

# **Environmental Observation to Support Natural Capital Assessment**

## **Workshop Report**

**Anita Weatherby & Charlie Stratford  
UKEOF Secretariat**

**20 April 2017  
The Studio, Birmingham**

# 1. Executive Summary

## 1.1 Overview

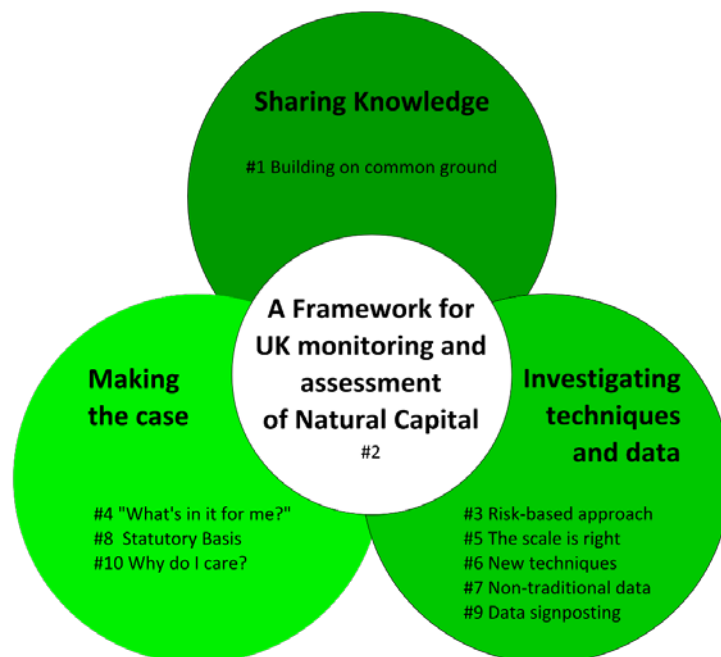
The UKEOF workshop titled “Environmental Observation to Support Natural Capital Assessment” was held in Birmingham on 20 April 2017. The workshop was attended by 26 representatives of UKEOF partner organisations from across the UK.

The aims of the workshop were to

1. Share understanding of how well current monitoring and other observations enable natural capital to be measured.
2. Explore the observational data requirements of current approaches for natural capital, covering UK interests including the 25 Year Plan for the Environment.
3. Assess the gaps in available monitoring data and consider how these gaps can be filled.

The main output of the day was a set of prioritised ideas that could form the basis of an action plan for how environmental monitoring for Natural Capital purposes needs to evolve. The ideas collectively contribute to the overall goal to develop ‘A framework for UK monitoring and assessment of Natural Capital’. There are three groupings of coordination activities under this overall goal: Sharing Knowledge, Investigating Techniques and Data, and Making the Case.

Figure 1 shows how the ten ideas developed at the workshop fit into this framework, the numbering shows the priority rank of the idea, based on the attendees level of support for the idea.



## 1.2 Summary of the ideas developed

### Overall Goal: A Framework for UK monitoring and assessment of Natural Capital (NC)

- UK countries work together to agree an approach for NC
- Aim for consistent framework and data UK wide
- Share knowledge to agree principles, common approaches, pool resources

### Coordination Activity: Sharing Knowledge

- A UK-wide working forum / network for NC, gather best practice and approaches
- It could include creating a hub platform for synthesis and knowledge exchange

- Engagement could go beyond UKEOF partners

**Coordination Activity: Investigating techniques and data**

- Develop understanding to enable a risk based approach for monitoring change in NC (ID assets, ability to detect change), link with social scientists to understand impacts on benefits
- Develop understanding to enable monitoring of NC appropriate to scale for different NC metrics / locations
- Develop understanding to enable integration of data from new technologies / techniques including earth observation, automatic sensor networks, UAVs, citizen science
- Develop understanding to include non-traditional data to bring in socio-economic benefits e.g. business data, labour market, urban, wellbeing
- Improve signposting of data for NC

**Coordination Activity: Making the case**

- Set up time limited “what’s in it for me?” group, a sounding board / user group outside “the usual suspects”
- Consider what is needed in terms of capability to measure change to put NC on a statutory basis (like Climate Change Act), and how this might be done
- Enable public and decision makers to understand the impact of NC on their lives by developing clear link between assets and benefits and using this to raise awareness

### **1.3 Evaluation & feedback**

The event was very well received, with great enthusiasm for developing this agenda at the UK level. Participants noted that this was the first time all relevant bodies were in the same room, and starting to build a common understanding. Attendee feedback forms were very positive, in particular appreciating the opportunity to hear from and network with others working on similar issues, and in support of the ambition for taking forward real actions. Attendees recommended that the ideas need to be “sanity checked” and time taken to reflect on what is realistic for UKEOF activities, perhaps taking a Delphi approach. Attendees were keen for a clear plan of action to be agreed, and many volunteered to be involved in future stages.

### **1.4 Follow up steps**

Following the workshop, the UKEOF Management Group agreed to establish a working group to scope a plan of action based on the proposals identified at the workshop for UK coordination of activities, and facilitating development of a common UK approach to Natural Capital monitoring.

## **2. Workshop Report**

### **2.1 Introduction**

The UK Environmental Observation Framework (UKEOF) organised and facilitated a workshop looking at how environmental monitoring for Natural Capital purposes needs to evolve. The workshop title was “Environmental Observation to Support Natural Capital Assessment” and it had three specific objectives:

1. To share understanding of how well current monitoring and other observations enable natural capital to be measured.
2. To explore the observational data requirements of current approaches for natural capital, covering policy interests across the UK.
3. To assess the gaps in available monitoring data and consider how these gaps can be filled.

The full agenda is included in Annex A. The workshop was attended by 25 members of UKEOF partner organisations, with representation from across the UK (Annex B).

The outcomes of the workshop will support development of a UKEOF action plan by identifying a prioritised list of activities required in order to ensure that future environmental monitoring meets the data needs of natural capital assessment. The UKEOF management group will use this action plan as the basis upon which to take forward their natural capital work.

This report provides a summary of the presentations and activities that took place during the workshop. Full details of outputs are in Annexes C-F, and attendee feedback on the workshop is included in Annex G.



### **2.2 Morning Session 1: Introduction, Context and Research Aspects**

On arrival, participants completed two exercises. The first asked them to imagine it was the year 2027 and environmental observation is successfully enabling natural capital to be quantified. With this in mind, participants were asked to write down what was the biggest challenge addressed in

achieving that outcome. Ideas included agreed indicators and data types; a core monitoring network and approaches to using new technology and analysis. Some examples are given in Box 1 below and the full responses are included in Annex C.

**Box 1. Time Travel: what challenges have we addressed by 2027 for monitoring natural capital?**

*“It’s 2027 and it’s all gone wrong – the environment is ruined, we are all starving and we are fighting civil local wars over land – what went wrong and how could we have prevented it: Pre-Mortem!”*

*“A core sustainable network of environmental monitoring (meteorological co-located with key ecological/ biological/ other measures) across whole of the UK, with demonstrated value to Natural Capital through a few targeted case studies.”*

*“We finally defined what we wanted and then put the right monitoring in place (that serves multiple needs).”*

*“Funding for: aligned local level recording – which can make use of national data where local information is insufficient and can be used within the common analytical framework to provide local information on Natural Capital metrics.”*

The second exercise asked participants to indicate how much they already knew about the approaches to natural capital monitoring for each UK country. The number of respondents for each level of expertise are shown in the Figure below: most participant responses were at the low knowledge end, with only six of the attendees claiming a high or expert level of knowledge.

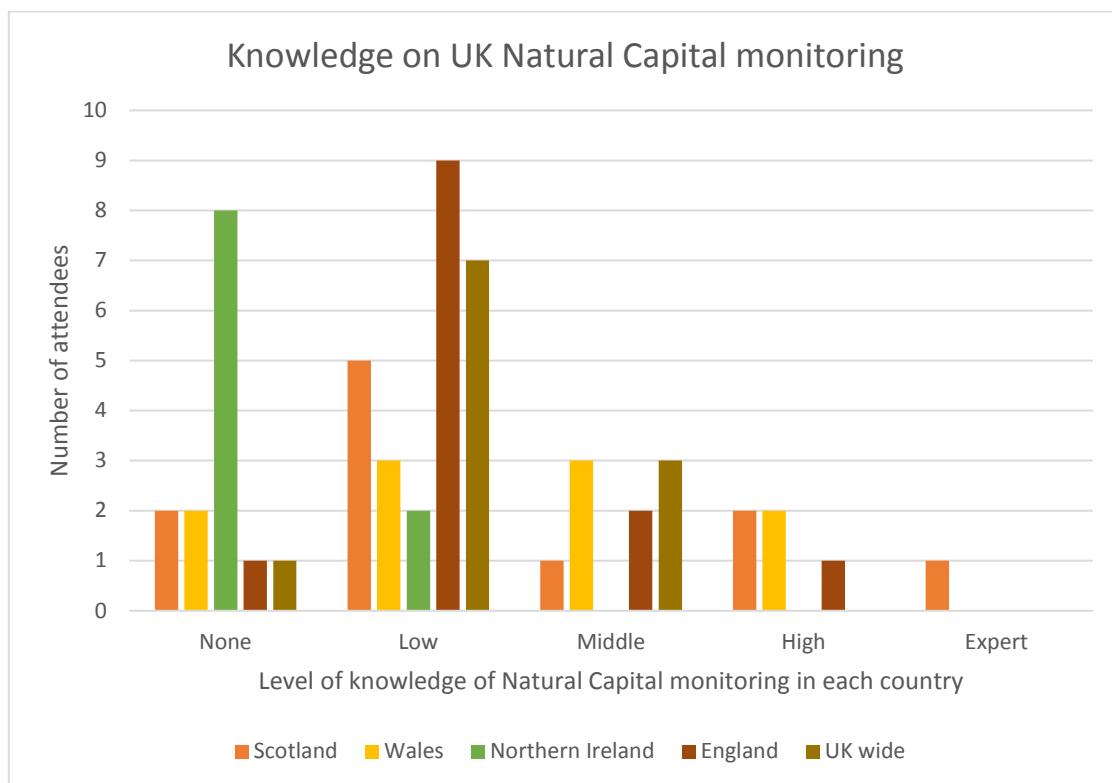


Figure 1. Self-reported level of pre-existing knowledge on monitoring for Natural Capital in each UK country and UK-wide.

