Natural Capital Data Assessment for York, North Yorkshire, East Riding and Hull

The East Riding of Yorkshire Council on behalf of the North Yorkshire & York and Hull & East Yorkshire Local Nature Partnerships

Project number: 60589993

27 March 2019

Quality information

Prepared by	Checked by	Verified by	Approved by
Sarah Krisht (AECOM) Campbell Howe (AECOM) Simon Pickles (NEYEDC)	Petrina Rowcroft (AECOM)	Steven Smith (AECOM)	Petrina Rowcroft (AECOM)

Revision History

Revision	Revision date	Details	Authorised	Name	Position
1	27/02/19	Draft report	27/02/19	Sarah Krisht	Project Manager
2	27/03/19	Final report	27/03/19	Sarah Krisht	Project Manager

Prepared for:

The East Riding of Yorkshire Council on behalf of the North Yorkshire & York and Hull & East Yorkshire Local Nature Partnerships

Prepared by:

AECOM Infrastructure & Environment UK Limited
Aldgate Tower
2 Leman Street
London E1 8FA
United Kingdom
aecom.com

Prepared in association with:

North and East Yorkshire Ecological Data Centre

Table of Contents

Figures

Tables

Executive summary

ES.1 Introduction

This report presents the findings of the *Natural Capital Data Assessment for York, North Yorkshire, East Riding and Hull* project. AECOM was commissioned to carry out the study by East Riding of Yorkshire Council on behalf of the North Yorkshire & York and the Hull & East Yorkshire Local Nature Partnerships (LNPs) in order to:

- Identify and analyse the range of natural capital data sets associated with the goals, measures and metrics set out in the Government's 25-Year Environment Plan (25 YEP); and
- Investigate the feasibility of establishing a regional natural capital data hub to support the development and implementation of a natural capital investment framework.

The project was funded by North Yorkshire County Council to support the LNPs' work to progress with the adoption of a natural capital approach in this area. This project complements work to develop a natural capital investment framework for York, North Yorkshire, East Riding and Hull, which is being financially supported by the local authorities, the Local Enterprise Partnership (LEP) and other LNP partners in the area.

Within Yorkshire, the North Yorkshire & York and the Hull & East Yorkshire LNPs are working together to develop a natural capital investment framework for the geography of York, North Yorkshire, East Riding and Hull (YNYERH), including the Yorkshire Dales and North York Moors National Parks. The aim of the framework is to improve understanding of North and East Yorkshire's natural capital assets in order to inform local and sub-regional decisions that have, or could have, an impact on the environment, and to identify opportunities to enhance social and economic benefits derived from investment in the environment. The framework, which will be closely aligned with the goals of the 25 YEP, is recognised as crucial to facilitating sustainable growth, business resilience and the quality of life of communities across the sub-region.

Within this context, the overall aim of the study is to establish the need for, and feasibility of, developing a natural capital data hub to underpin the development and implementation of the natural capital investment framework for YNYERH. To meet the study objectives, a three-fold approach was followed based on the following questions.

ES.2 What information, models and tools have we got?

The study reviewed more than 130 data sets, products, tools and sources between November 2018 and February 2019 to support efforts to better understand the state of natural capital and the benefits it delivers within YNYERH in relation to the following eight goals of the Government's 25-Year Environment Plan:

- Clean air
- Clean and plentiful water
- Thriving plants and wildlife
- Reduced risk of flooding and drought
- Sustainable use of natural resources
- Enhanced beauty, heritage and engagement with the natural environment
- Climate change mitigation
- Climate change adaptation

The review provides a broad indication of the availability of natural capital data that could be included in a regional natural capital hub. It is likely that a more comprehensive and detailed process of data discovery and analysis would be required once the broad specification of a hub has been determined.

The review of data sets, products, tools, and sources suggests that there is a significant volume of data available for commercial use. This data does not, however, tend to be available at a fine enough scale to facilitate local decision-making and monitoring against the 25 YEP goals. Where data is available, there is a potential role for a hub to draw together existing information that could be used to measure progress against the 25 YEP goals, based on the forthcoming 25 YEP indicators.

Critically, the review suggested that there is scope and value in potentially developing new data products as part of a hub that could make it a definitive source of up to date and quality assured data with clear licensing terms. For example, a hub could include an initiative to collate habitat data that is currently held by local organisations. There is also a substantial volume of habitat data that could potentially be gathered from private organisations including environmental consultancies.

ES.3 What do we need and where do the challenges and gaps lie?

The study included engagement with potential users of a natural capital data hub, via an online survey and semi-structured interviews, to determine: (i) the contexts in which they assess natural capital; (ii) the evidence they use; (iii) whether and how a natural capital data hub could support them; and (iv) features of a hub that they would find useful.

Of the 90 individuals contacted as part of the project, over 40% completed the survey. Table ES.1 presents the breakdown of responses across the different stakeholder groups that participated in the survey (in descending order). At least one respondent from each of the stakeholder groups contacted completed the survey. Following the survey, 10 respondents were interviewed.

Table ES.1: Survey respondents by stakeholder group

Stakeholder group	% (n=40)
Local authorities	48%*
Defra family	18%*
Protected landscapes	10%*
Environmental charities	10%
Public Health teams	5%
Catchment partnerships	3%
Grant bodies	3%
Local Enterprise Partnerships	3%
Utility companies	3%
Total	100%

Notes: *includes one partially completed response that was included in the analysis to make use of as much data as possible.

Engagement with data users and potential users of a natural capital data hub within this project revealed that most users assessed environmental impacts (including impacts on natural capital) in their daily tasks such as impact assessments, assessing planning applications, etc. This suggests the potential relevance and utility of developing a hub to facilitate such assessments. It is important to note though that most users did not undertake formal and comprehensive assessments using a natural capital approach. This is possibly due to the lack of regulatory drivers, but also due to challenges they face in relation to data availability within their organisations.

Stakeholders were generally split between those that had the expertise and tools to undertake spatial analysis and those that did not. Broadly speaking, these two groups favoured very different hub functionality. Specialists tended to favour hub options that either signposted or hosted data (repositories). Non-specialists tended to favour hub options that allowed them to visualise data via an interactive web map.

ES.4 What could a centralised data hub, that addresses user needs and adds value, look like?

The analysis of feedback from stakeholders suggested a range of potential hub options that are summarised in Figure ES.1 and described in more detail in the main report.

Figure ES.1: Summary of hub options

Hub features	Hub options										
	1	2	3a	3b	3c	4a		4b		4c	5a	5b
Signposting	X		X			X		X				
Repository		X		X	X		X		X			
Web map			X	X	X						X	X
Data capture					X							
Offline tool						X	X					
Online tool								X	X		X	X
Offline data service										X		

It is important to recognise that regardless of which hub option is selected, there may be value in first undertaking an initial preparatory exercise: LNPs could start by developing a sub-regional natural capital asset register (an inventory of indicators of the extent and condition of natural capital), using available data, which is the first step of a natural capital account. This could:

- Provide an initial baseline, using available data, against which future changes in the state of natural capital can be assessed;
- Identify where there are specific local / regional data gaps, particularly where new data is required;
- Begin to identify where investments in natural capital are needed (where it is in poor condition) or where there are opportunities to enhance natural capital to deliver a wider range of benefits / or to maximise the benefits;
- More clearly demonstrate the links between the condition of natural capital and the value of the benefits that it provides. This can in turn stimulate more active engagement and connection of stakeholders to their environment;
- Help upskill potential hub users by engaging them in the process; and
- Better inform the selection of a hub option.

The evaluation of the options considered a number of important factors, including (i) stakeholder needs and interests; (ii) data availability; (iii) the cost of developing and maintaining the hub; and (iv) the mechanism for identifying and curating new data as well as amending existing data e.g. where an investment in natural capital has taken place such as habitat creation. It is, however, important to note that the feasibility of most of the hub options was found to depend on factors that were not intrinsic to the options themselves, including:

- The need for a financial commitment to ensuring timely and continuous data discovery to maintain the relevance and integrity of the hub;

- The collation or collection of existing local data to make it available to hub users;
- The influence of policy drivers and developments on other initiatives to make data more accessible to users, as mentioned above;

In comparing the different hub options, it would seem that the most feasible options would:

- Allow users to save time and effort in collating, processing and/or analysing data;
- Be reliable and identify current data, clear licensing terms and reliable outputs; and
- Address gaps in the coverage of data, models and tools available elsewhere.

In terms of the specific options assessed, stakeholders that already had GIS skills tended to favour a signposting service or a repository (Option 1 or Option 2) although they consistently recognised the limited availability of local data at a resolved scale. Most users intuitively thought of an interactive web map (Option 3) when they thought of a natural capital data hub. However, users with GIS skills felt this option would be of limited utility and other non-specialist users felt that this option would not add significant value to Option 1 or 2 given that it would duplicate the functionality provided by the Defra Magic Map application, among other examples. There was little support among stakeholders for more analytical options (Option 4 and 5) as they felt that the most pressing priority was to make it clear to users what data is available (via Option 1 or 2) rather than developing or promoting the use of a certain analytical approach for which the necessary input data was not fully available. The lack of demand coupled with the high resource requirement of these two options means that they are not likely to be currently feasible based on the findings from this study. Stakeholders also recognised the need to increase knowledge and skills among potential users before Option 4 or Option 5 could be developed and used.

ES.5 Recommendations and next steps

Overall, the SWOT analysis, coupled with findings from other tasks suggests that currently the most feasible hub options are a signposting service (Option 1) or a repository (Option 2). However, these options would likely only add value to an existing hub if they included efforts to improve the quality of local data. Option 2 may arguably save users more time than Option 1, as it would put the onus of managing licensing terms on the hub manager. It may also be possible to add a web map to Option 2 at relatively low cost, thereby effectively making it Option 3b. This would avoid excluding non-specialists that do not have access to GIS software. A web map may however present the risk of non-specialist users misinterpreting visual representations without recourse to the underlying metadata. It is likely that this option can be achieved in the medium-term i.e. within a two-year period. It is important to note that securing sufficient funding to allow for regular data discovery and curation will be crucial to the success and uptake of any hub option.

It is recommended that if the preferred hub option is identified, further detailed engagement should be undertaken with the following stakeholders, to definitively decide on that option and develop a full hub specification:

- Data providers to understand the extent of local data available in more detail;
- Other hub developers and managers such as the Environment Agency and the Centre for Ecology and Hydrology to understand their existing and on-going initiatives in the natural capital space. This would help identify lessons learnt, potential synergies and opportunities for collaboration; and
- Potential hub users to understand their detailed needs in relation to the selected hub option.

In the spirit of collaboration and timing, it also recommended that any sub-regional initiatives to develop a hub should recognise the impending major policy developments that could significantly affect the need for natural capital assessments, the availability of data, the development of other related initiatives and any sub-regional actions in this space. These policy developments include:

- The potential for the 25 YEP to gain a statutory footing in the forthcoming Environment Bill;
- The potential for the objectives of achieving biodiversity net gain and possibly environmental net gain to become mandatory requirements for built developments; and
- The extent and speed with which the Government responds to the recommendations of the Natural Capital Committee in their Sixth State of Natural Capital Report (NCC, 2019).

In the meantime, progress can be made in the region by training and upskilling non-specialists so they can effectively contribute to and maintain natural capital monitoring efforts. This can be done by starting with an initial preparatory exercise of developing a natural capital asset register for the region. The process can help them begin to see the environment as an asset that provides benefits to wider society, rather than a constraint on built development, and to identify gaps where new data may be needed or where specific tools may be helpful.

It also recommended that LNPs engage with the Natural Capital Coalition regarding the *Data Information Flow* project[1]. The Coalition is working with the UN Environment Programme World Conservation Monitoring Centre (UNEP-WCMC) and a broad range of partners to develop a project that will bring together data users, data providers, data funders and academics to explore key data questions over different project phases. While this project is aimed largely at businesses who want to assess their impacts and dependencies on natural capital, it will nevertheless include overlap with the objectives and data contained in any version of a sub-regional natural capital data hub.

[1] See https://naturalcapitalcoalition.org/projects/data-kit/

1. Introduction

This report presents the findings of the *Natural Capital Data Assessment for York, North Yorkshire, East Riding and Hull* project. AECOM was commissioned to carry out the study by East Riding of Yorkshire Council on behalf of the North Yorkshire & York and the Hull & East Yorkshire Local Nature Partnerships (LNPs) in order to:

- Identify and analyse the range of natural capital data sets associated with the goals, measures and metrics set out in the Government's 25-Year Environment Plan; and
- Investigate the feasibility of establishing a regional natural capital data hub to support the development and implementation of a natural capital investment framework.

The project was funded by North Yorkshire County Council to support the LNPs' work to progress with the adoption of a natural capital approach in this area. This project complements work to develop a natural capital investment framework for York, North Yorkshire, East Riding and Hull, which is being financially supported by the local authorities, the Local Enterprise Partnership (LEP) and other LNP partners in the area.

1.1 Background and purpose

In January 2018 the Government published its 25 Year Environment Plan (25 YEP) (HM Government, 2018) setting out how it will deliver on its pledge to leave the environment in a better state for the next generation. At the heart of this is the adoption of a natural capital approach to incorporate the often hidden benefits of the environment into management and policy decisions. The 25 YEP argues that:

> *"When we use a natural capital approach, we are more likely to take better and more efficient decisions that can support environmental enhancement and help deliver benefits such as reduced long-term flood risk, increases in wildlife, and a boost to long-term prosperity."*

The revised National Planning Policy Framework (MHCLG, 2019, Section 15) also makes specific reference to the need for planning policies and decisions to recognise "the intrinsic character and beauty of the countryside, and the wider benefits from natural capital and ecosystem services – including the economic and other benefits of the best and most versatile agricultural land, and of trees and woodland" and to "plan for the enhancement of natural capital at a catchment or landscape scale across local authority boundaries".

Further to this, in December 2018, the Government launched a consultation on proposals to reform the planning system to mandate biodiversity net gain in developments. Such an approach is intended to secure positive outcomes for the environment, create better places for local communities and improve the process for local planners, developers and infrastructure providers to support the delivery of housing, infrastructure and wider development by standardising planning requirements. The Government's longer-term commitment, as set out in the 25 YEP, is to expand the net gain approaches used for biodiversity to include wider natural capital benefits such as flood protection, recreation and improved water and air quality.

A solid evidence base and robust analysis are arguably key to implementing a natural capital approach and achieving environmental gain as these are fundamental to efforts to both understand and measure:

- The extent (quantity) and condition (quality) of the stock of natural capital assets in the area under consideration;
- The quantity and value of the flow of ecosystem services and consequent economic and social benefits that are delivered by these natural capital assets; and

- The impact of actions that aim to protect and enhance natural capital and ecosystem services, as well as the costs of these actions.

Within Yorkshire, the North Yorkshire & York and the Hull & East Yorkshire Local Nature Partnerships (LNPs) are working together to develop a natural capital investment framework for the geography of York, North Yorkshire, East Riding and Hull (YNYERH), including the Yorkshire Dales and North York Moors National Parks. The aim of the framework is to improve understanding of North and East Yorkshire's natural capital assets in order to inform local and sub-regional decisions that have, or could have, an impact on the environment, and to identify opportunities to enhance social and economic benefits derived from investment in the environment. The framework, which will be closely aligned with the goals of the 25 YEP, is recognised as crucial to facilitating sustainable growth, business resilience and the quality of life of communities across the sub-region. In practice, the investment framework should help to:

- Provide a detailed understanding of the extent and condition of natural capital assets in the sub-region and the value of the benefits delivered by these assets to businesses and local communities;
- Identify risks and opportunities with respect to natural capital and the associated priorities for investment to protect and enhance natural capital stocks and the benefits they provide;
- Inform policy, planning and business decisions; and
- Monitor changes in natural capital stocks and flows over time as policies, plans and investments, including potential offsets are implemented, thereby helping provide the evidence base to support future policy- and decision-making.

1.2 Project aims and objectives

Within this context, the overall aim of the study is to establish the need for, and feasibility of, developing a natural capital data hub to underpin the development and implementation of the natural capital investment framework for YNYERH. The specific objectives of the project are to:

- Assess existing frameworks, methodologies and data systems in order to understand the most appropriate methodologies and tools for monitoring the state of, and investment in, the natural capital of YNYERH;
- Establish the region's current capacity to report on the changing status of natural capital in the YNYERH geographical area;
- Establish an agreed range of relevant natural capital data sets that can be interrogated for a range of ecosystem services, and layered (with one another, or potentially with other spatially explicit data sets such as population the Indices of Multiple Deprivation) to identify key areas of importance or investment need in relation to economic growth, resilience, public health and biodiversity;
- Identify base natural capital data sets that could be used, together with information on their spatial coverage, resolution, ownership, frequency of updating, ease of access and cost of access;
- Consult with the custodians of those data sets to establish the scope for supplementing them with localised data on changes in natural capital and ecosystem service flows; and
- Assess the feasibility of establishing an accessible natural capital data hub.

1.3 Overview of approach and report structure

To meet the study objectives, a three-fold approach was followed based on the following questions:

1. What information, models and tools have we got?

- Section 2 presents the results from an extensive desk-based review of existing natural capital data sets, products, tools and sources to determine the information available to assess and

monitor changes in the state of natural capital and the benefits it delivers at the local or sub-regional scale;

2. **What do we need and where do the challenges and gaps lie?**

- Section 3 presents the results from an online survey and a series of semi-structured interviews with stakeholders across a range of organisations to better understand data needs and challenges when assessing natural capital, or aspects thereof, including whether the development of a natural capital data hub could support their assessment work;

3. **What could a centralised data hub, that addresses user needs and adds value, look like?**

- Section 4 presents an assessment of potential options for the specification of a natural capital data hub in light of the insights obtained from the review of available data, user needs and challenges.

The key findings and recommendations from the above are reported in the final section of the report (**Section 5**).

This report is supported by five appendices:

- **Appendix A** which sets out the criteria used for the review and assessment of data sets, products, tools, and sources;
- **Appendix B** which lists the data sets, products, tools and sources covered by the review. The detailed information collected for the purposes of the review and analysis is available as a separate Excel workbook;
- **Appendix C** and **Appendix E** which present the online survey questionnaire and descriptive statistics respectively; and
- **Appendix D** which presents the interview protocol used in the semi-structured interviews with stakeholders.

A glossary of key terms is provided at the end of this report.

2. Review of data for natural capital assessments

This section sets out the approach and findings for the review of the information and tools that are available to support efforts to better understand the state of natural capital and the benefits it delivers within YNYERH in relation to the following eight goals of the 25 YEP:

- Clean air
- Clean and plentiful water
- Thriving plants and wildlife
- Reduced risk of flooding and drought
- Sustainable use of natural resources
- Enhanced beauty, heritage and engagement with the natural environment
- Climate change mitigation
- Climate change adaptation

The purpose of the review was to examine:

- The availability of information to assess the state of natural capital, prioritise investments in natural capital and monitor their impacts within the region and in the context of a natural capital investment framework; and
- The implications of both data availability and characteristics for the potential development of a sub-regional natural capital data hub.

This section also includes a more detailed review of the Natural Capital Planning Tool (NCPT) developed by the Consultancy for Environmental Economics and Policy (CEEP), as a means to assess natural capital, as it was specifically highlighted in the project specification.

2.1 Scope and approach

There is a substantial volume of information in the natural capital 'datasphere' and approaches to measuring changes in natural capital and the benefits it delivers are still evolving to reflect:

- Changes and improvements in our understanding of the relationships between natural capital assets and human well-being, including the factors that affect delivery of ecosystem services (e.g. stock, condition, spatial configuration, and ecosystem processes);
- Advances in the technologies available for monitoring and assessing changes in the environment; and
- Emerging issues and priorities including the evolution of policy drivers such as the 25 YEP.
- The scope of the data review and analysis conducted for this project has therefore been defined by:
- An understanding of the hypothetical types of questions that stakeholders (i.e. prospective hub users) in YNYERH may be seeking to address in theory and;
- Knowledge of the information required to conduct natural capital assessments and/or develop natural capital investment plans;
- Emerging metrics and indicators for monitoring changes in the environment in general and the state of natural capital in particular; and
- The resources available for this study.

