of services from the environment to people. There is potentially only one project from our sample that deliberately intends to attempt to represent flows in future but the method is undecided.

Perspectives of the interviewees ranged from considering the concept to be counter-productive when engaging with stakeholders (as it would make the project seem more complicated than necessary and detract from the main purpose) to being useful – the latter most likely in industries such as forestry where the economics aspect of the system is central to stakeholders' work. Cultural services seem to be the most conceptually difficult ecosystem service to apply the concept to. It is worth noting that some interviewees had not come across the concept before and that interpretations of the terms are likely to vary.

5.2 Impacts of ecosystem service mapping projects

A broad range of impacts and target beneficiaries have been identified across our case studies (Table 1). Even in those case studies which are currently at too early a stage to have had a definitive impact, there tends to be a lot of interest in the work. In some cases the work has been contracted to the organisation interviewed so further uses, impacts and unexpected impacts may be unknown.

i. Public perception and the decision-making process

Assisting decision-making by local authorities, both through influencing planning application decisions to feeding into Green Infrastructure Plans, appears to be a common purpose for ecosystem service mapping projects at a local (and higher) level. Not all of the projects have 'official' roots. For example, one project in the Dorset Area of Natural Beauty was undertaken purely to encourage consideration of, and to help landowners make decisions about, conservation management – from a

landscape rather than an individual farm perspective. The project leaders have seen some success on the ground already through the testing they have undertaken. Beyond their original aspirations, their maps have been refined for use in the Fire Service's Fire Management Plan to map areas of heathland close to urban areas that are particularly susceptible to wild fires.

As another relatively focussed example, base maps produced for the Nene Valley Nature Improvement Area (Nene Valley NIA) are to be used to identify the best areas to pursue Payment For Ecosystem Services schemes within the NIA, to influence planning policy through links with the planning sector and, critically for an initiative such as an NIA, to assist interaction with local groups.

At the other end of the scale, impacts have been felt at a national level. The Social Economic and Environmental Research project (SEER) run by CSERGE (Centre for Social and Economic Research on the Global Environment), for example, was a central contributor to the first UK National Ecosystem Assessment (UK NEA, 2011), is continuing to contribute to the on-going work of the NEA and has been delivered to a range of public and private decision-makers from the Forestry Commission to South-West Water. One of our case study projects was contracted by Natural England to be used as evidence in the Common Agricultural Policy reforms. Another inadvertently expanded to be used elsewhere (such as for Wessex Water who are looking at mapping ecosystem services through their catchment pilot) due to collaboration with consultants on an original piece of work.

Natural Resources Wales (formally the Countryside Council of Wales) have used their ecological connectivity mapping system internally both to help to identify and justify Natura 2000 site designations and to make decisions on allocation of the funding for the Resilient Ecosystems Fund. Similarly, the Ministry of Defence (MOD) contracted Smiths Gore to develop an ecosystem service mapping system intended for internal use – but again this will have impacts that spill over to other organisations (such as water companies or the Environment Agency) if, for example, possibilities are identified for their estates to contribute 'more significantly to the framework directive objectives'. In the meantime, it is expected that the work will be used first by strategic managers before being fed down into day-to-day management.

As initially suggested, there is a lot of interest in ecosystem service mapping projects which, as stated by one interviewee, is from 'a whole variety of completely different organisations... it's not something that just conservation organisations are getting interested... a lot of councils and planning organisations and even the NFU and County Landowners Association... are also into the idea'. This interviewee went on to sum up mapping tools as 'such a visual way of doing it. It's a really good way to look at ecosystem services basically'.

5.3 Factors contributing to success of ecosystem service mapping projects

A number of success factors in relation to impacts (and how they have been promoted within our case study projects) have been identified, and are summarised in Table 2 and discussed further below.

The reputation of the department and/or individuals involved in certain projects was believed to be a

factor that helps to broaden the impact and credibility of the work being undertaken. This could act through the awareness created if the project is promoted by those people in different places, through a greater likelihood that the project will be noticed by people from a range of backgrounds (from government panels to practitioners) if it is founded by people who they already know of and respect, and also if opportunities to disseminate results at conferences or workshops are more readily available. The latter point, publicising a project as widely as possible, was in itself considered an important factor with respect to the impact the work could have.

Table 2. A summary of success factors relating to impacts and how they have been promoted within projects.

