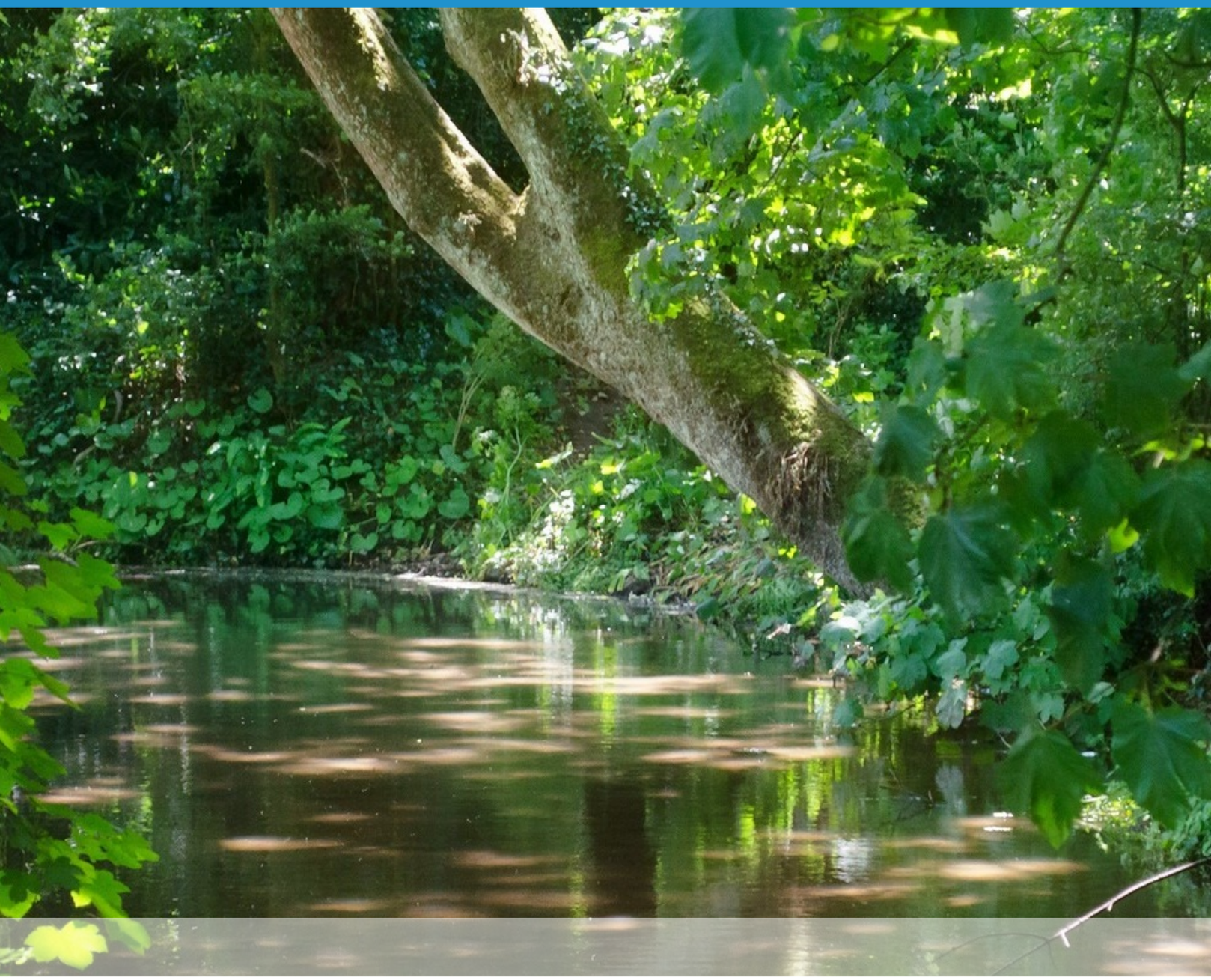


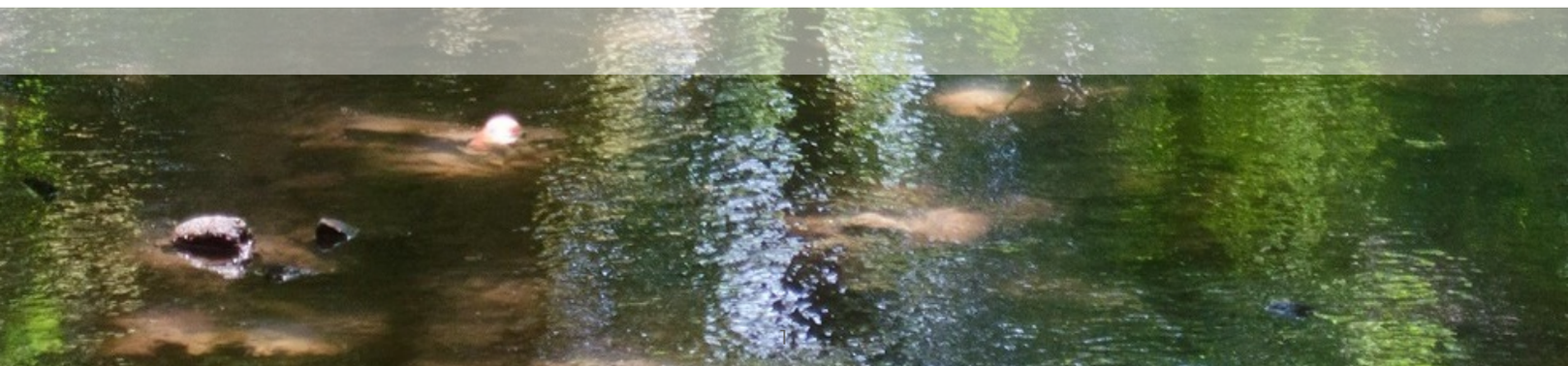
Connecting the Culm

Interreg 2 Seas Mers Zeeën Co-Adapt

European Regional Development Fund

Environmental Evidence Review

1st Edition: February 2021



Connecting the Culm is a three year project which aims to make the River Culm and its floodplain more resilient to flood and drought, improve water quality, support biodiversity and habitats, and involve local people and organisations in the process.

Connecting the Culm is a partnership project working to tackle some significant challenges faced by the River Culm. It is part of the wider Co-Adapt programme, with funding from the Interreg 2 Seas programme, co-funded by the European Regional Development Fund. Co-adapt has allied projects in Somerset, the Netherlands, Belgium and France. This wider partnership will demonstrate how communities can come together to implement nature-based solutions to climate-change related issues. The project is running from January 2019 until June 2022.

The £1 million Connecting the Culm project is funded 60% by Interreg 2 Seas programme (co-funded by the European Regional Development Fund) and the remainder by partners. The project has been developed by a partnership of organisations including the Devon County Council, Environment Agency, Mid Devon District Council and National Trust and is led by the Blackdown Hills AONB.

This document has been created by Westcountry Rivers Trust to support the development of a baseline of evidence and evidence-led opportunities for action.

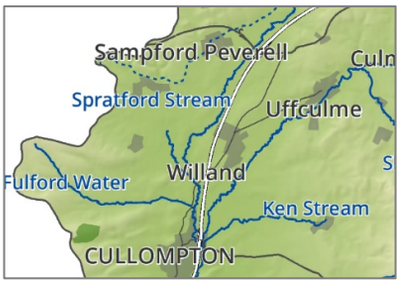
Executive Summary

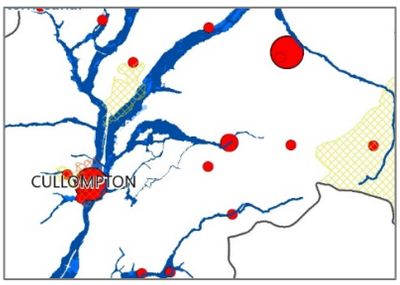
The River Culm winds its way through the Redlands of Mid and East Devon. The longest tributary of the River Exe, it drains around 280km² of land encompassing the Blackdown Hills and the town of Cullompton, reaching its confluence with the Exe north west of the City of Exeter. The Culm catchment has been under strain for some time; it is not as resilient as it could be in the face of the climate crisis.

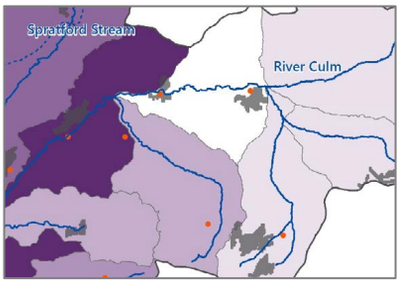
The Connecting the Culm project aims to reduce vulnerabilities and enhance resilience and this Environmental Evidence Review brings together environmental data and evidence for the entire catchment. The report walks you through the catchment, theme by theme, from the Culm in the context of the climate crisis, through its physical characteristics, ecosystems and habitats and then to the services they provide for nature and people, delving into topics such as water quality and water quantity. Bringing all this evidence together, the report then presents the current condition of the river and the catchment, as well as identifying where the vulnerabilities and challenges are located. Finally, it sets out some opportunities and scenarios to take forward in the form of Potential Areas for Improved Resilience or 'PAIRS'. These are for everyone to work with to achieve enhanced resilience in an integrated, co-created, exciting and never-tried-before way!

The next step in the journey is to co-create the Blueprint for the Culm, with many activities relating to that process already underway. Through the Connecting the Culm project and beyond, we can bring about positive change together and make ourselves, our river and our landscape more resilient.

Contents

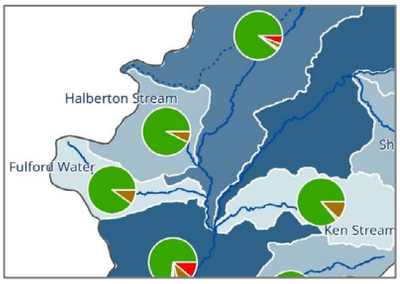






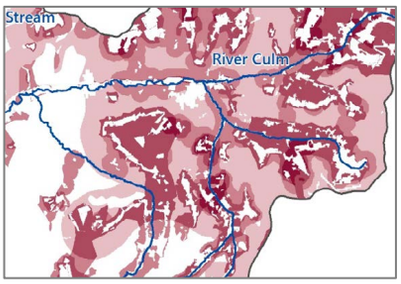
Improving Resilience to Drought: pages 24 - 28

An assessment of the available data and evidence about low flows, water supply and drought. This section looks at priority areas, natural assets which help to regulate water movement in the catchment, and an assessment of current water supply across the Culm and the whole of East Devon. Opportunities for reducing the likelihood of droughts are sought by mapping areas which may be suitable for wetland creation.



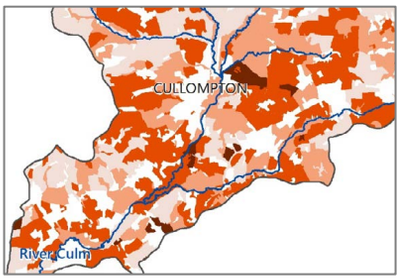
Water Quality: pages 29 - 39

A variety of datasets are used to investigate water quality in the Culm catchment. First, an investigation into priority areas and protected zones. Then, the parts of nature which help to regulate water quality are mapped, such as soil type and slope. Data on current water quality, from national and local assessments, are presented, followed by a look at possible sources of water pollution. Finally, areas which may pose a risk to water quality are mapped in order to show areas where work is needed to protect clean water.



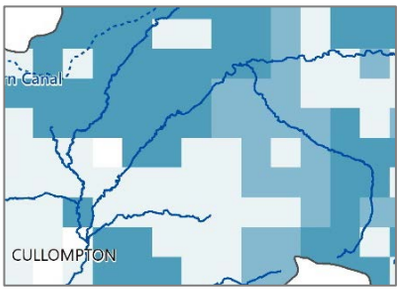
Biodiversity: pages 40 - 47

Plants, wildlife and habitat networks are explored in this section. Current important sites are mapped and a variety of datasets are used to help understand the current quality of the landscape for supporting plant and wildlife communities. Habitat network maps are explored and combined to identify opportunities for enhancing and linking up the habitat network, to make the landscape more resilient for biodiversity.



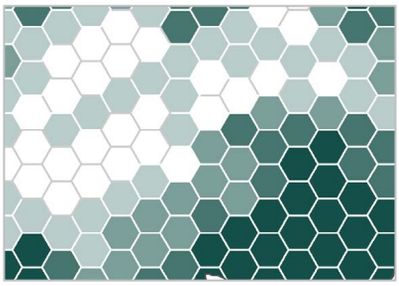
Heritage, Culture & Recreation: pages 48 - 53

An introduction into the cultural value of the landscape, including an assessment of accessible areas for recreation, locations of heritage sites and landscape scale data on how land use has changed over time. An initial assessment is then undertaken to find areas where more or better recreational resources could be beneficial.



Climate Regulation: pages 54 - 57

An initial investigation into where carbon is currently stored in the catchment, in soils and vegetation, and where this could be enhanced through changes in land use. This section focuses on carbon sequestration, the long-term removal of carbon dioxide from the atmosphere, as a method of climate change mitigation. However, the Connecting the Culm project as a whole will also consider how the catchment can become better adapted and resilient to climate change.



Summary of Opportunity Areas: pages 57 - 61

Throughout the document, layers of information for each theme are overlaid and combined to create maps showing broad landscape-scale opportunities for work to protect and enhance each ecosystem service. These maps are summarised into grids to aid comparison and interpretation, to allow them to be used to guide prioritisation and action across the catchment.

Next steps: page 62

Data Sources and References: pages 63-66

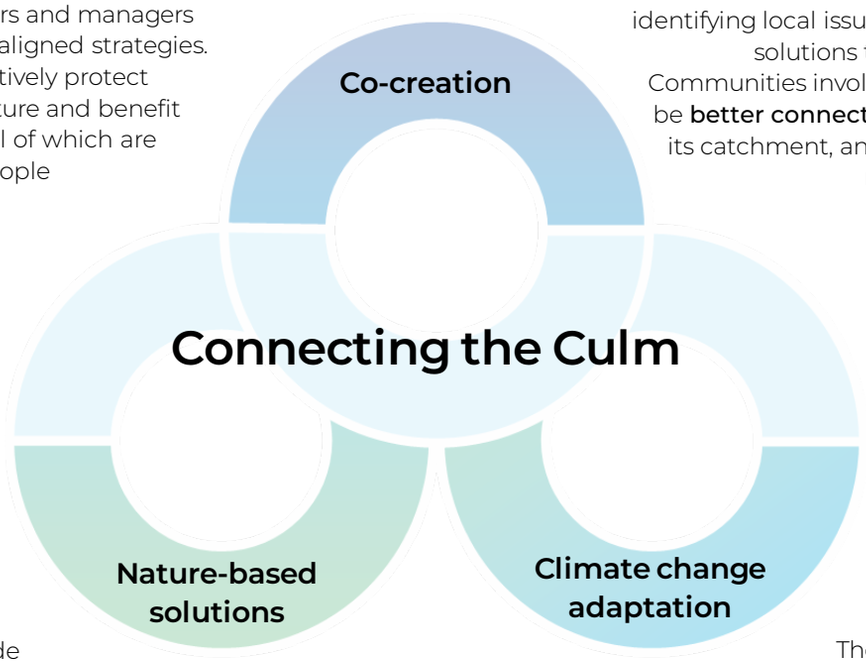
Connecting the Culm

Connecting the Culm is a three year project which aims to make the River Culm and its floodplain more resilient to flood and drought, improve water quality, support biodiversity and habitats, and involve local people and organisations in the process.

The project takes a strategic approach at a catchment scale and is based on three key pillars: co-creation, nature-based solutions and climate change adaptation.

Strategic planning on a catchment scale allows for greater cooperation between landowners and managers to implement well-aligned strategies. This will more effectively protect property, infrastructure and benefit the environment, all of which are valuable to local people and the economy.

A **co-creation** approach **empowers communities** to take ownership in identifying local issues, and developing solutions to overcome them. Communities involved in this way will be **better connected** to the river and its catchment, and will deliver more **resilient solutions**.



Nature-based solutions can provide a **cost-effective solution** to tackle catchment-wide issues, by restoring and **emulating natural catchment functions** as well as providing a range of **benefits to society**.

The Culm catchment needs to adapt to ensure **robust strategies** are implemented that address the current **climate emergency**.

Blueprint for the Culm

The project aims to develop a long-term masterplan for the catchment called the Blueprint for the Culm, which will shape policies and investment decisions affecting the river and its tributaries for the next 25 years and beyond. It will be co-created by the people that live and work within the catchment and the organisations that have a role in the area.

Aims of the Blueprint

- Reduced flood risk along the Culm and downstream
- Farmland soils are protected
- Cost savings for everyone
- Better water quality
- A better environment for wildlife and fish stocks
- A more enjoyable and attractive place to live

Connecting the Culm and the Climate Crisis

A key pillar of the Connecting the Culm project is addressing the issues developing as a result of climate change. This page and the next summarise the issue being faced, how it affects us at a local level and the approach the Connecting the Culm project is taking to help reduce the impact in the Culm catchment.

Climate Change Overview

Over the last 150 years the average temperature of the planet has risen by around 1°C. This is a rapid change in our global climate system, which has been stable for the last 11,000 years. Over this same time the amount of carbon dioxide, methane and several other gases in our atmosphere has increased dramatically. These gases are known as greenhouse gases because they slow the escape of heat from the planet's surface into space. Without these gases present in small quantities, the earth would be too cold for human life; but when their concentrations get too high and too much of the sun's energy is trapped, temperatures rise and a series of changes are triggered, including melting ice sheets, rising sea levels and the loss of species. This is the process known as climate change.

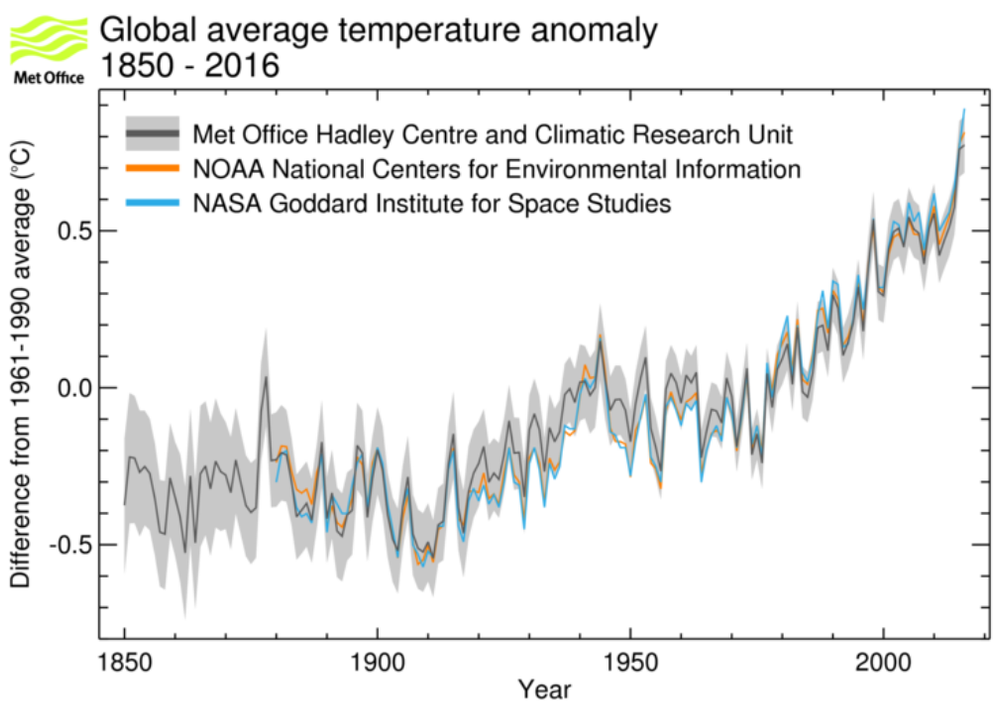
Where do greenhouse gases come from?

Natural processes like plant growth and animal digestion generate greenhouse gases but the rapid increase in the last two centuries is mainly due to human activities such as burning fossil fuels, farming and land use changes, deforestation, and the manufacture of cement, chemicals and metals.

Climate change impacts globally

The effects of climate change are already being felt across the planet. Changes include:

- Extreme weather – weather events such as heatwaves, droughts, and floods are becoming more intense and frequent, .
- Rising ocean levels - melting glaciers and the expansion of ocean water is causing sea levels to rise
- Ocean acidification – Ocean acidification occurs when the ocean absorbs carbon dioxide and becomes more acidic. This damages coral reefs and other essential marine ecosystems.



▲ Plot showing the global temperature change from 1850 to 2018, compared to the 1961-1990 average temperature (Source: Met Office).

Connecting the Culm and the Climate Crisis

Climate change and the Culm

Our climate is changing and this will impact people and the environment in the catchment of the River Culm. The Connecting the Culm project will explore what these changes will mean for people, their properties and livelihoods, and the natural environment.

What does the future hold?

Climate models tell us that under a scenario of ever-increasing greenhouse gas emissions the world could become up to 4.8°C warmer than the pre-industrial period by the end of this century.

In the Paris Agreement of 2015, the nations of the world agreed to try to limit global temperature rise this century to 'well below' 2°C and ideally below 1.5°C. To achieve this target, when we have already triggered warming of 1°C, is going to be a huge global challenge.

It is an important challenge too. If warming of 4°C happens, the impacts on us and the rest of life on the planet will be dangerously high. We can seek to adapt to warming below 2°C, but above this level it will become increasingly hard for normal life to continue.

This is why we need to focus partly on **adaptation** (becoming more resilient to the changes that we know are happening already and in the near future) and partly on **mitigation** (rapidly reducing our greenhouse gas emissions) to try and reduce the risk of warming over 2°C.

Connecting the Culm is first and foremost an adaptation project. But, through the Blueprint for the Culm, the project will also incorporate carbon emission reduction plans that can simultaneously help make us more resilient. Tree planting is a good example: the trees slow flood water and help soils absorb more water, but they also lock in carbon from the atmosphere.

Climate change impacts in Devon

As a result of climate change, Devon's weather is changing. We are already seeing wetter and warmer winters, more frequent hot and dry periods increasing the risk of drought in summer, and more frequent extreme weather events such as storms with more intense rainfall causing floods.

Data shows[1] that South West England is experiencing almost 10% more rainfall over the year now than in 1961. Seasonal rainfall is highly variable, but since 1961 it has decreased by 9% in summer and increased in autumn by 28% and in winter by 16%. Our winters are also milder – on average per year, South West England has almost 21 fewer days of air frost than it did in 1961.

With the current rate of global greenhouse gas emissions, estimates are that by the 2080s:

- Mean summer temperatures in Devon will increase by between 2.4 and 8.3°C (with the warmest summer day being up to 9.4°C hotter than the 1961 – 1990 average)
- Precipitation will increase by 20 – 50% in the winter and decrease by 30 – 40% in the summer.

What does this mean for you?

The Connecting the Culm project aims to help protect our communities and our natural environment from the impacts of climate change, and in particular flooding and drought. By working together, and by working with nature, we can build a river catchment that is better able to withstand extreme weather events, and at the same time create better places for nature and people.

This summary has identified some of the ways in which the climate is already changing and will continue to change, and some of the impacts this will cause. Through the Connecting the Culm project we want to explore what these changes will mean for people, their properties and livelihoods, and the natural environment, and build a plan together so we can manage these changes carefully, making sure that people and nature are protected in the best way possible.

An Evidence Base for the Culm

A key stage in the Connecting the Culm project is to build understanding about the catchment amongst practitioners and stakeholders. This will allow the co-creation element of the project to be realised most successfully with the ultimate aim of interventions taking place in areas where they will have the greatest benefit. It is therefore important to take a review of the data and information available for the catchment and to use this information to make positive, evidence-based decisions.

This document presents available environmental evidence for the Culm catchment. It is based on a method developed over several years for undertaking stakeholder-led spatial visualisation of natural capital and ecosystem services across a catchment landscape[1]. The concepts of natural capital and ecosystem services are described in more detail on the following page.

Through analysis of the available data, alongside dialogue with stakeholders and technical specialists, it is possible to highlight areas of the catchment which may be most likely to play a critical role in the provision of different ecosystem services. The process followed in this evidence review is:

1) Priority areas and drivers

For each service it is first important to identify all of the **priority areas, drivers and receiving features** affected by the provision or non-provision of the service. This sets out where the beneficiaries are and where there are drivers (statutory, social or economic) for the enhancement of the service.

2) Natural assets and infrastructure that regulate the service

The second stage is to undertake a comprehensive audit of the **features in the landscape** (environmental infrastructure) that are **responsible for the provision of each service**. A strategic programme of measures must be based on a good understanding of the current provision so that this can be protected and/or enhanced through interventions in suitable locations.

3) Assessing the provision of the service

Following on from this audit, available data and evidence should then be used to assess the current **condition of the ecosystem** and to determine its **ability to provide the service** in question. Understanding the condition of the current environment indicates whether something needs to be done to enhance the provision of a service, and this gives a mandate to act.

4) Opportunities for enhancement

If the accumulated evidence indicates that the provision of the service is below that required, criteria are then developed and mapped which define **areas of priority, suitability and/or opportunity** for the delivery of interventions to enhance the provision.

The individual opportunity maps are summarised and can be compared and overlaid to identify areas of the catchment which have the potential to enhance the provision of multiple services if the right interventions took place.

Data

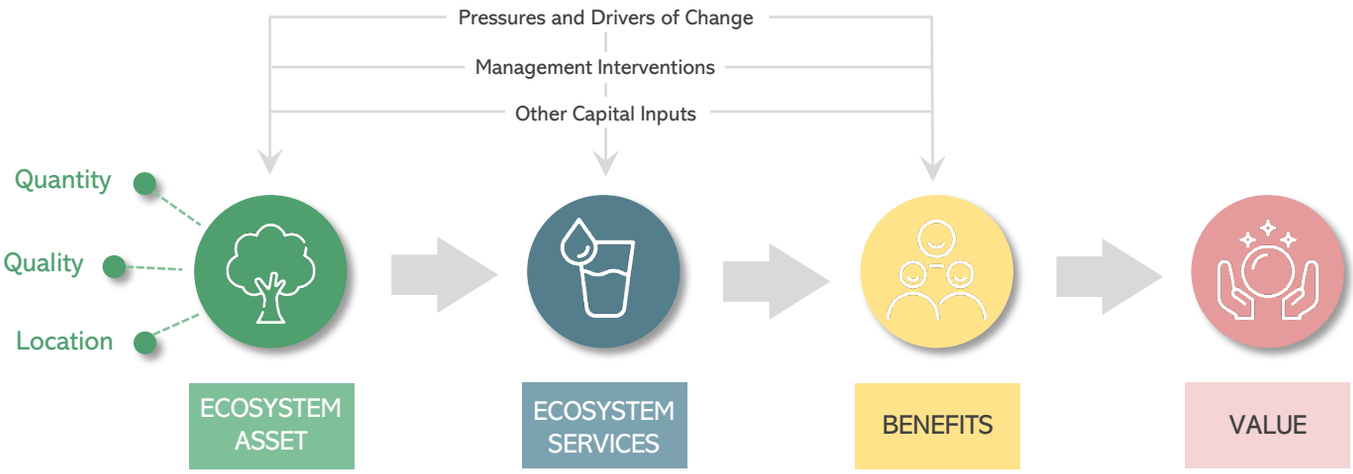
It is not possible to map all aspects of the health of the natural environment with existing datasets, and the true state of the environment may not be fully reflected in the datasets for various reasons including the age of the data and the resolution. Nonetheless, the available data has been reviewed and the best data currently available has been used. Each dataset is listed next to the map and has been given a broad Red, Amber or Green rating for its resolution and age. There is more detail about the datasets on page 63.

Natural Capital & Ecosystem Services

This document will take a natural capital approach to assessing the environmental data and evidence for the Culm catchment.

Natural capital is 'the elements of nature that directly or indirectly produce value to people'. When we talk about natural capital, we talk in terms of 'assets'. **Natural assets** include land, soils, freshwater, air, oceans, habitats, species and ecological communities.

Ecosystem services are **functions and products from nature** that can be turned into **benefits for people**. Ecosystem services include clean water, clean air, opportunities for recreation, and reduced risk of hazards such as flooding. The diagram below show the links between assets, service and benefits.



The ability for a natural asset to provide benefits is affected by where it is, how much of it there is and the quality or condition it is in. In the case of biodiversity as an ecosystem service, a small, isolated patch of degraded habitat will be less effective at providing the service than a large, healthy, well-connected patch. The assets and services can also be affected by negative pressures, or positive interventions and investment taken to improve them.

It is therefore important to consider natural assets, ecosystem services and the benefits they bring us when making plans for protecting and managing the natural environment. A compelling case for reducing negative pressures and increasing positive interventions can be developed, because there is a clear logical chain through to the value it brings us as people and a society.

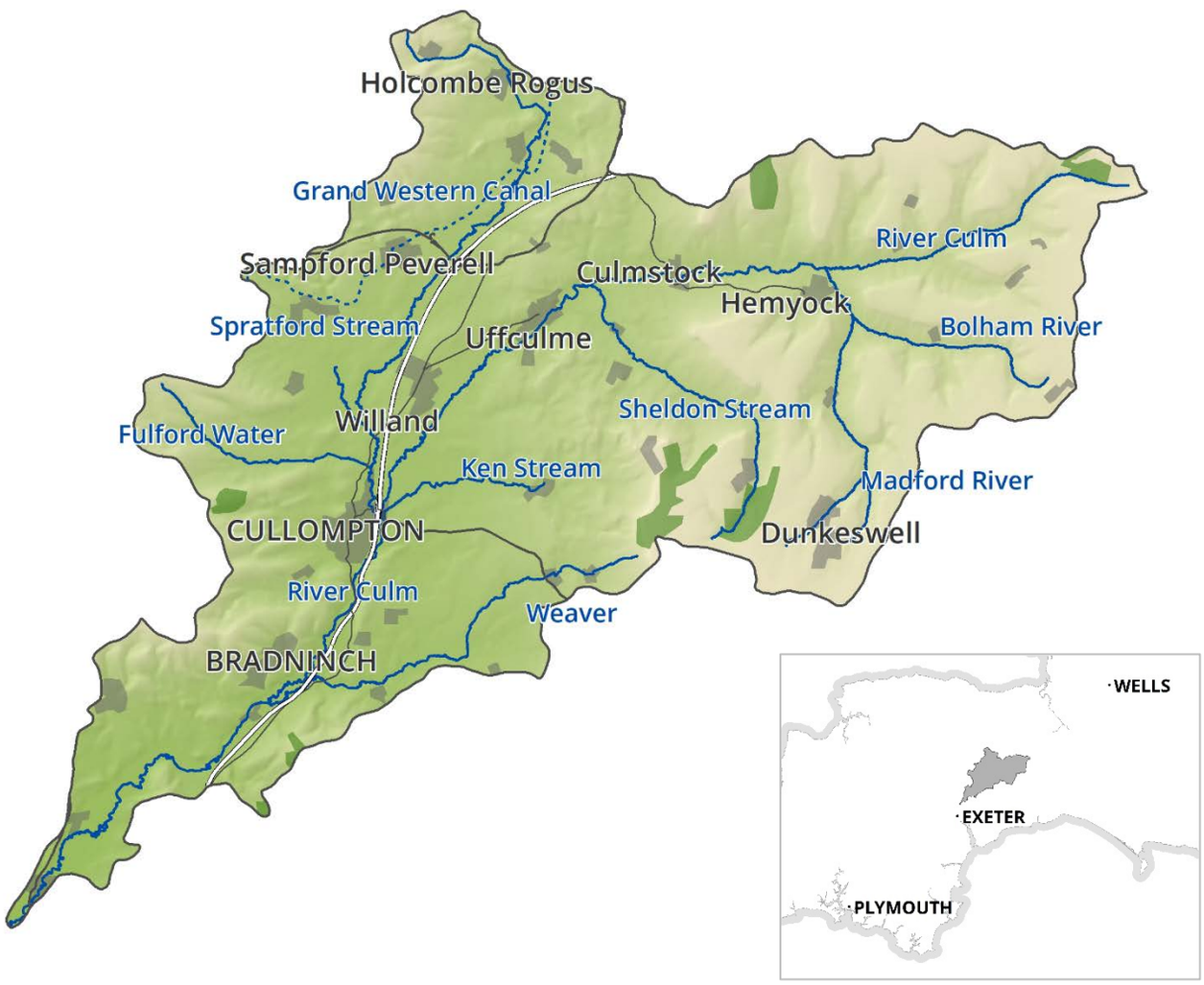
Ecosystem services we benefit from include clean drinking water, biodiversity, recreation, food, climate regulation and reduced risk of floods and droughts. ▶

The Culm Catchment

The River Culm flows through the Redlands of Mid and East Devon and is the longest tributary of the River Exe.

It rises in the Blackdown Hills at a spring near RAF Culmhead in Somerset, and flows west through Hemyock, then Culmstock to Uffculme. The river then turns south, through Cullompton and alongside the M5 motorway, skirting the northern boundary of Killerton Park to join the River Exe north-west of Exeter.

The river and its tributaries drain an area of approximately 280 square kilometres. This area is the catchment of the Culm and is the focus of the Connecting the Culm project.



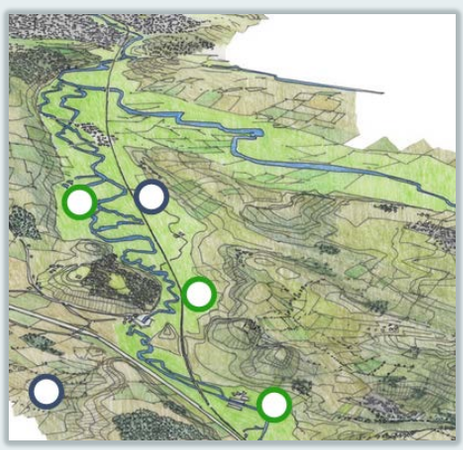
View of the Culm

The Connecting the Culm project has worked with a local artist to put together annotated visualisations of the Culm catchment, highlighting important features and issues and pressures affecting the area. These can be viewed online by clicking the links below:

- North East across the Culm Valley
- South West from Cullompton to Exeter

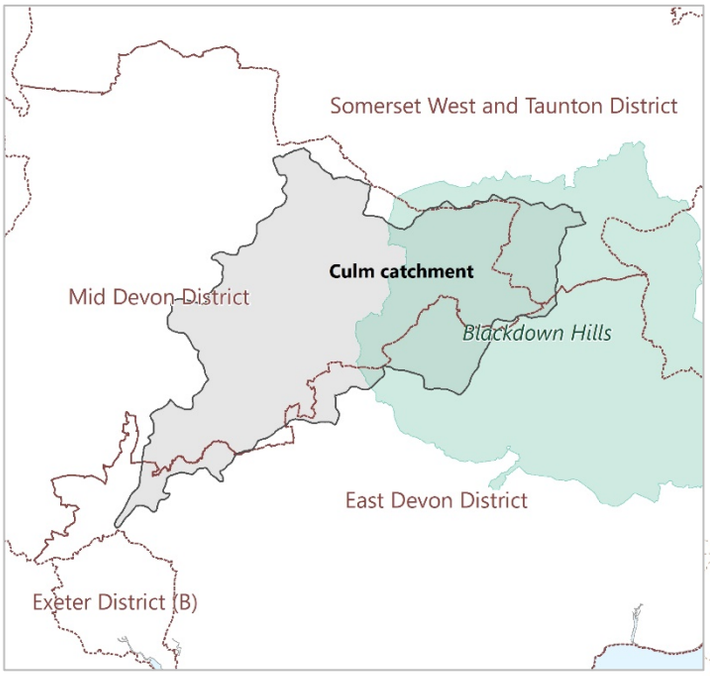
The visualisations are also accessible via the Blueprint section of the Connecting the Culm website (connectingtheculm.com).

(left: extract from South West View of the Culm)



Datasets used in maps: OSVM, WBL, WBC, DTM50, OSS.
For full references see page 63.