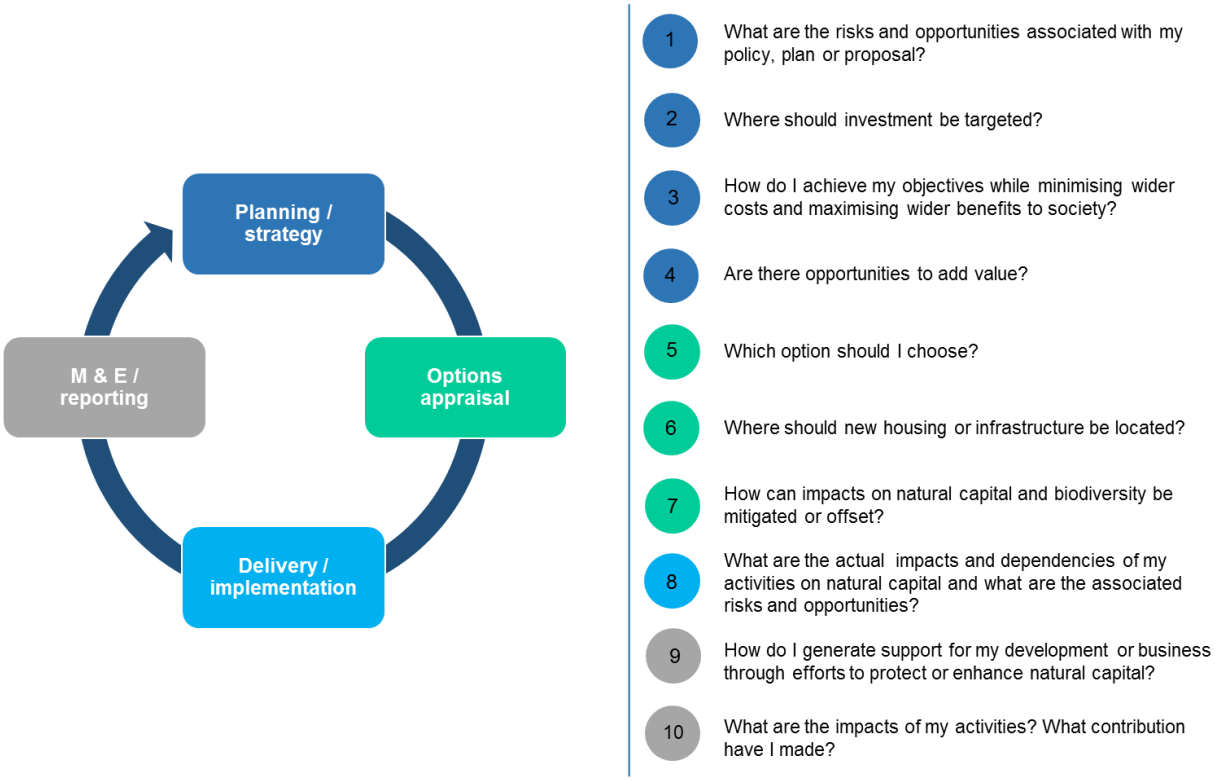
2.1.1 Hypothetical questions that stakeholders and prospective hub users may seek to address

There are many circumstances where individuals and groups might want to use natural capital data, often in combination with other data sets, to protect and improve the environment (see Figure 2.1). The objectives of this study (as set out in the project specification) suggest that there are three broad and closely related areas of interest:

- Monitoring and reporting on the status and trends in natural capital in YNYERH;
- Identifying areas of investment need in relation to economic growth, resilience, public health and biodiversity; and
- Measuring the impacts (positive and negative) on natural capital of both development (e.g. as a result of policy and planning decisions relating to new development such as housing or infrastructure, or business activities) and investment in the natural environment. This may extend to having access to reliable information on the value of benefits and costs arising from environmental improvements and change.

There may also be a fourth particular area of interest: in cases where stakeholders are interested in identifying opportunities to work with nature to deliver policy objectives, for example, through investment in green infrastructure such as sustainable drainage systems (SUDS), or in land management activities that result in the delivery of higher quality water or reduce the risk of flooding and hence the need for investment in 'grey infrastructure'.

Figure 2.1: Example of questions that prospective hub users may seek to address



Note: M & E: monitoring and evaluation

It is further recognised that stakeholders may:

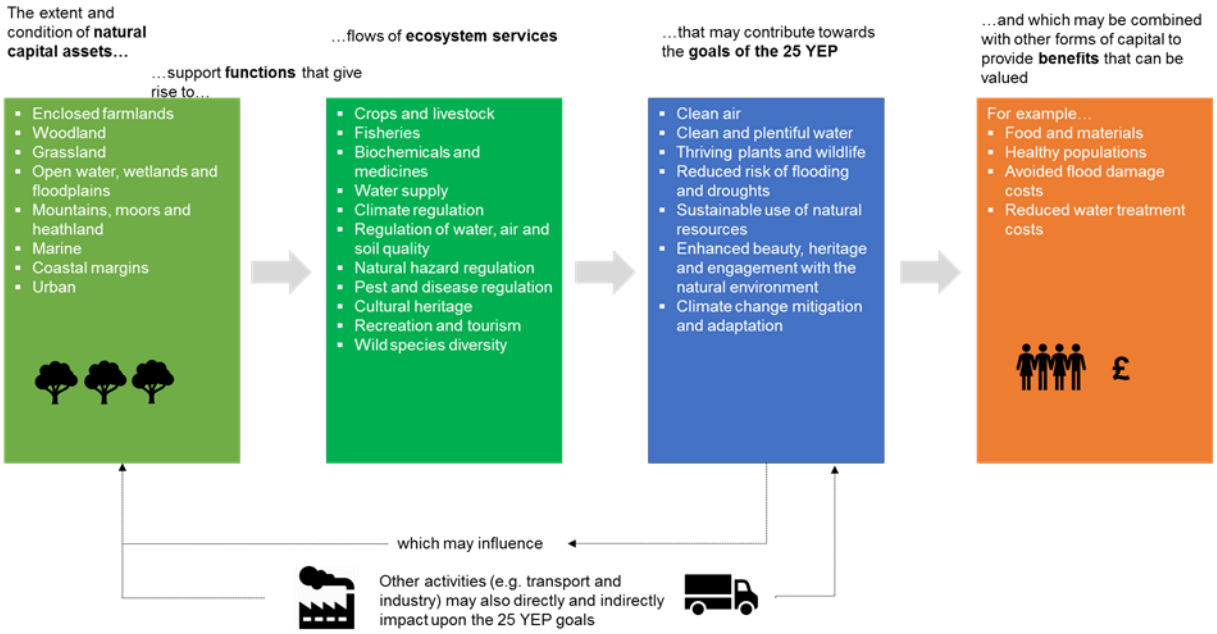
- Be interested in different aspects of natural capital. For example, they may have a focus on specific habitats (e.g. woodland, semi-natural grasslands, coastal margins), species (e.g. pollinators, protected species), or societal benefits/outcomes (e.g. flood production, clean water, recreation). Or they may wish to understand their impacts and dependencies on all aspects of natural capital; and/or
- Operate at a variety of scales (e.g. plot, field, farm, catchment, landscape, or region).
- These are important factors to consider in evaluating the need and options for a natural capital data hub and, therefore, they also need to be considered in the data review. A more detailed understanding of user needs was obtained through engagement with stakeholders described in Section 3 of this report.

2.1.2 Information required to support a natural capital approach

In its Sixth Report on the State of Natural Capital, the Natural Capital Committee (NCC, 2019) urged Government to develop and promote a natural capital baseline assessment methodology for implementation at a local level that was based on the NCC's 'How to do it Workbook' (NCC, 2017). It also recommended a standardised set of metrics and accounting approaches to not only measure progress against the 25 YEP goals, but also for the assessment of built developments, the calculation of net environmental harms, and the location and form of compensation payments. If such approaches and standardised sets of metrics were to be developed, these could potentially provide a useful basis for scoping the content of a sub-regional natural capital data hub or, at the very least, the contents of a regional hub would need to be updated to allow users to implement the recommended approaches.

As noted in Section 1, any natural capital assessment requires a solid evidence base that encompasses a variety of data and knowledge across the chain of evidence linking changes in the extent and condition of habitats to changes in human well-being and achievement of the 25 YEP goals (see Figure 2.2).

Figure 2.2: Natural capital logic chain in relation to 25 YEP goals



Note: Other forms of capital include physical capital (e.g. machinery), human capital (e.g. labour), financial capital, etc.

This includes on-going work to develop a standardised set of metrics and indicators for monitoring changes in the environment and natural capital in England. This work includes several recent reports and consultation documents that provide a useful steer for this study, such as:

- Natural England's Natural Capital Indicators for defining and measuring change in natural capital (Lusardi et al., 2018);
- The Centre for Ecology and Hydrology (CEH) Natural Capital Metrics project (CEH, 2017);
- Defra's consultation on the draft indicators framework for the 25 YEP (Defra, 2018); and
- Defra's consultation on net gain (Defra, 2018) and Natural England's proposed updates to the Defra Biodiversity Metric (Natural England, 2019).

The evidence review for this project covered these on-going initiatives and others as a part of a high-level examination of data across the rapidly developing natural capital space. The list of reviewed

items was compiled based on knowledge of data used in existing natural capital assessments at local, regional and national scale. The list was iteratively developed based on insights from the engagement with data users (Section 3) and further desk-based research.

Overall, more than 130 data-related items were identified and reviewed up between November 2018 and February 2019, including:

- **Data sets:** raw data that usually cannot be disaggregated and typically requires software or processing to make it useable and useful to users;
- **Data products:** data derived from two or more raw data sets to convey information about natural capital. A data product could be an output from a natural capital tool;
- **Visual and/or analytical tools:** interfaces that utilise primary tools (e.g. Excel, GIS software) to process and/or interpret data and present it to users in visual or numerical form. Tools usually follow set workflows or impact pathways embedded within their software; and
- **Sources and/or searchable databases:** organisations or websites that provide a variety of data sets, products and/or tools, sometimes in the form of searchable databases[2].

Items were reviewed against a set of criteria that covered characteristics of the data and its role in assessing natural capital. The criteria and the review were developed with the aim of being comprehensive yet proportionate. In this context, the review of data sets, products and sources utilised the full set of criteria. The review of tools utilised a subset of the criteria to recognise the availability and key characteristics of tools and the fact that a hub will at most act as a signposting service or repository for tools versus fully incorporating them into the hub.

The scope and depth of the review recognises the fact that the volume and type of information required will differ depending upon the scope of the assessment and the level of detail and confidence in the results required. The review conducted for this study is therefore not considered exhaustive. Rather, it is intended to provide a broad indication of the availability of natural capital data that could be included in a regional natural capital hub. It is likely that a more comprehensive and detailed process of data discovery and analysis would be required once the broad specification of a hub has been determined. Furthermore, this process should be iteratively undertaken throughout the lifespan of the hub to maintain its relevance and robustness.

The full list of criteria developed and utilised for the review is included in Appendix A to this report.

2.2 Key findings

2.2.1 Broad overview

The review covered over 130 items (data sets, products, tools and sources) across more than 60 data owners. A full list of items reviewed is included in Appendix B to this report.

Table 2.1 presents the breakdown of these items by type (data set, product, tool, or source) and across the sectors of data owners. Government bodies were found to own the majority of the items reviewed, with 60% of them being data products. The private sector was found to own the fewest items reviewed. This is expected as private sector organisations do not tend to widely publish their data. This finding highlights the potential need for targeted engagement with data providers, in a similar way to how data users are engaged in Section 3.

[2] This was a catch-all category to manage the scope of the review in cases where some organisations and websites were found to provide over 100 data sets or products.

Table 2.1: Number of data items by sector

Item type	Owner sector					
	Academic	Government	NGO/ charity	Private	Other*	Total
Data set	-	14	2	-	4	20
Data product	2	43	5	1	6	57
Visual and/or analytical tool	3	13	6	3	10	35
Source and/or searchable database	3	3	8	-	6	20
Total	8	73	21	4	26	132

Note: *This category includes data owners that are owned by multiple entities from different sectors or consortia that consists of organisations from different sectors.

Around 75% of data owners identified were also found to be the managers of their data sets, products, tools or sources. This overlap would likely facilitate the development of a hub, as less people would need to be contacted and consulted in setting up and managing the hub.

Table 2.2 presents the breakdown of items across their geographical scope. Most of the data identified was national data with very few local data sets, products, tools or sources found to be publicly available. This again demonstrates the potential value for further engagement with data providers to determine availability of more local data to inform a sub-regional hub. In addition to this, over 90% of the items reviewed were accessible online, which would support the option of having an online rather than offline data hub.

Table 2.2: Number of data items by geographical scope

	n	%
International	19	14%
Local	9	7%
National	100	76%
Regional (including catchment-level)	4	3%
Total	132	100%

The frequency of update for around 40% of the data sets, products and sources reviewed was not specified. This was followed by nearly 30% for which updates were carried out sporadically. This implies that there may cost savings to data users if a hub were to be developed, as it would minimise the time they spend on data discovery and updates.

For over 80% of data sets, products and sources, the extent of quality control and validation was not specified. This includes how frequently the data set, product or source is validated, verified and quality assured and whether it is used in published case studies or peer review studies. This again may affect the resources required to curate and validate different data sets, products and sources which are signposted or subsumed in the hub.

Nearly 80% of the data sets, products and sources reviewed had no clear mechanism for users to request updates to data as a result of detecting errors or the need to reflect local changes (including the impact of investments in natural capital). The development of a data hub could help fill this gap by providing a mechanism for users to submit amendments to data in some capacity.

For the majority items reviewed there were no restrictions on non-commercial use (82%) or commercial use[3] (58%). Most of the items suitable for commercial use (57%) were available under the Open Government License, whereby no charge for use is applied. Information about the cost of accessing other items for commercial use was not readily available. This suggests that there is a significant amount of data that is readily available to feed into a hub, but that remaining data may need to be secured following negotiation with data providers.

In terms of the software requirements to utilise the data sets, products, tools or sources that were reviewed, the most common requirements were:

- GIS software to access and analyse over 40% of the items reviewed;
- A web browser to access nearly 30% of items including visual and/or analytical tools; and
- Excel to access and analyse around 15% of the data products reviewed, which were not spatially explicit.

The review found that most of the items reviewed required advanced skills including GIS and ecological knowledge to access, use and interpret them. This suggests that there is a potential role and benefit from developing a hub for use by a wide range of users, including non-specialists.

The review found that nearly all data sets, products and sources could be downloaded and combined with other items, which suggests that there is potential for the hub to utilise these items to create new data products.

The review also considered the spatial resolution of items. For 45% of the items, the resolution was not specified in the metadata. The remaining items ranged with finest resolution being 10 m^2 and the coarsest being 200 km^2. This suggests that there is a wide range of resolutions at which data is available, and there is limited data available at a fine enough scale to facilitate local decision-making.

2.2.2 Implications for natural capital assessments

The review also considered the extent to which different items could help establish the baseline against which to monitor progress towards the 25 YEP goals.

The most well-covered goal of the 25 YEP, across the items reviewed, was ‘thriving plants and wildlife’, which was covered by 28% of items. This reflects, at least in part, the fact that this is a broad goal that is arguably open to a wide variety of interpretations (NCC, 2019) and that requires multiple approaches for progress to be assessed against it.

This was followed by ‘clean and plentiful water’ covered by 18% of items. Again, this could potentially be due to the broad scope and cross-cutting nature of this goal. The least extensively covered goals were ‘managing exposure to chemicals’, and ‘minimising waste’. This is in line with expectations, as natural capital assessments aim to reveal the benefits delivered by natural capital assets, whereas negative environmental impacts such as chemicals emissions and waste are traditionally captured in other assessments.

The review considered the UK National Ecosystem Assessment (UK NEA) habitat types that each item covered[4]. Most habitat types were covered by 11% - 15% of the items reviewed, with woodland being the most well-covered habitat type. The least extensively covered habitat was the marine

[3] Commercial use is primarily intended for or directed towards commercial advantage or monetary compensation.
[4] The UK National Ecosystem Assessment (NEA) habitat types are (i) coastal margins; (ii) enclosed farmland; (iii) freshwater, wetlands and floodplains; (iv) marine; (v) mountains, moors and heaths; (vi) semi-natural grasslands; (vii) urban (green space); and (viii) woodland. They are used in natural capital assessments undertaken by Defra and the Office for National Statistics’ (ONS) national natural capital accounts. They also link to the Defra 25-Year Environment Plan (25 YEP) draft metrics which include the following components of the environment: water; air; mountains, moors and heaths; farms; towns and cities; and seas.

environment, with only 8% of items. These findings are consistent with previous reviews of scientific and monetary evidence to inform natural capital assessments including the UK NEA (2011).

The majority of the data sets, products and sources provided information that related to or could aid with an assessment of the extent and condition of natural capital (67% and 54%, respectively). Metrics that could be derived from the data included the area of habitats or designations, species counts, the status of waterbodies, the condition of SSSIs, etc.

Only 26% of the data sets, products and sources reviewed related to or could aid with an assessment of the physical flow of ecosystem services delivered by natural capital. The categories of ecosystem services[5] in order of coverage were as follows:

- **Regulating services**, notably air quality regulation and climate regulation. The fact that these services are the most well-covered is potentially explained by the breadth of relevant monitoring data available at the national level;
- **Provisioning services**, notably food and fresh water. This latter finding is consistent with the fact that 'clean and plentiful water' is a well-covered area of the 25-Year Environment Plan;
- **Supporting services,** notably biodiversity. This is consistent with the fact that 'thriving plants and wildlife' is the most well-covered area of the 25-Year Environment Plan in the review; and
- **Cultural services,** for which individual ecosystem services are evenly covered. The lack of coverage of cultural services is due to known gaps in the availability of information to assess the physical flow of these services, most notably recreation. To date only the Outdoor Recreation Valuation (ORVaL) Tool, developed by the University of Exeter, allows for an assessment of visits to recreational sites. However, the tool has known limitations such as only covering green spaces, and also using national aggregate data from Natural England's Monitor of Engagement with the Natural Environment (MENE) survey which is then disaggregated to the site-level based on a range of assumptions and adjustment factors to reflect potential margins of error.

These findings suggest that there are no systematic gaps in the coverage of data that could inform a natural capital assessment, as part of the development of a natural capital investment framework. However, the availability of local data at a fine scale to inform local decision-making is limited.

The remainder of this section presents a more detailed analysis of the data in relation to each of the 25 YEP goals.

[5] The classification of ecosystem services is based on the Millennium Ecosystem Assessment (MEA, 2005) classification which recognises provisioning, regulating, cultural and supporting ecosystem services. This classification can be consistently mapped to other including the UK NEA and the Common International Classification of Ecosystem services (CICES).

Clean air

Key themes in the 25 YEP

The focus of the 25 YEP is on:

- Meeting legally binding targets to reduce emissions of five damaging air pollutants. This should halve the effects of air pollution on health by 2030.
- Ending the sale of new conventional petrol and diesel cars and vans by 2040.
- Maintaining the continuous improvement in industrial emissions by building on existing good practice and the successful regulatory framework.

The adoption of a natural capital approach may also support this objective by recognising the, albeit modest (Defra, 2018), role that vegetation may play in absorbing harmful pollutants from the air. However, given that this is not a focus of the 25 YEP, that the effects of absorption are considered to be modest at best, and that at very localised scales (for example street level) the effects of vegetation on air quality depends upon the species composition and can be positive or negative (CEH, 2015) and that no generalised models exist, a detailed analysis of the data available to conduct such an assessment has not been presented here.

Extent

Not applicable as it is not possible to measure the extent of 'clean air' as an asset.

Condition

Defra produces a wide range of Modelled Air Quality Datasets that are available from the UK-AIR website. This includes:

- Background pollution maps at 1x1 km resolution that are modelled each year under Defra's Modelling of Ambient Air Quality (MAAQ) contract. These maps are used to provide policy support for Defra and to fulfil the UK's reporting obligations to Europe. They are also made publicly available for other research applications such as university studies, epidemiology and public health research, nature and conservation studies.
- Local Authority-specific maps which are alternative maps based on the same model results as above but which provide source-sector splits and projections to future years by Local Authority to aid the Local Air Quality Management process. The main purpose of the background maps is to provide estimates of background concentrations for specific pollutants. These can then be used in air quality assessments to better understand the contribution of local sources to total pollutant concentrations. They provide information on how pollutant concentrations change over time and across a wide area; they also provide an estimated breakdown of the relative sources of pollution. The maps were last updated in 2015. The maps are all downloadable as .csv files for each year and for each pollutant/metric.
- Modelled estimates of population-weighted annual average PM2.5 concentrations suitable for use in estimating the mortality burden associated with long-term exposure to anthropogenic particulate air pollution at Local Authority level.
- Information on Air Quality Management Areas (AQMAs) including an interactive map with downloadable datasets (including shapefiles). All derived data downloads are made available and licensed under the Open Government Licence

Physical and monetary flows

The National Atmospheric Emissions Inventory provides data on annual emissions by sector at national, regional and local authority scale. The regional and local authority data is freely available in MS Excel format from BEIS through the gov.uk website. East Riding Observatory also contains data on local CO2 emissions (by sector) which are an extract from the datasets published by BEIS.

Monetary values of changes in air quality can be estimated using Defra's Air Quality Damage Cost Guidance (2019) and accompanying appraisal toolkit which provides unit estimates for different types of pollutants in different contexts (e.g. rural, urban, transport, industry, etc). The user enters information on reductions in emissions (tonnes) per year and the tool works out the corresponding annual values and present discounted value over the selected appraisal period. Aggregate values can also be calculated using the Defra Environmental Valuation Look-Up (EVL) tool and, for the purposes of transport appraisal, the Department for Transport's web-based Transport Appraisal Guidance (webTAG) contains an air quality valuation workbook for estimating the monetary value of air quality impacts from changes in traffic volumes and flows. These tools are all Excel-based and are free to download and use.

Potential role of hub

Air quality data at regional and local authority level is freely available from the UK Air Information Resource (UK AIR) and from the gov.uk website. There is a potential role for a hub in drawing together the information that is applicable to users in the YNYERH region and signposting or hosting relevant air quality damage cost valuation tools should users wish to monetise the impacts of changes in emissions.

