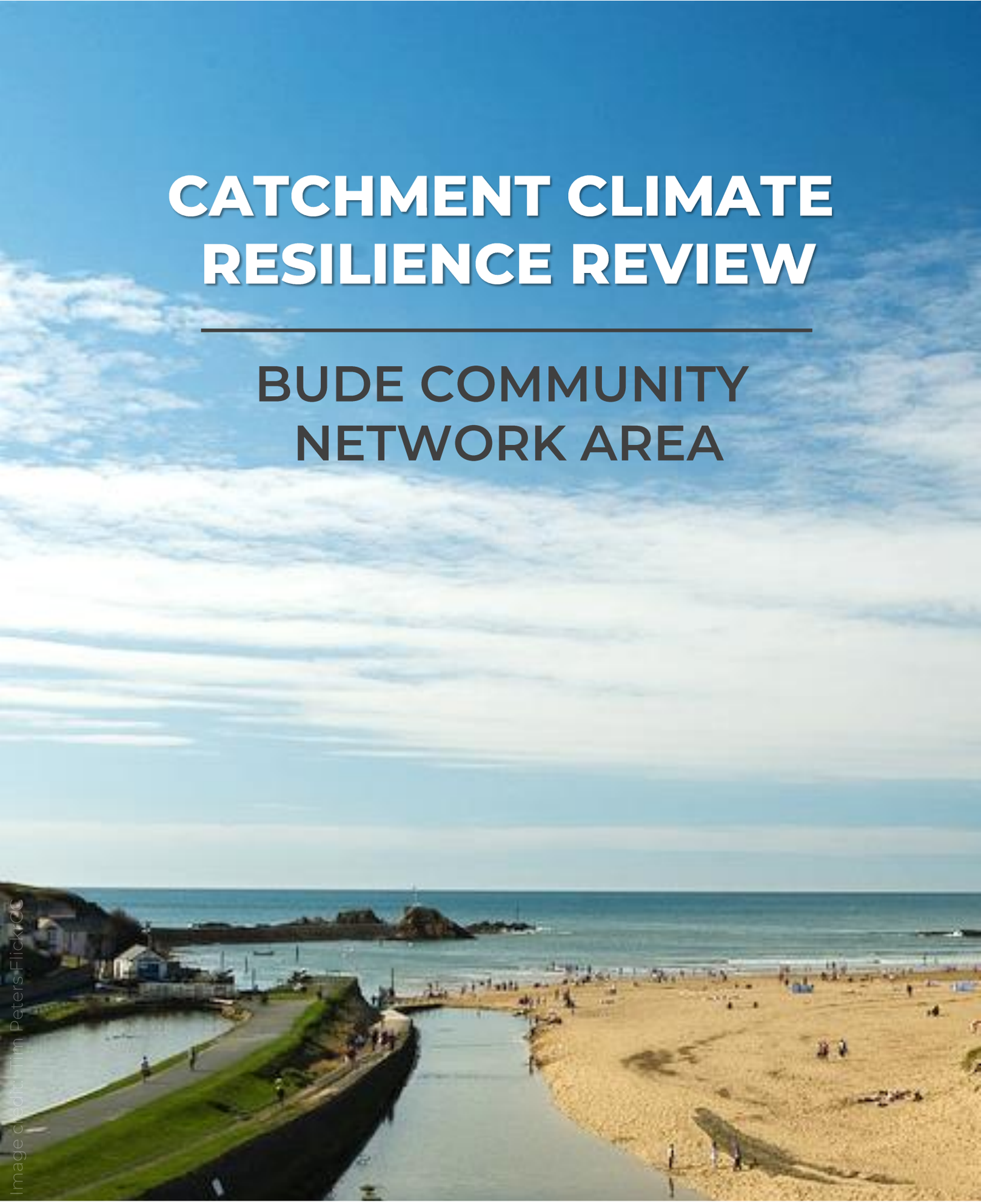
CATCHMENT CLIMATE RESILIENCE REVIEW

BUDE COMMUNITY NETWORK AREA



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WESTCOUNTRY RIVERS TRUST

BUDE CLIMATE PARTNERSHIP

BUDE CLIMATE PARTNERSHIP

Bude Climate Partnership is a group of 12 local community organisations, awarded £200,000 by the National Lottery Climate Action Fund for an 18-month project to investigate, test and develop ways to protect the Bude area and community against the impact of climate change.

The successful bid for Lottery funding will enable the Bude area to develop its community response to climate change. It follows the declaration of a Climate Emergency by Bude-Stratton Town Council in September 2019.

Bude Climate Partnership brings together the skills, experiences and interests of a wide variety of local environmental and community-interest groups. Its seven core members comprise: The 2-Minute Foundation, Bude Cleaner Seas Project, Connect Bude, Westcountry Rivers Trust, ReFill Shop, Repair Café Bude and Bude Coastal Community Team.

EXECUTIVE SUMMARY

The river catchments of the Strat and Neet - along with a number of smaller coastal catchments make up the rural hinterland of Bude-Stratton. They are largely dominated by dairy farms with some livestock and maize growing too. Rural areas can have a huge role to play in the fight against climate change - both by reducing carbon dioxide emissions and by sequestering carbon.

This project will enable the Bude Climate Partnership to investigate, test and develop ways to protect the Bude area and community against the impact of climate change and set out its community response to climate change. This Catchment Climate Resilience Review brings together environmental data and evidence in order to understand which areas within the Bude Community Network Area (CNA) will be at greatest risk from climate change and what specific pressures could cause those risks to be realised. The report walks you through, theme by theme, from the CNA 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. Bringing all this evidence together, the report then presents the current condition of the landscape, as well as identifying where the vulnerabilities and challenges are located. Finally, and most importantly, it recommends mitigation approaches and highlights where in the landscape those will be best placed to deliver maximum benefit.