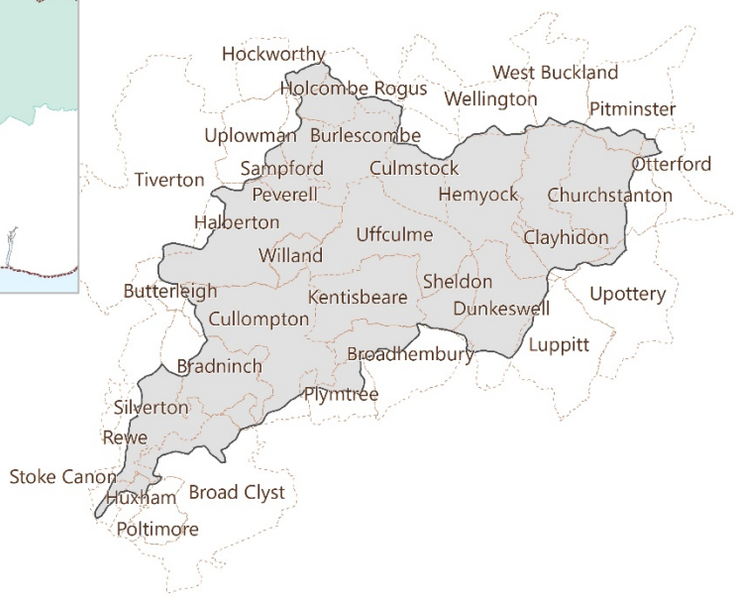
The Culm Catchment



Location within human boundaries

The Culm falls mainly within Devon County, with the eastern part falling within Somerset. The local authorities in this area are Mid Devon, East Devon and Somerset West and Taunton.

The eastern part of the Culm catchment is designated as part of the Blackdown Hills Area of Outstanding Natural Beauty. ◀



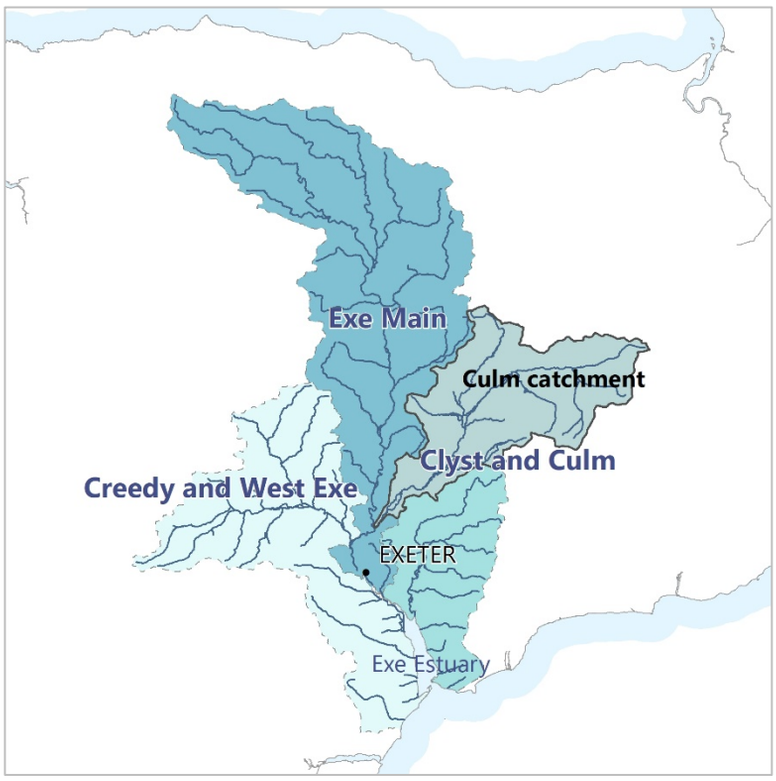
Thirty-three Parish Councils share some of their area with the Culm catchment. ▶

Location within natural boundaries

The Culm is one of several rivers which feed the River Exe and the Exe estuary. The rivers which feed the Exe Estuary are split into three main groups for management:

- The main Exe river and its direct tributaries, which feed in from the North
- The Creedy and West Exe and other rivers which join the River Exe and Exe Estuary from the West
- The Clyst and Culm and other rivers which feed the River Exe and Exe Estuary from the East

The Culm is joined by it's tributaries along its course from north-east to south-west. It then joins the main River Exe to the north of Exeter. ▶



Datasets used in maps: OSVM, WBL, WBC, OSBL, AONB, OPC.
For full references see page 63.

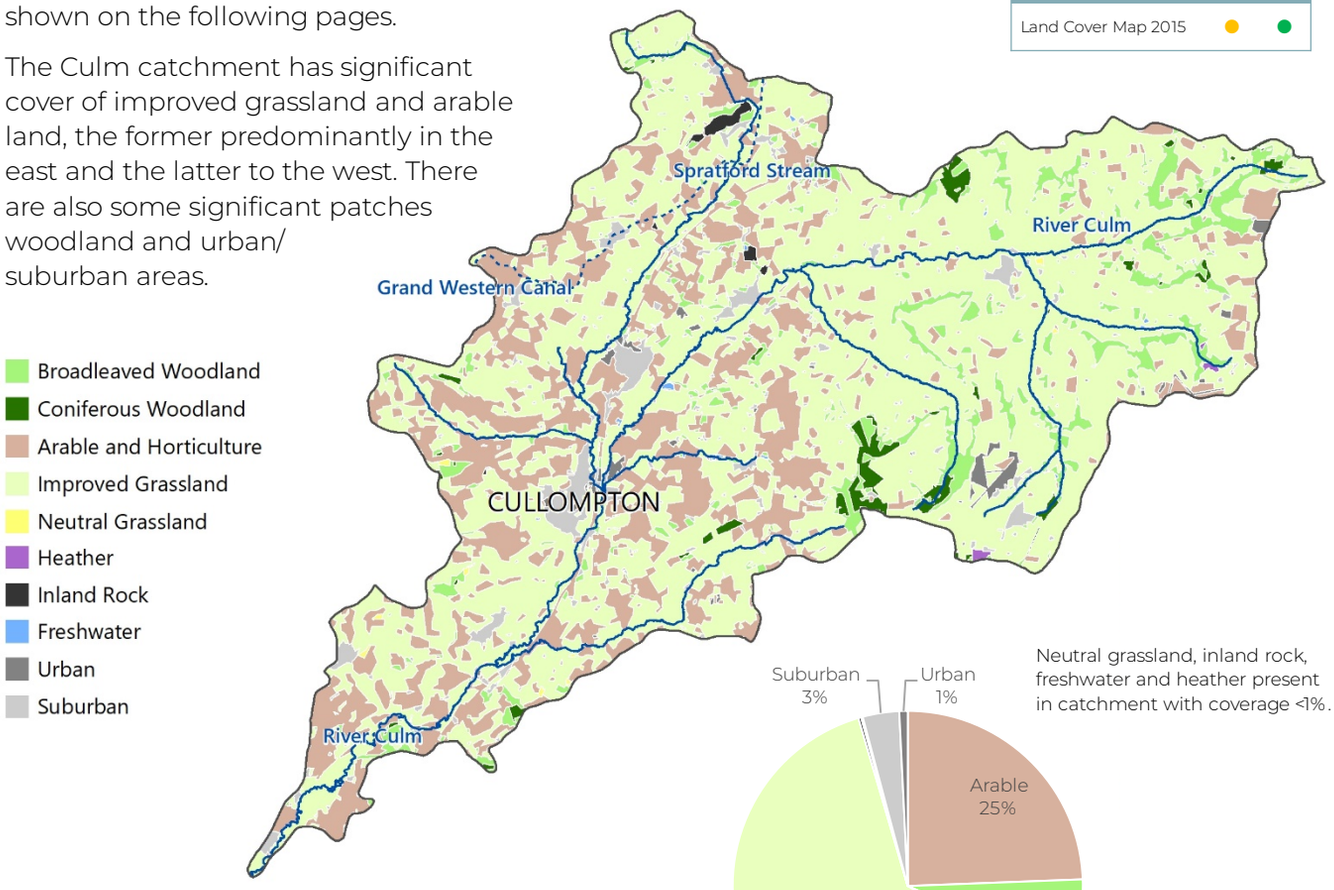
Natural Assets – Land use & Water

Land use

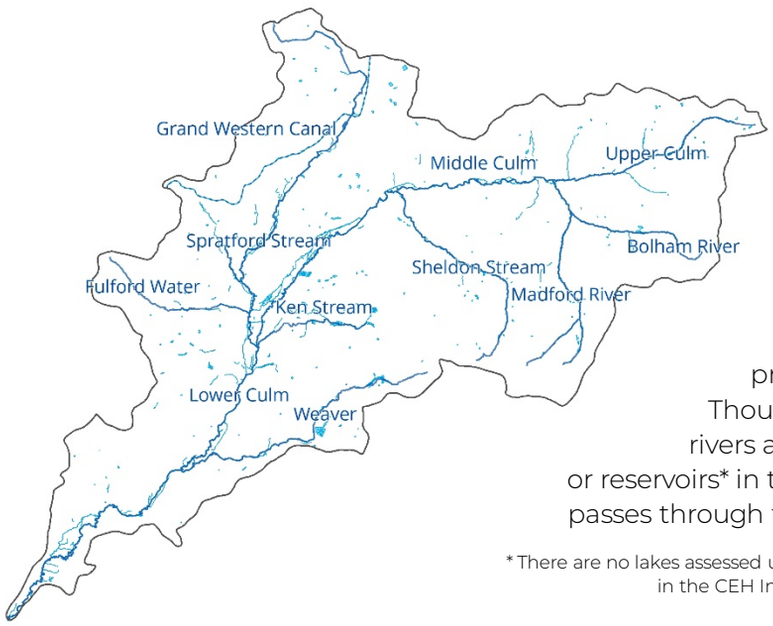
Land Cover Map is a country-wide assessment of land use. Land cover includes roads and buildings, natural and managed vegetated surfaces and inland water. It gives a broad insight into how the land in a catchment is being used, and this can be a very useful indicator of its ability to provide different ecosystem services. It is particularly useful for seeing the spread of managed land like arable and improved grassland. More detailed datasets for woodlands and important habitats for wildlife are shown on the following pages.

The Culm catchment has significant cover of improved grassland and arable land, the former predominantly in the east and the latter to the west. There are also some significant patches woodland and urban/ suburban areas.

Dataset	Age	Res.
Land Cover Map 2015	●	●



Neutral grassland, inland rock, freshwater and heather present in catchment with coverage <1%.



Dataset	Age	Res.
OS VectorMap District – Surface Water	●	●
WFD Waterbodies	●	●

Freshwater

Freshwater in the Culm catchment is predominantly found in rivers and streams. Though there is surface water outside of these rivers and streams, there are no significant lakes or reservoirs* in the catchment. The Grand Western Canal passes through the north-western part of the catchment.

* There are no lakes assessed under the Water Framework Directive or reservoirs included in the CEH Inventory of reservoirs amounting to 90% of total UK storage

Datasets used in maps: OSVM, WBL, WBC, LCM2015.
For full references see page 63.

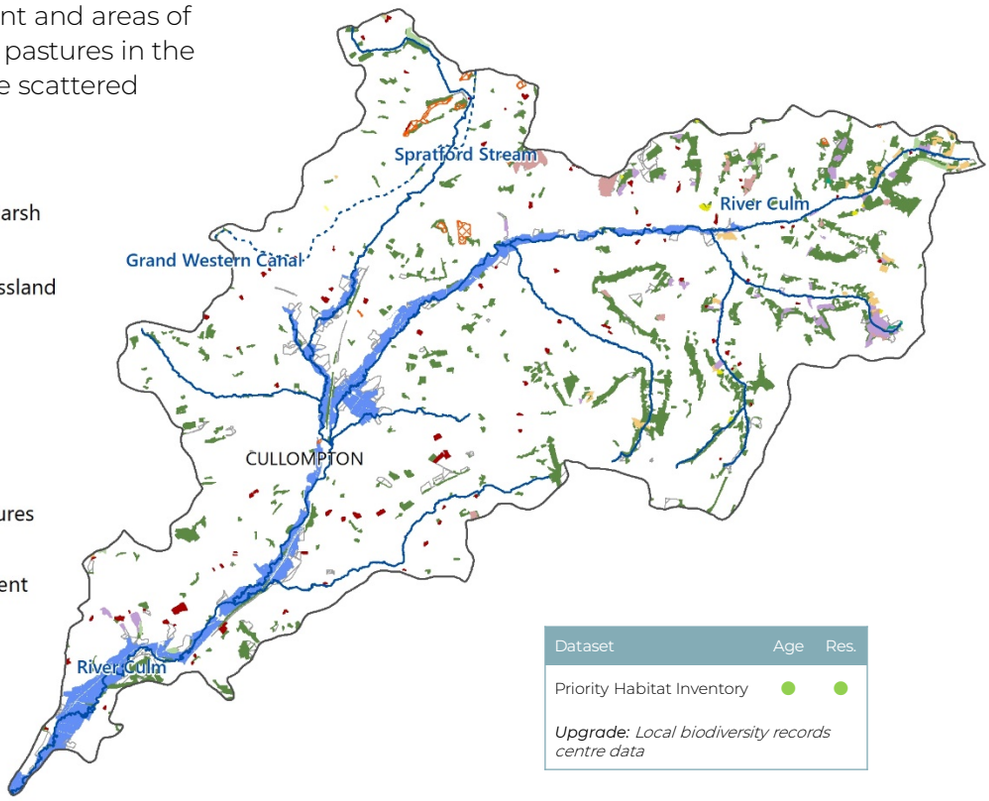
Natural Assets - Habitats

Priority Habitats

The habitats mapped in the Priority Habitat Inventory (PHI) are habitats of principle importance under the Natural Environment and Rural Communities Act (2006).

The Culm catchment has significant areas of floodplain grazing marsh and deciduous woodland, with areas of lowland heath in the north of the catchment and areas of purple moor grass and rush pastures in the east. Traditional orchards are scattered across the catchment.

- Coastal and Floodplain Grazing Marsh
- Deciduous Woodland
- Good Quality Semi-Improved Grassland
- Lowland Calcareous Grassland
- Lowland Dry Acid Grassland
- Lowland Fens
- Lowland Heathland
- Lowland Meadows
- Purple Moor Grass and Rush Pastures
- Traditional Orchards
- No Main Habitat but Habitat Present
- Open Mosaic Habitat



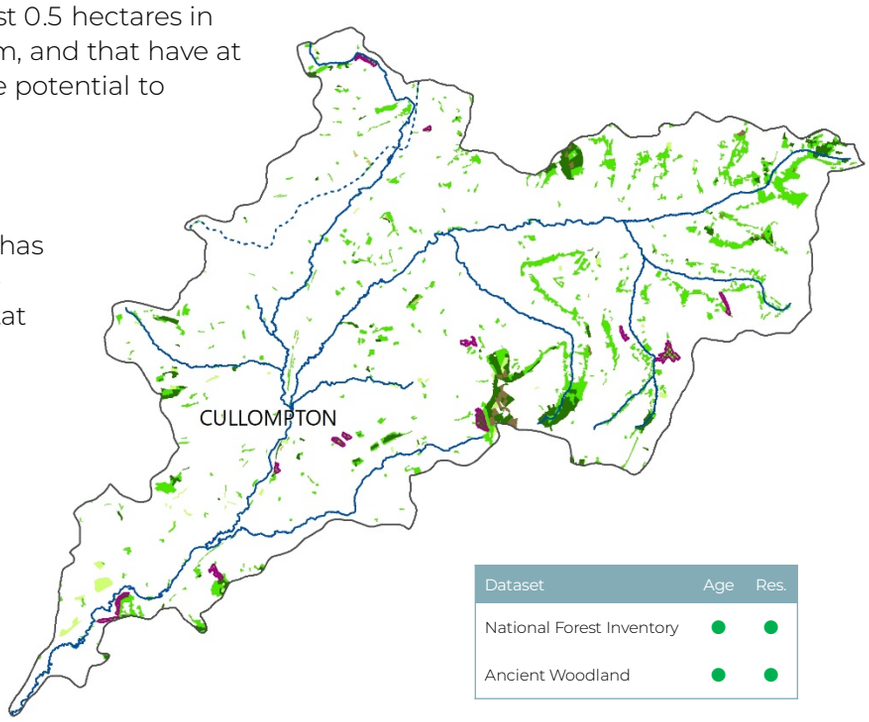
Dataset	Age	Res.
Priority Habitat Inventory	●	●
Upgrade: Local biodiversity records centre data		

Woodland

The National Forest Inventory records any forest or woodland in Great Britain of at least 0.5 hectares in area with a minimum width of 20m, and that have at least 20% tree canopy cover (or the potential to achieve this).

The map to the right also shows designated ancient woodland. Ancient woodland is any area that has been woodland continuously since 1600AD. It is an irreplaceable habitat which is valuable for its value to wildlife, soil health and culture.

- Broadleaved/ mixed broadleaved
- Conifer/ mixed conifer
- Felled
- Shrub
- Other
- Ancient Woodland



Dataset	Age	Res.
National Forest Inventory	●	●
Ancient Woodland	●	●

Datasets used in maps: OSVM, WBL, WBC, PHI, OMH, NFI, AW.
For full references see page 63.

Natural Assets - Geodiversity & Soils

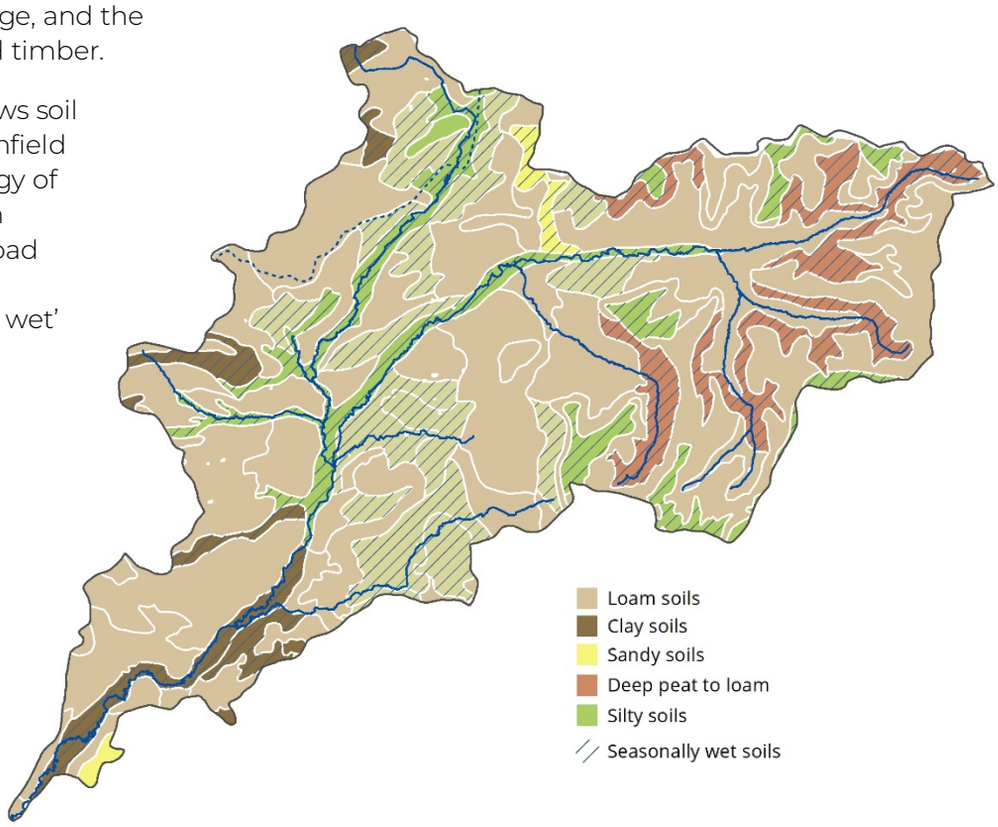
Geodiversity is the variety of rocks, minerals, landforms, geomorphological processes and soils which together form the basis of how our landscapes look and function. Geodiversity directly affects the species and habitats present and the natural processes which take place in a landscape.

Soil Type

Soil is vital to the support of plant species and as home to a huge diversity of animal species and micro-organisms. Soils also influence the character of a landscape, and provide indications of what habitat types may have been present in the past and perhaps could be restored. Soils contribute to many ecosystem services such as nutrient cycling, water purification, water regulation, carbon storage, and the production of crops and timber.

The map to the left shows soil parcels mapped by Cranfield University. The symbology of the soil types have been simplified into more broad categories, with those described as 'seasonally wet' also indicated.

Dataset	Age	Res.
NATMAP Vector Soils	●	●

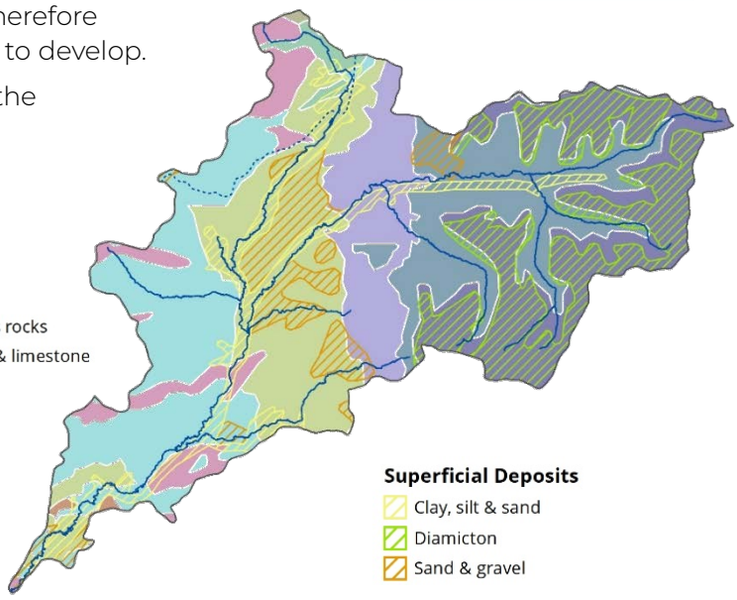


Geology

Geology is a key influence on the landscape, affecting the types of habitats and species present and the processes and functions taking place. Some of these influences are direct, such as lichens which grow on exposed rock surfaces, while others are less direct, with the geology affecting factors like acidity and drainage and therefore influencing the kinds of habitats which are able to develop.

Dataset	Age	Res.
BGS Geology 625k	●	●
Upgrade: More detailed BGS data e.g. Geology 50k		

Of particular interest in the Culm catchment is the 'Diamicton' deposits, known more locally as the 'clay caps' which are an influence on water drainage and therefore flood risk in the upper, eastern parts of the catchment.

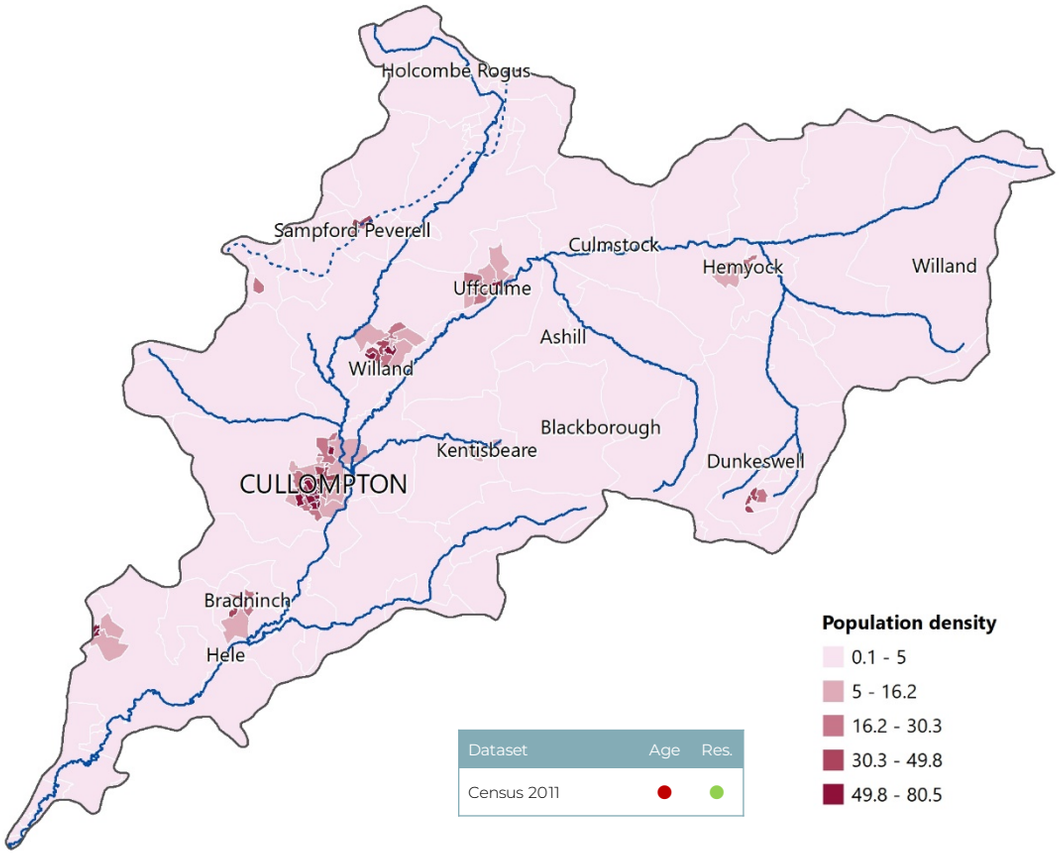


Datasets used in maps: OSVM, WBL, WBC, NAT, BGS.
For full references see page 63.

People in the Culm Catchment

Population

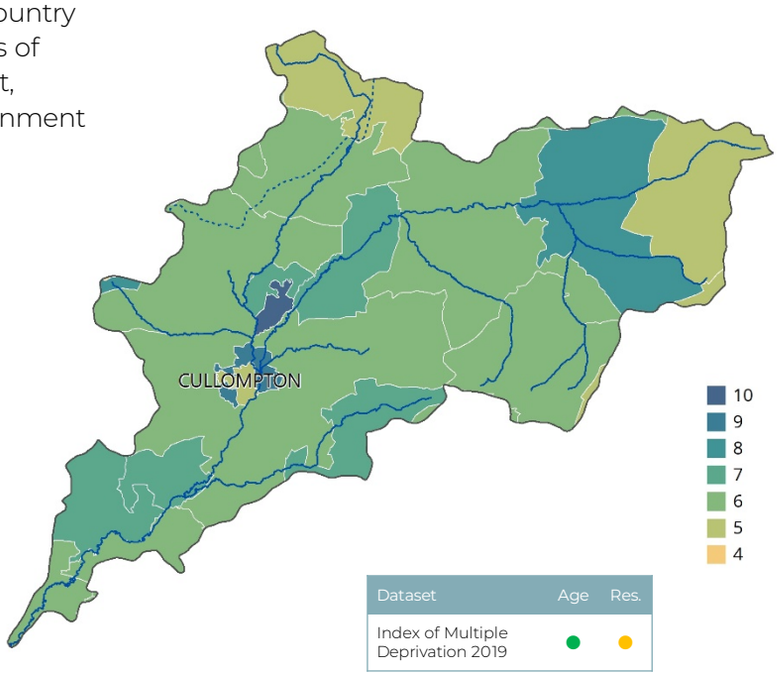
Census statistics provide an account of the British population every 10 years (most recently 2011). Census information allows central and local government, health authorities and many other organisations to target their resources and plan housing, education, health and transport services.



Social Deprivation

The English Indices of Deprivation (IMD) 2019 provide a relative measure of deprivation at small area level across England. Areas are ranked from the least deprived to most deprived across the country according to seven different dimensions of social deprivation (income, employment, health, education, housing, living environment and crime) and an overall composite measure of multiple deprivation.

The map shows overall IMD in the Culm catchment according to deciles. Deciles for IMD are calculated by ranking small areas in England from most deprived to least deprived, and dividing them into 10 equal groups. Areas with a decile score of 10 are the least deprived 10% of small areas nationally.



Datasets used in maps: OSVM, WBL, WBC, CEN-2011, CEN-COA, CEN-LSOA, IMD. For full references see page 63.

Improving Resilience to Flooding

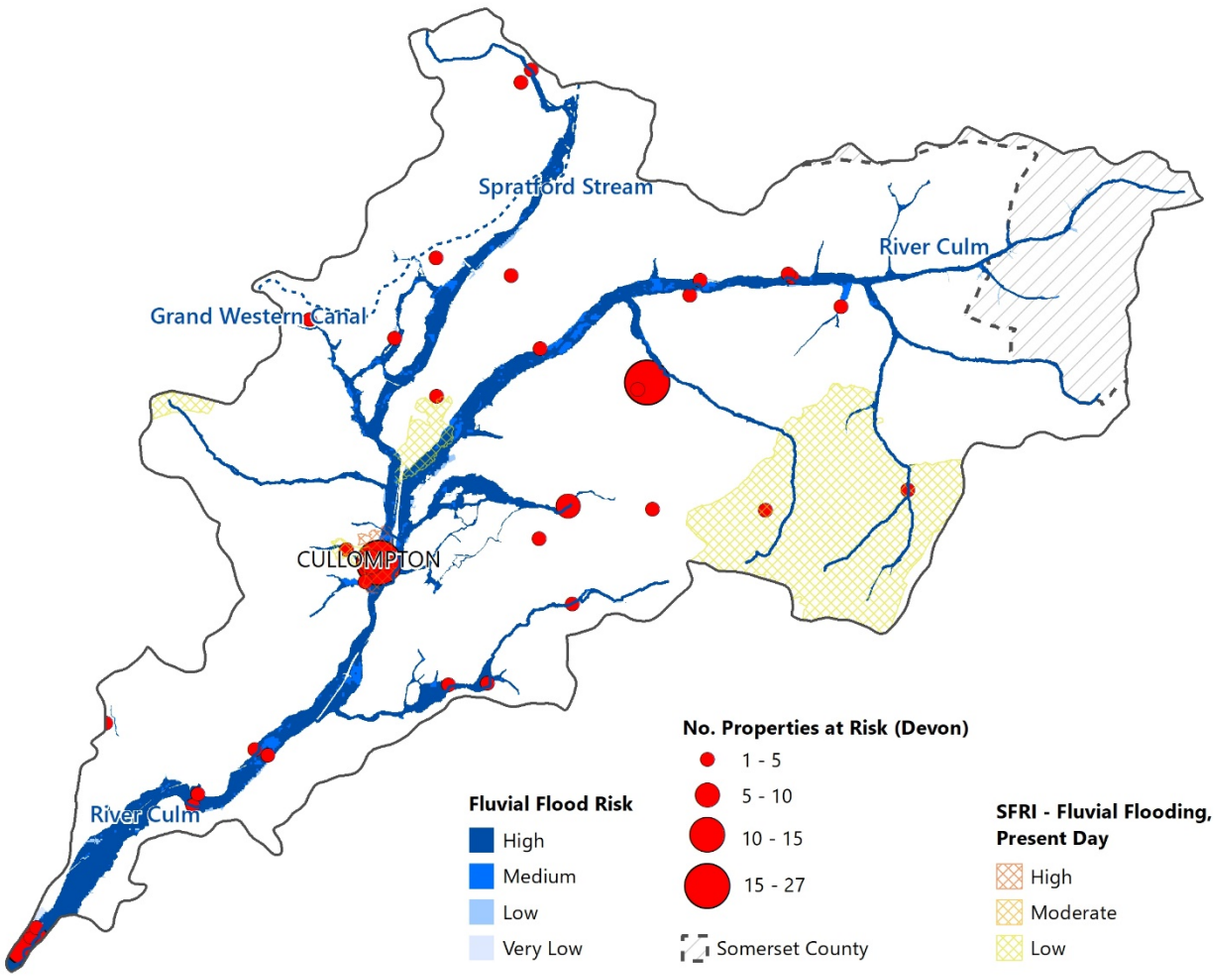
Improving resilience to flooding is important for safety, reducing risk to our homes and infrastructure, and for our mental well-being.

Priority Areas & Drivers for Improving Resilience to Flooding

There are often many locations in a catchment where the unregulated release of water from the land and into our rivers can pose a threat to people living in the catchment and cause community disruption.

The properties and infrastructure at risk of being flooded can be mapped and cross-referenced against the flood risk zones to identify where there is a risk of flooding and damage to property or threatening human health and safety.

In addition, a community can be more vulnerable to the effects of flooding depending on the ability of the local population to prepare, respond and recover and the community support available.



Sites important for improving resilience to flooding			
Dataset	Description	Age	Res.
Fluvial Flood Risk Zones	Areas modelled to be at risk from flooding from rivers and the sea (fluvial flooding).	●	●
Properties at Risk	Properties at risk of flooding in Devon	●	●
Social Flood Risk	Neighbourhoods which are at risk of flooding and which are deemed to be more vulnerable to the impact of flooding based on issues such as health, preparedness and community support. This map shows social flood risk from fluvial flooding under present day climatic conditions.	●	●
Areas Benefitting from Flood Defences	Areas that benefit from the presence of defences in a 1 in 100 chance of flooding each year from rivers; or 1 in 200 chance of flooding each year from the sea. If the defences were not there, these areas would flood in such incidents. *Note: there are no areas benefiting from flood defences in the Culm catchment according to EA data, but the data is not comprehensive.*	●	●

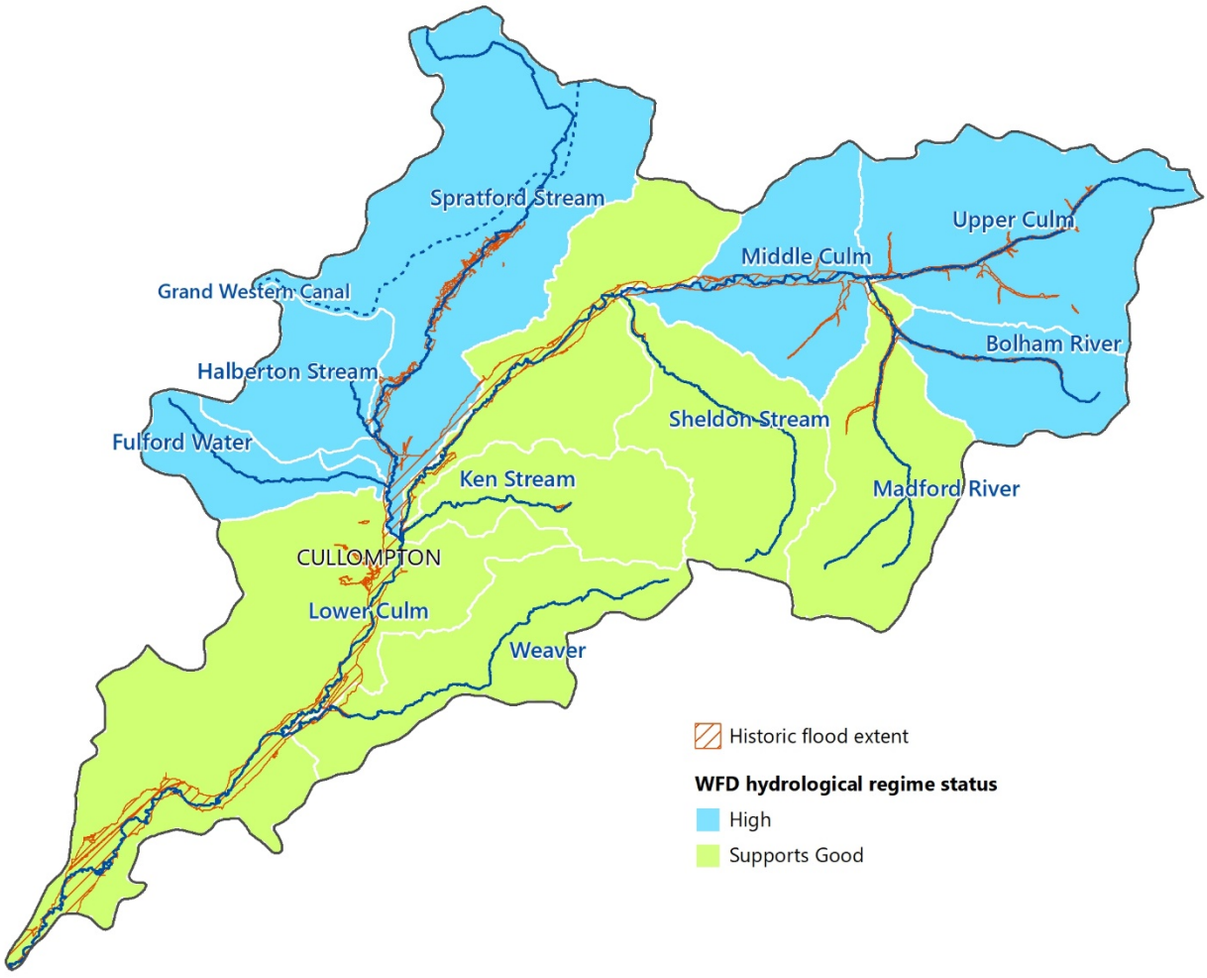
Datasets used in maps: OSVM, WBL, WBC, PAR, FFR, OSBL, SFRI.
For full references see page 63.