Clean and plentiful water
Key themes in the 25 YEP
• Waterbody status • Bathing water quality • Sustainable abstraction
Extent
• Environment Agency monitoring data for the Water Framework Directive (WFD) and the revised Bathing Water Directive (rBWD) can help assess the extent of rivers, canals, lakes, coastal waters, transitional waters and groundwaters. • National habitat data layers may also be utilised (e.g. CEH Land Cover Map, CORINE Land Cover Map, etc.). This can be cross-checked with the Ordnance Survey MasterMap water network layer. • These data sets and products are available for non-commercial and commercial use, although the CEH Land Cover Map is available at a cost. • Data on abstraction of water for use by businesses and households is not publicly available but could be obtained upon request and negotiation with water companies in the region. • These are all national data sets and products, and the review did not identify local evidence for this topic area.
Condition
• Environment Agency monitoring data for the WFD and rBWD can be used again to determine the number and length of waterbodies across different levels of water quality i.e. bad, poor, moderate, good for water bodies regulated under the WFD; and poor, sufficient, good, excellent for water bodies regulated under the rBWD. This includes a breakdown by indicators of quality such bacteriological quality. Environment Agency data on groundwater source protection zones (SPZs) can be also utilised to determine groundwater bodies that are at risk of contamination. • These data sets and products are available for non-commercial and commercial use. • Data on whether current abstraction of water for use by businesses and households is sustainable is not publicly available but could obtained upon request and negotiation with water companies in the region. • These are all national data set and products, and the review did not identify local evidence for this topic area.
Physical and monetary flows
• The benefits of waterbodies include the provision of fisheries; fresh water; healthy water quality; recreational opportunities; and aesthetic value. • An assessment of the physical flow of fisheries and fresh water for a site under consideration would require primary data collection. This would be outside the scope of a data hub. • Improvements in water quality, recreational opportunities and aesthetic value are assessed collectively as it is challenging to isolate the impact of each of these components. The Environment Agency Benefits Inventory and the Defra Environmental Value Look-Up Tool can be used to assess the monetary value of these benefits to surrounding beneficiary populations. Both of these tools are available for non-commercial and commercial use. • These tools are intended for national use but include evidence derived at the local level. For example, the Environment Agency Benefits Inventory includes evidence at the catchment level.
Potential role of a hub
• A hub could pool together and standardise the set of indicators required for an assessment of the baseline and future progress towards this 25 YEP goal. If a hub were to include a web map, users could explore the data including potential topological issues and disparities in the different resolutions of data sets and products. • A hub could develop new habitat layers using a collection of higher resolution data layers. • A hub could signpost or subsume tools that enable an assessment of the monetary flow of benefits provided by freshwaters and coastal waters. • Most of the data set and products mentioned are updated sporadically, so having a central hub could help users save time when sourcing this information.

Thriving plants and wildlife

Key themes in the 25 YEP

- Aquatic and terrestrial biodiversity
- Protected sites
- Habitat creation including increasing woodland cover
- Species recovery

Extent

- The CEH Land Cover Map and the CORINE Land Cover Map provide information on the extent of habitats that support plants and wildlife. This information is considered to have low resolution and not therefore suitable for more local assessments. The highest resolution data product that could provide information on extent is the CEH Countryside Survey which is available at 1km^2 resolution. Note that this product does not cover coastal margins and the marine environment which are two areas that this 25 YEP goal importantly applies to.
- These data sets and products are available for non-commercial and commercial use, although the CEH maps are available at a cost.

Condition

- National data sets and products from Defra, JNCC and Natural England for environmental designations can be used to provide information on protected areas and their status.
- There are several opportunity maps developed across the region. These reflect the willingness of organisations to work in particular areas and undertake habitat restoration and recovery rather than the existence of natural capital. These have not been collated and are not available online, but could be with some investment in collation.
- There is a range of species data, indicators of the density of priority species occurrence, environmental designations, and invasive species data which in combination could be useful as an indicator of the condition of habitats and their ability to support plants and wildlife. A hub could include a data product that combines these individual elements.
- This information can be used to estimate the Defra Biodiversity Metric for an area under consideration. A hub could potentially incorporate this calculation, depending on the availability of its inputs and the overall design of the hub.

Physical and monetary flows

- There are tools that model the physical flow of ecosystem services that are dependent on biodiversity, but not biodiversity itself. This is because biodiversity underpins the health and productive capacity of all habitat types and also the provision of other ecosystem services. It is therefore challenging to disentangle the contribution of biodiversity to other ecosystem services.
- Evidence to assess the value of changes in biodiversity in monetary terms is contained in the Defra Environmental Value Look-Up Tool. However, the tool suggests that using this evidence requires input from specialists and adjustments to the evidence being transferred. It is unlikely that a hub could include the capability to carry out this sort of analysis.

Potential role of a hub

- A hub could include an initiative to collate habitat data that is currently held by local organisations. There is also significant habitat data that could be gathered from private organisations including environmental consultancies. The scope of this initiative would depend on the design and target audience of the hub. It would bring together data that has not been previously collated and made accessible. However, it may not deliver a complete high-resolution habitat layer for the whole region and/or all habitat types. Examples include developing a new LNP area-wide habitat mapping initiative or using remote sensing to generate a high-resolution area-wide habitat layer.
- Other possibilities to assess the extent of habitats that support biodiversity include building a habitat layer based on existing products e.g. from organisation such as NGOs that manages sites for biodiversity and hold related data.
- The boundaries of second tier sites are not widely available online, and are distributed to authorities that support their development and are maintained by the North and East Yorkshire Ecological Data Centre (NEYEDC). This data could be placed on a data observatory or hub, but it would require a change in current local authority policy to make the data accessible to all local authorities and external organisations.
- There are range of data products that are linked to planning policy that are not available to download. This includes the ecological networks and natural capital mapping suggested by the National Planning Policy Framework (NPPF). In a number of authorities, these do not exist whilst in most they are an internal data product. Providing access to these data products via a data hub could increase the utility and relevance of that hub.
- A hub could pool together and standardise the set of indicators required for an assessment of the baseline and future progress towards this 25 YEP goal. If a hub were to include a web map, users could explore the data including potential topological issues and disparities in the different resolutions of data sets and products.

Reduced risk of flooding and droughts
Key themes in the 25 YEP
• Impacts of coastal erosion and flooding on communities and assets • Water supply during droughts
Extent
• The Environment Agency National Receptor Database, Flood Maps and National Coastal Erosions Risk Mapping (NCERM) can be used in conjunction with other data sets and products to assess the extent of assets at risk of flooding and erosion. This includes the number of residential and non-residential properties, length of roads and railways, the extent of agricultural land (via Natural England's Agricultural Land Classification data), etc. Risk to built assets such as properties, roads and railways is outside the scope of a natural capital assessment at it relates to built rather than natural capital. • The CEH Land Cover Map and the CORINE Land Cover Map provide information on the extent of habitats that provide protection against environmental hazards such as flooding. This information is considered to have low resolution and therefore not suitable for more local assessments, as mentioned above. • The National Receptor Database is available upon request from the Environment Agency. The review could not conclude whether a charge would apply to accessing this data. • Other data sets and products are available for non-commercial and commercial use, although the CEH maps are available at a cost. • The review did not identify information related to droughts that was readily available. Defra holds data on the number of drought orders but only up to 2011. Information of droughts and related water supply would need to be obtained in collaboration and negotiation with water companies in the region, including their Water Resource Management Plans (WRMPs).
Condition
• The condition of different assets at risk of flooding and erosion depends on their likelihood to be affected by flooding and erosion. The Environment Agency's Flood Maps allow the number of assets with different probabilities of flooding to be identified e.g. probability of 1 flood event every 100 or 1,000 years, etc. The National Coastal Erosion Risk Mapping presents different percentiles of erosion that translate to different likelihoods of erosion affecting assets. • Some of the assets at risk of flooding and erosion may be high-grade agricultural land, Ramsar wetlands or Sites of Special Scientific Interest (SSSIs) all of which have associated data which can be used to determine the condition of these assets. • These data sets and products are freely available for non-commercial and commercial use. • Beyond this, the review did not identify other indicators of condition, although it may be possible to consider indicators of soil quality as indicators of the ability of habitats deliver flood protection benefits.
Physical and monetary flows
• The monetary value of the benefits of protection against flooding and erosion are generally expressed in terms of avoided damage to assets at risk. • The Environment Agency's Economic Valuation of Environmental Effects handbook can be used to value the benefits of protecting or creating wetland habitats. The valuation evidence in the handbook is also referenced in the Defra Environmental Value Look-Up Tool which includes reference to other sources in the valuation literature. • This information is freely available for non-commercial and commercial use. The evidence would require adjustments when used in a local context in line with Defra's guidelines for value transfer (Defra, 2010) – this means it can be signposted but not subsumed within a hub. • Other avoided damages e.g. to properties are outside the scope of a natural capital assessment.
Potential role of a hub
• A hub could pool together the already standardised set of indicators and data required for an assessment of the baseline and future progress towards this 25 YEP goal. This is unlikely to include the National Receptor Database, where access is granted upon request, and possibly at a charge, noting that this is technically outside the scope of a natural capital assessment. • If a hub were to include a web map, users could explore the data including potential topological issues and disparities in the different resolutions of data sets and products. • A hub could develop new habitat layers using a collection of higher resolution data layers. • Most of the data set and products mentioned are updated sporadically, so having a central hub could help users save time when sourcing this information.

Sustainable use of natural resources

Key themes in the 25 YEP

The focus of the 25 YEP is on ensuring that resources from nature, such as food, fish and timber, are used more sustainably and efficiently by:

- Maximising the value and benefits obtained from natural resources, doubling resource productivity by 2050.
- Improving the approach to soil management using natural capital thinking to develop appropriate soil metrics and management approaches.
- Increasing timber supplies.
- Ensuring that all fish stocks are recovered to, and maintained at levels that can produce their maximum sustainable yield.
- Ensuring that food is produced sustainably and profitably.

As with *Thriving plants and wildlife*, *Using resources from nature more sustainably and efficiently* is a broad goal that needs to be assessed in a range of ways.

Extent

- The UK Soils Observatory (UKSO) hosts a map viewer which allows users to visualise information from large-scale soils datasets. The UKSO also holds various soils datasets (e.g. from Countryside Survey, National Forest Estate, Forest Research, Ordnance Survey, and the Cranfield Soilscapes mapper etc). Metadata for each of the maps hosted on the site is made available to the user showing the source, scale, format, cost and uses, all of which differ according to the specific maps or datasets of interest.
- Forest Research publishes annual forestry statistics and time series data on sustainably managed woodland area (FSC certified) and planting but this is available at national (England) level only. Currently, only woodland used for forestry over 0.5 hectares in size is included in these statistics. Smaller woodland and individual trees are not.
- The Defra June Survey of Agriculture and Horticulture (June Survey) records the area (in hectares) of farmland in the UK. Figures for key crop areas are available by local authority (< Lower Super Output Area) on an annual basis. It is also possible to obtain maps (at 5km grid square resolution) which could be 'cookie cut' for more localised assessments although these would not be suitable for application at a farm- or plot-scale. The Survey is free to access and is updated annually.

Condition

- Forest Research publishes annual forestry statistics and time series data on woodland condition, covering coniferous and broadleaf stock available, area of FSC certified woodland and tonnes of carbon stored by forests and populations of wild and woodland birds. This is only available at national scale.
- There is limited data available of the health of soils. Datasets produced by Countryside Survey, Cranfield's National Soil Inventory (LANDIS) and the British Geological Society (Geochemical Baseline Survey of the Environment) is partial and based on point survey data. Countryside Survey data, while free to access, was last collected in 2007. LANDIS is updated every 6-10 years and can be accessed with a licence.
- The ONS collates national-level data on farmland condition for inclusion in the natural capital accounts. This is derived from a variety of sources including the British Trust for Ornithology, the Royal Society for Protection of Birds, the Joint Nature Conservation Committee, and Defra.

Physical and monetary flows

- The ONS collates and publishes data on natural resource use including timber, water, food production, minerals, water and energy from renewables. This is published annually in the form of natural capital accounts but the data is available at the national scale only.
- Forest Research publishes annual forestry statistics and time series data on timber production and but this is available at national (England) level only. Forest Research also publishes timber price indices
- The Marine Management Organisation (MMO) publishes annual UK Sea Fisheries Statistics which are used in the national accounts. There is, however, very limited data on fisheries at a regional or local scale.
- Crop yield and price data is available from the annual Farm Business Survey which is available under Open Licence from the gov.uk website. These are, however, national averages and may not therefore be representative of typical farms in the region or a specific locality.

Potential role of a hub

- While there are, as yet, no standardised indicators and metrics, the high-level review conducted for this project suggests that the data that could potentially be used to support an assessment of the sustainable use of natural resources is spread across a wide range of sources and is very limited at the regional and local scale.
- A hub could potentially guide users to sources of information or host the information that is suited for use at the local or regional scale but this would only support partial assessments or rely on the use of national level averages as proxies.

Enhanced beauty, heritage and engagement with the natural environment
Key themes in the 26 YEP
• Landscape designations • Heritage features • Access to blue and green space • Aesthetics
Extent
• The CEH Land Cover Map and the CORINE Land Cover Map provide information on the extent of habitats that support recreation, cultural heritage and aesthetics. This information is considered to have low resolution and therefore not suitable for more local assessments. The highest resolution data product that could provide information on extent is the CEH Countryside Survey which is available at 1km^2 resolution. • Public Right of Way Data can be used to determine the number and length of pathways which make these habitats accessible to recreational visitors. Ordnance Survey paths data may also be used to sense change this data. • These data sets and products are available for non-commercial and commercial use, although the CEH maps are available at a cost.
Condition
• There is a variety of data on site designations that can be used to assess the condition of habitats. These are mentioned in the table above for 'thriving plants and wildlife'. • Data regarding Scheduled Monuments can be used to identify the number and location of these assets across habitats. • There is likely to be data from English Heritage and Heritage Gateway that could be used as well. The review did not identify the specific underlying data provided by these organisations or the licensing of this data due to the large volume of items they publish. A hub could investigate this area further, in conjunction with these organisations, and provide access to relevant data and clear licensing terms.
Physical and monetary flows
• The University of Exeter's Outdoor Recreation Valuation (ORVaL) Tool or the upcoming Natural Environment Valuation Online (NEVO) Tool (that includes modelling from the ORVaL Tool) can be used to estimate the number of visits to green spaces in England. However, both of these tools are intended for broad brush assessments and are not amenable to local site-level assessments due to their low resolution. They also do not cover all habitat types and would therefore only allow for a partial assessment. • Primary data collection is therefore likely to be required for local sites of importance that may be affected by a policy or project. • The number of recreational visits to sites can be valued in monetary terms using evidence that is signposted in the Defra Environmental Value Look-Up Tool that covers all habitat types as well as formal and informal recreational visits/activities. • The Forestry Commission's Woodland Valuation Tool also provides evidence that is specific to woodlands and consistent with the Defra tool. • These tools are freely available for commercial and non-commercial use, except for the NEVO Tool which is still in development.
Potential role of a hub
• A hub could pool together the already standardised set of indicators and data required for an assessment of the baseline and future progress towards this 25 YEP goal. It could also signpost the relevant tools. • If a hub were to include a web map, users could explore the data including potential topological issues and disparities in the different resolutions of data sets and products. • A hub could develop new habitat layers using a collection of higher resolution data layers. • Most of the data set and products mentioned are updated sporadically, so having a central hub could help users save time when sourcing this information.

Climate change mitigation and adaptation

Key themes in the 25 YEP

- Continuing to cut greenhouse gas emissions including from land use, land use change, the agriculture and waste sectors and the use of fluorinated gases.
- Making sure that all policies, programmes and investment decisions take into account the possible extent of climate change this century.
- Implementing a sustainable and effective second National Adaptation Programme.
- Note that adaptation to climate change is a cross-cutting issue and key aspects of adaptation are captured within other relevant goals including Clean and plentiful water, Reduced risk of flooding and droughts and Thriving plants and wildlife.

Extent

- The CEH Land Cover Map and the CORINE Land Cover Map provide information on the extent of habitats (woodland, peatland, coastal margins) that support vegetation that stores and sequesters carbon.
- This information is of low resolution and therefore not suitable for more local assessments. The highest resolution data product that could provide information on extent is the CEH Countryside Survey which is available at 1km^2 resolution. This data is only updated periodically (every 10 or so years) and was last updated in 2007. It does not therefore capture changes that have occurred more recently.
- These data sets and products are available for non-commercial and commercial use, although the CEH maps are available at a cost.
- The National Forestry Inventory provides data on woodlands at a much finer scale (20m resolution) and therefore provides more detailed information on the species mix within smaller areas of local woodlands which may be useful for ascertaining baseline carbon stocks in woodland vegetation.
- The extent of the stock of peatlands in the UK is not precisely known, being measured differently under different definitions and methods deployed to develop different data sets. Key data sources are the Land Cover Map (LCM) 2007, the Countryside Survey (CS), national soil surveys and the British Geological Survey (BGS). These sources have different levels of accuracy and peat definitions, and are used in different combinations in different parts of the UK to establish peatland cover. Using the LCM2007 may create problems for peatland definition in that, as a land-cover map, it does not always classify land according to soil type. Although some (wetland) land cover classes are specifically associated with the presence of peat, areas where peat underlies other land classes such as coniferous woodland or arable land cannot be distinguished from areas of the same land use on mineral soils. The CS gives more accurate data for individual surveyed areas, but is based on a sample, so is not spatially complete.

Condition

Habitat condition (for estimating the capacity of habitats and soils to sequester and store carbon and/ or the impacts of land use change or vegetation disturbance on GHG emissions)

- Data on habitat condition may be derived from a variety of sources including Forestry Commission Forestry Statistics, Natural England, JNCC and the IUCN Peatland Compendium. Work on assessing the most appropriate data sources for establishing peatland condition is, however, in the early stages as there is no single source that is spatially complete and covers all peatland types (Smyth et al., 2015)
- Data on soil carbon stocks is available from the National Soil Inventory (LANDIS) held by Cranfield University. A free online map viewer (Soilscapes) produces summary soils information for a specific location, based upon the “Soilscapes” soil thematic dataset. It is a 1:250,000 scale simplified soils dataset and is not intended as a means for supporting detailed assessments, such as land planning applications or site investigations; nor should it be used to support commercial activities. For such applications, a parallel service Soils Site Reporter provides comprehensive reporting for specific locations (at least at 1km grid square resolution but possibly higher).

Physical and monetary flows

GHG Emissions (for the purposes of monitoring progress against the 25 YEP objectives)

- BEIS publishes data on GHG emissions by sector for each local authority on an annual basis. Data is available from the gov.uk website for 2005 to 2016.
- The Centre for Ecology and Hydrology prepares estimates of GHG emissions from land use, land use change and forestry (LULUCF) annually for inclusion in the UK GHG Inventory. These estimates are made using dynamic models of changes in stored carbon, driven by land use change data. For forestry, the model deals with plant carbon, dead organic matter, soil and harvested wood products and is driven by the area of land newly afforested each year, management practices and harvesting. Changes in soil carbon are driven by estimated time series of land use transitions between semi-natural grassland, improved pasture, cropland, forest land and settlement land uses. The LULUCF Sector differs from other sectors in the Greenhouse Gas Inventory in that it contains both sources and sinks of greenhouse gases. The sources, or emissions to the atmosphere, are given as positive values; the sinks, or removals from the atmosphere, are given as negative values. Estimates are produced at a 1km grid square resolution but are aggregated and published at local authority level.
- In addition to the downloadable data tables available in Excel or csv format from the gov.uk website, an interactive local authority emissions map (based on 2016 data) is also available on the National Atmospheric

Climate change mitigation and adaptation
Emissions Inventory (NAEI). The user can choose to show different sectors on the map, and select a specific local authority by clicking on the map, or selecting the name from the menu next to the map. The user can click on the local authority region to see any point sources within that region. All data on this site is derived from mapping data provided by one of the UK national mapping agencies and other organisations. • The emissions data for this map can be downloaded from the UK local authority and regional carbon dioxide emissions national statistics website. Downloads are made available and licenced under the Open Government Licence. • Tools such as INVEST and Aries may be used for estimating changes in GHG emissions arising from land use change but these require GIS software and expertise and are data intensive. **Monetary flows** • Monetary values (per tonne CO_2e) do not vary spatially and can be estimated by applying the standard BEIS carbon prices (available on the BEIS website) for the traded and non-traded sectors. These prices are updated annually and vary by year. • There are several toolkits available for download that calculate monetary values once the quantities of emissions from each sector (traded and non-traded) are known. These include the Department for Transport's web-based Transport Appraisal Guidance (webTAG) for estimating changes in GHG emissions from traffic and the Defra Environmental Valuation Look-Up (EVL) Tool.
Potential role of a hub
• A hub could pool together the already standardised set of indicators and data required for an assessment. of the baseline and future progress towards this 25 YEP goal. It could also signpost the relevant tools. • The datasets, products, models and tools that may be required to estimate carbon storage and sequestration from vegetation and soils – and particularly changes in land cover and land use – are available from a variety of locations and therefore a hub could bring these together in one location, potentially with guidance as to what data, models, knowledge and tools may be helpful in deriving estimates of physical and monetary flows.

2.2.3 Natural Capital Planning Tool

A particular focus highlighted in the project specification is the need to review the Natural Capital Planning Tool (NCPT)[6] including whether it can inform a natural capital investment framework and interact with a natural capital data hub.

Overview

The NCPT is a free Excel-based site assessment tool developed by the Consultancy for Environmental Economics and Policy (CEEP) for the planning context in England. The tool allows non-specialist users to undertake an indicative but systematic assessment of the impact of proposed plans on ten ecosystem services over 25 years, post-development. The tool calculates an ecosystem service impact score (from -5 to +5 points) that indicates the likely direction of change and magnitude of the impact that the proposed plan or development will have on ecosystem services, individually and overall.

The impacts considered in the tool relate to the following goals in the 25 YEP:

- Clean air;
- Clean and plentiful water;
- Thriving plants and wildlife;
- Reduced risk of harm from environmental hazards (flooding, drought, etc.);
- Using resources from nature more sustainably and efficiently;
- Enhanced beauty, heritage and engagement with the natural environment; and
- Mitigating and adapting to climate change.