Success factors:	Promoted by:
Increased awareness and promotion through publicising a project	Reputation and credibility of the department or individuals
Buy-in from stakeholders for a more 'robust' project	Engaging key stakeholders from the beginning of a mapping project
Wider support to facilitate project development	External publicity for the ecosystems approach to management
Having a range of expertise to develop and disseminate project findings	Having a dedicated research element within the wider practical project

i. Buy-in to mapping projects from external organisations

The idea of 'buy-in' was mentioned as both a factor contributing to success and therefore a barrier when it had not been secured early enough in the project. One example of successful buy-in is the MoD's contracted project on developing an ecosystem service mapping system in which the whole process was eased due to the fact that the senior military management 'got the project completely' and considered it essential to their work. In an example given by an interviewee of a project other than their own, data had been incorporated into planning decisions, Green Infrastructure plans and habitat conservation work because they had the time and got people on board from the start, thus building a 'much more robust' project.

External publicity for the topic of ecosystem services and landscape-level approaches has in itself proved beneficial for a number of our case studies, even if they had already gone through the planning stages before the publication of influential documents such as the Lawton Review and the Natural Environment White Paper. A growing awareness of the need to do things at a landscape scale, and a strong political emphasis in this direction (for example the reorganisation of the public bodies responsible for the environment in Wales), has drawn attention to ecosystem service mapping projects and perhaps facilitated their development further than originally anticipated.

Having a dedicated research aspect within a larger practical project was noted by one interviewee to provide the 'best of both worlds' as time was not required to develop those contacts and

partnerships. They already had the buy-in from a range of different types of partners – from which they could make the most of expertise, and through which they could disseminate research. Elsewhere, funding that had been earmarked broadly to look at 'landscape connectivity' provided a lot of freedom for one team to develop their approach based on the latest thinking – and was considered of great benefit to their work.

5.4 Barriers to ecosystem service mapping

A number of problems and barriers were identified by our case study projects. These are summarised in Table 3 and discussed further below.

Table 3. Problems and barriers affecting case study projects

Barriers	Details
Limits to data quality and availability of data	Lack of scientific understanding and established methods for measuring ecosystem services Lack of complete coverage of ecological data and habitats restricts some projects
Data licensing and ownership	Delays in projects can be caused by licensing issues Limited funding can restrict access to certain data
Technical and skills-based barriers	Lack of expertise in handling large datasets can restrict projects
Restrictions of time and funding	Funding restrictions can limit the equipment available for projects Time restrictions can limit the detail and quality of project outputs
Translational and communication difficulties	Difficulties in communicating the ecosystems approach to stakeholders can limit participation Regular communication needed to improve understanding and 'buy-in'

i. Data availability, quality and format

Naturally, the various organisations interviewed have attempted to utilise the best available data with respect to quality and resolution. However, most did not have formal data standards. For some sources, it was assumed that data standards had already been set by the providers. Where it was known that data quality might limit the reliability of the mapping systems, but no alternative was available, such limitations tend to be acknowledged by the developers and taken into account throughout their use. In at least some cases steering groups were consulted on the suitability of datasets. Data quality and availability were frequently highlighted as limitations.

Even in a heavily recorded area such as biodiversity, there is still severe under-representation of many taxonomic groups. Added to this is an issue associated with being a relatively young field of

study – that although some ecosystem services have undergone quite a lot of research, others are much less well-defined as concepts and we lack both scientific understanding and established methods for their measurement (never mind the actual data). Subjectivity is currently required for quantifying services in many cases which is also not ideal.

Building complete coverage of ecological data, habitats and services is therefore challenging and the need to 'make use of what's available' – particularly when covering such large areas – was virtually ubiquitous across the case studies. An example discussed in relation to Phase One Habitat Classification survey data was the potential for it to have been collected over a decade previously. Reaching the desired resolution, having cleaned up and integrated various datasets, can be difficult to achieve and to manage with respect to both spatial and temporal scales. In addition, the format of datasets tends to be highly variable, causing difficulties when they must be stitched together, and on a larger scale the lack of consistency of data across the different countries of the UK – which separate organisations are responsible for – was flagged as a limiting factor.

Using data with some error built into it was stated as difficult for one interviewee's colleagues to deal with as they were 'used to working with data that has been collected in the field and is therefore very accurate'. A representative from another project highlighted their concerns with the fact that OS MasterMap data are commonly used as a basis for defining habitats in mapping projects when the people producing it 'aren't necessarily ecologists [with] that kind of expertise in interpreting what the habitat is'. Instead this project team tried to use information collated locally by a specialist as much as possible.