The workshop was introduced by Doug Wilson (UKEOF Chair) who outlined the role of UKEOF as the coordinating body for public sector organisations carrying out environmental observation in the UK and its aim of ‘maximising the value of the UK’s environmental observations’. Doug gave an

overview of the background to the workshop, referring to the various natural capital policy drivers that exist in England, Scotland, Wales and Northern Ireland. The scope of the workshop was outlined as having a UK-wide focus, dealing with strategic level issues, being from a monitoring perspective, and leading to a targeted output in the form of the action plan. With this in mind it was clear to see how this workshop complemented previous activities such as the Natural Capital Committee's workshop on metrics and the JNCC workshop on terrestrial biodiversity and avoided duplicating existing effort.

Anita Weatherby (UKEOF Programme Manager) then set out the plan for the day in which the morning would introduce the natural capital context and research aspects followed by experiences from each of the four UK countries. The afternoon would commence with two current case study examples, followed by a series of exercises designed to encourage attendees to think broadly about ideas for an action plan and then giving them the responsibility of developing and prioritising the ideas.

An introduction to the context for measuring natural capital was given by Paul Leinster (Workshop Chair and member of the Natural Capital Committee) who highlighted the need to protect and improve the state of the natural environment. Paul highlighted the importance of appropriate measurements and observations for natural capital assessment. The role of natural capital assets in providing services and benefits was described and the need to differentiate between renewable and non-renewable forms of capital, in addition to understanding the stock and condition of assets and whether they are at risk, was set out. Paul drew everyone's attention to the recently published Natural Capital Committee '[How to do it](#)' guide and talked through the five steps that form the approach. The guide is intended to be a practical guide aimed at anyone who wants to use natural capital approaches in making decisions about the natural environment. In conclusion, Paul identified several areas in which improved application of the natural capital concept could bring about benefit including; guiding decisions around new infrastructure and housing, developing CAP reform, promoting integrated approaches to planning activities, and opportunity mapping.

Rosie Hails (Centre for Ecology & Hydrology) presented the research perspective, with examples of five current areas of monitoring work that are contributing towards a better understanding of natural capital. The benefits of long-term, detailed monitoring were demonstrated using CEH's Cumbrian Lakes research platform. For example pressures at a range of scales may cause ecosystem responses such as a de-synchronisation between primary and secondary consumers and impact on food availability with consequences for biodiversity. Rosie then described various observational challenges such as the ongoing desire to make high resolution observations over a large scale. Issues of duration and temporal frequency were also highlighted. Of particular interest were examples of research addressing these challenges using new technologies (e.g. the new UK-wide COSMOS soil moisture network), new methods (e.g. combining observational datasets collected using differing methodologies including citizen science), and bringing all of this together with the development of integrated monitoring. Current work to better understand the evidence linking presence and state of a natural capital asset to delivery of a benefit was presented. Development and application of systematic review techniques provides robust and defensible evidence and helps to identify the observational data requirements of natural capital assessment. Rosie concluded by demonstrating some of the methods used to enhance access to natural capital information, using mapping tools such as Ecomaps, and the increasing use of web-based systems for sharing data.

## **2.3 Morning Session 2: Experience from UK Countries**

During the second morning session, invited speakers from England, Scotland, Wales and Northern Ireland gave overviews for each country on the policy drivers for natural capital assessment and a summary of current activities, highlighting successes and challenges with particular relevance to observational data.

### **Scotland – Nicola Melville (Scottish Environment Protection Agency)**

Nicola gave an overview of relevant Scottish policy including the Scottish Government National Performance Framework, Scotland's Landuse Strategy and the 2020 Challenge for Scotland's Biodiversity. These policy drivers have led to publication of the Natural Capital Asset Index with further outputs such as Ecosystem Health Indicators and the Habitat map of Scotland anticipated in summer 2017. The approach to national mapping and assessing ecosystem services follows the European Environment Agency classifications (EUNIS/CICES), primarily using existing data sets and infilling with aerial photography where possible. Nicola highlighted difficulties in dealing with small areas of habitat and of differentiating between different habitats such as wet and dry heath. At a local scale, application of the EUNIS framework does not always fit with the range of habitats present. The Scottish Natural Capital Index has quantified relative changes extent and condition of natural capital, broken down by habitat type, from the year 2000 to present. Notable successes in Scotland include the Natural Capital Asset Index and its inclusion in the National Performance framework, and the use of the ecosystems approach to with engage local people about the value of their environment. A key challenge identified is the difficulty of finding data with which to assess habitat condition outside of protected sites and WFD water body areas. Looking to the future, challenges exist in finding cost effective methods for collection of observational data at a fine enough resolution to be useful, and in applying assessment methods to marine areas.

### **Wales – Emily Finney (Welsh Government) and David Allen (Natural Resources Wales)**

Emily introduced the Environment (Wales) Act 2016 and Wales' approach to the sustainable management of natural resources, which has an objective to 'manage our natural resources in a way and at a rate that can maintain and enhance the resilience of our ecosystems whilst meeting the needs of present generations without compromising the ability of future generations to meet their needs and contribute to the achievement of the well-being goals'. The State of Natural Resources Report (SoNaRR), produced by NRW, will track the progress being made towards achieving this objective. This also links to the National Natural Resource Policy and the Wellbeing of Future Generations (Wales) Act.

David Allen then described the approach used in Wales to monitor natural resources and work carried out in SoNaRR to assess the resilience of a range of ecosystems. This information about ecosystem resilience is then used to evaluate the risk of Wales not achieving a defined set of well-being goals. Using the example of erosion control, David illustrated how risks and opportunities are being mapped at a country scale. Habitat maps are a key resource in carrying out this work. NRW has produced a framework for describing the evidence across marine, freshwater, land and atmospheric domains that is needed to support the sustainable management of natural resources. David concluded by describing the Natural Resource Monitoring Framework, a Welsh initiative to provide better coordination and integration of field monitoring, earth observation, models and expert evidence.

### **England – Robert Bradburne (Defra) and Jane Lusardi (Natural England)**

Robert described the Natural Environment and Rural Evidence Plan, which sets out to support delivery of 'A cleaner healthier environment, benefitting people and the economy'. The plan will include a section on monitoring and surveillance to develop and deliver natural environment and rural policy. A key objective within the framework for monitoring and evaluation of natural capital is

to better understand the impact of interventions on the environment and the point was made that the Defra Group have in place interventions at all stages of environmental management. It is important to assess whether these are effective in delivering benefits.

Jane Lusardi presented Natural England's work on natural capital indicators. The work consists of several parallel strands including; a review of indicators suggested by previous projects and initiatives; development of 70 detailed logic chains which identify the ideal attributes of natural capital necessary to measure change; cataloguing of existing data sets and identification of gaps where data is not currently available to measure the ideal attributes. Jane presented the approach to development of the logic chains, in which the quantity, quality and spatial configuration of ecosystem assets is linked via the flow of ecosystem services to benefit. Specific reference was made to the chain developed to understand water quality and this usefully highlighted the considerable complexity and number of factors that need to be considered to properly understand these links. This was mapped through to a comprehensive table of available datasets so that any gaps could be identified.

#### **Northern Ireland – Ken Bradley (Department of Agriculture, Environment and Rural Affairs)**

Ken Bradley commenced with an overview of governmental structure in Northern Ireland and described public opinion with respect to environmental issues. Ministerial agreement on the importance of natural capital was formalised in January 2017 and this now provides an important driver for further adoption of the approach going forward. Delivery of a review of natural capital approaches is anticipated by the end of 2018 and efforts to develop a practical example are currently being considered, looking in particular at how inclusion of the natural concept might improve decision making. DAERA have appointed a new staff member who will spend 50% of their time working on natural capital and as part of this will liaise with other government bodies to identify the most suitable approaches for Northern Ireland. Ken outlined current successes including better links between the economy and the environment, agreement of an agricultural land use strategy, and financial commitment to management plans for all SACs. Ken also highlighted various challenges such as the difficulty of demonstrating the potential benefits of adopting the concept, particularly to sceptics. Support through links with the Republic of Ireland and the Irish Forum on Natural Capital is proving beneficial to Northern Ireland and proposed pilot studies demonstrating practical approaches will be a useful cross-border resource. In conclusion, Ken recognised that this is a long journey but one that will be made all the easier by coordinated activities and sharing of experience across the UK and Ireland.

#### **Discussion**

As an introduction to the open discussion, Paul Leinster reminded the assembled group of the current uncertainties (in particular potential consequences of the UK's exit from the European Union) and how they might affect the UK's approach to environmental issues, but also highlighted the importance of coming together as the four UK countries and the potential benefits of sharing knowledge and experience. There are considerable opportunities for environmental enhancement alongside current and future infrastructure projects and we should be ambitious, thinking not in terms of 'no net loss' let's but instead of 'net gain'.

The discussion was then opened to the floor and an important point was raised that we must be wary of becoming too 'data-led' and losing sight of the aim of natural capital valuation which is to support decision making. Communicating the multiple benefits that can be achieved through this approach will be a powerful mechanism for helping people to understand the value of the environment whether off-shore, rural catchment or city centre.

Although much work is still required to truly adopt a natural capital approach to decision making, the considerable progress made over the past 10 years was highlighted. Government policy in each of the four countries now recognises the importance of the natural environment. UKEOF is well



placed to support some of the coordination activities required to continue this progress in the future, and of particular use would be an understanding of where common approaches exist and where they are required.