[6] http://ncptool.com/

The ecosystem service impact score is calculated with user inputs for the study area plus at least a 300m buffer around the area. The inputs are required per- and post- development and are commonly available as part of the planning process. These include:

- Land use[7];
- Biodiversity Action Plan (BAP) Priority habitats;
- Flood risk maps showing the risk of flooding from rivers, seas and surface water;
- Drinking water safeguard zone maps for surface water and groundwater;
- A map identifying all areas that are freely accessible to the public;
- The Agricultural Land Classification (ALC) of land;
- The population density and age structure;
- Heat exposure and the proportion of built- up area;
- Air Quality Management Area boundaries;
- The size and accessibility of green spaces sites; and
- Information on soil drainage, carbon stock, and contamination.

The tool provides links to sources where users can find some of these inputs. However, some of these inputs will inevitably require GIS software and analysis.

Potential role of the tool in prioritising investments or projects that manage, maintain or enhance natural capital

The tool has been identified in the YNYERH Natural Capital Investment Framework Delivery Plan for its potential use by Local Planning Authorities (LPAs) in the assessment of plans and developments and by Local Enterprise Partnerships (LEPs) to assess funding bids.

The tool provides a score for the impact of developments on ecosystem services, individually and overall. This can indicate whether a development has resulted in net positive or negative impact on natural capital and the ecosystem services it provides. The magnitude of the impacts is however driven by the underlying scores assigned to ecosystem services that were derived in a workshop with experts in the field.

While the tool is useful in identifying developments which result in a gain or loss to natural capital, it may be limited in its ability to prioritise multiple projects because the underlying scores and the way in which they come together is not standard. Conversely, the Defra Biodiversity Metric is a more widely accepted metric to show the direction and magnitude of the impact of a development on biodiversity. In December 2018, the Government launched a consultation on whether to mandate the delivery of biodiversity net gain for development requiring planning permission, where biodiversity losses and gains are measured using the standard Defra Biodiversity Metric. Furthermore, the revised National Planning Policy Framework (NPPF) requires that plans identify and pursue opportunities for securing measurable net gains for biodiversity (MHCLG, 2019). The tool also does quantitatively assess changes in the provision of ecosystem services, due to the development, in physical or monetary terms. To do this, users would need to consult other sources and approaches.

Potential interactions with a natural capital data hub

Nevertheless, the ability of the tool to clearly score projects in terms of their net positive or negative impact on ecosystem services is useful. In fact, the tool could interact a natural capital data hub in a number of ways:

[7] Based on the Joint Nature Conservation Committee's Phase I habitat classification.

- It could be signposted by the hub;
- It could be downloaded from the hub if the hub is developed as a repository[8];
- The hub could also signpost or subsume data that would provide users with some of the inputs required to use the tool; or
- The hub could also allow this data to be analysed and visualised within the hub if it included an interactive web map.

2.3 Concluding remarks

The review of data sets, products, tools, and sources suggests that there is a significant volume of data available for commercial use. This data does not, however, tend to be available at a fine enough scale to facilitate local decision-making and monitoring against the 25 YEP goals. Where data is available, there is a potential role for a hub to draw together existing information that could be used to measure progress against the 25 YEP goals, based on the forthcoming 25 YEP indicators.

The review found that most data required advanced skills such as GIS to be used. A hub with an interactive web map could help non-specialist users overcome this barrier. A web map would also allow users to explore data within a hub including potential topological issues and disparities in the different resolutions of data sets and products. Alternatively, this may also suggest that there is a need to upskill potential users of a hub regardless of what hub specification is pursued.

Critically, the review suggested that there is scope and value in potentially developing new data products as part of a hub that could make it a definitive source of up to date and quality assured data with clear licensing terms. For example, a hub could include an initiative to collate habitat data that is currently held by local organisations. There is also a substantial volume of habitat data that could potentially be gathered from private organisations including environmental consultancies.

The finding from the data review are revisited in the assessment of hub options in Section 4, alongside the review of user needs in the following section.

[8] Written permission would need to be sought from the tool developer (CEEP) particularly if there is a fee associated with accessing and using the hub.

3. Review of user needs

This section sets out the approach and results for the review of user needs and how they may feed into the development of a natural capital data hub. This included an online survey and a series of semi-structured interviews to examine:

- The contexts in which stakeholders in the region assess natural capital (linking back to Figure 2.1);
- The evidence they use for these assessments;
- Whether and how a natural capital data hub could support these assessments; and
- The features of a hub that users would find useful.

The findings from the engagement with users feed into the assessment of the feasibility of data hub options (Section 4). It is, however, important to note that the small sample size means that responses cannot be assumed to be representative of the breadth of potential users and uses of a natural capital data hub. The responses do nevertheless provide useful insights that have been combined with findings from the other scoping tasks in evaluating the feasible options for establishing a natural capital data hub.

3.1 Scope and approach

The online survey was administered via Survey Monkey during November and December 2018.

The survey comprised 32 questions in total, some of which were conditional on responses to previous questions. Question formats included single choice, multiple choice and open-ended questions, covering:

- The data sets, products, tools and/or sources that stakeholders currently use;
- What their organisation uses and needs them for;
- How their organisation uses them; and
- What could be done to make them more useful in their work.

The full survey questionnaire is included in Appendix C to this report.

Overall, 90 individuals identified by the Steering Group were contacted across the public, private and third sector. Responses were tracked and sense-checked over the course of the survey to check the quality of responses, the average time taken to complete the survey, and whether there were any systematic ‘drop-off’ points for respondents. Weekly reminders were sent to stakeholders to remind individuals to respond to the survey in a bid to secure as many responses as possible.

Following the close of the survey, responses were scanned and analysed to identify a short list of ten respondents to take part in follow-up interviews. Interviewees were selected on the basis of the detail provided in their responses to the survey, and to obtain a spread across sectors (public, private, and third sector) and applications of natural capital approaches.

The interviews followed a semi-structured format and were guided by the use of an interview protocol. The protocol included 18 questions that were meant to be used flexibly and serve as a checklist during the interview. The interviews covered:

- Details of the types of natural capital assessment that stakeholders undertake;
- Features of a hub that would add value and support them in their assessments; and
- Practicalities of the hub such as data that respondents could provide as inputs to the hub, and data management.

The full interview protocol is included in Appendix D to this report.

3.2 Key findings

This sub-section sets out the headline results from the survey of stakeholders and the semi-structured interviews that followed. The full set of descriptive statistics from the online survey is provided in Appendix E to this report. Full interviews transcripts are not provided in order to preserve the anonymity of respondents.

3.2.1 Contexts for natural capital assessments

Of the 90 individuals contacted as part of the project, over 40% completed the survey (n=37), the majority of which agreed to be interviewed (over 75%). Three additional respondents completed all but the last two questions of the survey and were therefore included in the analysis to make use of as much information as possible. The results presented in this sub-section are based on these 40 responses (37 completed and 3 partially completed).

Table 3.1 presents the breakdown of responses across the different stakeholder groups that participated in the survey (in descending order). At least one respondent from each of the stakeholder groups contacted completed the survey.

Table 3.1: Survey respondents by stakeholder group

Stakeholder group	n	%
Local authorities	19*	48%
Defra family	7*	18%
Protected landscapes	4*	10%
Environmental charities	4	10%
Public Health teams	2	5%
Catchment partnerships	1	3%
Grant bodies	1	3%
Local Enterprise Partnerships	1	3%
Utility companies	1	3%
Total	40	100%

Notes: *includes one partially completed response.

Only 25% of respondents indicated that they were responding on behalf of their entire organisation. (Q2 in Appendix E). Most survey respondents indicated that they were completing the survey either for their team only (50%) or for themselves and their projects only (25%).

Table 3.2 shows the contexts in which survey respondents reported undertaking natural capital assessments or using natural capital and related environmental data. The vast majority of respondents suggested that they assessed environmental impacts (including impacts on natural capital) in their daily tasks such as impact assessments, assessing planning applications, etc. This suggests the potential relevance and utility of developing a hub to facilitate such assessments. The most common contexts were (i) planning strategy and decisions, (ii) habitat and wildlife surveys and assessment, followed by (iii) flood risk assessments and (iv) housing development strategy and decisions. This finding, along with the less common contexts in Table 3.2, illustrate the potential range of contexts that could include an assessment of natural capital (or aspects thereof), and that a natural capital data hub may therefore need to cater to. It is important to note this finding is however driven by the structure of the sample of respondents who completed the survey, most of which worked within a planning context.

Table 3.2: Contexts and applications for natural capital assessments (online survey)

	% (n=40)		
	Yes	No	Total
Planning strategy and decisions	73%	28%	100%
Habitat and wildlife surveys and assessments	65%	35%	100%
Environmental and sustainability impact assessments	55%	45%	100%
Flood risk assessments	55%	45%	100%
Housing development strategy and decisions	48%	53%	100%
Catchment management (including water resources management plans)	45%	55%	100%
Climate change risk and opportunity assessments	45%	55%	100%
Land management	45%	55%	100%
Sustainability appraisals	45%	55%	100%
Strategic environmental assessment	40%	60%	100%
Economic and economic development strategy and decisions	38%	63%	100%
Statutory environmental monitoring and enforcement	30%	70%	100%
Transport and infrastructure appraisals	30%	70%	100%
Other	13%	88%	100%
None of these	3%	98%	100%

3.2.2 Data sources used for natural capital assessments

Table 3.3 presents the results for the top five types of data sets and products, tools or sources that respondents to the online survey reported using. Most respondents reported that they did not use any of the data sets, products, tools or sources presented, including the top five in each category. This could indicate low use or access to the range of data available for natural capital assessments, which is in some cases driven by the availability of data for commercial use. The development of a natural capital data hub could potentially help to usefully fill this gap. The top three data sources in Table 3.3 are exceptions, however, with most respondents having selected these options. The full list of options that was presented to respondents is provided in Appendix E (Q4, Q5, Q6). The list was compiled based on knowledge of data typically used in undertaking natural capital assessments. It formed the starting point for the review of data for natural capital assessments (Section 2) which also used desk-based research and input from survey respondents to iteratively develop the list.

Table 3.3: Top five data sets, products, tools and sources used by respondents (online survey)

	% who selected option
Top five data sets and products	
English Heritage - Historic Places data	35%
Ordnance Survey Paths data	30%
Air Pollution Information System (APIS)	20%
British Trust for Ornithology (BTO) data	20%
Botanical Society of Britain and Ireland (BSBI) data	15%
Top five visual and/or analytical tools	
Environment Agency Catchment Data Explorer	35%
Historic England Listed Buildings	33%
National Biodiversity Network (NBN Atlas)	25%
Environment Agency Bathing Water Quality Data Explorer	20%
Heritage Gateway	15%
Top five data sources	
Natural England data sets e.g. Agricultural Land Classification; Priority Habitat Inventory; etc.	73%

	% who selected option
Environment Agency data sets e.g. Flood Maps; invasive species data; etc.	68%
North and East Yorkshire Ecological Data Centre (NEYEDC) data	58%
British Geological Survey	33%
Catchment-Based Approach (CaBA) catchment data	33%

Besides the external data sources listed above, respondents were also asked whether their organisation held any internal data that they make use of when conducting natural capital assessments or assessing specific aspects of natural capital. A third of respondents (n=13) reported using internal data while 40% said they did not know if their organisation held internal data that could be used to assess impacts or opportunities relating to natural capital (Q17 in Appendix E). The latter finding is consistent with the fact that most respondents did not complete the survey from the perspective of their entire organisation (Q2 in Appendix E).

The internal data reported by respondents was wide-ranging, and included:

- The Environment Agency Benefits Inventory;
- The Environment Agency Economic Valuation of Environmental Effects (EVEE) handbook;
- Farm Environmental Plan condition assessments;
- Habitat Suitability Modelling for bats and waders;
- Habitat surveys;
- Highway trees and potential sites for tree planting;
- Historic character and setting in York;
- Historic Environment Record;
- Hull Local Plan Sustainability Assessment and Habitats Regulations Assessment; and
- Local plan data sets.

Only a third of respondents who reported having internal data (n=4) stated that their organisation provides access to its internal data, most of whom said it could be provided free of charge (Q27 in Appendix D) and this was confirmed in the interviews. These findings suggest that a natural capital data hub may need to either signpost or contain data that is owned and held by stakeholders and that could be subject to different sharing and licensing conditions. A hub may even have a feature that allows users to post their own data onto the hub.

3.2.3 Patterns of use and potential features of a natural capital data hub

The online survey and interviews probed stakeholders regarding different ways that they used or would like to use data for natural capital assessments. The helps establish patterns of use that could potentially inform some of the features of a natural capital data hub including:

- **Whether respondents combined different data sets or products:** 50% of respondents to the online survey (n=20) reported combining different data sets or products in natural capital assessments (Q8 in Appendix E). A series of open-ended questions were used to determine their purpose and objectives for doing so. Responses were analysed and summarised as shown in Table 3.4 and Table 3.5 respectively.
- When asked how they combined different data sets or products, the majority of respondents said they used GIS software such as QGIS or MapInfo. Around 60% of respondents (n = 12) reported the need to carry out further analysis as part of their assessment (Q11 in Appendix E). This included analyses of economic impacts, aerial photographs and site visits. This implies that the use of spatial analysis is often a necessary step in an assessment but typically needs to be combined with other information in order to fulfil user needs.

- The wide range of purposes and objectives reported by respondents in Table 3.4 and Table 3.5 respectively, demonstrate the potential breadth of applications that could be covered by a natural capital data hub that allows users to combine different data sets and products. There was a consensus among interviewees that a data hub would still be useful even if it did not have the option of allowing users to overlay spatial data. Interviewees still see value in a hub that signposts or contains data without having this additional function. It was, however, noted that those interviewees that attached greater value to a hub with the ability to visually map and overlay spatial data were typically those with less experience in conducting spatial analyses. Other stakeholders were sceptical about this feature of a hub because of the risk of non-specialist users incorrectly interpreting information. For example, if users can visually identify overlaps between different layers, they may mistake this correlation for causation.

Table 3.4: Reported purpose of combining data sets or products (online survey)

	% (n=20)
Constraints/opportunities mapping	35%
Assess interaction between different data sets	30%
Assess conservation designations in study area	5%
Build a green infrastructure map for an area	5%
Improve coverage of natural flood management (NFM) maps	5%
Conduct a natural capital baseline	5%
Strategic Housing and Employment Land Availability Assessment (SHELAA)	5%
Understand woodland cover	5%
Not specified	5%
Total	100%

Table 3.5: Reported objectives of combining data sets or products (online survey)

	% (n=20)
Assess planning application	25%
Assess impacts and opportunities on natural capital	15%
Habitat Regulation Assessment, Sustainability Appraisal, Strategic Environmental Assessment	10%
Identify opportunities to improve natural capital (including NFM)	10%
Meet objectives set out in the Defra 25-Year Environment Plan	5%
Develop neighbourhood plan	5%
Diagnose, detect and treat the problems (e.g. health inequalities)	5%
Monitor and evaluate a programme	5%
Prioritise areas	5%
Reconcile different data sets	5%
Site assessment	5%
Meet statutory obligations	5%
Total	100%

- **Whether respondents amended data for errors or local changes:** 38% of respondents to the online survey (n=15) reported that they had detected errors or local changes that were not reflected in data sets or products (Q13 in Appendix E). Of these, only 33% (n=5) reported that they had attempted to correct these errors or update information to reflect these local changes (Q14 in Appendix E). Some examples given by respondents of the types of amendments and the ways in which these have been made are provided in Table 3.6. Most of these respondents reported that the amendments increased the accuracy of their analysis by helping them use more up to date information that reflected local changes. Note that only four respondents are

presented in Table 3.6 as one respondent did not provide additional information regarding the amendments they made.

Table 3.6: Amendments to data sets or products by respondents (online survey)

Respondent	Amended data	Type of amendments	Approach
1	Flood map	Take flood defences into account	In-house analysis and external consultants
2	Not specified	Topology of data sets	Manually editing features of data set
3	Priority Habitat Inventory, Land Cover Map	Updated habitat information	Manually editing locally held layers
4	Priority Habitat Inventory	Area	In house WebMap tool

- Over half of respondents stated that they did not correct errors or reflect local changes when using data because either (i) it would not have a material difference to their work, or (ii) they found that there was no mechanism to easily make amendments. The latter finding is consistent with the results from the data review and suggests this is a gap that a hub could potentially fill by allowing users to submit amendments to data in some capacity. Interviewees appear to agree that introducing an option for users to edit data in a hub would be challenging to manage and administer. Interviewees instead favoured an option where hub users could report errors to the hub manager. The manager would then feed those changes back to data providers for the edits to be made centrally, rather than locally. For example, one interviewee stated:

  "You would not want just anyone to edit data sets or leave comments about edits that need to be made. This could make other users doubt the data and would create more work for individuals that have to validate and check this information, when they are already struggling to keep up."

- **Challenges encountered by natural capital data users:** When asked about the key gaps and challenges that they encountered in using data sets, products, tools and sources in their assessments, the top reason respondents gave was the difficulty in locating the information that they needed. This was confirmed in the interviews that highlighted the value of developing a hub which at least signposts data sources, with one interviewee stating:

  "Even if the hub just tells us where things are, that would be a good start and could save us time."

- Other reasons, selected by over half of respondents, included a lack of clear guidance regarding which data to use, and a mismatch between the spatial resolution of data and level of decision-making where data is needed.

The interviews probed stakeholders further about potential features of the hub. This included:

- **The use of existing data and hubs:** interviewees agreed that developing a hub could be the impetus for improved collaboration between data providers and users. For example, the hub could realise synergies with other organisations who are seeking to make their data more accessible to the public. It could also build off on-going efforts by organisations that are in the process of developing their own internal hubs e.g. by co-developing one regional hub together, or signposting data that was collated in another hub with a narrower scope, within a more inclusive regional hub.
- **Data discovery**: Interviewees recognised that having an adequate and systematic process for discovering new data to feed into a hub was crucial to maintaining its relevance, usefulness and integrity. There was also consensus among interviewees that data discovery should also include clear licensing terms to be managed by the hub manager. Nearly all interviewees agreed that a hub would help them with their daily monitoring and enforcement activities as it would reduce the time spent searching for data, thereby confirming the importance of data discovery:

> *"If there is a hub which gives consistency in the data used and becomes recognised at the wider sub-regional level, we would use it"*

- **Analytical capability:** Interviewees were presented with different attributes and functions of possible hub specifications for discussion. The key hub options that emerged included a hub which simply signposted data, a repository that subsumed data, a hub with the option to visualise and layer data via an interactive web map, and more analytical hubs that could take users through various stages of a natural capital assessment including monetary valuation.

  Interviewees recognised the important trade-offs between different hub options during the discussion, for example:

  The majority of interviewees' assessments involved a combination of numerical outputs, written reports and maps. This would support the development of an all-encompassing hub with a repository, interactive map and analytical tool to assess changes in ecosystem services in physical and monetary terms. However, interviewees agreed that it may not be feasible to develop this hub and meet the plethora of user needs and applications that exist. They also recognised that developing such a hub would be significantly more expensive than simpler versions and therefore less likely to be developed and adequately maintained.

  Users favoured the idea of a multi-topic hub over a single-topic hub. While they felt the latter would allow deeper coverage of data, they also felt the hub could usefully cover various applications and user types even if it only signposted data. A number of interviewees raised the idea of potentially staging the development of a hub, starting with a generalised hub that signposts available data, then moving to a more specialised and analytical hub over time. Overall, the most favoured hub option by users was a local or regional repository from which definitive versions of data sets and data products could be obtained and where the data licencing would be managed by a hub manager. This was followed by a hub that had an interactive web map for users to view and overlay data.

- **Ownership and funding:** Interviewees were uncertain when the issue of funding the hub was discussed. Some felt that a hub run on a commercial basis is more likely to promote the longevity of the hub and would be more accountable to users. Others thought that an existing local government online observatory would be most useful and less costly as the infrastructure is already present. There was no clear consensus on what type of organisation should own the hub but interviewees were of the view that free access to the hub was an important driver in their decision to use a hub, with one interviewees stating:

  > *"We do not mind who owns the hub or whether there is a hub manager. The key thing for us is being able to access to the hub"*

- **Accessibility:** It was widely agreed that while an offline hub could enable remote working, it would require syncing with new data updates regularly and would be difficult to automate. An online hub was therefore considered to be more feasible.

4. Assessment of natural capital data hub options

This section sets out the approach and results from the assessment of the feasibility of natural capital data hub options. The scope of the assessment is outlined based on criteria that influence the feasibility of different options that were identified during the stakeholder interviews. Following this, each option is defined and assessed based on its strengths, weaknesses, opportunities and threats; known as SWOT analysis.

