Applying an ecosystem service approach to the production of the second river basin management plans

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The James Hutton Institute

The Scottish Government
Centre of Expertise for Waters (CREW)

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Executive Summary

Project reference: CD2011/5 Applying an ecosystem services approach to the production of the second River Basin Management Plan (RBMP) – identifying indicators of key ecosystem services and pressures.


Background to research

SEPA is considering using an ecosystem services approach to produce the second phase of River Basin Management Planning (RBMP). If successful, this will pave the way towards use of an ecosystem services approach in other parts of SEPA’s work. So far there is widespread acceptance that the ecosystem services concept offers a useful way of describing and valuing environmental change but there are few examples of practical application of an ecosystem services approach to decision making. In addition, the UK National Ecosystems Assessment (NEA) made the point that we already have sufficient information and understanding to start to make use of an ecosystems approach. The aim of this work would therefore be to advise SEPA on the availability and accessibility of data that will help it to apply an ecosystem services approach to the second phase of RBMP. If it is decided to adopt an ecosystem services approach, the outputs from this piece of work will be used to inform the characterisation and Significant Water Management Issues (SWMI) reporting that is required in advance the second phase of RBMP.

Objectives of research

1) To identify what key ecosystem services are associated with the water environment in Scotland (at the national level);
2) To identify indicators for these key ecosystem services which are accessible; mappable (i.e. easily transferred to GIS layers); compatible with existing datasets; and available for immediate use by SEPA;
3) To identify pressures on the provision of these key ecosystem services associated with the water environment in Scotland and the key causes of these pressures;
4) To identify indicators for the activities that are causing pressures on ecosystem service provision in Scotland which are accessible, mappable, compatible with existing datasets and available for immediate use by SEPA; and
5) To identify further information needs and challenges that would improve the ability to apply an ecosystem services approach to preparation of the second round of RBMP.

Key findings and recommendations

A facilitated workshop that involved SEPA staff and researchers identified 14 key ecosystem services associated water in Scotland with very high significance at the national level. There was limited success at the workshop to identify indicators and associated spatial datasets. In part this is due to the lack of data of either the provision of ecosystems services or the benefits to society. Depending on what ecosystem services are chosen, there is a lack of indicators (especially for non–provisioning services). Work is required to develop these indicators if an ecosystem service based approach is to be used.

Key words

Ecosystem service; indicators; water Scotland; National level.
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Glossary

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
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</thead>
<tbody>
<tr>
<td>Habitat &amp; Area</td>
<td>This is an area of land and/ or water that can be anything in size from a patch, to field/garden, to farm/woodland/park to the whole of a hydrological catchment.</td>
</tr>
<tr>
<td>Ecosystem Function</td>
<td>The contribution (and capacity) of an area of habitat to supply ecosystem services.</td>
</tr>
<tr>
<td>Ecosystem service flow</td>
<td>Ecosystem services flow from where they are generated to where people experience benefits from these flows (can be matter, energy of information).</td>
</tr>
<tr>
<td>Ecosystem Service</td>
<td>The contributions that ecosystems make to human well-being.</td>
</tr>
<tr>
<td>Beneficiaries</td>
<td>An individual or group of individuals whose wellbeing is improved (increased) by an ecosystem service (by its use or by its existence (non-use)).</td>
</tr>
<tr>
<td>Final ecosystem service type</td>
<td>These are Provisioning; Regulating and Maintenance; and Cultural and Social services (Haines-Young and Potschin, 2011).</td>
</tr>
</tbody>
</table>

1. INTRODUCTION

SEPA is considering using an ecosystem services approach to produce the second phase of River Basin Management Planning (RBMP). If successful, this will pave the way towards use of an ecosystem services approach in other parts of SEPA’s work. So far there is widespread acceptance that the ecosystem services concept offers a useful way of describing and valuing environmental change but there are few examples of practical application of an ecosystem services approach to decision making. In addition, the UK National Ecosystems Assessment (NEA) made the point that we already have sufficient information and understanding to start to make use of an ecosystems approach. The aim of this work would therefore be to advise SEPA on the availability and accessibility of data that will help it to apply an ecosystem services approach to the second phase of RBMP. If it is decided to adopt an ecosystem services approach, the outputs from this piece of work will be used to inform the characterisation and Significant Water Management Issues (SWMI) reporting that is required in advance the second phase of RBMP.

A CREW call down project was request by Rebecca Badger and James Davidson (SEPA) to address the following aims:

1) To identify what key ecosystem services are associated with the water environment in Scotland.
2) To identify indicators for these key ecosystem services which are accessible; mappable (i.e. easily transferred to GIS layers); compatible with existing datasets; and available for immediate use by SEPA.
3) To identify pressures on the provision of the key ecosystem services associated with the water environment in Scotland and the key causes of these pressures.
4) To identify indicators for the activities that are causing pressure on ecosystem service provision in Scotland which are accessible, mappable, compatible with existing datasets and available for immediate use by SEPA.
5) To identify further information needs and challenges that would improve the ability to apply an ecosystem services approach to preparation of the second round of RBMP.
There is a need to add value to existing RBMP and assessments of good ecological status (GES) that focus on the state of ecosystem service provision associated with the water environment. Recently, Mark Everard (In Press) a leading exponent of ecosystem based regulatory approaches, has set out an argument for framing Water Framework Directive (WFD) goals in terms of ecosystem service terms, as this would provide a stronger linkage between ecosystem health and societal benefits. SEPA sees the advantages of taking an ecosystem service based approach as improving communication of the benefits to people/society from the water environment and better targeting of SEPA’s management efforts. It is hoped that mapping ecosystem service delivery and aligning this/comparing with existing assessments of GES may tell a more complete story on what the water environment provides for Scotland’s people.

There is a large body of existing knowledge and experience of using indicators to support decision making in the context of greater levels of sustainable development (this will be set out in greater detail in appendix I; not-completed). In particular the driver-pressure-state-impact-response (DPSIR) framework is widely used to support EU policies at the EU and national levels. The development and use of indicators to support operational/practical ecosystem service based approaches is relatively new. A recent review of the lessons learned from developing ecosystem service indicators in sub-global and related initiatives made the following recommendations: ensure objectives are clear; adopt a small set of specific, policy relevant indicators; go beyond provisioning services; utilise existing data and proxies (but recognise limits); think about sustainability- include indicators for both ecosystems and benefits; include biodiversity; be sensitive to scale; assess trends and consider synergies and trade-offs; engage stakeholders early; and focus on communication (UNEP-WCMC, 2011a).

