Review of existing natural asset registers and literature

RD1.4.1a Deliverable D1: Review existing natural asset registers and literature

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Glossary

Natural Asset	The stock of assets from nature e.g. trees, soil from which ecosystem services potentially flow.
Natural Capital	Used interchangeably with Natural Asset.
Broad habitats	A classification which was developed as part of the UK Biodiversity Action Plan
Ecosystem services	The benefits people obtain from ecosystems (Millenium Ecosystem Assessment, 2005)
CICES	Common International Classification of Ecosystem Services (http://biodiversity.europa.eu/maes/common-international-classification-of-ecosystem-services-cices-classification-version-4.3)
Open data	Data that is made available without any fee under a licence that permits use with minimal restrictions
MAES	Mapping and Assessment of Ecosystems and their Services in the European Union

Executive summary

This paper presents a review of the current state of development of natural capital asset registers and their drivers to inform the development of a Natural Asset Register as part of the RESAS Strategic Research Programme 2016-2021. We have mainly focussed on Scottish and wider UK practical initiatives with a view to understanding how comprehensively and in what ways this information is currently made available.

A total of 19 initiatives of various types were reviewed and are summarised below and described in detail in Appendices 1 and 2.

General findings/lessons[1]

A rapid increase in initiatives over the past 12-24 months

The majority of the actively supported initiatives have been started in the last few years, reflecting where policy and social needs to assess natural capital assets have met with innovations in the technological capability required to meet those needs.

There are two main types of initiatives relevant to the SRP Natural Asset Register, depending on its final purpose and functionality

Our review found that relevant initiatives could be most efficiently grouped into initiatives that primarily asses natural capital and its services and valuations, and a second group focussed on the provision of environmental information.

All of these initiatives are dependent on using established standards and approaches

A range of standards are in place, from those governing the electronic publication of data to ecosystem service classification. All of the assessed initiatives utilise standards, but to varying degrees.

Digital (web) technologies are enabling the development of these initiatives, especially free and open source software

The development of these initiatives is being accelerated and their implementation simplified and made less resource intensive by the development of these established standards and also by free to use templates and software.

There is a need to link assessments of natural capital assets with data on those assets

There is currently little overlap between projects assessing assets and those which make environmental data accessible. No project which provided a comprehensive assessment of a broad range of terrestrial natural assets and which made that assessment accessible was identified in our review.

What we have learned from initiatives primarily providing assessment functionality

There is a need to include information on the quality of natural capital assets

There has been more emphasis on the quantity of natural capital than on assessing the quality of those assets. However ecosystem service provision can only be accurately assessed when both the quality and quantity of natural capital are known.

[1] These titles correspond to titles within the remainder of the document.

There are a number of limitations related to providing functional assessment of natural capital assets

In addition to the requirement for qualitative assessment of assets there is a need to ensure that information is captured which takes account of how natural assets change over time. There is a need for time series data that measures the flow of assets or services.

Key Limitations: Lack of approaches to reproducibly value these assets and services

The valuation of natural capital and services is rapidly developing. However, there remain significant challenges to monetisation and non-monetary valuations of services.

Key Limitations: Existing initiatives have been criticised for including indicators that do not reflect the status of natural capital assets

A systematic evaluation of the Scottish Natural Capital Asset Index found a low percentage of indicators were fit for purpose, and those few reflected changes in flows or the resilience of the resource.

What we have learned from initiatives primarily providing environmental data

There has been a recent increase in the number of new data and information initiatives of relevance to the SRP Natural Asset Register

There is currently a lot of activity in producing new spatial data sharing websites and in updating existing sites. This is particularly the case in Scotland. These sites cover a diverse range of data types, purposes and intended audiences.

There are a range of approaches to presenting web based complex information on natural capital assets

This range of approaches is a response to a number of factors, including the diversity of information being presented, but also editorial decision making. Sites which offer flexible user interaction but also fixed pre-defined outputs appear to offer more successful solutions.

Web services are increasingly used to provide information on natural capital assets

Web Mapping Services (WMS) are a key component in the reviewed sites. However, the use of WMS presents significant cartographical challenges unless there is significant collaboration among providers.

Remote and/or local data access

EU regulations give guidance on the best approach to data access. However, there are technical requirements that can mandate specific data holdings. A range of solutions has been observed and these have been governed by the functions provided by the sites. There are trade-offs between level of site functionality and the resource required to support it.

Developing the scope, focus and requirements of the SRP Natural Asset Register

References to the Natural Asset Register in in the Main Research Providers Strategic Research Programme proposals

There are references to the Natural Asset Register across all three SRP Themes, with particular emphasis in Theme 1. The diversity of the research deliverables referencing the Natural Asset Register requires that significant flexibility be incorporated into its design.

Where does the SRP Natural Asset Register fit in relation to the initiatives reviewed?

There is currently significant capacity in the supply of environmental data in Scotland. However, the SRP Natural Asset Register will avoid duplication in being unique in adhering to CICES and in focussing on natural assets, ecosystem services and valuations. It will also provide access to SRP spatial outputs which are currently largely missing from other initiatives.

The next steps in developing the SRP Natural Asset Register

This report will be followed by discussions with appropriate individuals and bodies to develop the scope and specification of the Natural Asset Register. These will build on our initial consultation carried out during this review. There is an aspiration that the Natural Asset Register's scope will be co-constructed with RESAS, MRP colleagues and other stakeholders.

Consultation for this review

A letter was drafted to consult a wide range of experts in the field of ecosystem services and environmental data. Several replies were received and, where relevant the suggestions included in this review. The methodology is described in Appendix 3: Consultation .

1. Introduction

1.1 Objectives and audiences for this review

This review is the first task in the RESAS Strategic Research Programme (SRP) funded development of a Natural Asset Register (RD1.4.1 Objective A: Development of a Natural Asset Register). This research aims to "develop a comprehensive natural asset register that captures condition, assets 'at risk' and asset health/functioning as well as ecosystem service flows (and their values) that originate from the assets. (…) Natural capital accounts should be developed from the asset and service flow register using appropriate monetary values."[2] Here we present our review of existing natural asset registers and similar initiatives e.g. environmental data and information web sites, which can inform the development of the SRP Natural Asset Register.

The RESAS SRP tender suggested the research "should start from the approach set out in 'Mapping and Assessment of Ecosystems and their Services' (EU, 2014) and ecosystems services categorised following the Common International Classification of Ecosystem Services (CICES) and take account of ecosystem service potentials, flows and demands."[1] Whilst discussing the focus of this review with the WP1.4 RESAS contact, it was agreed that 'natural assets' and 'natural capital' were used interchangeably in the Invitation To Tender for Grant Funding (ITGF). In this report, we have used the term 'natural capital asset/s' to cover both natural assets and natural capital. Our use of the term 'Natural Asset Register' refers to the digital resource/database we are developing in this project (RD1.4.1 Objective A). The ITGF also refers to the development of an asset inventory and an asset register without differentiating between the terms. In this review we have chosen to use the term Natural Asset Register and propose to use this term in subsequent outputs.

Scotland's natural capital is the stock of assets from nature e.g. trees, and these stocks provide flows of ecosystem services to beneficiaries e.g. a forestry business. Ecosystem/natural capital accounting involves estimating the value of the ecosystem/natural capital, and is increasingly being used in government and corporate planning and decision making.

It is not explicitly stated in the RESAS SRP tender and Main Research Providers (MRPs) proposal exactly what the Natural Asset Register is required to provide in terms of data and functionality, and to whom, and for what purposes. Two of the objectives of carrying out this review are: 1) to contribute to a discussion on the purpose of the SRP Natural Asset Register, and 2) evaluate how the Natural Asset Register relates to the wide range of rapidly developing and web based initiatives already available or planned in this area. An additional objective of carrying out this review was to increase the authors' knowledge of recent developments in practical applications: 1) for assessing the quality and quantity of natural assets, the ecosystem services they provide and accounting for these, and 2) of the range of online data and information resources relevant to these assessments and the approaches taken to the sharing of this information.

The audience of this review is primarily RESAS and CAMERAS partners. Researchers working under the Natural Assets Theme at the Main Research Providers (MRPs) will also be interested in learning about the current status of natural asset registers and initiatives related to enabling the assessment of natural assets and the sharing of data, information and knowledge about their status. In relation to the first objective above, it became clear whilst writing this report that even amongst MRP

[2] RESAS SRP Invitation to Tender for Grant Funding (p. 38)

researchers involved in the development of the SRP Natural Asset Register there were different perspectives on what exactly the purpose and functionality of the Natural Asset Register was to be. RESAS are keen that the Natural Asset Register enables integration of data and information from across the SRP, and as highlighted in this report there are many references in the SRP proposals to the Natural Asset Register.

1.2 Policy drivers for the development of the SRP Natural Asset Register

1.2.1 Natural capital assets: Scottish and UK policy contexts

The concepts of natural capital assets, and the ecosystem services they provide for society, are increasingly becoming embedded in policy and management guidance in Scotland and internationally. For example, under the 'investment' priority of Scotland's economic strategy it states the need for: "Protecting and enhancing the stock of natural capital, which includes our air, land, water, soil and biodiversity and geological resources, is fundamental to a healthy and resilient economy. It also supports sectors such as agriculture, forestry, fisheries, tourism and renewables" (Scottish Government, 2015b, 45).

Recently, the Scottish Government has adopted Scottish Natural Heritage's Natural Capital Asset Index as one of its 55 national indicators, which it uses to track progress towards achieving national outcomes. The remaining 54 indicators include 'improve the condition of protected nature sites', 'increase the abundance of terrestrial breeding birds: biodiversity', and 'improve the state of Scotland's marine environment': all of which provide information on Scotland's natural capital assets (http://www.gov.scot/About/Performance/scotPerforms/indicator). A discussion paper on the commonalities and differences between the Natural Capital Asset Index (NCAI) and a new set of indicators of biological natural capital assets called the 'Ecosystem Health Indicators' (EHIs) said: "Whilst the NCAI and the EHIs aim to tell a story about the changing state of the natural environment, the NCAI is intended for national communication and policy evaluation, alongside GDP as a test of sustainability, whereas EHIs are largely to inform regional and local priorities on investment, and priority measures to enhance the environment (national as well as local). This is important as the NCAI may hide important trends in particular regions or components" (SNH, 2014, 7).