The following options are assessed and summarised in Figure 4.1:

- Option 1 – Data discovery and signposting service
- Option 2 – Data repository
- Option 3 – Visual hub with interactive web map
  a. Interactive web map
  b. Interactive web map with download function
  c. Interactive web map with download and data capture functions
- Option 4 – Analytical hub to formally assess natural capital (no web map)
  a. Offline natural capital assessment tool supported by an online data hub
  b. Online natural capital assessment methodology
  c. Offline data service
- Option 5 – Web map with additional analytical functionality
  a. Web map with extended GIS functionality
  b. Web map with embedded natural capital assessment capability

Figure 4.1: Summary of hub options

Hub features	Hub options										
	1	2	3a	3b	3c	4a		4b		4c	5a	5b
Signposting	X		X			X		X				
Repository		X		X	X		X		X			
Web map			X	X	X						X	X
Data capture					X							
Offline tool						X	X					
Online tool								X	X		X	X
Offline data service										X		

It is important to recognise that regardless of which hub option is selected, there may be value in first undertaking an initial preparatory exercise: LNPs could start by developing a sub-regional natural

capital asset register (an inventory of indicators of the extent and condition of natural capital), using available data, which is the first step of a natural capital account. This could:

- Provide an initial baseline, using available data, against which future changes in the state of natural capital can be assessed;
- Identify where there are specific local / regional data gaps, particularly where new data is required;
- Begin to identify where investments in natural capital are needed (where it is in poor condition) or where there are opportunities to enhance natural capital to deliver a wider range of benefits / or to maximise the benefits;
- More clearly demonstrate the links between the condition of natural capital and the value of the benefits that it provides. This can in turn stimulate more active engagement and connection of stakeholders to their environment;
- Help upskill potential hub users by engaging them in the process; and
- Better inform the selection of a hub option.

4.1 Scope and approach

The range of hub options that are assessed consist of different combinations of the following steps that a hub could fulfil:

1. **Data discovery:** the process of identifying and maintaining an up to date evidence and database to underpin the hub which is crucial to maintaining the use and relevance of a hub;
2. **Data curation:** the process of tailoring the data identified to the target users, scope, objectives and intended applications of a hub. This could include the development of new data products, amendments to existing data, etc.;
3. **Analysis and visualisation:** the process of designing a hub including the capacity to signpost, be a repository, analyse data and produce outputs;
4. **Dissemination:** the process of making a hub accessible to target users
5. **Feedback:** the process of receiving and acting on feedback from users and data providers to maintain and improve the performance of the hub especially in informing (2) and (3).

The assessment of options highlights the strengths and weaknesses that are inherent to each option based on knowledge of the functionality of hubs, natural capital assessments, the availability of data (Section 2), and user needs (Section 2.1.1 and 3). The opportunities and threats of each option are assessed in relation to potential up-take, usefulness and relevance of options.

The SWOT analysis of options is undertaken with reference to following criteria which differs across options:

1. Stakeholders:

- Public, private and third sector users of a hub.
- The funders, owners and/or managers of a hub.
- Decision-makers who may use evidence from a hub in their assessments and decisions.

2. Suitability for local decision-making:

- The ability of a hub to provide access to high-resolution data to enable local assessments and decision-making.

3. Financial aspects:

- One-off costs for developing a hub.
- Annual operational costs for maintaining a hub.

- The potential to charge users to access a hub[9].

4. Timescales:

- For developing and rolling-out a hub, noting that it is possible for data needs to shift while the hub is in development due to policy and other drivers.
- Short-term: 6 months to 1 year
- Medium-term: Up to 2 years
- Long-term: Up to 5 years

5. Mechanism for amending data

- Whether and how users can make or request amendments to data because of errors or local changes.
- Whether a hub could help replace BARS (Biodiversity Action Reporting System)[10] by having users submit a change to data in a log or spatially delineating the change in terms of change in land cover.

In addition to these criteria, four possible permutations are considered possible for each hub option based on the following characteristics:

- **Single-topic hub:** a hub that covers one topic or one of the 25 YEP goals e.g. the Environment Agency's Catchment Data Explorer;
- **Multi-topic hub:** a hub that covers more than one topic or more than one of the 25 YEP goals e.g. the Defra Statistics which cover the environment as a whole**;**
- **Online hub:** a hub that requires internet access to be used e.g. the University of Exeter's Outdoor Recreation Valuation (ORVaL) tool; and
- **Offline hub:** a hub that does not require internet access to be used but that may be synced with updates to the central version of the hub periodically e.g. the Natural Capital Planning Tool**.**

The strengths and weaknesses of these characteristics are common across different hub options, whereby:

- **Single-topic hub:** a hub that covers one topic will be useful to a smaller number of stakeholders but will be less costly to set up and maintain;
- **Multi-topic hub:** a hub that covers more than one topic will be useful to a larger number of stakeholders but will be more costly to set up and maintain;
- **Online hub:** a hub that requires internet access to be used and does not require manual syncing periodically;
- **Offline hub:** a hub that does not require internet access (i.e. users may use it offline) but that will require manual syncing to the central version of the hub periodically.

Because of this commonality across options, these characteristics do not carry as much weight in the assessment of hub options as other considerations above. For this reason, and for ease of comparison, the hub options evaluated in the sub-sections that follow are not split on the basis of these characteristics.

[9] Charging for access to a hub affects the licensing of the hub because it involves re-selling the data in the hub. If this were to be implemented for any options, it would need to be clear to users and data providers that the charge was financing the infrastructure and maintenance of the hub, not the underlying data (which is owned and made available by other organisations).
[10] The Biodiversity Action Reporting System (BARS) was a web-based information system that supported the planning, monitoring and reporting requirements of national and local Biodiversity Action Plans (BAPs). BARS was available free of charge to all members of the wider BAP partnership and enabled parties involved in BAP implementation to enter action plans and record progress towards targets and actions.

4.2 Option 1 – Data discovery and signposting service

4.2.1 Definition

This is the simplest functionality that a hub could have. A discovery and signposting hub would alert users to the publication of data sets and provide them with information on how to find metadata to allow them to evaluate the data sets themselves and how they can be obtained for use. A hub of this type could be single-topic, concentrating on a specific area of natural capital or multi-topic, aiming to signpost data from a range of natural capital interest areas.

A discovery and signposting hub could utilise a range of different infrastructures. There is currently no comprehensive way to automate the discovery element and so it would need to be supported by a human resource that could not only undertake a range of online searches for new data, but would also maintain a network of contacts within the natural capital space to allow horizon scanning for new data sets. The signposting functionality of this model could be achieved through actively circulating information to a pre-subscribed user base using newsletters, emails or other notifications or it could be passive, requiring users to access a website or periodically updated information sheet.

The utility of a signposting hub may be increased significantly by the addition of a tool, which provides information on which data sets and products can be used to inform natural capital assessments of different sorts and at different spatial resolutions. Medcalf et al. (2014) designed a Bayesian Decision Network for the Join Nature Conservation Committee (JNCC) that fulfils this function for ecosystem service assessment and is available online. Similarly, the Natural Capital Coalition, together with UNEP-WCMC, is developing a natural capital data kit[11] for businesses wishing to apply the Natural Capital Protocol. This is being developed in light of feedback from the 50 or so businesses who piloted the Natural Capital Protocol and indicated that the lack readily available robust data for decision making was often a barrier for understanding and managing their impacts and dependencies on natural capital. This is, however, likely to be a global system and therefore its applicability to users operating at localised scales in the UK remains to be seen.

[11] See https://naturalcapitalcoalition.org/projects/data-kit/

4.2.2 Assessment

Strengths	Weaknesses
• Gives users flexibility to assess the suitability of data for their specific use. • May save time and resources for users already engaged in some form of natural capital assessment in the broadest sense. • Has a low start-up cost for hub owners / managers. • The on-going cost of maintaining the hub infrastructure is potentially low. • A hub of this type could be developed in the short-term. • As the hub does not actually serve data, there are no licencing implications of charging a subscription for access to the hub.	• It does not support users that do not have the ability to download, visualise or analyse data locally. • There is no curation of the data for specific purposes e.g. to assess the extent of natural capital. • It is up to users to clarify data licensing terms with data providers. • There is no obvious mechanism for handling errors in data detected by users. After signposting, users have a direct relationship with the data provider. • No new data products would be created within the hub because it is merely signposting existing data.
Opportunities	**Threats**
• A hub of this type would clearly meet the need of one cohort of potential users; those that already access natural capital data and currently spend significant time and effort in identifying and sourcing data. • A signposting hub could establish itself as a desirable place for data providers to promote data sets.	• The human resource necessary to maintain this type of hub could easily be underestimated by non-specialist stakeholders. • The hub would need to quickly establish a reputation for signposting new data in a timely and comprehensive way to maintain its relevance, or it would risk being abandoned by users. • The hub would not help fill existing gaps in the evidence base particularly for local assessments (by creating new data products) as identified in the data review (Section 2). It may therefore not add value for users who are looking for local data at a fine resolution.

4.2.3 Concluding remarks

There was strong evidence in both the questionnaire and the subsequent interviews that a leading obstacle to the use of data in natural capital assessments was uncertainty about how to locate appropriate data. The engagement with data users also highlighted the wide range of applications and approaches that a hub may need to cater to. This suggests the need for a hub to facilitate access to the widest possible range of data. Given this and the relatively low resource requirement, the feasibility of Option 1 would seem to be relatively high. There is also evidence that the utility of this option would be enhanced by the addition of a tool or expert system to inform users of appropriate uses of each data set or product signposted.

This option was popular with the cohort of interviewees that already undertake natural capital assessment in some form, however, the lack of a means of visualising data online excludes its use by the cohort that currently has no access to GIS or other means of data visualisation.

It is important to note that a number of respondents indicated that they would only continue to use a discovery and signposting hub if it was seen to be both comprehensive and current in its content. There are though several other signposting hubs in this field. One way to make a new hub distinct would be to signpost *local* data effectively. However, this option would not help fill gaps in the local evidence base, as it does not entail the development of new data products. It would also not allow users to request amendments or edits to data sets or products, which was an important feature to interviewees. On the whole, this option would add value by identifying what data is available, but it would not necessarily promote improvements in existing data or help in recognising the need to develop new data.

4.3 Option 2 – Data repository

4.3.1 Definition

A data repository would augment Option 1 (data discovery and signposting services) with the facility for users to download data directly from the hub. Under this option, it would be a matter of policy whether data sets or products would be signposted if they could not be held directly.

As with the Option 1, the option could be either single-topic of multi topic, though whilst the technology would remain similar in each case, both the human and technical resources required would increase significantly for a multi-topic hub. A hub of this type could in principle be an offline entity; indeed internally many Local Authorities seem to request and receive data internally via email rather than through an internal tool or intranet GIS application. It would seem more efficient, however, for this model to be delivered as an online hub.

The addition of a tool as described in Option 1, to provide information on which data sets and products can be used to inform natural capital assessments (of different sorts and at different spatial resolutions), could equally enhance the functionality of a data repository.

A data repository would have two additional elements of functionality not required in Option 1:

1. The curation of data sets and products; and
2. The ability to serve them to users.

Data set curation is an offline activity requiring significant human resource. Before a data set or product can be mounted on a data repository, the hub owners and/or managers would need to contact the data owner or custodian, establish permission to make the data available, clarify any data licencing issues, and agree procedures for obtaining and identifying new versions of that given data set or product.

Traditional approaches to data dissemination have relied on email, file transfer sites and the physical distribution of memory devices. Sometimes these approaches are still necessary when transferring very large data sets now associated with remote sensing applications. But most data can now be reliably served online in a number of formats. Data is most commonly made available as either a comma separated file (compatible with Excel) or an ESRI shape file (compatible with most GIS systems). Web Map Services (WMS) and Web Feature Services (WFS) are growing in popularity as is the practice of providing data as an API for use in user applications.

4.3.2 Assessment

Strengths	Weaknesses
• May save time and resources for users already engaged in some form of natural capital assessment in the broadest sense. • May reduce obstacles to engaging in natural capital assessment for some potential users. • Data licencing issues are clarified for the user through curation activities. • Some degree of validation and verification of the data set can be incorporated within data curation (e.g. checking GIS layer topological integrity). • Error correction can be incorporated as part of the curation process. • Has a low to medium start-up cost for hub owners / managers. • A hub of this type could be developed in the short-term.	• It does not support users that do not have the ability to download, visualise or analyse data locally. • While a repository could provide access to local data that was previously not available online, it would not necessarily involve the creation of new data products within the hub because it is merely making existing data available to users.
Opportunities	**Threats**
• There is the opportunity to tailor the data held by the data repository to the specific needs of its users. • A data repository could hold local data sets not currently held online elsewhere and identified as a gap in the data review (Section 2).	• The human resource necessary to maintain this type of hub could easily be underestimated by non-specialist stakeholders. • The hub would need to quickly establish a reputation for identifying and serving users with new data in a timely and comprehensive way to maintain its relevance, or it would risk being abandoned by users.

4.3.3 Concluding remarks

This option was clearly the preferred option of most of the respondents that already undertake natural capital assessments as, in addition to the benefits outlined in Option 1, it also has the potential to reduce the resources required to undertake natural capital assessments by making the process of data collation simpler. As this is also a relatively low resource option, with the potential to utilise existing infrastructure, it may also be a feasible and attractive option.

It also shares many of the drawbacks of Option 1. This hub option could be made distinctive by investing the resources in on-going hub management to allow effective administration and curation of data (to ensure potential resource savings are made by users) and potentially in the production of appropriate and highly usable data products from raw data sets. This would have most impact in respect to developing local data products that have full coverage of the LNP geographies.

Overall, choosing Option 2 over Option 1 may only make a difference to a small cohort of users. Moreover, the utility of Option 2 may not be sufficiently greater than Option 1, for the limited cohort that would use it, to warrant the additional expenditure in developing it.

4.4 Option 3 – Visual hub with interactive web map

4.4.1 Definition

A visual hub or a hub with an interactive map is one that contains spatial data sets and data products and allows users to view them in the form of a map or other visual representation. A number of the organisations surveyed during the project currently operate an offline hub for generating visualisations from data and many others use both online and offline infographics for summarising and disseminating natural capital data. For most of those questioned, however, the idea of a visualisation hub is associated with an interactive web map through which users can select, unselect, or layer data sets and data products, such as the Defra Magic Map application[12]. The ability to filter data is common as it is often desirable to group different data sets and data products by theme e.g. river water quality; water scarcity; biodiversity; recreation etc. GIS functionality is usually limited to the ability to interrogate object attributes and control the appearance / formatting of maps and data objects.

A visualisation hub could be single-topic or multi-topic. However, the user interface of such a hub may become unwieldy to use and difficult to interpret if a large number of layers are made available through this technology. For this reason, it may be necessary to constrain users' activity through the design of the interface to improve users' experience. This will of course be at the expense of the flexibility users have to apply the hub in different contexts.

The technology to deliver online interactive maps is well established and has become relatively cost-effective in recent years. The cost of simple implementations of web maps in particular have decreased with the release of products like ESRI online and QGIS Cloud. Whilst the available technology has become cheaper, it has also diversified and for any given web map implementation, there are numerous possible technical infrastructures that could be used to deliver it. A full review of this range of infrastructures is beyond the scope of this study. However, it is possible to consider two different broad approaches:

- A hub could be a single bespoke website that is complete with integral mapping functionality. Indeed, it should be noted that a number of the existing data observatories already have the functionality necessary to achieve this; or
- A hub could enable the creation of online maps that can be embedded simply and at very low cost in one or more existing websites using iFrames. In this way, identical web maps can be available on a whole range of websites and intranets at little additional cost. In this model, curation of data is managed once, but dissemination is from multiple outlets.
- There are at least three possible variants on a visualisation hub identified through the interviews with stakeholders:
- Option 3a: An interactive web map;
- Option 3b: An interactive web map with functionality that allows users to download data to be used locally; and
- Option 3c: An interactive web map with functionality that allows users to download data to be used locally, and with the ability to capture data from users.
- Other variants were not identified as being desirable during the stakeholder interviews. The technology, resources, investment and operational cost to implement these variants increases with their complexity thereby making them infeasible, especially given the lack of user interest.

[12] https://magic.defra.gov.uk/MagicMap.aspx

4.4.2 Assessment of Option 3a – Interactive web map

This option is characterised by a simple interactive web map. A typical example of this form of a hub is The Greater Manchester Open Data Infrastructure Map (GMODIN)[13].

Strengths	Weaknesses
• A hub with visualisation capabilities may engage users that do not currently have access to technology that enables them to visualise data sets and data products. • It may reduce obstacles to engaging in natural capital assessment for some potential users. • It could enable users to explore data including potential topological issues and disparities in the different resolutions of data sets and products. • Data sets and products are carefully curated, validated and verified. • Data licencing issues are clarified for the user through curation activities. • All users have access to the same body of data and versioning of data is managed by the hub. • Error correction can be incorporated as part of the curation process. • Has a low to medium start-up cost for hub owners / managers. • A hub of this type could be developed in the short-term.	• A number of stakeholders currently engaged in natural capital assessment specifically stated that they had no use for a hub of this type because they have the capability and software to map and visualise the data they need for their assessment. • The natural capital data sets and products available on the system may be limited by the human resources available to negotiate appropriate access and post them on the system, thereby limiting the utility of the hub. • The range, scope and spatial resolution that can be viewed are determined by the curation of data and management of the hub.
Opportunities	**Threats**
• There is potential to use existing infrastructures to deliver the hub functionality, including data observatories. • Using available technology, identical web maps could be mounted simultaneously on a range of websites and intranets. • There is an opportunity to engage a cohort of users not currently engaged in natural capital assessment • There is the opportunity to tailor the visualisations to the specific needs of users (though not using existing infrastructures). • A visualisation hub could hold local data sets and products not currently held online elsewhere.	• The hub would need to quickly establish a reputation for identifying new data in a timely and comprehensive way to maintain its relevance, or it would risk being abandoned by users. • It may be difficult to establish the hub as a definitive source of natural capital data for North and East Yorkshire in a crowded field of online maps. • Visualisation hubs do not encourage users to consider the metadata of data sets before considering the visualisation and could lead to misinterpretation of data. • Visualisations may be a helpful step in allowing users to get a sense of the data available for a natural capital assessment. But they do not constitute an assessment in themselves.

[13] https://mappinggm.org.uk/gmodin/#os_maps_light/10/53.5069/-2.3201

4.4.3 Assessment of Option 3b – Interactive web map with download function

A well-known example of this model might be the Defra Magic Map application. Most of the elements of Option 3a also apply to this option. Most of the issues discussed below are, therefore in addition to those identified for Option 3a.

Strengths	Weaknesses
• Has utility for a wider set of users than Option 3a. • Existing users of natural capital data can view and evaluate data before downloading it. • Provides access to visualisations to potential users that currently do not have access to the technology required to visualise natural capital data.	• The range of accessible data available for download or visualisation may be more limited than would be the case for Option 2 (data repository). • Embodies the functionality of both Option 2 and 3a so would be more resource intensive to develop and maintain. • Could only be achieved in the medium term unless existing infrastructures were employed e.g. existing data observatories. • Would be difficult to implement a funding model based on user subscription. • Data licencing might be difficult to manage, as the hub would allow users to use the data via two mode: visualisation and download.
Opportunities	**Threats**
• May promote co-working between those that are currently undertaking natural capital assessment and those that currently have technical barriers to participation.	• If no commercial funding model is available, it would require a strong long-term partnership to meet the increased on-going costs of this option. An example of this is NBN Atlas, which has found it difficult to satisfy the needs of both data providers and users.

4.4.4 Assessment of Option 3c – Interactive web map with download and data capture functions

This option builds on Option 3b with an additional data capture function that allows users to submit their data via an online map. There are a number of examples of this type of hub, including several that have been built using the Indicia toolkit for Drupple developed by the Centre for Ecology and Hydrology's Biological Record Centre (BRC). Recently, the Yorkshire Wildlife Trust has started trialling the implementation of a web map with online data capture, built using ESRI Online, on their intranet[14].

Most of the elements of the assessments of Option 3a and 3b also apply to this option. Most of the issues discussed below are, therefore in addition to those identified for option 3a.

Strengths	Weaknesses
• Allows data to be captured and collated from different users. • Allows people to check existing data and propose amendments or identify omissions.	• Technically more difficult to develop and therefore more likely to be established in the medium term. • Increased functionality will come at an increased cost. • The hub would need to have different levels of access and administration rights for different users depending on whether they would access the hub to visualise data or add data. This would add to the complexity of setting up and maintaining this option. • There would be a need to establish clear protocols for adding data to layers, otherwise the resulting data layer would need significant additional quality assurance. • Data captured from users would need to be quality assured and will probably require some processing before it would be disseminated or widely used. This would help check that data meets the required standards including layer topology. The need for this would probably be underestimated by most non-specialists.
Opportunities	**Threats**
• May promote co-working between those that are currently undertaking natural capital assessment and those that currently have technical barrier to participation. • Could provide a tool to capture information on project that involve investments in natural capital including meeting objectives for biodiversity and environmental net gain. • This would effectively replace the Biodiversity Action Reporting System (BARS). • Opens the door to undertaking GIS for Participation (GISP) activities.	• Whilst some stakeholders mentioned the need to capture data on investments in natural capital (including actions to meet objectives of net biodiversity or environmental gain), none of these stakeholders felt this hub option would be a priority for their organisation, particularly in terms of funding. If no commercial funding model is available, it would require a strong long-term partnership to meet the increased on-going costs of this option.

4.4.5 Concluding remarks

It was clear from the interview process that the idea of a natural capital hub made most stakeholders think an interactive web map. It was also clear that the aspirations and expectations of different users in terms of the data types mounted and the functionality of the hub varied hugely, with surprisingly little consensus. Most respondents that expressed an interest were primarily interested in a web map that met a very specific internal requirement of their organisation. Where more general applications

[14] https://yorkswildlife.maps.arcgis.com/apps/webappviewer/index.html?id=dfa3b2c4a93749389ea3f3ed0fe39588

were mentioned, it was most often in the context of existing data observatories and the potential for those existing hubs to mount a wider range of data.

Further to this, a number of stakeholders already engaged in natural capital assessment specifically stated that they had no use for a hub of this type because they had the capability and software to visualise and map the data they need for their assessment.