The importance of having a consistent and repeatable approach to monitoring was highlighted as was the need to understand where earth observation data can provide useful information and where more traditional monitoring techniques are required. We must also take opportunities for monitoring before and after interventions so that we can build a knowledge base of likely outcomes of activities.

## **2.4 Afternoon Session 1: Natural Capital observational data requirements**

The afternoon session commenced with a presentation from Emily Connors who described work by the Office of National Statistics to develop Natural Capital accounts for the UK and their aim is to have functioning accounts by the year 2020. Emily highlighted the importance of having a set of accounts in a form that can be integrated with other UK accounts and using the same language. The 2 stage process by which the accounts are constructed was outlined; stage 1 produces non-monetary account, linking the extent and condition of a stock, to the flow of ecosystem services, and stage 2 provides the final integrated ecosystem-economic accounts by linking the flow of services to the life of the natural asset. Examples were shown for the change in extent and condition accounts of UK farmland between 1998 and 2014. Other services that are either partially or fully developed include carbon sequestration, recreation, air pollution removal and public water supply. Emily concluded by sharing some of the lessons learnt such as the value of bringing together physical data and producing physical as well as monetary accounts, and also pointed out that whilst coming up with a 'big number' for the value of a natural asset might be draw attention, it doesn't have much practical use. Data gaps identified through this work include a general need for more spatial and more consistent data and specific needs for better information on soils, vegetation in urban environments and linear features, expenditure on flood defences, and visits by people (whether for education, business or recreation).

Alessandro Gimona then presented work that he and colleagues at the James Hutton Institute have been doing to assess ecosystem services at a national scale using remote sensing data. Datasets provided by the MODIS, Sentinel 1 and Sentinel 2 programmes were outlined and their usefulness in relation to ecosystem services assessment outlined. Of particular benefit is the regular and repeatable coverage over the spatial area of interest provided by satellite observation, however the potential danger of being over-reliant on remotely sensed data without adequate ground truthing was also highlighted. Using the CICES framework for classifying ecosystem services Alessandro presented a series of maps showing services such as provisioning of crops, animals and water, and regulation of climate, nutrient flows and soil erosion. In each case the remote sensing data used were clearly identified. Also discussed was the suitability of various ecosystem services to the stock and flow conceptual model and whilst some services such as provisioning of surface water were considered suitable, others such as regulation of pollination were not and in these cases it would be more relevant to keep track of the service rather than the stock. In conclusion the point was made that whilst satellite data play an important role in mapping ecosystem services, it is important to remember that the ultimate goal is to influence decision making and the data requirements of achieving that goal should be borne in mind.

## **2.5 Afternoon Session 2: Developing the Action Plan**

The second afternoon session consisted of a series of exercises through which attendees were asked to come up with a prioritised list of ideas that could form the basis of an action plan for how environmental monitoring for Natural Capital purposes needs to evolve.

### **Identifying Strengths and Gaps in current monitoring**

The first step was to identify strengths and gaps in current environmental monitoring for Natural Capital needs. Attendees worked in groups to list information types (e.g. water quality, woodland extent) for which current monitoring / observation is **likely** (strengths) or **not likely** (gaps) to be able to meet Natural Capital needs? The results are summarised below with full details in Annex D.

The main **strengths** identified were environmental monitoring for water quality and quantity, air quality, and land cover mapping. Ordnance survey and Sentinel satellite data were seen as strengths, along with the huge amount of data available. The use of common approaches UK-wide was seen as a strength e.g. Land Cover Map, Water Framework Directive, National Forest Inventory, CICES (Common International Classification of Ecosystem Services), air quality monitoring and protected site condition assessment. Beyond environmental data, the MENE (Monitoring of Engagement for the Natural Environment) reporting was a strength for Natural Capital. Attendees felt the UK had world leading expertise on Natural Capital, and that new opportunities were stimulated by the Open Data agenda, including involving businesses and the public.

Specific **gaps** in environmental monitoring were identified for urban features, soil information, habitat condition and biodiversity and the condition and resilience of natural assets. Although satellite data is a major strength, there is a gap in ground truthing satellite data and providing the process understanding to improve interpretation of satellite data e.g. on productivity. Non-environmental gaps were noted for health and well-being information, cultural services and benefits. Other challenges recorded covered data integration and access, spatial resolution, dealing with inter-relationships and data uncertainty and the need for frequent updates for data to be meaningful. There is a need to better understand what evidence is needed to inform what decisions, and how to turn monitoring information into knowledge and decisions.

### **Developing the Action Plan – Part 1: Generating Ideas**

Attendees were asked for their ideas for an action plan for how environmental monitoring for Natural Capital purposes needs to evolve. Each idea was written on post it notes which were arranged in groups under one of these topic headings:

- i. monitoring **amount/status**
- ii. monitoring **trends/changes**
- iii. monitoring to address issues of **scale/spatial configuration**
- iv. areas that need further information or **research**
- v. **sharing** knowledge & experience
- vi. developing new **methods / technologies**
- vii. any **other**.

The full list of ideas is given in Annex E.

### **Developing the Action Plan - Part 2: Working Up Ideas**

Attendees worked in groups to develop details of ideas they felt were important. For each idea each group wrote a description of the idea, identified the output/outcome, suggested who and what was involved, and whether this was suitable as a UKEOF coordinated activity. They then reported back to the whole workshop.

### **Developing the Action Plan - Part 3: Prioritising the Ideas**

Over tea each participant had the chance to add comments to each idea, and to mark on a scale their level of support for the idea and how feasible they felt it was.

The results of these exercises are summarised below, and full details are given in Annex F.

## Summary of proposals for the Action Plan

The key priorities identified were:

- Sharing knowledge
- Investigating techniques and data
- Making the case

and collectively these contribute to delivery of the overall goal to develop 'A framework for UK monitoring and assessment of Natural Capital' (Figure 1.).

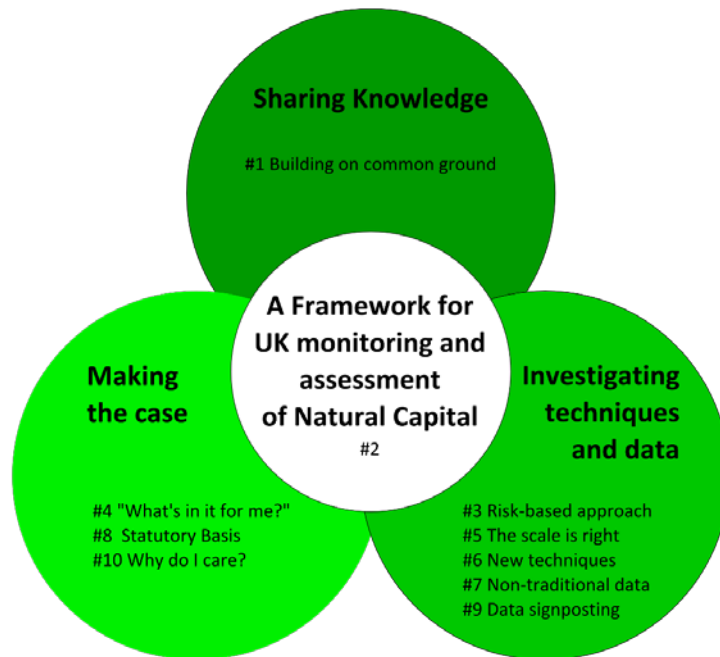


Figure 1. Priority areas identified during the workshop. The numbers in each circle correspond to the ideas developed

A summary of the areas developed is given below, see Annex F for more details.

### Overall Goal: A Framework for UK monitoring and assessment of Natural Capital (NC)

- UK countries work together to agree an approach for NC
- Aim for consistent framework and data UK wide
- Share knowledge to agree principles, common approaches, pool resources

### Coordination Activity: Sharing Knowledge

- A UK-wide working forum / network for NC, gather best practice and approaches
- It could include creating a hub platform for synthesis and knowledge exchange
- Engagement could go beyond UKEOF partners

### Coordination Activity: Investigating techniques and data

- Develop understanding to enable a risk based approach for monitoring change in NC (ID assets, ability to detect change), link with social scientists to understand impacts on benefits
- Develop understanding to enable monitoring of NC appropriate to scale for different NC metrics / locations
- Develop understanding to enable integration of data from new technologies / techniques including earth observation, automatic sensor networks, UAVs, citizen science

- Develop understanding to include non-traditional data to bring in socio-economic benefits e.g. business data, labour market, urban, wellbeing
- Improve signposting of data for NC

#### **Coordination Activity: Making the case**

- Set up time limited “what’s in it for me?” group, a sounding board / user group outside “the usual suspects”
- Consider what is needed in terms of capability to measure change to put NC on a statutory basis (like Climate Change Act), and how this might be done
- Enable public and decision makers to understand the impact of NC on their lives by developing clear link between assets and benefits and using this to raise awareness

## **2.5 Concluding Remarks**

Paul Leinster concluded the afternoon session by highlighting a few of the challenges that lie ahead. There is an ongoing need to make the case for why natural capital is important and to provide stakeholders with the information to understand what’s in it for them. Similarly the case needs to be made for the benefits of a coordinated and integrated approach and why this might be a better option than going it alone. We must continue to maintain a focus on the end users and think about how we can produce information that is of use to decision makers (notable examples include those involved in infrastructure development and agricultural policy). In relation to this workshop, how do we take forward the activities identified?

Doug Wilson then brought the workshop to a close by thanking all attendees for their positive contributions throughout the day. Once the results of the exercises have been written up these will be circulated to attendees for comment and approval and being shared with the UKEOF Management Group. The secretariat will be looking at the workshop outcomes and working with the Management Group to agree how to take these forward.