Despite these problems, it was suggested that if those people undertaking the mapping are aware of the limitations of the data at the start, and acknowledge these so that any conclusions come with certain caveats, then data quality issues can be worked around. One interviewee suggested that 'having mechanisms to be able to improve data quality is something that [they] would like to see be developed and put in place'.

ii. Data licensing and ownership

Licensing and ownership issues frequently came up as a limitation when discussing the extent to which mapping work can be shared in the public domain. Beyond that, access issues have occurred across different government departments, and researchers have had to go through official channels to get permission for data to be released from other departments. Whilst this was not considered to be a major barrier, it held up the project – and time has been highlighted as a restriction elsewhere. In other cases, funding may restrict the ability of groups to acquire the 'best' data if it is not freely available and in one instance data was actually denied by someone who, despite being a county recorder, claimed ownership of it.

iii. Technical and skills-based barriers

Due to the very nature of landscape-scale mapping projects, a further problem encountered has been the sheer amount of data and the capacity of computing equipment to cope with it. To illustrate this, for one representative stated that there were problems 'literally just opening up GIS

maps'. Although this is a general issue with the current abilities of technology versus the quantities of data that can be produced, this can still relate back to restrictions imposed by the funding and resources available to any particular project. One public body employee stated 'we are more restricted to what we can get within our own unit which isn't necessarily very much' and suggested that the way things are set up may be detrimental compared to a situation where resources are provided more centrally.

iv. Restrictions of time and funding

Funding, time and resources were often named as significant restrictions – from having the right equipment as described above, to being able to focus on the project rather than having to leave it for long periods and pull it all together again later, to having 'the time available to do it properly'. One interviewee explained that the priority had been to get the basic mapping done to enable the work to feed into Local Plans – but that they 'haven't really been able to put too much resource into improving data quality because all the resource is going into [the former] aspect'. This was perceived to be a big issue for them and for the District Councils they were working with. The availability of resources extends beyond the projects to the ability of local authorities to provide data in that they too often lack the resources to ensure datasets are up to date and of the highest possible quality.

v. Translational and communication difficulties

The difficulties that can arise when trying to explain the Ecosystem Approach to those outside academia were frequently highlighted – and to add emphasis to this point, two interviewees independently referred to it as an 'abstract' concept. It was noted that convincing stakeholders (and sometimes team members) of the benefits and practical outcomes, whilst also highlighting the limitations, can take up a lot of project members' time – and yet, conversely, that it tends to slow the project down if stakeholders are not engaged effectively as early as possible. Attempting to 'raise awareness about what needs to be done and why it needs to be done and tie that in with what the legislation is' was said to be a particular challenge for one project working with local authorities – whose aspirations naturally concern issues other than just the environment. Achieving that 'buy-in' was therefore highlighted in the interviews both as a major factor contributing to success and as a barrier for the projects in which it was lacking.

Advice offered by a member of an interdisciplinary team included the need to clarify from the start the definitions of terms to ensure that members from different fields have a shared understanding. Regular communication was deemed to be essential including ensuring that, when developing variables, maps or data that need different models, this is done in such a way that they are useful for each individual component in order to avoid different parts of the team 'reinventing the wheel' each time. It was advised that in projects which require systems from different groups to be integrated, all parties must ensure that they 'both understand what each project is seeking to achieve and they are both in sync with each other'.

6. Key challenges when obtaining and using data for mapping ecosystem services

A workshop was held on the 18th November 2013 in York in order to discuss what some of the key challenges are regarding obtaining and also using data when mapping ecosystem services. The workshop also focussed on priorities and frameworks when looking for solutions to some of the challenges. The key outputs from the workshop are summarised below.

6.1 Data quality and availability

The discussion in this session generated a number of priorities and potential solutions for tackling data quality and availability issues. The key points are highlighted below.

i. Priorities:

1. There is a need for a system so that date-users can find out which data is available in relation to ecosystem services.
2. The licensing process needs to be more transparent.
3. There is a need for high quality, detailed habitat maps – LCM2007 is not fine-grained enough for mapping some ecosystem services.
4. Data are often collected and collated at the national-level, this is often does not provide a sufficient resolution at the landscape-level, which is the scale at which ecosystem services operate.
5. Current methodologies for collecting data (Phase 1 habitat survey and NVC survey) are often used without ecosystem services in mind. Therefore there is a need to customise these methodologies for ecosystem services specifically.
6. There is a need to engage Local Authorities, when collecting and distributing data.
7. National organisations would perhaps benefit from a national partnership to make sure that data sharing is taking place and that efforts aren't duplicated.
8. More thought needs to be given to data translation to ecosystem services and particularly how stocks and flows can be determined.

ii. Solutions:

- Utilise existing resources: There are already some existing databases that can be used to obtain different datasets, these include: UKEOF, JNCC terrestrial monitoring and surveillance strategy and the JNCC Crick framework.