Assessing the Provision of the Service

There is evidence available that can be used to indicate whether high flows have caused a problem in a catchment and to therefore quantify the provision of this ecosystem service.

A key piece of evidence is the Environment Agency's historic flood map which shows the maximum extent of recorded floods from rivers, the sea and groundwater and therefore shows areas of land that have previously been subject to flooding.

The naturalness of flow regimes, as indicated by the hydrological regime status under the Water Framework Directive (WFD) is an indicator of the quality of natural assets and their functioning in relation to improving resilience to flooding..



Historic flooding			
Dataset	Description	Age	Res.
Historic Flood Extent	Areas of land that have previously been subject to flooding in England since records began in 1946.	●	●

Naturalness of flow regime			
Dataset	Description	Age	Res.
WFD Hydrological Status 2019	WFD hydrological regime classification describes the naturalness of river flows. 'High' status signifies the quantity and dynamics of flow, and the resultant connection to groundwaters, reflect totally, or nearly totally, undisturbed conditions.	●	●

Datasets used in maps: OSVM, WBL, WBC, CDE-STAT, HFE.
For full references see page 63.

Opportunities for Enhancement

An important element of the Connecting the Culm project, led by JBA Consulting, is the development of a flood model for the catchment. Alongside the flood model, JBA worked with partners to develop opportunities for nature-based solutions (NBS) which may help to reduce the impact of flood events. These 'Potential Areas for Improved Resilience' can then be used in the model to reveal the possible impact on flood risk of multiple nature-based solutions across multiple sites.

Flood Model

The flood model works at a broad-scale and aims to help stakeholders understand how the catchment responds to different flood events, especially the possible future flood events which may be experienced with a changing climate. It has also been used to model the possible impact of changes in land use from the implementation of nature-based solutions.

The model focuses on surface runoff, and can be used for:

- Understanding how the whole catchment broadly responds to different events and to changes that represent resilience measures
- Understanding flow pathways and accumulations to help with siting of NBS
- Understanding where there may be expandable field storage to accommodate the bigger flows resulting from climate change
- Prioritising where there are risk hot-spots where more detailed investigations can be made
- Estimating volumes of water stored on the floodplain
- Understanding a range of 'what-if' scenarios and the impacts on flooding in the long-term

The model was calibrated, to assess and improve its accuracy, on the November 2012 flood event in the Culm catchment, where good data are available on the flood event and the areas which were flooded.

Potential Areas for Improved Resilience

Potential Areas for Improved Resilience (PAIRs) were developed with partners in the Culm catchment. The areas were developed by first looking at a set of opportunities, developed by the Environment Agency at a national scale, for flood prevention measures which are based on enhancing and replicating natural processes. This dataset is called 'Working With Natural Processes' (WWNP) (although the concept is also known as 'Natural Flood Management'). The WWNP opportunity areas were refined through workshops, field visits and a series of catchment walkover surveys.

Three sets of PAIRs were developed, which formed into three scenarios, which are described and mapped on the following pages.

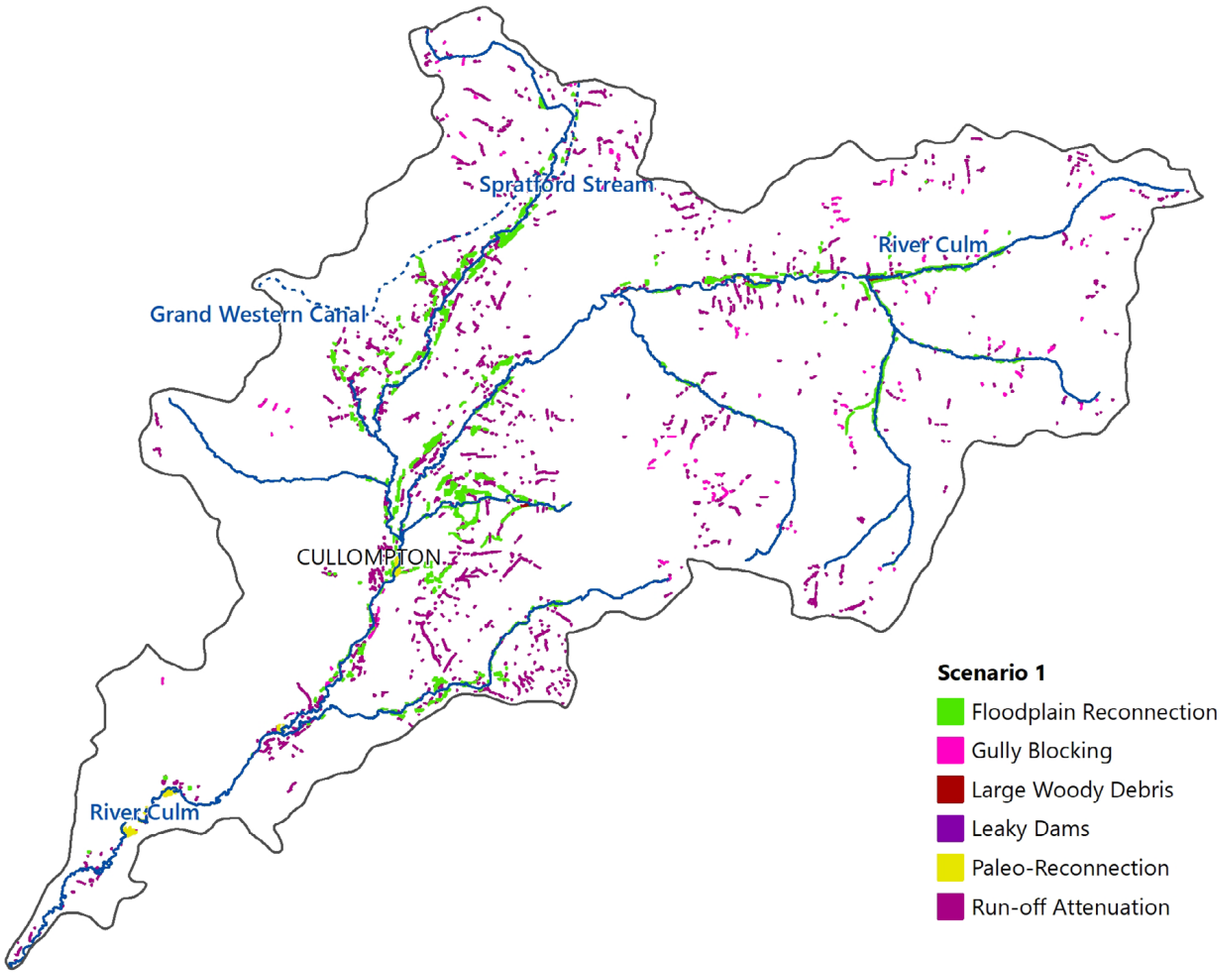
Opportunities for Enhancement

Scenario 1: Runoff interception, floodplain reconnection & increasing temporary flood water storage

The areas identified in this scenario were developed from WWNP features which have the potential to temporarily store water during flooding or re-connect the floodplain, and areas connected to the river which could provide additional storage of water on fields. The dataset identifies opportunities for:

- Runoff attenuation features – designed to intercept and store flood water temporarily. RAFs on steep slopes are called gully blocking.
- Floodplain reconnection – allowing temporary storage on floodplains currently not connected to the watercourse
- Paleo-channel reconnection
- Large woody debris and leaky dams – for water storage
- Reconnection of historic drainage leats

High quality agricultural land and thin slivers of floodplain were excluded from the opportunity mapping.



Datasets used in maps: OSVM, WBL, WBC, PAIRS.
For full references see page 63.

Opportunities for Enhancement

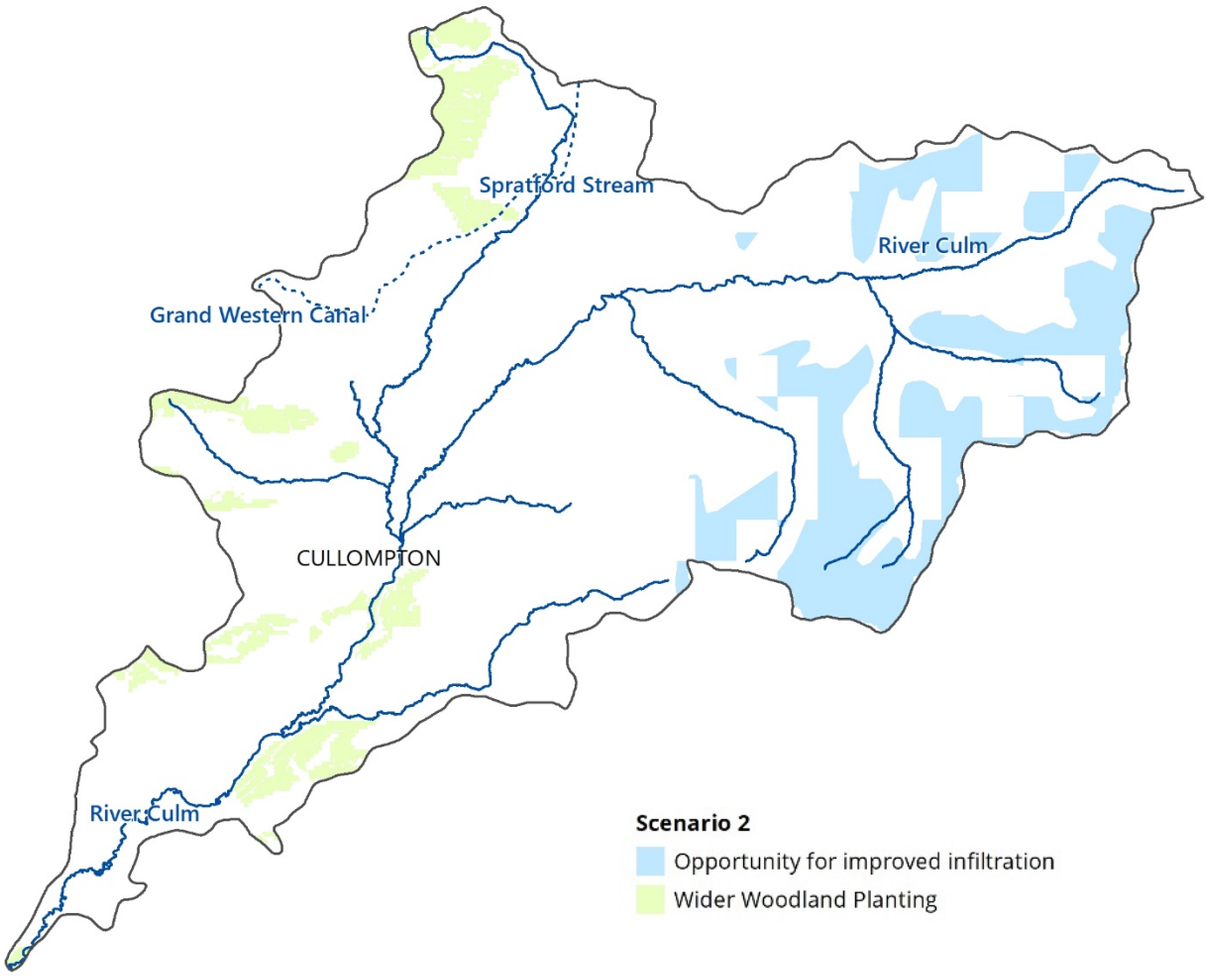
Scenario 2: Improvements to soil management to reduce compaction and increase infiltration

In this scenario, potential areas for infiltration improvements were identified where soils may be compacted or have low permeability. Identification of problematic muddy flooding or excessive runoff could help to prioritise these areas further. Nonetheless, the areas identified include:

- The presence of till-diamicton in the superficial geology – 'the clay caps' in the Culm catchment.
- Slowly permeable soils layer from the WWNP maps (wider woodland plating opportunities)

Areas of peat have been removed (due to the coarseness of the datasets this gives some areas a blocky shape).

It should also be noted that modelling soil improvements and their impact on flood hydrograph is an ongoing challenge in hydrology. Modelling the effect of soil or infiltration improvement for this scenario was approximate but it is hoped it can be improved when new versions of the modelling software are released.



Datasets used in maps: OSVM, WBL, WBC, PAIRS.
For full references see page 63.

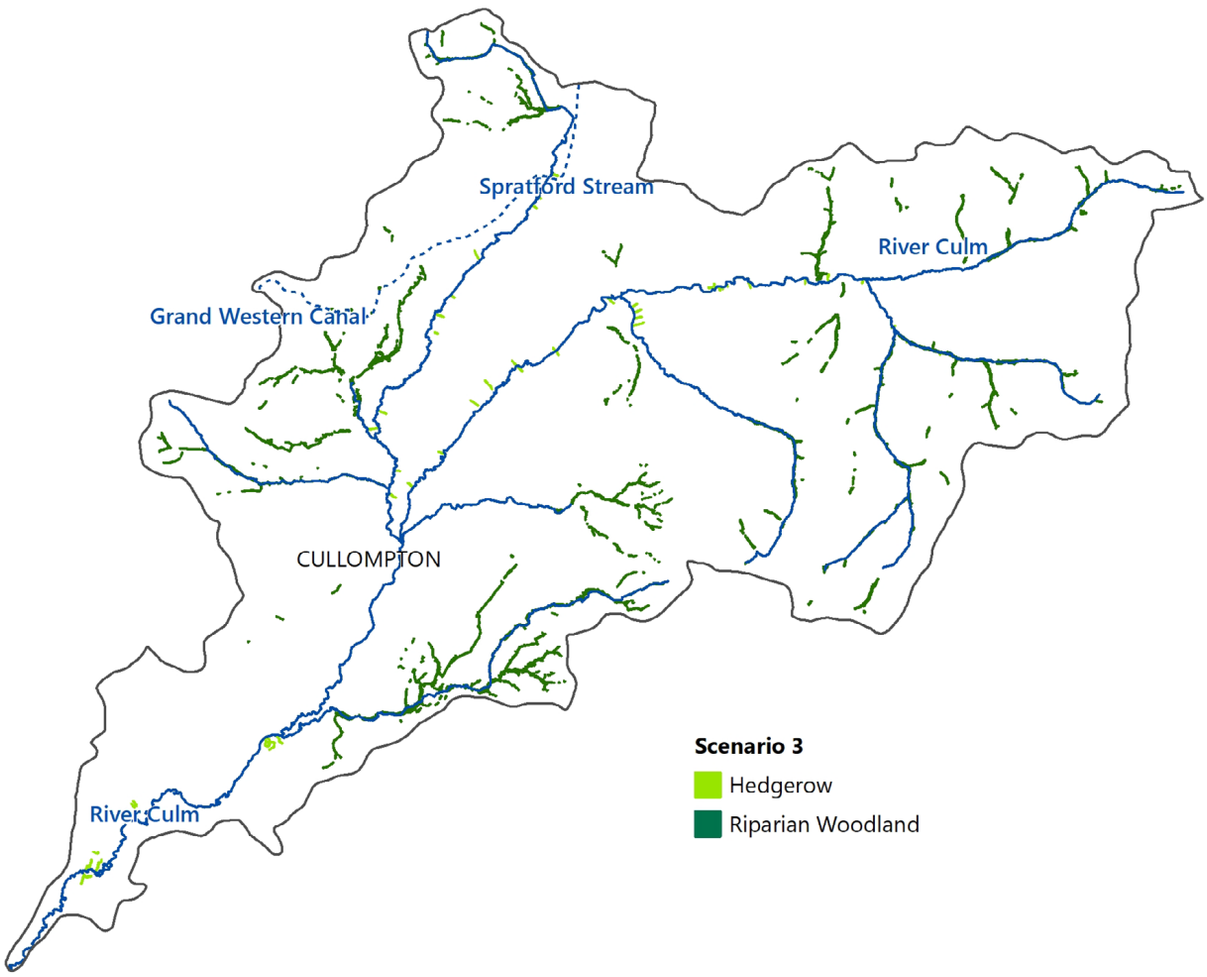
Opportunities for Enhancement

Scenario 3: Riparian tree planting and hedgerows

The areas identified in this scenario are based on the WWNP areas for riparian tree planting, which were created by considering areas which are within 50m of a watercourse but are not currently wooded. These areas were the refined to areas within the 1 in 100 year surface water flood risk zone.

Areas of planting downstream of urban areas or known pinch-points for surface water were excluded as trees could cause a backing up of water.

The initial results of this method revealed 343ha of potential planting areas. Based on extensive work by the flood modelling team in neighbouring catchments, this was considered to be unrealistic. As a further refinement, therefore, upland planting was prioritised in smaller sub-catchments. This reduced the total area of planting to 125ha, which was considered more realistic.

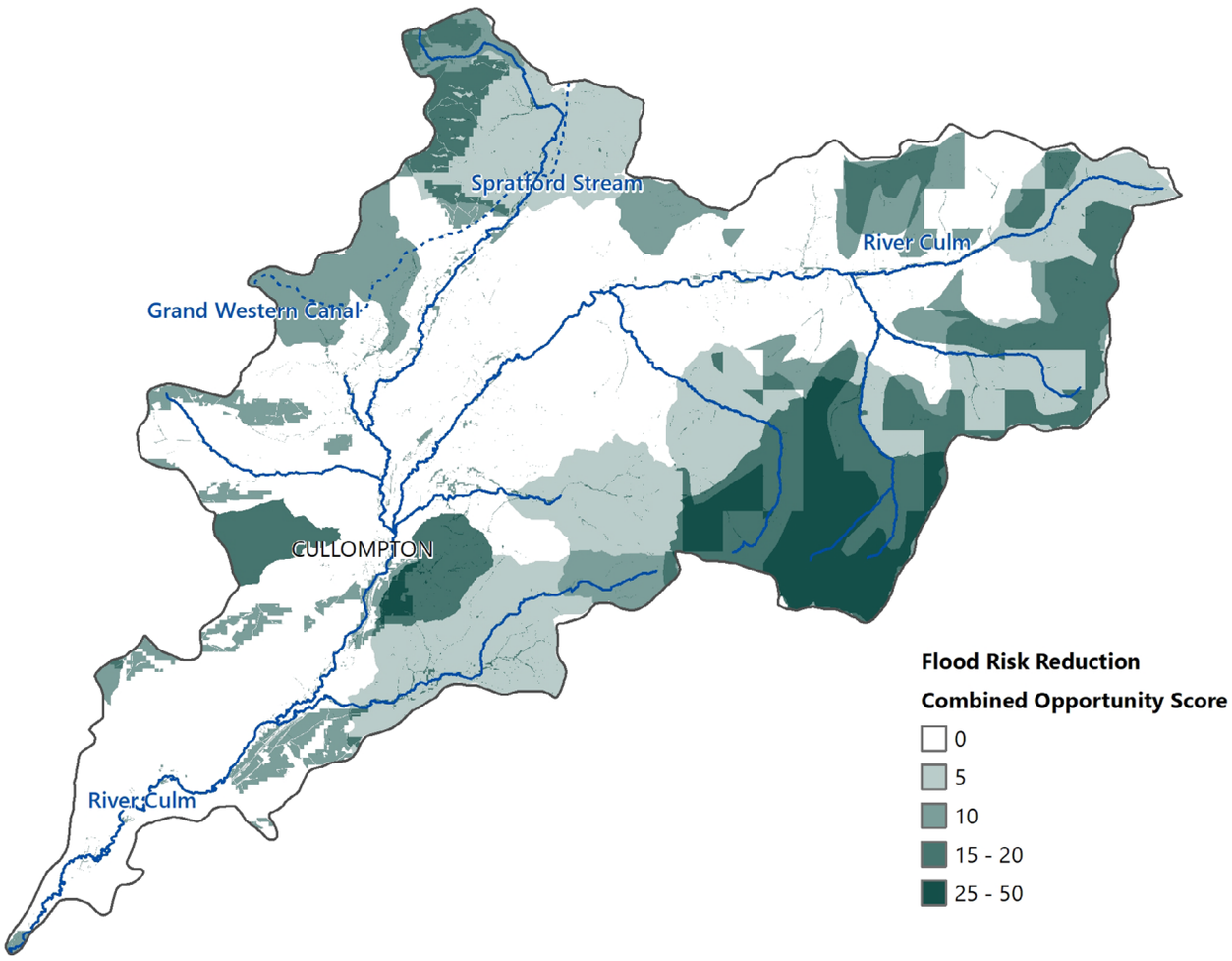


Datasets used in maps: OSVM, WBL, WBC, PAIRS.
For full references see page 63.

Opportunities for Enhancement

The flood model maps areas where Nature-Based Solutions (NBS) may be possible in the Culm catchment. To refine and prioritise these areas for further investigation and implementation, it is important to also consider where these solutions may be most effective and have the most impact, both for reducing flood risk and reducing its impact on people who are most vulnerable to the effects of flooding.

The map below combines the flood model PAIRS with an assessment of where there are small hydrological catchments, where nature based solutions are likely to have more of an effect on flood peaks, and a consideration of social flood vulnerability.

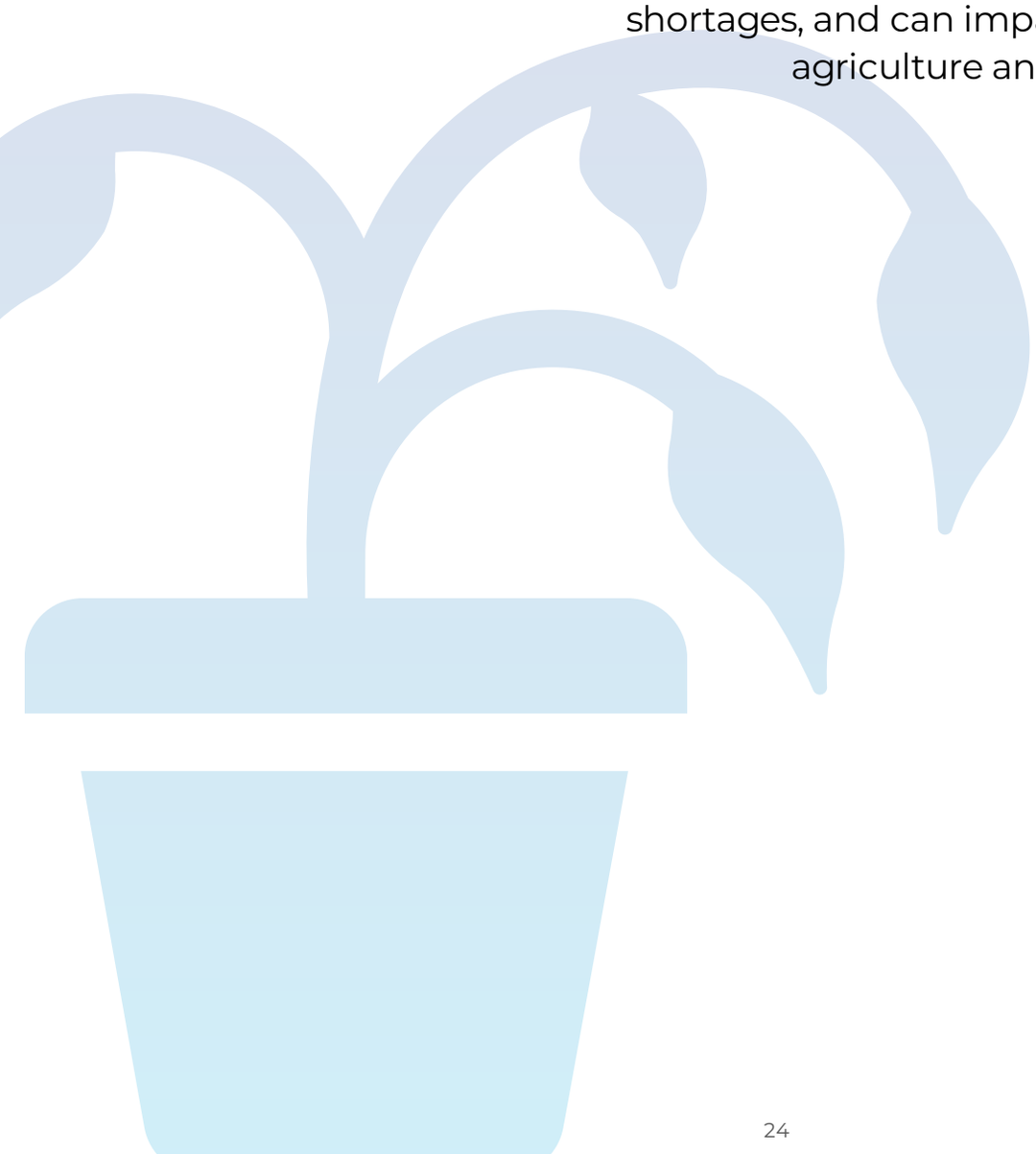


Relevant factors & scoring	Description
 **PAIRS** Opportunity for NBS = 10 Outside = 0	As shown in the previous page, areas of opportunity for nature-based solutions (NBS) based on flood modelling.
 **Small Catchments** Catchment < 5km² = 10 Catchment 5-20km² = 5 Outside = 0	NBS for flood management typically only achieve measurable attenuation of peak flows in small catchments. In larger and more complex catchments it is not possible to store enough water to have a noticeable effect on the flood peak. Using information about the shape of the land, and properties located in flood risk zones, it is possible to model where there are properties at risk of flooding which have a small catchment above them and which therefore could benefit from NBS.
 **Social Flood Risk** Areas connected to neighbourhoods of above average SFRI = 10 Other = 0	As shown at the start of this chapter, there are communities which are both at flood risk, and have a higher than average vulnerability to the social impacts of flooding. Areas which are both part of the small upstream catchments identified above, and which are within or upstream of a vulnerable community, have been highlighted.

Datasets used in maps: OSVM, WBL, WBC, PAIRS, SMC, SFRI.
For full references see page 63.

Improving Resilience to Drought

Droughts are prolonged periods of water shortages, and can impact ecosystems, agriculture and the economy.

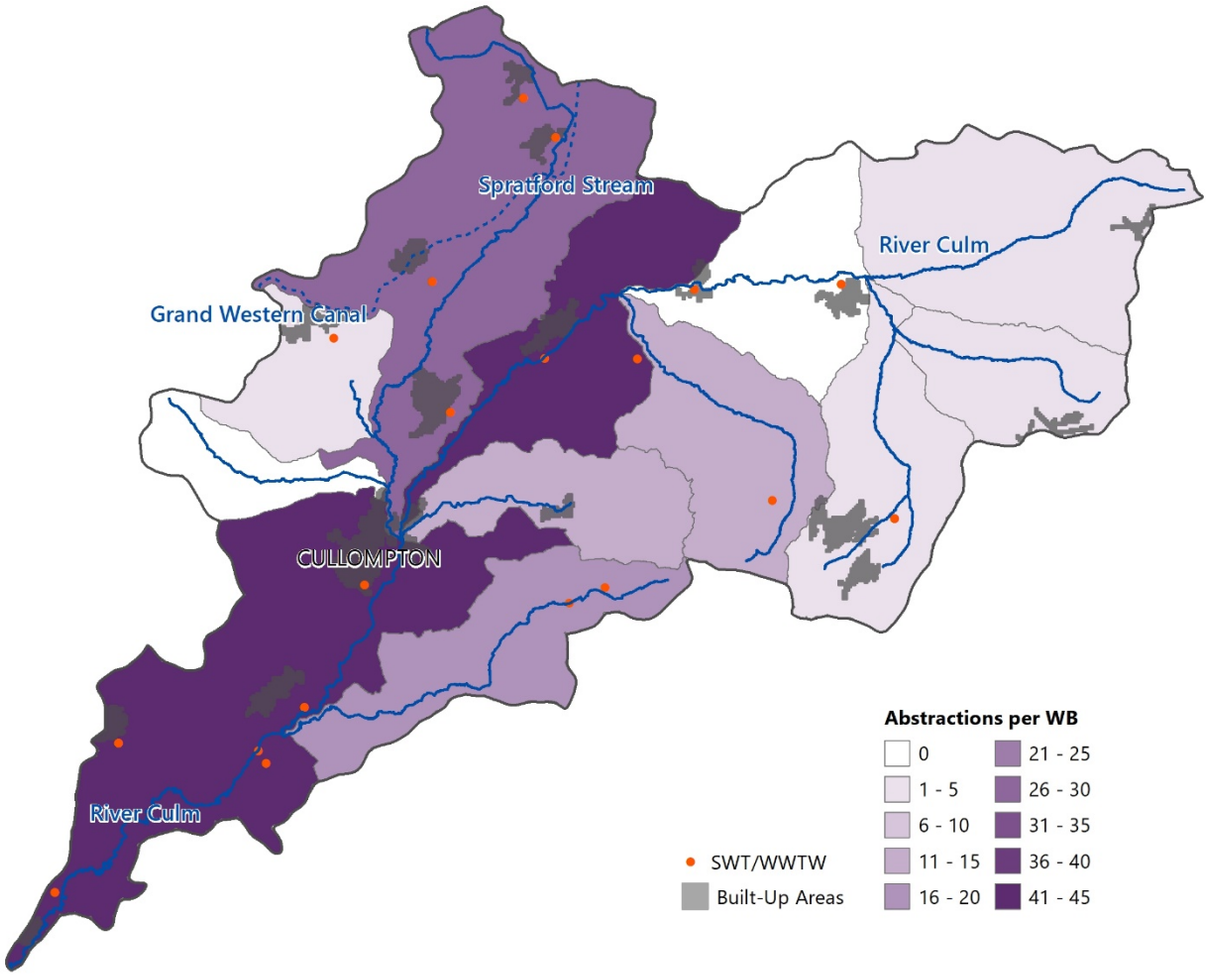


Priority Areas & Drivers for Improving Resilience to Drought

There are a number of locations in a catchment landscape where a reduced ability for an ecosystem to maintain base flows in rivers during periods of low rainfall will have a negative impact.

The levels of water in a river has a direct bearing on the effluent volumes and concentrations that can be discharged from point sources of pollution. High enough flows are required to ensure that effluent is diluted appropriately downstream.

In addition, where abstraction intake licences exist for drinking water supply there is a clear need for baseflows to be maintained. Rivers also require sufficient flow during dry periods to remain in good ecological condition.



Sites important for improving resilience to drought			
Dataset	Description	Age	Res.
Drinking Water Protected Areas	WFD waterbody catchments where drinking water for public supply occurs are designated as Drinking Water Protected Areas *Note: there are no drinking water abstraction points in the Culm catchment*	●	●
Abstraction Licences	Locations licenced to abstract water, summarised to waterbody scale.	●	●
Waste Water Treatment Works	Location of the consented discharge points associated with water waster/sewage treatment works. Consented discharges are discharges to rivers which the Environment Agency regulates. Typically, these will cause more of a problem for water quality at low flows due to reduced dilution.	-	●
Reasons for Not Achieving Good (attributed to flow)	The EA Reasons for Not Achieving Good database identifies the cause of less than Good classifications under WFD and can be used to identify where low flow is causing ecological degradation. *Note: there are no RNAGs attributed to flow on in the Culm catchment*	●	●

Datasets used in maps: OSVM, WBL, WBC, ABS, CON, ONS.
For full references see page 63.

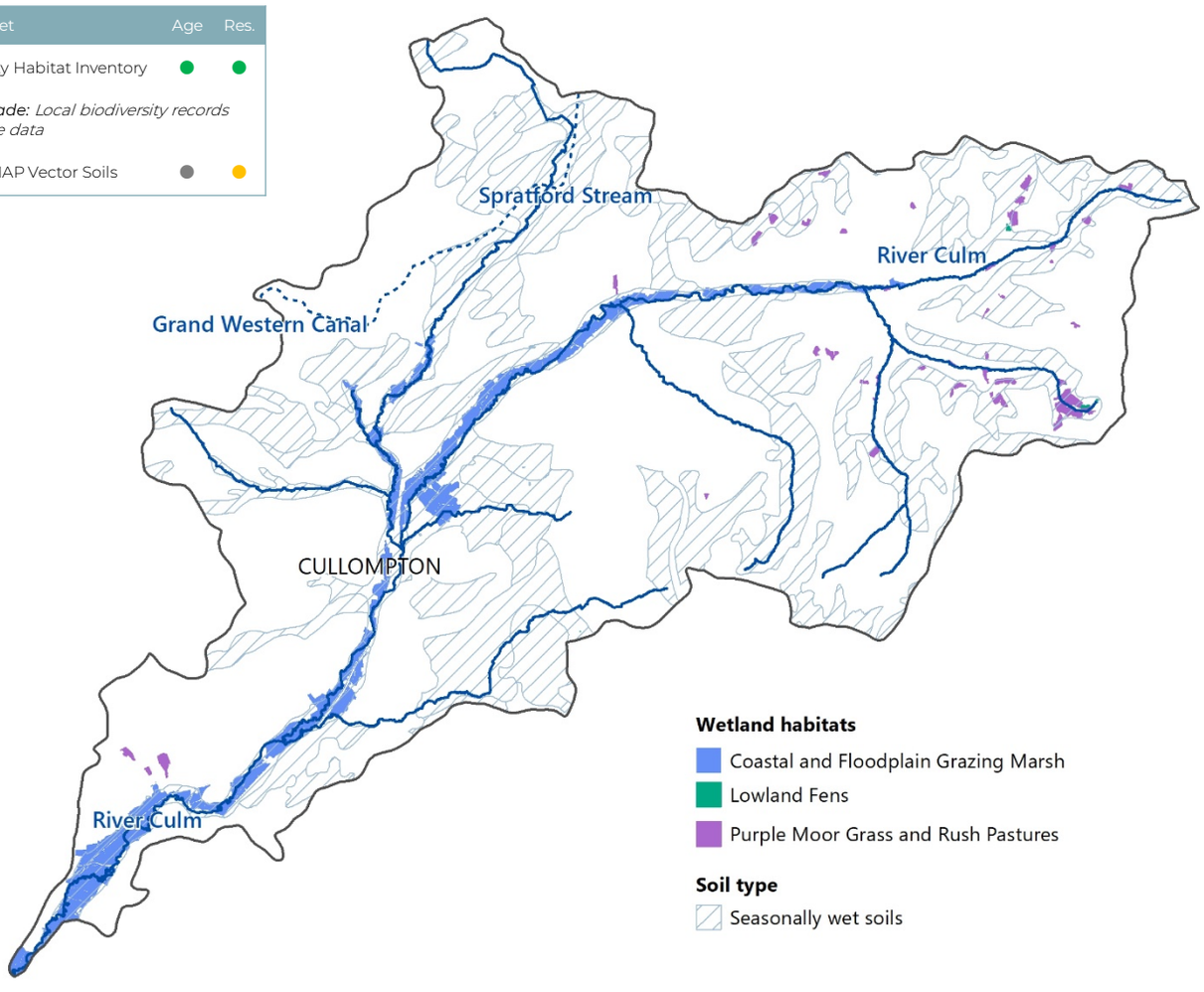
Natural Assets that Regulate the Service

The principal land-based interventions that can delay the release of water from a catchment are: good management practices that maintain healthy soil structure, the cessation of land drainage in areas with a propensity to accumulate water (i.e. that are naturally wet), and the creation or restoration of upland and floodplain wetland habitats.

Wetland Habitats

Wetland habitats, whether on upland peat-based soils or on the floodplain, have been shown by many studies to play a key role in the regulation of water in river catchments. One of their key roles is to store water and then release it slowly to rivers. This helps maintain base flows and river levels during periods of low rainfall.

Dataset	Age	Res.
Priority Habitat Inventory	●	●
Upgrade: Local biodiversity records centre data		
NATMAP Vector Soils	●	●



Soil Hydrology

Soil hydrology is a key factor when examining the ability of an area to hold water for longer and release it slowly to maintain base flows.

Soils with a natural propensity to be water-logged are likely to play a greater role in regulating the flow of water through a landscape via surface waters, while free-draining soils (especially sandy soils) play a key role in transferring water into groundwater stores.