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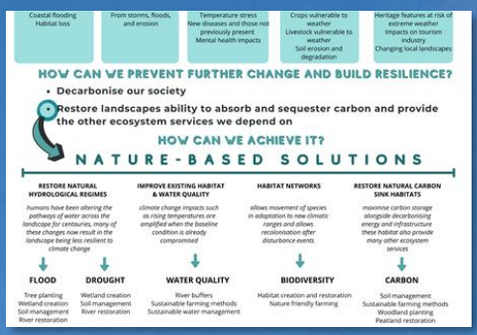

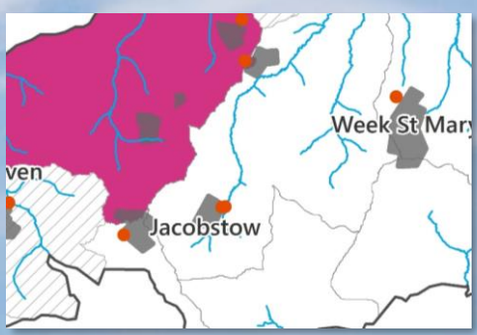

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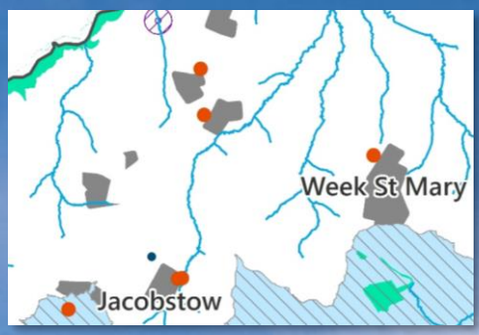

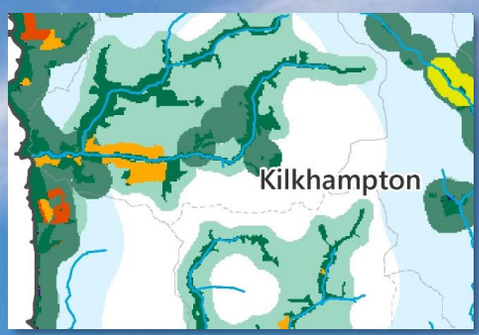

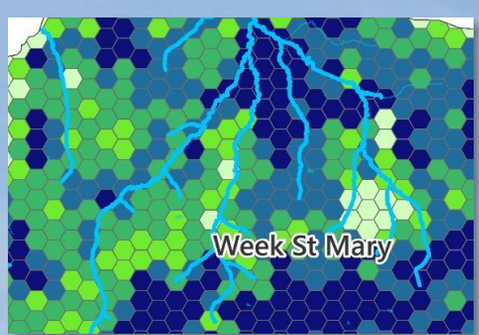

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INTRODUCTION

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BUDE CLIMATE PARTNERSHIP

The project is centred upon the north Cornwall resort town of Bude but embraces the entirety of the Bude Community Network Area as defined by Cornwall Council. This includes the eleven most northerly civil parishes in Cornwall: Bude-Stratton, Jacobstow, Kilkhampton, Launcells, Marhamchurch, Morwenstow, North Tamerton, Poundstock, St Gennys, Week St Mary and Whitstone. These parishes have a combined population of 18,140 people.

Bude and the surrounding parishes sit on a thin strip of land between the Atlantic Ocean and the Cornish border with Devon. At the sharpest edge of the impacts of climate change, it is more affected by peripherality than anywhere in mainland Britain. Farmland predominates, containing tributaries of the river Neet, which empties into the sea at Bude. The area has been identified as one of the least altered, anciently enclosed landscapes in Cornwall. The largest concentrations of population are Bude, Kilkhampton, Marhamchurch, Poughill, Stratton, Week St Mary and Widemouth.

Extreme weather is already a regular occurrence, and the coastline is eroding as a result of above average rainfall and winds. The communities are battling to prevent rising sea levels and increasingly fierce storm events from flooding Bude.

At the same time Bude is further from a railway station than anywhere in the country. With few buses it's an hour's car drive to the nearest hospital, tertiary education institution or local government office and it lacks the municipal and emergency services that other parts of the country take for granted.

As an exposed coastal community, Bude has no choice but to respond seriously and immediately to the threats posed by climate change. It is an existential dilemma that will seriously impact on the way of life and well-being to a considerably greater extent than less exposed, less peripheral locations.