- A tiered system or hierarchy approach could be used to establish the scale and level of data needed. This would need to be endorsed and reliable.

- Guidance could be produced to improve survey methods for ecosystem service purposes.

- Better integration of data collection/monitoring. This could take place across volunteer networks for example. A potential incentive for this work could be the production of an annual report to demonstrate the outcomes that result from greater data sharing across networks.

6.2 Frameworks for data management

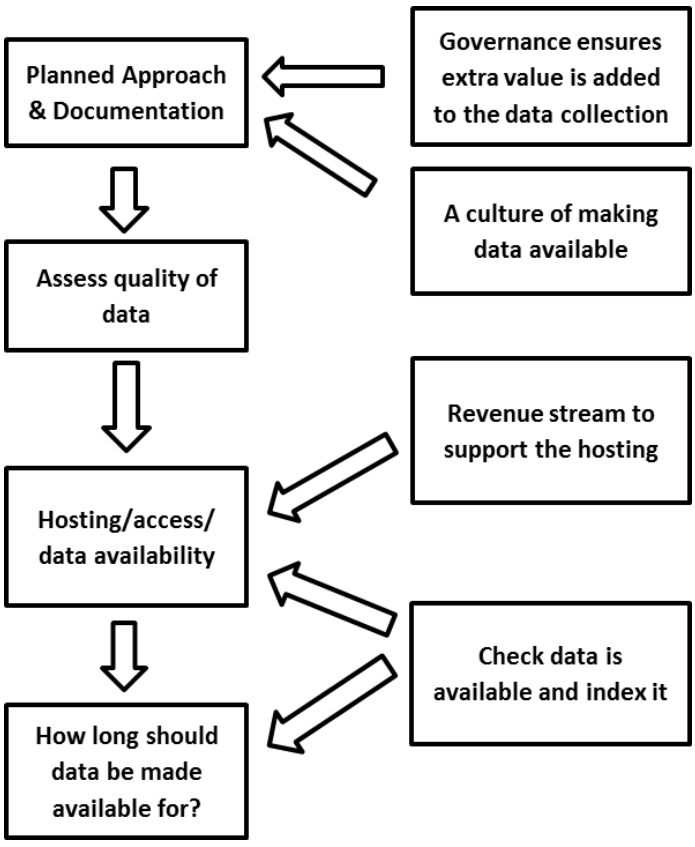
The workshop participants then discussed how a framework approach could be developed to enable some of the previous solutions mentioned. Each group produced a separate framework and therefore these are both resented below.

Group 1 - framework

Framework description:

- A planned approach with good governance would mean that datasets collected could be used by other individuals/organisations for different purposes.
- There must be a sense that that data can be re-useable and can be repurposed using a data management plan.
-

