Ecosystem Services Evidence to inform the West of England Joint Spatial Plan: Issues & Options Stage 2

Part One

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Report prepared by:
This report was produced by Environment Systems on behalf of the West of England Nature Partnership. It was commissioned by the four Unitary Authorities of the West of England to provide additional environmental evidence required to inform the development of a Joint Spatial Plan.

Environment Systems Ltd.
11 Cefn Llan Science Park
Aberystwyth
Ceredigion
SY23 3AH

Tel: +44 (0)1970 626688
www.envsys.co.uk
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Executive Summary

The four West of England authorities are working together to produce a Joint Spatial Plan (JSP) for the West of England, covering the period 2016 - 2036. The plan will establish the quantum of housing and employment land required and broad spatial distribution of development across the region.

The JSP seeks to apply a robust evidence base to inform decision making, and has commissioned Environment Systems to undertake analysis of the ecosystems and ecosystem service provision within the West of England. Ecosystem services can be described as the benefits people obtain from ecosystems.

This approach follows national planning policy (NPPF para 165) which requires that “planning policies and decisions” be based on “up to date information about the natural environment”. It is best practice to work with Local Nature Partnerships, such as the West of England Nature Partnership (WENP), to include an “assessment of existing and potential components of ecological networks” as part of the evidence base for planning future strategic development. This work will complement, and add to the ecosystem service work currently being undertaken by the West of England Nature Partnership who are producing a 'State of Environment Assessment' for the West of England region that supports an ecosystem service approach.

This project used the ‘SENCE’ methodology (Spatial Evidence for Natural Capital Evaluation) to analyse multiple datasets and evidence. In accordance with the SENCE approach, ecosystem services are considered to be controlled by four key factors; the type of land cover; the underlying soil and geology; the topography/slope; and the type of land management. The ecosystem service approach focuses on how ecosystems function and the services they provide to people, such as pollination, flood attenuation and water regulation. It also considers ecosystems ability to provide these services when external pressures are exerted upon them.

The project evaluated the existing land use, accounting for the current ecosystem services (what already exists and where) and opportunities to enhance those services. This approach provides the evidence required to prioritise and guide decisions to achieve optimal land use.

Based on the SENCE approach, the following ecosystem services were assessed:

- **Three types of ecological networks:**
  - grassland
  - woodland
  - wetland

- **Water quantity**: Highlighting areas of land which temporarily store water, thereby helping to mitigate flood risk by storing water after a heavy rainfall and then slowly releasing it back into the environment.

- **Water quality**: Areas of land which help filter water due to the land cover and soil/rock types which naturally filter pollutants or excess nutrients, thereby contributing to cleaner water.

- **Combined stock**: A final layer showing the combined ecosystem service maps showing multiple ecosystem service provision.

The maps have been designed to take a strategic overview of ecosystem service provision within the West of England, by showing the multiple services the environment provides in a visual form. When considering development and growth, it is important to consider these services and the impact development may have on their ability to continue providing these services.

This report provides an overview of the maps, the data that was used in their production and how they can be used to help inform decision making.
1. Introduction

1.1. Land Use in the West of England

The land resource of the West of England provides a range of important ecosystem services that benefit people and wildlife. However, it is a fixed and finite resource that is often overlooked with demands on it continually growing and changing.

The Joint Spatial Plan (JSP) is being developed by the combined West of England authorities to consider quantum and location of housing and employment land requirements. This plan will provide a sustainable strategic spatial framework for each of the unitary authority’s forthcoming local plans.

The application of ecosystem service data modelling was identified as key piece of evidence for supporting the environmental assessment for the JSP to better understand the contributions that resources make.

1.2. The ecosystem approach

The Convention on Biological Diversity (CBD) defines the ecosystem approach as:

‘A strategy for the integrated management of land, water and living resources that promotes conservation and sustainable use in an equitable way, and which recognises that people, with their cultural and varied social needs, are an integral part of ecosystems’.

The ecosystems approach focuses on the integrated management of land, water and living resources to promote conservation and sustainable use. It can be used to look at ecosystems as a whole during the decision making process, and for valuing the ecosystem services they provide. By evaluating the system holistically and highlighting areas of trade-off (where one service replaces the others for example planting forests mean you no longer use the land for crops), where there are pressures on the land and where management can provide multi-benefits, this can help the maintenance of a healthy and resilient natural environment for current and future generations.