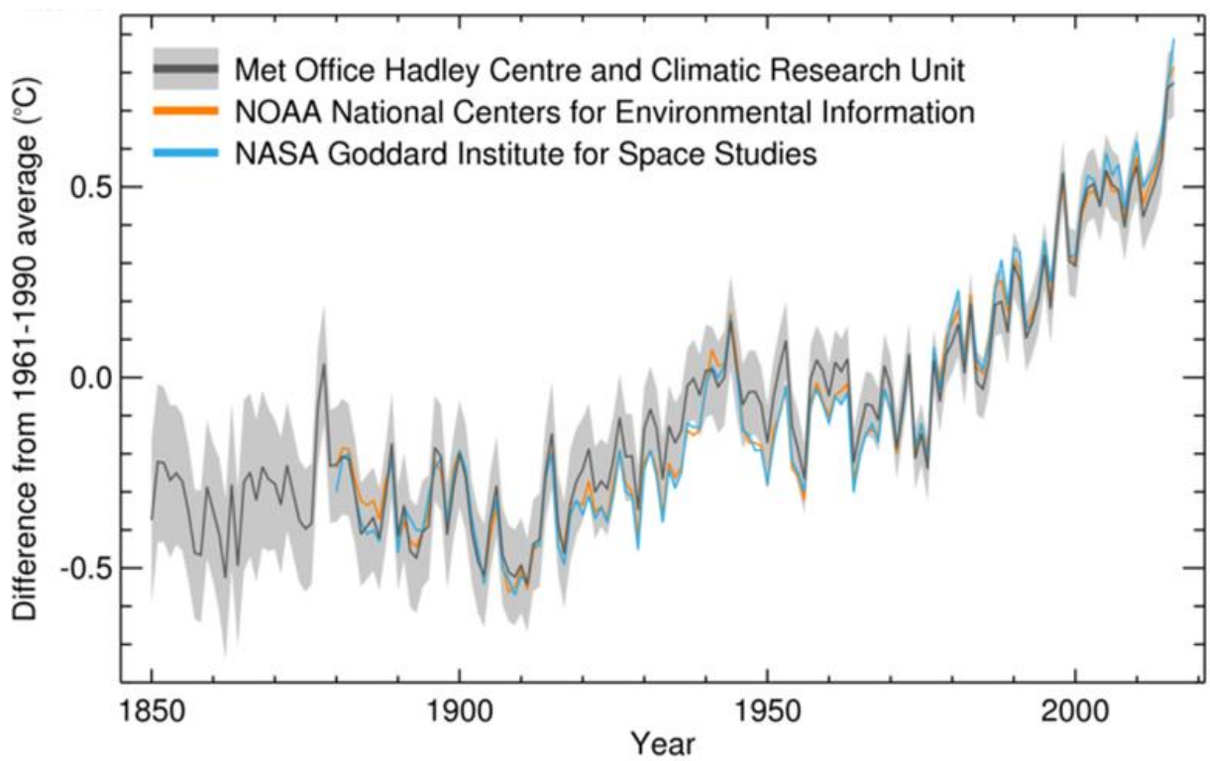
A key stage in the development phase of the Bude Climate Partnership is to build understanding about the landscape amongst partners and stakeholders. This will support the design and implementation of measures for mitigation and adaptation to climate change, targeted in areas where they will have the greatest benefit for people and nature. By reviewing the available data and information for the area we can use it to make positive, evidence-based decisions. The analysis used to create this report can also be used to support the projects other studies into the resilience of infrastructure and community services to climate change.

Bude CNA is largely rural and so this report will also look to understand the current farming landscape, as it is likely to hold the greatest opportunities for increasing resilience. For this work we have used only data which is openly available and therefore it may not be the most up to date or detailed versions. A key step in the next stage of the project will be to further explore this topic, including on the ground surveys and information gathering from farmers and land managers.

BUDE AND THE CLIMATE CRISIS

CLIMATE CHANGE OVERVIEW

Over the last 150 years the average temperature of the planet has risen by around 1°C[1]. 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. 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. The average temperature of the planet has been steadily warming since the industrial revolution.



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

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

- **Extreme weather** – heatwaves, droughts, and floods are becoming more intense and frequent.
- **Rising sea levels** - melting glaciers and the expansion of warming ocean water is causing sea levels to rise
- **Ocean acidification** – the ocean absorbs carbon dioxide and becomes more acidic, damaging coral reefs and other essential marine ecosystems.
- **Loss of biodiversity** – climate change and other threats are putting many species at risk of extinction
- **Spread of diseases** – ranges of vector borne diseases are expanding as favourable conditions spread

The 2015 Paris Agreement of the UN Framework Convention on Climate Change (UNFCCC) commits nations to limit global temperature rise well below 2°C and pursue efforts to limit it to 1.5°C (compared to preindustrial levels). This requires a 45% decline in global emissions by 2030 and net zero by 2050[2]. In 2018, the IPCC's Special Report: "Global Warming at 1.5 Degrees Celsius" concluded the difference between 1.5°C and 2°C degrees could mean substantially more poverty, extreme heat, sea level rise, habitat loss, and drought. If no interventions are taken, global average temperatures could rise by up to 4°C by 2100. The impacts of this on us and the rest of life on the planet will be dangerously high. We can seek to adapt to warming levels below 2°C, but above this level it will become increasingly hard for normal life to continue.

The UK's commitment to reaching net zero by 2050 is also reflected under the statutory requirement of the Climate Change Act 2008. Achieving this target will not only require the decarbonisation of our energy, transport and other sectors, but significant changes to the management of our environment. Our natural ecosystems will be essential in achieving net zero as they act as carbon sinks, balancing any unavoidable emissions. They also provide us with many essential services that would be extremely expensive and energy intensive if we had to soley provide for ourselves, such as clean water and storm protection. However, many of our habitats in the UK are in a degraded state and this means they are often sources of greenhouse gases and are compromised in their ability to provide essential services[3]. The protection, expansion and improved management of natural areas is therefore an essential part of preventing dangerous climate change and surviving the changes we have already started to experience.

THE BIODIVERSITY CRISIS

In addition to climate change our environment is already suffering a biodiversity crisis. This is another largely human induced threat as it is caused by land use change, pollution, and over exploitation. The biodiversity crisis is also exacerbated by climate change and reduces our resilience to it. Our efforts to tackle these two challenges must be integrated as supporting biodiversity will help the landscape to adapt to the changing climate and us achieve net zero emissions[3].

WHAT DOES CLIMATE CHANGE MEAN FOR BUDE?

Cornwall is already suffering from the visible impacts of a changing climate such as increased flooding, wind, rain and storm intensities. Yet there are also hidden impacts such as droughts, biosecurity, invasive species, and seasonal changes to the food chains for species. Cornwall acts as a weather-break and break-water for the south of the UK, and is particularly susceptible to flood risk from intense rainfall and coastal communities are at risk from storms and erosion.

The following tables show what conditions could be experienced in Bude under different levels of warming[5]:

HOTTEST DAY

Temperature	Current (1991-2019)	2ºC Warming	4ºC Warming
Summer	30.9ºC	32.7ºC	37.6ºC
Winter	17.2ºC	17.8ºC	18.9ºC

SUMMER DAYS*

Days > 25ºC per month	Current (1991-2019)	2ºC Warming	4ºC Warming
Summer	1	2	7

**The World Meteorological Organization (WMO) defines any day with a maximum temperature above 25C as a "summer day".*

RAINY DAYS

Average rainy days per month	Current (1991-2019)	2ºC Warming	4ºC Warming
Summer	12	11	9
Winter	16	16	16

WETTEST DAYS

Rainfall on wettest day	Current (1991-2019)	2ºC Warming	4ºC Warming
Summer	64mm	73mm	80mm
Winter	46mm	56mm	57mm

METHOD

This document presents the available environmental evidence for the Bude CNA. 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[5]. This allows stakeholders to design and implement targeted nature-based solutions that can provide multiple benefits for people and nature. The concepts of natural capital, ecosystem services and nature-based solutions are described in more detail on the following page. For an overview of how the focus of this report fits into the climate and biodiversity crisis see the summary of page 11.