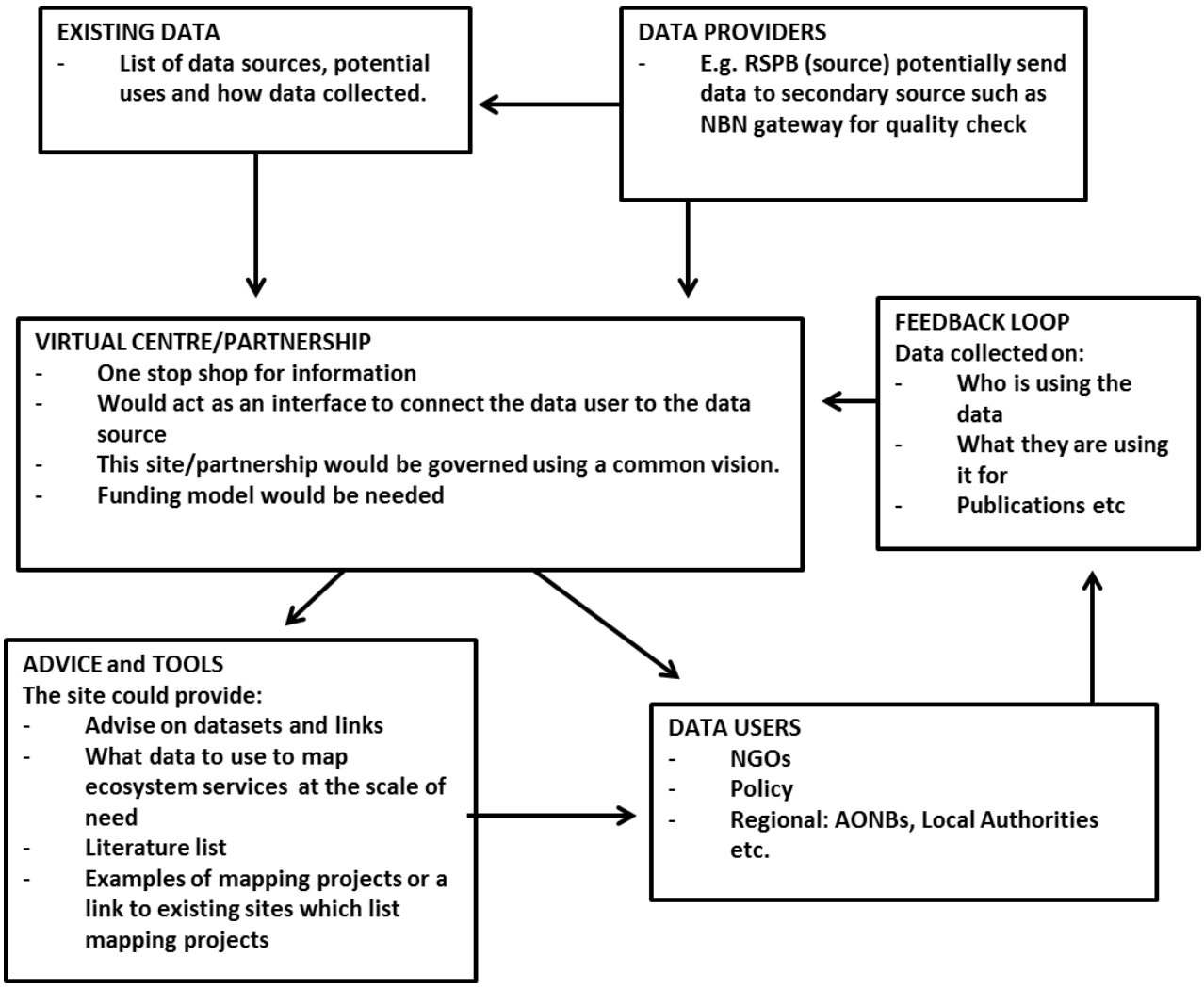
Based on these finding, a suggested outline of the data provision and management is shown in Figure 1:



Group 2 – framework

- One site (or existing site) could be used to look for data – then use this to see which data can be used to map which ecosystem services.
- A national data sharing/exchange partnership could be established: Organisations could volunteer data to the partnership.
- Local datasets should also be considered, as national datasets may not be suitable for mapping ecosystem services at local levels.
- The datasets for use would need to be validated. Self-assessment could be conducted using a set of criteria.
- Criteria could be used to filter the datasets for the site. Or, the data could be filtered by the 'data user' allowing people to filter it themselves according to need.
- Guidance could also be established on how to take an ecosystem services approach using existing data.
- Engagement and funding would be needed to establish this and a business case would be needed.

Figure 2. Alternative suggested framework for data collection and management



7. Good practice guidelines for ecosystem service mapping projects

The principles below should be considered when starting any ecosystem service mapping project. We have included principles that are relevant for any project, regardless of the scale of the project or the ecosystem services that are being mapped. References in square brackets are to projects featured on the Ecosystem Service Mapping Gateway.

1. **Consider fitness for purpose**

   Some mapping projects will have clear aims and objectives from the beginning, while others may take a more flexible approach, adjusting their goals in an adaptive manner based on data availability and other factors that are subject to change. However, all projects will benefit from considering, from the outset, the main purpose of the ecosystem service mapping and the type of project development and outputs that are needed in order to fulfil that purpose.

   For example, if the purpose of the mapping is to produce highly detailed maps for the purpose of research or land management planning (and time and resources are not limiting factors), then that project may choose to spend a large part of the project time and funding on data and model development. Alternatively, if the purpose of the project is to develop maps that will mainly be used in an indicative manner in order to encourage discussion or communication with stakeholders, simple maps may be more appropriate. In such cases, absolute accuracy may not necessarily be so important, and overly-detailed maps may actually be counter-productive and divert attention from the main purpose of the project. Instead, simple maps can be developed further using stakeholder participation.