2. APPROACH
To meet the aims of this work, the following steps were carried out:

2.1 Review of how indicators have been used to support an ecosystem service based approach and what is required
First a brief review was carried out covering how indicators have been used to support an ecosystem service based approach and what is required. The rationale behind this activity was to ensure SEPA benefits from existing work (operational and research based) on indicators of ecosystem services. This review will be found in appendix I (not 100% completed).

2.2 A workshop to identify key ecosystem services, pressures and datasets
A one day workshop was designed in collaboration with SEPA staff to test and further develop an approach to identify indicators for key ecosystem services associated with the water environment (covering WFD freshwater and coastal waters) at the national level in Scotland. Key SEPA staff and an equal number of researchers who are actively involved in understanding Scotland’s water related ecosystem services (freshwater and coastal systems) were invited (see appendix II). The workshop was facilitated, so that pairs (SEPA staff member and researcher) and subsequently small groups would use templates to discuss and record the information required in part to meet aims 1-4 of this project. A workshop was used, as this not only brought together the relevant expertise that spanned the operational (SEPA) and research communities, but also provided a greater legitimacy and robustness to the selection of key ecosystem services (Table 1). The details of workshop structure, including the templates used, supporting information and detailed
results are presented in appendix II. At the start of the project the requirements for indicators were they should be mappable, straightforward (free or low cost) to access and available in a format which is consistent with (and can be overlayed on) existing mapped datasets held by SEPA. At the workshop these criteria were expanded to include: accessible to non-GIS expert and reliable.

3. **RESULTS AND DISCUSSION**

3.1 **Review of existing approaches and actual indicators of ecosystem services**

The key messages from this review are that despite the wide development and use of indicators to support the aim of sustainable development, the existing indicators in use for policy and operational purposes are mainly based on the state of the environment in terms of the potential supply of ecosystem services (or aspects of this supply), often framed within the widely used DPSIR framework. There is a need to develop indicators that not only reflect the condition of an ecosystem or the state of the ecosystem service supply, but also the potential and actual benefits provided by these ecosystem services. Indicators are also required on the performance (sustainability) of these systems to deliver these services. Indicators used to support an ecosystem service based approach need to be classified according to types (Table 2).

As highlighted in the review (appendix I) there are a number of approaches that are currently being used in ecosystem service assessment or are under development. In summary these can be grouped into:

1) **Re-use of existing indicators** that are widely used within a DPSIR/PSR frameworks. The majority of these indicators that are said to provide a measure of ecosystem services are often only an indicator of the state/condition of the environment, so at best offer only a proxy of the system/habitat to potentially provide a service. Examples of where these are used in national scale assessments include those highlighted in the recent report on sub global assessments (UNEP-WCMC, 2011).

2) A number of operational e.g. Scottish Natural Heritage National Capital Index, West Country Rivers Trust and research based examples of ecosystem service assessment e.g. Burkhard et al. (In press) have relied on using spatial land cover/habitat data and through expert judgement assessed the potential for service supply e.g. National Capital Index or have attempted to assess the supply and demand of services and simply subtract these to highlight where there may be mismatch between supply and demand (Burkhard et al., In press). These approaches do not utilise the fact that many ecosystem services (esp. those associated with water) flow through the environment between the habitats and the beneficiaries (Bagstad et al., 2011; Fisher et al., 2011).

3) Development of more complex indicators and indices that in part capture the dynamics of the supply and demand of ecosystem services e.g. (Walter and Cornelia, 2009). In this study the Swiss Federal Office for the Environment (FOEN) developed an inventory of ecosystem services relevant to Switzerland and developed indicators of 26 final ecosystem services. They used the CICES definitions (Haines-Young and Potschin, 2011) and focussed on non-monetary (mainly bio-physical) indicators as these were viewed as having greater data availability and being more reliable. Related to this group is the suggestion by DeGroot et al. (2010) that a set of indicators were required that fully represented how ecosystem processes and structures interact with ecosystem services. They suggested using state and performance indicators, where state indicators provide information on what ecosystem process or structure is providing a
service and how much service is being provided. And performance indicators provide information on how much of that service can be used in a sustainable way.

Due to the difficulty in capturing the dynamics of ecosystem supply and demand in a single indicator the use of model structures based on Bayesian Belief Networks (BBN) (that allow experts opinion to be integrated with knowledge of ecosystem functioning) has been used recently to develop complex model based indices of ecosystem services (Haines-Young, 2011). In a recent report for Natural England Bellamy et al. (2011) suggest that the use of a series of BBNs within a GIS environment is potentially an effective and efficient way to make use of the existing datasets and overcome data gaps.

The focus of this report is on pressure and state information (i.e. state of ecosystem service provision and the pressures on it), where ecosystem service state is the novel aspect for SEPA. Bearing in mind that RBMP goes beyond the river, to include coastal systems.

3.2 Identification of key ecosystem services at the national level
Out of the 37 ecosystem services that were identified at the workshop, 14 of these were rated by the participants (not all ecosystem services were rated) as being of a very high significance at the national level. These services are presented in Table 1, along with information on which class of final ecosystem service they belong to, their original workshop code (in a supplementary MS Excel workbook) and how many instances of these ecosystem services were identified by the different sets of SEPA/researcher pairs.

3.3 Key discussion points raised by the workshop participants
In addition to the value gained from operational and research staff co-identifying and co-selecting ecosystem services and the pressures on them. The workshop provided an important opportunity for discussion on taking an ecosystem service based approach and in particular on the activities carried out during the workshop. There were a number of key points raised and these are summarised below (the contractor has a full record of the discussion points):

Surface/ground water catchment boundaries. Linked indicators of the supply and demand of ecosystem services are required. “Indicators need to be a combination of data e.g. volume of water/by population (manipulation of supply and demand)”. “[Indicators] are not a single dataset and we can combine a couple of datasets- would be good to work out which can be combined.” This assessment is at the national level, there is also a need for catchment level assessments. Scale and consistency when working across from the local/catchment to national level is key (parking lot). The importance of small locations can get lost when looking at the national level. There was discussion on the value of existing indicators. When it came to examining the pressures (and activities causing these pressures) there was disagreement between SEPA staff involved in freshwater and marine systems if activities were a useful concept or not. Assessing the significance of ecosystem services is always going to be very challenging, the classes of number of people benefitted could be set as the whole of Scotland, a large number of local population or a small number of a local population. The need to focus on final ecosystem services was not agreed by all participants. Is an alternative way to assess the significance of an ecosystem service to remove them (in a thought experiment) and then to assess the impact on society. It is likely that even for one single ecosystem service that a large number of indicators is required to capture the benefits to a wide range of
beneficiaries. The state of marine systems is difficult to measure, often pressures e.g. catch numbers are used as the indicator.