For this analysis we have focused on the themes of; Flooding, Drought, Water Quality, Biodiversity and Carbon loss. These threats are best suited to this type of analysis and other threats will be investigated through further projects in the Bude Climate Partnership development and implementation stages, such as human health, cultural impacts and infrastructure assessment. Sea level rise and the resulting coastal erosion is a key threat in the Bude CNA and although it is not covered here there is already work in progress by the Environment Agency. This report will touch on the threats to agriculture through each theme but a further indepth study is required to follow on from this initial work, which will require dialogue with and input from the local community.

Each theme is separated into chapters that follow this process:

1) PRIORITY AREAS AND DRIVERS

Identifies the priority areas, drivers and receiving features affected by the provision or non-provision of the ecosystem 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

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 nature based solutions in suitable locations.

3) ASSESSING THE PROVISION OF THE SERVICE

All available data and evidence should 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

Criteria are developed and mapped to define areas of priority, suitability and/or opportunity for the delivery of nature based solutions which can enhance the service provision, which will increase resilience to climate change.

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.

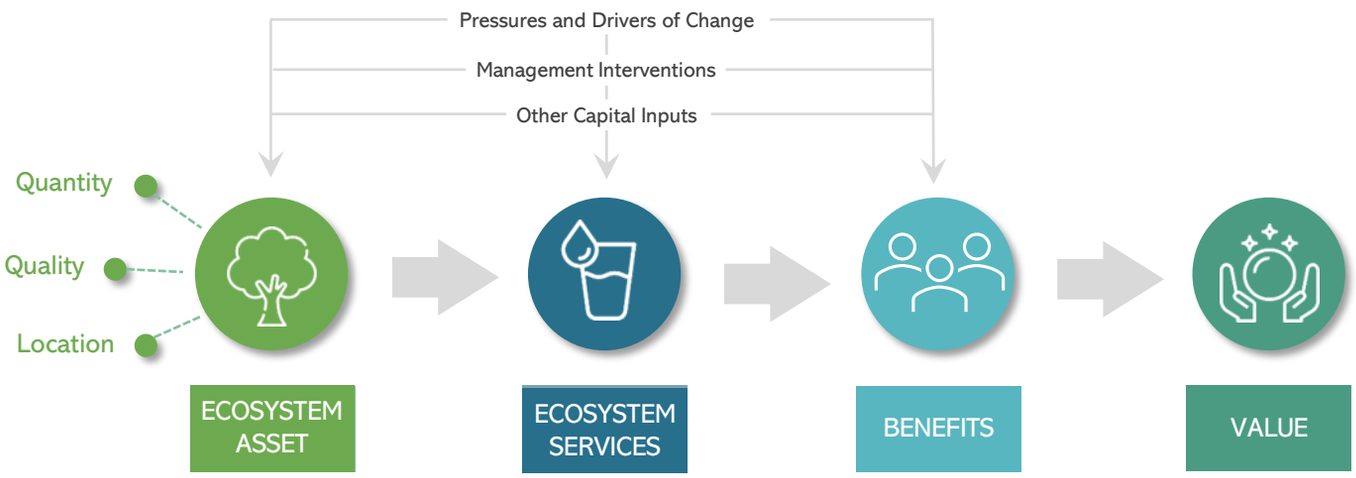
DATA

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. There is more detail about the datasets on page 59.

NATURAL CAPITAL, ECOSYSTEM SERVICES & NATURE BASED SOLUTIONS

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 water and air purification which provides the natural assets of clean water and clean air. The diagram below show the links between assets, service and benefits.



© Natural England, 2019 [6]

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.

Climate change poses a threat to the ecosystem assets in our landscape and therefore the services we benefit from. To increase the resilience of communities like Bude to climate change we must work together to protect, enhance and restore our natural assets in a way that also supports biodiversity and future climate change adaptation.

We can achieve this through **nature based solutions**, which involves working with nature to address societal challenges, providing benefits for both human well-being and biodiversity. They are actions that are underpinned by biodiversity and are designed and implemented with the engagement and consent of local communities.

The types of solutions we can used depend on the location within the landscape, the natural assets present and the conditions experienced in that location. This report indicates opportunities to implement these sort of nature based solution through this project:

- Tree planting and woodland creation
- Wetland creation
- Soil management
- River restoration
- River buffers
- Sustainable farming methods
- Sustainable water management
- Habitat creation and restoration
- Nature friendly farming

CLIMATE CHANGE

Fossil fuel burning
Land use change

→ Changing global temperature patterns
Changing global precipitation patterns
Increasing severity and frequency of storms and extreme weather events

↓

Floods
Droughts
Extreme heat
Extreme cold
Violent storms
Seasonal shifts

→ **DEGRADED ECOSYSTEMS**

BIODIVERSITY CRISIS

Loss of species
Loss of genetic diversity
Loss of resilience to extreme events

← Land use change (habitat loss & fragmentation)
Pollution
Over exploitation
Invasive non native species
Climate change

↓ **DEGRADED ECOSYSTEMS**

↓ ↓

REDUCED ECOSYSTEM SERVICE PROVISION

↓ ↓ ↓

Reduced resilience to FLOODING	**Reduced resilience to DROUGHT**	**Declining WATER QUALITY**	**BIODIVERSITY loss**	**Reduced CARBON SEQUESTRATION**
Increasing periods of intense rainfall and extreme storms	Increasing frequency of extended dry periods and low rainfall	Rising water temperature *decreased oxygen availability* Low water levels *reduce dilution of pollutants* Increased sediment loads *from increased erosion*	Competition from invasive non native species New pests and diseases Local extinction due to range shifts Life cycle disruption from seasonal variation Food-web disruption	Greenhouse gases released from degraded habitats