   [See for example: Natural England's 'Mapping Ecosystem Services' project].

2. **Use available data where possible**

   Most projects will seek to use the best available data wherever possible for their maps. But often, due to licensing and/or funding limitations, those data may not be obtainable. Project officers should therefore undertake an assessment of which datasets are suitable and available to them at the start of the project.

   For some projects, it may be appropriate to spend considerable time and resources trying to obtain or collect data. However, there may be datasets that are freely available and would be suitable as proxies for the ecosystem services that the project intends to map. Using these datasets may be the most cost and time effective approach until new datasets become available. Potential data limitations will need to be acknowledged from

the beginning of the project and explained fully when maps are presented to stakeholders and/or end-users.

[For an example of a project that used current data see: Natural Resource Wales' 'SCCAN' project]

3. Involve stakeholders from the outset

By involving a range of stakeholders in mapping projects from the start of the project, it is more likely that the maps will be fit for purpose, best-suited to stakeholder needs and best-adapted for use in the study area. Stakeholders can be internal or external to the organisation conducting the mapping depending on purpose and scale of the mapping project undertaken.

Methods of stakeholder involvement can take place using meetings, workshops, participatory GIS or similar methods which allow for participation and interaction. If stakeholder involvement is a primary objective of the project, then these meetings should take place as regularly as time and resources allow.

[For an example of a project with regular stakeholder involvement see: the Westcountry Rivers Trust's 'Tamar Catchment Pilot project'].

4. Use an iterative and flexible, but well-documented approach

In order for stakeholder involvement to be most beneficial, projects will need to take an iterative and flexible approach. Project officers should be prepared to adapt to feedback and change the focus of the work if necessary.

Whatever methods are used for the development of ecosystem service maps, it is critical that projects retain a clear record of procedures and any steps taken to transform or amend data, so that the same approaches could be replicated consistently by other mapping projects.

[For an example of a project that have used an iterative approach see: Forest Research's 'Land Use and Ecosystem Services (LUES)' project]

5. Learn from other projects

Ecosystem service mapping is a growing field, with new projects starting all the time. However, there is already a wealth of projects that have gone through the process and have created maps in a way that could be beneficial to new projects starting out. It is therefore important to take stock at the start of any project of what other projects have been done, what methods have already been used and whether those projects have something to offer, such as data.

There are existing resources, such as the BESS Ecosystem Service Mapping Gateway that list a number of projects, operating at different stages, with details of their approach and how to contact the project representative.

In turn, existing projects need to ensure that they collaborate and share knowledge with other organisations and mapping projects as much as possible, so that best practice can evolve over time.

[For an example of a project that has done this see: the project conducted by the National Forest Company].

6. Update as new data is available

Project officers should ensure that, whatever method is used for an ecosystem service mapping project, it can be updated as new data becomes available. It is important to build longevity into a project, even if it is not clear whether there will funding to continue it in the future.

Many aspects of the landscape could change over the course of an ecosystem service mapping project and this could change aspects of the mapping outputs. Projects may alter some of the maps based on stakeholder or expert opinion and this will need to be incorporated in the project design as well.

[For an example of a project that updates with new data see: SEPA's 'Ecosystem services for economic characterisation of the Scottish water environment' project].

7. Maps are only one tool in the Ecosystem Approach

While ecosystem service mapping is an expanding area that offers many benefits and uses within the ecosystems approach, the approach must be used in conjunction with other tools and processes. The final map output can sometimes be considered the final part of the process whereas, for some projects, it may be the beginning in terms of opening communication and dialogue between relevant stakeholders.

[For an example of a project where maps have been used in this way see: Natural Resource Wales' 'SCCAN' project]

8. Communication of findings

The Ecosystem Service Mapping Gateway (http://www.nerc-bess.net/ne-ess/) has been updated with information regarding new mapping projects that have been acquired during the interview work, and case studies have developed from the information collected from the in-depth interviews.

An example of one of the case study projects is given in Appendix 2. The information for each project has been presented in a similar way with extra materials (if provided by each project) such as examples of maps, photos, presentations and links to reports and websites.

The good practice guidelines contained in this report are also available on the Ecosystem Services Mapping Gateway.

It is anticipated that the Ecosystem Service Mapping Gateway will be supported until 2017 under the auspices of the NERC Biodiversity and Ecosystem Services Directorate.

9. General conclusions and recommendations

The key objectives for this part of the project were to investigate the approaches that a number of local initiatives are taking to develop spatially explicit maps of ecosystem services including what datasets, data standards and data models they are using, and how they involve stakeholders and end users in the process.