In view of this, it may be difficult to devise an implementation of Option 3 that satisfies a sufficiently broad range of needs. Most respondents felt that their organisation was unlikely to financially support a web-mapping application of this sort, in some case due to their existing data observatories. Where some stakeholders indicated that resources may be available, it was clear that the application would need to meet very specific criteria to unlock the funding, which again would arguably not satisfy a broad enough range of user needs to render this option a priority. The fact that a web map can be achieved quickly and with relatively modest resources may be a driver for existing local examples of this form of a hub, rather than the desire to add value.

An unexpected area of consensus among stakeholders was around the idea of a web map that also captured users' data, particularly as a result of investment in natural capital (e.g. habitat creation and restoration). This was clearly linked to, and driven by, the idea of achieving net biodiversity or environment gain and often articulated in relation to a replacement for the Biodiversity Action Reporting System (BARS), which no longer exists.

4.5 Option 4 – Analytical hub to formally assess natural capital (no web map)

4.5.1 Option 4a – Offline natural capital assessment tool supported by an online data hub

4.5.1.1 Definition

This option combines two elements:

- An existing offline tool, owned and managed by a third party, that allows users to undertake a natural capital assessment; and
- A supporting online tool that could either (i) guide users through a set of signposted data sources that they source independently to produce necessary inputs to the above tool (like Option 1 in Section 4.2); or (ii) act as a repository of these data sources (like Option 2 in Section 4.3).

There are a number of offline tools available for use in natural capital assessment that have no spatial interface. These tools are often in the form of macro-enabled spreadsheets, whilst others are bespoke "black box" software products with inflexible user interfaces. These tools do not usually have integrated evidence bases and the user is left to source, format and input the data necessary to undertake analysis. Such is the case for the Natural Capital Planning Tool (NCPT) reviewed in Section 2. In some instances these characteristics could be a barrier to natural capital assessment, especially for non-specialist users. It would be possible to develop an online data hub, which supported a user in employing an offline tool of this type; for example, a hub that gave users access to the data inputs required for the NPCT (listed in Section 2). There are a large number of possible technical approaches and infrastructures to develop a hub that supports users of an offline natural capital assessment tool without an added visual element. It would only be possible to evaluate these in the light of a more specific hub specification.

Though a hub of this type could be single- or multi topic, it more likely to be the former because it is designed to support specific offline tools. The hub would lead users through the use of an offline tool, via a decision tree or expert system to guide them to appropriate sources of input data for each stage of the assessment process. Guidance on how the data should be prepared for input to the offline tool would also be provided e.g. the unit of the area of habitat affected. A further development of this idea might be a repository that subsumes spatial data sets and makes them available to users in the appropriate format as inputs to an offline tool or suite of tools, giving the user the ability to download sub-sets of larger data sets that are appropriate to their needs.

The combined use of a data hub and an existing offline natural capital assessment tool could allow users to do one or all of the following:

- **Quantitatively assess the extent of natural capital assets.** The online hub may signpost or allow users to download relevant data and quantitatively assess the extent of natural capital assets using their own offline GIS software. Metrics calculated could include the area of different habitats, the length of footpaths, etc. and would feed into the offline tool;
- **Quantitatively assess the condition of natural capital assets.** The online hub may signpost or allow users to download relevant data to quantitatively assess the condition of natural capital assets using their own offline software. Metrics calculated could include the number of species in a given study area, the biodiversity metric in a given area (based on the Defra biodiversity metric), the area of land under designations, etc. and would feed into the offline tool;
- **Quantitatively or qualitatively assess the physical flow of ecosystem services delivered by natural capital assets.** If the assessment is qualitative, the offline tool would tell users the ecosystem services delivered by habitat types (that users indicate are in their study area) and how significant they are (low, medium, high). If the assessment is quantitative, users need to input the area and condition of different habitat types in their study area into the offline tool. The tool then estimates the physical flow of ecosystem services in the study area e.g. tonnes of carbon sequestered by habitats; number of visits to habitats;

- **Quantitatively assess the monetary flow of ecosystem services delivered by natural capital assets.** The online hub could signpost or allow users to download monetary unit values for the assessment of environmental impacts. Users can then combine this information, in the user interface of the offline tool, with estimates of the physical flow of ecosystem services to obtain an aggregate monetary value of the flow ecosystem services.

4.5.1.2 Assessment

In many ways, the variants of Option 4 described above could be seen as special cases of Option 1 and Option 2 respectively, however, the close integration of this option with specific offline tools merits its own assessment, as follows:

Strengths	Weaknesses
• The integrated capability of this option is helpful to users that have GIS skills but do not currently undertake natural capital assessments. • Takes advantage of existing offline natural capital assessment tools, many of which are open source and free to use. • Does not require the resources associated with developing a web map (Option 3). • Could be developed in the short- to medium-term.	• Does not provide a mechanism for visualisation without additional processing by users. • Excludes users that do not have GIS skills and software.
Opportunities	**Threats**
• Provides a standardised approach to assess natural capital using a consistent database. • Could allow the routine implementation of natural capital assessment within some administrative processes including some aspects of planning e.g. development screening, where in-house / offline natural capital assessment processes may be preferred.	• The hub would be designed to provide data and information to support the use of a third party tool. There is a risk that the hub would need to be updated very regularly to stay aligned with the development of the tool / tools it supports. • The development of the offline tool would be in the hands of third party organisations. There is a risk that the tool may be discontinued rendering the online data hub obsolete.

4.5.2 Option 4b – Online natural capital assessment methodology

4.5.2.1 Definition

A logical extension to Option 4a is to take a suite of natural capital assessment methodologies or the algorithms from an existing natural capital assessment tool and integrate them within an online data hub, providing users with easy access to both data and the means to undertake natural capital assessments. Again, this could be achieved in a large number of ways and an evaluation of potential online infrastructures would require a more detailed hub specification.

An example of this could use elements of the NCPT in terms of its mechanism for calculating ecosystem service impact scores of different projects as well as its underlying assumptions. This hub option would attempt to replicate this calculation, for example, and provide users with signposted or downloadable data to calculate the inputs and produce the outputs, all within one online entity.

Whilst this may seem to be an attractive idea, it would be technically difficult, requiring a long period of development. Furthermore, it would be challenging to develop a user interface without an element of spatial visualisation (the user would be restricted to describing the locations at which assessments would take place as a point and radius or bounding box). In practice, in order to meet user aspirations for usability, a hub like this would probably need to converge with the hub in Option 5 below.

4.5.2.2 Assessment

Most of the elements of Option 4a also apply to this option. Most of the issues discussed below are, therefore, in addition to those identified for Option 4a.

Strengths	Weaknesses
• Higher level of integration may make use of the hub more efficient and straightforward for users.	• Could not be produced in the short term; this would be a medium- to long-term development. • User interface could be complicated and difficult to make suitable for users with a range of expertise. • Very high investment to support a tool that may end up being useful to a sub-set of data users.
Opportunities	**Threats**
• No additional opportunities beyond those provided by Option 4a.	• High investment cost in development to embed methodologies that are rapidly evolving and changing. • Cost of development is high relative to in-house use of an offline tool and difficult to get a partnership together to support costs with such a specialised application.

4.5.3 Option 4c – Offline data service

This option is an offline natural capital assessment service. It could manage the necessary natural capital data for an area that users would like to assess and undertakes natural capital assessments within that area upon request. There is at least one example of this option, offered by an organisation called eCountability[15], subject to a user subscription fee. A hub option along these lines would not add value beyond this existing option, and it is therefore not assessed further.

[15] See http://ecountability.co.uk/

4.5.4 Concluding remarks

Whilst this is an option that is suggested and implied by the consideration of the NCPT, none of the stakeholders interviewed made reference to a tool that fulfilled the functions offered by Option 4. The feeling amongst stakeholders was that a hub which relies on a single tool or analytical approach would not be able to meet the plethora of user needs and context.

Further, as the development costs of this option would be relatively high, it would likely only be feasible for a single organisation (whose needs it would meet) with a very high investment and commitment to a single natural capital assessment tool or methodology.

4.6 Option 5 – Web map with additional analytical functionality

This option builds on Option 3 (visual hub with interactive web map) by adding analytical capability to provide various levels of added functionality. This could include extending the GIS capability of a web map to allow users to more fully interrogate or manipulate attributes of the existing data layers. A more advanced interpretation of this option would embed workflows or methodologies from recognised natural capital assessment approaches, so that users could undertake more complicated analyses, and possibly produce new data products.

4.6.1 Option 5a – Web map with extended GIS functionality

4.6.1.1 Definition

In its most basic form, this option could extend the visualisation capability of the web map in Option 3 to include added GIS functionality. This would allow users to interrogate the attributes of mapped layers and carry out basic quantitative procedures like area calculations, the summation of attribute values or attributes of all the objects on one layer that fall within a boundary on a different layer. This functionality could allow users to do one or all of the following:

- **Quantitatively assess the extent of natural capital assets.** The hub would allow users to determine the area of different habitats, the length of footpaths, etc. in their study area;
- **Quantitatively assess the condition of natural capital assets.** The hub would allow users to determine the condition of different habitats based on the available data. This could include species counts, the area of land under designations, etc. The GIS capability of the web map may be enhanced further to allow simple manipulations to be performed on data attributes and the resultant outputs to be thematically mapped;
- **Qualitatively assess the physical flow of ecosystem services delivered by natural capital assets.** Based on extent and condition of natural capital in users' study areas, determined in preceding steps, the hub would tell users the ecosystem services delivered by habitat types and how significant they are (low, medium, high).

GIS functions could be available for users to apply to all data at will within the hub's web map system, giving users an explorative experience. Alternatively, GIS functions could be set to perform specific operations on a subset of layers and attributes. As the degree of freedom and flexibility available to users increase, so would the complexity and cost of developing and maintaining this hub option. The functionality of this option would therefore need to be carefully tailored to the needs of the target user group.

4.6.1.2 Assessment

Strengths	Weaknesses
• A hub with visualisation capabilities may engage users that do not currently have access to technology that enables them to visualise data sets and data products. • It could enable users to explore data including potential topological issues and disparities in the different resolutions of data sets and products. • Allows users with no access to GIS to interactively interrogate data more fully than a basic web map (Option 3). • Data sets and products are carefully curated, validated and verified. • Data licencing issues are clarified for the user through curation activities. • All users have access to the same body of data and versioning of data is managed by the hub. • Reduces the risk of misinterpretation of data by allowing more rigorous exploration of the data. • Could facilitate group understanding and interrogation of a shared evidence base.	• Many experienced users would prefer to interrogate data in their own GIS environments. For them, this functionality is redundant. • The natural capital data sets and products available on the system may be limited by the human resources available to negotiate appropriate access and post them on the system, thereby limiting the utility of the hub. • Requires significantly more resources to be invested. • The range, scope and spatial resolution that can be viewed are determined by the curation of data and management of the hub. • Likely to be at least a medium-term option, as detailed consultation would be necessary to identify the appropriate functionality to embed in the hub.
Opportunities	**Threats**
• There is an opportunity to engage a cohort of users not currently engaged in natural capital assessment • To increase the analytical and GIS awareness of a broad range of users.	• The hub would need to quickly establish a reputation for identifying new data in a timely and comprehensive way to maintain its relevance, or it would risk being abandoned by users. • Visualisation hubs do not encourage users to consider the metadata of data sets before considering the visualisation and could lead to misinterpretation of data, although to a lesser degree than Option 3. • The lack of standardisation of GIS products may make this model difficult to implement or require significant pre-processing of data before it is posted on the hub. This may limit the number and range of data sets and products on the hub. • Providing desktop GIS and appropriate training for potential hub users may be a more attractive to some organisations than investing in this option.

4.6.2 Option 5b – Web map with embedded natural capital assessment capability

It would also be possible to embed functionality from a recognised natural capital assessment methodology or tool within a web map hub. This is analogous to embedding a GIS workflow into the hub, though the analytical processes may be carried out with a range of technologies.

In order for this option to be clearly differentiated from Option 5a, the hub would need the capacity for users to input spatial or non-spatial information, either as whole input data sets (most likely shapefiles or spreadsheet CSV files) or input data in response to a prompt, made by a user interface within the hub. The hub would perform an analysis on the input data. The resulting data product could be displayed on the web map within the hub. The facility to download the resultant data product could also be developed with additional resources.

In this sense, this option combines elements from Option 3a (interactive map) and Option 4b (online natural capital assessment methodology) as it consists of an online natural capital assessment tool supported by an online web map. The hub would overlap with existing tools such as the Natural Environment Valuation Online (NEVO) Tool which is currently in development by the University of Exeter. The difference between Option 5b and 5a, is that the former requires users to input data to visualise it on the hub whereas the latter incorporates necessary data into the hub already.

This option would allow users to do one or all of the following:

- **Quantitatively assess the extent of natural capital assets.** The hub would allow users to upload relevant data, which could be displayed on the hub's web map, but would ultimately be used to quantitatively assess the extent of natural capital assets in users' study areas. Metrics calculated could include the area of different habitats, the length of footpaths, etc. and would feed into the offline tool;
- **Quantitatively assess the condition of natural capital assets.** The hub would allow users to upload relevant data, which could be displayed on the hub's web map, but would ultimately be used to quantitatively assess the condition of natural capital assets in users' study areas. Metrics calculated could include the number of species in a given study area, the biodiversity metric in a given area (based on the Defra biodiversity metric), the area of land under designations, etc. and would feed into the offline tool;
- **Quantitatively assess the physical flow of ecosystem services delivered by natural capital assets.** Users would need to input the area and condition of different habitat types in their study area, determined in preceding steps, in the hub's user interface. The hub would then estimate the physical flow of ecosystem services in the study area e.g. tonnes of carbon sequestered by habitats; number of visits to habitats; etc.;
- **Quantitatively assess the monetary flow of ecosystem services delivered by natural capital assets.** Based on the physical flow of ecosystem services in the preceding step, the hub would estimate the monetary value of this flow using monetary value evidence embedded in the hub. This would use the physical flow of ecosystem or the area of habitats in users' study area depending on the units that monetary evidence is expressed in (e.g. £ per visit or £ per tonne of carbon dioxide equivalent as opposed to £ per ha).
- The on-going resources necessary to maintain a hub of this type would be significant. The requirements would extend to maintaining the currency and integrity a complicated online infrastructure and the on-going curation of relevant data.

4.6.2.1 Assessment

Strengths	Weaknesses
• A hub with visualisation capabilities may engage users that do not currently have access to technology that enables them to visualise data sets and data products. • May reduce current obstacles to undertaking natural capital assessment. • May reduce the amount of specialist knowledge required by staff undertaking natural capital assessments. • May allow "what-if" scenarios to be considered. • May lead to standardisation in approach to natural capital assessment.	• Resource intensive to develop. • Would be a medium- to long-term option. • Limits the range of natural capital assessment methodologies that can be applied. • Difficult to agree on methodologies to be embedded in the hub. • Lack of agreed analysis standards both locally and nationally. • Difficult to accommodate analyses at different spatial scales. • Expensive and difficult to update as new methodologies and user needs emerge.
Opportunities	**Threats**
• Potential to facilitate assessments across administrative boundaries. • Potential to engage a wider range of people in quantitative natural capital assessments. • Potential to drive the collection of new natural capital data sets.	• Many organisations are focused on local, bespoke natural capital assessments. • Many organisations currently require a range of natural capital related assessments at a range of spatial scales. • Little consensus on future direction of natural capital assessment across different user groups may mean that this option is not inclusive to all users. • Risk of advocating a formulaic approach for the range of dynamic questions that need to be answered. • May undermine the position of current experts, leading to opposition. • Lack of stakeholder willingness to invest in embedded analysis tools. • Would require a very strong partnership or clear funding model to meet on-going maintenance and development needs. • State-of-the-art of natural capital assessment and upskilling of data users may move more quickly than the development of this option thereby making it obsolete before it is complete.

4.6.3 Concluding remarks

- Whilst the variants of Option 5 are technically possible, there was little demand for this level of sophistication from any of the stakeholders interviewed. The wide range of applications that respondents expressed interest in would make what is a significant technical challenge even more problematic, as it would require significant work to hone a sufficiently detailed specification to operationalise the hub.
- A number of respondents commented that they would rather see investment in increasing access and awareness for existing data and filling key data gaps. This is because they felt that developing a highly analytical and data-hungry hub in the absence of (local) data required would not be sensible. It follows the Option 5a and Option 5b would likely only be feasible if new data were to be collected to fill existing gaps.
- Furthermore, the availability of low-cost, highly competent GIS systems coupled with the increasing number of graduates with GIS and coding skills, and the increased rate of roll-out of GIS within organisations may render the development of a hub of this level of sophistication infeasible.

5. Conclusions and recommendations

This section sets out the key findings for the project including the implications and recommendations for further research.

5.1 Data availability

The review of available data for natural capital assessment revealed a significant volume of national data but, equally, significant gaps in local data at higher resolutions. Where data is available, it is often not readily accessible, or requires substantial processing. In many cases, this means a sub-regional assessment of the baseline and progress towards the 25 YEP goals is not currently possible.

There is a clear divide between data sets and products with a spatial resolution that allows natural capital to be assessed for broad strategic versus operational purposes. It is not possible to categorically state the data resolution required to undertake local assessments, however this is likely to be at least at a 1 km^2 resolution.

There is a great deal of data available to download with spatial resolutions adequate to inform strategic scale natural capital assessment. They tend to have:

- Free access for non-commercial and commercial use;
- Full geographical coverage of the region;
- A format that would require minimal post-processing before it could be mounted on an online hub; and
- Sufficient metadata.

Much of this data, however, is already available through existing hubs including the Government's '*Find Open Data'* page[16], the Defra Magic Maps application and local data observatories, thereby limiting the utility of a new hub. However, the current difficulty in correcting errors and amending these national data sets and products, because of local differences, supports the availability of this function if a hub were to be developed.

In developing a hub, there is also an opportunity to improve existing data such the Priority Habitat Inventory. However, this would need to be done in coordination with data providers and would require additional investment. There are also new technologies emerging that could form the basis of new data sets and data products that would help to facilitate natural capital assessment at the operational level, however, these would require strategic adoption and significant assessment.

Generally, it is possible to collate existing data and create new data products in the context of a data hub. However, any such efforts need to be mindful of:

- Potential policy and legislative changes that could affect user needs. This includes, for example, the likelihood that biodiversity net gain (and eventually environmental net gain) will be made mandatory for all new developments and follow-up actions by the Government in response to the Natural Capital Committee's Sixth State of Natural Capital Report (NCC, 2019) which may provide an impetus for stakeholders to routinely compile natural capital asset registers and account for their impacts on natural capital using standardised metrics and approaches. Until then, there is a need to train and upskill data users, who currently only assess specific aspects of natural capital, to enable them conduct more holistic assessments.
- The historic reliance on ad-hoc funding for specific projects, which favours novelty solutions as opposed to continuous and planned investments in the development of standardised tools and solutions. In light of this, if a hub were to be developed, it would be crucial to assess the likely level of funding available to keep the hub relevant and useful for users but also to keep data collection activities going.

[16] See https://data.gov.uk/

While there is also a range of natural capital assessment tools that are freely available, the outputs generated by these tools are only as good as the data inputs that they require. In light of the limited local data that this project has been able to identify, these tools may be of limited use until more complete data at sub-regional and local scales becomes available. The varying complexity of these assessment tools would require significant investment to embed them in an online hub environment. This includes maintaining the currency of the system both in terms of its technology and the availability of input data.

5.2 User needs

Engagement with data users and potential users of a natural capital data hub within this project revealed that most users assessed impacts on natural capital in the different contexts presented to them, with only 3% stating otherwise. This suggests the potential relevance and utility of developing a hub to facilitate such assessments. It is important to note though that most users did not undertake formal and comprehensive of assessments of natural capital. This is possibly due to the lack of policy drivers, but also due to challenges they face in relation to data availability within their organisations. For example, some organisations do not have access to GIS software, no longer collect data internally, or no longer subscribe to external data services. In this context, the potential development of a hub is seen by stakeholders as a way to meet their internal needs in a cost-effective way from their organisation's perspective. It follows that none of the stakeholders contacted during the project thought that their organisation would be willing to invest in a hub that formally assessed natural capital.

Stakeholders were generally split between those that had the expertise and tools to undertake spatial analysis and those that did not. Broadly speaking, these two groups favoured very different hub functionality. Specialists tended to favour hub options that either signposted or hosted data (repositories). Non-specialists tended to favour hub options that allowed them to visualise data via an interactive web map.

5.3 Feasibility of a hub

The analysis of feedback from stakeholders suggested a range of potential hub options that have been categorised as follows:

- Option 1 – Data discovery and signposting service
- Option 2 – Data repository
- Option 3 – Visual hub with interactive web map
    a. Interactive web map
    b. Interactive web map with download function
    c. Interactive web map with download and data capture functions
- Option 4 – Analytical hub to formally assess natural capital (no web map)
    a. Offline natural capital assessment tool supported by an online data hub
    b. Online natural capital assessment methodology
    c. Offline data service
- Option 5 – Web map with additional analytical functionality
    a. Web map with extended GIS functionality
    b. Web map with embedded natural capital assessment capability

The evaluation of the options considered a number of important factors, including:

- Stakeholder needs and interests (as described above);
- The suitability of data within the hub to be used for local decision-making (as described above);
- Financial aspects including the cost of developing and maintaining the hub;
- The timescales for developing the hub; and
- The mechanism for discovering and curating new data as well as amending existing data e.g. where an investment in natural capital has taken place such as habitat creation.
- It is, however, important to note that the feasibility of most of the hub options was found to depend on factors that were not intrinsic to the options themselves, including:
- The need for a financial commitment to ensuring timely and continuous data discovery to maintain the relevance and integrity of the hub;
- The collation or collection of existing local data to make it available to hub users;
- The influence of policy drivers and developments on other initiatives to make data more accessible to users, as mentioned above;
- In comparing the different hub options, it would seem that the most feasible options would:
- Allow users to save time and effort in collating, processing and/or analysing data;
- Be reliable and identify current data, clear licensing terms and reliable outputs; and
- Address gaps in the coverage of data, models and tools available elsewhere.