The Biodiversity 2020 Challenge which aims to halt overall decline in Biodiversity sets out three key steps to guide the approach to any ecosystems evaluation, these are;

- **Take account of how ecosystems work**, Nature connects across landscapes, so we need to consider the broad and local scales. The capacity of ecosystems to respond to impacts and provide resources is not infinite. Ecosystems are dynamic so we must recognise that change can alter their ability to provide these services. By using up-to-date information, embracing adaptive management principles, and identifying where nature is providing multiple benefits, we can ensure that nature continues to contribute to sustainable development in the West of England.

- **Take account of services that ecosystems provide to people**, The UK National Ecosystem Assessment categorised ecosystem services into four main functions - regulating services, such as flood mitigation and climate regulation; supporting services, such nutrient cycling and soil formation; provisioning services, the products supplied by ecosystems such as food, fuel and water; and cultural services such as aesthetic experience, recreation and wellbeing. The UK NEA found these services to be critical to our wellbeing and economic prosperity, but often undervalued in decision making.

- **Involve people in decision making**, This means valuing people’s knowledge, helping people to participate, and giving people greater ownership and responsibility.
1.3. **State of Environment Assessment**

The West of England Nature Partnership are producing a State of Environment Assessment to better understand the natural environment and the services it provides. This work is supported by the partnership and is an ongoing project to demonstrate the contribution that natural resources make in the West of England.

1.4. **Aims of ecosystem service mapping for the Joint Spatial Plan**

The aim of the project was to consider the impact of development upon ecosystems within the West of England.

The aim of the ecosystem services assessment is:

- to consider existing land uses in a collective and integrated way; and
- to establish a means to prioritise or guide decisions so as to optimise the use of land.

The maps aim to provide additional information about the ecosystem services in the West of England region, and enable informed decisions to be made regarding land use and development. Often the services provided by ecosystems are hidden and therefore can be overlooked, but by looking at the opportunities to enhance ecosystem services and the best place for action, they may also help to significantly help contribute to other regulatory objectives such as Biodiversity 2020, the Water Framework Directive, River Basin Management Plans and Flood Risk Management Plans.

The aim of these maps and the ecosystem information is to provide a mechanism which considers existing and future land uses in a collective and integrated way with a view to optimising the use of the land. This information could potentially be used to establish a mechanism to prioritise or guide decisions about possible competing or conflicting uses.
2. The SENCE Approach

The SENCE (Spatial Evidence for Natural Capital Evaluation) approach was developed by Environment Systems on behalf of the Joint Nature Conservancy Council (JNCC).

Land provides not just direct benefits to society such as food and timber or a building plot, but also indirect benefits such as the regulation of water flow to prevent flooding and the storage of carbon in the soil which will help mitigate the effects of climate change. The methodology captures, and reflects this as far as possible by using an expert rule base system where datasets are evaluated in terms of both the knowledge about the ecosystem service being considered and the knowledge about the data sets used to either map that service or provide a proxy for the service so that it can be mapped.

Using this data and knowledge of interactions between a habitat, its location, management and the associated ecosystem service, it is possible to grade the importance into a simple categorisation, of high, medium and low effect. This assessment took a practical approach to the mapping and modelling of ecosystem services, acknowledging that whilst this is a young science with many unknowns, there is a large body of data already available which can be used to inform policy decisions at national, regional and local levels.

This ecosystem services assessment reflects the land cover available within an area. It is based on four factors which interact together in different ways for the services under consideration. These four key factors are:

- The type of habitat or land cover (e.g. woodland or heathland);
- The soil and geology upon which the habitat has established;
- The position in the landscape (e.g. on a steep slope or valley bottom next to a river); and
- The management imposed upon land (e.g. intensive or extensive or little active management).

2.1. The West of England Ecosystem Services Maps

Using scientific understanding and knowledge about how the key four factors interact was used to build spatially explicit ecosystem service maps that are of importance to the regions forthcoming West of England Joint Spatial Plan. These included:

- Combined ecological networks (grassland, wetland and woodland);
- Land promoting good water quality; and
- Areas of land which temporarily store water, thus helping mitigate flood risk.

To present the ecosystem service value of each option a combined ecosystem service map to spatially assess the multiple-benefits provided by the land at each option was prepared using the process shown in Figure 1. This combined map takes the values of each stock layer and identifies which areas of each option are most important for the supply of ecosystem services.

Using the same method but assessing the four key factors with reference to the stock layers, it was possible to identify areas and/or locations within each option where opportunities exist to enhance the supply of multiple ecosystem services.
Figure 1: Process for producing combined ecosystem service and opportunity maps
2.2. Data used to create the maps.

The maps were created using multiple datasets gathered from a variety of sources. Including Ordnance Survey MasterMap, designated sites information, and the Agricultural Land Classification (ALC). Tables detailing the assessment system applied to each of the ecosystem service layers is included in Appendix A.