The Scottish Government's Land Use Strategy 2016-2021 highlighted the importance of taking our natural resources into account in our decision making to keep our natural assets in a healthy and functioning state (Scottish Government, 2016). The first policy of the Land Use Strategy 2016-2021 sets out:

> "We are committed to better understanding and managing Scotland's natural resources to enable their fair, wise and productive use, and to conserve stocks of ecosystem services for future generations. We will do this by promoting an ecosystem approach to managing our natural capital" (Scottish Government, 2016, 14).

In terms of 'biological' natural capital assets, the Scottish biodiversity strategy 'Scotland's Biodiversity, A Route Map to 2020' lists as a key pressure on biodiversity that there is a:

> "Lack of recognition of the value of nature-Currently, the vital benefits that healthy stocks of nature, or 'natural capital', provide to society are not fully recognised or appreciated and

> therefore are not sufficiently considered in decision making" (Scottish Government, 2015a, 9).

The 'route map' also sets out six big steps for nature including "Investment in natural capital- to ensure the benefits which nature provides are better understood and appreciated, leading to better management of our renewable and non-renewable natural assets" (Scottish Government, 2015a, 11).

In addition to the Scottish policy context, the UK government in their response to the recommendations produced by the Natural Capital Committee, stated that while they do not "currently consider the approach of creating 'registers of natural capital' as universally applicable. However we would encourage those organisations with significant influence or dependence on land, air and water assets to consider how best they can manage these to maximise value and minimise risks – the methods explored in corporate natural capital accounting can help enhance the quality of organisational decision making in this regard" (Defra, 2015, 3).

It was Defra's view (2015) there needed to be a more widely agreed approach to natural capital accounting before supporting further adoption of the creation of natural capital registers.

1.2.2 Policy drivers for increased sharing of digital data on Scotland's natural capital assets

Over the past five years in Scotland and the UK there have been several policies and strategies developed and implemented concerning open digital data and information. In 2011 in 'Scotland's Digital Future' the Scottish Government (2011) set out the Scottish Government's strategy to build on existing strengths to deliver a fairer and more prosperous digital Scotland that included among its actions one focussed on developing proposals for releasing more government information and data for use by the public. They also produced a strategy document on data linkage 'that set out aims to enable a culture where legal, ethical, and secure data linkage was accepted and expected' (Scottish Government, 2012). More recently SNH (2015) and SEPA (2016) have developed and published open data publication policies and plans in the past year. They both plan to make all of their data available, as at least three star level of openness (e.g. csv file format) with an Open Government Licence, by the end of 2016.

To enable better informed decision making there is a need to make data and information on Scotland's natural resources more accessible and useful for a wide range of purposes. It is widely appreciated that to effectively manage a particular resource, you need to be able to assess and monitor the use and demand for that resource, and changes in its quantity and quality. This is set out in the sixth Land Use Strategy policy (Scottish Government, 2016):

> "We will continue to encourage those holding public data to make it open and available for others to use and will facilitate access to that data via the Land Use Data Directory. We will explore the development of models and Geographic Information System (GIS) tools to enable assessments of land use/management change" (Scottish Government, 2016, 23).

1.3 Background to the development of natural capital asset registers

This section of the report sets out some of the key research related to the development of natural capital asset registers in the UK. However, it does not provide a comprehensive review of all the international scientific literature, as literally thousands of scientific papers have been produced over the past 20 years, on this broad set of topics.

The importance of natural capital assets for sustainable development was set out in 1987, by Gro Harlem Brundtland in the influential report 'Our Common Future': "The process of economic development must be more soundly based upon the realities of the stock of capital that sustains it" (Brundtland, 1987, 48). Costanza and Daly (1992) reinforced the importance of natural capital assets when they set out operational principles for sustainability, where "the main principle is to limit the human scale to a level which, if not optimal, is at least within the carrying capacity of the remaining natural capital and therefore sustainable"(Costanza and Daly, 1992, 44). They distinguished between 'renewable or active natural capital' e.g. a woodland, and 'non-renewable or inactive natural capital' e.g. subsurface mineral deposits. Increasing international concern on the state of natural capital assets and the ecosystem services resulted in the publication of the Millennium Ecosystem Assessment, which provided an assessment of the condition and trends of the world's ecosystems and the services they provide (Millenium Ecosystem Assessment, 2005).

1.3.1 UK National Ecosystem Assessment and related research projects

Following publication of the Millennium Ecosystem Assessment (2005), the UK government funded the UK Natural Ecosystem Assessment (UK NEA) which concluded that the natural world and ecosystems were consistently undervalued in conventional economic analysis and decision making (NEA, 2011). The UK National Ecosystem Assessment Follow-on (UK NEAFO) aimed to provide new information and tools to aid decision makers across a wider range of sectors to better understand the value of our ecosystems and the services they provide (UK National Ecosystem Assessment, 2014).

The UK NEAFO developed a Natural Capital Asset Check to help map out the relationships between natural capital assets and the wider economy. The final report on the Natural Capital Asset Check (Dickie et al., 2014) defined natural assets through existing environmental classifications e.g. habitats, and other assets e.g. renewable/non-renewables. This was done with a focus on productive combinations, where an asset is anything that can be controlled or owned to produce positive economic value. An asset based approach was suggested to enable linkages with existing accounting approaches, and for the value to be carried forward from one accounting period to the next. They suggested that individual assets (which were either living or non-living, and renewable or non-renewable) and ecosystem assets together formed natural assets. Dickie *et al*.(2014) suggested that Natural Capital Asset Checks could be carried out to generate information to support decisions related to natural assets.

To increase the UK research capacity to support interdisciplinary valuing of the stocks of natural capital assets and the provision of goods and services they can provide, the UK Research Councils established 'The Valuing Nature Network' (2011-2014; VNN1) with two aims: "1. Articulate the challenge of valuing the contribution that the stock of natural capital and the flow of ecosystem services make to human well-being, and developing meaningful methods of valuation. 2. Identify

and develop the underpinning socio-ecological system knowledge that will enable robust monetary and non-monetary valuation to be achieved." (http://valuing-nature.net/background). Ten interdisciplinary projects were funded using the common VNN1 conceptual model (http://valuing-nature.net/valuing-nature-projects-2011-2013). A recent paper by Jones *et al*. (2016) from the 'stocks and flows' project (http://valuing-nature.net/stocks-and-flows) adapted existing classifications of capital to consider six types: natural, human, produced, social, financial, and cultural. Natural capital was further split into atmospheric, biological, hydrological, pedological, and geological (Jones et al., 2016).

1.3.2 Ecosystem/natural capital accounts

In 2009, the European Environment Agency (EEA) established a project to implement simplified ecosystem capital accounts for Europe (Weber, 2011). At a similar time in the UK, the Government's Economic Service Review of the Economics of Sustainable Development recommended that a natural asset check should be explored for use in appraising public policy options (Price et al., 2010). Howard *et al.*(2011) in considering what would be needed for the design of a natural asset check in public policy appraisal, suggested that some form of accounting model rather than the frameworks used for ecosystem assessments was likely to be needed as the basis of a natural asset check. They also recommended that the classification approach should link the ecosystem services to the natural asset. Earlier RESAS research investigated incorporating natural capital assets into calculations of GDP for Scotland (Vellinga et al.).

Natural capital accounts can provide insight into the gains, losses and relative importance of ecosystem services provided by natural assets. They can assist management and resourcing decisions, and highlight the connections between economic activity and pressures on natural capital. The Third State of Natural Capital Report (Natural Capital Committee, 2015) said there was a need for improved accounting of natural assets, at the national and corporate levels.

The UK Office for National Statistics has been working with Defra and the Natural Capital Committee to review progress from the first two years of the UK Roadmap (to incorporate natural capital into UK Environmental Accounts by 2020), and to set out priorities for the next phase of the Roadmap (Khan, 2015). Achievements include publication of initial UK land use, land cover, woodland and freshwater accounts. They identified challenges for future work to include the development of accounts for practical applications, capacity for natural capital accounting, as well as wider awareness and use of the accounts. The Natural Capital Committee commissioned the development of the Corporate Natural Capital Accounting framework (Provins et al., 2015). The aim was to produce a set of reporting statements that can be to monitor and measure the health and value of natural capital.

There are an increasing number of national and international efforts to develop natural capital accounts. Terema *et al*. (2015) reviewed recent efforts to develop international and national policy frameworks, strategies, and standards for natural capital accounting. They found three types of challenges for national implementation of natural capital accounting: political awareness and will; enabling laws, policies and institutions; and technical knowledge and capacity. To enable countries to implement ecosystem accounts the Secretariat of the Convention on Biological Diversity set out a guide for countries willing to start implementing ecosystem accounts with its Ecosystem Natural

Capital Accounts: A Quick Start Package. This is a comprehensive approach applicable to all ecosystems, whether natural or modified by anthropogenic activities (Weber, 2014).

Mace *et al.* (2015) carried out a preliminary assessment of natural capital in the UK using a risk register for natural capital assets. The assets were assessed based on asset-benefit relationships for ten types of benefits that included food, fibre (timber), energy, aesthetics, freshwater (quality), recreation, clean air, wildlife, hazard protection and equable climate for eight broad habitat types in the UK. Mace *et al*. (2015) used quality, quantity and spatial configuration as three dimensions of natural capital within each of the habitat types. Despite knowledge gaps about asset-benefit relationships, certain freshwater, mountain, moor and heathland assets were found to have a high risk of not being able to sustain certain benefits, in particular freshwater, wildlife and climate regulation (Mace et al., 2015).

Maseyk *et al.*(2016) produced a framework that linked stocks of natural capital with ecosystem services with the aim of identifying key attributes for the management of natural capital stocks e.g. soil organic matter. Their conceptual framework was based on relationships between interventions (policy and management), the natural capital (stocks and processes) and then the ecosystem services and benefits to humans. They demonstrated their approach based on revegetation of the Loess Plateau in China. To address the disconnect between the concept and its application to support management decisions, they suggested the use of a facilitated process based on structured decision making (Gregory et al., 2012).

In addition to the development and application of a range of academic and accounting based frameworks and approaches for assessing natural capital across all habitats, certain habitats figure more highly in literature searches related to natural capital assets. For example, there are many studies on wetlands as natural assets e.g. (Barbier, 2011, Maltby and Acreman, 2011).

One of the challenges of developing natural capital asset registers is assessing the state of the assets, and not just their extent. Gibbs (2016) recently explored if an engineering management approach to asset management had any value in environmental management.