SEA LEVEL RISE	**DAMAGE TO INFRASTRUCTURE**	**HUMAN HEALTH**	**Reduced AGRICULTURAL PRODUCTION**	**CULTURAL/ RECREATIONAL**
Coastal flooding Habitat loss	From storms, floods, and erosion	Temperature stress New diseases and those not previously present Mental health impacts	Crops vulnerable to weather Livestock vulnerable to weather Soil erosion and degradation	Heritage features at risk of extreme weather Impacts on tourism industry Changing local landscapes

HOW CAN WE PREVENT FURTHER CHANGE AND BUILD RESILIENCE?

- **Decarbonise our society**
- **Restore landscapes ability to absorb and sequester carbon and provide the other ecosystem services we depend on**

HOW CAN WE ACHIEVE IT?

NATURE-BASED SOLUTIONS

RESTORE NATURAL HYDROLOGICAL REGIMES

humans have been altering the pathways of water across the landscape for centuries, many of these changes now result in the landscape being less resilient to climate change

↓ ↓

FLOOD

Tree planting
Wetland creation
Soil management
River restoration

DROUGHT

Wetland creation
Soil management
River restoration

IMPROVE EXISTING HABITAT & WATER QUALITY

climate change impacts such as rising temperatures are amplified when the baseline condition is already compromised

↓

WATER QUALITY

River buffers
Sustainable farming methods
Sustainable water management

HABITAT NETWORKS

allows movement of species in adaptation to new climatic ranges and allows recolonisation after disturbance events

↓

BIODIVERSITY

Habitat creation and restoration
Nature friendly farming

RESTORE NATURAL CARBON SINK HABITATS

maximise carbon storage alongside decarbonising energy and infrastructure these habitat also provide many other ecosystem services

↓

CARBON

Soil management
Sustainable farming methods
Woodland planting
Peatland restoration

AREA OVERVIEW

Image credit: Hello I'm Nick/Unsplash

BUDE COMMUNITY NETWORK AREA

The Bude Community Network Area as defined by Cornwall Council, includes the eleven most northerly civil parishes in Cornwall.

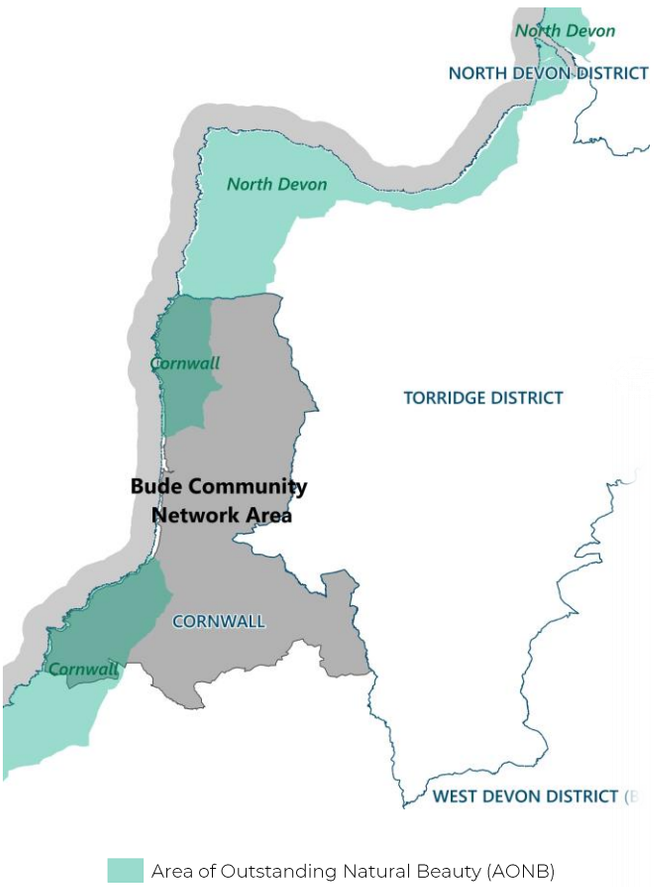
It sits on a thin strip of land between the Atlantic Ocean and the Cornish border with Devon. The area is predominately farmland and contains the tributaries of the river Neet, which empties into the sea at Bude. The largest concentrations of population are Bude, Kilkhampton, Marhamchurch, Poughill, Stratton, Week St Mary and Widemouth.

Datasets used in maps: OSVM, OSS, OSOR, NFI, TELSW. For full references see page 59.

LOCATION WITHIN HUMAN BOUNDARIES

Bude CNA encompasses the northern most tip of Cornwall and lies along its border with Devon. The local authority is Cornwall County Council and the neighbouring authority is Torridge District Council.