In terms of the specific options assessed, stakeholders that already had GIS skills tended to favour a signposting service or a repository (Option 1 or Option 2) although they consistently recognised the limited availability of local data at a resolved scale. Most users intuitively thought of an interactive web map (Option 3) when they thought of a natural capital data hub. However, users with GIS skills felt this option would be of limited utility and other non-specialist users felt that this option would not add significant value to Option 1 or 2 given that it would duplicate the functionality provided by the Defra Magic Map application, among other examples. There was little support among stakeholders for more analytical options (Option 4 and 5) as they felt that the most pressing priority was to make it clear to users what data is available (via Option 1 or 2) rather than developing or promoting the use of a certain analytical approach for which the necessary input data was not fully available. The lack of demand coupled with the high resource requirement of these two options means that they are not likely to be currently feasible based on the findings from this study. Stakeholders also recognised the need to increase knowledge and skills among potential users before Option 4 or Option 5 could be developed and used.

5.4 Recommendations and next steps

Overall, the SWOT analysis, coupled with findings from other tasks suggests that currently the most feasible hub options are a signposting service (Option 1) or a repository (Option 2). However, these options would likely only add value to an existing hub if they included efforts to improve the quality of local data. Option 2 may arguably save users more time than Option 1, as it would put the onus of managing licensing terms on the hub manager. It may also be possible to add a web map to Option 2 at relatively low cost, thereby effectively making it Option 3b. This would avoid excluding non-specialists that do not have access to GIS software. A web map may however present the risk of non-specialist users misinterpreting visual representations without recourse to the underlying metadata. It is likely that this option can be achieved in the medium-term i.e. within a two-year period. It is important to note that securing sufficient funding to allow for regular data discovery and curation will be crucial to the success and uptake of any hub option.

It is recommended that if the preferred hub option is identified, further detailed engagement should be undertaken with the following stakeholders, to definitively decide on that option and develop a full hub specification:

- Data providers to understand the extent of local data available in more detail;
- Other hub developers and managers such as the Environment Agency and the Centre for Ecology and Hydrology to understand their existing and on-going initiatives in the natural capital space. This would help identify lessons learnt, potential synergies and opportunities for collaboration; and
- Potential hub users to understand their detailed needs in relation to the selected hub option.

In the spirit of collaboration and timing, it also recommended that any sub-regional initiatives to develop a hub should recognise the impending major policy developments that could significantly affect the need for natural capital assessments, the availability of data, the development of other related initiatives and any sub-regional actions in this space. These policy developments include:

- The potential for the 25 YEP to gain a statutory footing in the forthcoming Environment Bill;
- The potential for the objectives of achieving biodiversity net gain and possibly environmental net gain to become mandatory requirements for built developments; and
- The extent and speed with which the Government responds to the recommendations of the Natural Capital Committee in their Sixth State of Natural Capital Report (NCC, 2019).

In the meantime, progress can be made in the region by training and upskilling non-specialists so they can effectively contribute to and maintain natural capital monitoring efforts. This can be done by starting with an initial preparatory exercise of developing a natural capital asset register for the region. The process can help them begin to see the environment as an asset that provides benefits to wider society, rather than a constraint on built development, and to identify gaps where new data may be needed or where specific tools may be helpful.

It also recommended that LNPs engage with the Natural Capital Coalition regarding the *Data Information Flow* project[17]. The Coalition is working with the UN Environment Programme World Conservation Monitoring Centre (UNEP-WCMC) and a broad range of partners to develop a project that will bring together data users, data providers, data funders and academics to explore key data questions over different project phases. While this project is aimed largely at businesses who want to assess their impacts and dependencies on natural capital, it will nevertheless include overlap with the objectives and data contained in any version of a sub-regional natural capital data hub.

[17] See https://naturalcapitalcoalition.org/projects/data-kit/

Glossary

Biodiversity: the variability among living organisms from all sources including, inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part, this includes diversity within species, between species and ecosystems (Convention on Biological Diversity, Article 2).

Broad habitat: a means of classifying ecosystems. The UK National Ecosystem Assessment (UK NEA, 2011) defines ecosystems based upon recognised 'broad habitats' within the UK. These are: (i) coastal margins; (ii) enclosed farmland; (iii) freshwater, wetlands and floodplains; (iv) marine; (v) mountains, moors and heaths; (vi) semi-natural grasslands; (vii) urban (green space); and (viii) woodland.

Data hub: online or offline tool or repository of data sets, products or signposted sources. It is underpinned by primary tools and can include visualisations.

Data products: data derived from two or more raw data sets to convey information about natural capital. A data product could be an output from a natural capital tool.

Data sets: data that captures information on the extent (quantity) and/or condition (quality) of natural capital assets. Raw data usually cannot be disaggregated and typically requires software or processing to make it useable and useful to users.

Ecosystem services: functions and products from nature that can be turned into goods and services with varying degrees of human input.

Ecosystem services approach: a term that is used to describe a framework for analysing how human populations are dependent upon the condition of the natural environment. The approach explicitly recognises that ecosystems and the biological diversity contained within them contribute to individual and social wellbeing.

Natural capital: the elements of nature that directly and indirectly produce value or benefits to people, including ecosystems, species, freshwater, land, minerals, the air and oceans, as well as natural processes and functions (Natural Capital Committee, 2014).

Natural capital assessment: a qualitative and/or quantitative assessment of impacts and/or dependencies on natural capital that includes one or more of the following: (i) an assessment of the extent (quantity) of natural capital assets; (ii) an assessment of the condition (quality) of natural capital assets; (iii) an assessment of physical flow of ecosystem services delivered by natural capital assets; and/or (iv) an assessment of the monetary flow of the ecosystem services delivered by natural capital assets, which could include the cost of maintaining these flows.

Primary tools: tools used to manipulate data and/or data products in an open and flexible way e.g. GIS, CAD, Excel.

(Secondary) visual and/or analytical tools: interfaces that utilise primary tools to process and/or interpret data and present it to users in visual or numerical form. Tools usually follow set workflows or impact pathways embedded within their software.

Sources and/or searchable databases: organisations or websites that provide a variety of data sets, products and/or tools, sometimes in the form of searchable databases.

Visualisations: features and functions of primary and secondary analytical tools, which enable users to spatially visualise raw data sets or data products. This may extend to manipulating the colour, transparency, and style of data and include techniques such as 3D rendering and heat mapping.

References

Centre for Ecology and Hydrology (2017) Natural Capital Metrics. Phase 1 Final Report: Central components. CEH Project NEC06063 [online] available at https://www.ceh.ac.uk/sites/default/files/documents/Natural_Capital_Metrics_project_NEC06063_Final_Report_central_components.pdf [Accessed February 2019].

Defra (2010) Valuing environmental impacts: guidelines for the use of value transfer. https://www.gov.uk/government/publications/valuing-environmental-impacts-guidelines-for-the-use-of-value-transfer [Accessed February 2019]

Defra (2018) Measuring environmental change – draft indicators framework for the 25 Year Environment Plan. Draft for discussion [online] available at https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/766207/indicator-framework-consult-document.pdf [Accessed February 2019].

Defra (2018) Net gain Consultation proposals [online] available at https://consult.defra.gov.uk/land-use/net-gain/supporting_documents/netgainconsultationdocument.pdf [Accessed February 2019]

Defra AQEG (2018) Impacts of Vegetation on Urban Air Pollution. Report of the Defra Air Quality Expert Group [online] available at https://uk-air.defra.gov.uk/assets/documents/reports/cat09/1807251306_180509_Effects_of_vegetation_on_urban_air_pollution_v12_final.pdf [Accessed February 2019].

HM Government (2018) A Green Future: Our 25-Year Plan to Improve the Environment. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/693158/25-year-environment-plan.pdf [Accessed January 2019].

Lusardi, J., Rice, P., Waters, R.D. and Craven, J. (2018). Natural Capital Indicators: for defining and measuring change in natural capital. Natural England Research Report, Number 076 [online] available at http://publications.naturalengland.org.uk/publication/6742480364240896 [Accessed February 2019].

Medcalf, K., Small, N., Finch, C., Williams, J., Blair, T., Haines-Young, R., Potschin, M. & Parker, J., (2014), Further development of a spatial framework for mapping ecosystem services, JNCC Report 514, ISSN 0963 8901 http://jncc.defra.gov.uk/page-6690 [Accessed February 2019].

Millennium Ecosystem Assessment (MEA) (2005) Ecosystems and Human Well-being: General Synthesis. Island Press, Washington, DC.

Ministry of Housing, Communities and Local Government (MHCLG) (2019) National Planning Policy Framework https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/779764/NPPF_Feb_2019_sweb.pdf [Accessed February 2019]

Natural Capital Committee (NCC) (2014) The State of Natural Capital: Restoring our Natural Assets. Second Report to the Economic Affairs Committee. March 2014. https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/516698/ncc-state-natural-capital-second-report.pdf [Accessed January 2019].

Natural Capital Committee (undated) How to do it: a natural capital workbook [online] available at https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/608852/ncc-natural-capital-workbook.pdf [Accessed February 2019].

Natural England (2018) Updating the Defra Biodiversity Metric [online] available at http://publications.naturalengland.org.uk/file/6016536200609792 [Accessed February 2019].

Office of National Statistics (various) Natural Capital Accounts [online] available at https://www.ons.gov.uk/economy/nationalaccounts/uksectoraccounts/methodologies/naturalcapital [Accessed February 2019].

Smyth, M.A., Taylor, E.S., Birnie, R.V., Artz, R.R.E., Dickie, I., Evans, C., Gray, A., Moxey, A., Prior, S., Littlewood, N. and Bonaventura, M. (2015) Developing Peatland Carbon Metrics and Financial Modelling to Inform the Pilot Phase UK Peatland Code. Report to Defra for Project NR0165, Crichton Carbon Centre, Dumfries [online] available at http://sciencesearch.defra.gov.uk/Document.aspx?Document=13239_PeatlandCodemetricsFinalReportforpublication.pdf [Accessed February 2019].

UK National Ecosystem Assessment (UK NEA) (2011). The UK National Ecosystem Assessment: Synthesis of the Key Findings. UNEP-WCMC, Cambridge.

White C, Dunscombe R, Dvarskas A, Eves C, Finisdore J, Kieboom E, Maclean I, Obst C, Rowcroft P & Silcock P. (2015) Developing ecosystem accounts for protected areas in England and Scotland: Main Report. Department for Food, Environment & Rural Affairs/The Scottish Government.

Appendix A – Review criteria

This appendix set out the criteria used for the review of data sets, products, visual and/or analytical tools, and sources and/or searchable databases. The criteria are reported in the table below, along with the instructions provided to the reviewer to provide consistency across the items examined. Criteria in bold are utilised for the review of all items while other criteria are utilised for the review of data sets, products, and sources only.

Criteria	Notes
Data set, product, tool or source name	-
Data set, product, tool or source?	Select from dropdown • Data sets: raw data that usually cannot be disaggregated and typically requires software or processing to make it useable and useful to users; • Data products: data derived from two or more raw data sets to convey information about natural capital. A data product could be an output from a natural capital tool; • Visual and/or analytical tools: interfaces that utilise primary tools to process and/or interpret data and present it to users in visual or numerical form. Tools usually follow set workflows or impact pathways embedded within their software; and • Sources and/or searchable databases: organisations or websites that provide a variety of data sets, products and/or tools, sometimes be in the form of searchable databases.
Ownership	Provide the name of the organisation that owns the data set, product, tool or source
Owner/host sector	Select from drop-down • Academic • Government • NGO/charity • Other • Private
Manager and custodian	Provide the name of the organisation that holds and manages the data set, product, tool or source
Brief description	Describe the data set, product, tool or source i.e. What is it? What does it do? What uses and applications is it intended for?
Links to 25 Year Environment Plan (YEP)	Specify the aspects of the Defra 25 YEP that the data set, product, tool or source relates to • Clean air • Clean and plentiful water • Thriving plants and wildlife • Reduced risk of harm from environmental hazards (flooding, drought, etc.) • Using resources from nature more sustainably and efficiently

Criteria	Notes
	• Enhanced beauty, heritage and engagement with the natural environment • Mitigating and adapting to climate change • Minimising waste • Managing exposure to chemicals • Enhancing biosecurity
Location of data set, product, tool or source	Specify the location and hyperlink where the data set, product, tool or source can be accessed
Geographical scope	Select from drop-down • International • Local • National • Regional (including catchment-level)
Specific location	If the data set, product, tool or source cover specific location, please list them in full. For example, this could be a specific Local Authority, town, river, or catchment area.
Unit of analysis	Describe the unit(s) of analysis used in the data set, product, tool or source. For example, the data could be presented per person, per site, per beach, per tree, per Local Authority etc.
Spatial resolution	Describe the resolution of data e.g. 1 square kilometre
First year of data	Provide the first year when data in the data set, product or source was first entered
Last year of data	Provide the year when data in the data set, product or source was last updated
How frequently is the data in the data set, products, or source updated?	Select from drop-down • Daily • Weekly • Monthly • Quarterly • Bi-annually • Annually • Every two years • Every few years • Sporadically • Never • Not specified
Validation and quality control	Specify how frequently the data set, product or source is validated, verified and quality assured
Validation and quality control	Specify the extent to which the data set, product or source is used in published, peer reviewed case studies
Validation and quality control	Provide any further information related to the validity, quality and credibility of the data set, product or source

Criteria	Notes
Is there a cost associated with accessing the data set, product, tool or source for non-commercial use?	Select from drop-down • Yes • No • Unknown
If yes, how much does it cost to access and use the data set, product, tool or source for non-commercial use?	Specify how much it costs in £ and whether this is a one-off or annual payment
Is the data set, product, tool or source available for commercial use?	Select from drop-down • Yes • No • Unknown
If 'yes' or 'unknown', what conditions are there to access and use the data set, product, tool or source for commercial use? This includes the cost of access in £	Specify the condition of access including how much it costs in £ and whether this is a one-off or annual payment
Software requirements	Specify the software required to view or use the data set, product, tool or source. For example, a tool may require a web browser and spatial data may require GIS software.
Can the data set, product or source be downloaded and modified to combine with other data sets, products or sources?	Select from drop-down • Yes • No
User skills required to access, use and interpret data set, product or source	Select from drop-down • High (advanced skills required) • Medium (some specialist skills required) • Low (no specialist skills required)
Description of user skills	Provide more details on the user skills required such as specific software, technical knowledge, etc.
Mechanism for updating data set, product or source with local changes	Specify whether and how the data set, product or source can be updated with local changes or data sets
Relevant habitat type(s)	Specify which habitat types this data set, product, tool or source is relevant to: • Coastal margins; • Freshwaters, wetlands and floodplains; • Marine; • Enclosed farmland; • Semi-natural grasslands; • Woodland; • Mountains, moors and heaths; • Urban green space

Criteria	Notes
Sub-habitat type	Separate multiple sub-habitats by semi-colons. Sub-habitats types are as follows: - Coastal margins: • coastal dunes and sandy shores; saltmarsh; transitional and coastal waters - Freshwaters, wetlands and floodplains: • standing open waters; rivers and streams; groundwaters; wetlands - Marine: intertidal rock; intertidal sediment; subtidal rock; shallow subtidal sediment; deep sea bed - Enclosed farmland: • enclosed arable farmland - Semi-natural grasslands: • semi-natural grasslands - Woodland: • woodland - Mountains, moors and heaths: • blanket bog; mountains, moors and upland heaths; lowland heath - Urban green space: • built urban; green space
For which of these sub-habitat types does this data set, product or source provide information about extent (quantity)? E.g. area of sub-habitat type etc.	Specify which sub-habitat types are covered.
For which of these sub-habitat types does this data set, product or source provide information about condition (quality)? E.g. designations, condition of peatland, soil, etc.	Specify which sub-habitat types are covered.
Does this data set, product or source describe or relate to the physical flow of ecosystem services provided by natural capital? E.g. volume of timber, number of visits to recreational sites etc.	Select from drop-down • Yes • No
If yes, list the provisioning ecosystem services that it relates to If it does not relate to provisioning services, write 'none'	Provisioning services include • Food; Fibre and fuel; • Genetic resources; • Biochemicals, natural medicines, pharmaceuticals; • Ornamental resources; • Fresh water
Which sub-habitat types do these provisioning services relate to?	If these provisioning services do not relate to all the sub-habitat types in this data set, product or source, specify which habitat types are covered
If yes in column AL, list the regulating ecosystem services that it relates to If it does not relate to regulating services, write 'none'	Regulating services include: • Air quality regulation; • Climate regulation; • Waste regulation; • Natural hazard regulation; • Pest regulation; • Disease regulation; • Erosion regulation; • Water purification and waste treatment;

Criteria	Notes
	• Pollination
Which sub-habitat types do these regulating services relate to?	If these regulating services do not relate to all the sub-habitat types in this data set, product or source, specify which sub-habitat types are covered
If yes in column AL, list the cultural ecosystem services that it relates to If it does not relate to cultural services, write 'none'	Cultural services include: • Cultural heritage • Recreation and tourism • Aesthetic value
Which habitat types do these cultural services relate to?	If these cultural services do not relate to all the habitat types in this data set, product or source, specify which habitat types are not covered
If yes in column AL, list the supporting ecosystem services that it relates to If it does not relate to supporting services, write 'none'	Supporting services include: • Soil formation; • Primary production; • Nutrient cycling; • Water cycling; • Photosynthesis; • Biodiversity
Which sub-habitat types do these supporting services relate to?	If these supporting services do not relate to all the habitat types in this data set, product or source, specify which habitat types are not covered
Does this data set, product or source describe or relate to the monetary value of the flow of ecosystem services provided by natural capital? E.g. value of timber, value of visits to recreational sites etc.	Select from drop-down • Yes • No
Provide some examples of potential metrics and/or outputs that could be generated with this data set, product or source	Metrics could include (i) indicators of extent such as area of habitat types; (ii) indicators of condition such as number and area of designations; (iii) physical metrics such as volume of timber or number of visits to recreational sites; and (iv) monetary metrics such as the price of timber or the value of visits to recreational sites. Outputs could include maps, charts, tables, reports, etc.

Appendix B – List of data sets, data products, tools and sources reviewed

This appendix set out the 131 items that were reviewed in Section 2. More detailed information about each of these is available in a separate Excel workbook.