1.3.3 Common International Classification of Ecosystem Services

To enable consistent and comparable identification and mapping of ecosystem services in support of natural capital accounting the EEA and other organisations have been developing the Common International Classification of Ecosystem Services (CICES). The CICES definitions provide a standardised list of ecosystem services for natural capital accounting. This classification system has been used in a number of initiatives, including the Scottish Government Land Use Strategy Data Directory (http://www.gov.scot/Topics/Environment/Countryside/Landusestrategy/datadirectory). The CICES classification is used within the 'Mapping and Assessment of Ecosystems and their Services' (MAES) framework to help with pan-European consistency.

1.3.4 European Commission's 'Mapping and Assessment of Ecosystems and their Services'

The RESAS SRP ITGF suggested using the European Commission's MAES framework as a starting point for developing the SRP Natural Asset Register. Under the MAES initiative, EU Member States are committed to improve the knowledge and evidence base of Europe's ecosystems, with support from the European Commission and the EEA. The MAES initiative is an essential part of the EU

Biodiversity Strategy to 2020 (European Commision, 2011). Action five calls on member states to map and assess the state of ecosystems and their services in their national territory.

The MAES model uses a four-step approach to each ecosystem: mapping, assessment, measuring of services, and compilation of data into an integrated ecosystem assessment. The MAES analytical framework is structured around a conceptual framework that links human societies and their well-being with the environment. It uses 12 main ecosystem types based on the European Nature Information System (EUNIS) habitat classification. EUNIS is a reference information system linked to Natura 2000 processes and EEA reporting activities (http://eunis.eea.europa.eu/). The EUNIS Land Cover of Scotland map was produced by Scottish Natural Heritage in 2015. There are a number of MAES case-studies, though none were based in Scotland. The case-study of a national assessment for Wales may provide useful information for the creation of the SRP Natural Asset Register (http://biodiversity.europa.eu/maes/maes-catalogue-of-case-studies).

2. What we have reviewed and learned

In this review we have focussed on a broad range of recent and established initiatives relevant to the assessment of natural capital assets and environmental data, and the exchange of data, information and knowledge of their status. However, we have excluded narrower domain/sector initiatives i.e. those that provide a specific dataset or information on one particular type of natural capital asset e.g. soil or fresh water. A review of technologies and geographic data models suitable for constructing and providing the SRP Natural Asset Register will be covered in future RD1.4.1.a work, and this will result in a formal specification of the Natural Asset Register.

In this project we have reviewed a broad area of research and practice that encompasses assessment of natural capital assets, the ecosystem services they provide and the valuation of them. These include existing and proposed projects, mainly with a UK focus as the SRP Natural Asset Register's geographical boundary is Scotland's.

An online search for 'natural asset registers' returns three main groups of initiatives:

1) initiatives providing functional assessment of natural capital assets and/or ecosystem services and/or their valuation,

2) those initiatives that provide access to environmental data and supporting information, and

3) natural resource management initiatives that pre-date the Millennium Ecosystem Assessment (2005).

This report focusses on the first two groups. Prior to publication of the Millennium Ecosystem assessment (2005) the term 'natural assets register' had been used in a few examples of natural resource management initiatives: for example the Sankey catchment natural asset register in the UK (EA, 1998). That report was based on a series of paper maps, tables of indices of e.g. the capability of streams to provide ecosystem services and recommended plans of action to improve service provision. However, this third group of initiatives is an older and now outdated means of creating a natural asset register and is not the focus of this report.

2.1 Initiatives reviewed

We have collected examples of practical initiatives based on our existing knowledge, from web based searches and through formally consulting with researchers and policy and management colleagues (Appendix 3: Consultation) for their suggestions. We emphasise that these examples have been chosen to cover the wide range of project types (but with additional emphasis on Scotland and wider UK), and that this list is not intended to represent a complete survey of natural capital asset initiatives. There are a number of international and national drivers behind these (including those described in section 1.2): the INSPIRE directive; Digital Scotland; Scottish Government Open Data Strategy; the LIFE+ funding of Scotland's Environment Website (and subsequent funding by SEPA); and a range of EU, UK and Scottish research programmes.

Initiatives we have considered needed to provide more than just one type of data e.g. surface and ground water quality to be included. These were divided into those that: 1) primarily carried out or provided assessments of natural capital assets, and/or ecosystem services, and/or their accounting; and 2) those that focused on the registering and/or provision of environmental data and information, particularly where that information is spatial data. The initiatives that have been reviewed are included in Table 1. Each of the projects in this table is described in Appendix 1: Initiatives primarily providing assessment functionality or Appendix 2: Initiatives primarily providing environmental data and information. Please refer to these appendices for more detailed information and links to each tool or website.

Table 1 Summary of existing natural asset registers and related practical initiatives

	What is covered			Provision of data		What is it?
	Natural capital assets	Provision of ecosystem services	Valuation of natural capital/ services	Does it provide spatial data?	Spatial extent	
Initiatives primarily providing assessment of functionality (see Appendix 1)						
SNH Natural Capital Asset Index (NCAI)	Y	Y	N	N	Scotland	Index
Defra & Scottish Government ecosystem accounts pilots	Y	Y	Y	N	Regional	Report
UK Natural Capital Asset Check	Y	Y	Y	N	UK	Report
UK national level and corporate level natural capital accounts	Y	Y	Y	N	Site, UK	Report
RICS sponsored Natural Capital Planning Tool (NCPT)	Y	Y	N	N	Site	Report, Tool
Natural Capital Protocol	Y	N	Y	N	Site, business	Tool/framework
Initiatives primarily providing environmental data and information (see Appendix 2)						
Scotland's Environment Website-first phase	Y	Few	N	Y	Scotland	Website
Scotland's Environment Website – Shared Digital Hub/ Environment Information Portal	?*	?	?	?	Scotland	Website
Scotland's Environment Website – Centralised Environmental Data Catalogue	?	?	?	?	Scotland	Website
Scotland's Environment Website – Ecosystem Health Indicators	?	?	?	?	?	Website
Scotland's Environment Website – Ecosystem service Data Management Tool	?	?	?	?	?	Website

Perth and Kinross Council – Instant Atlas	Y	Y	N	N	Regional	Website
Scottish Government Land Use Strategy Data Directory	Y	?	?	?	Scotland	Website
National Biodiversity Network Gateway	Y	N	N	Y	Site, Regional, UK	Website
Atlas of Living Scotland	Y	N	N	Y	Site, Regional, Scotland	Website
Spatial Hub (Scotland)	?	?	N	Y	Scotland	Website
NERC Biodiversity and Ecosystem Services Directorate Mapping Gateway	Y	Y	N	N	Site	Website
UK Environmental Change Network	Y	N	N	N	Site	Website
CEH Environmental Information Platform	Y	Y	N	Y	Site, Regional, UK	Website
European Environment Agency: European Data Portal	Y	?	?	Y	EU	Website
European Nature Information System (EUNIS)	Y	N	N	Y	EU	Website
EUROSTAT	Y	N	N	Y/N**	EU	Website
Geospatial Resources at the US Environmental Protection Agency	Y	Y	?	Y	USA	Website

*A question mark indicates that the content of recently announced initiatives is uncertain at this time.

** Datasets with a European extent are often limited to one single value for the whole of the UK (let alone Scotland).

2.2 What we have found and learned

2.2.1 General findings/lessons

There are a wide range of potential purposes and associated functionality that can be included in the proposed SRP Natural Asset Register. These range from storing and providing just new (2016-) MRP RESAS research data on Scotland's natural capital assets, to providing functionality of national scale spatially explicit assessment of a complete range of Scotland's natural capital assets, and the ecosystem services they can provide.

Rapid increase in initiatives over the past 12-24 months that is likely to continue

Recently there has been a large amount of interest in environmental data and information and how this can be provided, as evidenced by the rapidly growing number of new initiatives in this field (some of which are described in Appendices 1 and 2), and this is relevant to developing the SRP Natural Asset Register. All of the initiatives in Table 1 (Section 2.1 Initiatives reviewed) have been developed in the past five years and they have been driven by these needs:

- to include natural capital assets, ecosystem services and their valuation in policy and management decision making;
- to meet the EU INSPIRE (Infrastructure for Spatial Information in the European Community) directive (2007) and
- to meet other institutional or legal requirements to provide open data (and supporting information) to a wide range of users in a consistent and quality assured manner, e.g. Scotland's Open Data Strategy.

Several of the initiatives that are primarily focused on providing environmental data and information have been announced or developed in the past six months. This proliferation of projects, particularly in Scotland, provides an opportunity for greater coordination and a need to ensure that the SRP Natural Asset Register complements rather than duplicates efforts in this area.

There are two main types of initiatives relevant to SRP Natural Asset Register, depending on its final purpose and functionality

The initiatives we have found can be broadly split into two groups (Table 1). The first group includes site to national scale initiatives that primarily assess the state of natural capital assets, the services they provide and their valuation, e.g. the SNH Natural Capital Asset Index. The second, significantly larger group is focussed on web based provision of environmental data and information to support a wide range of purposes, e.g. Scotland's Environment Website.

All of these initiatives are dependent on using established standards and approaches

It may be considered that the initiatives which have been reviewed would all benefit from adhering to existing and established approaches, (e.g. MAES) and standards (e.g. CICES). However, the benefits from following these standards, and they are many and varied, and not always consistently used, must be balanced with the anticipated skills and expectations of each of the project's target audiences and the necessity of avoiding jargon and excessively technical language in sites intended for the general public.

Digital (web) technologies are enabling the development of these initiatives, especially free and open source software

The use of existing templates (e.g. Atlas of Living Scotland which is based on the Atlas of Living Australia) or generic and open source platforms (e.g. the Comprehensive Knowledge Archive Network (CKAN)[3] as used by Spatial Hub Scotland) may result in considerable efficiencies and cost savings in the development and maintenance of the site and the common navigation structures may also aid users familiar with other sites. However, this must be balanced against the flexibility and control that can be gained from completely bespoke designs (e.g. Scotland's Environment Web site – known as "SEWeb"). These considerations must inform the discussion of the content and structure of the SRP Natural Asset Register. Limited resources (budgetary and human) to develop a spatial data sharing project may dictate that existing and proven free to use platforms must be used.

There is a need to link assessments of natural capital assets with data on those assets

As an outcome of our review we have observed that there is a need to link the assessment functionality provided in the first group of initiatives, with the tools of the second group to provide accessible online environmental data and information to support decision making. For example the Millennium Ecosystem Assessment in 2005 assessed the state of the natural environment and the benefits it gives to society in terms of ecosystem services, but the spatial data behind it cannot be viewed by those without specialised software and the skills to use it (http://millenniumassessment.org/en/GraphicResources.html, accessed 11th July 2016). Additionally, the project data itself was unavailable for several years, emphasising the importance of ongoing support for projects.