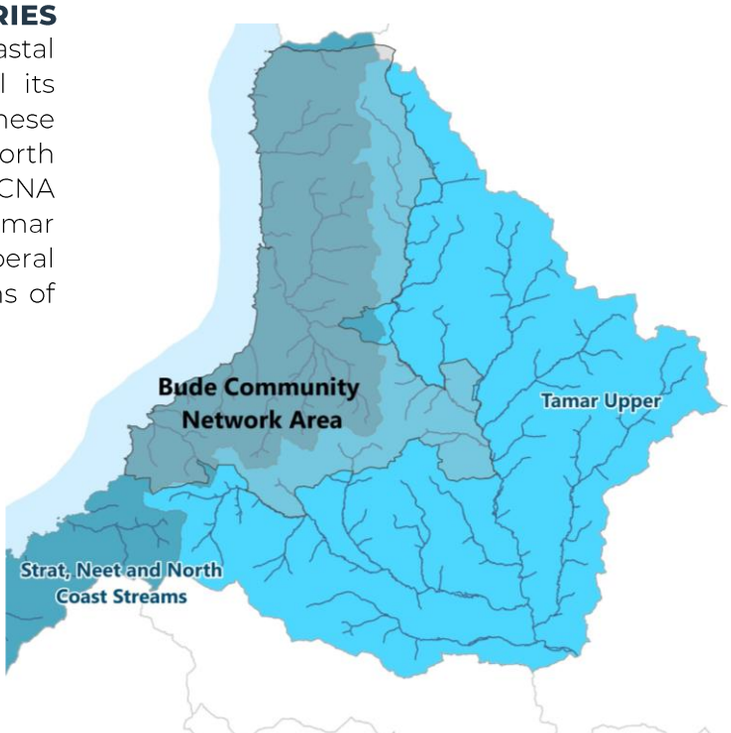
The northwest and southwest parts of Bude CNA are designated as part of the Cornwall Area of Outstanding Natural Beauty. ◀



Eleven Parishes make up Bude CNA. ▶

LOCATION WITHIN NATURAL BOUNDARIES

Bude CNA contains a number of small coastal streams as well as the River Neet and all its tributaries, which enter the sea at Bude. These waterbodies are part of the Strat, Neet and North Coast Streams operational catchment. Bude CNA also includes some areas of the Upper Tamar operational catchment, namely the Lamberal Water, Caudworthy Water and upper regions of the Tamar main river. ▶



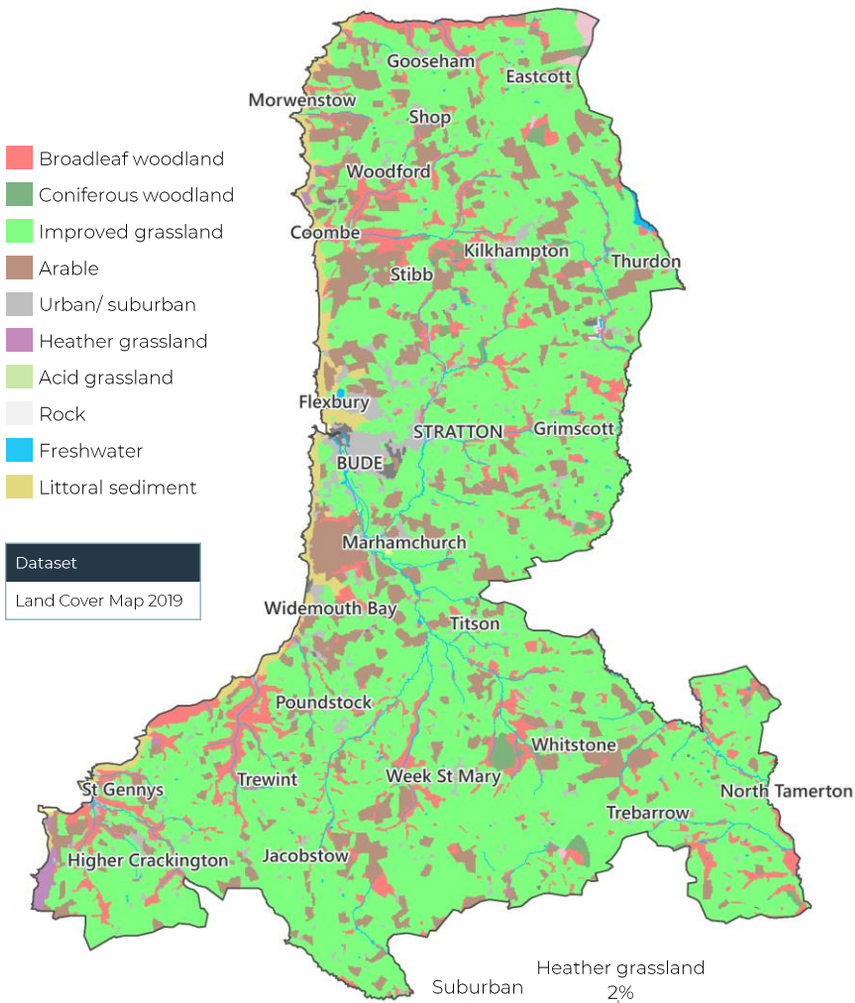
Datasets used in maps: OSVM, OSS, OSOR, NFI, TELSW WBL, OSBL, AONB, . For full references see page 59.