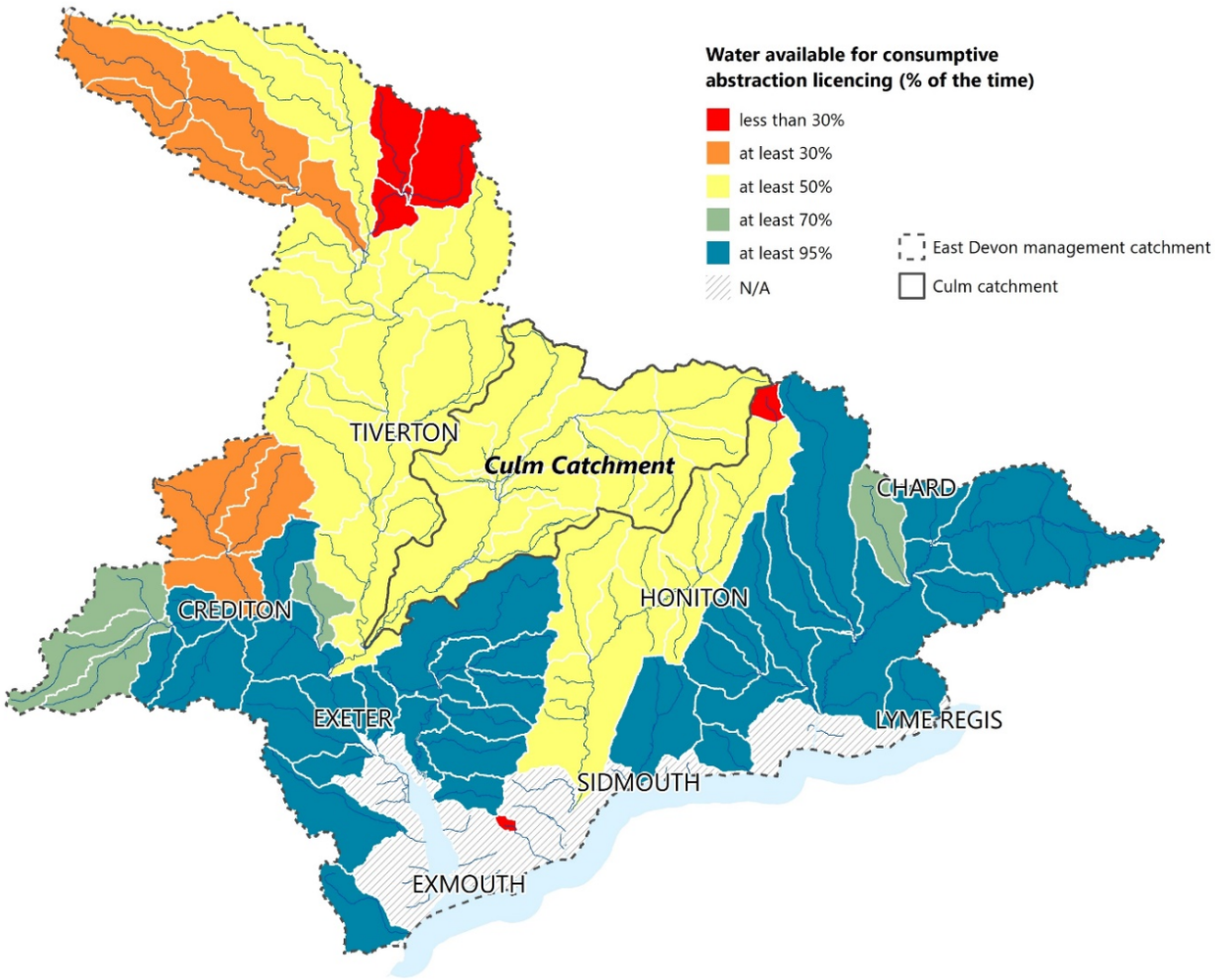
Datasets used in maps: OSVM, WBL, WBC, PHI, NAT.
For full references see page 63.

Assessing the Provision of the Service

Water resources assessment

When considering the provision of an ecosystem service, such as the regulation of water flow, it is important to consider the time at which the greatest demands are placed on the service and to look into the future to assess whether greater demands will be placed on the service in the future.

The Environment Agency is responsible for managing water resources in England and they use the catchment abstraction management strategy (CAMS) process and abstraction licensing strategies to do this.



Sites important for water resources			
Dataset	Description	Age	Res.
Catchment Abstraction Management Plans	The Water Resource Availability and Abstraction Reliability Cycle 2 dataset indicates whether, and for what percentage of time, additional water may be available for consumptive abstraction.	●	●
Reasons for Not Achieving Good (attributed to flow)	The EA Reasons for Not Achieving Good database identifies the cause of less than Good classifications under WFD and can be used to identify where low flow is causing ecological degradation. *Note: there are no RNAGs attributed to flow on in the Culm catchment*	●	●
Upgrade: Walkover surveys and biological sampling methods can be used to collect local data to identify where lack of flow may be impacting the ecological health of a watercourse. However, this data may be challenging to obtain and analyse.			

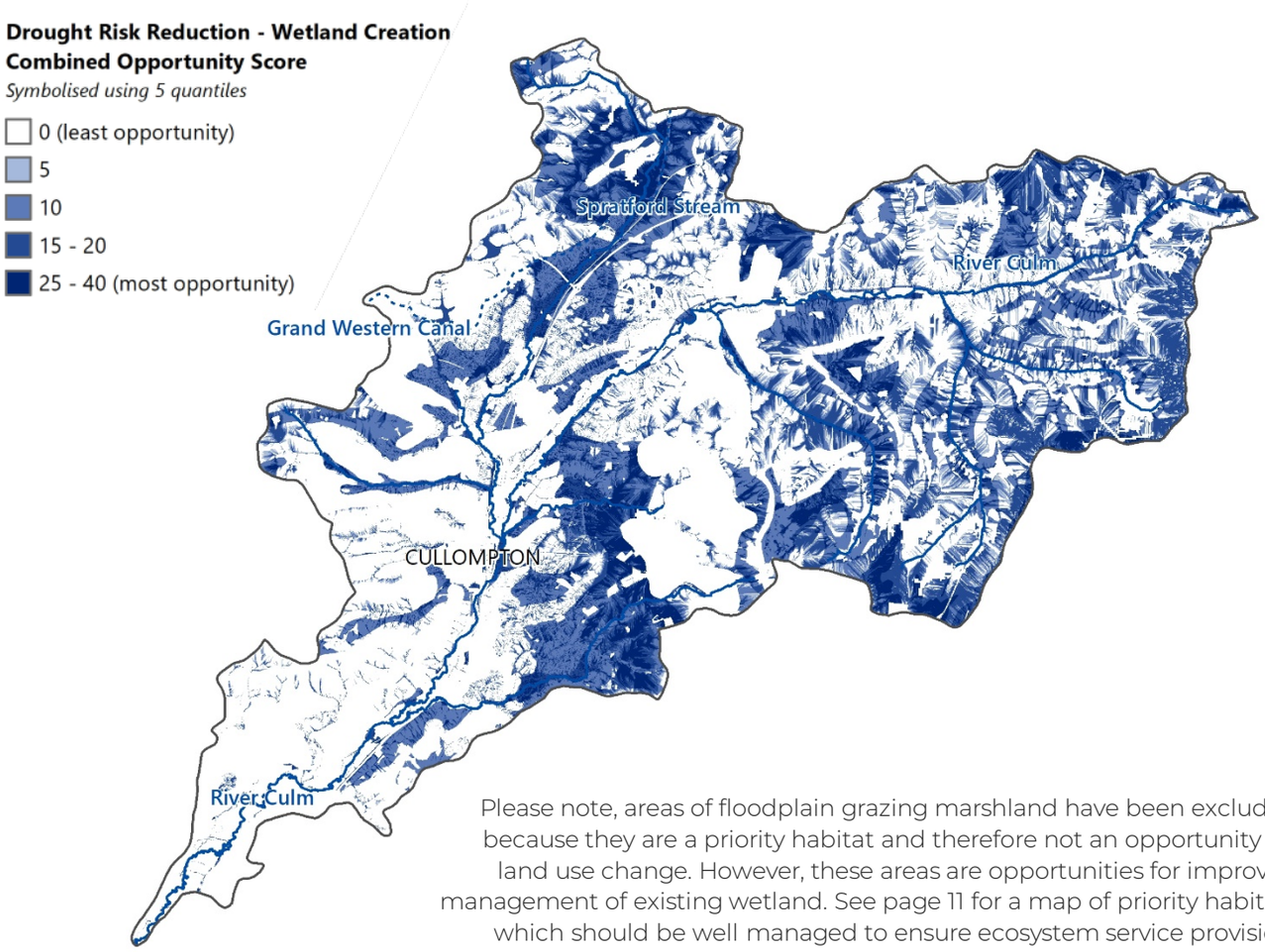
Datasets used in maps: OSVM, WBL, WBC, CAMS.
For full references see page 63.

Opportunities for Enhancement

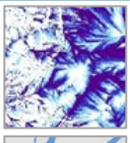
At a landscape scale, resilience to drought can be improved by encouraging water to be held in the landscape for longer and then released more slowly after it rains.

There are two important ways to do this: 1) restore soil health and maintain good soil condition, and 2) restore and/or create wetland habitats. The former of these is important across rural catchments. This section focuses on the second, through a wetland creation suitability mapping exercise.

The highest scoring opportunity areas for wetland restoration or creation are identified by combining information about land condition and the natural infrastructure that regulates water movement and storage, while excluding areas which are highly unlikely to be opportunities due to existing use.



Please note, areas of floodplain grazing marshland have been excluded because they are a priority habitat and therefore not an opportunity for land use change. However, these areas are opportunities for improved management of existing wetland. See page 11 for a map of priority habitats which should be well managed to ensure ecosystem service provision.

Relevant factors & scoring	Description
 **Hydrological connectivity** [3] Land scored 0, 5, 10, 15 or 20 based on connectivity	As shown on page 32, in some locations water has a greater propensity to run over the surface and collect due to the shape of the land and the size of the upstream catchment area. These areas are important for the regulation of water flow as this is where water can be slowed as it moves through the landscape.
 **Floodplain – 1 in 100 year flood extent** Within floodplain = 10 Outside = 0	Wetland restoration or creation is most successfully achieved on land with a high natural propensity to be seasonally or permanently wet or water-logged. In many strategic mapping approaches this land is primarily identified as being on the floodplain.
 **Soil hydrology** Seasonally wet soils = 10 Other = 0	Soil hydrology is a key factor when examining an areas ability to hold water for longer and release it slowly to maintain base flows. Soils with a natural propensity to be water-logged are likely to play a greater role in regulating the flow of water through a landscape.
 **Exclusion areas** Areas with exclusion criteria are reset to 0	Factors that make it less likely that wetland creation could be undertaken are excluded. These include urban areas, main road and railway infrastructure, productive agricultural land, protected sites and priority habitats.

Datasets used in maps: OSVM, WBL, WBC, DTM2, FZ2, NAT ALC, SCH, SSSI, AW, PHI. For full references see page 63.

Water Quality

Clean water is vital to drinking water supply, healthy habitats, cultural services and health benefits.

Priority Areas & Drivers for Water Quality

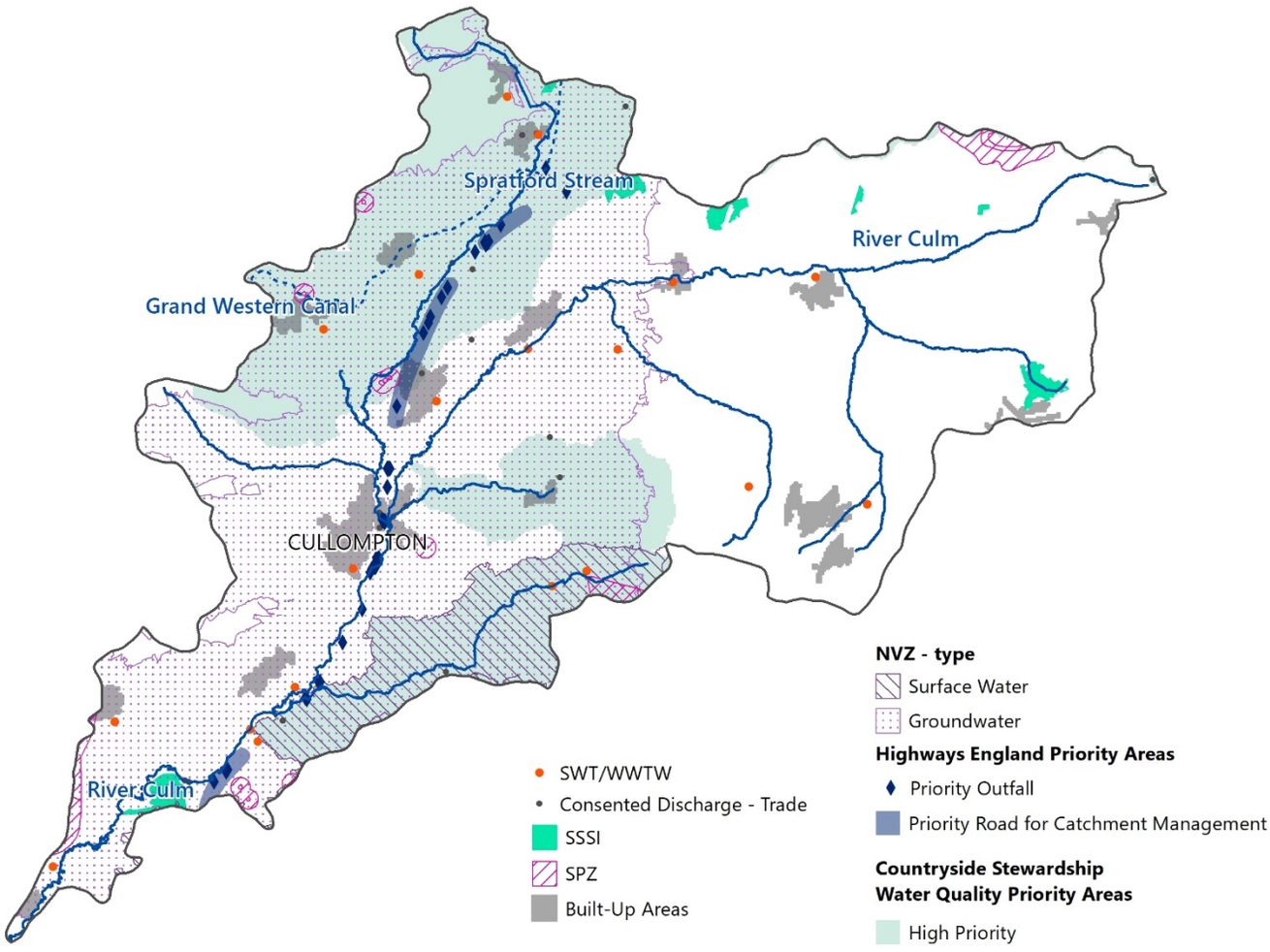
There are three key areas in a catchment where degradation of the water quality in our rivers and streams can result in the loss of the provision of good water quality as an ecosystem service:

1) within the aquatic ecosystems themselves,

2) at downstream locations in the river system, and

3) where water is abstracted from rivers and reservoirs for provision as drinking water.

The distribution of these features across the catchment are shown in the map and listed in the tables below. These features are critical in targeting the programme of work to improve water quality.



Sites important for water quality			
Dataset	Description	Age	Res
Nitrate Vulnerable Zones (NVZ)	Areas designated as at risk from agricultural nitrate pollution, in accordance with Nitrate Pollution Prevention Regulations 2015.	●	●
Source Protection Zones (SPZ)	Areas designated around large, public potable groundwater abstraction sites to safeguard water quality by constraining the proximity of activities that may impact drinking water abstraction.	●	●
Sites of Special Scientific Interest (SSSI)	Sites designated at a national scale for important habitats, wildlife and/or geology.	●	●
Highways England Priority Areas	Areas of road network that could benefit from upstream catchment management of runoff.	-	●
Countryside Stewardship Priority Areas	Priority areas for countryside stewardship activities based on water quality objectives.	●	●

People & infrastructure	
Human population	Residents and visitors using the environment can be susceptible to effects of poor water quality.
Waste Water Treatment Works	Location of the consented discharge points associated with water waster/sewage treatment works. Consented discharges are discharges to rivers which the Environment Agency regulates. Typically, these will cause more of a problem for water quality at low flows due to reduced dilution.
Industrial discharges	Location of the consented discharge points associated with trade/industry.

Datasets used in maps: OSVM, WBL, WBC, CON, SSSI, SPZ, NVZ, HEP, CSP, ONS. For full references see page 63.

Natural Assets & Infrastructure that Regulate the Service

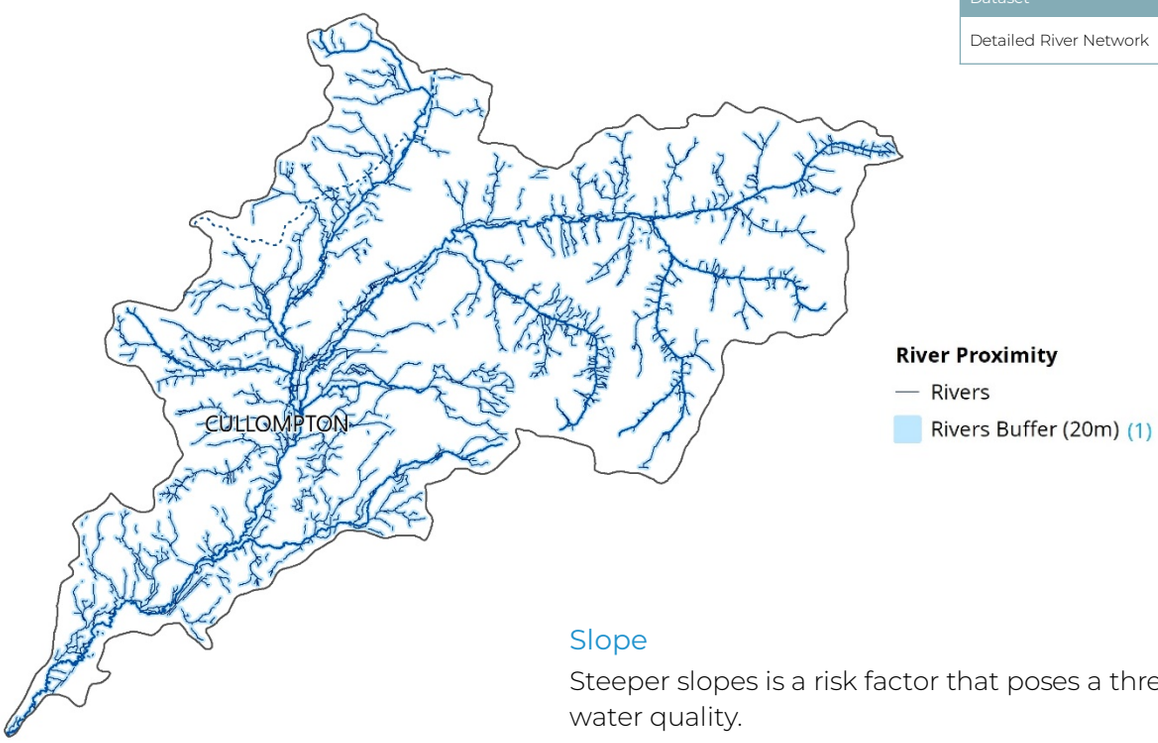
The land areas that play a key role in the regulation of water quality as it moves through the landscape can be identified by mapping a series of key indicators of inherent water quality risk.

By documenting where these features occur and where they coincide we can identify areas of land that play a greater role in the regulation of water quality and where there is a correspondingly greater risk of water quality being degraded in the catchment. This then allows us to target these areas for protection or interventions that mitigate this threat

Proximity to watercourse

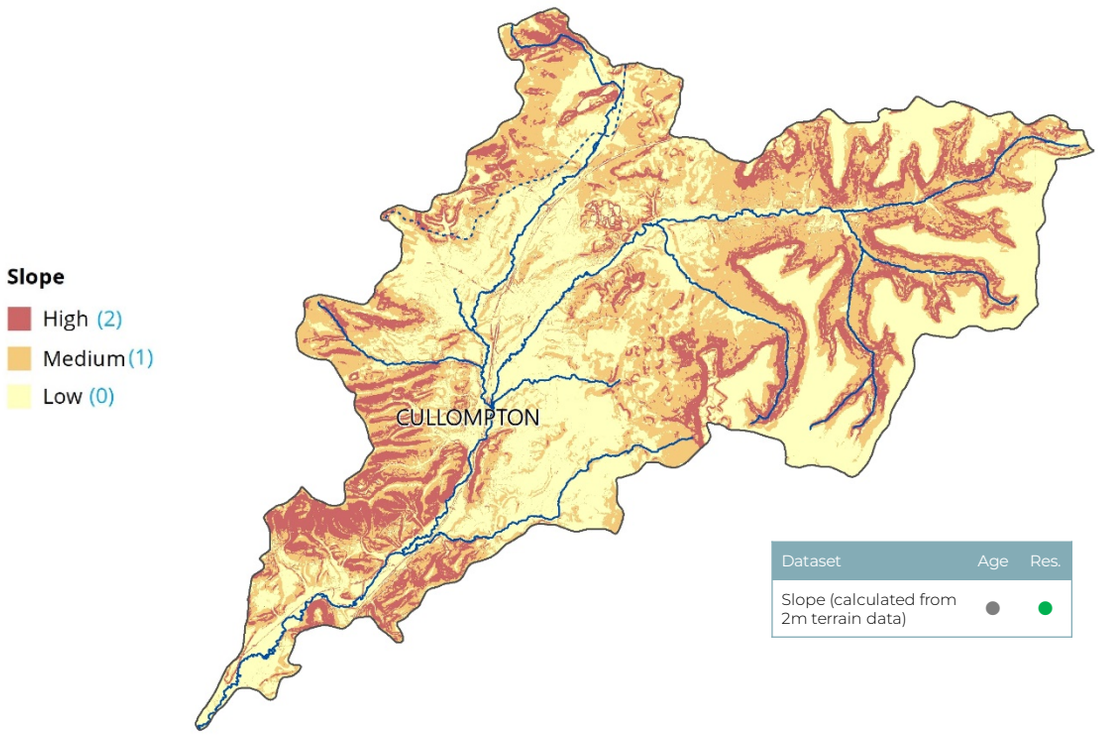
Areas in the 'riparian corridor' are considered to pose an elevated risk to water quality because they are likely to have direct connectivity to the watercourse.

Dataset	Age	Res.
Detailed River Network	●	●



Slope

Steeper slopes is a risk factor that poses a threat to water quality.



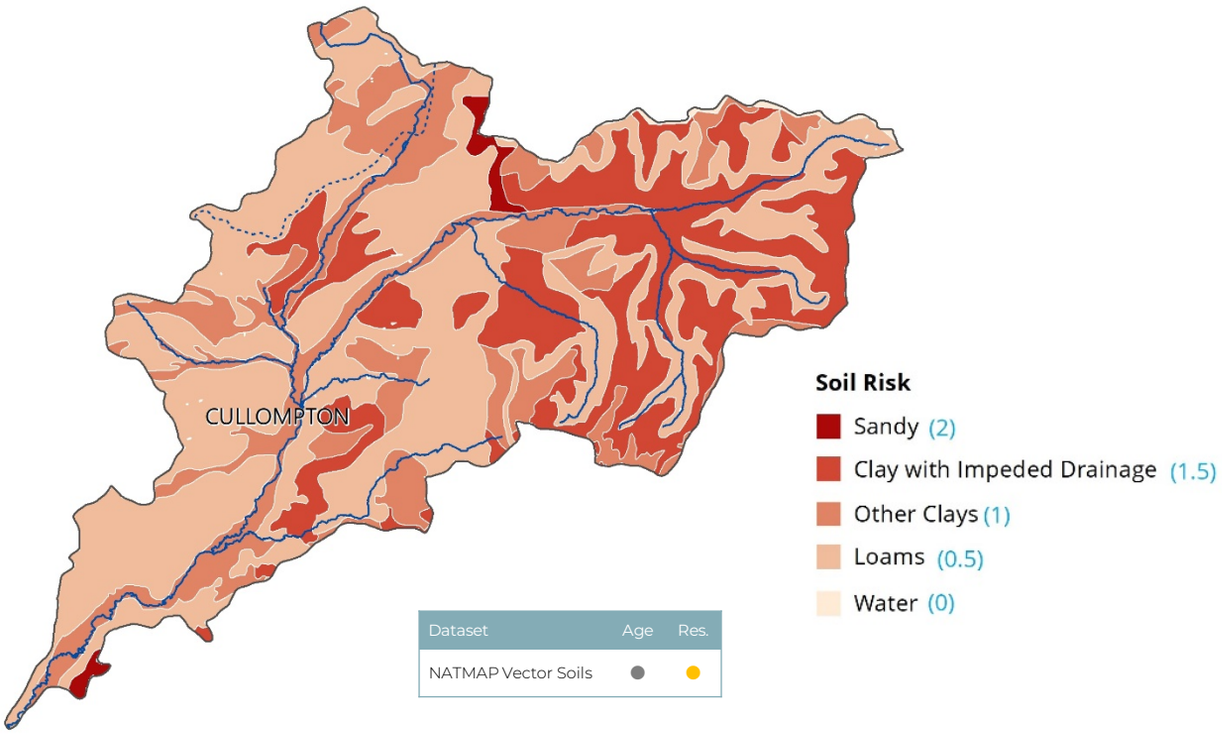
Dataset	Age	Res.
Slope (calculated from 2m terrain data)	●	●

Datasets used in maps: OSVM, WBL, WBC, DRN, DTM2.
For full references see page 63.

Natural Assets & Infrastructure that Regulate the Service

Soil type

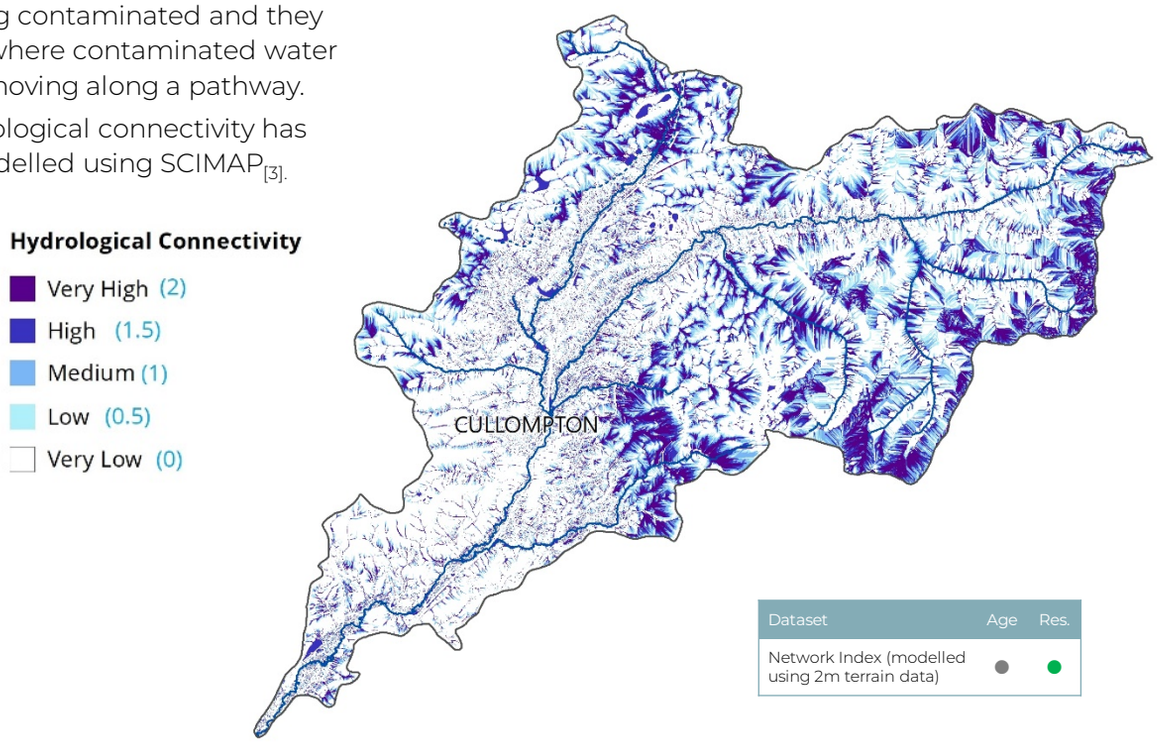
Some soils are particularly prone to run-off/erosion, while others represent a risk due to rapid leaching of pollutants in solution.



Hydrological connectivity

In some locations water has a greater propensity to run over the surface and collect due to the shape of the land and the size of the upstream catchment area. These areas are of critical importance to the regulation of water quality as moving water has the greatest chance of becoming contaminated and they suggest where contaminated water may be moving along a pathway.

The hydrological connectivity has been modelled using SCIMAP[3].



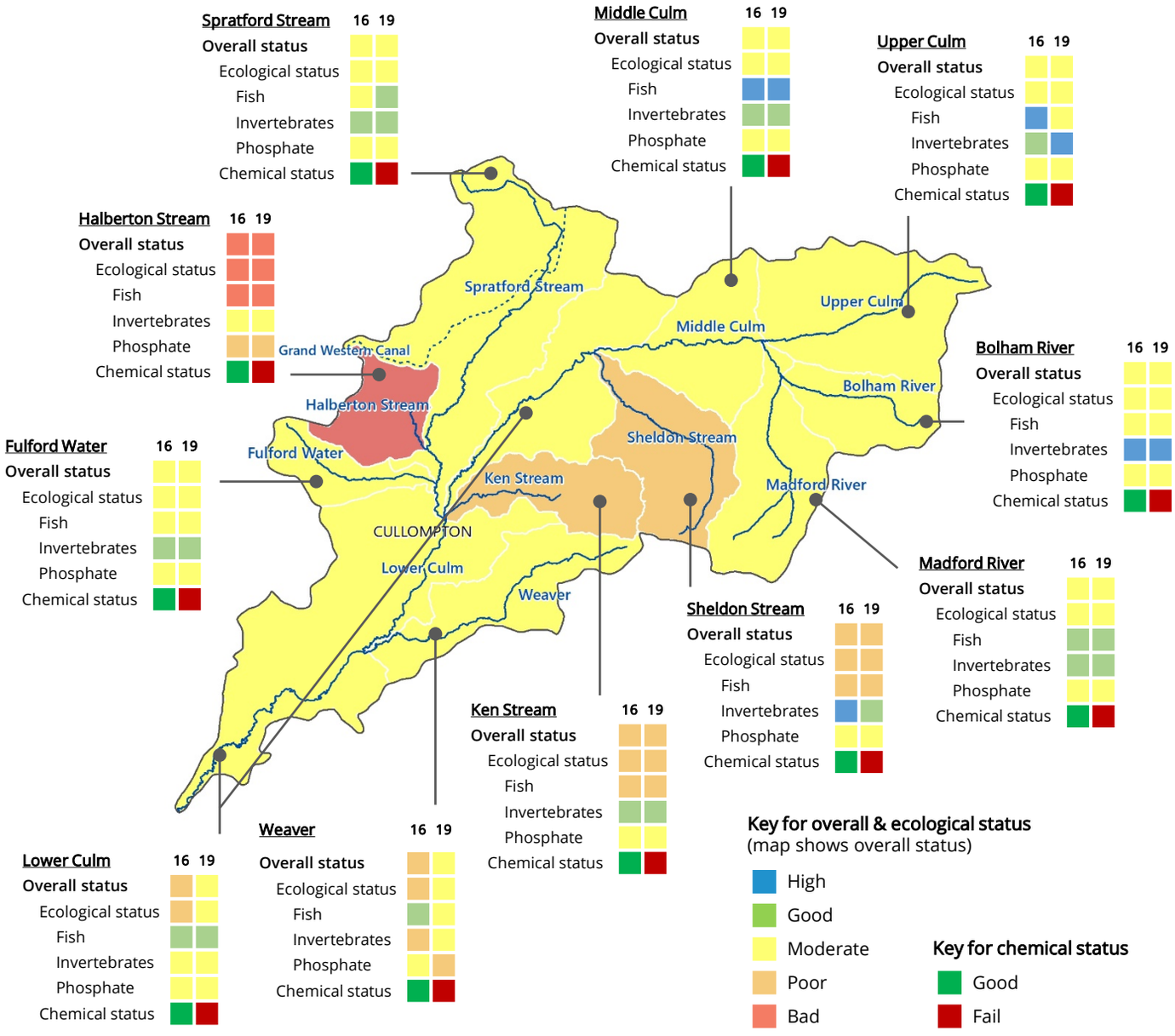
Datasets used in maps: OSVM, WBL, WBC, NAT, DTM2.
For full references see page 63.

Assessing the Provision of the Service

Water Framework Directive 2016

The main set of evidence used to assess the water quality in a catchment is the Water Framework Directive (WFD) classification of waterbodies. A series of parameters are used to assess the status of a waterbody. A status of moderate or worse is regarded as a failure.

Classifications for 2019 have recently been released, updating the previous data from 2016. In this round of assessment, more chemical pollutants have been assessed, which has meant that all the waterbodies in the Culm (and across England) now fail to reach good chemical status.



Dataset	Assessment level	Description	Age	Res.
Water Framework Directive waterbody assessment	Overall status	WFD is a hierarchical system, with overall status being comprised of an ecological and chemical component, which each then are assessed via various elements.	●	●
	Ecological status	Demonstrates degrees of disturbance through various indicators of ecological health.		
	- Fish status	Fish populations, especially salmonid species, are good biotic indicators of river health.		
	- Invertebrate status	The type and abundance of invertebrates collected during sampling gives an indication of environmental stress.		
	- Phosphate status	Excess nutrient can degrade the ecological health and balance of a waterbody. The phosphate status gives an indication of whether nutrients are at the right level for that waterbody.		
	Chemical status	An assessment of the levels of certain priority and hazardous substances in the water.		

Datasets used in maps: OSVM, WBL, WBC, CDE-STAT.
For full references see page 63.

Assessing the Provision of the Service

Reasons For Not Achieving Good Status

The Environment Agency's WFD 'Reasons for Not Achieving Good' database identifies the causes of a waterbody being determined to be at less than 'Good' status. The cause is recorded using a defined set of reasons and pressures. The table below shows some of the common pressures, and the waterbodies in the Culm catchment where they have been identified in recent years.

Note: Currently RNAG data is primarily only available for 2014 and 2015.

Water Body	Year	Item					Pressure (Tier 3)				
		Ammonia	Fish	Invertebrates	Macrophytes & Phytobenthos	Phosphate	Ammonia	Fine Sediment	Phosphate	Physical Modifications	Salinity
Bolham River	2014		▲		▲	▲		▲	▲	▲	
	2015		▲			▲		▲	▲		
Fulford Water	2014				▲				▲		
	2015										
Halberton Stream	2014		▲			▲		▲	▲	▲	
	2015	▲		▲			▲	▲			▲
Ken Stream	2014		▲		▲	▲		▲	▲		
	2015	▲					▲				
Lower Culm	2014		▲		▲	▲			▲	▲	
	2015			▲					▲		
Madford Water	2014				▲				▲		
	2015					▲			▲		
Middle Culm	2014				▲				▲		
	2015					▲			▲		
Sheldon Stream	2014		▲		▲	▲		▲	▲	▲	
	2015										
Spratford Stream	2014		▲			▲	▲	▲	▲	▲	
	2015										
Upper Culm	2014		▲		▲	▲		▲	▲	▲	
	2015										
Weaver	2014										
	2015			▲		▲			▲		

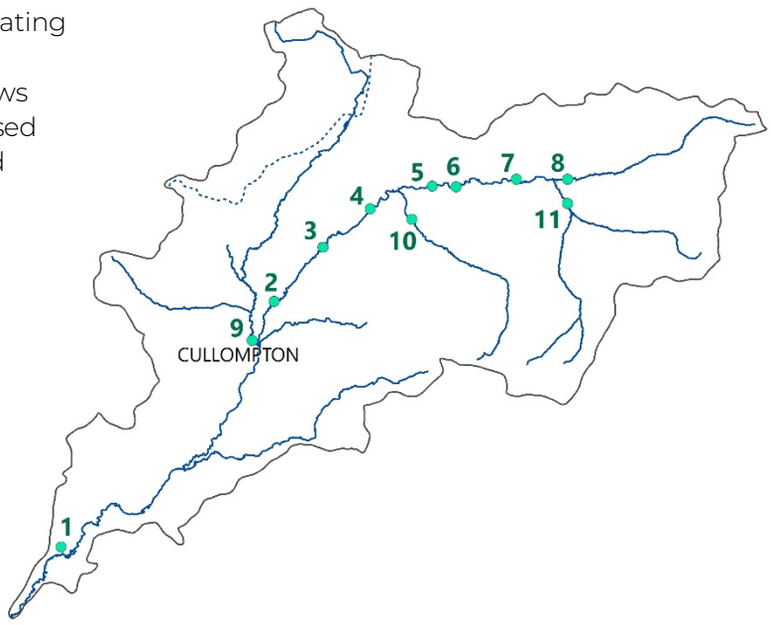
Assessing the Provision of the Service

Riverfly monitoring

The Riverfly Partnership is a network of groups and organisations working to understand the populations of riverflies in our rivers, and use this information to work to protect water quality and conserve riverfly habitats. A network of volunteers use a simple, standardised monitoring technique to survey riverfly populations. Through these surveys they are able to detect any severe perturbations in river water quality, and report to the regulating body (the Environment Agency in England).