Our in-depth interviews with representatives of these ecosystem service mapping projects have shown that projects often differed greatly in terms of their approach. External stakeholders were sometimes involved in the project development but projects varied in their approach to this. Some projects were driven by stakeholder input from the beginning whereas others involved stakeholders at the very end in order to verify and refine map outputs.

A broad range of impacts and target beneficiaries have been identified across our case studies. Even in those case studies, which are currently at too early a stage to have had a definitive impact, potential impacts have been recognised. Impacts have been demonstrated at both the national and the local level from aiding local Fire Management Plans in Dorset to contributing to follow-on work for the UKNEA.

Challenges and barriers were common for the case study mapping projects, with many citing that time, funding and communication problems as causing difficulties. Most common though, were challenges relating to data availability and quality.

A follow-up workshop was held to discuss some of the key challenges regarding data availability to ecosystem service mapping, and to identify some possible means of overcoming existing barriers, including new frameworks for data collection and provision.

A number of priorities were identified at the workshop in terms of what was needed to improve the current data management system. These priorities included a need for a system so that data-users can find out which data are available in relation to ecosystem services, understand how different datasets can best be integrated procedures to maximise use of the data in terms of ecosystem services, and encourage more data sharing to avoid data replication.

Potential solutions and frameworks will need to focus on utilising existing data and databases, providing guidance and tools and enhanced integration of data for use specifically on ecosystem services.

10. Acknowledgements

The work contained within this report would not have been possible without the time and resources provided by a great number of people. In particular, we would like to thank the following:

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Rick Stuart (CEH), Paul Robinson (JNCC), Paula Lightfoot (NBN), Ola Tomczyk (University of York), Lynne Osgathorpe (RSPB), Simon Pickles (NEYDC) and Mark Thorley (NERC) for attending the workshop on data availability and management.

Helen Pontier (Defra) for her advice and support throughout the project.

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Medcalf, K. A., Small, N., Finch, C., & Parker, J. (2012). Spatial framework for assessing evidence needs for operational ecosystem approaches. JNCC Report No 469.

UK NEA (2011a) The UK National Ecosystem Assessment: Technical Report. UNEP-WCMC, Cambridge.

UK NEA (2011b) The UK National Ecosystem Assessment: Synthesis of the key findings. UNEP-WCMC, Cambridge.

12. Appendices

Appendix 1

Part 1 – Core interview questions

General information regarding projects:

Q. What stage is your project in terms of the mapping process? Please describe. (Prompt – it may be helpful to ask them if they fit into one of the stages below or confirm with them after their description):
- Planning stage
- Preliminary stage (primary or secondary data gathering)
- Development stage (developing the frameworks/maps)
- Final stage (map outputs or frameworks have been developed)
- Other

Q. What datasets did you or are you planning to use in your project? (Please list). Are these data freely available or restricted through licensing agreements in anyway? (We have already asked them this in the survey so we are just looking for more details here really). If freely available, would it be possible to link them to the Ecosystem Service Mapping Gateway?

Q. Were any data standards set when using the data? Please give details.

Q. Have data models been used in the project? (In this case we mean data that has been derived using models rather than data which has been derived empirically). If models have been used, please describe these models and the methodology involved in using them.

Q. Please briefly describe the overall methodology used throughout the project (see also next section).

Q. Have any outputs been produced yet for your project? If so, are they freely available or restricted? (Again we have already asked them this so just more details needed). If freely available, would it be possible to link them to the Ecosystem Service Mapping Gateway? If restricted, would it be possible to provide them by request?

Stakeholder involvement in projects

Q. Have stakeholders been involved in the framework/mapping process?

Q. Which stakeholders/stakeholder groups have been involved?

Q. At which stage in the above outlined methodology were they involved?

Q. Which methods of stakeholder engagement did you use? (Prompt – it may be helpful to ask them if they have used one of the methods below or confirm with them after their description):
- Interviews
- Focus groups
- Workshops
- Interactive mapping etc.

Stocks and flows

Q. What they mean by stocks and flows and is it different from our definition?

Q. In your project, are you distinguishing between ecosystem stocks and flows of ecosystem services?

Q. Have used one or other or both, and how they have interpreted?

Q. If so, how are capital stocks and flows of ecosystem services represented? Why have you chosen to do it this way?

Q. Have there been any challenges in representing or interpreting stocks and flows?

Q. In your view, how does this affect the perception and uptake of the information by the users? For example, did you decide to use certain representations of stocks and flows to meet any specific desire to engage with certain user groups? In your experience, do certain representations of different stocks or services help or hinder understanding, progress or uptake of the mapping projects (if you are at this stage in your project where end-users have been identified and shown the maps).