[3] CKAN is an open source (so available for free) system for the storage and distribution of open data

2.2.2 What we have learned from initiatives primarily providing assessment functionality

The initiative-specific drivers influence the approach and extent of the assessment functionality

These are driven by specific needs e.g. to incorporate the status of natural capital assets in national, regional or corporate accounting, or to support consideration of a wider range of benefits provided by natural capital assets during planning applications e.g. Natural Capital Planning Tool (Holzinger et al., 2016) and across individual national policies e.g. Defra and the Scottish Government's project 'Developing ecosystem accounts for protected areas in England and Scotland' (White et al., 2015).

There is a need to include information on the quality of natural capital assets

There are an increasing number of initiatives that have called for, or attempted to provide information on the quality of natural capital assets, as well as their quantity. For example, a number of the studies have been described as providing a 'natural capital asset check' (Dickie et al., 2012, Dickie et al., 2014). These studies have considered the quantities of natural capital assets and what condition they are in, what do they produce, and how do our decisions affect them. A qualitative assessment of natural assets (e.g. the type and age of woodland) is a key requirement in the quantification of ecosystem service provision.

There are a number of limitations related to providing functional assessment of natural capital assets

These studies have identified a range of challenges and barriers to carrying out comprehensive assessments of natural capital assets, the ecosystem services they provide and their valuation due to: the lack of appropriate spatial data that covers the quality of the habitats and how these change over time for a range of ecosystem services, and the lack of approaches to reproducibly value these assets and services.

The lack of spatial data on the quality of habitats and their temporal changes was identified by White *et al*. (2015) in their pilot project to develop ecosystem accounts. They were unable to produce reliable estimates of trends in ecosystem extent and condition over the period 2007 to 2015. They reported that time series data for the physical flow accounts were in general found to be more readily available, apart from those services based on habitat area due to limitations of the land cover map data.

Lack of approaches to reproducibly value these assets and services

The valuation of natural capital assets and the ecosystem services they provide is an area of rapid development. Existing initiatives that have attempted to link the status of natural capital assets to their valuation have found this challenging. For example, White *et al*. (2015) found it more difficult to produce monetary flow accounts compared to the physical flow accounts due to conceptual challenges of monetisation, and a lack of reliable and reproducible approaches for valuation for a range of services that included non-drinking uses of water, flood protection, education, heritage, aesthetic and existence values.

Existing initiatives have been criticised for including indicators that do not reflect the status of natural capital assets

As highlighted above a comprehensive set of datasets on condition of natural capital assets for the whole of Scotland does not exist. This leads to the inclusion of proxy indicators in existing

assessments of natural capital assets. For example, a systematic evaluation of the Scottish Natural Capital Asset Index (NCAI) by Albon *et al*., (2014) found that a low percentage (< 30%) of the indicators were fit for purpose and many of the indicators reflect changes in ecosystem services flows and not the ability of the Broad Habitats to sustain those services. Albon *et al*. (2014) found that few indicators reflected changes in the 'condition' of a natural capital assets. The evaluation suggested four areas of development should be considered:

- removal of problematic indicators,
- alternative measures of key properties and processes,
- the need for weighting across ecosystem service groups, and
- appropriate time intervals for the collection of indicators.

2.2.3 What we have learned from initiatives primarily providing environmental data and information

There has been a recent increase in the number of new data and information initiatives of relevance to the SRP Natural Asset Register

In the last few years a large number of web based initiatives have either been established or recently initiated (particularly in Scotland) to make spatial data on natural capital assets accessible to a wide range of users. These projects can be classified in numerous ways, including the following:

1. The target audience, e.g. the Improvement Service's Spatial Hub is specifically for Scottish Local Government while Perth and Kinross Council's Instant Atlas is primarily aimed at local residents and council staff.
2. The type of data they provide, and how do they provide it: is the data stored locally in an asset register, or accessed remotely through a live connection to the owners of the data? This is of particular for relevance to the SRP Natural Asset Register.
3. The geographical scope of the project.
4. The supporting information included with the data. For example Scotland's Environment Web includes the State of Environment report which was created by experts in each area whereas the Scottish Government Land Use Strategy Data Directory is a small number of web pages containing links to relevant data.

The web based initiatives listed in Table 1 and described in Appendices 1 and 2 have a range of purposes in terms of the types of data, the variety of natural capital assets the data represent, the spatial extent of the data, and whether or not they provide visual summaries of the data, metadata about the data, or the spatial data themselves.

The provision of data and information ranges from a list of links in a table (e.g. the Land Use Strategy Data Directory), through the presentation of themed maps (e.g. SEWeb), to an interactive hub for data upload and download (e.g. Scotland's local authorities' Spatial Hub).

The primary purposes of these initiatives are generally to make natural capital or natural asset information available, although these terms are not among those which are generally used. Natural capital/assets are referred to in the SEWeb State of the Environment reporting section, but not in the section for displaying environmental data. This difference in approaches and use of terms may reflect the needs or expectations of different target audiences and a wish not to discourage general

users by the use of terms which can be perceived as being overly technical. At present SEWeb includes several hundred data sets of natural assets but only (at this time) a few of these are recognisably indicators of ecosystem services. From this it may be inferred that SEWeb is not currently addressing ecosystem services, their flows and valuations as a priority; although a number of projects to create ecosystem services sites e.g. Ecosystem Service Data Management Tool, which would be a SEWeb subsidiary site have been proposed or discussed (see Appendix 2 for more detail).

There are a range of approaches to presenting web based complex information on natural capital assets

The sites reviewed can also be compared in terms of their approaches to dealing with the complexity of presenting a diverse list of data sets. Scotland's Environment website has several hundred mapping layers grouped into three classes and many sub-classes. However, the project's success in collating a comprehensive collection of mapping layers has had the result that it can be time consuming to find a required layer. An attempt has been made at producing themed maps, but these are only moderately successful and the combinations of layers chosen appears rather arbitrary (e.g. the "Land" map includes soils data, national park boundaries and designated areas, but no land cover layer). As a comparison, the Perth and Kinross Council site also offers a tool whereby the user may choose which layers are required for the map, but also includes effective predefined maps for particular purposes. A combination of providing flexibility to those who require it, but also a simple ready-made solution to those who do not would appear to be a successful approach.

Web services are increasingly used to provide information on natural capital assets

The majority of initiatives reviewed which include data owned by other parties take advantage of Web Mapping Services (WMS) to display this data. With this technology data is held remotely (usually by its owner) and software makes available an image of the data to any website (or desktop software) that is designed to display it. As it is an image of the data that is shared (the appearance of which is decided in advance by the creator of the WMS) organisations hosting a website such as Scotland's Environment have very little control over the appearance of the map. As there is often little or no collaboration between organisations when deciding on the cartographical appearance of their data, when WMS layers from different organisations are combined in a single view it can result in maps which can be difficult to understand or which fail to convey meaningful information. It is likely that there will be a migration to a different type of mapping service (Web Feature Service - WFS) by late 2020 when the EU INSPIRE directive fully applies to all environmental spatial data[4]. This type of spatial data service will offer more flexibility in data access and provision, but until then this limitation is a factor in considering whether data belonging to other parties should be stored in the SRP Natural Asset Register (which would offer full control over mapping symbology) or WMS (which would offer virtually no control) should be used.

Among the projects reviewed there is variety in the way in which users can interact with data. SEWeb uses the Spotfire tool to allow the user to examine data with a spatial component to extract localised maps and charts, some of which can be compared over time. The CEH Environmental Information Platform in particular presents data in an interesting and clear manner. The US Environmental Protection Agency has a very large range of tools to present its comprehensive data, these include conventional mapping but also reports and graphs that can be generated for selected

[4] EU INSPIRE Roadmap

areas and digital dashboards showing neighbourhood environmental data. The Digital Catapult: Environmental Data Exchange includes a diverse set of data, including links to sources of satellite data that could be useful to researchers producing analyses of ecosystem services.

Local and Remote Data Access

The decision on whether data should be stored within the Natural Asset Register or accessed remotely also falls under the EU INSPIRE regulations. It is a general principle of INSPIRE that data should be kept where it can be maintained most effectively, and in most cases this is likely to be where the data was produced. This raises the question of whether the Natural Asset Register should hold copies of e.g. the National Forest Inventory or should it instead contain a link to the data on Forestry Commission servers? If copies of the data are included then ensuring that current versions of data are maintained becomes crucially important to the success of the project. However, the maintenance of the Natural Asset Register can include electronic subscriptions to the INSPIRE mandated pre-defined download services so that notified updates can be included. For data sets which are not INSPIRE compliant ensuring that the latest versions of data are included is likely to be problematic and time consuming. However, from a user's perspective, a site that provides the data for download is more convenient than one which does not.

The decision on whether to store data locally or to use WMS also determines the functionality that a site can offer. The Atlas of Living Scotland has requested data from owners so that it can implement spatial analysis tools such as those currently provided on the Atlas of Living Australia (the site that has provided the template for the Atlas of Living Scotland). On the Australian site a user can perform a number of spatial analysis tasks such as classifying one dataset by its overlap with another. This type of analysis can only be done where data is stored locally (or WFS are used) it cannot be performed when WMS is used as in Scotland's Environment mapping pages. The Scotland's Environment sub-site Land Information Search does offer a spatial search tool but this does not function with the full suite of mapping layers, only those locally stored or for which feature services have been enabled.

3. Developing the scope, focus and requirements of the SRP Natural Asset Register

Two of the objectives of writing this review of existing 'natural asset registers' were to: 1) contribute to a discussion on the purpose of the SRP Natural Asset Register, and 2) evaluate how the Natural Asset Register relates to the wide range of rapidly developing and related web based initiatives already available. These are discussed below, following the first section which describes the references to the Natural Asset Register in the MRP SRP proposal.

3.1 References to the Natural Asset Register in in the Main Research Providers Strategic Research Programme proposals

Across the RESAS SRP Themes there are a large number of references to the Natural Asset Register (Table 2), including from the fields of genetics, demographics, soil, biodiversity and the rural economy. The diversity of these research deliverables (RD) referring to the Natural Asset Register requires that a large degree of flexibility to accommodate this content must be incorporated into its design. In scoping out the focus and requirements of the Natural Asset Register, the potential requirements of these connections need to be set out explicitly and summarised in terms of the next

stage of developing the formal specification. Two examples, taken from the technical approaches in Objectives 1.4.1B and C, provide indications of the potential requirements of the Natural Asset Register.