In the wider Exe catchment, which the Culm falls within, surveys are undertaken at a network of 52 sites in the spring (11-26 May), summer (6-21 July) and autumn (7-22 September). 11 of these sites are within the Culm catchment, 8 on the main River Culm and 3 on its tributaries.

The results for the Culm catchment in 2019 are shown below, with a red number indicating scores at or below the trigger level for reporting to the EA. The table also shows whether the seasonal score has increased (blue) or decreased (orange) compared to the previous year.



Dataset	Age	Res.
Riverfly Surveys	●	●

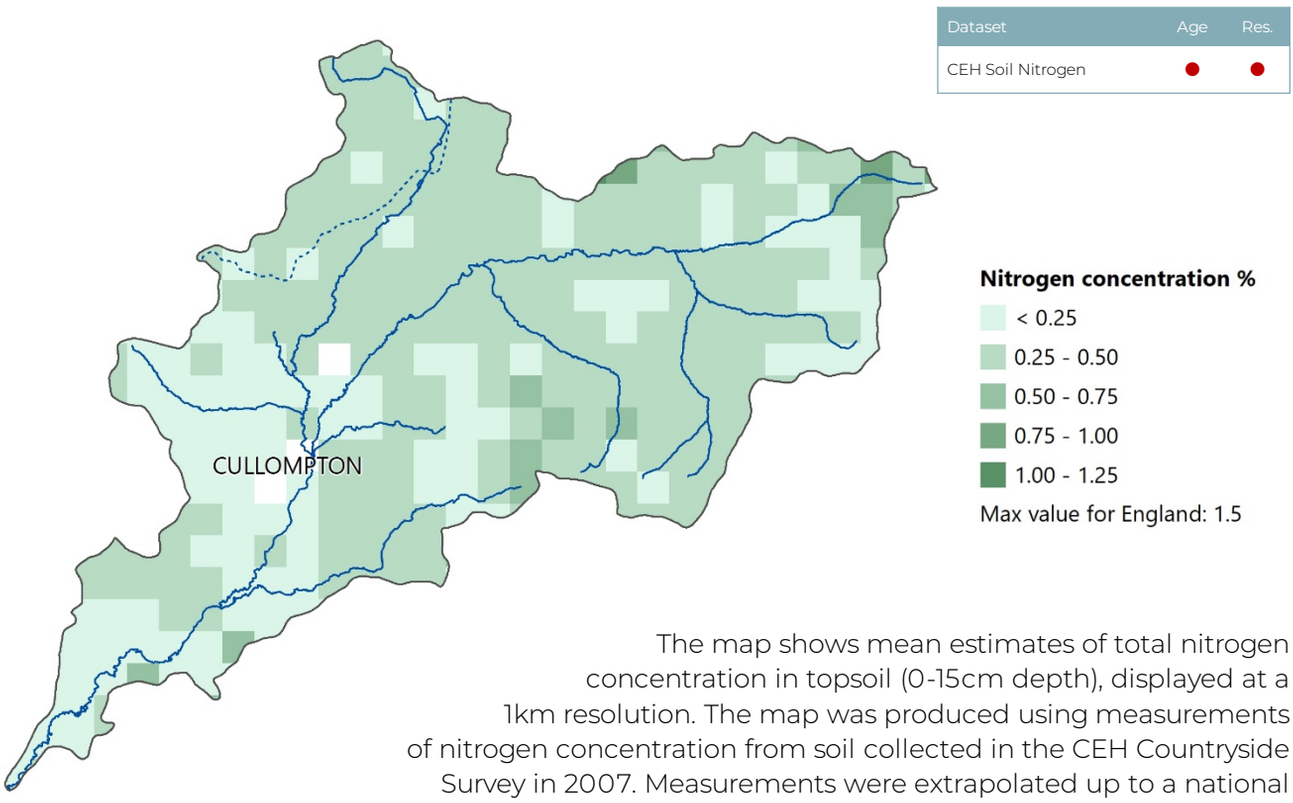
Map label	River	Location	2019 Score			2019 vs 2018		
			Spr	Sum	Aut	Spr	Sum	Aut
1	Culm	Rewe		7				
2	Culm	Hayne Barton	11	9	7		-1	-2
3	Culm	Ford Farm	12	10	8	-4	-4	-3
4	Culm	u/s Uffculme	14	12	9	+4	+4	+3
5	Culm	Woodhayne Barton	11	11	10	+2	+4	
6	Culm	Culmstock	10	10	8	-1	+1	+3
7	Culm	Whitehall	12	12	9		+5	-2
8	Culm	Flashford Br u/s Hemyock	20	17	14		+2	-3
9	Spratford Stream	Cullompton	10	6	6	+2	-1	-1
10	Sheldon Stream	Craddock	14	13	12	+3	+2	+1
11	Madford River	Holcombe	21	17	15	+2	-2	+1

Datasets used in maps: OSVM, WBL, WBC, RF.
For full references see page 63.

Assessing the Provision of the Service

Nutrient Status of Soil - Soil Nitrogen

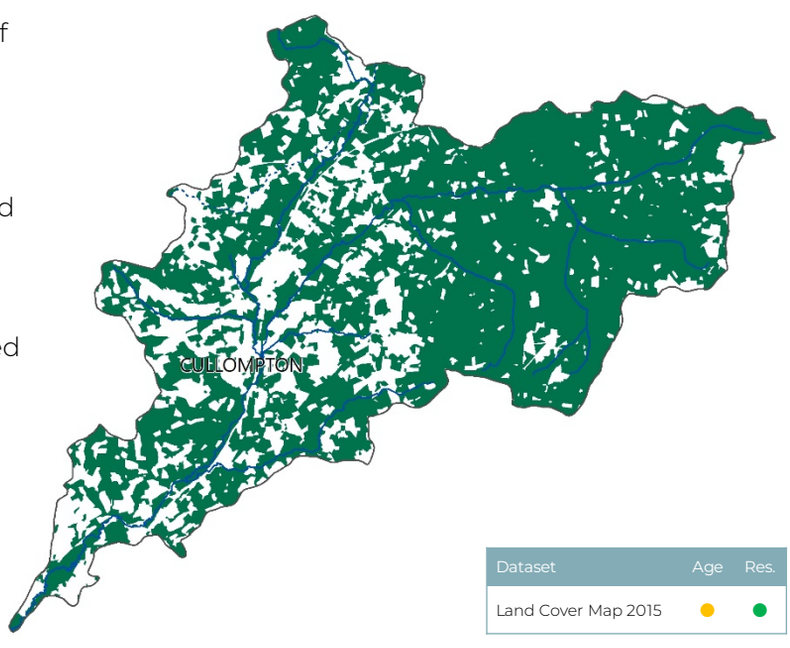
The nutrient status of soil can be indicated using the Centre for Ecology and Hydrology (CEH) soil nitrogen spatial dataset[4].



The map shows mean estimates of total nitrogen concentration in topsoil (0-15cm depth), displayed at a 1km resolution. The map was produced using measurements of nitrogen concentration from soil collected in the CEH Countryside Survey in 2007. Measurements were extrapolated up to a national level using statistical analysis. This extrapolation was based on total nitrogen concentration values associated with a combination of habitat type and soil parent material (the geological material, bedrock, superficial and drift from which soil develops)..

Extent of Permanent Vegetation

Vegetation cover affects a number of ecosystem services including water quality. An indication of the likely extent of permanent vegetation can be gained using Land Cover Map (as mapped previously), to highlight land uses which are assumed to be permanently vegetated, including woodland, grassland and heathland (shown in green). The land is assumed to be permanently vegetated if it is not classified as urban, water, rock, sediment or arable.

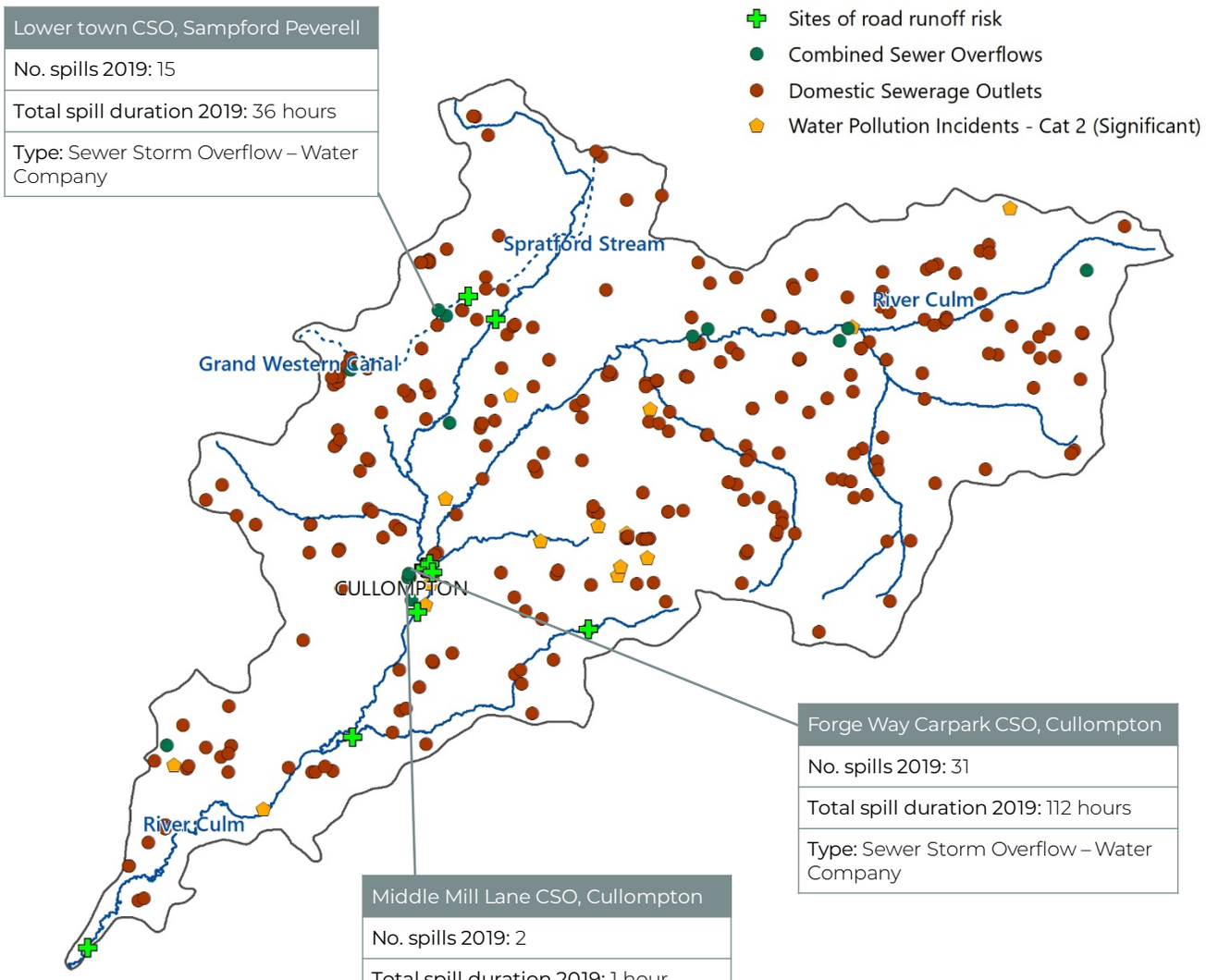


Datasets used in maps: OSVM, WBL, WBC, CEHN, LCM2015.
For full references see page 63.

Assessing the Provision of the Service

Point sources of pollution

There are a huge number of pollutants that are derived from 'point' sources. Point sources of pollution are single points such as outfalls, discharges, drains and mis-connections, and should be considered alongside more 'diffuse' sources of pollution which derive from across a wide area, such as field runoff or runoff from urban areas (see next page).



Potential point sources of water pollution			
Dataset	Description	Age	Res
Domestic Sewerage Outlets	Consented discharge point attributed to sewage from domestic properties.	-	●
Combined Sewer Overflows (CSOs)	During exceptionally heavy rain, combined sewer systems can overflow at these points, discharging untreated sewage and waste-water. Some CSOs have spill duration monitoring. Data is available for these sites to show the frequency and duration of CSO spills in 2019, and these details are shown in the boxes around the map.	●	●
Points at Risk of Road Runoff	Locations where a main road crosses a main river.	●	●
Pollution Incidents	Locations where a pollution incident has been assessed as having a significant impact on water quality (Category 2 for water)	-	●

Datasets used in maps: OSVM, WBL, WBC, CON, CSO, POL. For full references see page 63.

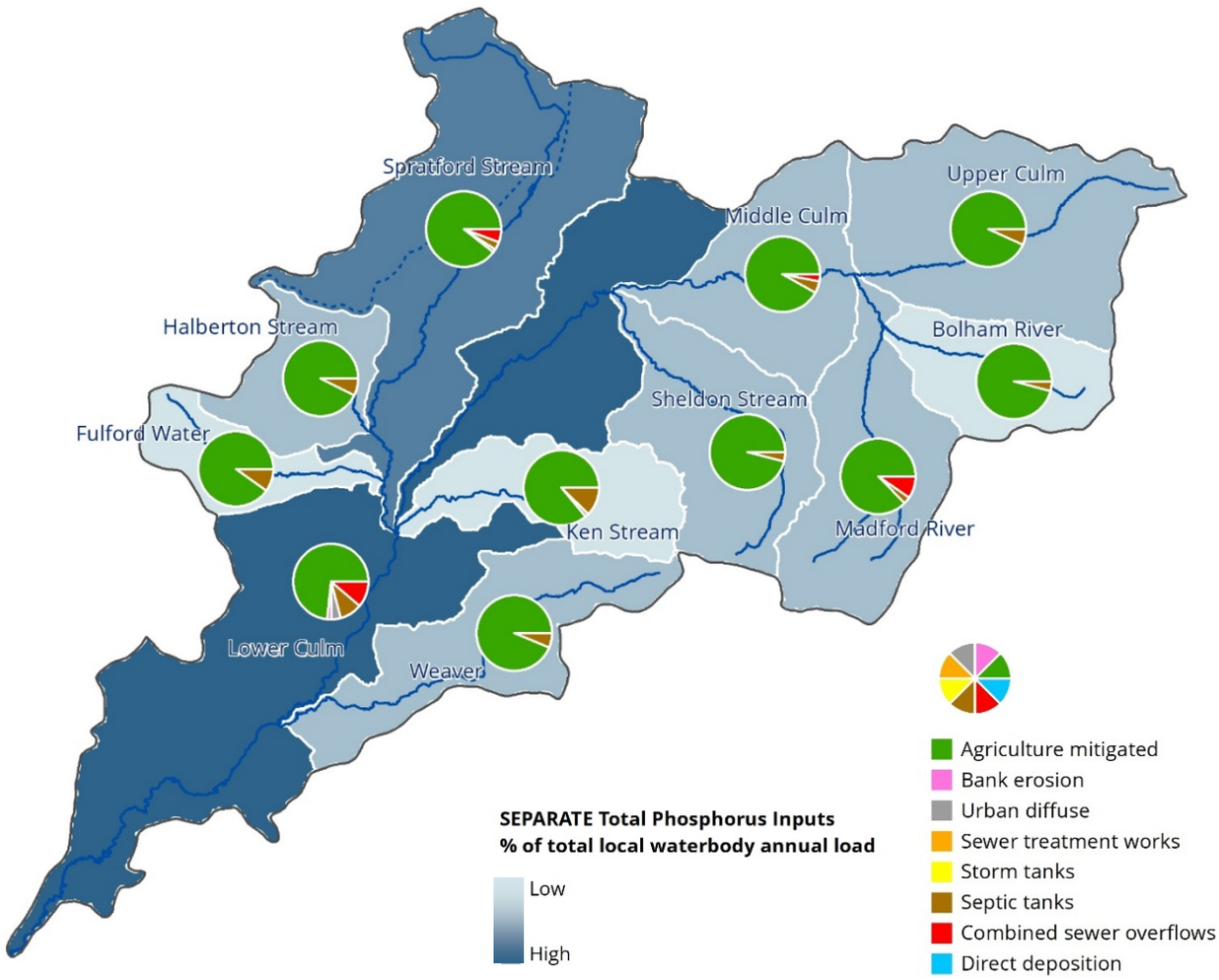
Assessing the Provision of the Service

Pollution source apportionment

The sources of different pollutants occurring in a catchment can be estimated from a variety of data, water quality monitoring and modelling techniques. SEPARATE (SEctor Pollutant AppoRtionment for the AquaTic Environment) is a multiple pollutant source apportionment model, providing data summarised by WFD waterbodies.

The map shows the modelled SEPARATE outputs for total Phosphorus inputs. Darker shading in the background represents more phosphate in that catchment, while the pie charts show the sources.

In the Culm catchment, the Lower Culm is most affected by phosphate. Across all catchments, the biggest contributor is agriculture, with CSOs and septic tanks also contributing in many of the catchments.

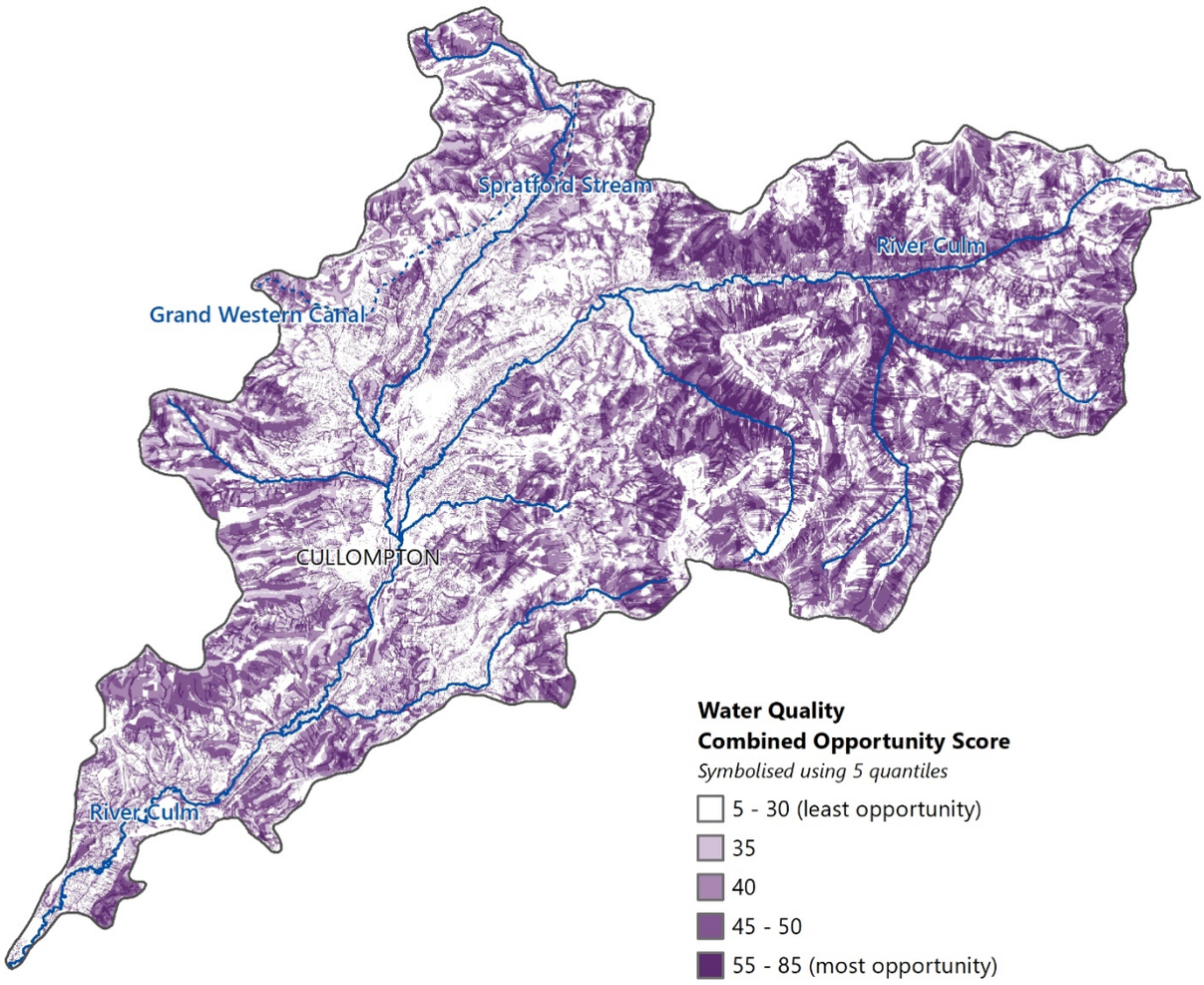


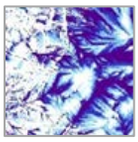
Dataset	Age	Res.
SEPARATE Model Outputs	-	●

Datasets used in maps: OSVM, WBL, WBC, SEP.
For full references see page 63.

Opportunities for Enhancement

The priority areas for water quality protection/enhancement are defined as areas of increased risk/importance for water quality regulation (as shown on pages 16 and 17) with additional information about land use and condition superimposed on the top.

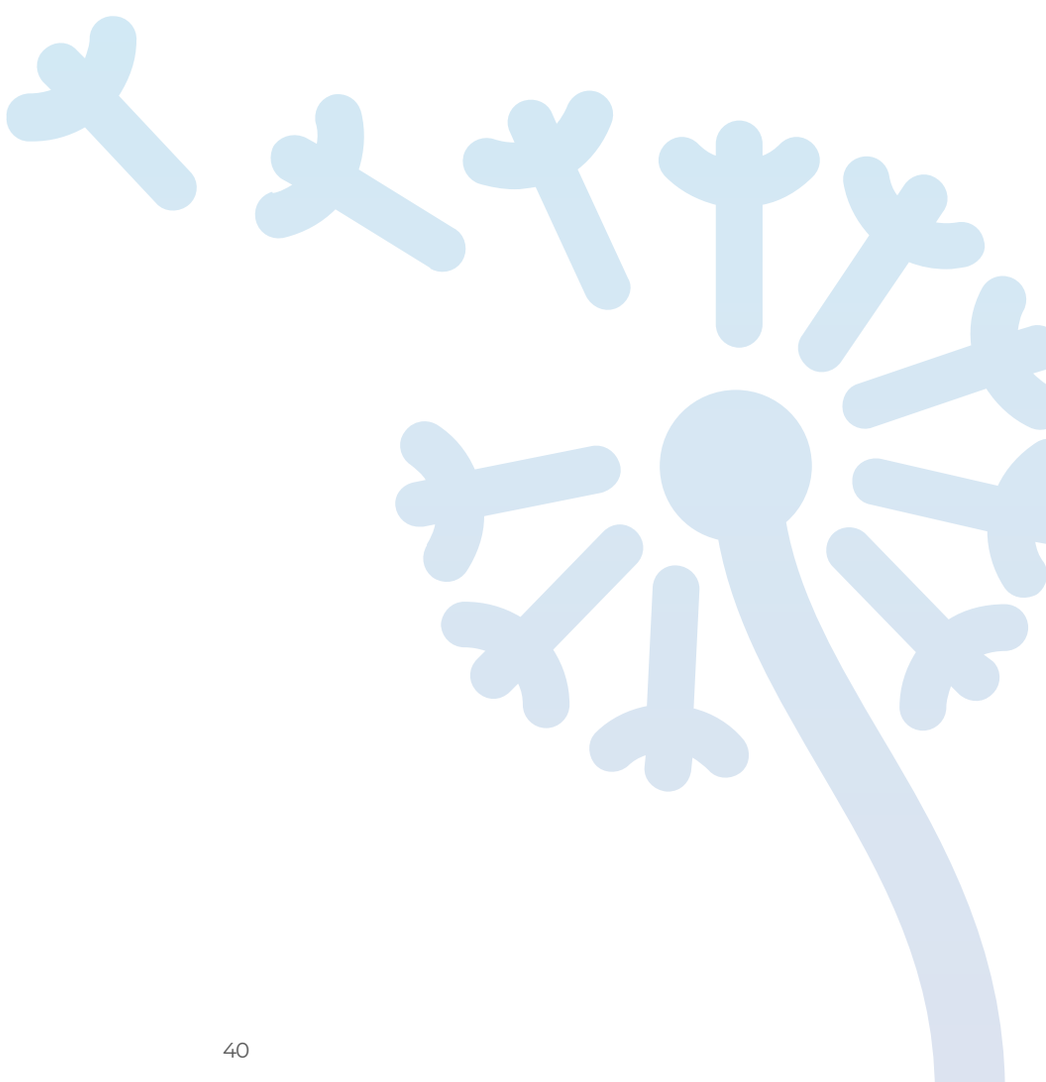


Relevant factors & scoring	Description
 **Hydrological connectivity** Land scored 0, 5, 10, 15 or 20 based on connectivity	Locations where water has a greater propensity to run over the surface.
 **Slope** Land scored 0, 10 or 20 based on steepness of slope	Slope is a risk factor that poses a threat to water quality.
 **Soil type** Sandy = 20 Clay with impeded drainage = 15 Other clays = 10 Loams = 5 Water or no soil = 0	Some soils are particularly prone to run-off/erosion, while others represent a risk due to rapid leaching of pollutants in solution.
 **Proximity to water course** Within 20m = 10 Outside = 0	Areas in the 'riparian corridor' are considered to pose an elevated risk to water quality because they are likely to have direct connectivity to the watercourse.
 **Land use** Arable = 20 Improved grassland = 15 Natural grassland = 10 Natural habitats & urban = 5	Land use is a key indicator of diffuse pollution risk as there are some practices/land uses which inherently pose more of a threat to water quality.

Datasets used in maps: OSVM, WBL, WBC, DTM2, NAT, DTM, LCM2007. For full references see page 63.

Biodiversity

Biodiversity, the variety of life in our habitats and ecosystems, is valuable in its own right. It also underpins cultural activities like bird-watching and fishing, is important for research and education, and some habitats will support food supply, resilience to flooding and climate regulation.



Priority Areas & Drivers for Biodiversity

The conservation of wildlife and biodiversity in the UK traditionally focuses on three approaches:

(1) the protection of important species and habitats through designation of high quality habitats supporting priority species,

(2) the creation and management of habitats on farmland through agri-environment schemes

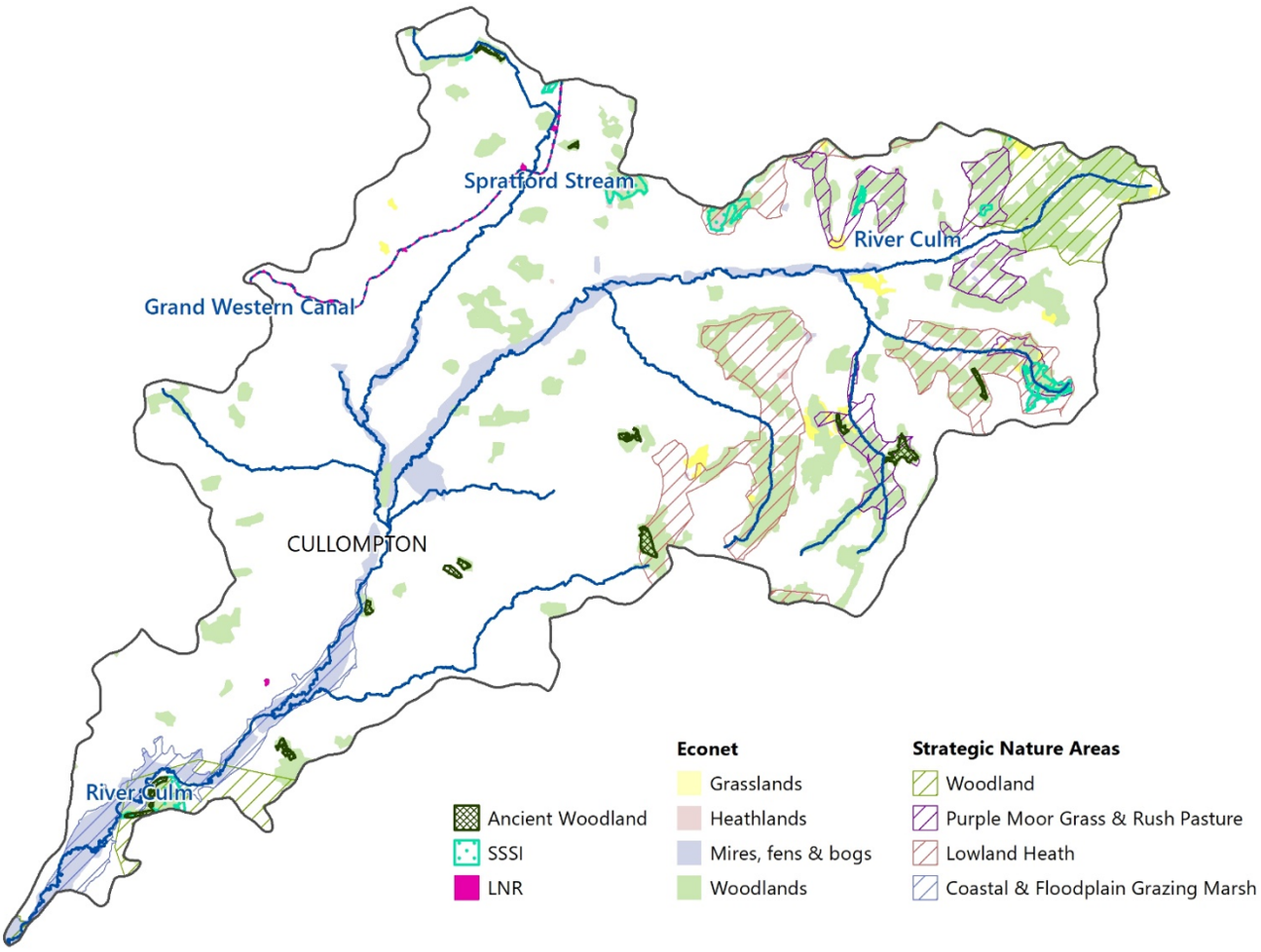
(3) the protection or creation of green spaces in urban areas through local planning processes.

The priority areas highlighted on this page focus on the first of these approaches. In addition, mapped below are the outcomes of two strategic mapping exercises have been undertaken to identify priority areas where habitat creation and/or restoration work could best be undertaken to enhance ecological networks at a landscape-scale.

Designated & Strategic Sites

There are a number of statutory designations for wildlife sites. Sites are selected for their importance in the conservation of biodiversity in the UK and should be prioritised for protection. In the Culm catchment there are no internationally designated sites, but there are nationally important sites.

There are also locations which have been identified as strategic for the protection and enhancement of certain habitat types during different studies.



Important sites for habitats and biodiversity			
Dataset	Description	Age	Res.
Ancient Woodland	Areas that have been woodland continuously since 1600AD	●	●
Sites of Special Scientific Interest (SSSI)	Sites designated at a national scale for important habitats, wildlife and/or geology.	●	●
Local Nature Reserves	Areas important at a local level for wildlife and access to nature.	●	●

Strategic areas for habitats			
Dataset	Description	Age	Res.
Econet (Multiple Habitat Inventories)	Areas where clusters of sites are likely to be working as a network and where species movement may be possible across less intensively managed land.	●	●
Strategic Nature Areas	Areas assessed to offer the best potential to maintain and expand terrestrial wildlife habitats at a landscape scale.	●	●

Datasets used in maps: OSVM, WBL, WBC, AW, SSSI, LNR, ECO, SNA. For full references see page 63.

Natural Assets that Regulate the Service

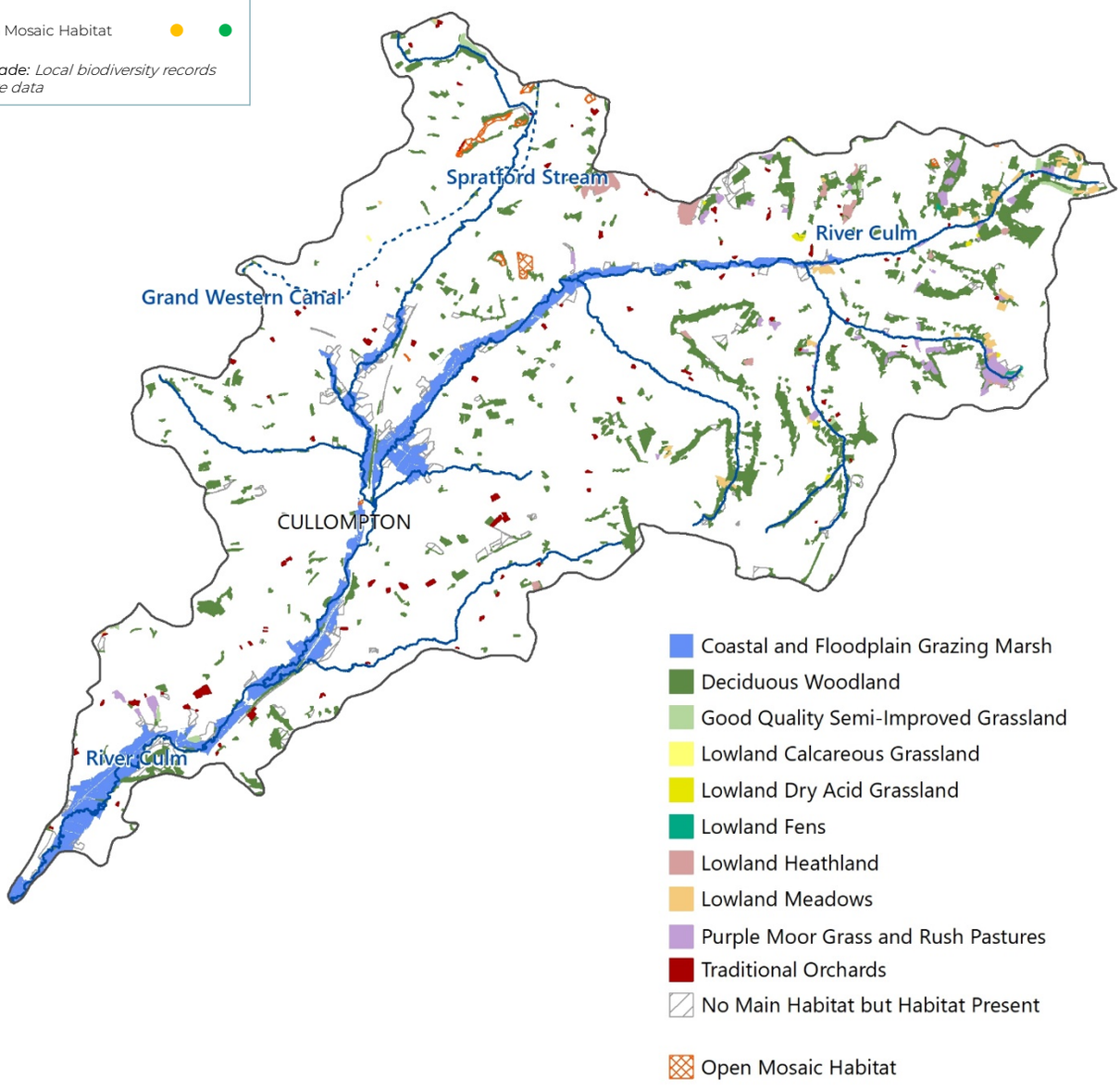
The species and biodiversity that occur in a catchment landscape are supported by a network of natural habitats and greenspaces. If habitat patches are of a sufficient extent and connectivity, it is believed they create a functional ecological network which supports a variety of species.

Before any work is done to expand this network, it is vital to map the current habitat components and that work is undertaken to protect and enhance them – there is no point working to add to the ecological network in a landscape if the current infrastructure in the landscape is being degraded or damaged at the same time.

Current environmental assets are shown in more detail on pages 12 and 13, including priority habitats (shown again below), woodlands and freshwater. The map below also shows open mosaic habitats, which arise on sites such as railway sidings, quarries and former industrial works. The disturbance at these sites creates habitat diversity which can support rich assemblages of invertebrates. This has led to 'open mosaic habitats on previously developed land' being added to the UK Biodiversity Action Plan (UK BAP) as a Priority Habitat.