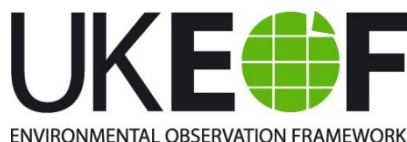
## **2.6 Evaluation & feedback**

The event was very well received, with great enthusiasm for developing this agenda at the UK level. Participants noted that this was the first time all relevant bodies were in the same room, and starting to build a common understanding. Attendee feedback forms were very positive, in particular appreciating the opportunity to hear from and network with others working on similar issues, and in support of the ambition for taking forward real actions. Attendees recommended that the ideas need to be “sanity checked” and time taken to reflect on what is realistic for UKEOF activities, perhaps taking a Delphi approach. Attendees were keen for a clear plan of action to be agreed, and many volunteered to be involved in future stages.

## **2.7 Follow up steps**

Following the workshop, the UKEOF Management Group agreed to establish a working group to scope a plan of action based on the proposals identified at the workshop for UK coordination of activities, and facilitating development of a common UK approach to Natural Capital monitoring.

## Annex A: Workshop Agenda



### UKEOF Workshop – Environmental Observation to Support Natural Capital Assessment

20 April 2017

The Studio, 7 Cannon Street, Birmingham, B2 5EP

#### Purpose and scope of this workshop

The aim of this workshop is to agree an action plan for how environmental monitoring for Natural Capital purposes needs to evolve (see Fig. 1 for an example Natural Capital Conceptual Framework). This could include initiating development of a UK-wide environmental monitoring strategy to support assessment of Natural Capital.

This workshop will build on other recent workshops and activities related to environmental monitoring and natural capital but this workshop will focus specifically on environmental observation and its role in underpinning Natural Capital assessment.

The workshop will:

1. Share understanding of how well current monitoring and other observations enable natural capital to be measured.
2. Explore the observational data requirements of current approaches for natural capital, covering UK interests including the 25 Year Plan for the Environment.
3. Assess the gaps in available monitoring data and consider how these gaps can be filled.

The workshop outputs will be a report, presentations and the action plan for how environmental monitoring for natural capital purposes needs to evolve. These will be published on the UKEOF website.

## Agenda

### Morning Session

*Current understanding of environmental monitoring and requirements for natural capital assessment*

#### 09:30 Registration, Coffee and Exercises: (i) Time Travel (ii) Temperature Test

*On arrival attendees will be asked to carry out two exercises:*

*(i) Time Travel. Attendees are asked to answer the following question: It is 2027 and our monitoring and observation of the natural environment is being used successfully to enable Natural Capital to be quantified and decisions to be made. We've addressed the biggest challenge for **monitoring** for Natural Capital – what was that challenge?*

*(ii) Temperature Test. Attendees are asked to put a cross on a scale to show how much they already know about approaches to monitoring for Natural Capital for each UK country.*

<b>10:00</b>	<b>Introduction</b>	Doug Wilson (UKEOF Management Group Chair)
<b>10:10</b>	<b>Context for the day &amp; questions on scope</b>	Paul Leinster (Workshop Chair)
<b>10:25</b>	<b>Monitoring Natural Capital: The Research Perspective</b>	Rosie Hails (CEH)

**10:40 Experience from UK Countries (including a chance to grab a coffee)**

*Presentations on the Natural Capital approach and data and monitoring needs.*

- Scotland - Nicola Melville (SEPA)
- Wales - Emily Finney (Welsh Government) and David Allen (NRW)
- England - Jane Lusardi (NE) and Robert Bradburne (Defra)
- Northern Ireland - Ken Bradley (DAERA)

**11:45 Discussion of UK experiences**

*In discussion of UK countries' experiences of developing environmental observation for natural capital assessment, attendees are particularly asked to consider*

- similarities and differences (e.g. Where are there common interests or divergent approaches?)*
- challenges and opportunities (e.g. What aspects are not meeting needs, where are there gaps? What is working well, are there activities in one part of the UK that are of interest to others?)*

**12:15 Lunch**

**Afternoon Session**

*Develop an agreed action plan for environmental monitoring for natural capital*

**13:00 Natural Capital observational data requirements**

*Examples of current applications of environmental monitoring for Natural Capital purposes.*

The UK Natural Capital Accounts: data gaps - Emily Connors (ONS)

Mapping and modelling of Natural Capital in Scotland: data needs - Alessandro Gimona (JHI)

**13:30 Snapshot Exercise – what are the strengths and gaps in current capability?**

*Working in groups, attendees are asked to identify where current monitoring and observation capability provides a strong platform for anticipated Natural Capital reporting needs and where there are major gaps. This exercise is intended to provide a quick snapshot of priorities, not a comprehensive or detailed assessment. After 15 mins each group will report back.*

**14:00 Developing the Action Plan - Part 1: Generating Ideas**

*Attendees are asked to work individually to generate ideas for activities that could form part of an action plan for how environmental monitoring for Natural Capital purposes needs to evolve. Specifically, what do we need to do to address the gaps identified? Each idea should be written on a post-it note and placed under the most relevant topic (these topics are not intended to limit ideas): (i) monitoring **amount/status**, (ii) monitoring **trends/changes**, (iii) monitoring to address issues of **scale/spatial configuration**, (iv) areas that need further information or **research**, (v) **sharing** knowledge & experience (vi) developing new **methods / technologies** (vii) any **other**.*

**14:20 Developing the Action Plan - Part 2: Working Up Ideas**

*Attendees will choose which topic they want to work on. In groups they will develop an idea within the topic and complete an A3 form for each to describe the idea in more detail. After 20 mins attendees will be given the option to move to another table on another topic. After*

another 20 mins we will hear back from each table, and the A3 forms will be stuck on the walls around the room.

**15:20 Tea and Developing the Action Plan - Part 3: Prioritising the Ideas**

Over tea, attendees will be asked to review the ideas, add any comments or suggestions, and put a cross on a scale for each idea to show how strongly they support it and how feasible it is to deliver.

**15:40 Final discussion and concluding remarks**

**Paul Leinster and Doug Wilson**

Review which activities have most support, and whether there is support for developing a UK Monitoring Strategy to support assessment of Natural Capital. Agree next steps, do we need a follow up workshop on one of the action plan activity areas in a few months?

**16:00 End & feedback forms**

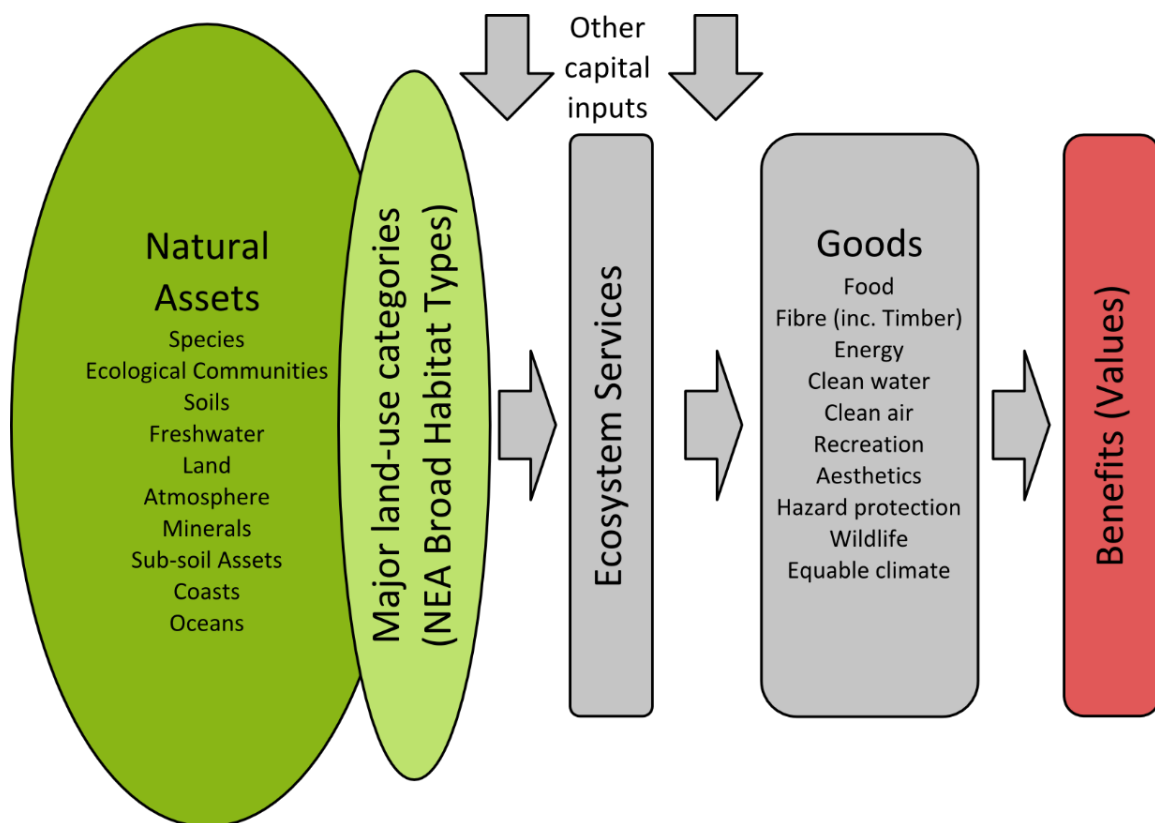


Figure 2. Natural capital and benefits to people - a framework (Natural Capital Committee, 2014)

## **Annex B: Workshop Attendees**

David	Allen	Natural Resources Wales
Vicky	Beaumont-Brown	Environment Agency
Robert	Bradburne	Defra
Ken	Bradley	Dept of Agriculture Environment & Rural Affairs, Northern Ireland
Emily	Connors	Office of National Statistics
Jack	Cosby	Centre for Ecology & Hydrology
Ben	Ditchburn	Forestry Commission
Emily	Finney	Welsh Government
Alessandro	Gimona	James Hutton Institute
Rosie	Hails	Centre for Ecology & Hydrology
Debbie	Hemming	Met Office
Sara	Huntingdon	UK Space Agency
Ruth	Jones	Environment Agency
Joana	Kamenova	Satellite Applications Catapult Ltd
Paul	Leinster	Natural Capital Committee
Jane	Lusardi	Natural England
Nicola	Melville	Scottish Environment Protection Agency
Andy	Nisbet	Natural England
Lisa	Norton	Centre for Ecology & Hydrology
Jodey	Peyton	UK EOF Secretariat
Deborah	Proctor	Joint Nature Conservation Committee
Charlie	Stratford	UK EOF Secretariat
Jennifer	Taylor	Environment Agency
Anita	Weatherby	UK EOF Secretariat
Doug	Wilson	Environment Agency



## Annex C: Time Travel Exercise

On arrival, participants were asked to answer the following question.