"This objective will use a variety of modelling approaches to link the data and indicators in the Natural Asset Register to the flow of ESs [ecosystem services]; this will draw on spatial analysis within the RD [research deliverable] and modelling work undertaken across Theme 1. (…) It will also be used within continuing research in the RD to use the Natural Asset Register to identify areas for priority action in terms of ecosystem management and restoration and use the Natural Asset Register to develop new methodological approaches to understanding the relationships between natural assets, ecosystem functioning, and service delivery." (RESAS Objective O1.4.1B Assessing ecosystem service delivery and interactions).

"The objective of the RD will use the Natural Asset Register to develop Natural Capital Accounts. These will combine the biophysical data in the Natural Asset Register with ecosystem services flows and economic valuation data to develop a spatial Natural Capital Accounts framework. The Natural Asset Register will be used to 1) develop the Natural Capital Accounts from the Natural Asset Register, and 2) apply the Natural Capital Accounts across a range of scales and end-users (Government, agencies, specific sectors or industries, and business)." (RESAS Objective O1.4.1C Natural capital accounts).

Table 2: References to the Natural Asset Register across Strategic Research Programme Themes

Theme	WP	RD	Name of RD
1	1.1	1.1.4	Soil management
1	1.2	1.2.1	Water and its ecosystem functions
1	1.2	1.2.2	Impacts of change on water
1	1.3	1.3.1	Biodiversity and ecosystem function
1	1.3	1.3.2	Ecosystem services supply
1	1.3	1.3.4	Biodiversity management
1	1.4	1.4.2	Identifying and understanding multiple benefits and trade-offs
1	1.4	1.4.3	Practical interventions to realise multiple benefits and manage trade-offs
2	2.3	2.3.2	Protecting Genetic Diversity
2	2.4	2.4.3	Environmental sustainability and circularity of the rural economy
3	3.4	3.4.1	Demographic change in remote areas
3	3.4	3.4.3	Rural Landscapes and Community wellbeing

3.2 Where does the SRP Natural Asset Register fit in relation to the initiatives reviewed?

In this section we discuss the SRP Natural Asset Register in relation to the initiatives reviewed in Table 1 (Section 2). The Natural Asset Register will seek to use common approaches, standards and available digital technologies. It will also adhere to the specifications set out in the EU INSPIRE directive.

Consideration is required as to what extent the SRP Natural Asset Register should duplicate functionality and content to be found in existing projects such as Scotland's Environment Website (SEWeb), albeit the SRP Natural Asset Register will have a different focus, such as structuring data storage according to the CICES classification or providing more technical information than a site intended for a more general audience. This consideration is closely linked with a decision on whether the Natural Asset Register is to be set up as a stand-alone website or as part of a larger site such as SEWeb, this matter will be resolved in the accessibility consultation which is due to be completed in March 2017. The Natural Asset Register is likely to be classed as belonging in the second group of initiatives that primarily provide environmental data and information (as described above in Section 2). The RD141 Objective A to build a Natural Asset Register does not on its own carry out the assessment of natural capital assets, their ecosystem services, or their valuations, as this will be carried out by Objectives 1.4.1. B and C and elsewhere in the research programme. However, in providing access and storage for relevant RESAS SRP spatial data outputs and their accompanying metadata the SRP Natural Asset Register has a unique role. Additionally, by including an emphasis on cultural ecosystem services (RD141, Objective B) and the outputs of ecosystem services valuation work (RD141, Objective C) the Natural Asset Register will also provide access to information and functionality which is largely unavailable at present in Scotland.

A range of technological sophistication in the existing initiatives has been described above: from the webpages with tables of links to resources (Land Use Strategy Directory), interactive maps with many data layers and up to geographic information systems functionality (Atlases of Living Australia and Scotland). The SRP Natural Asset Register will include functionality which at a minimum accomplishes the aims set out in the SRP proposal and 'will develop a comprehensive, national, spatially-explicit NAR, which will allow the identification of assets "at risk" and include an inventory of ES flows from the assets'. The inclusion of more sophisticated functions such as those to be found in very well-funded and resourced projects (e.g. the Atlas of Living Australia) will be explored during an analysis of the needs of the project which will follow on from this review.

3.3 The next steps in developing the SRP Natural Asset Register

Following acceptance of this report we hope to discuss this review with relevant internal and external colleagues and stakeholders, including Chris Dodds (RESAS) and Paul Watkinson (SNH lead on Natural Capital Asset Index). These discussions will also focus on what is to be the scope and aim of the Natural Asset Register, and also that we wish to co-construct these with RESAS, MRP colleagues and other stakeholders. Questions to be addressed in developing its scope include whether it is primarily a strategically relevant research tool or is it intended to be more of a tool for the general public, leading onto identifying who is the primary audience.

Among the outcomes of those discussions will be a decision as to whether or not the Natural Asset Register will include data published and made freely available by other bodies (e.g. SNH) or if it will contain only MRP outputs on asset condition, assets at risk, ecosystem service flows and valuations. This discussion will be used to inform a formal specification for the Natural Asset Register which will include both its content and its structure. The specification may also contain an approach as to how outputs from other parts of the SRP will be collated into the register, as this will be a key consideration in its overall success.

This specification will guide the construction of the draft (and at this stage internal only) SRP Natural Asset Register database, due at the end of March 2017. A consultation on providing access to the Natural Asset Register is also due in March 2017. We will at all stages of the scoping and development seek to ensure that we retain as much flexibility to accommodate unforeseen changes in the technological, environmental and legislative areas.

The process of developing websites for the provision of ecosystem services and valuation data may also lead to a discussion on trusted sources, or provenance of this type of data. For example Hutton is known to be the trusted source of soils data, SEPA for water quality etc., but which organisation or spatial information portal will be considered to be a trusted source of ecosystem services datasets which integrate data and models from many sources using highly complex models which require detailed parameterisation? Additionally there may be multiple sources of comparable ecosystem services data resulting from varying models from which a definitive example must be chosen. There may also be considerations on data quality and how this is assessed and verified and the data then approved for publication. Therefore, this provides the SRP Natural Asset Register with an opportunity to be explored with potential end-users and data suppliers alike.

Appendices

Appendix 1: Initiatives primarily providing assessment functionality

SNH Natural Capital Asset Index (NCAI)

Key sources/references

Scottish Government use of Natural Capital Asset Index as a Land Use Strategy indicator
http://www.gov.scot/Topics/Environment/Countryside/Landusestrategy/Monitoring/Indicator5
(accessed 8th July 2016)
2015 summary of the Natural Capital Asset Index
http://www.snh.gov.uk/docs/B814140.pdf (accessed 8th July 2016)

Background and purpose

Scottish Natural Heritage have developed the Natural Capital Asset Index (NCAI) over the past several years. The NCAI was developed as a measure of relative change in the extent and condition of each of seven ecosystems (Broad Habitats) weighted across ecosystem services, and standardised to 100 in the year 2000. Then a single aggregate value for Scotland was derived by weighting across Broad Habitats. An evaluation of the NCAI was undertaken by Albon *et al*., (2014) (A systematic evaluation of Scotland's Natural Capital Asset Index. Scottish Natural Heritage Commissioned Report No.751) found that a low percentage (< 30%) of the indicators were fit for purpose and many of the indicators reflect changes in ecosystem services flows and not the ability of the Broad Habitats to sustain those services i.e. natural capital. Albon *et al*., (2014) found that few indicators reflected changes in the 'condition' of a natural capital assets. The evaluation suggested four areas of development that should be considered: removal of problematic indicators, alternative measures of key properties and processes, the need for weighting across ecosystem service groups, and appropriate interval for the collection of indicators (Albon et al., 2014).

Relevance to SRP Natural Asset Register

The NCAI provides spatially aggregated values for the quality and quantity of terrestrial habitats in Scotland to supply ecosystem services. To estimate the quality of habitats it provides an evaluation of the potential of each European Nature Information System (EUNIS) habitat in Scotland to provide a range of ecosystem services. It also uses a set of indicators to monitor changes in the quality of these habitats.

Status of the initiative

The methodology was revised in 2015 based on the evaluation by Albon *et al*., (2014). Changes included use of the EUNIS habitat classification. The NCAI has recently been chosen as the indicator to monitor the change in natural capital in Scotland as part of the Land Use Strategy (http://www.gov.scot/Topics/Environment/Countryside/Landusestrategy/Monitoring/Indicator5).

Defra and the Scottish Government pilot project 'Developing ecosystem accounts for protected areas in England and Scotland'

Key sources/references

Defra project record and reports

http://sciencesearch.defra.gov.uk/Default.aspx?Menu=Menu&Module=More&Location=None&Completed=0&ProjectID=19271 (accessed 8th July 2016)

Background and purpose

In 2014-15 Defra and the Scottish Government set up a pilot project entitled 'Developing ecosystem accounts for protected areas in England and Scotland'. The aim of the project was to scope and develop ecosystem accounts for a selected suite of protected areas (National Parks and Areas of Outstanding Natural Beauty) in England and Land Use Strategy (LUS) pilot areas in Scotland that provide multiple ecosystem services from a range of habitats. The accounting framework was based on earlier Defra and Office for National Statistics (ONS) work and utilises the UN System of Environmental Economic Accounting (SEEA) guidance on Experimental Ecosystem Accounting (EEA) (White et al., 2015). Pilot sites were chosen with stakeholders and included the Borders and Aberdeenshire LUS pilot areas. They carried out a literature review of related initiatives that were developing ecosystem accounts linked to the UN SEEA guidance on EEA. This review informed the framework they used to carry out the pilot accounts. Following existing UK guidance on the Principles of ecosystem accounting(ONS and Defra, 2014) there are three types of accounting units that enabled three sets of interrelated accounts to be developed (Table 1).

Table 1. Three types of ecosystem accounting units and three sets of interrelated ecosystem accounts (White et al., 2015).