NATURAL ASSETS – Land use & Water

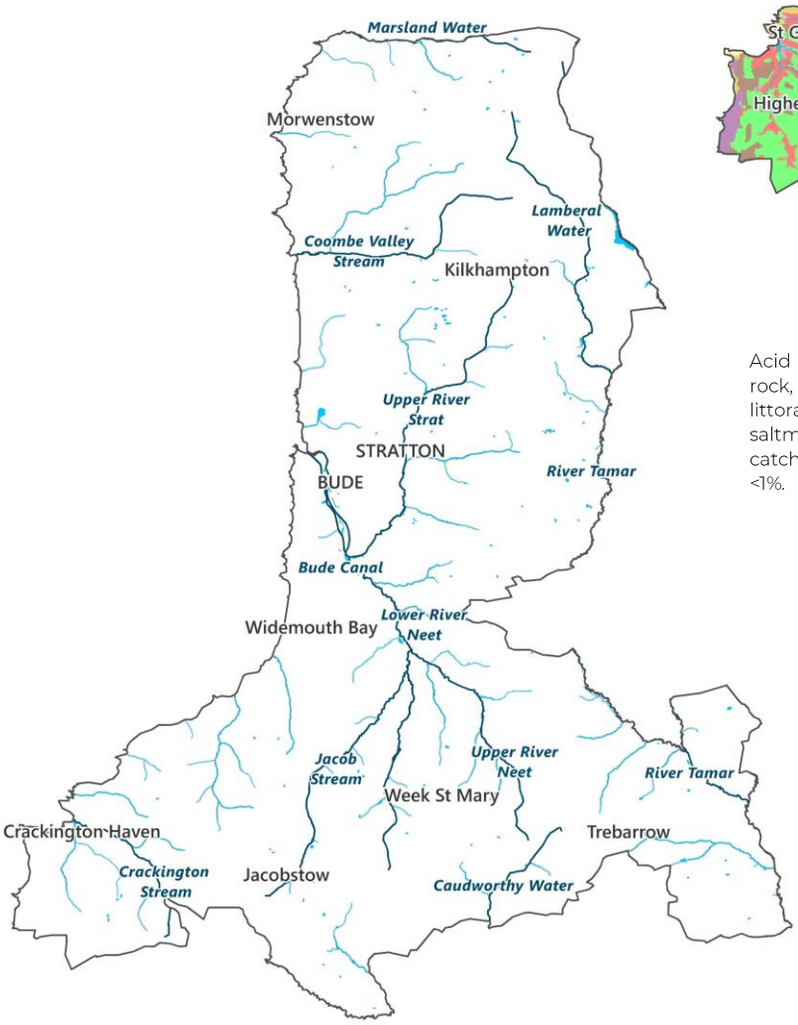
LAND USE

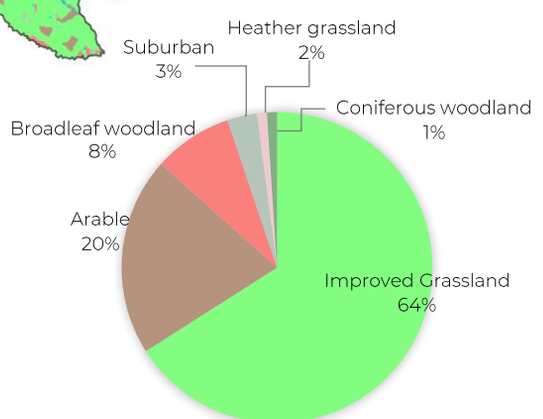
Land Cover Map is a country-wide assessment of land use. Land cover includes roads and buildings, natural and managed vegetated surfaces and inland water. It gives a broad insight into how the land in a catchment is being used, and this can be a very useful indicator of its ability to provide different 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.

Bude CNA has significant cover of improved grassland and arable land. There are also some significant patches woodland and urban/ suburban areas. ▶



Dataset
Land Cover Map 2019





Acid grassland, inland rock, freshwater and littoral sediment, fen and saltmarsh present in catchment with coverage <1%.

FRESHWATER

Freshwater in Bude CNA is predominantly found in rivers and streams, though the area boundary runs through the Upper Tamar Lake. This South West Water reservoir supplies the drinking water in Bude. There is also the remaining section of the Bude canal from Helebridge to the sea at Summerleaze beach.

Dataset
OS VectorMap District – Surface Water
WFD Waterbodies

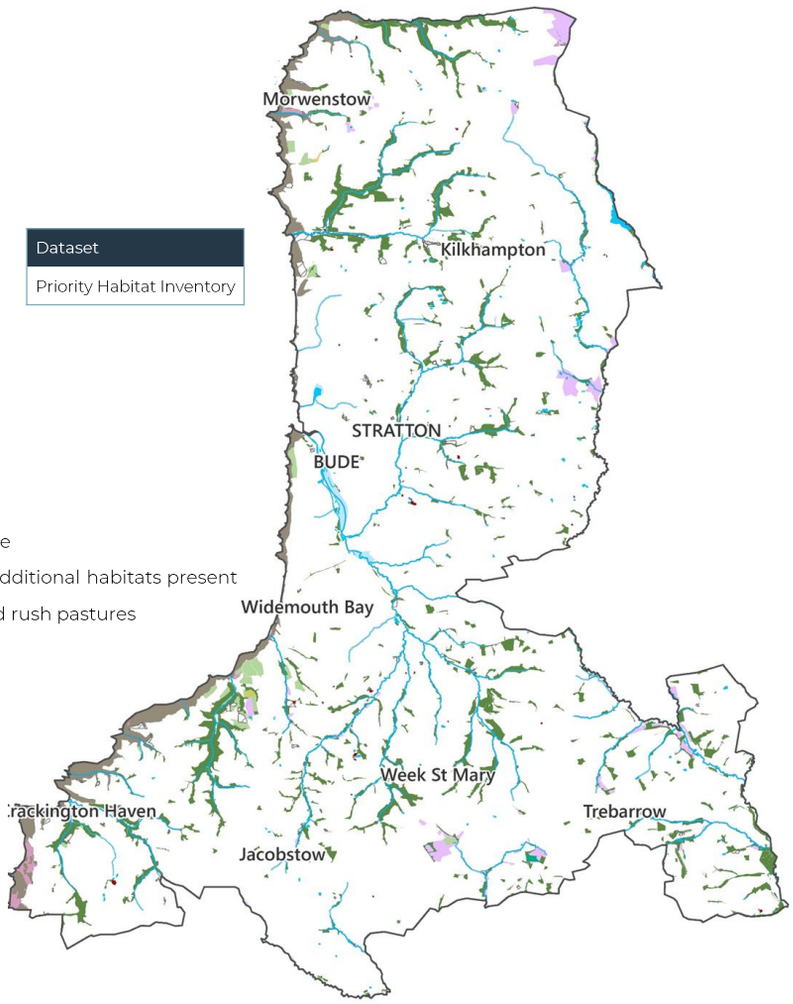
Datasets used in maps: OSVM, OSS, OSOR, NFI, WBL, WBC, LCM-2019. For full references see page 59.