Dataset	Age	Res.
Priority Habitat Inventory	●	●
Open Mosaic Habitat	●	●

Upgrade: *Local biodiversity records centre data*



Datasets used in maps: OSVM, WBL, WBC, PHI, OMH.
For full references see page 63.

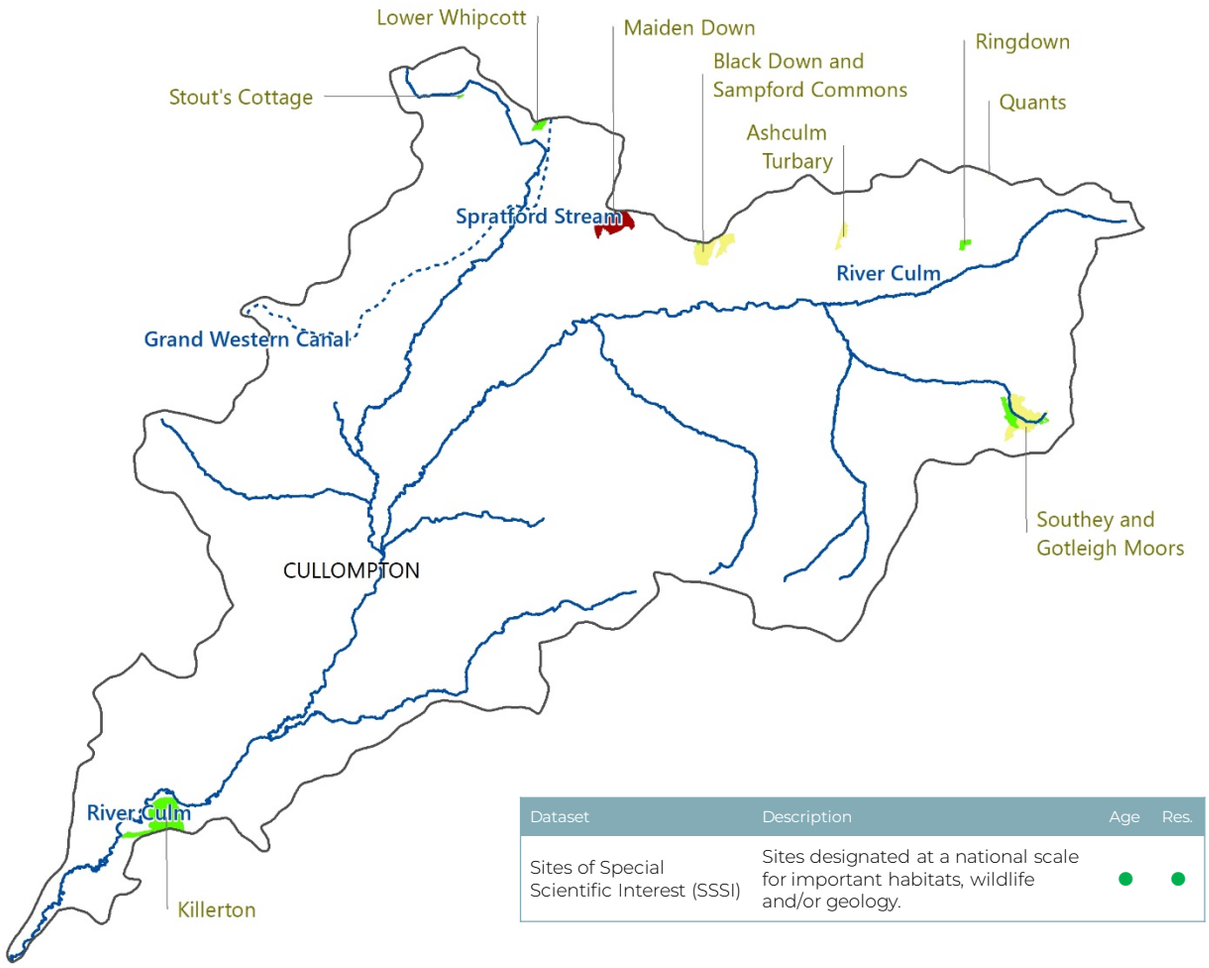
Assessing the Provision of the Service

There are numerous sources of data and evidence for the assessment of ecological health across a catchment landscape. Designated sites are classified according to their condition and rivers and other aquatic ecosystems are assessed via a number of metrics, including the Water Framework Directive ecological assessments.

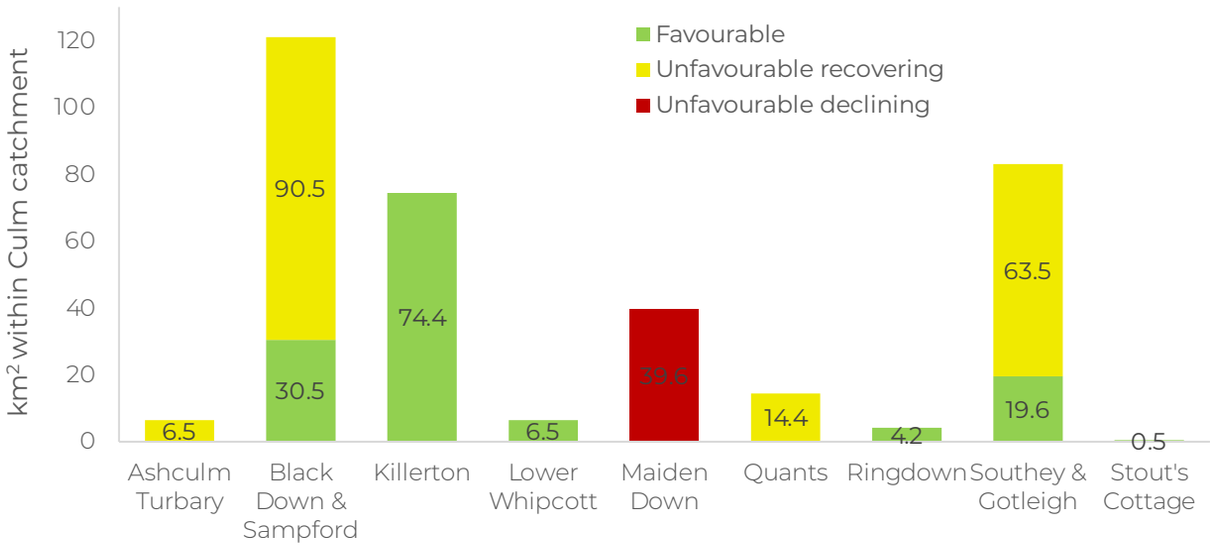
In addition to these assessments there has been some modelling undertaken based on ecological surveys, which can give an indication of the broad condition of the landscape.

Terrestrial Habitats & Biodiversity

Site of Special Scientific Interest - Condition



Dataset	Description	Age	Res.
Sites of Special Scientific Interest (SSSI)	Sites designated at a national scale for important habitats, wildlife and/or geology.	●	●

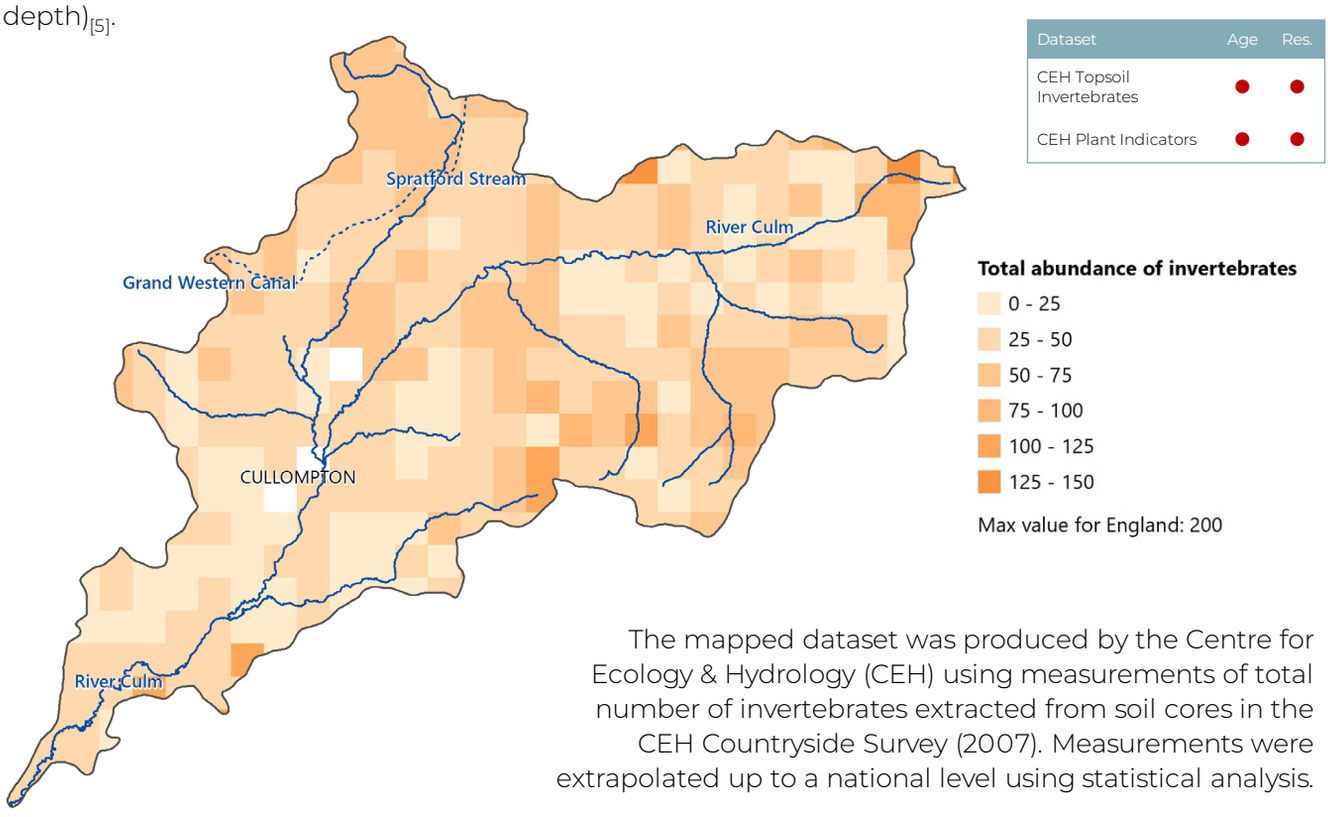


Datasets used in maps: OSVM, WBL, WBC, SSSI. For full references see page 63.

Assessing the Provision of the Service

Soil Biota - Topsoil Invertebrates

The map below shows mean estimates of total abundance of invertebrates in topsoil (0-8cm depth)[5].



The mapped dataset was produced by the Centre for Ecology & Hydrology (CEH) using measurements of total number of invertebrates extracted from soil cores in the CEH Countryside Survey (2007). Measurements were extrapolated up to a national level using statistical analysis.

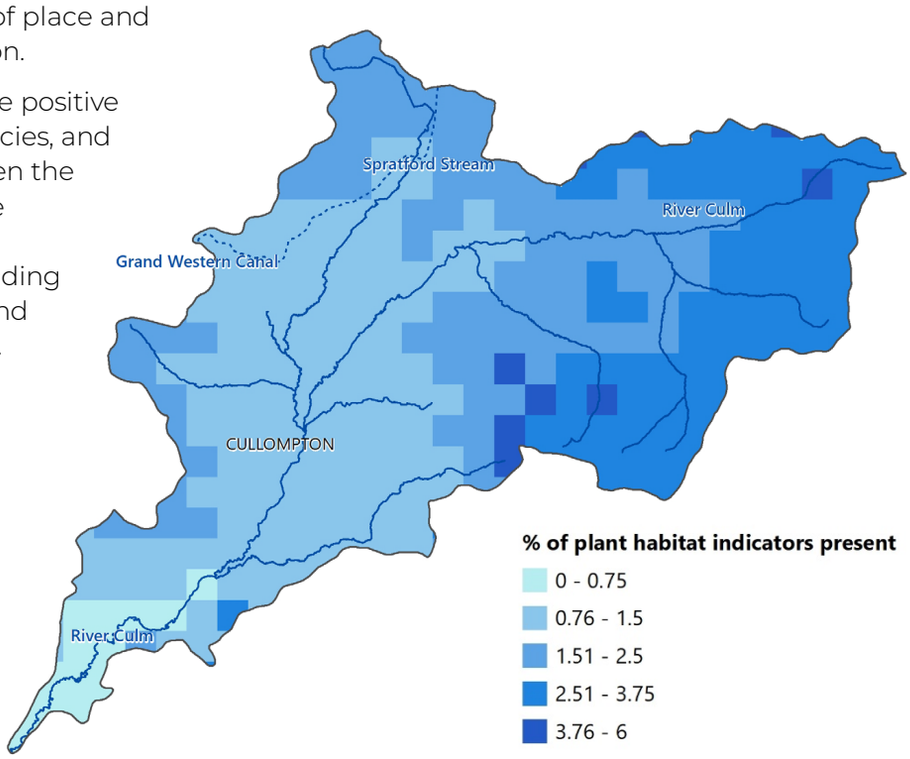
Naturalness of Biological Assemblage - Plant indicators for habitats in good condition

The CEH expected plant indicators map is based on the occurrence of plant species that are characteristic of habitats which are in good condition[6].

A more traditional indicator of biodiversity, total plant species richness, can be deceptive as higher species numbers may be an indicator of nutrient enrichment or disturbance. Additional species may be out of place and therefore indicate poor condition.

By instead using species that are positive indicators, or 'characteristic' species, and calculating a proportion between the observed plant diversity and the potential indicators within that habitat type, a better understanding is gained of habitat condition and the nature of the plant diversity.

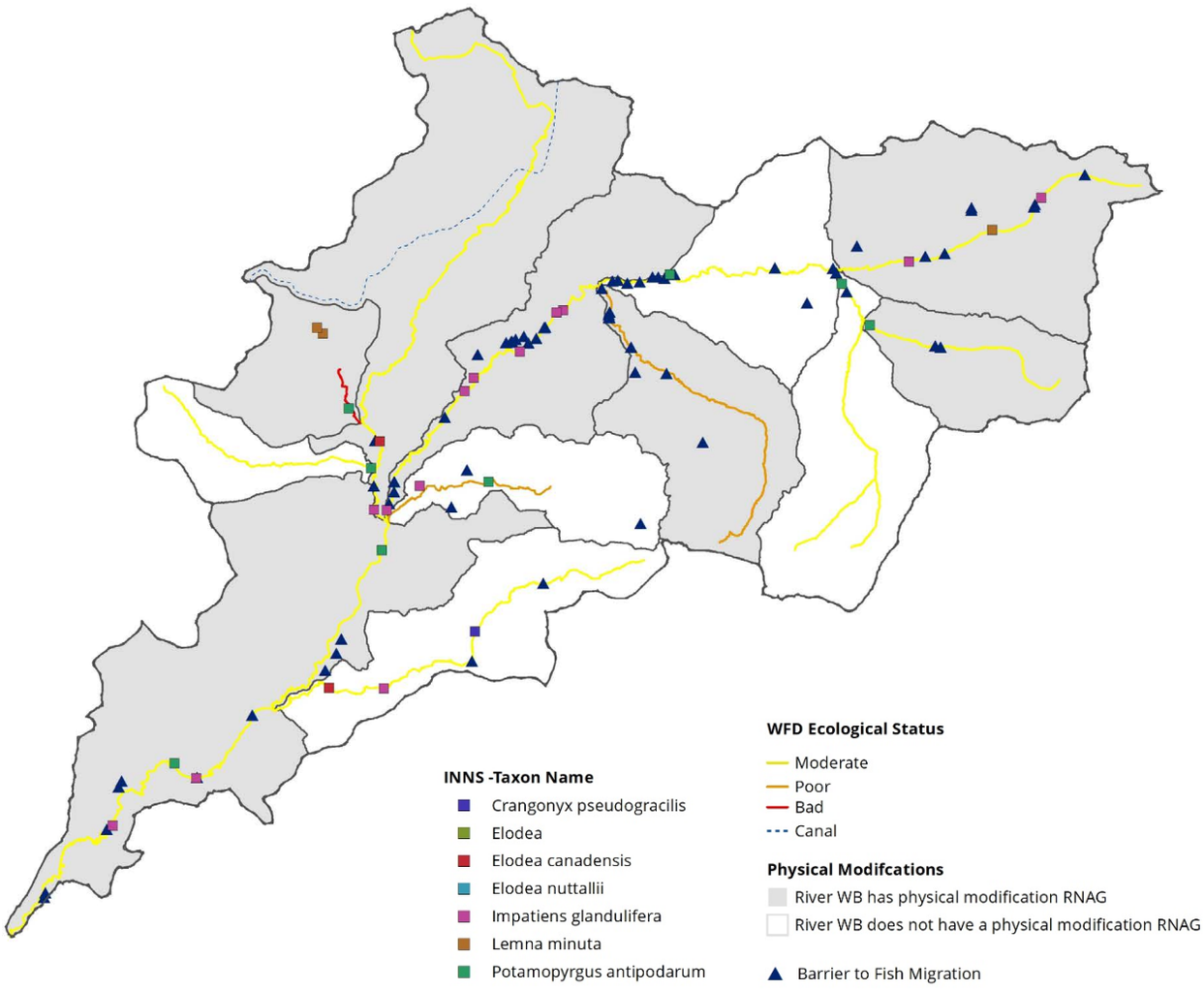
As with the previous map, the mapped dataset was produced by CEH using the Countryside Survey (2007) and extrapolated up to a national level using statistical analysis.



Datasets used in maps: OSVM, WBL, WBC, CEHTI, CEHPI.
For full references see page 63.

Assessing the Provision of the Service

Freshwater Habitats & Biodiversity



Indicators of the condition of freshwater habitats			
Dataset	Description	Age	Res.
WFD Ecological Status (2019)	Indicates the degree of disturbance through various indicators of ecological health	●	●
Barriers to Fish Migration	Weirs and other barriers prevent migratory fish from being able to move through river systems so easily, preventing them accessing the habitats they need through their life cycles.	●	●
Invasive non-native species	Species which have been introduced from other parts of the world and which are now difficult to control and causing ecological damage. Though dependent on sampling effort, the points on the map indicate the types of invasive species found in the Culm catchment during river surveys.	●	●
Reasons for Not Achieving Good (attributed to physical modifications)	The EA Reasons for Not Achieving Good database identifies the cause of less than Good classifications under WFD and can be used to identify where physical modifications to the river are causing ecological degradation. A lack of physical modifications is indicative of a waterbody likely to have better quality habitats for freshwater biodiversity.	●	●

Data & evidence upgrades and extensions for assessing condition of assets linked to habitats and biodiversity	
Dataset	Description
Local Record Centre species data	Local Environmental Record Centres hold data for important species, though species data can be more affected by sampling effort than habitat data.
Indicator species data	Long-term monitoring datasets exist for a number of species including woodland and agricultural birds – for example, the BTO Breeding Bird Survey is comprehensive and systematic in their sampling and could be used to indicate wildlife populations present.
Citizen science data	There is a growing trend towards data collected by members of the public, to achieve a greater coverage than might be possible using conventional surveys. The Big Butterfly Count is an example.

Datasets used in maps: OSVM, WBL, WBC, CDE-STAT, CDE-RNAG, BAR, INNS. For full references see page 63.

Opportunities for Enhancement

Natural England have developed a set of 'National Habitat Network Maps' to support wildlife recovery based on the need, identified in the Lawton report, for; more habitat, in better condition, in bigger patches, that are more closely connected.

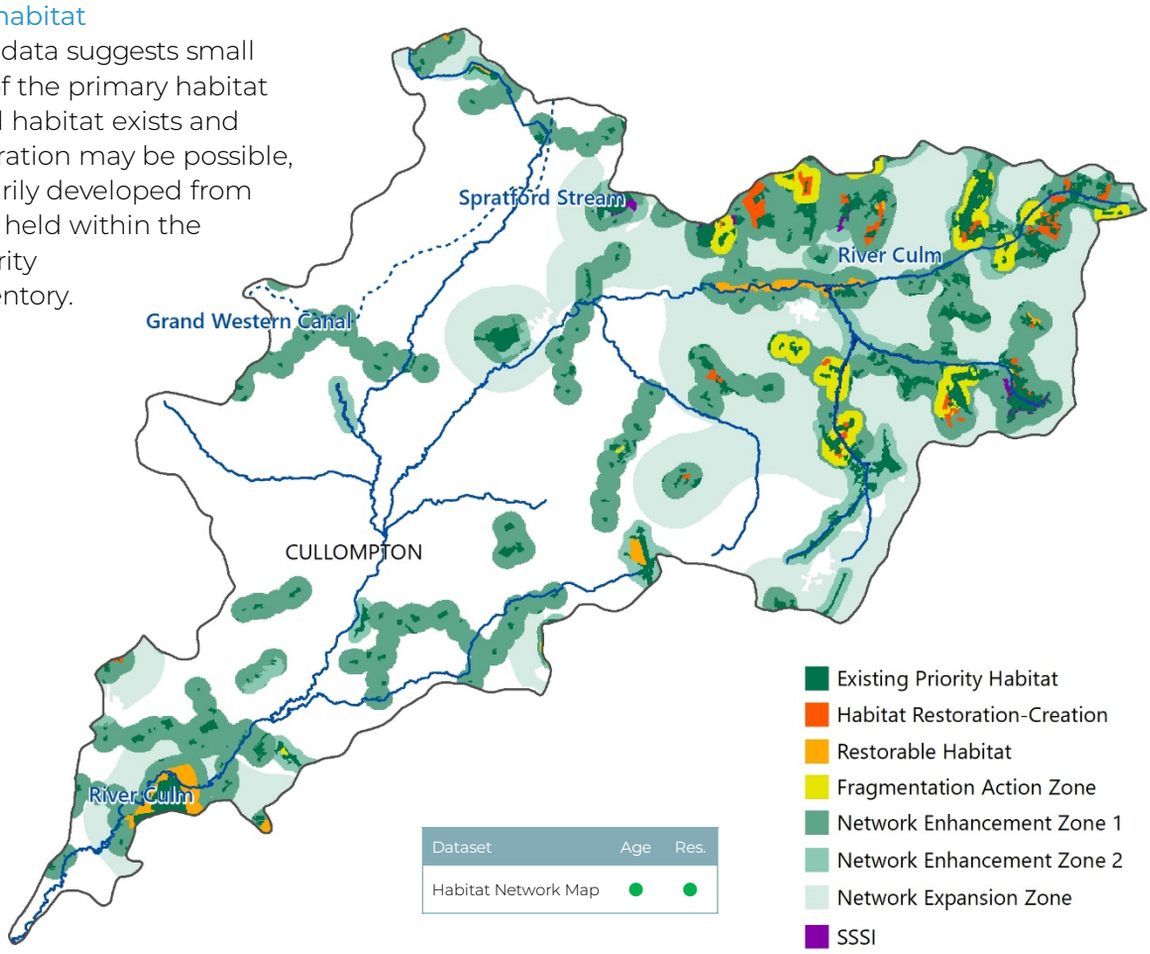
The map shows, in shades of orange, two 'Habitat Components' of the mapping system:

Habitat creation

The locations where habitat creation or restoration is known to occur - primarily sites under relevant agri-environment options.

Restorable habitat

Sites where data suggests small fragments of the primary habitat or degraded habitat exists and where restoration may be possible, this is primarily developed from information held within the current Priority Habitat Inventory.



The map shows in shades of yellow/pale green the 'Network Zones':

Fragmentation Action Zone

Land immediately adjoining existing habitat patches that are small or have excessive edge to area ratio where habitat creation is likely to help reduce the effects of habitat fragmentation.

Network Enhancement Zone 1

Land in close proximity to the existing habitat components that are more likely to be suitable for habitat re-creation for the particular habitat. These areas are primarily based on soils, often refined by other data such as hydrology, altitude and proximity to the coast.

Network Enhancement Zone 2

Land in close proximity to the existing habitat components that are unlikely to be suitable for habitat re-creation but where other types of habitat may be created or land management may be enhanced, including delivery of suitable Green Infrastructure.

Network Expansion Zone

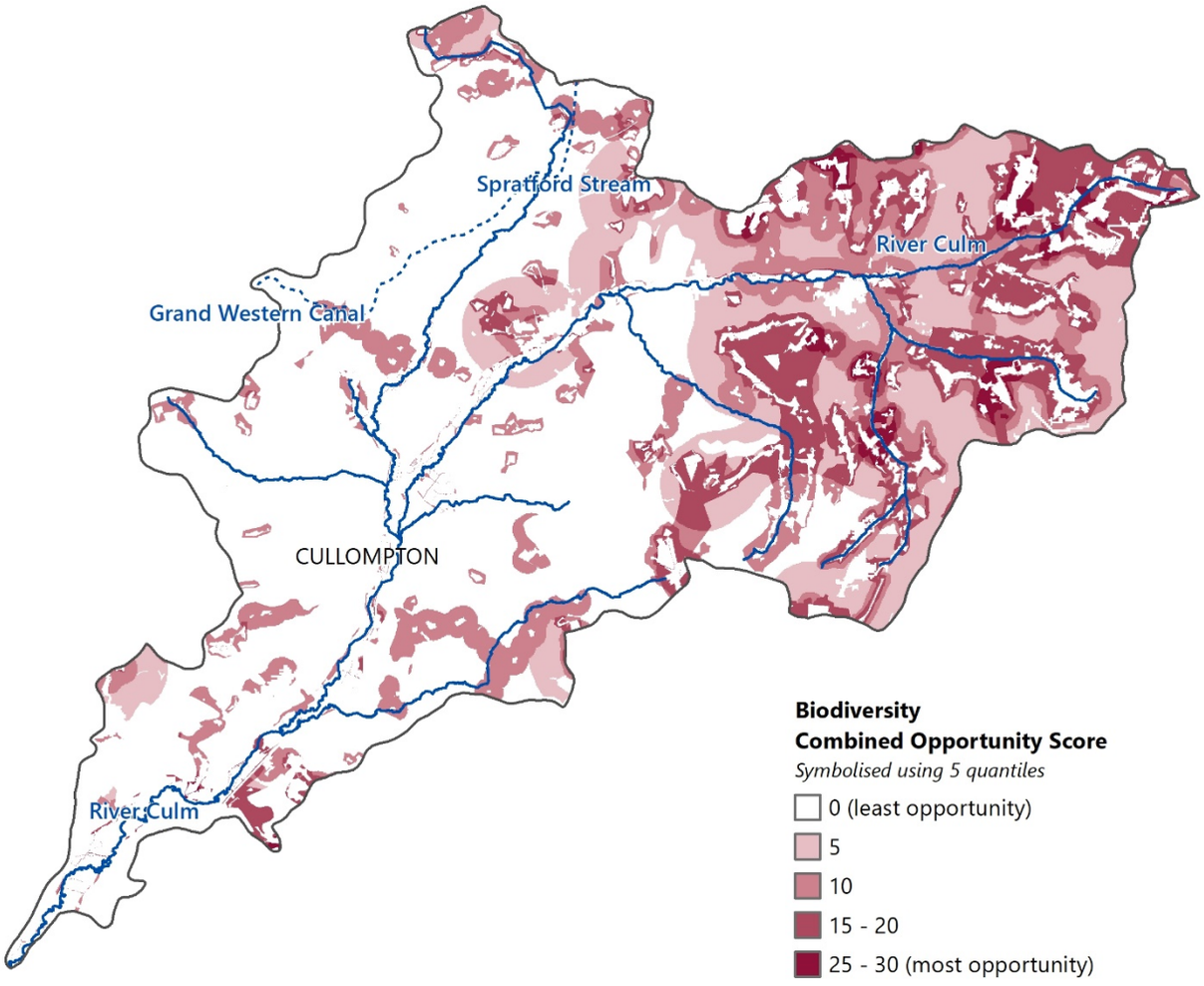
Land in relatively close proximity to the Network Enhancement Zones 1 & 2 that are more likely to be suitable for habitat creation for the particular habitat and identifying possible locations for connecting and linking up networks across a landscape.

Datasets used in maps: OSVM, WBL, WBC, HNM. For full references see page 63.

Opportunities for Enhancement

Areas of land where there may be opportunity for the restoration or creation of natural habitats as an ecological network can be identified by combining a series of criteria that each indicate some level of suitability or opportunity. One of the key criteria included in this process is the Habitat Network Map from the previous page, which is scored and combined with the strategic areas highlighted on page 39 and a number of other criteria (shown below).

It is important to remember that these opportunity areas for enhancement of the ecological network are to be targeted over and above efforts to protect and improve the condition of existing habitats in the landscape.

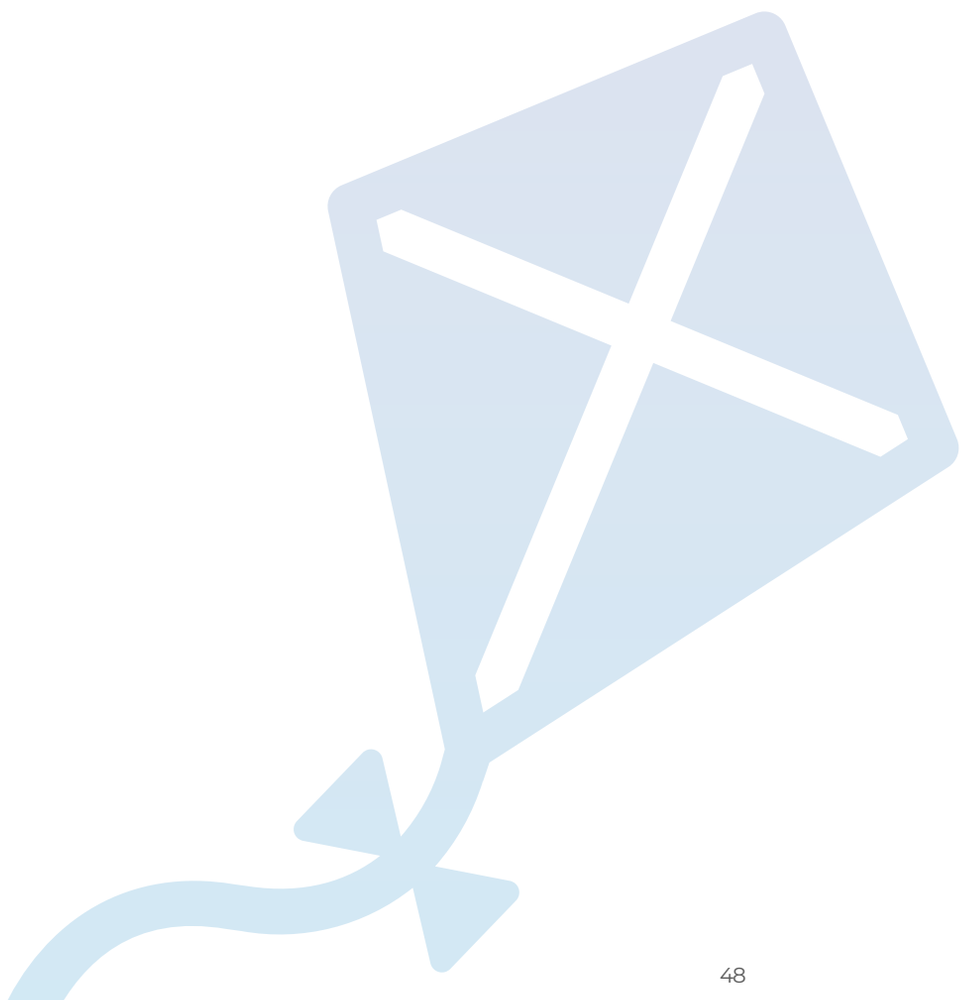


Relevant factors & scoring	Description
 **Habitat Network Map** Habitat components = 20 Fragmentation zone = 15 Enhancement zones 1 & 2 = 10 Expansion zone = 5 Existing habitats and areas outside habitat network = 0	See previous page for more information. Priority was given to habitat restoration and creation, followed by the improvement of fragmented habitats, and then the extension of the habitat network.
 **Strategic areas for habitats** Econet and/or Strategic Nature Areas = 10 Outside = 0	The strategic areas shown on page 39 are given priority.
 **Exclusion areas** Areas with exclusion criteria are reset to 0	Factors that make it less likely that habitat creation could be undertaken are excluded. These include urban areas, main road and railway infrastructure, protected sites and priority habitats.

Datasets used in maps: OSVM, WBL, WBC, HNM, ECO, SNA, ALC, SCH, SSSI, AW, PHI. For full references see page 63.

Heritage, Culture & Recreation

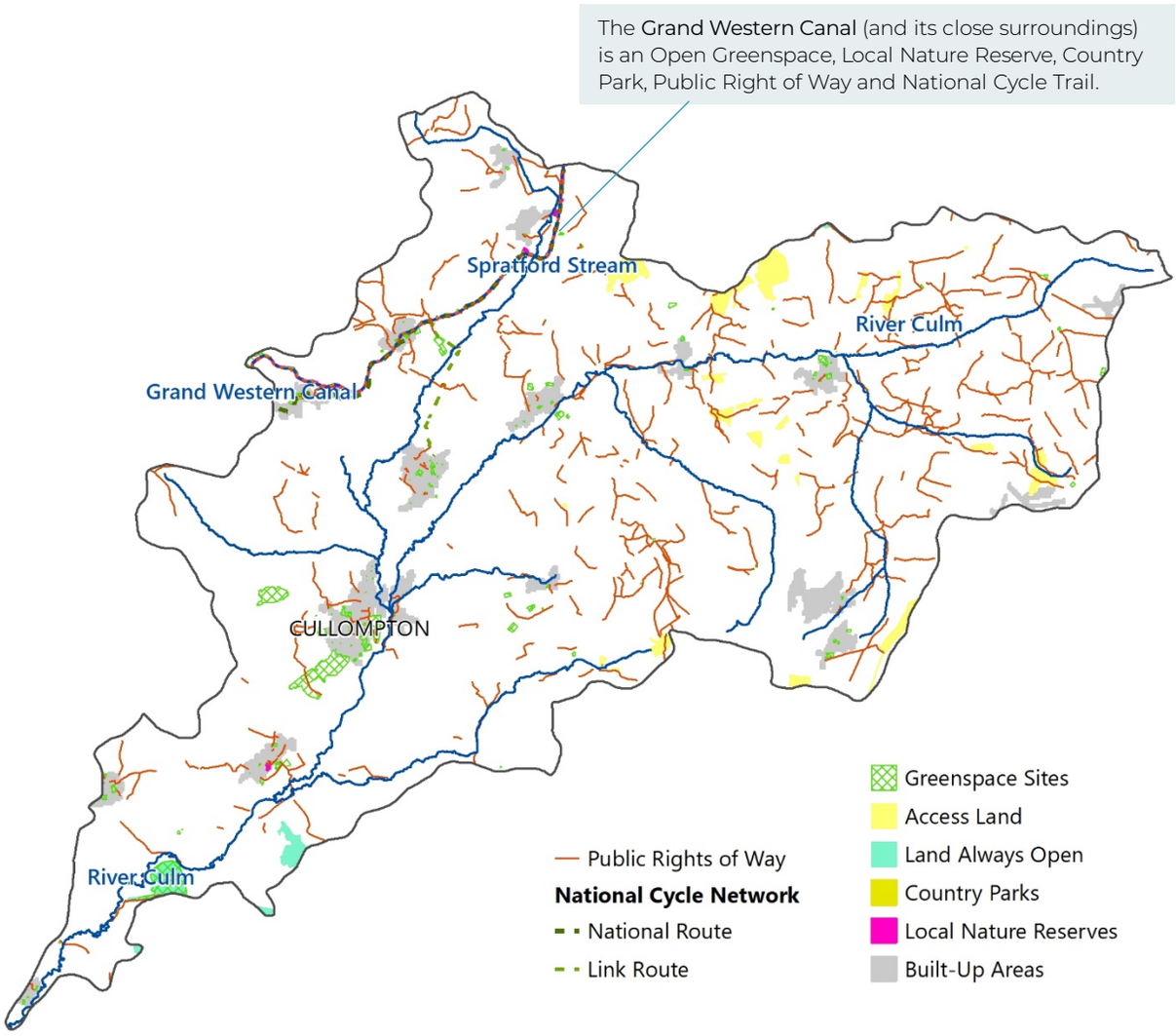
Benefits we gain from the environment which are ‘non-material’ are usually called ‘cultural services’. This group includes the cultural identity, sense of place and spiritual experiences we gain from the environment, as well as opportunities for tourism and recreation.