Beneficiaries and impact

Q. Have any end-users/beneficiaries been identified for your project? Who are your main audiences?

Q. If you are at the output stage, have you interacted with your end-users and shown them the outputs/maps?

Q. How has this knowledge exchange occurred?
- Interviews
- Focus groups
- Workshops
- Interactive mapping etc?

Q. How have the outputs/maps been perceived? Has there been any formal analysis of these perceptions?

Q. Have these outputs/maps been used yet in terms of any decision-making processes?

Q. Have there been any other impacts resulting from your outputs/maps? Who has this affected? Has this impact resulted in any evidence or been monitored/evaluated in any way?

Q. In your opinion, what are the factors that have contributed to the impact that your project has had?

Barriers/issues encountered during project development

Q. Has your project faced any barriers/problems in relation to using/obtaining data in the map development process?

Q. Have there been any problems relating to data access or quality?

Q. Has your project devised any novel ways of sharing information or data, or using alternative, freely available data, to overcome some of these issues?

Q. Have there been any ecosystem services (or stocks of natural capital) which have provided specific challenges in any stages of your project?

Further questions

Q. Is there any other information that you would like to share with others doing similar projects? Do you have any other materials, that could be linked to externally, or that we could host on the ESMG, such as jpegs of maps, photos, videos etc, to add interest and detail to the case studies.

Appendix 2

Example of a National Project case study

The Social, Economic and Environmental Research (SEER) project into Multi-Objective Land Use Decision Making

Contact: Amii Harwood

Original project information provided:

The SEER project seeks to fundamentally improve option analysis and policy formation with respect to any area of decision making linked either directly or indirectly to the natural environment. The project takes the principles of scientific method and economic theory which underpins the 'ecosystem services' approach to decision making and blends these to yield the coherent methodology, integrated analyses, and analytic tools required to implement this approach in practice. SEER is necessarily a highly interdisciplinary undertaking, bringing together economists with ecologists, hydrologists, spatial and policy analysts, etc. SEER applies advanced analysis techniques to highly detailed datasets comprising spatially detailed information gathered over extended periods. The SEER work was a central contributor to the first National Ecosystem Assessment (UK NEA) and is continuing to contribute to the on-going work of the NEA.

Case study information obtained via interview

1. Approach used current stage of project

This project has contributed to the UKNEA and the follow-on report. Maps have been produced at a 2km resolution for the whole of Great Britain and have focussed on a set of ecosystems services and goods including agriculture, recreation, GHG emissions and urban green space.

Economic values were calculated using separate models and then integrated to form a spatial output of economic values for each ecosystem service and good. Different scenarios where applied to a baseline to show the spatial distribution of changes in ecosystem service value if that scenario where to occur. The maps therefore show gains and losses in ecosystem service value in £/ha/year (please see example map provided).

A large number of datasets were used in the project. These included: Land cover data, agricultural census data, water quality data, economic valuation data and social data such as the Monitoring the Engagement of the Natural Environment (MEME, Natural England) data. The project also used data on greenhouse gases, timber, soil data, and climate data.

2. Stakeholder involvement

As the aims of the project are to work at a national level the main stakeholder interaction has been with national partners and national interest decision-makers, although there have been local presentations given of mapping output to decision-makers in and around Norfolk. The national partners and decision makers include Defra, the Forestry Commission and Forestry Commission Wales. In the first phase of the project, these stakeholders received feedback via presentations and

webinars, but during the second stage stakeholders have also been involved in the development of the project, including the provision of data.

3. Beneficiaries and impact

As mentioned above, the main audience for the outputs of the project have been national partners and national interest decision-makers. In terms of impacts, the outcomes of the UKNEA have fed into the Natural Environment white paper. The project has also contributed to the Natural Capital report and some high profile scientific publications. The project has also provided guidance to the Office for National Statistics.

The project has found that certain factors have helped contribute to the impact of the project. In particular, links with public and private sector agencies such as the Forestry Commission, and South-west Water have helped to disseminate the research.

4. Further information

Website: http://www.cserge.ac.uk/news-archive/2013/science-paper-published

Report: http://uknea.unep-wcmc.org/Home/tabid/38/Default.aspx

Published paper: http://www.sciencemag.org/content/341/6141/45