*It is 2027 and our monitoring and observation of the natural environment is being successfully used to enable Natural Capital to be quantified and decisions to be made. We've addressed the biggest challenge of monitoring for natural capital – what is the challenge?*

The responses are given below.

### **Avoid catastrophe!**

- It's 2027 and it's all gone wrong – the environment is ruined, we are all starving and we are fighting civil local wars over land – what went wrong and how could we have prevented it: Pre-Mortem!

### **A UK network – and funding model**

- A core sustainable network of environmental monitoring (meteorological co-located with key ecological/ biological/ other measures) across whole of the UK, with demonstrated value to Natural Capital through a few targeted case studies
- Funding for: a consistent, regularly updated nationally representative set of core monitoring activities and protocols for all Broad and Priority habitats – EO and field based – professional and volunteer. Closely aligned and feeding into a common analytical framework.
- Getting individual organisations to put aside their own ways of working and delivering as one body for greater good and agreeing a central budget which is ring fenced from department politics
- Affordability!

### **Agreed metrics & indicators**

- To distil from the mass of possible metrics, a succinct set that provides a balanced view of different values, and resonates with decision makers
- To have an agreed set of c.10 indicators and monitoring data for these, that represents the state (and changes) in order to quantify the NC of the environment effectively
- We finally defined what we wanted and then put the right monitoring in place (that serves multiple needs)

### **Linking assets to services and benefits**

- Monitoring reflects services as well as state
- Monitoring Natural Capital for the provision of cultural ecosystem services!
- Understanding/ characterising the pathways between the assets and the benefits

### **Condition & resilience**

- Able to assess condition of all natural assets and understand its capability
- Monitoring indicators of resilience

### **Using new technologies**

- Finding ways to use new technology and analysis approaches while maintaining consistency in accounts

### **Data – access, integration, management**

- Consistent data and frequency
- Accessible (via web portal) core environmental monitoring/ observation data for UK. Data should link ground-based observations with satellite and other remotely sensed sources.
- Enough space and time resolution, integration of ground and remote surveys, (real time) remote streaming of data from automated stations, handling big data

## National and local

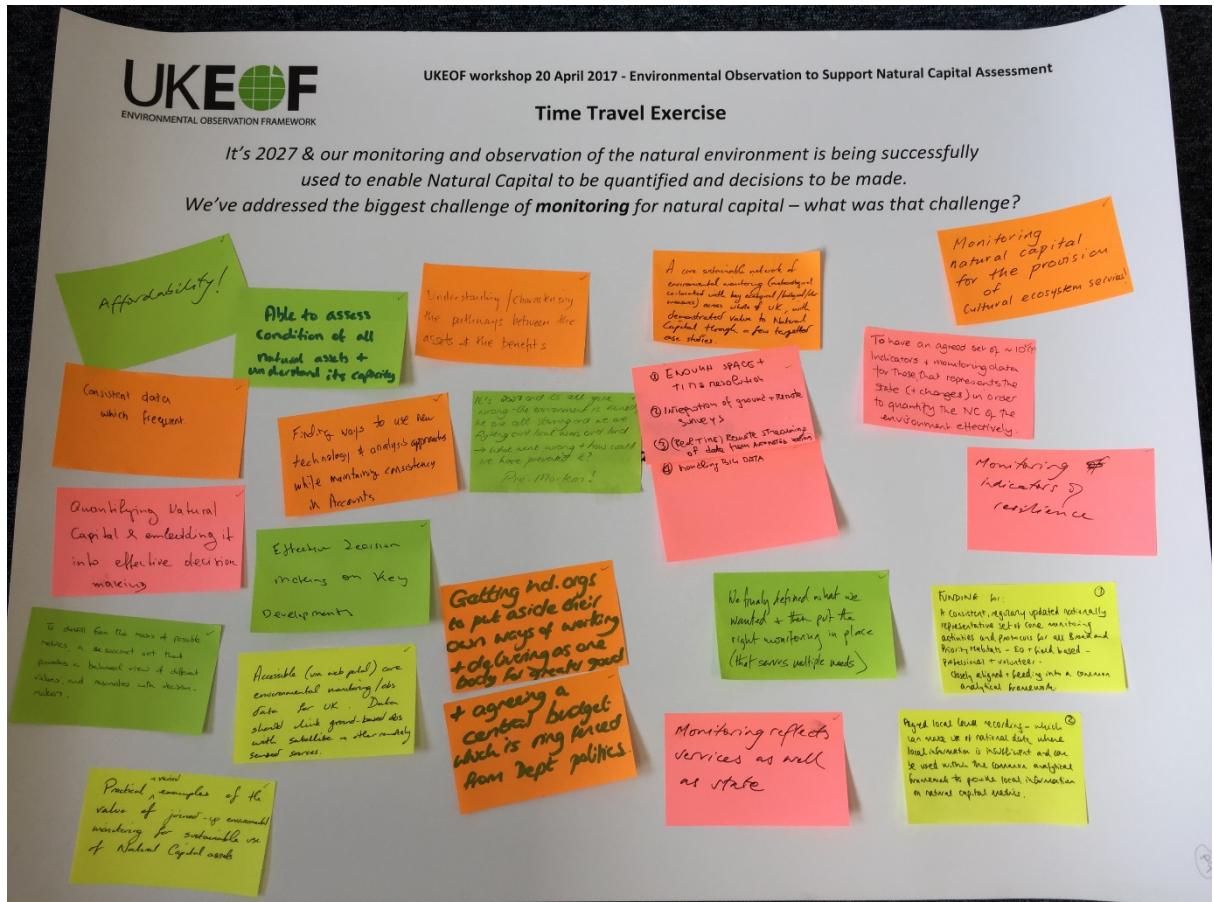
- Funding for: aligned local level recording – which can make use of national data where local information is insufficient and can be used within the common analytical framework to provide local information on Natural Capital metrics

## Decision making

- Quantifying Natural Capital and embedding it into effective decision making
- Effective decision making on key developments

## Case studies

- Practical and varied examples of the value of joined-up environmental monitoring for sustainable use of Natural Capital assets



## Annex D: Snapshot of current environmental monitoring for National Capital needs.

Attendees worked in groups to identify strengths and gaps in current environmental monitoring for National Capital needs. They were asked to list information types (e.g. water quality, woodland extent) for which current monitoring / observation is **likely** (strengths) or **not likely** (gaps) to be able to meet National Capital needs.

Full results are given below. The results are marked up in green for **Monitoring Information Types** and in blue for **Other Issues e.g. Monitoring capabilities / approaches / understanding / governance**.

### Strengths

#### Monitoring information types

##### Water Quality

- Lots of **Water Quality Data** (WFD) (State/ quantity vs Stock) – UK wide
- **Bathing Water / Recreation** – links to human use/ contamination (faecal)
- **Water Quality – frequency/ currency of data** – e.g. WFD classifications every 3 years
- **UK water quality** (EA, SEPA)

##### Water quantity

- **UK water quantity**

##### Air Quality

- **UK air quality** – reasonably well monitored, although urban maybe less so

##### Land Cover Maps

- Lots of **land cover maps!**
- **UK land cover extent\*** (CEH) \*Changing cover only possible from now onwards
- **Land cover**

##### Biodiversity

- **Biodiversity surveillance and indices – birds, butterflies, plants**

##### OS mapping

- **OS master maps**

##### Satellite data

- **Sentinel data** – free!

##### Amount of data

- A **lot of data** compared to other countries
- **Huge amount of information** out there
- Several thousand observations
- **Quantity**

##### Integration

- Some **integration** and collection of data has been done → different assets

##### Expertise

- **Specific expertise in specific areas** →
- **World leading R&D / expertise**

##### Non-environmental data / data sources

- **Lots of people and business data**

- **Open data stimulates new capabilities and ideas in industry and public (don't have to do it all ourselves...)**
- **MENE (England) Monitor of Engagement with the Natural Environment**

### Approaches

- Good/ new ways of working on **citizen science**

### Common approaches

- Using of CICES (**Common International Classification of Ecosystem Services**) – we are all using this
- Common use of land cover map
- **Common approaches for**
  - **Land Cover Map, Water Framework Directive, National Forest Inventory**
  - **UK air quality monitoring and local plans**
  - **Protected sites condition data**

### Gaps

#### Monitoring information types

Other issues e.g. **Monitoring capabilities / approach / understanding / governance**

#### Urban

- **Urban features (small scale)**
- **Urban**

#### Soil

- **UK soil characteristics maps** – not regularly updated
- **Soil information (especially repeats / updates)**

#### Habitat & biodiversity

- **UK habitat condition (including biodiversity)**
  - Broad habitats (priority habitats better)
  - not regular updates
- **Different habitat classification used and filling gaps**

#### Ground truthing Earth Observations & models

- **Modelling – EO data daily to ground truth modelling data** – it needs to happen more
- **Process understanding to improve satellite data on productivity (i.e. MODIS NPP) vs ground truthing**
- **Ground truthing of data**
- **Ground truthing habitat data** is key e.g. condition assessment for woodland

#### Condition

- **Condition** of natural assets
- **Lack of condition information**
- **Quality / condition**

#### Resilience

- **Resilience metrics**

#### Health & Wellbeing

- **Health and well being**
- **Well-being** – especially impact on mental health – how is it measured?