Remotely sensed data was used to supplement existing habitat data. No comprehensive hedgerow data was available for West of England, therefore the remote sensing data analysis was used to identify hedgerows. The hedgerow analysis could not be repeated for the entire study area due to time and data processing constraints, as higher detail in spatial datasets can lead to unmanageably large file sizes.

National Soil Map (NATMAP) data was obtained under license from the National Soil Resources Institute. This dataset is the most detailed soil map currently available for England. However, the dataset is partially modelled from discrete sample points taken over a 60 year period. As a result, the mapped transitions between soil types may not precisely reflect the gradients in soil properties on the ground, and should be viewed as indicative only.

When interpreting the ecosystem service maps, due consideration must be given to the scale of the original input datasets (See Table 1 for reference). Many key input datasets, such as NATMAP are regional or national scale datasets, and are therefore most suitable for interpretation at these scales. Caution should be applied when interpreting the ecosystem service maps at more detailed scales, as it is possible that the input datasets do not accurately represent conditions on the ground at the precise location of interest; this could be due to the modelled nature of input data, coarse scale of original data capture, or due to real changes in conditions since the time of data capture. For these reasons, any land use decisions based on the ecosystem service maps should be supported by ground-based validation checks or other supporting evidence prior to implementation.

Table 1: Datasets used for the four key factors, including comments on the accuracy and resulting resolution of these datasets

<table>
<thead>
<tr>
<th>Key factor</th>
<th>Datasets used</th>
<th>Accuracy and Resolution comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Land cover</td>
<td>Phase 1 / IHS habitat layer BRERC Good quality grasslands BRERC NE, BAP Priority Habitats National Forest Inventory Managed woodland in the SW Ancient Woodland inventory Econet Woodland / Grassland Pond surveys Shoreline management plans WFD Coastal waterbodies Saltmarsh species Areas not covered by above have been analysed from remote sensing data</td>
<td>The land cover data was created from an amalgamation of these surveys; they are from multiple dates and all should be assumed to be prior to 2014. (Currency would need to be assessed by field survey for any actual site development work) Some of the area has been assessed by field survey (e.g. Phase 1 /IHS surveys) and this has accuracy on the ground of between 0.1ha and 0.25ha. Modelled data (NFI and remote sensing analysis has an accuracy of at best 0.25ha, hedgerows have only been identified where they are wider than approximately 2m)</td>
</tr>
<tr>
<td>Substrate</td>
<td>Natmap vector soil data – Scoring based on depth of soil, permeability and porosity of the soil, chemistry of the soil</td>
<td>This dataset has a general resolution of 1:50,000 and the exact boundaries would need to be checked in the field for any site specific features</td>
</tr>
<tr>
<td>Landform</td>
<td>Classification of the DTM into slope and into the Agricultural Land Classification (ALC) categories Outputs of the SCIMAP analysis giving drainage channels which could be reinstated</td>
<td>The DTM for the majority of the area had a resolution of 5m in the horizontal and an accuracy of 0.5m in the vertical</td>
</tr>
</tbody>
</table>
### Key factor

<table>
<thead>
<tr>
<th>Datasets used</th>
<th>Accuracy and Resolution comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Allotments</td>
<td>These data set have boundaries which are generally captured at 1:10,000</td>
</tr>
<tr>
<td>Higher level stewardship targeting maps</td>
<td></td>
</tr>
<tr>
<td>Ancient woodland</td>
<td></td>
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<td>Woodland trust sites</td>
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<td>Local wildlife sites</td>
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<td>Local nature reserves</td>
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<tr>
<td>National nature reserves</td>
<td></td>
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<tr>
<td>Special areas of conservation</td>
<td></td>
</tr>
<tr>
<td>Sites of Special Scientific Interest</td>
<td></td>
</tr>
</tbody>
</table>

### 2.3. Maps and how to use them

One map per ecosystem service has been produced using the SENCE method. These were then combined to show multiple ecosystem service provision, as shown in Figure 1. Each map has been designed so that the darker colours indicate that more ecosystem services are supported. These areas are often semi-natural habitats that are more resilient to climate change, as well as providing temporary storage of water; helping mitigate flood risk and promoting good water quality. Light shades show areas where there is less ecosystem service provision, or only one service present such as intensive agriculture.

For each layer a number of datasets were analysed which consider the ‘unseen’ factors that affect how the land contributes to an ecosystem service. The type of service, its importance and how each ecosystem service map was created is detailed in Table 1. The maps should be interpreted as showing the most readily available information during 2014/2015.