Ecosystem accounting units
The **Ecosystem Accounting Unit (EAU)** is the largest spatial unit and defines the extent of the ecosystems and ecosystem service flows to be captured within the accounts. This is delineated by the administrative boundaries of the six pilot areas.
The **Land Cover Ecosystem Unit (LCEU)** is an intermediate spatial unit which is used to identify the ecosystems within the EAU boundary that provide service flows. This is compiled from the land cover classes set out in the Land Cover Map (LCM) 2007 and is aligned with the UK NEA broad habitat types; although marine and urban habitats were excluded. As such, the LCEU's included in the accounting framework are: woodland; enclosed farmland; semi-natural grassland (SNGL); open water, wetland, and floodplain (OWWF); mountain, moorland, and heath (MMH); and coastal margins.
The **Basic Spatial Unit (BSU)** is the smallest unit type and is used to assess local variation in ecosystem service flows. BSUs are the basis for compilation of all other units and mapping outputs, and are defined as 1 km grid squares.
Interrelated ecosystem accounts
Asset accounts: which measure the extent and condition of ecosystems in terms of their ability or

capacity to provide ecosystem service flows. Population of the asset account framework involved selection of a set of indicators used to provide 'proxies' for the capacity of ecosystem assets to deliver services. The asset accounts were compiled at an LCEU level for each of the broad habitat types contained within a pilot area's boundaries i.e. separate asset accounts for woodland; enclosed farmland; semi-natural grassland; open water, wetland, and floodplain; mountain, moorland, and heath; and coastal margin habitats for each of the six pilot areas. Data was collated across the period 2007 to 2015 in order to identify whether robust comparisons could be made between a hypothetical opening and closing balance.
Physical flow accounts: which measure the actual flows of services provided by the ecosystems. Fifteen services were selected for inclusion within the accounts. Logic chain diagrams were developed for each of the ecosystem services to clearly set out the links between ecosystem characteristics, ecosystem services, human inputs, and goods. The physical flow accounts were also compiled at an LCEU level for each of the broad habitat types contained within the boundaries of each pilot area. All of the data on physical flows was collated and stored in a GIS which facilitated the production of maps (at a 1 km^2 resolution) to illustrate the spatial distribution of ecosystem services within each pilot area.
Monetary flow accounts: which measure the value of these flows in monetary terms. The structure closely follows that of the physical flow accounts and they are compiled at an LCEU level. However, in addition to time series estimates of the monetary flows of each service each year, an asset valuation calculation was also undertaken to provide an estimate of the net present value of ecosystem service supply in future.

Relevance to SRP Natural Asset Register

White *et al.*, (2015). found a series of challenges and limitations to applying their accounting framework (Table 2). They were unable to produce reliable estimates of trends in ecosystem extent and condition over the period 2007 to 2015 (White et al., 2015).They provided an opening balance for the asset accounts based on data available from 2013. Ecosystem condition was based on five categories of indicators: biomass/carbon, biodiversity, soil/water quality, accessibility, and conservation status. Time series data for the physical flow accounts were in general found to be more readily available, apart from those services based on habitat area due to limitations of the land cover map data (White et al., 2015).They found it more difficult to produce monetary flows account compared to the physical flows account due to conceptual challenges of monetisation, and lack of reliable and reproducible approaches for valuation for a range of services that included non-drinking uses of water, flood protection, education, heritage, aesthetic and existence values. A state of progress of each of the fifteen services and list of specific lessons learned was provided.

Table 2 Key challenges and limitations identified in developing ecosystem accounts (White et al., 2015).

Key challenges and limitations
Asset account With the Land Cover Map (LCM) data it is difficult to obtain reliable estimates of habitat change over

time as a result of changes to the surveying methodologies employed in each successive land cover mapping exercise. Linking physical flows of services to the condition of the ecosystems from which they originate is challenging. High level indicators were used to measure the condition of ecosystems in the pilot areas over the period 2007 to 2015. However, while there are a number of good quality datasets available for tracking high level indicators of ecosystem condition, accessing consistent, reliable time series data over this period was a recurrent challenge throughout population of the asset account.
Physical flows account For some services based on habit area it was difficult to establish temporal trends due to the limitations of the LCM data. For other services it was not possible to develop an indicator to monitor temporal change, these included: flood protection, education and heritage.
Monetary flows account Conceptual challenges of monetisation. Lack of reliable and reproducible approach for valuation of a range of services.

Status of the initiative

It is unclear if there is ongoing activity after the report on the pilots was published in 2015.

UK Natural Capital Asset Check

Key sources/references

Report

http://uknea.unep-wcmc.org/LinkClick.aspx?fileticket=ALFqJld0K8o%3D&tabid=82 (accessed 8th July 2016)

Background and purpose

In the UK a Natural Capital Asset Check has been developed (Dickie et al., 2012). This is an assessment of the current and future performance of natural capital assets, with performance measured in terms of their ability to support human well-being. It considered how much natural capital asset there is, what condition it is in, what does it produce, and how do our decisions affect it.

Relevance to SRP Natural Asset Register

The final report on the Natural Capital Asset Check (Dickie et al., 2014) defined natural assets through existing environmental classifications e.g. habitats, and other assets e.g. renewable/non-renewables. This was done with a focus on productive combinations, where an asset is anything that can be controlled or owned to produce positive economic value. An asset based approach would enable linkages with existing accounting approaches and for the value to be carried forward from one accounting period to the next. Dickie *et al.*, (2014) defined natural capital as the configurations of natural assets and/or other types of capital, which produce flows of goods and services. They suggested that individual assets (which were either living or non-living, and renewable or non-renewable) and ecosystem assets together formed natural assets. Dickie *et al*.,(2014) suggested that Natural Capital Asset Checks could be carried out to generate information to support decisions related to natural assets.

Status of the initiative

This initiative appears to have been completed. It has influenced related natural capital accounting projects.

UK national level and corporate level natural capital accounts

Key sources/references

See text for references

Background and purpose

A first estimate by the Office of National Statistics of the monetary value of UK natural capital for 2011 was £1,573 billion, which was 4.1% lower than in 2007 (Khan et al., 2014) The UK Office for National Statistics has been working with Defra and the Natural Capital Committee to review progress from the first two years of the UK Roadmap to incorporate natural capital into UK Environmental Accounts by 2020 (ONS 2012) and to set out priorities for the next phase of the roadmap (Khan, 2015). Achievements included initial UK land-use, land cover, woodland and freshwater accounts. They identified the development of accounts for practical applications, capacity for natural capital accounting, as well as wider awareness and use of the accounts to be key challenges that need addressing in the next phase of the roadmap. The Natural Capital Committee had commissioned the development of the Corporate Natural Capital Accounting framework (Provins et al., 2015). The aim is to produce a set of reporting statements that can be used to monitor and measure the health and value of natural capital.

Relevance to SRP Natural Asset Register

It covers both biotic (living) and abiotic (non-living and physical condition) components of natural capital. The Corporate Natural Capital Accounting framework provides an approach that links financial and non-financial data through the application of the asset register, and physical and monetary flow accounts. To populate the reporting statements information systems (environmental management information and business accounting systems and financial information) and support schedules (natural capital asset register) are required (NCC CNCA 2015). The natural capital asset register is defined as being the "repository of bio-physical metrics that measure and track the state of natural capital over time." (NCC CNCA 2015). The basic entity in the register is the "'accounting unit', which is a delineated plot of land of a single land cover type." For each accounting unit information on the boundary, extent and type of land over; major natural capital assets e.g. soil or species; condition of these assets as measured by quantity, quality and spatial configuration is required.

Status of the initiative

This initiative is ongoing.

RICS sponsored Natural Capital Planning Tool

Key sources/references

Report

http://www.rics.org/uk/knowledge/research/research-reports/natural-capital-tool-planning-/
(accessed 8th July 2016)

Background and purpose

The Royal Institution of Chartered Surveyors (RICS) has sponsored the development of the Natural Capital Planning Tool (Holzinger et al., 2016). The aim was to develop a reliable and industry acceptable methodology based on ecosystem services to assess and manage long-term impacts of proposed major developments and plans on natural capital and ecosystem services. A multi-criteria decision analysis framework was developed as the target audience are unlikely to have the expertise or time to individually assess the impact of developments on ecosystem services. Ten task groups were established, one for each of the Natural Capital Planning Tool (NCPT) ecosystem services. They comprised of experts from government institutions, academia, as well as practitioners including local authorities and businesses. The task groups identified feasible sets of indicators to assess each ecosystem service, and prioritised these to select a final set of indicators for the NCPT. The project resulted in the development of the assessment tool, which calculates a Development Impact Score, based on aggregated Ecosystem Service Impact Scores. The NCPT has been tested in three case-studies that included an Environment Agency Flood Alleviation Scheme in Staffordshire (Holzinger et al., 2016). The NCPT was seen to go beyond current tick-box assessments, and as a stepping stone to integrated management of natural capital and ecosystem services in a planning context (Holzinger et al., 2016).

Relevance to SRP Natural Asset Register

This is a practical tool to support decision making, which may be one of the key functions of the proposed asset register. However a set of ten ecosystem services has been chosen for this tool rather than e.g. using the CICES classification, so potentially limiting the usefulness of this initiative.

Status of the initiative

Active.

Natural Capital Protocol

Key sources/references

Website

http://naturalcapitalcoalition.org/protocol/

(accessed 27th July 2016)

Background and purpose

The Natural Capital Protocol has been produced by the Natural Capital Coalition to provide a framework to aid production of robust and useful information on natural capital for business managers to inform decisions. They suggest that if natural capital is not incorporated into commercial decision making there are significant opportunities and risks for businesses. It builds on existing guides, tools and methods to allow the measurement, valuation and integration of natural

capital into existing business processes through a framework based on four stages and the principles of relevance, rigour, replicability, and consistency. The four stages involve going through a series of linked questions and actions.

Relevance to SRP Natural Asset Register

This is a practical framework to support commercial decision making. It uses tools/databases like is proposed in the SRP Natural Asset Register.

Status of the initiative

Active.

Appendix 2: Initiatives primarily providing environmental data and information

Scotland's Environment Website

Key sources/references

http://www.environment.scotland.gov.uk/ (accessed 8th July 2016)

Background and purpose

The Scotland's Environment Website project (commonly known as SEWeb) was started in 2011 and it is a large project, having an initial budget of € 4,780,852.00 (http://ec.europa.eu/environment/life/project/Projects/index.cfm?fuseaction=search.dspPage&n_proj_id=3990) between 2011 and 2015 and further support from SEPA following the ending of the LIFE+ funding. It may be considered to be the largest environmental data project of its type in Scotland. The aim of SEWeb is that it should be the gateway to information about Scotland's Environment. Much of the investment in SEWeb has been used in assessing the most effective and efficient means to make environmental data accessible and lessons learned in this process are likely to be useful for the SRP Natural Asset Register.

The SEWeb project was managed by SEPA with significant contribution from Scottish Government and other institutional partners, including the James Hutton Institute, which was represented on the project management group by one of the authors of this review. The development of the site was informed by stakeholder workshops and consultations, online and offline interviews.