#### Cultural Services

- **Cultural services** very difficult to measure and link to assets

- **Cultural services**

#### Services & benefits

- **Services**
- **Benefits – patchy**

#### Non-renewable resources

- **Data / monitoring of non-renewable resources**

#### Effectiveness of management interventions

- On the **effectiveness of management interventions**

#### Uncertainty

- Communicating **uncertainty** in data sets
- How do we **prioritise and deal with uncertainties**?

#### Integration & understanding whole system

- More effective **integration** – using tools to do this – how can research / academia help?
- Lack of complete **understanding of system and inter-relationships and linkages** (lack of systems engineers!)

#### Spatial resolution

- **Spatial resolution** – difficult!
- **Spatial resolution (ability to break down)**

#### Use in decision making

- **Ability to turn it into knowledge and decisions**
- **What decisions** do we need to make? And **what evidence** do we need to inform these decisions?

#### Understanding what is needed

- **Understanding of what is “good enough” – Noise? Light pollution?**

#### Update frequency

- **Frequency** of updates (meaningful)
- **Time since last survey/ lack of update**
- **Frequency of update** – e.g. **urban edges** – context is important

#### UK Leadership / Policy

- **Who owns it? - Senior lead for all UK Gov?**
- **“GB Policy”** – we need one!
- What are the commonalities for policy across the four countries?
- We are not all using the term Natural Capital.

#### Data access

- Lots of info out there - but **not all consistent/ accessible/ funding / open data** (if public funding)

## Annex E: Generating Ideas for the Action Plan

As the first step of developing the Action Plan, attendees were asked for their ideas for an action plan for how environmental monitoring for Natural Capital purposes needs to evolve. Each idea was written on post it notes which were arranged in groups under one of these topic headings:

1. monitoring **amount/status**
2. monitoring **trends/changes**
3. monitoring to address issues of **scale/spatial configuration**
4. areas that need further information or **research**
5. **sharing** knowledge & experience
6. developing new **methods / technologies**
7. any **other**.

The full list of ideas is given below.

### E1: Monitoring amount/status

#### Standard UK measures and monitoring approach

- Identify a consistent set of NC indicators & agree UK approach to monitoring e.g. what, where, when
- Standardised datasets used for monitoring Natural Capital.
- Agreement on what the key metrics are for all of UK/GB & one centralised approach for acquiring that data & frequency needed.
- Develop a common UK approach. (Agree on common metrics but include others as necessary)
- Agree common metrics across England & devolved governments. (Each can also do their own in addition)
- Joined up monitoring approach - using the existing sources

#### Specific challenges for monitoring method

- Fit for purpose scale - what we can afford - need to fix on a resolution (or set of)
- How do we ensure consistency in monitoring data?
- Need precision & accuracy - plus measures to monitor - short term, minor change
- Match resolution, currency, accuracy to funds
- Include core programme of multi-sector modelling/scenario analyses to reduce risk something is being missed, or something will become obsolete.

#### Specific asset types / characteristics / processes / land uses

- Measure resilience of an asset (to pressures).
- Measure condition of an asset.
- Monitoring of soil health with openly available data.
- Develop a national soil monitoring programme (requires resources)
- Bring flood management into Natural Capital thinking.
- Mapping & quantifying Natural Capital & Ecosystem services in towns & cities.
- Common (or translatable) habitat/ecosystem classification & mapping approach.
- Develop prioritisation criteria for catchment monitoring based on key services provided.

#### Satellite and modelling

- Satellite data incorporated as Business as Usual where it can help/add value - SSGP can help here!
- Developing use of EO and modelling for condition

#### Human Values

- Research into valuing cultural services & the human interactions i.e. connecting people to nature.

#### **International relevance**

- Agree on approach to habitat / ecosystem classification that has wider European / International relevance.

## **E2: Monitoring trends/changes**

### **Review existing activities**

- Gap analysis - what is good enough (for priority assets/services/benefits) - what more needs to be done.
- Establish performance of national monitoring (UK) schemes where they exist. Ability to detect change over defined timescale with defined confidence (=> improved design).
- Desk research to identify current citizen science data (monitored regularly) i.e. Woodland Trust Natures Calendar, WOW (Weather On Web) & how these could be joined-up to monitor Natural Capital indicators.

### **Detecting change**

- Natural Capital assets consistently monitored over agreed time → change detection.
- Ability to assess change not just describe “current” state.

### **Link to wellbeing**

- How do you measure well-being on to other non-financial benefits?
- Link state of environment (Natural Capital) to well-being.

### **Cultural Services**

- Methods to reflect less tangible cultural services.
- Specific focus on cultural services and how these can be adequately addressed in a framework.

### **Citizen Science**

- Focussed Citizen Science project to monitor & apply a few Natural Capital case studies.
- Involve citizens in cultural services monitoring.

### **UK approach**

- Agree consistent UK approach for monitoring trends (i.e. when/where/what) based on agreed indicators.

### **Metrics for resilience**

- Agree metrics (checklist) that reflect resilience.

## **E3: Monitoring to address issues of scale/spatial configuration**

### **Useable at local AND national Scale**

- Develop approaches that are appropriate at specific scales - e.g. National, local BUT ensure transferability across scales.
- Ensure integrated approach to monitoring takes account of different spatial resolutions for different types of decision. (National accounts vs local land management decisions).
- Ensure flexibility in approach to monitoring to allow local data/monitoring to feed in for local decisions.
- Making data & measures practically useful for local communities and decision makers.

### **Build on existing approaches & address national issues**

- Build on existing approaches that work at national scales.
- What can be done now to protect and improve the environment via infrastructure, housing, CAP reform etc.

## **E4: Areas that need further information or research**

### **UK Framework**

- Develop a (prototype) systems monitoring strategy for a catchment (air, land, water, biodiversity) – how does that influence conventional siloed monitoring?
- Better understanding of links between assets/ stocks and services and benefits (research UK wide?)
- Work collectively on asset-benefit relationships (likely to be common to all)

#### **Interdisciplinary valuation**

- Cross silo / discipline measures – “landscape” quality
- Research valuing landscape

#### **Gap analysis**

- Detailed gap analysis of data
- “Priority Gap List” with leads across UK for filling (so we don’t duplicate effort)

#### **Better use of Earth Obs**

- Research for ground-truthing plant / veg condition derived from satellite i.e. NPP
- Invest in research to make greater practical use of earth observation data to fill gaps

#### **Research Proposals**

- Work with the research community to develop ideas for relevant research programmes to submit to research councils.

#### **Mental Health**

- Facilitate join up between the appropriate research councils to find research on the links between environment and mental health

#### **Water**

- Research valuing impacts on water quality and flooding of alternative land uses
- Water catchment measures re: different land uses

#### **Biodiversity proxies**

- Agreeing national proxies for biodiversity:
  - Bats?
  - House flies?
  - Apex predators

#### **Linking models & observations**

- Research linking land surface / earth system models with natural capital observations:
  - Improving modelling
  - Filling gaps where monitoring not possible
- Dynamic models that incorporate time series for refinement / validation

#### **Link asset to service**

- Accessible trait/ attribute information AND link to service

#### **Resilience**

- Focus on ecosystem asset resilience – continued ability to sustain provision of services and benefits into the future

## **E5: Sharing Knowledge & Experience**

#### **Better data (& metadata) sharing**

- Further open access data & mechanisms for sharing & accessing data - widely!
- Free & effective access to data. Better data sharing across Defra Group and wider.
- UK data dissemination platform (web) for all planned natural capital data.
- Generate map of monitoring points (type & frequency) for all UKEOF members.
- Metadata list of NC assets, services/benefits, values, pressure data.

#### **And sharing beyond data: evidence, tools, knowledge**

- Share assessment of data & information not just the data.
- Develop a hub for natural capital data, evidence & tools that is open to all (requires resources!)
- Knowledge exchange networks for NC - building in existing fora and networks.



- What would be the ideal methodology for sharing information? Who or what organisation should co-ordinate?

#### **Common UK approach**

- Are there areas where we're currently using different methods where we can come together and back a common approach?
- Further links between the different governments regarding Natural Capital.

#### **Recognise community / stakeholder priorities**

- Priorities list for data opening/accessibility - from the community to engage data holders.
- Clear view of stakeholders & their role.

#### **Keep a global perspective**

- Maintain global perspective to facilitate (steal good ideas, don't reinvent the wheel), and to establish credentials as good science/policy.
- Build a common approach around Sustainable Development Goals for health & wellbeing building on NRW work.

#### **Build on existing mandate, activities, databases**

- Recognise existing mandates for monitoring (and past programmes) and include in NC monitoring if possible.
- Make use of existing systems to collate new types of data (e.g. space for DNA into species databases.)

#### **Link from research to operation**

- R&D → Piloted Approach → Routine Use. What sits where? How to facilitate the flow.

#### **Education**

- Educational use of Natural Capital → Link with Forest schools nationally

## **E6: Developing new methods/technologies**

#### **Integration of techniques**

- Integrated approach to data - Earth Obs Field Data, UAVs
- Extend membership of Earth Obs C of E to allow more space vs ground work.
- Integrate automated sensor network with Earth Observation.
- Develop an approach for condition monitoring outside protected sites combining Earth Observation data and survey - build on CEH approach.
- Link citizen Science to Earth Observation for habitat condition monitoring.
- Explore methods for integrating disparate datasets & managing uncertainties.
- Modelling i.e. integration of information from multiple sources to infer service provision & Confidence Intervals

#### **Novel techniques / application**

- Low cost sensors (able to deploy easily & collect data from) IoT.
- Molecular techniques (protocols, multiple use)
- Developing Citizen Science to help ground truth maps, models and assessment of condition.