### Table 2: Ecosystem Service Map Descriptions

#### Multiple Ecosystem Service Analysis

Combining the stock layers of the areas which promote good water quality, areas which slow run-off and areas which form part of the existing habitat networks, show the areas which provide the most multiple benefits.

Areas often provide a range of ecosystem services. By combining these three layers it can be seen which areas are contributing to all these services.

#### Ecological Networks Combined

An ecological network is where good quality habitats are close enough together that species easily move from one area to another, maintaining genetic diversity. The Combined Ecological Network map combines the grassland, wetland and woodland networks, showing existing areas of these habitats, and the surrounding land required to support these networks.

Areas of native habitat within a network are more resilient to a changing climate or land management pressures. They often have a higher level of other ecosystem service provision as the species work together in harmony. Re-creation of native habitats will be far more effective if soil and habitat conditions are right and if the area is part of the network.

The habitat information has been amalgamated from existing data sources and infilled by remote sensing data, as shown in Figure 1. A ‘least cost’ model was applied to the relevant classes from the habitat map, for each of the networks. Other land cover types were scored based on their permeability relative to the habitat. They were scored as very permeable such as for the woodland network scrub is highly permeable meaning woodland species can move freely through it. Less permeable habitats would include grasslands where predator species or air temperatures differences would make movement through them more difficult. Poorly permeable habitats include sealed surfaces, which can
often form barriers to species moving freely.

Grassland:
Wetland:
Woodland:

**Land promoting good water quality**

Pure clean water is essential for human health and underpins the whole environment. Managing ecosystems to improve water quality can reduce water treatment costs prior to consumption. The Water Quality map shows where the land contributes to the filtration and supply of fresh water.

The map layer was created using information on soil type, landform/hydrology and vegetation as well as modelled data on sediment risk (SCIMAP). It uses scientific knowledge to model which areas of land have the greatest potential to help purify and filter the water. The map has been created using the datasets about habitats, slope, river networks, roads and buildings, soil and geology and information on land management.

**Areas of land which temporarily store water, helping mitigate flood risk**

Flooding is a major hazard in the UK. A number of factors help slow rainfall from major flood events. A key factor is the vegetation structure; habitats such as woodlands have many layers of vegetation, which help intercept the rain. Other contributing factors include porosity of soil type (some soils absorb a lot of water, other little), slope gradient and land use. By spatially assessing these factors, it is possible to show where the land is helping to slow the movement of rainfall over the land into rivers (also known as run-off or overland flow), and where is at most risk of flooding.

This map layer was created using a combination of vegetation type, slope, soil/geology type and Environment Agency (EA) flood risk areas. The EA data shows areas most at risk of flooding from rivers and the sea. Land was classified in terms of its ability to temporarily store water. Sealed surfaces have rapid runoff; lightly vegetated surfaces, such as grassland have moderate runoff and the most densely vegetated surfaces, such as woodland have low runoff by providing high water interception and often good infiltration rates in soil. The permeability and porosity of the soil and geology affects how well areas can absorb and hold water, these were also considered in the creation of these maps, as was topography (flat land holds back water whilst steep slopes shed water rapidly.)

**Opportunity Analysis**

For each stock map created a complementary ‘opportunity map’ was also created. The opportunity maps show where the best opportunities exist to enhance a given ecosystem service by changing or enhancing land management to result in more ecosystem service provision.

The following opportunity maps have been created: areas with opportunity to slow run-off, area with opportunities to promote water quality, areas of land suitable for grassland, woodland and wetland creation.

The opportunity layers were combined to show where opportunities exist for habitat restoration to result in multiple ecosystem services.

The scientific rules for the opportunity analysis include:

- Opportunities to enhance one habitat are not suggested where there is already good quality habitat of another type (e.g. woodland creation is not suggested over species rich grassland)
- Opportunities, taking into consideration the other factors (soil type, geology, land form) and are based on principle from habitat restoration ecology.
- Habitats are most easily restored where the soil chemistry and hydrology matches the natural environment and most difficult to restore on intensively managed arable land which has a high degree of chemical inputs.
2.4. Wildlife corridors and habitat size

The ecological network maps highlight where there are most likely to be wildlife corridors within this region, this is based on scientific research which showed how animals, insets and pollen can move through the environment. It utilises the priority habitat maps, as they contain habitats recognised as being of principal importance for the conservation of biodiversity (Section 41 of the NERC Act 2006). Wildlife corridors consist of ‘Core Areas’, which are the habitats most resilient to external pressures such as changes in land use and climate change. These areas should hold large enough populations to ensure genetic diversity. In addition, the centre of such areas provides space for specialist species to exist as they are protected from outside influences; an example could be spray drift from fertilizers which will only impact on the first 50m-500m of woodland nearest the arable field being treated:

In this study we have used the following width / size of habitat feature to represent these ‘core areas’ of the ecological network. If areas of habitat labelled as ‘core’ need to be disturbed by other land management developments, it is suggested that they are kept above the width to enable them to preserve their core habitat functions:

- Woodland core feature >2ha, ideal width not less than 1000m
- Grassland and wetland core feature >0.25ha, ideal width not less than 360m

In addition, wildlife tends to use a range of different habitats within a landscape to move between feeding and resting areas and to spread genetic diversity (Donald and Evans, 2006). The networks shown are where patches of good quality habitats are close enough together to allow species to move. However, they do not take into account exact species requirements and the distance certain species need differs depending on the type of development and, therefore, the ‘pressure’ exerted on them (Humphrey et al. 2014).

Figure 2 shows the better and worse patterns of habitats in a network for species movement and the table below outlines some consideration for different species for different types of land management developments.

![Figure 2: Comparison of different patterns with regards to habitat connectivity (Graphic from Watts et al. (2005))](image-url)
3. West of England Ecosystem Service Maps

- Combined networks
- Woodland network.
- Wetland network.
- Grassland network.
- Areas of land which temporarily store water, helping mitigate flood risk (with Environment Agency flood data overlay)
- Land promoting good water quality.
- Land suitable for agriculture
- Combined stock layers.
- Combined opportunities.
- B-Lines Map (provided for reference in addition to the grassland network)
Combined networks
Stock layer 6: V3 20/05/15

How to interpret the map:
An ecological network is where patches of native habitats are close enough together to allow seeds to blow from one to another or insect/birds to move between patches maintaining genetic diversity. This map combines the grassland, wetland and woodland networks, showing existing areas of these habitats, and the surrounding land which supports the networks.

Ecosystem service:
Combined habitat network

What the service is:
Existing native grasslands, wetlands and woodlands and the networks they form, within which species can move and spread to maintain genetic diversity.

Why it is important:
Areas of native habitat within a network are more resilient to change from a changing climate or management; they generally have a higher level of other ecosystem services as the organisms work together in harmony. Re-creation of native habitats will be far more effective if soil and habitat conditions are right and if the area is part of the network.

How the map was created:
The habitat information has been amalgamated from existing data sources and infilled by analysis of remote sensing data. A 'least cost' model was applied to the habitat map, for each of the habitat types. Other land cover types have been scored based on their permeability relative to the habitat, with some habitats as very permeable, some less permeable, and sealed surfaces are poorly permeable, often forming barriers.

Legend
- Existing grassland
- Grassland network
- Existing water and wetland
- Wetland network
- Existing woodland
- Woodland network
- Part of multiple habitat networks

Woodland network
Stock layer 5: V3 20/05/15

How to interpret the map:
An ecological woodland network is where blocks of woodland habitats are close enough together to allow seeds to blow from one to another or insects/birds to move between patches maintaining genetic diversity. The woodland network consists of those blocks of broad-leaved woodland greater than 2ha. The land that supports this network includes smaller patches of woodland, thicker hedges and areas of scrub in structural grassland. These areas are shown in light green and would be used by common woodland species.

Ecosystem service:
Woodland network

What the service is:
Existing woodlands and the network they create within which species associated with woodlands are likely to use. In the city you might be expected to see common woodland bird species within these areas e.g. coal tit and plants such as speedwells.

Why it is important:
Woodland within built up areas can provide urban cooling effects in addition to biodiversity and recreation. Where re-creation of woodland implemented in the right areas of soil and habitat condition it will be far more effective at providing the multiple ecosystem services.

How the map was created:
The habitat information has been amalgamated from existing data sources and infilled by analysis of remote sensing data. A least cost model was applied to the habitat map, patches of woodland and trees >2ha form the core existing network. Other land cover types have been scored based on their permeability to woodland species, scrub and gardens with scrub and trees are very permeable, grassland is less permeable, sealed surfaces and water are poorly permeable. Tree pollen and seeds are able to travel further than grass species therefore sealed surfaces and water form less of a barrier to them.
Wetland network
Stock layer 4: V3 20/05/15

Legend
- Wetland and water network
- Land supporting the wetland network
- Urban and infrastructure

How to interpret the map:
An ecological wetland network is where patches of native wetland habitats are close enough together to allow species and insect/birds to move between patches maintaining genetic diversity. The areas of core network are shown in dark blue, these are larger areas of water and wetland. Other areas which support the network are shown in pale blue. These areas include smaller areas of wetland and water, and areas which are likely to be used by wetland species, linking wetland areas.