For the purpose of this review the main area of interest is its Get Interactive section. This displays spatial information on Scotland's Environment from a number of owners of data (using Web Mapping Service – WMS) and allows users of the site to view the several hundred data sets in a map that can be viewed and panned and clicked to return information about features. The map layers are made available by the owners of the data (SEWeb itself does not contain or publish this data) and may be displayed superimposed on other layers.

Relevance to SRP Natural Asset Register

As there isn't significant collaboration between map service providers the maps produced by users of SEWeb by overlaying multiple layers, and even the default maps set up by SEWeb, can be less than clear. The data can be interrogated by clicking on the maps, but as a consequence of the chosen technology (WMS) there can be no interaction between the map layers and it is not possible for the user to customise the layer symbology to make the map more clear or even the sequence of display to ensure that point features appear above solid colour layers. Additionally, it is often not possible to readily identify the source of the data so that a user may download it from its provider. This is possibly due to a lack of adequate metadata provision by data owners. The map classification is in three groups: air, water and land. It is further broken down into sub-groups such as conservation, wetlands, waste, woodlands etc. The classifications appear to have been chosen using expert judgement or perhaps in a pragmatic response to data availability rather than adhering to an existing system such as CICES. At present (July 2016) there appears to be little emphasis on ecosystem services, perhaps deliberately to avoid confusing users with terminology which is currently obscure to most. It must also be noted that the current menu structure does not appear suited for the very large number of different layers, making it difficult to quickly find required data. It

is understood that there is an intention to improve the mapping interface to better present the mapping layers (personal communication).

In addition to interactive mapping SEWeb offers data exploration and charting tools where users can view data on e.g. waste, water and air quality and select spatial and temporal criteria on which data can be summarised. These “Spotfire” tools provide a novel and intuitive way to explore large and complex data sets.

The second main area of relevance is in the way that Scotland’s Environment website is relevant to this study is in the way that the site was developed. A steering group consisting of senior staff from partner organisations (including Scottish Government) and a management group with less senior representation were set up by the SEPA project managers. These groups were an important part of the success of the project and a similar governance or advisory structure (at a much smaller scale) could be considered for the SRP Natural Asset Register.

Status of the initiative

Active. This is a mature and successful project (recognised as such by its EU funders). The status of SEWeb is about to be modified (see below).

Scotland's Environment Website – Shared Digital Hub/Environment Information Portal

Key sources/references

Not yet available.

Background and purpose

This is a recently announced project (June 2016) which "provides support to mygovt.scot online transactions and exchanges, and other decision making activities of staff and customers, that require supporting environmental data from different sources and a signposting service to information, guidance, expertise available on partner and daughter websites" – *Future of Scotland's Environment Web Collaboration between RAFE Partners*, Peter Singleton and Jo Muse (SEPA, 6th June 2016). It is intended that this hub will be "the environmental data portal of choice for RAFE (Rural Affairs, Food and the Environment) partners" (ibid.).

This project will use the existing SEWeb infrastructure. The use of the word "signposting" suggests that it is likely that this portal will follow existing SEWeb practice by including web mapping services published by data owners and not hold any data. While this is understandable from the view of SEWeb as it reduces the amount of maintenance required to keep data sets current, and it is also justifiable by referring to EU INSPIRE principles, from the viewpoint of a user it would surely be to more convenient to be able to visit a single site to obtain all require data.

Relevance to SRP Natural Asset Register

There appear to be overlapping aims between this initiative and the SRP Natural Asset Register. However, the inclusion of ecosystem service flows and values and research outputs in the Natural Assets Register clearly separates the two projects. It is possible that the Shared Digital Hub will be designed for specific and limited purposes (e.g. planning applications) in ways that are not envisaged for the Natural Assets Register. Additionally SEWeb is being repositioned as "the environmental data portal of choice" (ibid.) and the prime function of the Natural Assets Register is as a register of natural asset data, that is a repository where the data is be stored and from which it is made accessible, including to initiatives such as the SEWeb information portal. We do not anticipate the SEWeb portal being used to collate new and innovative data sets such as those being produced under the Strategic Research Programme however it is possible that it will function as an entry point to the SRP Natural Assets Register.

Status of the initiative

This project has been approved by RAFE, but has yet to be implemented into the SEWeb structure.

Scotland's Environment Website – Centralised Environmental Data Catalogue

Key sources/references

Not yet available.

Background and purpose

SEWeb has proposed to develop a centralised Data Catalogue for all Open Data currently presented on the website data tools, and to extend the catalogue to include all relevant RAFE published environmental data to create a shared RAFE open data portal. – *Future of Scotland's Environment Web Collaboration between RAFE Partners,* Peter Singleton and Jo Muse (6th June 2016).

Relevance to SRP Natural Asset Register

This proposed tool appears to complement the proposed Shared Digital Hub. This could be a useful tool to improve access to the SRP Natural Assets Register.

Status of the initiative

This project was proposed in June 2016.

Scotland's Environment Website – Ecosystem Health Indicators

Key sources/references

Not yet available.

Background and purpose

According to www.snh.gov.uk/docs/A1308427.pdf (accessed 8th July 2016) "Both the analysis and the presentation of the indicators will be delivered through the Scottish Environment Web (SEWeb). Using the data analysis and data presentation tool Spotfire, data can be mapped, set out graphically or as figures."

Relevance to SRP Natural Asset Register

This is likely to be a significant source of information for the Natural Asset Register

Status of the initiative

The project appears to be in an early phase of its development.

Scotland's Environment Website – Ecosystem service Data Management Tool

Key sources/references

None.

Background and purpose

An Ecosystem Service Data Management Tool project was proposed to SEWeb in August 2015. There have been meetings to advance this project but it appears to have made limited progress. Its purpose has been defined as "To enable users to easily access ecosystem service data in maps, tools and other applications to inform their decisions about the sustainable use of natural resources and the services that the environment provides" (Scotland's Environment paper SEWeb PADG 15 020, Nicola Melville, SEPA)

Relevance to SRP Natural Asset Register

This scope and purpose of this proposed project appears to overlap significantly with the SRP Natural Asset Register. The authors of this paper have attended a meeting with the proposer of the project and other interested parties (including Scottish Government) and the existence of the SRP Natural Asset Register is known to those behind this SEWeb proposal.

Status of the initiative

Proposed. Information was requested but was not available at this time (8th July 2016).

Perth and Kinross Council – Instant Atlas

Key sources/references

Available through Perth and Kinross Council web site.
http://localapps.pkc.gov.uk/instantatlas/atlas.html?indicator=i4&date=2009 (accessed 7th July 2016)

Background and purpose

This is an interactive map website. Its purpose is to provide map based information showing the location of council facilities and services. It also includes facilities for proximity search (i.e. what is within the vicinity of a user specified location) and report creation.

Relevance to SRP Natural Asset Register

The site includes a Main Map facility where the user can freely choose which mapping layers to display, potentially building up a complex map with many layers. The site also includes a prepared set of predefined maps which could be useful for those with less developed information technology skills or those in a hurry to go to a straightforward map. This combination of offering both flexibility and simplicity is an approach that could be usefully included in a design of a Natural Asset Register.

Status of the initiative

Active.

Scottish Government Land Use Strategy Data Directory

Key sources/references

http://www.gov.scot/Topics/Environment/Countryside/Landusestrategy/datadirectory(accessed 8th July 2016)

Background and purpose

The Scottish Government's Land Use Strategy is a commitment under the Climate Change (Scotland) act. This tool is a directory of data sets pertinent to the strategy and it has been created and structured according to CICES. The primary audience for the tool is local authorities wanting to develop their own land use frameworks. It is acknowledged that the "datasets are loosely organised by ecosystem services category they could inform".

Relevance to SRP Natural Asset Register

This is a series of webpages with tables and links to data resources. The structure of the site follows CICES and also provides useful links to other ecosystem service information and this was used in part to inform this review.

Status of the initiative

In "Getting The Best From Our Land: A Land Use Strategy For Scotland 2016 – 2021" the Land Use Data Directory is described as "a first step towards facilitating access to the wide range of data currently available about ecosystem services in Scotland" It has been proposed that this resource will be transferred to the SEWeb Centralised Environmental Data Catalogue (Jo Muse (SEPA), presentation at Land Use Strategy Stakeholder event, SNH Battleby, 29th June 2016).

National Biodiversity Network Gateway

Key sources/references

https://data.nbn.org.uk/ (accessed 27th July 2016)

Background and purpose

This is a web based database of species records created by the National Biodiversity Network, which is a partnership between a wide range (150) of UK wildlife conservation organisations, national environmental agencies, local record offices and voluntary groups with the aim to exchange biodiversity information. Anyone is able to browse the information by datasets, species, sites, or designations e.g. Red Data List. They also provide a range of web services e.g. to produce web based map or lists of site species.

Relevance to SRP Natural Asset Register

The National Biodiversity Network Gateway is the primary source of species information in the UK. Other initiatives e.g. The Atlas of Living Scotland then use this information with additional functionality. They have developed UK species inventory and habitats dictionary that are of relevance to SRP Natural Asset Register.

Status of the initiative

A large number species records are added each day.

Atlas of Living Scotland

Key sources/references

http://www.als.scot/ (accessed 8th July 2016)

Background and purpose

The Atlas of Living Scotland is part of the SEWeb suite of websites and it has been designed to replace the National Biodiversity Network for Scotland. It has been based on work for the Atlas of Living Australia which received a very large investment from the Australian Government. The Atlas of Living Australia includes many functions which are not to be found on Scottish environmental websites, e.g. the ability to cross tabulate overlapping spatial data sets or to run spatial analysis models with user specified criteria. These functions enable it to be considered to be an online Geographic Information System (GIS) rather than a mapping portal. It has been reported that Atlas of Living Scotland has additional functionality embedded, but not yet switched on (Ed Mackie (SNH), presentation at Land Use Strategy Stakeholder event, SNH Battleby, 29th June 2016).

Relevance to SRP Natural Asset Register

The Atlas of Living Scotland will host species and habitat datasets and will also offer sophisticated analytical tools such that its content and functionality could be considered to serve as a benchmark for the SRP Natural Asset Register.

Status of the initiative

The Atlas of Living Scotland was launched earlier in 2016 and has not been fully populated nor had all its functionality enabled. The Atlas of Living Scotland has been built on a template supplied by the Atlas of Living Australia. Should all the functionality currently available on the Australian site be implemented on the Scottish site then it is likely that Atlas of Living Scotland will be the most technically sophisticated site of its type in Scotland.