#### **Defining metrics & values**

- Case studies focussed on farmers → super-users → work with super-user farmers to identify which NC indicators to monitor i.e. productivity and why?
- Consult/review the most appropriate metrics for resilience.
- Discussion about how services can be valued / should be valued.

#### **Using Data**

- Make monitoring data easier to use: Introduce Level 1 → Level 2 etc of elaboration.
- Use "Big Data" and machine learning to explore possibilities of relevant information to supplement/verify monitoring activities

#### **Aggregation to UK level**

- Aggregation of NC Accounts from Devolved Administrations to UK framework/standards.

### **Horizon Scan**

- Centralised technology horizon scanning - thematic basis.

### **Unconventional data sources**

- A strategy/discussion about making use of business data & other unconventional established sources for use in environmental statistics.

### **Interventions**

- Develop a framework to assess the effectiveness of interventions (agreed across GB devolved nations).

### **Urban**

- Develop an approach to urban assessment of Natural Capital → use this to develop monitoring approach for urban (scale).

## **E7: Any other**

### **Integrated UK monitoring strategy**

- Integrated UK monitoring strategy.
- Work up a UK integrated monitoring strategy.
- Overarching architecture of approach.
- Linkages established UK-GEOS → to bring coherence & alignment.
- Answer question about need for approaches to NC assessment - at what level do we desire consistency?
- Get key data providers to work together to identify potential savings through joint data collection.
- Collaboration across countries and across themes. e.g. Peatland monitoring across NI, Wales, Scotland, England.
- A focus on ecosystem function and processes underpinning the provision of services
- Prioritised action list.

### **Governance**

- Agreed governance structure which is pan GB (and resourced!)
- Small (>10 people) steering/ sharing committee
- Overarching governance

### **Statutory basis**

- A statutory basis in England
- At what stage/ time do we need to legislate for Natural Capital
- Bring together spatial planners: National infrastructure / Roads / Rail
- Planning policy changed to include Natural Capital measures up front i.e. vertical gardens, tree maintenance

### **Links to decision makers**

- Effective communications – linked to general public/ political priorities – what's in it for me, not – here is the science! Effect on mental health/ diabetes/ cancer/ heart disease/ cost of bread etc.
- Agree what Natural Capital information / evidence is needed for decision making and how good/ robust that evidence needs to be
- Getting a senior sponsor with a pan GB/ Government remit who is the lead on this! (Champion!)
- I can offer a conduit to policy/ decision-making at national level (Rob B)
- Making Natural Capital relevant and relatable to:
  - The public
  - Politicians
  - Industry/ businesses

## Annex F: Details of ideas developed

As a second step in developing the Action Plan, attendees worked in groups to develop details of ideas they felt were important. For each idea each group wrote a description of the idea, identified the output/outcome, suggested who and what was involved, and whether this was suitable as a UKEOF coordinated activity. They then reported back to the whole workshop.

For the third and final step of developing the Action Plan, each participant had the chance to add comments to each idea, and to mark on a scale their level of support for the idea and how feasible they felt it was.

Full details of the results are given below. Titles of the 10 ideas developed are given below, with scores (out of 10) for the level of support and feasibility. Ideas are ranked and presented in order of the level of support.

Rank	Title	Support	Feasibility
1	Building on common ground (a framework)	8.3	7.8
2	Framework for UK monitoring and assessment of Natural Capital	8.1	7.4
3	Risk based approach to monitoring change in Natural Capital and Ecosystem Services	8.1	6.4
4	“What’s in it for me?” group	8.0	7.1
5	The scale is right!	7.9	6.1
6	Integrating / Including New Techniques	7.4	6.5
7	Inclusion of non-traditional data	7.4	6.5
8	Statutory Basis	7.3	5.5
9	Signposting to data for decision makers	6.5	6.6
10	Natural Capital - Why do I care?	6.0	5.8

### 1. Building on common ground (a framework)

<b>Brief Description</b>	Gather best practice and approaches across the countries. Develop a working forum / network for NC for UK Developing a framework based on the conceptual model for an NC approach
<b>What would be the output / outcome?</b>	Agreed principles and common approaches Pooling of resources where effective to joint working Sharing our learning and learning by doing
<b>What would be involved?</b>	Informal topic based discussions would pull in wider people e.g. indicators for ecosystem health, SDGs
<b>Who would need to be involved?</b>	This would vary depending on topics The workshop reps from today (20/4/17) would be ideal to start to build up further networks
<b>Is this a UKEOF coordinated activity?</b>	Yes

<b>Follow up comments or suggestions from other workshop attendees</b>	Why does the government need to do it all? Charities, youth groups (land registry, OS not here!) Use the power of the masses, inspire the next generation
<b>Support</b>	8.3/10 (n=21)
<b>Feasibility</b>	7.8/10 (n=21)

## 2. Framework for UK monitoring and assessment of Natural Capital

<b>Brief Description</b>	Hub & synthesis Knowledge sharing platform
<b>What would be the output / outcome?</b>	1. Consistent data (ONS) UK accounting & reporting 2. Novel research 3. Scalability of outputs
<b>What would be involved?</b>	Somebody being given a statutory responsibility for <u>UK</u> monitoring (put someone in charge) or <u>get countries working together</u>
<b>Who would need to be involved?</b>	ONS, government departments
<b>Is this a UKEOF coordinated activity?</b>	Yes – this is <u>it</u>
<b>Follow up comments or suggestions from other workshop attendees</b>	None
<b>Support</b>	8.1/10 (n=20)
<b>Feasibility</b>	7.4/10 (n=20)

## 3. Risk based approach to monitoring change in Natural Capital and Ecosystem Services

<b>Brief Description</b>	Develop a framework for a risk based approach to monitoring change in Natural Capital and Ecosystem Services
<b>What would be the output / outcome?</b>	<ul style="list-style-type: none"> <li>• Early warning of increased risk to NC assets and reduced ES supply. Benefits: <ul style="list-style-type: none"> <li>○ avoid loss of benefits (≠ costs)</li> <li>○ avoid mitigation costs</li> <li>○ increase resilience</li> </ul> </li> <li>• Evaluation of impact of interventions</li> <li>• Identification of appropriate interventions</li> </ul>
<b>What would be involved?</b>	<ol style="list-style-type: none"> <li>1. Risk Assessment of catchment</li> <li>2. Identify key NC assets at risk and attributes to measure</li> <li>3. Review current monitoring to determine effectiveness in detecting change</li> </ol>

	<p>4. Identify baseline metrics and frequency of monitoring required</p> <p>5. Develop monitoring plan for “catchment”</p> <p>6. Evaluate</p>
<b>Who would need to be involved?</b>	<p>Monitoring Implementers (EA / NE / FC/ MMO / CEFAS / CEH)*</p> <p>Data providers (CEH Cranfield, 3<sup>rd</sup> parties)</p> <p>Ecologists, social scientists, economists</p>
<b>Is this a UKEOF coordinated activity?</b>	Maybe
<b>Follow up comments or suggestions from other workshop attendees</b>	<p>*England only?!</p> <p>Need to agree level of risk appetite</p> <p>Need to balance against loss of full overview and missing things not thought to be at risk</p> <p>Need to change behaviours – hard for “good enough”</p> <p>Note on feasibility: possible for some indicators. Target approach to key users / environment responders i.e. those with statutory responsibility to respond</p>
<b>Support</b>	8.1/10 (n=17)
<b>Feasibility</b>	6.4/10 (n=17)

#### 4. “What’s in it for me?” group

<b>Brief Description</b>	<p>A “non-exec” group / sounding board</p> <p>“user group” not the usual suspects</p> <p>Needs to go across government</p>
<b>What would be the output / outcome?</b>	<p>Recognised tools / processes which everyone uses</p> <p>Time limited task force</p> <p>Non-land managers</p> <p>Urban</p>
<b>What would be involved?</b>	<i>Not answered</i>
<b>Who would need to be involved?</b>	<p>NCC secretariat</p> <p>UK bodies – do Wales / Scotland have similar bodies? Can we learn?</p>
<b>Is this a UKEOF coordinated activity?</b>	<i>Not answered</i>
<b>Follow up comments or suggestions from other workshop attendees</b>	<i>None</i>
<b>Support</b>	8.0/10 (n=15)
<b>Feasibility</b>	7.1/10 (n=14)

#### 5. The scale is right!

<b>Brief Description</b>	Broad network of monitoring key Natural Capital characteristics overlapped by different higher-resolution monitoring focussed on specific characteristics and ecosystem processes e.g. 1km land cover data with higher resolution land cover data over complex biodiverse / land cover areas. Nested data transects that span biomes / climate transects and include range of scales.
<b>What would be the output / outcome?</b>	Understanding of which scales and configurations are most relevant for each NC characteristic being monitored i.e. 25m for biodiversity, 5km for air temperature. NC monitoring that is.... *Fit the scale to the purpose and the requirement*
<b>What would be involved?</b>	<ul style="list-style-type: none"> <li>• Analyse same metrics / characteristics at different scales and derive measures of which is most appropriate</li> <li>• Assessment of uncertainties involved in different scales (is it worthwhile to use higher resolution)</li> <li>• Data on metrics / characteristics at different scales – and / or reliable models / proxy data</li> <li>• Link satellite data with ground truthed – average satellite data to resolution of land networks</li> <li>• Focus on single site locations across biome and climate transects</li> </ul>
<b>Who would need to be involved?</b>	Data collectors, modellers, satellite data analysts
<b>Is this a UKEOF coordinated activity?</b>	Maybe
<b>Follow up comments or suggestions from other workshop attendees</b>	Do not need same resolution for all UK! Higher resolution of cities – multiple uses offsets costs of high resolution imagery. Lower resolution of rural – less use but free data. Data already out there at different scales that can be used for this type of analysis. Varies – not for all characteristics of NC at a scale that is meaningful locally
<b>Support</b>	7.9/10 (n=16)
<b>Feasibility</b>	6.1/10 (n=15)