Ecosystem service:
Wetland network

What the service is:
Existing native wetlands and the network they form and within which species can move and spread to maintain genetic diversity.

Why it is important:
Areas of native habitat within a network are more resilient to change from a changing climate or management, they generally have a higher level of other ecosystem services as the organisms work together in harmony. Re-creation of native wetlands will be far more effective if soil and habitat conditions are right and if the area is part of the network.

How the map was created:
The habitat information has been amalgamated from existing data sources and infilled by analysis of remote sensing data. A 'least cost' model was applied to the habitat map, wetlands greater than 0.5ha in size form the core existing network. Other land cover types have been scored based on their permeability to wetland species, other types of grasslands are very permeable, woodland and scrub less permeable, sealed surfaces are poorly permeable, often forming barriers.

Grassland network
Stock layer 3: V3 20/05/15

Legend
- Semi-natural grassland core habitats
  - Little contribution to the grassland network
  - Strong contribution to the grassland network
- Urban and infrastructure
- Water

How to interpret the map:
An ecological grassland network is where patches of native grassland habitats are close enough together to allow seeds to blow from one to another or insect/birds to move between patches maintaining genetic diversity. The areas of core network are shown in brown, these are areas of semi-natural grassland which are larger than 0.5ha in size. Other areas which support the network are shown in orange. These areas include smaller areas of grassland and areas which are likely to be used by grassland species, linking grassland areas.

Ecosystem service:
Grassland network
What the service is:
Existing native grasslands and the network they form and within which species can move and spread to maintain genetic diversity.
Why it is important:
Areas of native habitat within a network are more resilient to change from a changing climate or management, they generally have a higher level of other ecosystem services as the organisms work together in harmony. Native grasslands are particularly important for their support of pollinator species. In addition re-creation of native grassland will be far more effective if soil and habitat conditions are right and if the area is part of the network.
How the map was created:
The habitat information has been amalgamated from existing data sources and infilled by analysis of remote sensing data. A ‘least cost’ model was applied to the habitat map, semi-natural grasslands greater than 0.5ha in size form the core existing network. Other land cover types have been scored based on their permeability to grassland species, other types of grasslands are very permeable, woodland and scrub less permeable, sealed surfaces and water are poorly permeable, often forming barriers.

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Data used with permission.
Areas of land which temporarily store water, helping mitigate flood risk
Stock layer 2: V4 06/07/15

Legend
- Areas at Risk of Flooding (EA Flood Data)
  - High infiltration - low run-off
  - Low infiltration - high run-off

How to interpret the map:
Darker colours represent areas that are helping to slow water. The lighter colours represent areas where water moves very quickly through the environment and therefore contributes to the risk of flooding. The light orange cross hatching shows areas that the Environment Agency mark as at risk of flooding.

Ecosystem service:
Flood and overland flow risk.

What the service is:
This map shows where the environment is helping to slow the movement of rainfall over the land into rivers (also known as run-off or overland flow), and where is most at risk of flooding.

Why it is important:
Flooding is a major hazard in the UK. A number of factors help slow rainfall from major flood events. The first is the structure of any vegetation; habitats such as woodlands have many layers of vegetation, which help slow down the rain drops by interception. Therefore, by the time raindrops reach the ground they have been slowed down enough to sink into the soil. The other contributing factors are soil type (some soils absorb a lot of water, other little), the gradient of slopes and land management.

How the map was created:
This map was created using a combination of vegetation type, slope, soil/geology type and EA flood risk areas. The EA data shows the areas most at risk of flooding. Habitat information has been used from existing habitat datasets and additional data analysis of gardens from satellite and aerial imagery. Where the surfaces are sealed they have rapid run-off. Lightly vegetated surfaces such as grassland have moderate water run-off regulation. The most densely vegetated surfaces (woodland) provide high water interception and often good soil infiltration. The permeability and porosity of the soil and geology affects how well areas can absorb and hold water. Topography is significant, flat land holds water whilst steep slopes shed water rapidly. The map should be interpreted as showing the most readily available information during 2014/2015.

Land promoting good water quality
Stock layer 1: V2 6/05/15

Legend

- Areas which promote good water quality
- Areas which are less good for promoting water quality

How to interpret the map:
The darkest colours represent land that contributes most to water filtration and therefore "better" water quality. Lighter colours represent land that may be inputting impurities into the water environment.

Ecosystem service:
Regulation of water quality.

What the service is:
Contribution of the land to the filtration and supply of fresh water.

Why it is important:
Pure clean water is essential for human health and underpins the whole environment. Managing ecosystems to improve water quality can reduce treatment costs to clean water prior to consumption.