Spatial Hub (Scotland)

Key sources/references

www.spatialhub.scot (accessed 8th July 2016)

Background and purpose

The Spatial Hub (Scotland) is a new initiative and it was announced 23rd June 2016. The Spatial Hub is a website/portal for the upload, download and consumption of spatial data at a Scottish national level. For local authorities, it removes the need to develop their own portals to publish data as required under the INSPIRE directive and reduces the resources required to answer Freedom of Information requests regarding spatial data. For other organisations and the public, it provides easy access to local authority data in a consistent format.

Relevance to SRP Natural Asset Register

This tool differs to SEWeb in that it specifically makes data available for download which SEWeb does not, this may be a result of a different audience for this site – one that has the software to work with spatial data on the user's PC, rather than requiring web tools.

This is an interactive tool that allows registered users (typically local authorities) to both upload and download datasets. The site will also combine data sets uploaded by multiple users to produce continuous data sets of national extent. The data available is that for which local authorities are responsible (e.g. contaminated land, green belt etc.).

The site has been built using a suite of free and open source software tools which can be evaluated as part of the drafting of the specification for the Natural Asset Register.

Status of the initiative

Active. The Spatial Hub launched in June with an initial 12 datasets e.g. Green Belt areas.

NERC Biodiversity and Ecosystem Services Directorate Mapping Gateway

Key sources/references

http://www.nerc-bess.net/ne-ess/ (accessed 8th July 2016)

Background and purpose

The NERC funded Biodiversity & Ecosystem Service Sustainability (BESS) programme (2011-2017) funds a range of research projects into the functional role of biodiversity in key ecosystem processes and the delivery of ecosystem processes at the landscape scale. They have produced an online Ecosystem Service Mapping Gateway with a map of where the projects are based and categorised based on several headings including 'main purpose of project'.

Relevance to SRP Natural Asset Register

Only one project seems to be taking place in Scotland, in the Borders. The focus of many of the studies is to provide site specific information into ecosystem processes. The mapping gateway provides a useful list metadata headings which could inform the development of the SRP Natural Asset Register.

Status of the initiative

The BESS programme will run until at least 2017.

UK Environmental Change Network

Key sources/references

http://www.ecn.ac.uk/ (accessed 27th July 2016)

Background and purpose

The Environmental Change Network is a network of long term (eight sites provide over 20 years of data) environmental monitoring sites across the UK that make regular measurements of air, soil, water and biodiversity. The purpose is to provide information on how and why the natural environment is changing. A recent special issue in the Journal of Ecological Indicators presents research findings from the 20 year datasets, highlighted the need for integration with complementary programmes (Sier and Monteith, 2016).

Relevance to SRP Natural Asset Register

The Environmental Change Network collects data on a wide range of natural capital assets at its sites, and has developed databases and related dictionaries of relevance to the SRP Natural Asset Register. James Hutton staff provide data on sites included in the network.

Status of the initiative

Active for other 20 years.

CEH Environmental Information Platform

Key sources/references

Environmental Information Platform: https://eip.ceh.ac.uk/ (accessed 8th July 2016)

Background and purpose

The Environmental Information Platform provides enhanced access to CEH's key data holdings via web-based tools, programming interfaces and a data catalogue. It enables users to visualise and interrogate the diverse environmental datasets held by CEH.

Relevance to SRP Natural Asset Register

At present the scope of this tool is limited, however, the various approaches used in presenting data to non-specialist users should be used to inform the design of any tool to host the Natural Asset Register. Interesting data exploring tools e.g. the UK Lakes Portal at https://eip.ceh.ac.uk/apps/lakes/ and climate, hydrology and ecology tool CHESS Explorer at https://eip.ceh.ac.uk/apps/chess/. The focus appears to be on presenting the data in a way that is impressively clear and accessible and visually interesting and that does not require specialist tools or knowledge to interpret.

Status of the initiative

CEH are investing in providing a range of data sets and tools through this platform.

European Environment Agency – Open Data Portals

Key sources/references

http://www.europeandataportal.eu/ (accessed 8th July 2016)

Background and purpose

The Shared Environmental Information System (SEIS) aims to create an integrated, web-enabled, EU-wide environmental information system by simplifying and modernising existing information systems and processes.

Relevance to SRP Natural Asset Register

The approach taken by the European Environment Agency will influence the approaches taken in the member states. They are using open source technology including CKAN. To provide open linked data they are providing data in RDF format. The repository code is freely available for others to use: https://gitlab.com/groups/european-data-portal and much of the technology in use should be considered for inclusion in the Natural Asset Register.

Status of the initiative

Active.

European Nature Information System (EUNIS)

Key sources/references

http://eunis.eea.europa.eu/ (accessed 8th July 2016)

Background and purpose

The European Nature Information System, EUNIS, brings together European data from several databases and organisations into three interlinked modules on sites, species and habitat types. EUNIS is a reference information system for anyone working in ecology and conservation or those with an interest in the natural world. It is also used for

- assistance to the Natura 2000 process (EU Birds and Habitats Directives) and coordinated with the related EMERALD Network of the Bern Convention;
- the development of indicators (EEA Core Set);
- environmental reporting connected to EEA reporting activities.

Relevance to SRP Natural Asset Register

EUNIS is a large database on Europe's nature. The web site is easy to use, and provides the download of data in a range of formats including linked data i.e. RDF.

Status of the initiative

Active

EUROSTAT

Key sources/references

http://ec.europa.eu/eurostat (accessed 27th July 2016)

Background and purpose

Eurostat's mission is to be the leading provider of high quality statistics on Europe. It provides a wide range of datasets including range on natural resources through its Environmental Data Centre on Natural Resources.

Relevance to SRP Natural Asset Register

A useful example of an initiative providing a wide range of data sets that links to a wide range of other organisations and initiatives that provide the actual data. Using soil as an example, then you go to their web page (http://ec.europa.eu/eurostat/web/environmental-data-centre-on-natural-resources/natural-resources/soil ; accessed 27th July 2016) they provide a useful introduction to soil data, relevant European strategies and directives, and links to external soils data sources.

Status of the initiative

Active.

Digital Catapult: Environmental Data Exchange

Key sources/references

https://www.environmentaldataexchange.org.uk/ (accessed 8th July 2016)

Background and purpose

The Environmental Data Exchange is a tool to help the search, discovery and use of environmental data. It is the intention that it "will unlock the innovation needed to tackle the environmental challenges and opportunities by governments, organisations and SMEs alike". As with the majority of initiatives of this type it provides signposts to data, it does not host the environmental data. At present the structure appears less than optimally organised with data sets listed by name or by organisation but not classed into thematic groups.

Relevance to SRP Natural Asset Register

The design of the site is well presented and the wide range of data sets (e.g. various sources of satellite imagery) could inform the content of the SRP Natural Asset Register.

Status of the initiative

Active.

Geospatial Resources at the US Environmental Protection Agency

Key sources/references

https://www.epa.gov/geospatial (accessed 8th July 2016)

Background and purpose

The geospatial tools at the US EPA are comprehensive and allow users to view water and air quality and work with a number of tools giving neighbourhood level information. This information is presented in a wide range of maps, graphs and other types of graphical presentation such as dashboards.

Relevance to SRP Natural Asset Register

There is a large variety of tools and approaches to data presentation that could inform the content and the selection or creation of tools to be included in the SRP Natural Asset Register. The EPA also has an Ecosystems Research site (https://www.epa.gov/eco-research accessed 8th July 2016) that is a valuable source of reference material.

Status of the initiative

Active.

Appendix 3: Consultation Process

The following letter was sent to selected individuals in Atlas of Living Scotland, Department of Energy and Climate Change, Geographic Information Science and Analysis Team (Scottish Government), National Biodiversity Network, RESAS (Scottish Government), Royal Botanic Gardens of Edinburgh, Scotland's Environment Website, SRUC (Scotland's Rural College), Scottish Natural Heritage, Scottish Environment Protection Agency and to colleagues in the James Hutton Institute. A general call for information was also placed amongst Ecosystem Services Partnership members. A total of 22 emails were sent to correspondents at the above organisations. Information from the 15 responses which were received has been incorporated into this review.

Consultation Letter

We have identified you as an expert who may be able to assist us in the development of natural asset registers/natural capital accounts. We are developing a Natural Assets Register for Scotland with a draft report due at the end of July 2016. This is being done as part of the Scottish Government's Strategic Research Programme, 2016-21. Can you please reply to this email by 2nd June if you are aware of similar existing initiatives, either complete, in progress or proposed which we could include in our review of the current situation in the field of Natural Assets Registers?

In this research programme we are developing a Natural Assets Register for Scotland as part of a package of work the aim of which is to illustrate the multiple benefits that natural assets provide to Scottish society and to use this understanding to support decision making on trade-offs and management at multiple scales. The Natural Assets Register will include assessments of the condition of the assets, their role in providing ecosystem service benefits to society, and their contribution to Scotland's green growth aspiration as recognised in Scotland's Economic Strategy.

The Natural Assets Register will include existing published environmental data and will be comprehensive in its scope. It will integrate data from the research programme and be used to inform existing efforts to assess the state of Scotland's natural assets, e.g. SNH's Natural Capital Assets Index (NCAI), and to support better decision making, e.g. targeting of SRDP measures. It is intended that the Natural Assets Register will act as a key resource in terms of monitoring change in environmental health and service delivery, assessing the value of Scotland's natural assets through the development of natural capital accounts, and targeting action and preventing deterioration of our natural assets. The Natural Assets Register will be accessible to the public on a platform (e.g. Scotland's Environment Website) which will be selected following a consultation with the expected users. This consultation will happen later this year.

The development of the Natural Assets Register will take account of ongoing initiatives such as the proposed Scotland's Environment Ecosystem Services Data Management Tool, work by the Office of National Statistics and Scottish Government's Land Use Data Directory. We are currently working on a review of Natural Asset Registers and are consulting those knowledgeable in this field.

The existing initiatives on which we are seeking information need not be exactly the same as our proposed Natural Assets Register in scope, ambition or accessibility as we intend to produce a report which is a comprehensive assessment of the current position. If you do know of any such initiatives then we would be grateful if you could reply with a short email listing them, their locations (e.g. a website if one exists), and if possible include a comment describing your views of their usefulness

and any particular strengths or shortcomings. Any comments will be treated in the strictest confidence, and if included in our report this will be done so without attributing your name or organisation.

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