Assets & Infrastructure that Regulate the Service

Recreation: Accessible Areas

Open and green spaces (often referred to as 'green infrastructure') have an extremely important role in maintaining health, well-being and quality of life for people. They provide somewhere for people to engage in recreation and social activity, provide access to natural environments and can play a central role in the ecological, economic and social regeneration of our towns and cities. The data presented here gives flavour of the infrastructure that exists, focusing on resources which are accessible to all with no or minimal cost.



Recreation assets – linear features			
Dataset	Description	Age	Res.
Public Rights of Way	Public Rights of Way include footpaths, bridleways, and byways.	●	●
National Cycle Network	A UK-wide network of routes for walking, cycling, wheeling and exploring outdoors.	●	●

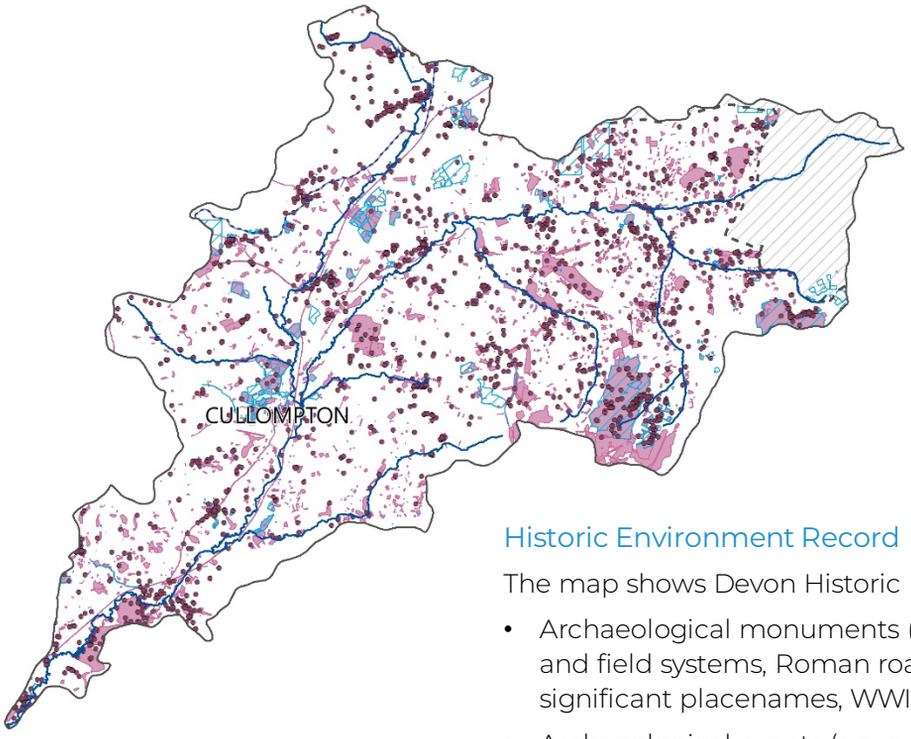
Recreation assets – open spaces and accessible land			
Dataset	Description	Age	Res.
CRoW 2000 Access Land	Some land across England is accessible without having to use paths, called the 'right to roam'. Access land includes mountains, moors, heaths and downs, registered common land and some land around the England Coast Path.	●	●
Local Nature Reserves	Areas important at a local level for wildlife and access to nature.	●	●
National Trust Land	The National Trust has some land which is always open to public on foot.	●	●
Urban Greenspace	Open urban green spaces such as public parks, playing fields, sports facilities, play areas and allotments.	●	●
Country Parks	An area designated for people to visit and enjoy recreation in a countryside environment.	●	●

Datasets used in maps: OSVM, WBL, WBC, PROW-D, PROW-S, NCN, OSG, CROW, NT, CP, LNR, ONS. For full references see page 63.

Assets & Infrastructure that Regulate the Service

Heritage

Heritage encompasses the inherited resources which are valued for reasons beyond simply their utility. Devon is celebrated for the beauty and diversity of its landscapes, which include historic settlements, ancient buildings and archaeological sites. It is important that the historic environment is protected for its own sake and for the information and pleasure it provides now and for future generations.



Dataset	Age	Res.
Historic Environmental Record – archaeological monuments and events	●	●

Historic Environment Record

- Archaeological Monument (point)
- Archaeological Monument (polygon)
- Event Polygon
- Somerset County

Historic Environment Record

The map shows Devon Historic Environment Record features:

- Archaeological monuments (e.g. prehistoric flint finds, hillforts and field systems, Roman roads, medieval fortifications, significant placenames, WWII defensive sites, etc.)
- Archaeological events (e.g. excavations, archaeological assessments, geophysical surveys, etc.)

Designated Historic Assets

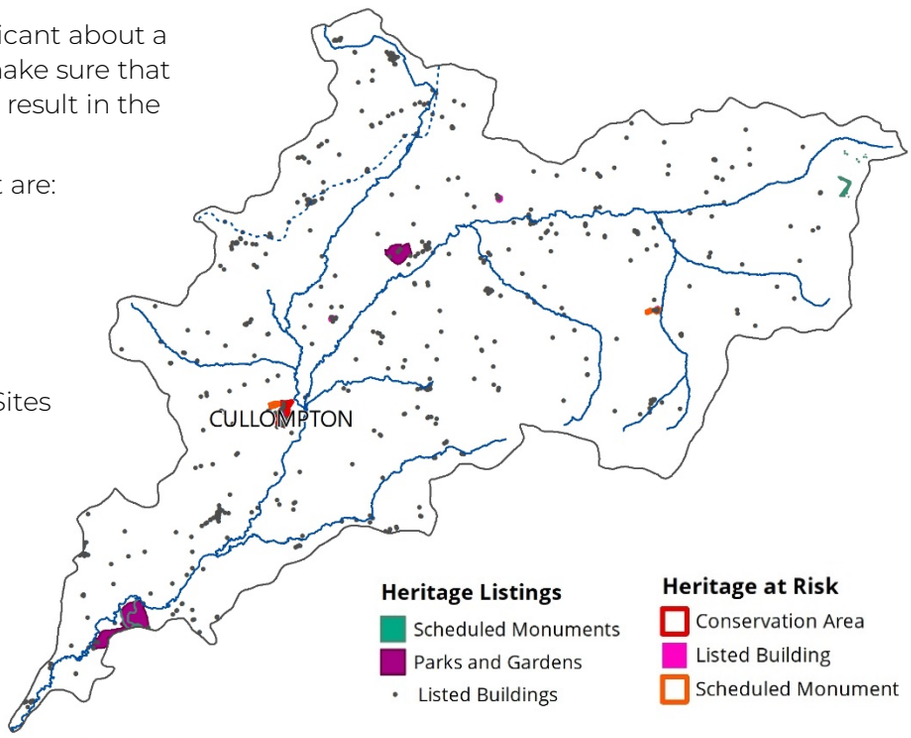
Listing is the term given to the practice of listing buildings, scheduling monuments, registering parks, gardens and battlefields, and protecting wreck sites.

Listing highlights what is significant about a building or site, and helps to make sure that any future changes to it do not result in the loss of its significance.

Shown on the map to the right are:

- Listed buildings
- Scheduled monuments
- Register parks and gardens

Note: There are no registered battlefields or World Heritage Sites within the Culm catchment.



Dataset	Age	Res.
Designated Historic Assets	●	●

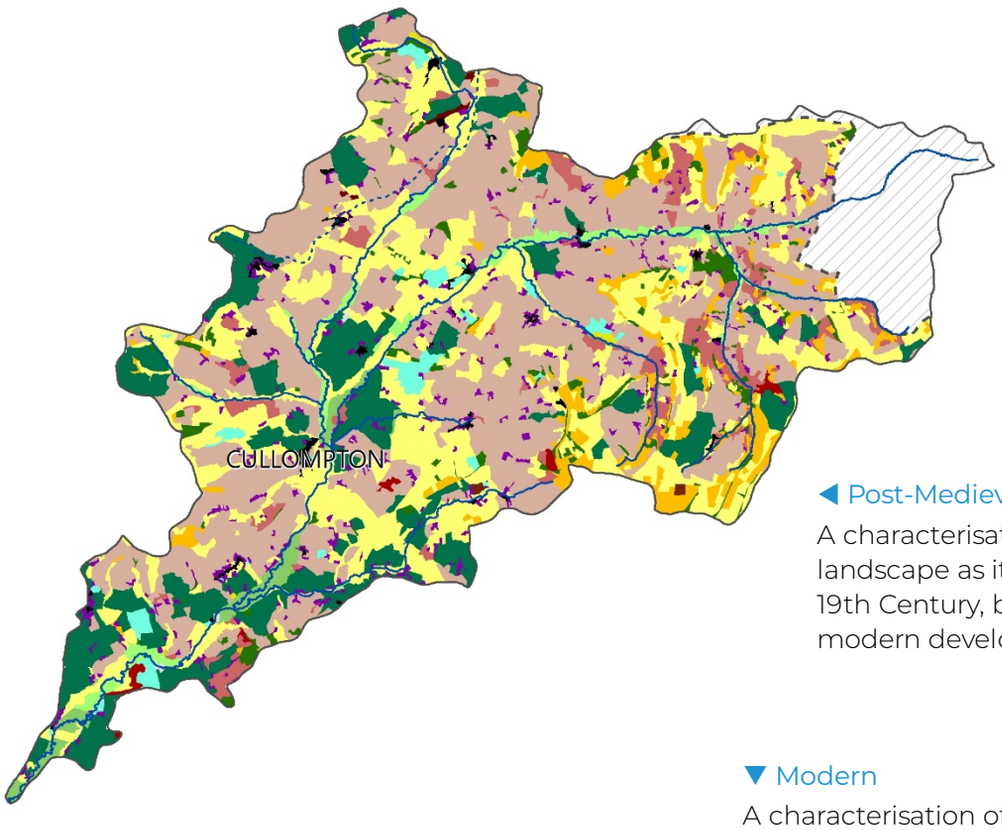
Datasets used in maps: OSVM, WBL, WBC, HER, SCH, PG, LB, HAR.
For full references see page 63.

Additional Evidence

Heritage

Historic Landscape Characterisation

Devon County Council and English Heritage have undertaken a 'Historic Landscape Characterisation' project for the county of Devon, to understand and map the landscape we see today with reference to its historical development.

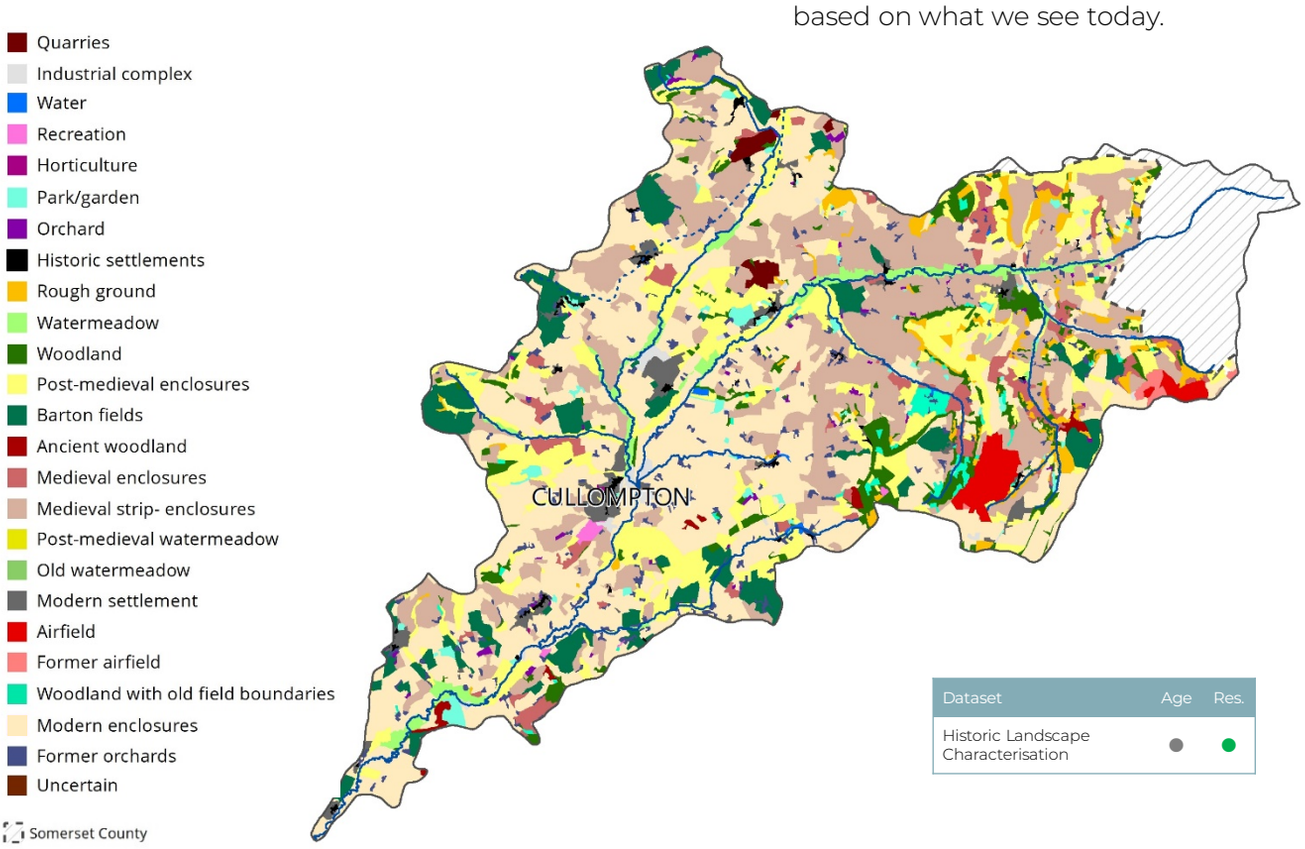


◀ Post-Medieval

A characterisation of the landscape as it was in the late 19th Century, before many modern developments.

▼ Modern

A characterisation of the landscape based on what we see today.



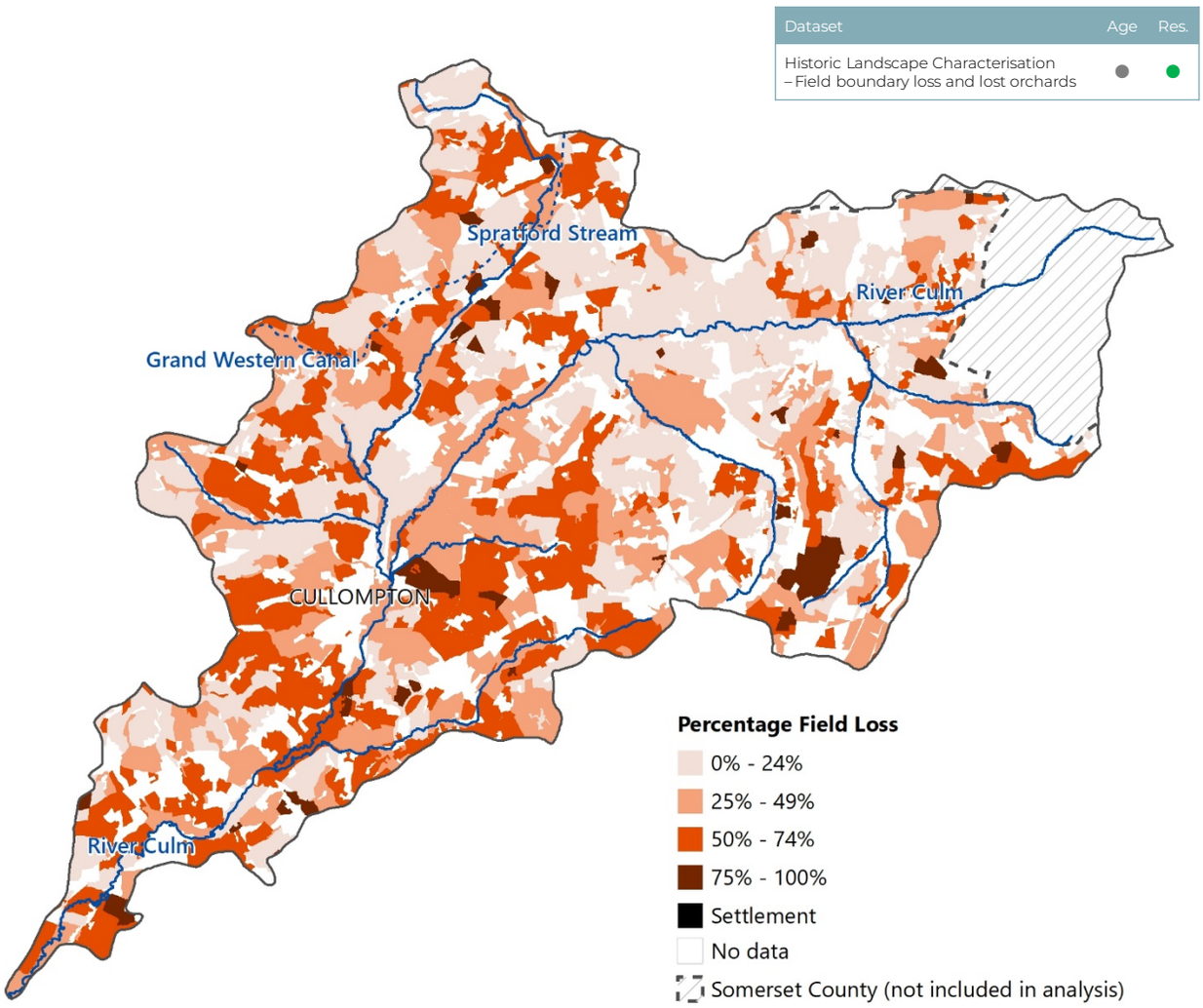
Datasets used in maps: OSVM, WBL, WBC, HLC.
For full references see page 63.

Additional Evidence

Heritage

Field Boundary Loss

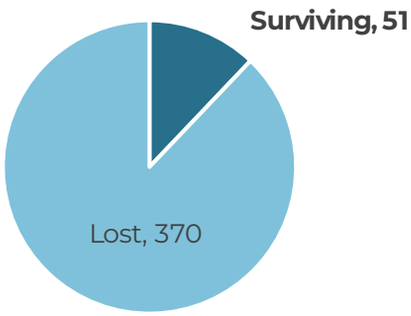
Through the Devon Historic Landscape Characterisation work, the team have also created a representation of the difference in the number of fields that there were in the late 19th Century compared to the present day.



Lost Orchards

Through the same project, the team analysed the distribution of orchards in Devon in the late 19th Century, and investigated whether they have survived or were destroyed in the 20th century. The data shows a great loss in orchards: around 85% of all orchards depicted on the 1st edition OS map have been lost. The orchards have been mapped, but due to their small areas, a table showing the information for the Culm catchment has been produced below.

	Number of sites	Area (km^2)
Surviving	51	0.6
Lost	370	7.5

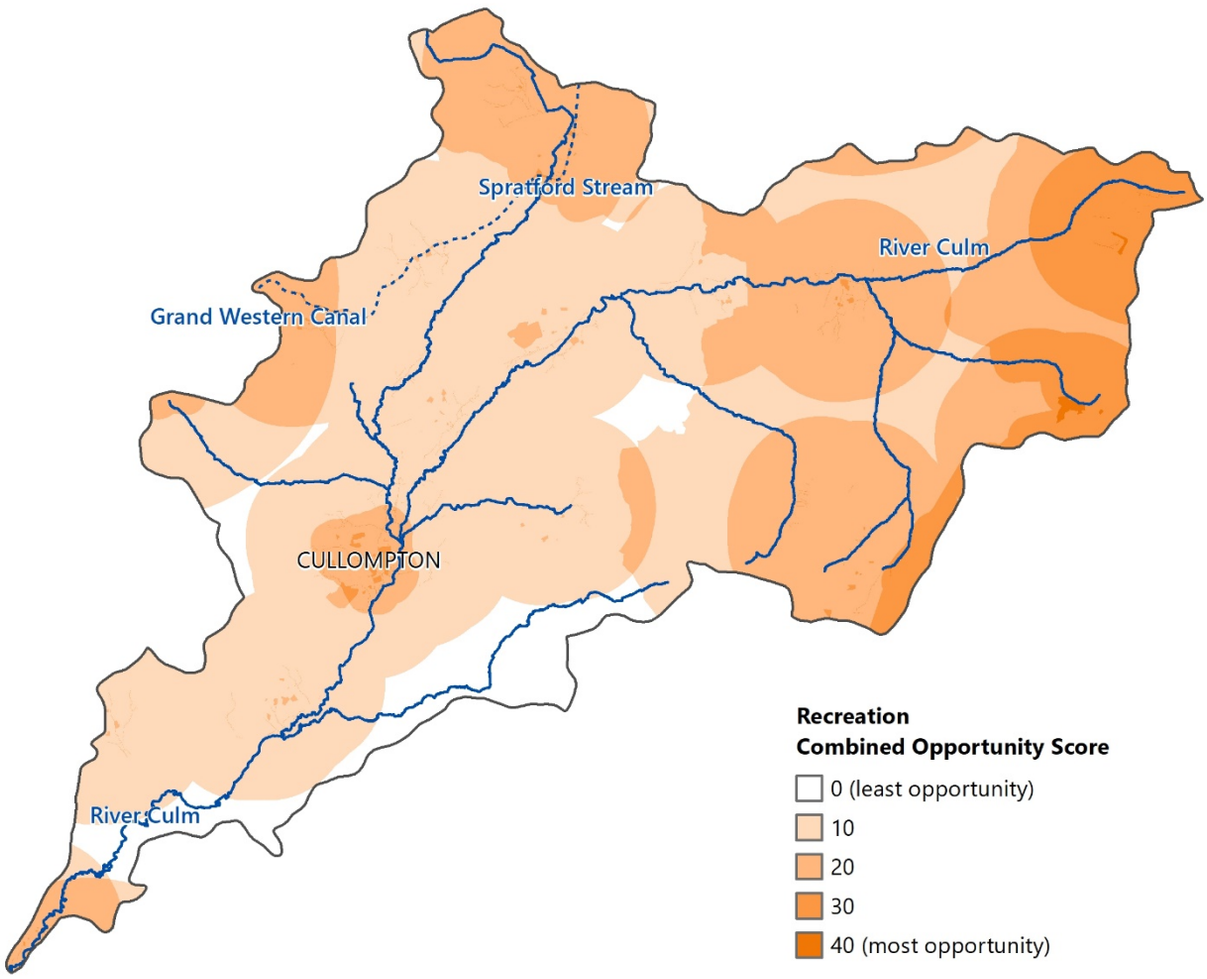


Datasets used in maps: OSVM, WBL, WBC, HLC.
For full references see page 63.

Opportunities for Enhancement

Recreation

The first step in enhancing the provision of recreational resources in a landscape is to improve the quality and increase the capacity of the resources already in place – i.e. existing resources receive priority. Then it is necessary to look for opportunities to increase the provision of recreational resources in the landscape, and to target this provision where it will have the greatest benefit for people and society.



Relevant factors & scoring	Description
 **Increasing access for people** Within 2km buffer = 10 Outside buffer = 0	To maximise the health and well-being benefits of greenspace it needs to be within an accessible distance of the resident population. To identify priority areas for creating recreational infrastructure a 2km buffer has been placed around human population centres.
 **Increasing access to existing greenspaces** Greenspace within 500m buffer = 10 Outside bufffer = 0	Access to open/green spaces can be achieved by opening up access to existing greenspaces or by creating more in areas close to human population. Existing green infrastructure within 500m of human population has been identified.
 **Other priority areas** Within AONB or Forestry Commission priority area = 10 Outside = 0	A number of organisations and institutions have undertaken strategic exercises to identify and map priority areas for the improvement of recreational access and these priority areas should be recognised when catchment management interventions are being considered in those areas.
 **Areas of higher deprivation** Within 500m of IMD decile ≤5 = 10 Outside = 0	Public Health England report that greener neighbourhoods benefit everyone, but appear to disproportionately benefit disadvantaged groups, and so priority for improving access to greenspace should be given to more deprived areas. A 500m buffer has been used around areas of a locally lower IMD score to highlight areas close to areas of more deprived population.

Datasets used in maps: OSVM, WBL, WBC, ONS, OSG, CROW, NT, CP, LNR, AONB, FCP, IMD . For full references see page 63.

Climate Regulation

A better regulated climate will reduce the risk of hazards such as floods, droughts and extreme temperatures, with associated benefits for health, safety and protection of infrastructure.

Priority Areas for Carbon Regulation

There are no statutory areas for targeting the benefits of carbon sequestration (the long-term removal of carbon from the atmosphere) or greenhouse gas regulation, although the emissions from farmland and farming activities do receive a great deal of attention due to the potential for carbon to be sequestered in farmland soils.

There is also significant focus on the major carbon stores (peatland and woodlands) and the drive to ensure that they continue to hold the carbon that contain and do not become carbon emitting sources of greenhouse gases.

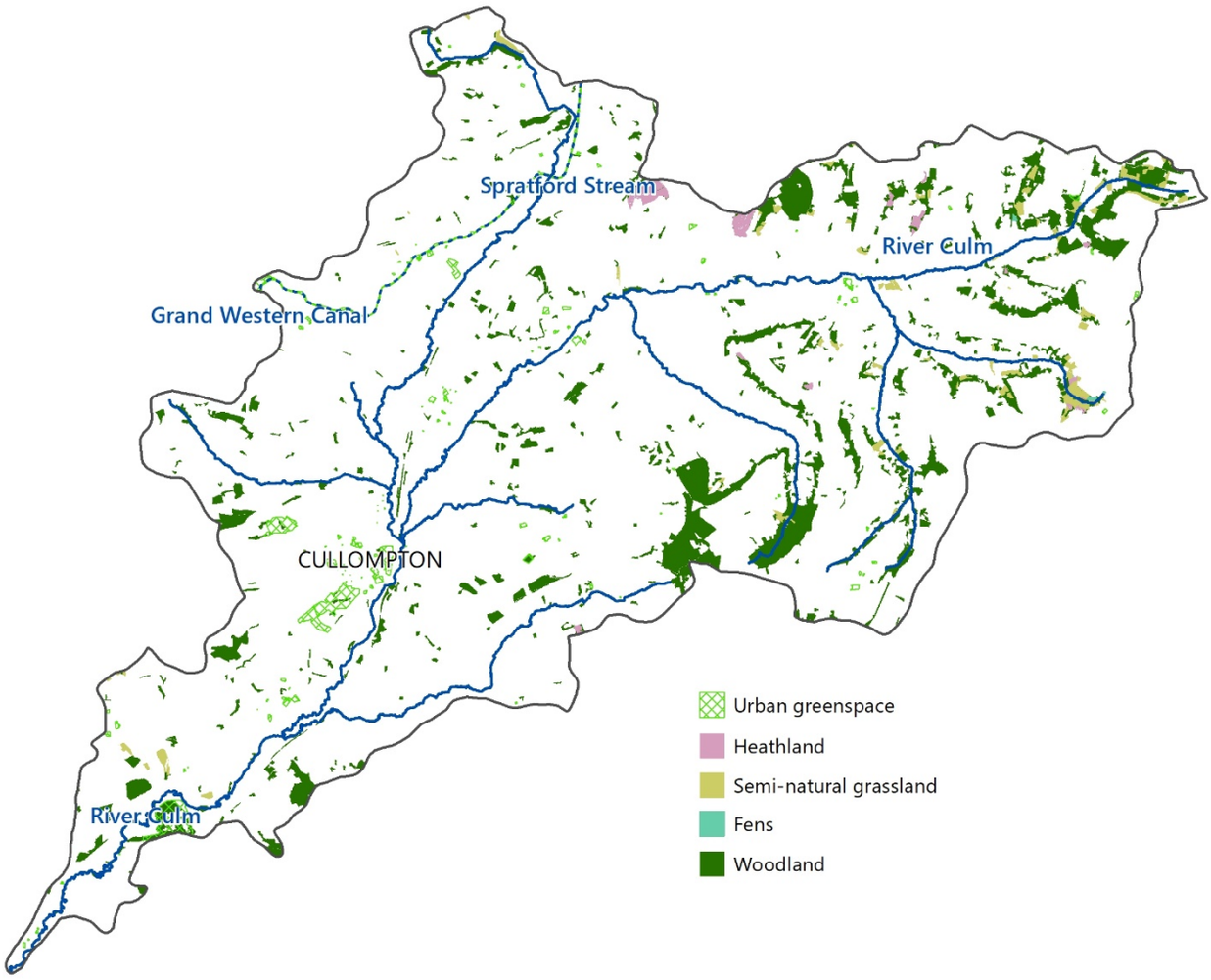
Everyone is a beneficiary of carbon sequestration and storage as it plays a key role in the regulation of the climate.

Natural Assets that Regulate the Service

It is important to undertake a broad assessment of where greenhouse gases/carbon are currently sequestered in the landscape. These areas must be restored and protected to ensure that they do not become degraded and that their reserves of carbon are not emitted into the atmosphere.

Land uses contributing to climate regulation

Certain land uses have been identified through the Natural England Indicators project[7] as contributing to climate regulation as an ecosystem service. These include all types of woodland, certain types of semi-natural habitats, and urban greenspaces.



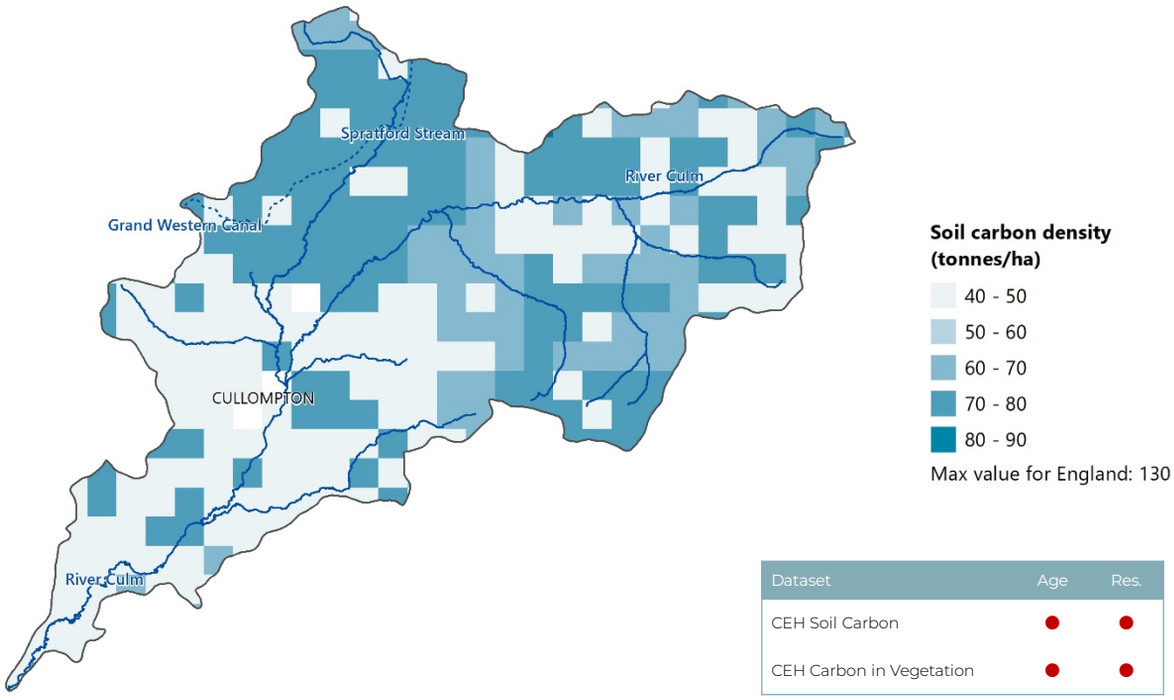
Assets which contribute to climate regulation			
Dataset	Description	Age	Res.
National Forest Inventory – all woodland	A record of all forests or woodlands in Great Britain of at least 0.5 hectares in area with a minimum width of 20m, and that have at least 20% tree canopy cover.	●	●
Priority Habitat Inventory – selected habitats	Habitats mapped in the Priority Habitat Inventory (PHI) are habitats of principle importance under the Natural Environment and Rural Communities Act (2006). The habitats shown above contribute to climate regulation.	●	●
OS Greenspace	Open urban green spaces such as public parks, playing fields, sports facilities, play areas and allotments.	●	●

Datasets used in maps: OSVM, WBL, WBC, NFI, PHI, OSG.
For full references see page 63.

Assessing the Provision of the Service

Soil carbon

Soil organic carbon is essential for its role as the primary energy source in soils. It is vital for maintaining soil structure, resilience and water retention. As soil carbon is the biosphere's largest carbon reservoir, soils play a vital role in climate regulation. The map below shows mean estimates of topsoil (0-15cm depth) carbon density in tonnes per hectare[8].

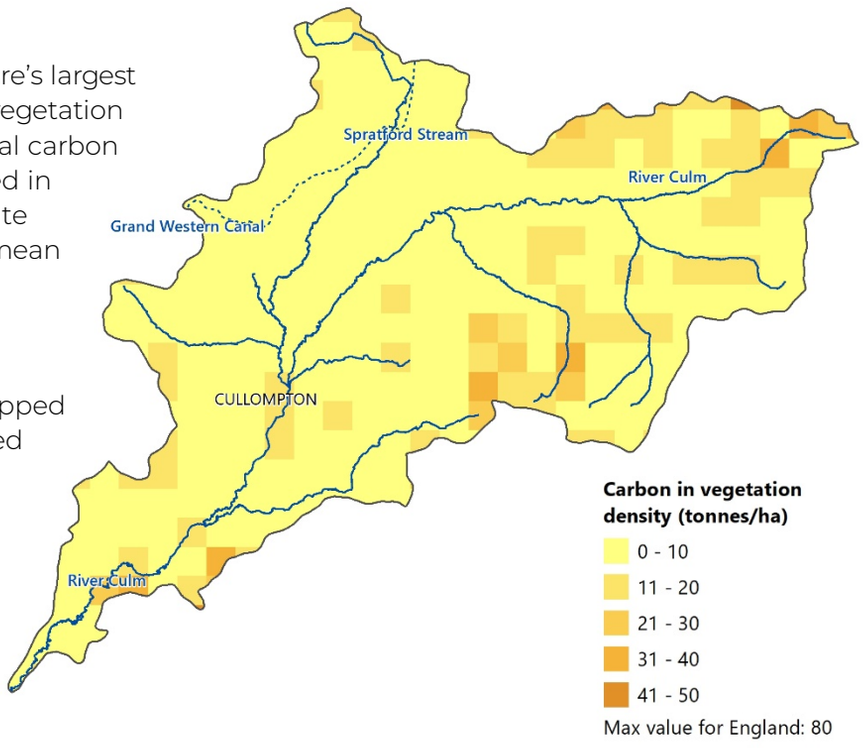


Dataset	Age	Res.
CEH Soil Carbon	●	●
CEH Carbon in Vegetation	●	●

Carbon in vegetation

Although soil carbon is the biosphere's largest carbon reservoir, forests and other vegetation also make up a large part of the total carbon pool. Carbon sequestered and stored in vegetation plays a vital role in climate regulation. The map below shows mean estimates of carbon stocks, in tonnes per hectare, stored in above-ground vegetation[9].

As with the previous map, both mapped datasets on this page were produced by CEH using the Countryside Survey (2007) and extrapolated up to a national level using statistical analysis.