How the map was created:
The map has been created using information on soil type, landform/hydrology and habitats as well as modelled data on sediment risk (SCIMAP). It uses scientific knowledge to model which areas of land have the greatest potential to help purify and filter the water. The map has been created using existing datasets. The map should be interpreted as showing the most readily available information during 2014/2015.
Land suitable for agriculture
Stock layer 9: V1 29/07/15

Legend
- Good agricultural land
- Moderate agricultural land
- Poor agricultural land
- Exclusion
- Non Agricultural
- Not Surveyed
- Other
- Urban

How to interpret the map:
The map has been coloured up according to the Agricultural Land Classification (ALC). Bright green colour represents land that is best suited for agriculture (Grade 1 and 2), yellow shows poor agricultural land (Grades 4 and 5). Light green land is either of moderate agricultural value (Grade 3) or has not been assessed post 1988. Grey areas have not been assessed, due to, for example, urban developments.

Ecosystem service:
Agriculture.

What the service is:
This map shows where the land present is best for the provision of food, which reflects the range and types of crops that can be grown.

Why it is important:
Food security is a major concern when considering ecosystem services. Healthy soil is one of the main pre-requisites for successful agriculture. In addition, an good climate and suitable slope are necessary. Feeding a growing population will require making best use of our agricultural resources.

How the map was created:
This map was created from ALC surveys by Natural England. Detailed surveys carried out post 1988 were used, with the less detailed results from earlier surveys filling in any gaps. The ALC grades were scored regarding their quality for agricultural production. Where detailed surveys have been done, Grade 3a land is scored as ‘good’.

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Combined stock layers
Stock layer 7: V2 20/05/15

Legend
- Important for delivery of 1 of the 3 services
- Important for the delivery of 2 of the 3 services
- Important for the delivery of all 3 services

How to interpret the map:
Combining the stock layers of the areas which promote good water quality, areas which slow run-off and areas which form part of the existing habitat networks, show the areas across the Local Nature Partnership which provide the most multiple benefits.

Ecosystem service:
Combined stock layers

What the service is:
A combination of the areas which promote good water quality, areas which slow run-off and areas which form part of the existing habitat networks.

Why it is important:
Areas often provide a range of ecosystem services. By combining these three layers it can be seen which areas are contributing to all these services. It therefore highlights those areas providing multiple benefits.

How the map was created:
This map was created by combining those areas which are particularly important for the provision of each service, areas which promote good water quality, areas which slow run-off and areas which form part of the existing habitat networks. For details on the creation of each of the component layers see the relevant maps.

How to interpret the map:
Combining the opportunities layers of the areas with opportunities to promote good water quality, areas which slow run-off and areas which form opportunities to extend the habitat networks, show the areas across the Local Nature Partnership where any work would provide benefits across several services.

Ecosystem service:
Combined opportunities

What the service is:
A combination of the areas with opportunities to promote good water quality, areas with opportunities to slow run-off and areas with opportunities to extend the habitat networks.

Why it is important:
Areas often provide a range of ecosystem services. By combining these three layers it can be seen where habitat restoration work would promote more than one ecosystem service. It therefore highlights those areas providing multiple benefits

How the map was created:
This map was created by combining those areas which have the most opportunities for each service, with opportunities to promote good water quality, areas with opportunities to slow run-off and areas with opportunities to extend the habitat networks. For details on the creation of each of the component layers see the relevant maps.
How to interpret the map:
Green areas show areas identified to benefit pollinator and other insect species in the B-Lines project from Buglife (https://www.buglife.org.uk/campaigns-and-our-work/habitat-projects/b-lines).

Ecosystem service:
Pollination.

What the service is:
Reproduction in some plant species relies on pollen grains (the male sex cells of plants) to be transported, for example by insects, to the female sex cells for fertilisation; this process is called pollination and is an important ecosystem service.

Why it is important:
Pollination is a very important ecosystem service, both for the maintenance of native plants and for effective agriculture, with some crop types depending on pollination by bees. In recent years, declines in pollinator species have been a source of concern for environmentalists.

How the map was created:
The areas shown on the map have been defined by initially identifying present, flower-rich habitats and connecting them with corridors that are now targeted for habitat optimisation for pollinators.
Detailed information is available on www.buglife.org.uk

4. References and Bibliography


Appendix A – Example Data Attribution

<table>
<thead>
<tr>
<th>Habitat Networks</th>
<th>Ecosystem Service Type</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Regulation and</td>
</tr>
<tr>
<td></td>
<td>Maintenance</td>
</tr>
<tr>
<td></td>
<td>Provisioning</td>
</tr>
<tr>
<td></td>
<td>Cultural</td>
</tr>
</tbody>
</table>

The value of a habitat parcel for biodiversity resilience can be assessed by considering:

**Size** – The area of a patch of habitat must be sufficient to be resistant to edge effects and invasive species, as well as being resilient to future environmental changes.