Table 2 – Ecosystem services identified in the workshop to have a very high significance at the national level in Scotland.

<table>
<thead>
<tr>
<th>Number</th>
<th>Ecosystem service</th>
<th>Type</th>
<th>Code</th>
<th>How many?</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Water abstraction for food production</td>
<td>Provisioning</td>
<td>P1</td>
<td>Two</td>
</tr>
<tr>
<td>2</td>
<td>Water use by industry</td>
<td>Provisioning</td>
<td>P6</td>
<td>Two</td>
</tr>
<tr>
<td>3</td>
<td>Water for power generation (hydroelectricity)</td>
<td>Provisioning</td>
<td>P8</td>
<td>Two</td>
</tr>
<tr>
<td>4</td>
<td>Provision of drinking water</td>
<td>Provisioning</td>
<td>P10</td>
<td>One</td>
</tr>
<tr>
<td>5</td>
<td>Nursery function (fish)</td>
<td>Provisioning</td>
<td>P11+12</td>
<td>Two</td>
</tr>
<tr>
<td>6</td>
<td>Coastal aquaculture</td>
<td>Provisioning</td>
<td>P3</td>
<td>Three</td>
</tr>
<tr>
<td>7</td>
<td>Water quality</td>
<td>Regulating and maintenance</td>
<td>RM1</td>
<td>Three</td>
</tr>
<tr>
<td>8</td>
<td>Supporting (underpinning final services)</td>
<td>Regulating and maintenance</td>
<td>RM4</td>
<td>Three</td>
</tr>
<tr>
<td>9</td>
<td>Flow regulation to reduce flood risk</td>
<td>Regulating and maintenance</td>
<td>RM7+8+9+10</td>
<td>Five</td>
</tr>
<tr>
<td>10</td>
<td>Carbon sequestration</td>
<td>Regulating and maintenance</td>
<td>RM13</td>
<td>One</td>
</tr>
<tr>
<td>11</td>
<td>Water sports</td>
<td>Cultural and social</td>
<td>CS4</td>
<td>Three</td>
</tr>
<tr>
<td>12</td>
<td>Beach: amenity, recreation</td>
<td>Cultural and social</td>
<td>CS6</td>
<td>Two</td>
</tr>
<tr>
<td>13</td>
<td>Habitat provision</td>
<td>Cultural and social</td>
<td>CS8</td>
<td>One</td>
</tr>
<tr>
<td>14</td>
<td>Tourism</td>
<td>Cultural and social</td>
<td>P16</td>
<td>One</td>
</tr>
</tbody>
</table>

The list of ecosystem services identified in Table 1, were then checked against the list of final ecosystem services in UK NEA (Table 2.2) (UKNEA, 2011). All of the NEA final ecosystem services were covered in Table 1, to a greater or lesser extent. The UK NEA final ecosystem service of Wild species diversity (recreation, bioprospecting and medicinal plants) is judged to be included under number 13 (CS8) Habitat provision. Biomass production is included under number 8. Coastal and freshwater related services are present in Table 1.
Table 2. Types of ecosystem service indicators (adapted from (De Groot et al., 2010; UNEP-WCMC, 2011))

<table>
<thead>
<tr>
<th>Category</th>
<th>Code</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Condition</td>
<td>C</td>
<td>The amount or quantity of underlying physical resources which influence the ability of ecosystems to support ecosystem processes and deliver ecosystem services.</td>
</tr>
<tr>
<td>Function</td>
<td>F</td>
<td>The processes by which ecosystems deliver services and benefits. Most regulating and supporting services within the Millennium Ecosystem Assessment framework can be ecosystem functions in this classification.</td>
</tr>
<tr>
<td>Service</td>
<td>S</td>
<td>These are ecosystem products that are important for supporting human well-being, but not directly consumed by people. For example, freshwater that is used for irrigation or aquaculture is classified as a service since freshwater in this instance supports peoples' livelihoods but is not directly consumed.</td>
</tr>
<tr>
<td>Potential benefit</td>
<td>PB</td>
<td>These are tangible products from ecosystems that can potentially benefit humans if directly consumed.</td>
</tr>
<tr>
<td>Benefit</td>
<td>B</td>
<td>These are tangible products from ecosystems that humans directly consume; the 'thing that has direct impact on human welfare' (Fisher et al., 2008). For example, fish produced by aquaculture would be classified as a benefit. It should be noted, however, that the term 'benefit' is often used as a synonym of 'service' in ecosystem service discussions within the context of the MA or in communication with the broader society and science-policy interface.</td>
</tr>
<tr>
<td>Impact</td>
<td>I</td>
<td>Indicators of the state of people's physical, economic, social, and spiritual well-being.</td>
</tr>
<tr>
<td>Pressure</td>
<td>P</td>
<td>The indicator of the pressures exerted on the system.</td>
</tr>
<tr>
<td>Performance</td>
<td>Per</td>
<td>Indicators that provide information on how much of that service can be used in a sustainable way.</td>
</tr>
</tbody>
</table>

3.4 Potential indicators of the water related ecosystem services

1) Water abstraction for food production


Indicator: Water abstracted for crop production.
Type of indicator: S/P.
Description: SEPA have information on the water abstracted for agriculture through issuing water abstraction licenses for irrigation from SEPA under Controlled Activities Regulations 2006. Maps of the water bodies affected by water abstraction (pressure) were presented in the significant water management issues reports (Environment Agency, 2005; SEPA, 2007). This would provide an indicator of the water withdrawn.
Data providers: SEPA.
Calculation: Water abstracted per water body.
Mappable: Yes.
Available/accessible: Yes.
Notes: To create an indicator of the benefit to the farmer, then an assessment of the added value that irrigation provides compared to producing the same or a different crop without irrigation.