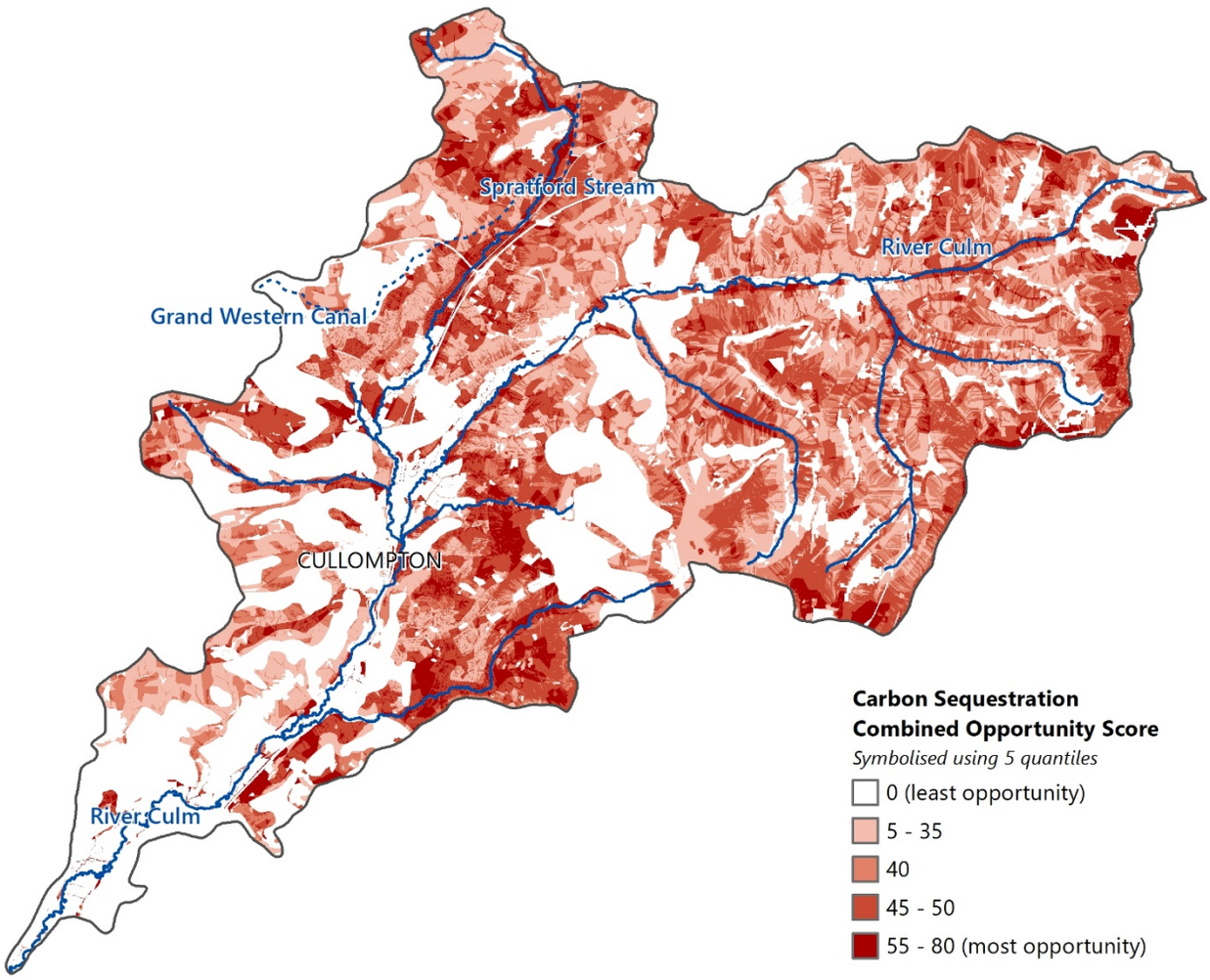
Extent of permanent vegetation

Page 36 shows extent of permanent vegetation which is also an indicator of how well the catchment may be providing climate regulation services.

Datasets used in maps: OSVM, WBL, WBC, CEHSC, CEHCV.
For full references see page 63.

Opportunities for Enhancement

A series of simple rules have been used to identify areas of land of greatest potential opportunity for carbon sequestration. Some of the criteria consider where the required interventions may or may not be feasible for cost-benefit or practical reasons.



Relevant factors & scoring	Description
 **Potential for land use change** Arable = 30 Improved grassland = 20 Other grassland = 10 Habitats and urban = 0	Changing land management practices can achieve small improvements in carbon sequestration, but significant improvements are achieved through permanent land use change along a arable > rotational cropping > temporary grassland > permanent pasture > woodland > wetland continuum.
 **Agricultural land class** Grade 1 or 2 = -10 Grade 3 or urban = 0 Grade 4 or 5 = 10	Agricultural Land Grade is designed to indicate areas of high and low productivity farmland. Conversion of high grade agricultural land to other land uses is unlikely to be taken up by land managers and so measures to enhance sequestration should be targeted towards 'low grade land'.
 **Soil type** Clays = 20 Loams/silts/sands = 10 Peat = 0	Some soils have a higher natural capacity to sequester carbon than others. While any soil can sequester carbon, clay-based soils have a greater capacity to lock up organic material, compared to lighter sandy or loamy soils. Soils will reach maximum capacity for sequestration and a healthy peat-based soil may have limited potential for further sequestration.
 **Wetland opportunity** High = 20 Med = 10 Low = 0	The outputs of the analyses undertaken to identify areas of wetland suitability, and therefore opportunity for wetland creation, have been included in this mapping exercise (see page 28).
 **Exclusion areas** Areas with exclusion criteria are reset to 0	Factors that make it less likely that carbon sequestration measures could be undertaken, including urban areas, main road and railway infrastructure, productive agricultural land, protected sites and priority habitats.

Datasets used in maps: OSVM, WBL, WBC, LCM2015, ALC, NAT, DTM2, FZ2, ALC, SCH, SSSI, AW, PHI. For full references see page 63.

Summary of Opportunity Areas

Throughout the document, opportunities for enhancement of the provision of ecosystem services have been identified by assessing and combining the most detailed data available. To make these maps easier to compare, the scored data has been summarised to a grid of 1km^2 hexagons.

In each map, darker shades show a greater need or opportunity for enhancing the service.

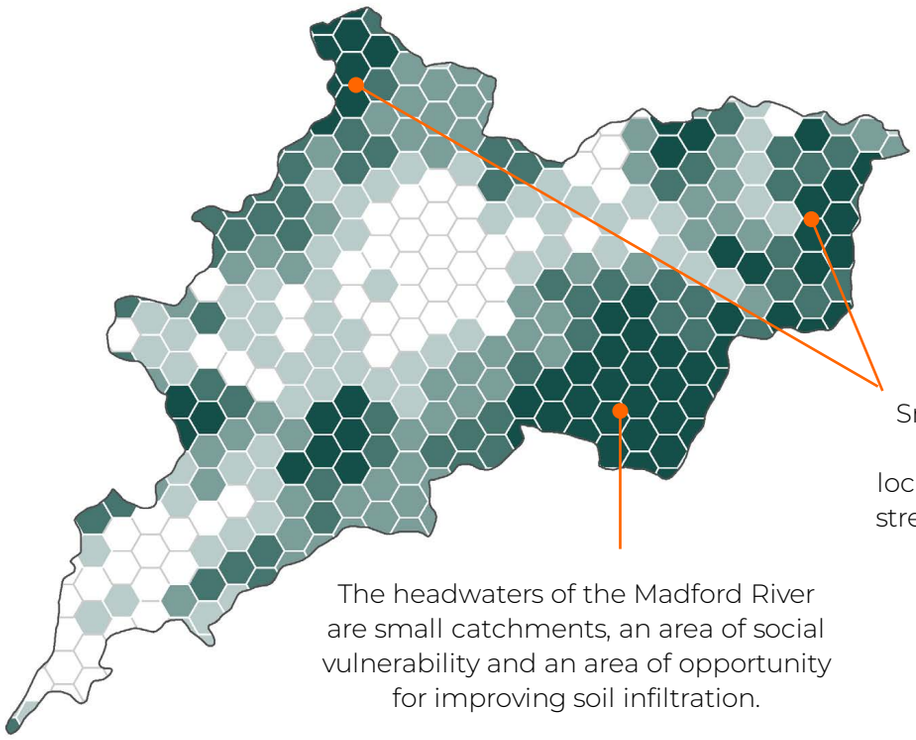
Following discussion and refinement with stakeholders, and alongside more detailed information, these maps will be used to guide prioritisation and action across the catchment.

Opportunities for Enhancement

Summaries for comparison

Flooding

Opportunities for nature-based flood resilience features will be most effective and have most positive impact where they fall within small catchments upstream of properties at risk and vulnerable communities.



The headwaters of the Madford River are small catchments, an area of social vulnerability and an area of opportunity for improving soil infiltration.

'POTENTIAL AREAS FOR IMPROVED RESILIENCE'
+
SMALL CATCHMENTS
+
SOCIAL FLOOD VULNERABILITY

For detailed map, see page 23.

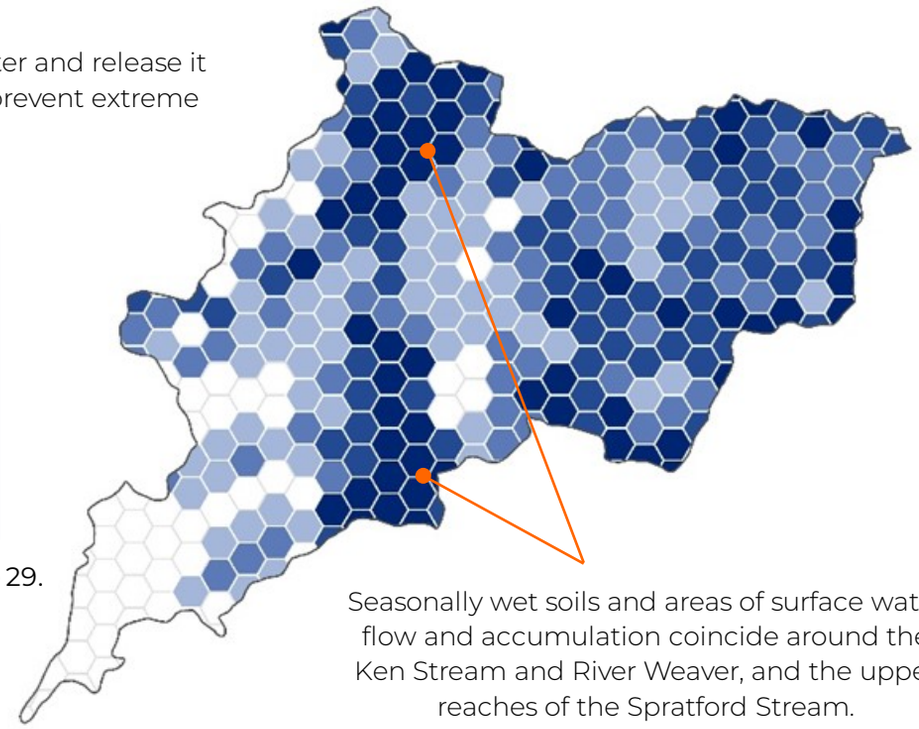
Small catchments upstream of properties at risk tend to be located around the headwaters of streams, and therefore around the edges of the catchment.

Drought

Wetlands help to store water and release it slowly, which can help to prevent extreme low flows and droughts.

SURFACE RUNOFF ZONES
+
FLOODPLAIN
+
WET SOILS
+
EXCLUSION AREAS

For detailed map, see page 29.



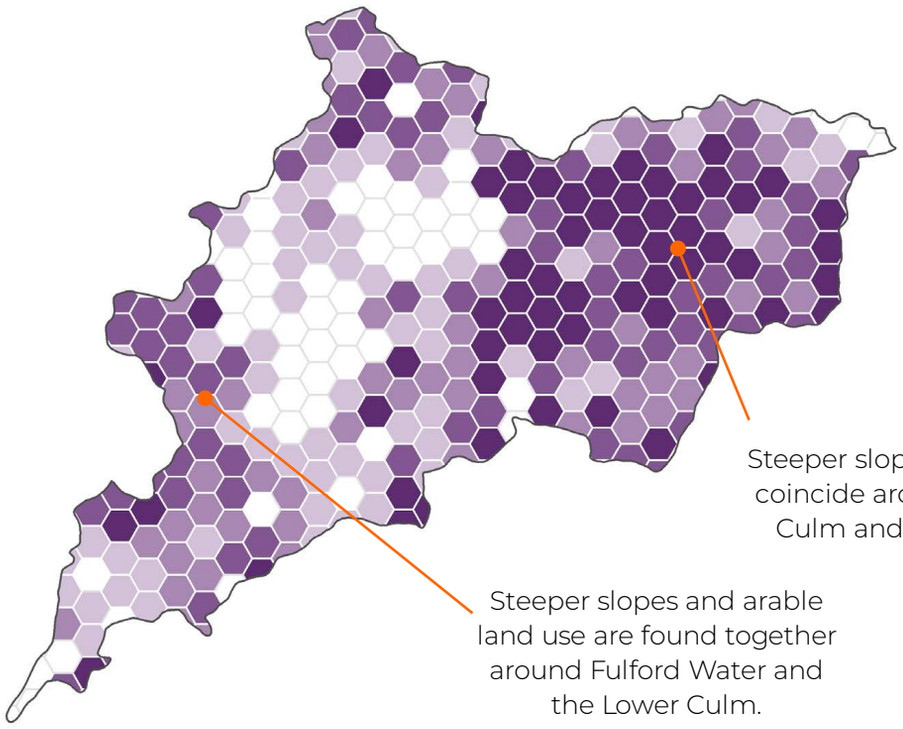
Seasonally wet soils and areas of surface water flow and accumulation coincide around the Ken Stream and River Weaver, and the upper reaches of the Spratford Stream.

Opportunities for Enhancement

Summaries for comparison

Water Quality

Where factors which are likely to negatively impact water quality coincide, there is a need for work to mitigate these risks and therefore work to protect water quality.



PROXIMITY TO RIVERS
+
SLOPE
+
LAND USE
+
SOIL TYPE
+
SURFACE RUNOFF ZONES

For detailed map, see page 39.

Steeper slopes and clay soils coincide around the Upper Culm and its tributaries.

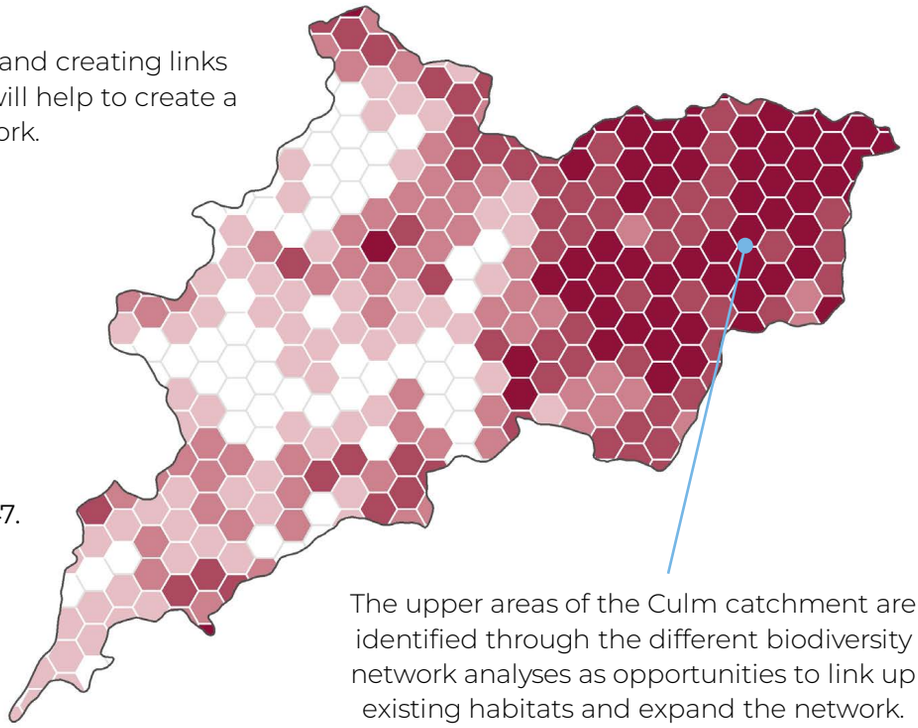
Steeper slopes and arable land use are found together around Fulford Water and the Lower Culm.

Biodiversity

Joining up habitat patches and creating links between existing habitats will help to create a more resilient habitat network.

HABITAT NETWORK ENHANCEMENT OPPORTUNITIES
+
STRATEGIC ZONES
+
EXCLUSION AREAS

For detailed map, see page 47.



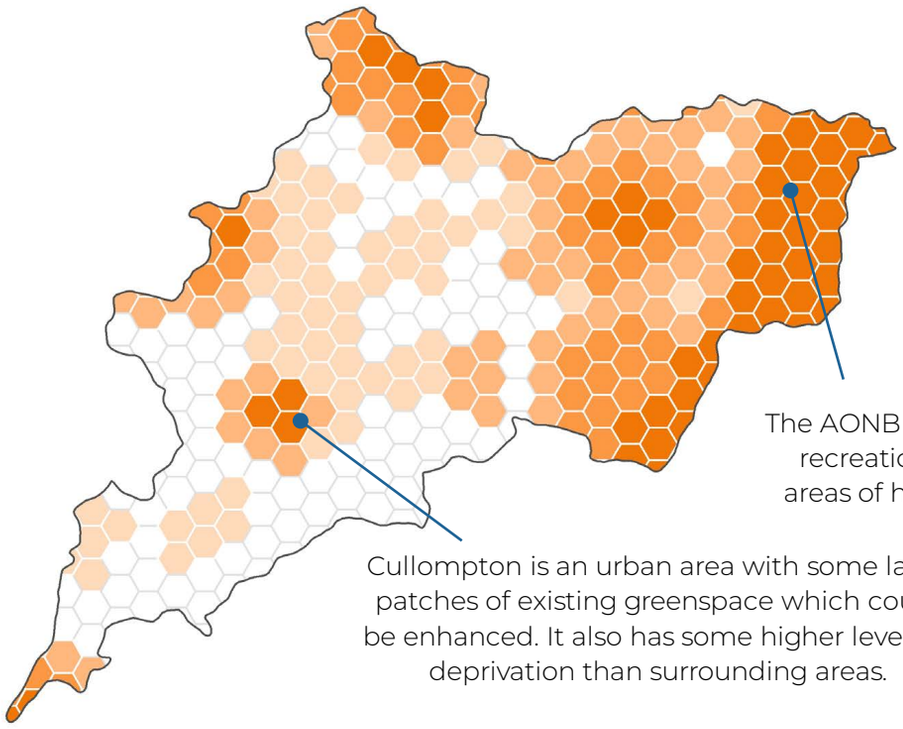
The upper areas of the Culm catchment are identified through the different biodiversity network analyses as opportunities to link up existing habitats and expand the network.

Opportunities for Enhancement

Summaries for comparison

Recreation

Improving access to outdoors recreation will be most effective close to where people live, especially where there are areas which score less well on the index of multiple deprivation, and where there are existing priorities for access and enjoyment of natural spaces.



PROXIMITY TO URBAN AREAS
+
GREENSPACES CLOSE TO URBAN AREAS
+
DEPRIVATION
+
PRIORITY AREAS

For detailed map, see page 53.

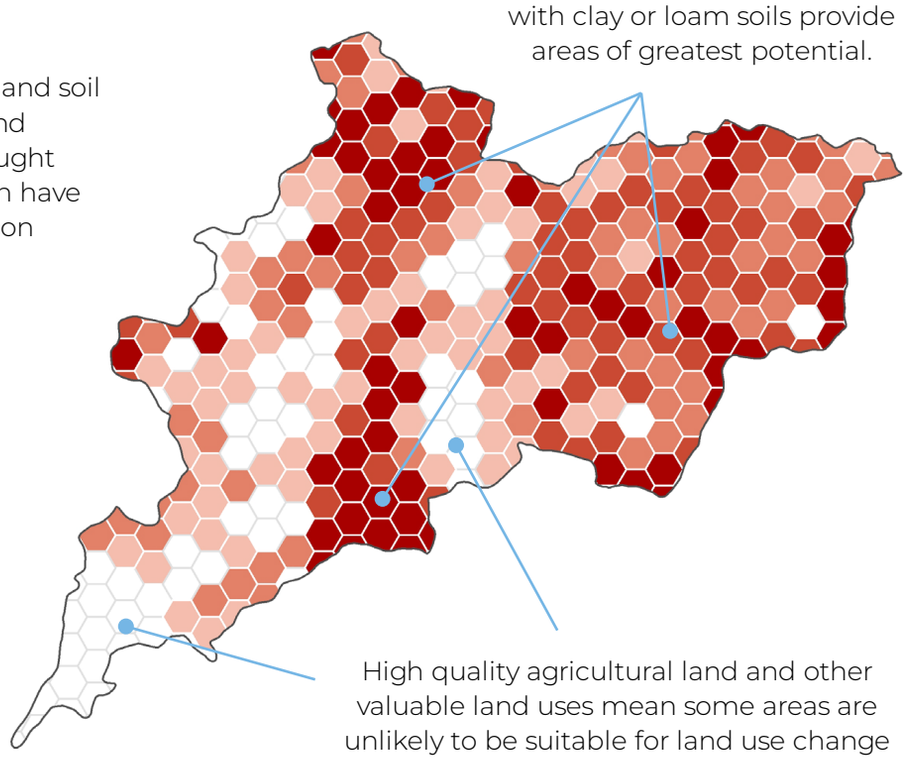
The AONB is a priority area for recreation and has some areas of higher deprivation.

Cullompton is an urban area with some large patches of existing greenspace which could be enhanced. It also has some higher levels of deprivation than surrounding areas.

Carbon

Current land use, land type and soil type, combined with wetland opportunities from the Drought section, suggest areas which have potential for improved carbon sequestration.

Wetland opportunities combined with clay or loam soils provide areas of greatest potential.



LAND USE
+
AGRICULTURAL LAND CLASS
+
SOIL TYPE
+
WETLAND OPPORTUNITY
+
EXCLUSION AREAS

High quality agricultural land and other valuable land uses mean some areas are unlikely to be suitable for land use change

For detailed map, see page 57.

Next Steps

Effectively protecting property, providing infrastructure and enhancing the environment takes knowledge, understanding, collaboration and co-creation. This Environmental Evidence Review provides a backdrop for this journey by delving deep into the scientific knowledge and current understanding we have of the Culm catchment.

We know our climate and environment is changing and we know there will be unavoidable impacts. We also know some of the challenges we can take action on and opportunities we can grasp in seeking to respond to these impacts and their consequences for environment, society and economy. Strategic planning on a catchment scale to implement the Potential Areas for Improved Resilience 'PAIRS' identified through flood modelling enables greater cooperation amongst stakeholders with diverse requirements and preferences. Broadening out from the focus on scientific knowledge and understanding presented in this report, the Blueprint for the Culm and the Blueprint Forum represent the next step in the journey. The Blueprint will explore nature-based solutions as cost-effective and multi-benefit approaches to catchment enhancement for all, enabling response and adaptation to living with climate and environmental change.

Sarah Ward

Connecting the Culm Co-creation Specialist

Data Sources

Please note: The dataset Red/Amber/Green classes are semi-subjective, and are used to give a quick indication of the dataset characteristics. More detail has been provided below to aid interpretation. Some datasets (e.g. soil, geology, terrain and location of features such as rivers and lakes) do not change regularly and therefore are not given a RAG status for age.

Dataset	Code	Source	Attribution Statement	Age		Resolution	
Abstraction Licences	ABS	Environment Agency via CaBA	Contains Environment Agency information © Environment Agency and/or database right	G	2019	A	Summarised to waterbody due to licence restrictions.
Agricultural Land Class	ALC	Natural England	© Natural England copyright. Contains Ordnance Survey data © Crown copyright and database right 2019.	G	Revised 2019	A	Digitised from the published 1:250,000 map
Areas Of Outstanding Natural Beauty	AONB	Natural England	© Natural England copyright. Contains Ordnance Survey data © Crown copyright and database right 2020.	n/a		n/a	
Ancient Woodland	AW	Natural England	© Natural England copyright. Contains Ordnance Survey data © Crown copyright and database right 2020.	G	Created 2013, revised 2020	G	Detailed mapping
Potential Sites Of Hydropower Opp.	BAR	Environment Agency	© Environment Agency copyright and/or database right 2015. All rights reserved.	A	2015	A	Point location of key barriers
Bedrock Geology & Superficial Deposits	BGS	British Geological Survey	Reproduced with the permission of the British Geological Survey ©UKRI. All rights Reserved	n/a		A	1:625 000 scale
Cams	CAMS	Environment Agency	© Environment Agency copyright and/or database right 2015. All rights reserved.	G	Revised 2019	A	Based on WFD waterbody catchments
Water Framework Directive – Reasons For Not Achieving Good	CDE-RNAG	Environment Agency	Sourced from Catchment Data Explorer https://environment.data.gov.uk/catchment-planning/	A	2016	A	Main rivers are assessed
Water Framework Directive – Waterbody Status	CDE-STAT	Environment Agency	Sourced from Catchment Data Explorer https://environment.data.gov.uk/catchment-planning/	G	2019	A	Main rivers are assessed
CEH Carbon In Vegetation	CEHCV	Centre for Ecology and Hydrology	Contains data supplied by Natural Environment Research Council © NERC (Centre for Ecology & Hydrology)	R	Created in 2016, based on 2007 data	R	1km grid
CEH Soil Nitrogen	CEHN	Centre for Ecology and Hydrology	Contains data supplied by Natural Environment Research Council © NERC (Centre for Ecology & Hydrology)	R	Created in 2012, based on 2007 data	R	1km grid
CEH Plant Indicators Of Habitats In Good Condition	CEHPI	Centre for Ecology and Hydrology	Contains data supplied by Natural Environment Research Council © NERC (Centre for Ecology & Hydrology)	R	Created in 2016, based on 2007 data	R	1km grid
CEH Soil Carbon	CEHSC	Centre for Ecology and Hydrology	Contains data supplied by Natural Environment Research Council © NERC (Centre for Ecology & Hydrology)	R	Created in 2012, based on 2007 data	R	1km grid
CEH Topsoil Invertebrates	CEHTI	Centre for Ecology and Hydrology	Contains data supplied by Natural Environment Research Council © NERC (Centre for Ecology & Hydrology)	R	Created in 2012, based on 2007 data	R	1km grid
Census - Population	CEN-2011	NomisWeb	Data sourced from NomisWeb	R	2011	G	Most detailed census output areas
Census Output Areas	CEN-COA	Office for National Statistics	Contains both Ordnance Survey and ONS Intellectual Property Rights.	n/a	Spatial data only, joined to other datasets as relevant	G	Most detailed census areas
Lower Super Output Areas	CEN-LSOA	Office for National Statistics	Contains both Ordnance Survey and ONS Intellectual Property Rights.	n/a	Spatial data only, joined to other datasets as relevant	A	Mid detail census areas
Consented Discharges	CON	Environment Agency via CaBA	Contains Environment Agency information © Environment Agency and/or database right	-	Unconfirmed	G	Point location
Country Parks	CP	Natural England	Natural England	G	Regularly updated	G	Detailed mapping
CRoW Access Land	CROW	Natural England	© Natural England copyright. Contains Ordnance Survey data © Crown copyright and database right 2020	G	Regularly updated	G	Detailed mapping
CSO Spill data 2019	CSO	The Rivers Trust	The Rivers Trust, The Guardian, Environment Agency	G	2019	A	Only some CSOs have spill monitoring
Countryside Stewardship Priority Areas	CSP	Natural England via CaBA	© Natural England copyright. Contains Ordnance Survey data © Crown copyright and database right	A	2015	G	Detailed mapping
Detailed River Network	DRN	Environment Agency via CaBA	Contains Environment Agency information © Environment Agency and/or database right	n/a		G	Detailed mapping

Data Sources

Dataset	Code	Source	Attribution Statement	Age		Resolution	
LIDAR Composite 2m Digital Terrain Model	DTM2	Environment Agency	Contains Environment Agency information © Environment Agency and/or database right	n/a		G	2m
Terrain50	DTM50	Ordnance Survey	Contains OS data © Crown Copyright [and database right 2020	n/a		A	50m
Econet (Multiple Habitat Inventories)	ECO	Natural England	© Natural England copyright. Contains Ordnance Survey data © Crown copyright and database right 2010	R	Created 2010	G	Detailed mapping
Forestry Commission Priority Areas	FCP	Forestry Commission	Contains Forestry Commission information licensed under the Open Government Licence v3.0. Contains OS data © Crown copyright and database right 2016	A	2016	G	Based on census output areas
Risk Of Flooding from Rivers And Sea	FFR	Environment Agency	© Environment Agency copyright and/or database right 2018. All rights reserved. Some features of this map are based on digital spatial data from the Centre for Ecology & Hydrology, © NERC (CEH) © Crown copyright and database rights 2018 Ordnance Survey 100024198	G	2018	A	Based on 50m cells
Flood Maps for Planning (Rivers And Sea) - Flood Zone 2	FZ2	Environment Agency	Environment Agency copyright and/or database right 2018. All rights reserved.Some features of this map are based on digital spatial data from the Centre for Ecology & Hydrology, © NERC (CEH) © Crown copyright and database rights 2018 Ordnance Survey 100024198	G	2018	G	Detailed mapping
Heritage At Risk	HAR	Historic England	Historic England 2020. Contains Ordnance Survey data © Crown copyright and database right 2020. The Historic England GIS Data contained in this material was obtained May 2020. The most publicly available up to date Historic England GIS Data can be obtained from http://www.HistoricEngland.org.uk.	G	Regularly updated	G	Detailed mapping
Highways England Priority Areas	HEP	Highways England via CaBA data package	Accessed via CaBA data package, attribution statement not provided	-	Unconfirmed	G	Detailed mapping
Historic Environment Record	HER	Devon County Council	Copyright 2019. Devon County Council.	G	2019	G	Detailed mapping
Historic Flood Extent	HFE	Environment Agency	© Environment Agency copyright and/or database right 2018. All rights reserved	G	Regularly updated	G	Detailed mapping
Historic Landscape Characterisation	HLC	Devon County Council	Data copyright © Historic England, Dartmoor National Park Authority, Tamar Valley AONB, Devon County Council Historic Environment Team	n/a		G	Detailed mapping
Habitat Network Map	HNM	Natural England	© Natural England copyright. Contains Ordnance Survey data © Crown copyright and database right 2020	G	2020	G	Created from high resolution habitat data
Index of Multiple Deprivation	IMD	Ministry of Housing, Communities & Local Government	Data sourced from Ministry of Housing, Communities & Local Government	G	2019	A	Joined to LSOA
Invasive Non-Native Species	INNS	Environment Agency	Contains Environment Agency information © Environment Agency and/or database right	A	2016	R	Data collected during river surveys so skewed towards aquatic/riparian species
Listed Buildings	LB	Historic England	Historic England 2020. Contains Ordnance Survey data © Crown copyright and database right 2020. The Historic England GIS Data contained in this material was obtained May 2020. The most publicly available up to date Historic England GIS Data can be obtained from http://www.HistoricEngland.org.uk.	G	Regularly updated	G	Detailed mapping
Land Cover Map 2007	LCM-2007	Centre for Ecology and Hydrology	LCM2007 © and database right NERC (CEH) 2019. All rights reserved.	R	2007	G	Detailed mapping
Land Cover Map 2015	LCM-2015	Centre for Ecology and Hydrology	© NERC (CEH) 2017	A	2015	G	Detailed mapping

Data Sources

Dataset	Code	Source	Attribution Statement	Age		Resolution	
Local Nature Reserves	LNR	Natural England	© Natural England copyright.	G	Regularly updated	G	Detailed mapping
NATMAP Vector Soils	NAT	Cranfield University NSRI	Copyright © 2019 Cranfield University | All Rights Reserved	n/a		A	1: 250,000 scale
National Cycle Network	NCN	Sustrans	© 2018 Sustrans	G	2018	G	Detailed mapping
National Forest Inventory	NFI	Forestry Commission	Contains Forestry Commission information licensed under the Open Government License v3.0	G	2018	G	Detailed mapping
National Trust Land Always Open	NT	National Trust	© National Trust	G	Regularly updated	G	Detailed mapping
Nitrate Vulnerable Zones	NVZ	Environment Agency	Open Government Licence © Environment Agency copyright and/or database right. Derived in part from geological mapping data provided by the British Geological Survey © NERC. Derived in part from data provided by the National Soils Research Institute © Cranfield University. Contains Ordnance Survey data © Crown copyright and database rights 2016. Derived in part from data provided by the Department for the Environment, Farming and Rural Affairs © Crown 2016 copyright Defra. Derived in part from data provided by the Centre for Ecology and Hydrology © NERC. Derived in part from data provided by UK Water Companies.	A	2017	G	Detailed mapping
Open Mosaic Habitat	OMH	Natural England	© Natural England copyright. Contains Ordnance Survey data © Crown copyright and database right 2020	A	Created 2010, revised 2017	G	Detailed mapping
ONS Built-up Areas	ONS	Office for National Statistics	Office for National Statistics licensed under the Open Government Licence v.3.0 Contains OS data © Crown copyright and database right 2017	n/a		n/a	
WFD Operational Catchments	OPC	Environment Agency	© Environment Agency copyright and/or database right 2014. All rights reserved.	n/a		n/a	
OS BoundaryLine	OSBL	Ordnance Survey	Contains OS data © Crown Copyright and database right 2020	n/a		n/a	
OS Greenspace	OSG	Ordnance Survey	Contains OS data © Crown Copyright and database right 2020	G	Regularly updated	G	Detailed mapping
OS Strategi	OSS	Ordnance Survey	Contains OS data © Crown Copyright and database right 2014	n/a		n/a	
OS VectorMap	OSVM	Ordnance Survey	Contains OS data © Crown Copyright and database right 2020	G	Regularly updated	G	Detailed mapping
PAIRS	PAIRS	JBA	Created for the Connecting the Culm project	G	2020	G	Detailed mapping
Properties at Risk	PAR	Devon County Council	Copyright 2019. Devon County Council.	G	2000-2019	A	Summarised to hotspots
Parks and Gardens	PG	Historic England	© Historic England 2020. Contains Ordnance Survey data © Crown copyright and database right 2020. The Historic England GIS Data contained in this material was obtained on [date]. The most publicly available up to date Historic England GIS Data can be obtained from http://www.HistoricEngland.org.uk	G	Regularly updated	G	Detailed mapping
Priority Habitat Inventory	PHI	Natural England	© Natural England copyright. Contains Ordnance Survey data © Crown copyright and database right 2020	G	Created 2014, revised 2019	G	Detailed mapping
Pollution incidents	POL	Environment Agency via CaBA data package	Contains Environment Agency information © Environment Agency and/or database right	-	Unconfirmed	G	Point locations
Public Rights of Way - Devon	PROW-D	Devon County Council	Copyright 2019. Devon County Council.	G	Regularly updated	G	Detailed mapping
Public Rights of Way - Somerset	PROW-S	Somerset County Council	© Copyright of Somerset County Council	G	Regularly updated	G	Detailed mapping
Riverfly survey results - River Exe System	RF	River Exe & Tributaries Association	River Exe & Tributaries Association	G	2019	A	Sites throughout Exe catchment

Data Sources

Dataset	Code	Source	Attribution Statement	Age		Resolution	
Scheduled Monuments	SCH	Historic England	Historic England 2020. Contains Ordnance Survey data © Crown copyright and database right 2020. The Historic England GIS Data contained in this material was obtained May 2020. The most publicly available up to date Historic England GIS Data can be obtained from http://www.HistoricEngland.org.uk.	G	Regularly updated	G	Detailed mapping
SEPARATE	SEP	CaBA data package	Data sourced from CaBA Data Package v5	-	Unconfirmed	A	Based on WFD waterbody catchments
Social Flood Risk Index	SFRI	Climate Just	Contains derived data from the Office for National Statistics licensed under the Open Government Licence © Crown copyright and database right 2012; Contains Ordnance Survey data © Crown copyright and database right 2012	A	2017	A	Based on Lower Super Output Areas
Small Catchments Upstream Of Properties At Risk	SMC	Westcountry Rivers Trust	Westcountry Rivers Trust	n/a		n/a	
Strategic Nature Areas	SNA	Biodiversity South West	© Biodiversity South West	R	2005	G	Detailed mapping
Source Protection Zones	SPZ	Environment Agency	© Environment Agency copyright and/or database right 2016. All rights reserved.	A	2016	G	Detailed mapping
Sites of Special Scientific Interest	SSSI	Natural England	© Natural England copyright. Contains Ordnance Survey data © Crown copyright and database right 2020	G	Regularly updated	G	Detailed mapping
WFD Waterbody Catchments	WBC	Environment Agency	© Environment Agency copyright and/or database right 2015. All rights reserved.	n/a		A	Main rivers are assessed
WFD Rivers and Canals Lines	WBL	Environment Agency	Contains Environment Agency information © Environment Agency 2017. All rights reserved. Based on digital spatial data licensed from the Centre for Ecology & Hydrology, © NERC (CEH). © Contains Ordnance Survey data © Crown copyright and database right 2013.	n/a		A	Main rivers are assessed

References

Much of the data and information in this report has been sourced from the datasets listed in the previous pages. In addition, the following sources have been used for background information, methods and modelling:

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