## 6. Integrating / Including New Techniques

<b>Brief Description</b>	Integrating Earth Observations with: <ol style="list-style-type: none"> <li>1. Low cost automatic sensor networks</li> <li>2. UAVs (Unmanned Aerial Vehicles)</li> <li>3. Citizen Science</li> </ol>
<b>What would be the output / outcome?</b>	<ul style="list-style-type: none"> <li>• Data repository / catalogue of where to get what data &amp; appropriate metadata</li> <li>• Data compatibility</li> <li>• Developing models to do the integration – executable</li> </ul>

<b>What would be involved?</b>	<ul style="list-style-type: none"> <li>• Resources by a central agency</li> <li>• Agreement across all 4 administrations</li> <li>• Good infrastructure</li> <li>• Joint government initiative (IPR issues etc)</li> </ul>
<b>Who would need to be involved?</b>	<p>Defra EO Centre of Excellence &amp; Space for Smarter Government Programme</p> <p>Citizen Science County Divisions</p> <p>Research institutes – modelling</p> <p>NGOs</p> <p>Space sector</p>
<b>Is this a UKEOF coordinated activity?</b>	<i>Not answered</i>
<b>Follow up comments or suggestions from other workshop attendees</b>	<p>There is already lots going on here – on data collection &amp; research</p> <p>Earth Obs portals in existence – sectors / data hub</p> <p>RPAS working group (Remotely Piloted Aircraft Systems)</p> <p>UKGEOS</p>
<b>Support</b>	7.4/10 (n=18)
<b>Feasibility</b>	6.5/10 (n=8)

## 7. Inclusion of non-traditional (novel) data

<b>Brief Description</b>	<ul style="list-style-type: none"> <li>• Accessing: <ul style="list-style-type: none"> <li>○ Business data</li> <li>○ Labour market data</li> <li>○ Urban data</li> <li>○ Other data that relates to wellbeing (self reported)</li> </ul> </li> <li>• Mining data and machine learning</li> <li>• Horizon scanning – what next? (GO Science!)</li> </ul>
<b>What would be the output / outcome?</b>	<ul style="list-style-type: none"> <li>• Better insight and benefit and linking national capital to social and economic</li> <li>• New sources of data</li> <li>• Ability to anticipate “cliff edges”</li> </ul>
<b>What would be involved?</b>	<p>Machine learning – already out there</p> <p>Big Data Institutes / Natural Capital / Social Science</p> <p>Hackathon / workshop</p> <p>Social &amp; economics dataset integration</p>
<b>Who would need to be involved?</b>	<i>Not answered</i>
<b>Is this a UKEOF coordinated activity?</b>	<i>Not answered</i>
<b>Follow up comments or suggestions from other workshop attendees</b>	<p>Data quality and consistency very important</p> <p>Amazon / google do it already! Learn lessons from industry</p>

<b>Support</b>	7.4/10 (n=19)
<b>Feasibility</b>	6.5/10 (n=19)

## 8. Statutory Basis

<b>Brief Description</b>	When are we at the point that we can measure change to a point we could put Natural Capital on a statutory basis? What does it take to get here? Is this country specific?
<b>What would be the output / outcome?</b>	Climate Change Act –type metrics
<b>What would be involved?</b>	Integration of four countries’ experience
<b>Who would need to be involved?</b>	Not answered
<b>Is this a UKEOF coordinated activity?</b>	Not answered
<b>Follow up comments or suggestions from other workshop attendees</b>	Already statutory in some countries?
<b>Support</b>	7.3/10 (n=12)
<b>Feasibility</b>	5.5/10 (n=12)

## 9. Signposting to data for decision makers

<b>Brief Description</b>	Using common INSPIRE terms e.g. common language
<b>What would be the output / outcome?</b>	Signposting between a plethora of data warehouses and portals Consistency of data used
<b>What would be involved?</b>	Identifying user needs in terms of language.
<b>Who would need to be involved?</b>	Data users – starting with UKEOF & then data managers
<b>Is this a UKEOF coordinated activity?</b>	Not answered
<b>Follow up comments or suggestions from other workshop attendees</b>	Metadata details needed and advice on appropriate use (or can be overwhelming) Politicians don’t care about metadata (✓✓✓) – what is impact on their priorities for health, jobs, housing, immigration Needs to be users not provider level
<b>Support</b>	6.5/10 (n=16)
<b>Feasibility</b>	6.6/10 (n=16)



## 10. “Natural Capital – Why do I care?” / How the investment in Natural Capital is realised for public good?

<b>Brief Description</b>	Explaining how R&D delivers value and affects Jo Public by clearly explaining the impact of actions on the environment and relevance to their lives
<b>What would be the output / outcome?</b>	<ul style="list-style-type: none"> <li>• Transparent linkage between R&amp;D, assets &amp; benefits</li> <li>• Improved knowledge on the relationship between assets &amp; benefits</li> <li>• Consensus over approach at a UK level</li> <li>• Clear case studies in public domain</li> <li>• Raised understanding, awareness &amp; ownership to influence change</li> </ul>
<b>What would be involved?</b>	<ol style="list-style-type: none"> <li>1. Develop and agree a national framework for linking assets to benefits</li> <li>2. Agree a set of benefits we want to explore (top 5)</li> <li>3. Map out the benefits &amp; dependencies – value chain (baseline &amp; change) Governance!</li> </ol>
<b>Who would need to be involved?</b>	UKRI, Devolved Administrations, UKEOF, public stakeholders, National Trust, NSRPB etc, ministerial champion, Defra Chief Scientific Adviser, Government Chief Scientific Adviser, ONS
<b>Is this a UKEOF coordinated activity?</b>	<p>Maybe</p> <p>Ministers in Scotland, Wales, England &amp; Northern Ireland need to work together! UKRI / Defra too &amp; Devolved Administrations</p>
<b>Follow up comments or suggestions from other workshop attendees</b>	<p>Communications / engagement plan and key messages with examples</p> <p>Is this a UKEOF responsibility?</p>
<b>Support</b>	6.0/10 (n=19)
<b>Feasibility</b>	5.8/10 (n=18)

## Annex G: Attendee Feedback

<b>What did you particularly like about the workshop and why? What has been particularly useful for you or your organisation?</b>	<b>What could have been better and how?</b>	<b>What would you like to see as a next step?</b>
The first time all the relevant bodies were in the same room Started to build a common understanding	Venue with parking facility	Cross organisation framework to: 1) co-ordinate activity 2) Create a common approach
Sharing knowledge and experience Meeting others working on similar issues Looking to take action not just talk	It was well organised and facilitated	Taking forward the common ground action to see which aspects are worth countries working together on
Venue - great choice Friendly bunch - good mix of raising awareness and getting up and doing stuff Meeting new contacts - particularly Paul Leinster and NI rep	Slides - very hard to read from a distance! Audio - speakers very quiet - use microphones as background noise very loud Lots of people stood around categorising post - it's by committee not effective - use tea breaks for facilitations and chairs to categorise and re-group	Condensed list of "sanity checked" proposals to management committee - hard to do by committee - get one person to co-ordinate and draft and circulate to key people for review and comment
How active it was and how it really focussed on what we can do. Very proactive. It brought together a lot of people and has certainly been useful for the UK accounts	Very broad topics - but good event	Some actions to come out of the things on the wall. Certainly something more to bring people together
Opportunity to hear from other grants	Greater challenge on actions - I think we're over optimistic!	Write it down and reflect!
Plenty of energy; lots to do; good balance of presentations and activities Good to hear what others are doing	In hindsight, given that engagement with local decision makers came up as an aspiration, might we have invited some?	Agreed plan of action
Sharing ideas and work Learning from and meeting others Good pace	Maybe bit more time for discussion and break out groups and less time on presentations (although all interesting)	Produce action plan with steering group under UKEOF

<b>What did you particularly like about the workshop and why? What has been particularly useful for you or your organisation?</b>	<b>What could have been better and how?</b>	<b>What would you like to see as a next step?</b>
Opportunity to interact with different backgrounds and institutional roles	Short profile of participants in documentation More discussion time	Report on results of the sessions
Great venue and good to meet new colleagues from other organisations and learning about different approaches across UK to countries	No Comments	Clear write up and actions from the workshop. Taking the actions forward
Working up ideas section	Possibly some end users from Agriculture / Infrastructure / Business to provide user requested context (maybe not enough time in the day for this!)	Funded case studies involving collaboration across organisations and users
Talking to others and catching up with that is going on elsewhere	Later start?	A group set up to facilitate an UK level monitoring framework
Well organised, clear goal Good chance to see other points of view re: NC (especially ON5)	National Overviews were a little inconsistent in form and content. Hard to get a coherent picture of who is actually doing what (Scotland good, Defra good)	1) Action Plan 2) Plan for future funding and coordination
The 4 countries coming together and comparing approaches. Great structure of the workshop. As part of the Defra EU CoE - it was interesting to see how Earth Obs fits into wider obs.	It was great!	Summary of workshop and worked up ideas. Plan for taking forward the priority ideas
Good group for networking People very open with ideas	Good development of a map(s) to show current monitoring by UKEOF organisations. "Not enough data...?!"	Clear list of UKEOF priorities around NC monitoring (i.e. which draft action plans are developed) so we can plan resource contributions and get into business plans. Can you circulate powerpoints please?
Updating knowledge Networking	N/A - worked for me!	Follow-up is always hard so perhaps a Delphi approach to ideas generated? By email not in a room. Think about products to cost up and tout?