**Vulnerability** - The speed of habitat turn-over and whether they are easily altered. This can be either because they are easy to overlook (e.g. species rich wet grasslands which can be considered ‘rough land’ by farmers) or because they are very sensitive to external changes in management, (e.g. calcareous grasslands, in the absence of management tend to scrub over).

**Connectivity** – Habitats which are well connected are less likely to suffer edge effects. Fragmented patches (depending on size) can only support smaller population and are therefore less resilient to stochastic event and less resistant to impacts.

For this resilience layer, important habitats have been included scored by their patch size and the type of habitat, with added value given to areas within the networks, as they are likely to be more resilient and the area surrounding the important habitats from the networks, picking up the less important vegetation which is likely to add to the network.

<table>
<thead>
<tr>
<th>Influencing Factors</th>
<th>Example attributes</th>
<th>Permeability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Resilience – patch size and vulnerability</td>
<td>Size of habitat patches Woodlands &gt;2ha Grasslands &gt;0.2ha</td>
<td>Core</td>
</tr>
<tr>
<td></td>
<td>Woodlands &lt;2ha Grasslands &lt;0.2ha</td>
<td>Associated (permeable)</td>
</tr>
<tr>
<td>Location within the landscape – surrounding vegetation types</td>
<td>Semi-natural habitat within the network Semi-natural habitat outside the network</td>
<td>Core Associated</td>
</tr>
</tbody>
</table>
Water quality regulation

| Ecosystem Service Type | Regulating |

Water quality regulation is a key ecosystem service that affects human health and wellbeing and can have significant economic consequences. Water quality is influenced by both natural processes and human activities.

Soil temporarily stores water that falls as rain and subsequently releases it to rivers and streams, or adds it to the overall ground water resource. Some soil types effectively filter water as it percolates through it, whilst others add to the suspended particulate matter and mineral burden of the water. Steep slopes shed water more rapidly than shallow slopes. The water has higher energy and is able to carry more particulate matter within it, picked up from the land surface.

Habitat, through its link to vegetation type and soil type, has an important influence on water quality. This is largely linked to the structure of the vegetation present. Some species of plants assist with water purification.

<table>
<thead>
<tr>
<th>Influencing Factors</th>
<th>Example attributes</th>
<th>Indicative scoring</th>
</tr>
</thead>
<tbody>
<tr>
<td>Habitat</td>
<td>Woodland</td>
<td>moderate/high</td>
</tr>
<tr>
<td></td>
<td>Hedge</td>
<td>moderate</td>
</tr>
<tr>
<td></td>
<td>Bog</td>
<td>moderate/low</td>
</tr>
<tr>
<td></td>
<td>Arable</td>
<td>low/negative</td>
</tr>
<tr>
<td>Filtration effect of the soils</td>
<td>Brown earths</td>
<td>moderate/high</td>
</tr>
<tr>
<td></td>
<td>Peaty soils</td>
<td>low</td>
</tr>
<tr>
<td>Slope is linked to flow rate</td>
<td>Steep slopes</td>
<td>Negative</td>
</tr>
</tbody>
</table>
Water quantity regulation | Ecosystem Service Type
--- | ---
Regulating

The regulation of water is complex and is affected by obvious factors such as climate (rainfall in particular), but also less obvious ones such as topography, soil, vegetation and land cover type (especially sealed surfaces, such as concrete and tarmac). At its simplest, soil temporarily stores water that falls as rain as it percolates through the system towards rivers and streams, or into the groundwater resource. The ability of soil to perform this function depends on its texture, depth and organic matter content, as well as the overall context of the soil in the landscape.

Habitat, through its link to vegetation type and soil type, has an important influence on water quantity. This is linked largely to the structure of the vegetation present and effect on interception and infiltration. Steep slopes shed water more rapidly than shallow slopes.

<table>
<thead>
<tr>
<th>Influencing Factors</th>
<th>Example attributes</th>
<th>Indicative scoring</th>
</tr>
</thead>
<tbody>
<tr>
<td>Habitat</td>
<td>Woodland, Wetland, Grassland, Arable</td>
<td>high, moderate, low, negative</td>
</tr>
<tr>
<td>Storage capacity of the soils</td>
<td>Peaty soils, Brown earths, Clay soils</td>
<td>high, moderate, low</td>
</tr>
<tr>
<td>Slope is linked to flow rate</td>
<td>Steep slopes</td>
<td>negative</td>
</tr>
</tbody>
</table>