Item		Ownership
1	Air Pollution Information System (APIS)	Centre for Ecology and Hydrology (CEH)
2	Ancient Woodland (England)	Natural England
3	Archaeology Data Service (ADS)	University of York
4	Area of Outstanding Natural Beauty data	Natural England
5	ARIES (Artificial Intelligence for Ecosystem Services)	ARIES
6	Bat Conservation Trust	Bat Conservation Trust
7	Blue Flag Beach Quality	Foundation for Environmental Education
8	British Geological Survey (BGS)	British Geological Survey
9	British Oceanographic Data Centre	British Oceanographic Data Centre (BODC)
10	British Trust for Ornithology (BTO)	British Trust for Ornithology (BTO)
11	BUGLIFE	BUGLIFE
12	Butterfly Conservation	Butterfly Conservation
13	Campaign to Protect Rural England	Campaign to Protect Rural England
14	CEH Countryside Survey - Field Survey	Centre for Ecology and Hydrology (CEH)
15	CEH Drought Portal	Centre for Ecology and Hydrology (CEH)
16	CEH Ecological status viewer	Centre for Ecology and Hydrology (CEH)
17	CEH Hydrology of Soil Types	Natural Environment Research Council (NERC)
18	CEH Insect Pollinators Imitative data sets	Centre for Ecology and Hydrology (CEH)
19	CEH Lakes Portal	Centre for Ecology and Hydrology (CEH)
20	CEH Land Cover Map	Centre for Ecology and Hydrology (CEH)
21	Centre for Environment, Fisheries and Aquaculture Science (Cefas) Data Hub	Centre for Environment, Fisheries and Aquaculture Science (Cefas)
22	Channel Coastal Observatory	Channel Coastal Observatory
23	Co$ting Nature	King's College London and AmbioTEK CIC
24	Corine high resolution layers	European Environment Agency
25	CORINE land cover map	European Environment Agency
26	Country Parks data	Natural England

Item		Ownership
27	Cranfield Soil and AgriFood Institute (CSAI) Soilscapes	Cranfield University
28	Defra Acid Water Monitoring Network	Environmental Change Research Centre
29	Defra Statistics (Environmental, Marine and Fisheries)	Department for Environment, Food and Rural Affairs
30	EA Bathing Water Quality Data Explorer	Environment Agency
31	EA Flood Map for Planning (Rivers and Sea)	Environment Agency
32	EA Groundwater Source Protection Zones (SPZs)	Environment Agency
33	EA National Coastal Erosion Risk Mapping (NCERM)	Environment Agency
34	EA Non-Native Species data	Environment Agency
35	EA River Habitat Survey	Environment Agency
36	EA Saltmarsh extents	Environment Agency
37	East Riding Data Observatory - Local CO2 Emissions	East Riding of Yorkshire Council
38	East Riding Local Wildlife Sites Partnership Habitat maps	East Riding of Yorkshire Council
39	East Riding of Yorkshire Integrated Habitat System (HIS) Application Programme Interface (API)	East Riding of Yorkshire Council
40	EcoServ-GIS	EcoServ-GIS
41	English Heritage	English Heritage
42	Environment Agency Catchment Data Explorer	Environment Agency
43	Environment Agency National Receptor Database	Environment Agency
44	Environment Agency Water pollution natural capital calculator	Environment Agency
45	Environmental Value Look-Up (EVL) Tool	Department for Environment, Food and Rural Affairs
46	European Commission Joint Research Center (Image 2000 data)	European Environment Agency
47	European Environment Agency	European Environment Agency
48	European Environment Agency - Urban wastewater treatment map	European Environment Agency
49	FAO (Food and Agriculture Organisation of the United Nations) Statistics	Food and Agriculture Organisation of United Nations
50	Forestry Commission Forestry Statistics	Forestry Commission
51	Forestry Commission National Forest Inventory woodland map	Forestry Commission
52	Forestry Commission Woodland Valuation Tool	Forestry Commission
53	Geochemical baseline data for the urban area of York	British Geological Survey
54	Global Biodiversity Information Facility (GBIF)	Global Biodiversity Information Facility (GBIF)

Item		Ownership
55	Green Infrastructure Valuation Toolkit	Consortium of organisations including Natural Economy Northwest, The Northern Way, Natural England and the Commission for Architecture and the Built Environment
56	Greenbelt data	Local Authorities
57	Heavy Metals Monitoring Network	Department for Environment, Food and Rural Affairs
58	Heritage Gateway	Historic England
59	International Cooperative Programme (ICP) on Assessment and Monitoring of Air Pollution Effects on Forests	German Government
60	International Cooperative Programme (ICP) Vegetation	Department for Environment, Food and Rural Affairs
61	InVEST (Integrated Valuation of Ecosystem Services and Trade-offs)	Natural Capital Project
62	i-Tree Eco	US Department of Agriculture Forest Service
63	JNCC Biodiversity Indicators	Joint Nature Conservation Committee (JNCC)
64	JNCC Offshore Marine Protected Areas	Joint Nature Conservation Committee (JNCC)
65	JNCC Removal of greenhouse gases by forestry	Joint Nature Conservation Committee (JNCC)
66	June Survey of Agriculture and Horticulture	Department for Environment, Food and Rural Affairs
67	LandIS (Land Information System)	Cranfield University
68	Local Air Quality Management (LAQM) concentration maps	Department for Environment, Food and Rural Affairs
69	Local Nature Reserve data	Natural England
70	LUCI (Land Utilisation and Capability Indicator)	LUCI (Land Utilisation and Capability Indicator)
71	Main River data	Environment Agency
72	Mapping the Potential for Working with Natural Processes	Environment Agency
73	Marine Environmental Data and Information Network (MEDIN)	Natural Environment Research Council (NERC)
74	Met Office Marine Automatic Weather Station (MAWS) Network	Department for Business, Energy and Industrial Strategy (BEIS)
75	National Biodiversity Network (NBN Atlas)	National Biodiversity Network
76	National Character Area data	Natural England
77	National Ecosystem Approach Toolkit (NEAT)	Consortium led by University of Birmingham
78	National Habitat Networks England	Natural England
79	National Nature Reserve data	Natural England
80	National Park data	Natural England
81	National River Flow Archive	Centre for Ecology and Hydrology (CEH)
82	National tree map	Bluesky

Item		Ownership
83	Natural Capital Planning Tool	Oliver Hölzinger, Consultancy for Environmental Economics & Policy
84	Natural Capital Protocol Toolkit	World Business Council for Sustainable Development
85	Natural England Agricultural Land Classification	Natural England
86	Natural England Ecosystem Service Transfer Toolkit	Natural England
87	Natural England Living Map	Natural England
88	Natural England Local Environment and Economic Development toolkit (LEED)	Consortium of organisations including Natural England
89	Natural England Long Term Monitoring Network	Natural England
90	Natural England Marine Conservation Zones	Natural England
91	Natural England Monitor of Engagement with the Natural Environment (MENE)	Natural England
92	Natural England Open Mosaic Habitats (draft)	Natural England
93	Natural England Traditional Orchards	Natural England
94	Natural England Wood pasture and Parkland	Natural England
95	Natural Environment Valuation Online (NEVO) Tool	Department for Environment, Food and Rural Affairs
96	NaturEtrade	Oxford University
97	Nidderdale Area of Outstanding Natural Beauty (AONB) National Vegetation Classification (NVC) maps	Nidderdale AONB
98	Nitrogen Dioxide Diffusion Tube Data Centre for England	Department for Environment, Food and Rural Affairs
99	North York Moors National Park National Vegetation Classification (NVC) Mapping	Yorkshire Dales National Park
100	North York Moors Phase 1 Habitat Survey 1989 - Areas	North York Moors National Park
101	North Yorkshire County Council and Districts Phase 1 Maps	Unknown
102	North Yorkshire Sites of Importance for Nature Conservation (SINCs) Partnership Habitat maps	North Yorkshire County Council
103	Office for National statistics data	Office for National Statistics
104	Ordnance Survey Greenspace Layer	Ordnance Survey
105	Ordnance Survey Paths	Ordnance Survey
106	OS MasterMap Water Network Layer	Ordnance Survey
107	Outdoor Recreation Valuation (ORVal) Tool	Department for Environment, Food and Rural Affairs
108	Public Right of Way data	Local Authorities
109	Ramsar sites data	Natural England
110	Scheduled Monument data	English Heritage

Item		Ownership
111	SENCE (Spatial Evidence for Natural Capital Evaluation)	Environment Systems (consultancy)
112	Sites of Special Scientific Interest (England)	Natural England
113	Special Area of Conservation (SACs) data	Natural England
114	Special Protection Areas (SPAs) data	Natural England
115	TESSA (Toolkit for Ecosystem Service Site-Based Assessment)	TESSA
116	The Archive for Marine Species and Habitats Data (DASSH)	Marine Biological Association
117	The Benefits of SuDS Tool (BeST)	CIRIA
118	The Crop Map of England (CROME) - North	Rural Payments Agency
119	The Woodland Trust wood and tree cover	The Woodland Trust
120	Treeconomics Urban Tree Cover	Treeconomics
121	UK Local Authority Carbon Dioxide emissions statistics	Department for Environment, Food and Rural Affairs
122	Viridian	Viridian
123	Water Abstraction Statistics: England 2000 to 2016	Department for Environment, Food and Rural Affairs
124	Water Quality Data Archive	Environment Agency
125	Westcountry Rivers Trust Urban Environmental Toolbox	Westcountry Rivers Trust
126	WFD Canals data	Environment Agency
127	WFD Classification Status data	Environment Agency
128	WFD Groundwaters data	Environment Agency
129	WFD Lake Waterbodies data	Environment Agency
130	WFD River Waterbodies data	Environment Agency
131	York Local Wildlife Site Partnership Habitat Maps	City of York Council
132	Yorkshire Wildlife Trust Habitat Maps	Yorkshire Wildlife Trust

Appendix C – Online survey questionnaire

See separate file < Appendix A - Online survey questionnaire.pdf>.

Appendix D – Interview protocol

See separate file <Appendix B – Interview protocol.pdf>.

Appendix E – Online survey descriptive statistics

This appendix sets out the descriptive statistics for single or multiple choice questions in the online survey. The full survey questionnaire is included in Appendix C to this report.

Note that the sample size may vary between questions due to the routing of the survey and the fact that the analysis includes three partially completed responses (out of a total of 40 responses).

Q2. Respondents' perspective in completing survey

	n	%
For my entire organisation	9	23%
For my team only	20	50%
For me and my projects only	10	25%
Other	1	3%
Total	40	100%

Q3. Broad contexts respondents where tend to assess natural capital (environmental) impacts and/or opportunities

	n			%		
	Yes	No	Total	Yes	No	Total
Environmental impact assessment	21	19	40	53%	48%	100%
Measuring and/or valuing environmental risks and opportunities	23	17	40	58%	43%	100%
Monitoring and evaluation	26	14	40	65%	35%	100%
Natural capital assessment	11	29	40	28%	73%	100%
Strategic environmental assessment	18	22	40	45%	55%	100%
Other	13	27	40	33%	68%	100%

Q4. Data sets and/or products used by respondents' organisation to assess natural capital (environmental) impacts and/or opportunities

	n			%		
	Yes	No	Total	Yes	No	Total
Acid Waters Monitoring Network	1	39	40	3%	98%	100%
Air Pollution Information System (APIS)	8	32	40	20%	80%	100%
Bluesky National Tree Map	1	39	40	3%	98%	100%
Botanical Society of Britain and Ireland (BSBI) data	6	34	40	15%	85%	100%
British Trust for Ornithology (BTO) data	8	32	40	20%	80%	100%
BUGLIFE data	3	37	40	8%	93%	100%
Butterfly Conservation data	5	35	40	13%	88%	100%
CORINE land cover map	1	39	40	3%	98%	100%
Countryside Survey	4	36	40	10%	90%	100%
Cranfield University National Soil Inventory	3	37	40	8%	93%	100%
English Heritage - Historic Places data	14	26	40	35%	65%	100%
Heavy Metals Monitoring Network data	1	39	40	3%	98%	100%
Heritage Lottery Fund National Park work	2	38	40	5%	95%	100%
LandIS (Land Information System)	2	38	40	5%	95%	100%
Ordnance Survey Greenspace Layer	6	34	40	15%	85%	100%
Ordnance Survey Paths data	12	28	40	30%	70%	100%
The Archive for Marine Species and Habitats Data (DASSH)	1	39	40	3%	98%	100%

UN Fisheries and Agriculture Organisation (FAO) Fisheries Statistics	2	38	40	5%	95%	100%
Water Security Knowledge Exchange Portal	1	39	40	3%	98%	100%
Don't know	7	33	40	18%	83%	100%
None of these	9	31	40	23%	78%	100%
Other	15	25	40	38%	63%	100%

Q5. Tools used by respondents' organisation to assess natural capital (environmental) impacts and/or opportunities

	n			%		
	Yes	No	Total	Yes	No	Total
ARIES (Artificial Intelligence for Ecosystem Services)	1	39	40	3%	98%	100%
Centre for Ecology and Hydrology (CEH) Drought Portal	1	39	40	3%	98%	100%
CEH Ecological status viewer	3	37	40	8%	93%	100%
CEH Lakes Portal	2	38	40	5%	95%	100%
Co$ting Nature	1	39	40	3%	98%	100%
Defra Environmental Value Look-Up (EVL) Tool	3	37	40	8%	93%	100%
eCountability tool	1	39	40	3%	98%	100%
Environment Agency Bathing Water Quality Data Explorer	8	32	40	20%	80%	100%
Environment Agency Catchment Data Explorer	14	26	40	35%	65%	100%
EcoServ-GIS	2	38	40	5%	95%	100%
European Environment Agency urban wastewater treatment map	1	39	40	3%	98%	100%
Forestry Commission Woodland Valuation Tool	5	35	40	13%	88%	100%
Green Infrastructure Valuation Toolkit	5	35	40	13%	88%	100%
Heritage Gateway	6	34	40	15%	85%	100%
Historic England Listed Buildings	13	27	40	33%	68%	100%
InVEST (Integrated Valuation of Ecosystem Services and Trade-offs)	1	39	40	3%	98%	100%
i-Tree Eco	1	39	40	3%	98%	100%
LUCI (Land Utilisation and Capability Indicator)	2	38	40	5%	95%	100%
Marine Environmental Data and Information Network (MEDIN)	3	37	40	8%	93%	100%
National Biodiversity Network (NBN Atlas)	10	30	40	25%	75%	100%
National Ecosystem Approach Toolkit (NEAT)	3	37	40	8%	93%	100%
National Trust Future Parks Toolkit	1	39	40	3%	98%	100%
Natural Capital Planning Tool (NCPT)	2	38	40	5%	95%	100%
Natural Capital Protocol Toolkit	2	38	40	5%	95%	100%
Natural England Local Environment and Economic Development toolkit (LEED)	5	35	40	13%	88%	100%
Natural England Ecosystem Service Transfer Toolkit	3	37	40	8%	93%	100%
NaturEtrade	1	39	40	3%	98%	100%
Outdoor Recreation Valuation (ORVal) Tool	3	37	40	8%	93%	100%
SENCE (Spatial Evidence for Natural Capital Evaluation)	1	39	40	3%	98%	100%
TESSA (Toolkit for Ecosystem Service Site-Based Assessment)	1	39	40	3%	98%	100%
The Benefits of SuDS Tool (BeST)	4	36	40	10%	90%	100%
UK Environmental Change Network (ECN) Data Centre	1	39	40	3%	98%	100%
Viridian	2	38	40	5%	95%	100%
West Country Rivers Trust Urban Environmental Toolbox	2	38	40	5%	95%	100%

Don't know	7	33	40	18%	83%	100%
None of these	6	34	40	15%	85%	100%
Other	7	33	40	18%	83%	100%

Q6. Data sources respondents' organisations used to assess natural capital (environmental) impacts and/or opportunities

	n			%		
	Yes	No	Total	Yes	No	Total
Archaeology Data Service	10	30	40	25%	75%	100%
Bat Conservation Trust data	7	33	40	18%	83%	100%
British Geological Survey	13	27	40	33%	68%	100%
British Oceanographic Data Centre	4	36	40	10%	90%	100%
Campaign to Protect Rural England data sets	4	36	40	10%	90%	100%
Canals and River Trust data sets	7	33	40	18%	83%	100%
Catchment-Based Approach (CaBA) catchment data	13	27	40	33%	68%	100%
Centre for Ecology and Hydrology (CEH) data sets e.g. Land Cover Map; National River Flow Archive; etc.	8	32	40	20%	80%	100%
Centre for Environment, Fisheries and Aquaculture Science (Cefas) Data Hub	2	38	40	5%	95%	100%
Channel Coastal Observatory	3	37	40	8%	93%	100%
Data North Yorkshire data sets	9	31	40	23%	78%	100%
Defra data sets e.g. air quality data catalogue; environmental statistics; etc.	12	28	40	30%	70%	100%
East Riding Data Observatory	5	35	40	13%	88%	100%
Environment Agency data sets e.g. Flood Maps; invasive species data; etc.	27	13	40	68%	33%	100%
Forestry Commission data sets e.g. National Forest Inventory; Butterfly Statistics; etc.	13	27	40	33%	68%	100%
Global Biodiversity Information Facility (GBIF) data	1	39	40	3%	98%	100%
Hull Data Observatory	2	38	40	5%	95%	100%
International Cooperative Programme (ICP) on Assessment and Monitoring of Air Pollution Effects on Forests	1	39	40	3%	98%	100%
International Cooperative Programme (ICP) on Effects of Air Pollution on Natural Vegetation and Crops	1	39	40	3%	98%	100%
Joint Nature Conservation Committee (JNCC) data sets e.g. Biodiversity Indicators; Marine Protected Areas monitoring; etc.	6	34	40	15%	85%	100%
Marine Management Organisation (MMO) data sets e.g. fish landings; Conversation Areas; etc.	5	35	40	13%	88%	100%
National River Flow Archive	3	37	40	8%	93%	100%
Natural England data sets e.g. Agricultural Land Classification; Priority Habitat Inventory; etc.	29	11	40	73%	28%	100%
North and East Yorkshire Ecological Data Centre (NEYEDC) data	23	17	40	58%	43%	100%
Office for National Statistics (ONS) data	11	29	40	28%	73%	100%
River Trust(s) data sets	8	32	40	20%	80%	100%
Royal Society for the Protection of Birds (RSPB) data sets	7	33	40	18%	83%	100%
The Woodland Trust data sets	7	33	40	18%	83%	100%
York City Environmental Observatory	3	37	40	8%	93%	100%
Yorkshire Wildlife Trust data	13	27	40	33%	68%	100%
Don't know	4	36	40	10%	90%	100%

None of these	2	38	40	5%	95%	100%
Other	8	32	40	20%	80%	100%

Q8. Whether respondents attempted to combine, overlay or layer data sets, products, tools and/or sources

	n	%
Yes	20	50%
No	13	33%
Don't Know	7	18%
Total	40	100%

Q10. Whether combining/overlaying/layering data sets, products and/or tools helped

	n	%
Yes	19	95%
No	1	5%
Total	20	100%

Q11. Was additional analysis (after layering) required?

	n	%
Yes	12	60%
No	8	40%
Total	20	100%

Q13. Whether respondent has detected errors or local changes that required amendment in data sets, products, tools and/or sources used

	n	%
Yes	15	38%
No	7	18%
Don't Know	18	45%
Total	40	100%

Q14. Whether respondent amended any of these data sets, products, tools and/or sources to correct errors and/or reflect local changes in underlying data

	n	%
Yes	5	33%
No	8	53%
Don't Know	2	13%
Total	15	100%

Q16. Reasons for not amending data sets, products, tools and/or sources to correct errors and/or reflect local changes

	n			%		
	Yes	No	Total	Yes	No	Total
The corrections would not have made a material difference to our work	4	4	8	50%	50%	100%
There were no local changes to correct	0	8	8	0%	100%	100%
We did not find or notice any errors to amend	4	4	8	50%	50%	100%

We do not have the time to make these amendments in-house	3	5	8	38%	63%	100%
We tried but found that there was no mechanism to edit the data sets, products, tools and/or sources	4	4	8	50%	50%	100%
We tried but found that it was too complex to edit the data sets, products, tools and/or sources	3	5	8	38%	63%	100%
Other	7	1	8	88%	13%	100%

Q17. Whether respondent's organisation holds internally and uses any data sets, products, tools and/or sources to assess natural capital (environmental) impacts and/or opportunities

	n	%
Yes	13	33%
No	11	28%
Don't Know	16	40%
Total	40	100%

Q19. Whether respondent would like to provide information about a second internally held data set, product, tools or source

	n	%
Yes	8	62%
No	5	38%
Total	13	100%

Q21. Whether respondent would like to provide information about a third internally held data set, product, tools or source

	n	%
Yes	7	88%
No	1	13%
Total	8	100%

Q23. Whether respondent would like to provide information about a fourth internally held data set, product, tools or source

	n	%
Yes	2	29%
No	5	71%
Total	7	100%

Q25. Whether respondent would like to provide information about a fifth internally held data set, product, tools or source

	n	%
Yes	1	50%
No	1	50%
Total	2	100%

Q27.Whether respondents' organisation provides access to these internally held data sets products and/or tools

	n	%
Yes, but we would charge for it	1	8%

Yes, for free	3	23%
No	4	31%
Don't know	5	38%
Total	13	100%

Q28. Whether respondent is happy to be contacted to provide access to these internally held data sets, products, tools and/or sources

	n	%
Yes	4	100%
No	0	0%
Total	4	100%

Q29. Contexts and applications where respondent's organisation assesses natural capital (environmental) impacts and/or opportunities

	n			%		
	Yes	No	Total	Yes	No	Total
Catchment management (including water resources management plans)	18	22	40	45%	55%	100%
Climate change risk and opportunity assessments	18	22	40	45%	55%	100%
Economic and economic development strategy and decisions	15	25	40	38%	63%	100%
Environmental and sustainability impact assessments	22	18	40	55%	45%	100%
Flood risk assessments	22	18	40	55%	45%	100%
Habitat and wildlife surveys and assessments	26	14	40	65%	35%	100%
Housing development strategy and decisions	19	21	40	48%	53%	100%
Land management	18	22	40	45%	55%	100%
Planning strategy and decisions	29	11	40	73%	28%	100%
Statutory environmental monitoring and enforcement	12	28	40	30%	70%	100%
Strategic environmental assessment	16	24	40	40%	60%	100%
Sustainability appraisals	18	22	40	45%	55%	100%
Transport and infrastructure appraisals	12	28	40	30%	70%	100%
None of these	1	39	40	3%	98%	100%
Other	5	35	40	13%	88%	100%

Q30. Key gaps and challenges in using data sets, products, tools and/or sources to carry out assessments

	n			%		
	Yes	No	Total	Yes	No	Total
Data and information not available at the spatial scale and resolution needed for my work	19	18	37	51%	49%	100%
Difficulty in knowing which economic evidence applies to my work	13	24	37	35%	65%	100%
Difficulty in knowing which scientific evidence applies to my work	12	25	37	32%	68%	100%
Economic evidence is dated	6	31	37	16%	84%	100%
Scientific evidence is dated	12	25	37	32%	68%	100%
Incompatibility of data sets, products, tools and/or sources with each other	13	24	37	35%	65%	100%
Lack of clear guidance on how to use data sets, products, tools and/or sources	17	20	37	46%	54%	100%

Lack of clear guidance on which data sets, products, tools and/or sources are most appropriate for my work	21	16	37	57%	43%	100%
Lack of clear workflows for the processing, combining and analysing data	7	30	37	19%	81%	100%
Metadata available for data sets, products, tools and/or sources does not allow me to fully evaluate whether it is appropriate for my work	8	29	37	22%	78%	100%
Not enough economic evidence	7	30	37	19%	81%	100%
Not enough scientific evidence	11	26	37	30%	70%	100%
Not enough visual data sets, products, tools and/or sources e.g. maps, charts, graphs, etc.	8	29	37	22%	78%	100%
Spatial coverage of data sets, products, tools and/or sources is incomplete with respect to my needs	10	27	37	27%	73%	100%
Uncertainty over where data sets, products, tools and/or sources are located	26	11	37	70%	30%	100%
None of these	2	35	37	5%	95%	100%
Other	9	28	37	24%	76%	100%

Q32. Whether respondent is happy to be interviewed

	n	%
Yes	28	76%
No	9	24%
Total	37	100%