Indicator: Water abstracted per unit of cropped area.
Type of indicator: S.
Description: Using CEH Land Cover Map 2007 (LCM2007) or Integrated Accounting and Control System (IACS) data, then using estimates of water used for irrigation for the main arable horticultural crops then an estimate of water abstracted per unit of cropped area.
Data providers: CEH, NERC provide LCM2007 as either free at 1km resolution or under licence at 25m resolution. SEPA should have access to IACS data from the Rural Payments and Inspection Division of the Scottish Government.
Calculation: A look up table of land use irrigation requirements would need to created.
Mappable: Yes.
Available/accessible: Yes, with some work.
Notes: Values for the amount of irrigated water used for specific crops will need to estimated based on values used in farming and the bioclimatic conditions in Scotland.

(for ecosystem services1-4)

Indicator: The water exploitation index (WEI)
Type of indicator: Per.
Description: The WEI is the mean annual total abstraction of freshwater divided by the mean annual total renewable freshwater resources at the water body level, expressed in percentage terms.
Data providers: SEPA and Scottish Water.
Calculation: The water used per water body or water resource zone needs to be calculated for each use of water. An estimate of the renewable freshwater resource at the water body or water resource zone would be needed.
Mappable: Yes.
Available/accessible: Yes, with significant work.
Notes: This is an indicator of a bundle of water provisioning services. This is an indicator that used by the EEA.

2) Water use by industry
Workshop suggestion: None.

Indicator: Freshwater abstracted by industry.
Type of indicator: S
Description: SEPA have water abstraction licenses under Controlled Activities Regulations 2006.
Data providers: SEPA.
Calculation: The freshwater extracted across a wide range of regulated industries will need to be calculated per water body.
Mappable: Yes.
Available/accessible: Yes, with significant work (depends if SEPA have calculated this indicator already).
Notes: This will also be a pressure indicator.

Indicator: Water use by industry as calculated by the water footprint methodology.
Type of indicator: S.
Description: There are standard methodologies for calculating green, blue and grey water footprints of industry based on [www.waterfootprint.org](http://www.waterfootprint.org) and specifically (Hoekstra et al., 2011).

Data providers: SEPA.

Calculation: Using the approach of [www.waterfootprint.org](http://www.waterfootprint.org) and specifically (Hoekstra et al., 2011).

Mappable: Yes.

Available/accessible: Yes, with significant work (depends if SEPA have calculated this indicator already).

Notes: The waterfootprint methodology is rapidly being accepted as a standard assessment tool. It includes the volume of water needed for the discharge of effluent.

3) Hydropower

Workshop suggestion: Actual SEPA licensing database (offshore tidal energy maps potential- Crown estate).

Indicator: Electricity generated by hydropower.

Type of indicator: B.

Description: SEPA have a database of licenses. The Crown Estate has maps of tidal energy production/potential.

Data providers: SEPA and Crown Estate.

Calculation: Freshwater and marine power generation need to be added and mapped to water bodies.

Mappable: Yes.

Available/accessible: Yes, with some work.

Notes: There are a number of issues when considering the impact of hydropower on water resources: understanding water ‘use’, ‘consumption’ and ‘loss’ that while electricity production does not ‘consume’ water, ‘losses’ do occur through changes in evaporation and downstream impacts due to altered flow regime; understanding a generation technology and its footprint is difficult since hydropower has multiple uses e.g. peaking and baseload capacity and hydropower reservoirs can provide multiple benefits; need to consider the climatic setting and the specific structure of the hydropower system.

4) Provision of drinking water (expanded to domestic use of water)

Workshop suggestion: Drinking water abstraction volume and treatment costs or quality.

Indicator: Water required to be produced at a Water Treatment Works

Type of indicator: PB.

Description: Scottish Water uses this as their main indicator of demand.

Data providers: Scottish Water.

Calculation: No.

Mappable: Yes.

Available/accessible: Yes.

Notes: The components of demand include: household consumption; measured non household consumption unmeasured non household consumption; distribution losses; losses from small supply pipes with the boundary of customers properties; water taken unbilled; and water used in the operation of the distribution system. Scottish Water has four customer operational areas with varying numbers of water supply zones and varying number of population connected to mans supply: North has 126 WRZ and 6% populated connected; East, 66 and 25% South 58 and 34% and West 61 and 35% (Scottish Water, 2011). This does not take account of private water supplies.
**Indicator:** Volume of freshwater in protected areas of drinking water supply.

**Type of indicator:** C.

**Description:** SEPA have maps of protected areas of drinking water supply. They are also likely to have estimates of the water supply potential of these water bodies.

**Data providers:** SEPA, maybe BGS.

**Calculation:** The volume of water supply per protected area of drinking water supply would need to be calculated based on existing water resource models.

**Mappable:** Yes.

**Available/accessible:** Yes, with significant work (depends if SEPA have calculated this indicator already).

**Notes:**

5) Nursery function (fish)

**Workshop suggestion:** Seagrass (Marine angiosperm) extent and condition.

**Indicator:** Seagrass (Marine angiosperm) extent and condition.

**Type of indicator:** F/C.

**Description:** Marine Scotland has maps of seagrass extent.

**Data providers:** Marine Scotland

**Calculation:** A calculation of the spatial condition may be needed based on observed data.

**Mappable:** Yes.

**Available/accessible:** Yes.

**Notes:** Seagrass beds are not the only nursery grounds for fish.

6) Coastal aquaculture

**Workshop suggestion:** Number or mass of fish produced.

**Indicator:** Atlantic Salmon (*Salmo salar*) farmed per annum.

**Type of indicator:** S.

**Description:** Marine Scotland produces an annual survey of Scottish Fish Farm Production. As well as producing smolts and exporting some of these the production of Atlantic Salmon from 30 companies operating 249 active farming sites. Map of sites shown. Regional statistics (North West, Orkney, Shetland, South West and Western Isles) total production broken down into grilse, pre-salmon and salmon.

**Data providers:** Marine Scotland.

**Calculation:** Not sure.

**Mappable:** Depends if Marine Scotland are able to provide spatial estimates due to data protection issues.

**Available/accessible:** Maybe.

**Notes:** A number of sites have a fallow period. The production of other species (Artic charr, Brown/sea trout, Cod and Halibut) was low (~ 200 tonnes per annum). Salmon and Sea Trout catches by rod (by region and river district within these 11 regions), by fixed engine by net and coble (the latter two by the 11 regions) and summary data are available.

7) Water quality

**Workshop suggestion:** None.

**Indicator:** Water quality status of Scotland’s water bodies.

**Type of indicator:** C.
**Description:** SEPA have maps of the water quality (unpolluted; unimpacted by pollution; slightly polluted; polluted and severely polluted) for all river, lochs and coastal water for WFD.

**Data providers:** SEPA.

**Calculation:** None.

**Mappable:** Yes.

**Available/accessible:** Yes.

**Notes:**

8) **Supporting (underpinning final services)**

**Workshop suggestion:** None.

**Indicator:** Water quality status of Scotland’s water bodies.

**Type of indicator:** C.

**Description:** SEPA have maps of the water quality (unpolluted; unimpacted by pollution; slightly polluted; polluted and severely polluted) for all river, lochs and coastal water for WFD.

**Data providers:** SEPA.

**Calculation:** None.

**Mappable:** Yes.

**Available/accessible:** Yes.

**Notes:**

9) **Flow regulation to reduce flood risk**

**Workshop suggestion:** Salt marsh extent.

**Indicator:** Natural flood management potential.

**Type of indicator:** S.

**Description:** SEPA in collaboration with consultants e.g. Halcrow are currently producing estimates of the potential of natural flood management.

**Data providers:** SEPA.

**Calculation:** Either based on habitats or standard hydrological models.

**Mappable:** Yes.

**Available/accessible:** Under-development.

**Notes:**

10) **Carbon sequestration**

**Workshop suggestion:** None.

**Indicator:** Surface and subsurface soil carbon storage.

**Type of indicator:** C/S/B.

**Description:** Staff at the James Hutton Institute (Allan Lilly and Steve Chapman and others) have produced maps of the carbon stored in Scotland’s soils.

**Data providers:** The James Hutton Institute/Scottish Government.

**Calculation:** These estimates have been calculated based on

**Mappable:** Yes.

**Available/accessible:** Yes.

**Notes:** It is estimated that Scotland’s soils contain about 2700 million tonnes (Mt) of carbon to a depth of 1m (Lilly et al., 2011) and an additional 516 Mt carbon below 1 m in organic soils (Chapman et al., 2009).
11) Water sports

Indicator: Number of days of inland water sports.
Type of indicator: B.
Description: This dataset does not exist. An estimate of the days spent carrying inland water sport activity could be estimated based on information from key associations involved with water sports e.g. sailing and paddling.
Data providers: Various.
Calculation: Unsure.
Mappable: Eventually.
Available/accessible: No.
Notes: SNH collect information on the SNH’s corporate outcome of ‘Greater and wider participation in enjoying the outdoors’ is ‘Proportion of people using the outdoor environment for physical activity, frequency of use and demographic breakdown of users’, they suggest that data sources for this could include the Scottish Recreation Survey (subsumed into a large survey). From a search of the internet esp. RYA Scotland Scottish Canoe Association there do not seem to be maps of water bodies used for water sports. Additional data on river level condition (in relation to particular rivers) would need to be taken from the river level data provided by [http://www.wheresthewater.com/](http://www.wheresthewater.com/).

12) Beach (coastal): amenity and recreation

Indicator: Coastal morpho-sedimentological characteristics.
Type of indicator: S.
Description: This provides the characteristics of Scotland’s coastline.
Data providers: The James Hutton Institute adapted data from a European Project [http://www.eurosion.org](http://www.eurosion.org) to provide a map.
Calculation: None.
Mappable: Yes.
Available/accessible: Should be.
Notes: This only tells you about the coarse characteristics of the coastline and very little about the benefits it provides.

13) Habitat Provision
Workshop suggestion: None.

Indicator: Notified habitats in favourable condition.
Type of indicator: C.
Description: SNH Biodiversity Indicator, Notified habitats in favourable condition, last updated: March 2011
Data providers: SNH.
Calculation: None.
Mappable: Yes.
Available/accessible: Yes.
Notes: The conservation of nationally important habitat and geological features is secured through a network of 1,881 protected areas (Sites of Special Scientific Interest, Ramsar, Special Protection Areas and Special Areas of Conservation). The protected areas extend
across more than one million hectares of Scotland. URL: 
http://www.snh.gov.uk/docs/B424913.pdf

14) Tourism
Workshop suggestion: None.

Indicator: SNH Natural Heritage Indicator N6 Tourism.
Type of indicator: PB.
Description: Scenery and wildlife attract visitors to Scotland. In 2007, 92% of visitors identified ‘scenery’ and 72% identified ‘nature and wildlife’ as key to their Scottish holiday (Visitor Experience Survey). The ‘top 20’ paid and unpaid attractions included a Country Park (Culzean), two mountains (Cairngorm and Ben Nevis), a National Park (Loch Lomond and the Trossachs) and a wildlife visitor centre (Scottish Seabird Centre, North Berwick).

Data providers: SNH.
Calculation: Not sure.
Mappable: No.
Available/accessible: Not sure.
Notes: There are likely to multiple aspects to tourism, not only that we have beautiful areas (an indication of the supply of ecosystem services, but is only a service if people get benefits). That is those visitors (Scotland or beyond), but also local and national inhabitants through finance. Visit Scotland produces tourism statistics. These include information on activities done (general sightseeing; short walks (less than 2 miles); explored Scottish scenery; just relaxed; visited castles/historic houses and palaces; toured the country; visited museums, art galleries/heritage centres; shopping; visited cities; watched for wildlife; explored Scottish beaches and coastline and longer walks / hikes (more than 2 miles) by UK holiday visitors. A different set of questions seem are asked of overseas holiday visitors at the UK level by Visit Britain. Year: 2009 data in 2010 report
Latest report: Scotland: the key facts on tourism in 2010. 

URL: 

An additional dataset that could be used to create an indicator is the Scotland Landscape Character Assessment. Last Updated: January 2010. Source: Scottish Natural Heritage. Resolution 12.5 meters. Format ESRI shapefile geographic markup language; google earth KML. Description: Landscape Character Assessment (LCA) is a recognised analytical technique which identifies areas with a distinct composition of inter-related natural, physical, cultural and historical characteristics. A national programme of LCAs was initiated by SNH in 1994 covering 29 regional studies with local authorities and other organisations.

3.5 Pressures on the above ecosystem services
(the details of these are contained in supplementary MS Excel workbook). The suggestions have not yet been expanded upon. SEPA has a good understanding and available spatial indicators on a number of these pressures based on the article 5 reports Significant water management issues flag up the main pressures and contain maps of
these (Environment Agency, 2005; SEPA, 2007) and they have a list of the water related pressures currently being used under WFD.

1) **Workshop suggestion:** None.  
**Indicator:** Water abstracted for crop production.

2) **Water use by industry**  
**Workshop suggestions:** Climate change. Population increase. Increasing demand of water.

3) **Hydropower**  
**Workshop suggestions:** Climate change. Population increase. Increasing demand of water.

4) **Provision of drinking water (expanded to domestic use of water)**  
**Workshop suggestions:** Diffuse pollution. Peat degradation.

5) **Nursery function (fish)**  
**Workshop suggestion:** None.

6) **Coastal aquaculture**  
**Workshop suggestions:** Removal of seabed habitat. Sewage/pollution of water in estuaries and sealochs.

7) **Water quality**  

8) **Supporting (underpinning final services)**  

9) **Flow regulation to reduce flood risk**  
**Workshop suggestions:** Urban run-off. Urbanisation/flooding. Habitat loss. Land use change. Climate change.

10) **Carbon sequestration**  
**Workshop suggestion:** None.

11) **Water sports**  
**Workshop suggestions:** Morphology (alteration of river). Intensive land use. Diffuse pollution. Point source pollution.

12) **Beach (coastal): amenity and recreation**  
**Workshop suggestion:** None.

13) **Habitat Provision**  
**Workshop suggestion:** None.

14) **Tourism**  
**Workshop suggestion:** None.
3.6 Summary of status with indicators
We do not have indicators of the majority of ecosystem services related to the water environment for Scotland. What there are some indicators of the state of the environment and for some provisioning services. Even these do not capture the full extent of the service or benefit at the national scale e.g. water for domestic use need to consider water used in the household from mains and private sources. This position of a lack of data and suitable indicators for an ecosystem service approach is not unique to Scotland. In England (Natural England pilot studies) and various other national and sub global ecosystem assessments then the indicators in current use are based on ecosystem state and quite often within a DPSIR framework of indicators.

3.7 Challenges and needs to advancing simple yet robust indicators of ecosystem services
As highlighted in section 3.1 above there are a number of ways that indicators of ecosystem services can be developed. There is a need to consider how individual services relate to other services and how best they may be bundled together. There is a need to consider developing indicators of performance/sustainability of ecosystem services.

References


UKNEA, 2011. UK National Ecosystem Assessment.

UNEP-WCMC, 2011. Developing ecosystem service indicators: Experiences and lessons learned from sub-global assessments and other initiatives. Secretariate on the Convention on Biological Diversity, Montréal, Canada, p. 118

APPENDICES

Appendix I  Review of approaches taken and existing ecosystem service indicators

This is work in progress.
Appendix II  Details of workshop

Workshop Invitation

Invitation to attend a SEPA/CREW water related ecosystem service/indicator workshop (Perth): either 15\textsuperscript{th} or 22\textsuperscript{nd} March 2012 (10am to 4pm)

Please reply by next Thursday, 9\textsuperscript{th} February, if you are able to attend, stating clearly your availability on either 15\textsuperscript{th} or 22\textsuperscript{nd} March (and dietary preference if important). If you are unable to attend, please can you suggest another colleague who could make a valuable contribution and is able to attend on these dates.

CREW project: Applying an ecosystem services approach to the production of the second River Basin Management Plans (RBMP) – identifying indicators of key ecosystem services and pressures.

Purpose: This workshop will test and further develop an approach to identify indicators for key ecosystem services associated with the water environment (freshwater and coastal) in Scotland.

Dates: These dates have been selected based on SEPA/project timescales and availability of key SEPA and JHI participants.

SEPA contacts: Rebecca Badger and James Davidson.

Participants: key SEPA staff and researchers.

Location: SEPA offices at Strathearn House, Broxden Business Park, Lamberkine Drive, Perth, PH1 1RX

http://maps.google.co.uk/maps?f=q&source=s_q&hl=en&geocode=&q=PH1+1RX&sll=56.39722,-3.444321&sspn=0.008479,0.019312&ie=UTF8&z=16&iwloc=A

Payment: for JHI and HEI participants, CREW can pay (~2 days) for your time to prepare/attend/contribute and T&S.

Background SEPA is considering using an ecosystem services approach to produce the second RBMP. If successful, this will pave the way towards use of an ecosystem services approach in other parts of SEPA’s work. So far there is widespread acceptance that the ecosystem services concept offers a useful way of describing and valuing environmental change but there are few examples of practical application of an ecosystem services approach to decision making. In addition, the UK National Ecosystems Assessment made the point that we already have sufficient information and understanding to start to make use of an ecosystems approach. The aim of this work would therefore be to advise SEPA on the availability and accessibility of data that will help it to apply an ecosystem services approach to the second RBMP. If it is decided to adopt an ecosystem services approach, the outputs from this piece of work will be used to inform the characterisation and Significant Water Management Issues reporting that is required in advance of producing the second RBMP.

Workshop agenda.

TODAY’S AGENDA
10.00 – 10.30 am  Coffee and tea on arrival
10.30 – 10.45 am  Round group introductions (All) (brief- who, what they can contribute), Welcome to the workshop (Rebecca Badger) (Purpose of the day and wider project/SEPA drivers and context of work)
10.45 – 10.55 am  Outline of the day (Sue Morris)  A1 poster on flipchart/ ‘Ground rules’ (5 min and 5 min for questions)
10.55 – 11.15 am  Presentation (Kit Macleod) 12 min on definitions, information sources, related efforts. Poster on the wall. 8 min for questions
11.15 – 11.35 am  Activity 1: Identify key ecosystem service linkages associated with the water environment in Scotland (in pairs). Ecosystem service linkage template to capture data. Figure and definitions of approach (Function, service, activities, pressures)
11.35 – 11.50 am  Activity 2: In same pairs assess the significance of ecosystem service linkage, using significance table/expert judgment. Rating the importance of ecosystem services
11.50 – 12.10  Activity 3: Discuss ecosystem service linkages, then identify indicators and datasets in groups of four (x3)
12.10 – 12.35 pm  Activity 4: Take ecosystem service linkage sheets to each type of Ecosystem Service- provisioning; regulating & maintenance; cultural & social- using headings
12.35 – 12.55 pm  Report back on Activity 4 summarising the ecosystem services and indicators for each of the 3 service types. (4 mins per group/8 mins general discussion)
12.55 – 1.30 pm  Lunch (non working)
1.30 - 1.45 pm  What have we missed?
1.45 – 2.25 pm  Activity 5: Adding activity and pressures to the ecosystem service linkages. 3 groups -Provisioning, Regulating and Maintenance, Cultural and Social - rotate through the 3 ecosystem services types (15 mins; 10 mins; 5 mins). Back to original ES type, look at material and summarise (5+5 min)
2.25 - 2.50 pm  Report back on Activity 6 summarising activities/pressures/indicators on ESS (5 mins each to report/10 mins discussion)
2.50 - 3 pm  Summary, feedback, next steps and thanks
3 -3.30 pm  Coffee, pack up and depart

Methodology
During the introduction by the lead facilitator a ‘parking lot’ was set up (see in results section below). The first activity was for pairs (SEPA and researcher) to indentify key ecosystem
services associated with the water environment in Scotland (at the national level) were recorded (using different coloured pens per each pair) using the template below (activity 1). The reason for using a template (see Figure 1 below) and not just a blank post—it note was to get the participants to focus on identifying ecosystem services and not ecosystem structures e.g. habitats or ecosystem functions. The pairs were provided with definitions of key terms and with a list of the final ecosystem services from the UK NEA 2011 (see below). A typology of beneficiaries (see below) was used to help the participants think about who are the beneficiaries, where they are located in comparison to where the potential for ecosystem services are produced and how these may flow through the environment to the beneficiaries.

Then two pairs were asked to join together and assess the significance of identified ecosystem services using a matrix (activity 2; see below). The approach designed in collaboration with SEPA (as always, could be improved, but the key aspect was we used a consistent approach across the groups) was based on the number of people directly benefiting and the importance of these benefits to those people.

These small groups were then asked to identify indicators of these ecosystem services and to provide information on key dataset criteria and information (see Figure 1). They were then asked to groups the ecosystem services into the final ecosystem services of: provisioning; regulating and maintenance and cultural and social (Haines-Young and Potschin, 2011).

Figure 1. A completed example of the ecosystem service linkage template
### Definitions and examples for ecosystem service linkages (v210312)

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Habitat &amp; Area</td>
<td>This is an area of land and/or water that can be anything in size from a patch, to field/garden, to farm/woodland/park to the whole of a hydrological catchment.</td>
</tr>
<tr>
<td>Ecosystem Function</td>
<td>The contribution (and capacity) of an area of habitat to supply ecosystem services.</td>
</tr>
<tr>
<td>Ecosystem service flow</td>
<td>Ecosystem services flow from where they are generated to where people experience benefits from these flows (can be matter, energy of information).</td>
</tr>
<tr>
<td>Ecosystem Service</td>
<td>The contributions that ecosystems make to human well-being.</td>
</tr>
<tr>
<td>Beneficiaries</td>
<td>An individual or group of individuals whose wellbeing is improved (increased) by an ecosystem service (by its use or by its existence (non-use)).</td>
</tr>
<tr>
<td>Service type</td>
<td>These are Provisioning; Regulating and Maintenance; and Cultural and Social services.</td>
</tr>
</tbody>
</table>

#### Final ecosystem service: UK National Ecosystem Assessment 2011 (based on habitat types)

**Enclosed farmland**

<table>
<thead>
<tr>
<th>Provisioning</th>
<th>Regulating</th>
<th>Cultural</th>
</tr>
</thead>
<tbody>
<tr>
<td>Food; Wild food; Bioenergy.</td>
<td>Climate regulation; Water quantity, Hazard regulation, Waste breakdown and detoxification and purification; Pollination; Biological pest control.</td>
<td>Employment; Sense of place aesthetics; Leisure; Human health.</td>
</tr>
</tbody>
</table>

**Freshwater**

<table>
<thead>
<tr>
<th>Provisioning</th>
<th>Regulating</th>
<th>Cultural</th>
</tr>
</thead>
<tbody>
<tr>
<td>Direct use of water; Water for power generation; Crops, plants, livestock and fish; Trees, standing vegetation and peat; Reedbeds.</td>
<td>Flood regulation; Carbon sinks and sources; Climate regulation; Waste disposal and dilution; Firebreaks; Health and diseases.</td>
<td>Heritage goods: history and archaeology; Multiple values of freshwaters; Health goods meaningful places including green and blue space; Socially valued landscapes and waterscapes.</td>
</tr>
</tbody>
</table>

**Woodlands**

<table>
<thead>
<tr>
<th>Provisioning</th>
<th>Regulating</th>
<th>Cultural</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trees for timber, fibre and fuel; Wild food, medicines and ornamental products; Genetic resources; Biodiversity.</td>
<td>Avoidance of climate stress; Avoidance of hazard; Detoxification and purification of water, air and soil.</td>
<td>Recreation and tourism, health and well-being; Heritage goods: citizenship and other cultural services including historical and landscape values.</td>
</tr>
</tbody>
</table>

**Urban**

<table>
<thead>
<tr>
<th>Provisioning</th>
<th>Regulating</th>
<th>Cultural</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crops, plants, livestock and fish (food e.g. veg; fibre e.g. compost ornamental e.g. flowers; genetic resource); Trees, standing vegetation and peat (trees e.g. timber, wood chippings fuel); Water supply (drinking water industrial use of water; energy); Wild species (wild food).</td>
<td>Climate (avoidance of climate stress; carbon sequestration); Hazard (erosion protection; avoidance of climate stress); Purification (clean air; clean water clean soil) Noise (noise reduction).</td>
<td>Environmental setting (Physical and mental health; spiritual and religious); Heritage (community; citizenship); Recreation and tourism; education.</td>
</tr>
</tbody>
</table>

**Coastal margins**

<table>
<thead>
<tr>
<th>Provisioning</th>
<th>Regulating</th>
<th>Cultural</th>
</tr>
</thead>
<tbody>
<tr>
<td>Production/livestock (crops; wild foods household goods, building materials</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
and fertilizers; other historical uses e.g. egg collection biochemical and pharmaceutical products); Water (aquifers) Afforestation; Soil and aggregate removal; Military use; Energy production; Golf courses.

<table>
<thead>
<tr>
<th>Regulating</th>
<th>Hazard regulation; Climate regulation; Water quality regulation; Soil quality regulation; Air quality regulation; Waste breakdown and detoxification; Pollination, pest control and nursery grounds; Noise regulation.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cultural</td>
<td>Visiting the coast; Coastal tourism; Meaning places; Socially valued landscapes/habitats.</td>
</tr>
</tbody>
</table>

**Typology of ecosystem service beneficiaries**

A simple typology of potential beneficiaries was presented in the Figure below.

**WA)** Within the surface water hydrological catchment that have no natural hydrological connectivity, but are artificially connected through water infrastructure.

**WN)** Within the surface water hydrological catchment that have natural hydrological connectivity (may or may not have water infrastructure connectivity).

**ON)** Outwith the surface water hydrological catchment and has no direct connection to the catchment, but benefits through the delivery of Regulating and Maintenance and Provisioning services.

**OV)** Outwith the surface water hydrological catchment, but visit the catchment.

**OA)** Outwith the surface water hydrological catchment, but are connected through artificial water infrastructure.

**Activity 2: Assessing the significance of an ecosystem service v210312**

**Purpose:** There is a need to make an initial (and highly subjective) assessment of the significance of the identified ecosystem services. This will enable us to focus on the most important services (and then to identify for each service which sites are most important).

**Task:**

For each ecosystem service you have identified, please can you estimate the number of people who are directly benefiting and the importance of the benefits to these individuals. Then use the table below to assess the significance of the identified ecosystem service. Please record these scores on the template.
Significance = number of people directly benefiting \times \text{importance of these benefits to those people}

Number of people directly benefiting can be split into the following four classes: 1-99, 100-9,999, 10,000-99,999, 100,000+ people.

The importance of these benefits to an individual can be split into: minor = a small contribution to an individual's wellbeing i.e. would not notice a change; major = a large contribution to an individual's wellbeing i.e. would notice a change; vital = is required for an individual's wellbeing.

<table>
<thead>
<tr>
<th>Importance of benefits</th>
<th>1-99</th>
<th>100-9,999</th>
<th>10,000-99,999</th>
<th>100,000+</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minor</td>
<td>VL</td>
<td>L</td>
<td>M</td>
<td>M</td>
</tr>
<tr>
<td>Major</td>
<td>L</td>
<td>M</td>
<td>H</td>
<td>VH</td>
</tr>
<tr>
<td>Vital</td>
<td>H</td>
<td>H-VH</td>
<td>VH</td>
<td>VH</td>
</tr>
</tbody>
</table>

One member of each group took each of the three final ecosystem service classes to pre-designated area were new groups were formed. These new groups were asked to look through the ecosystem services and to group these based on similarity and rank them based on the significance recorded in the templates or based on the groups view of their importance (activity 4). These groupings were then placed on the wall. Then one person from each of the three classes of ecosystem services was asked to report back to the whole group by the facilitator and questions were asked (discussion was recorded).

The next activity (activity 5) was to identify pressures (and associated) pressures on these ecosystem services using a second template (see below). The groups were asked to identify data sets and key criteria and information (though we did not have long for this activity, since the concept of pressures is well established good progress was made). These three groups then reported back to the wider group.

Results

The full list of the ecosystem services and associated material is available in a MS Excel spreadsheet. A summary of the results is presented in the main body of this report. In addition to these results the following notes were recorded by the facilitators (TBC).
Parking lot


Ecosystem function priority list. Policy priorities (e.g. Scotland performance) or Functions at risk?

It is all about scale and consistency. NATIONAL → REGIONAL SUBSIDIARITY.

Supporting services?


Is renewable energy an ecosystem service?

Pressure and impacts. Not activities.

Try “Least damaged/most natural” (by expert judgement). An evaluation of Habitat Quality (for marine protected areas). Can it be applied to Ecosystem Services (assessments). Data poor?
Appendix III  Interviews with key individuals

Interviews

Helaina Black (leads the RESAS Ecosystem Service theme work on indicators) 020212

HB liked the CBD list of: Provision of clean water (regulation of water quality), water availability (regulation), sediment transfer (supporting service), energy (provisioning), disease regulation, water as it underpins other provisioning services (food, raw materials, genetic resources, medicinal resources, and ornamental resources). This list is similar to the soils part of the SG env monitoring strategy.

Need to decide the purpose of the indicator and what are they likely to do.

Many of the current indicators are static and there is a need for dynamic indicators. This needs to consider the timescales of what benefit needs to be delivered in what time frame. E.g. flood protection as we are often looking at 1: x numbers protection then we need to include this in the indicator. Drinking water would be forever.

How responsive an indicator is, is largely unknown.

Indicators are likely to use field based observations and model structures to capture this. E.g. acidification of water uses the MAGIC model. , Soil C may use Roth C/Ecosse.

The indicator needs to provide early warning of change and in advance of the point of no/expensive return, so it acts as an early warning (this is lacking).

Indicators are often still viewed as being bio-physical and what is required are indicators that link to valuations and this is a massive leap.

Ideally we would explore the loss or increase in benefit due to loss in service.

Thresholds for different types and magnitudes of loss are required e.g. threshold point were the economic/social (or regulatory) changes are not acceptable.

Mark Everard (leads the Environment Agency approach on Ecosystem based approach) 250112

Has been trying to get the EA interested in ES for 20 years, SEPA seem more interested. Implementation of the WFD is currently based on technical standards, with the cost benefit work focused on these within small water bodies, with drop down list of pressures and measures to address these. The EA is a process based organisation so any solution will be a flow chart like the one from 25th May workshop. An ES approach allows you to ask different questions, how the system is working, who benefits and how services are produced.

These technical standards are in general indicators of the health of an ecosystem and ability to support well being. They are there to protect benefits and using an ES approach you can see who wins and who losses. We do not want to walk away from technical standards e.g. algal but need to use these to understand catchments. Often the logical boundary in the hydrological catchment.
The two EA case studies (Tamar and Wandle). Example of the Tamar and Plymouth, the immediate water body has little effect on the overall quality of the Tamar, there is a need to look at the whole system and potentially put in measures further up the catchment.

Appendix IV   Datasets (this could contain details of available datasets; work in progress)
CREW Facilitation Team
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