NATURAL ASSETS - Habitats

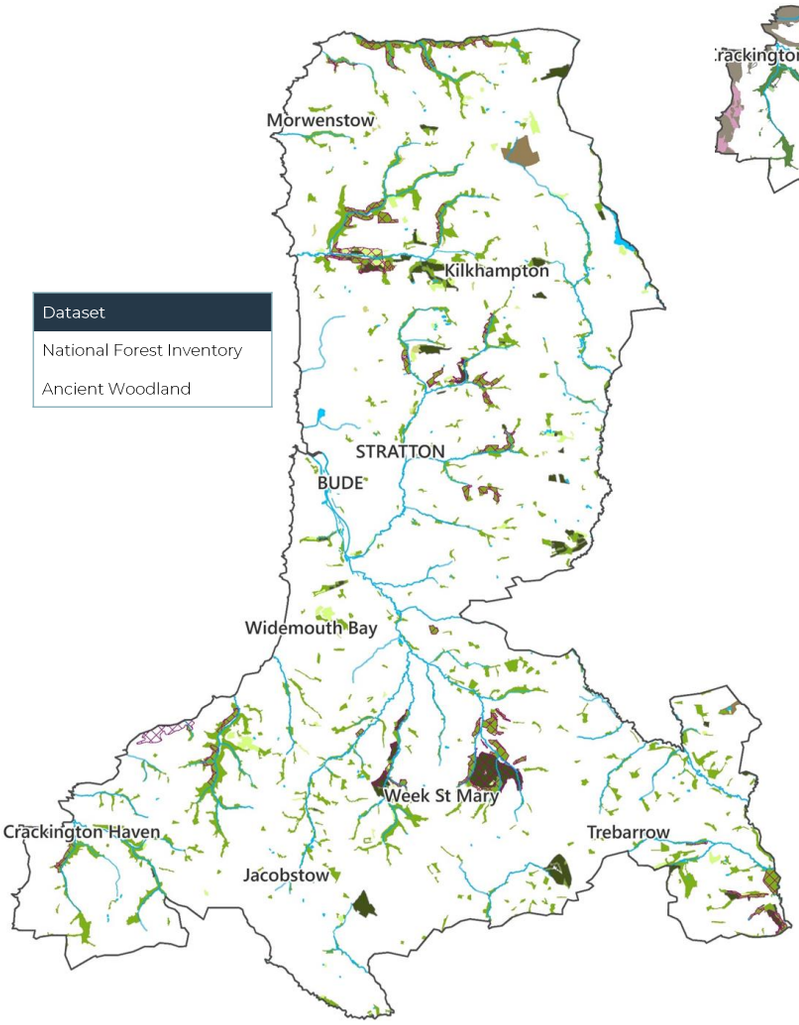
PRIORITY HABITATS

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

Bude CNA has significant areas of Maritime cliffs and deciduous woodland, with areas of purple moor grass and rush pastures and traditional orchards are scattered across the catchment. ▶



- Coastal & floodplain grazing marsh
- Coastal saltmarsh
- Deciduous woodland
- Good quality semi-improved grassland
- Grass moorland
- Lowland dry acid grassland
- Lowland fens
- Lowland heathland
- Lowland meadows
- Maritime cliff and slope
- No main habitat but additional habitats present
- Purple moor grass and rush pastures
- Traditional orchards



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 left 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

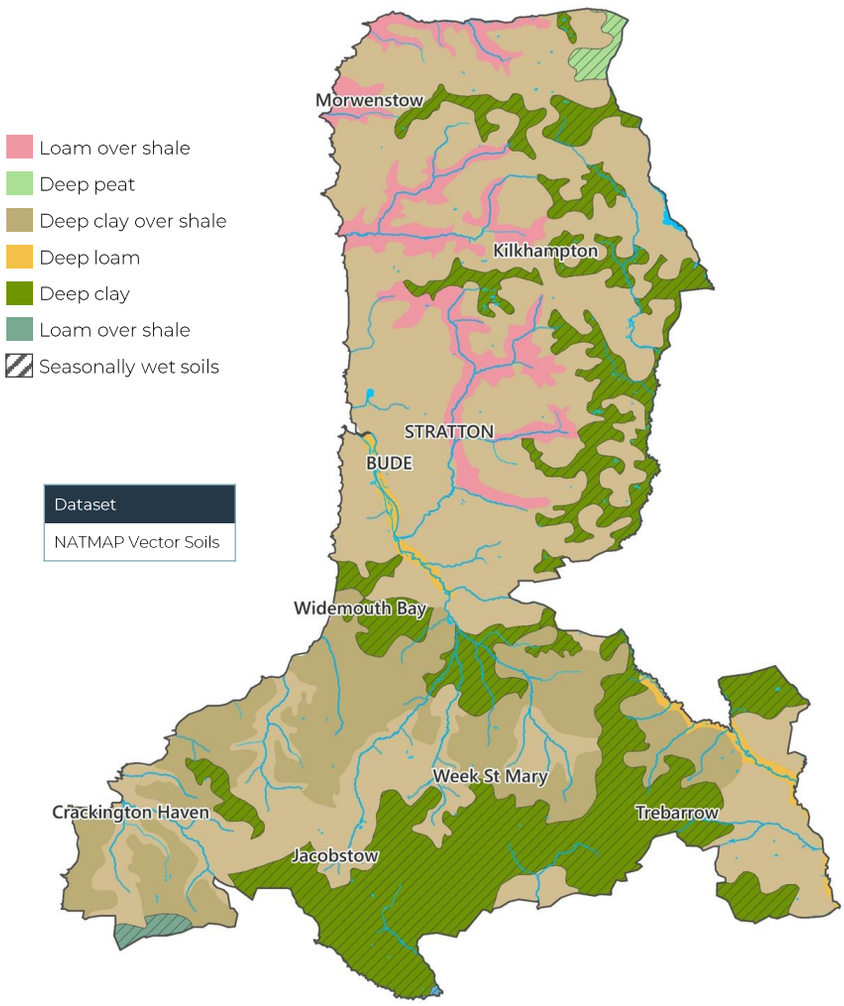
Datasets used in maps: OSVM, OSS, OSOR, NFI, PHI, AW. For full references see page 59.

NATURAL ASSETS - Geodiversity & Soils

SOIL TYPE

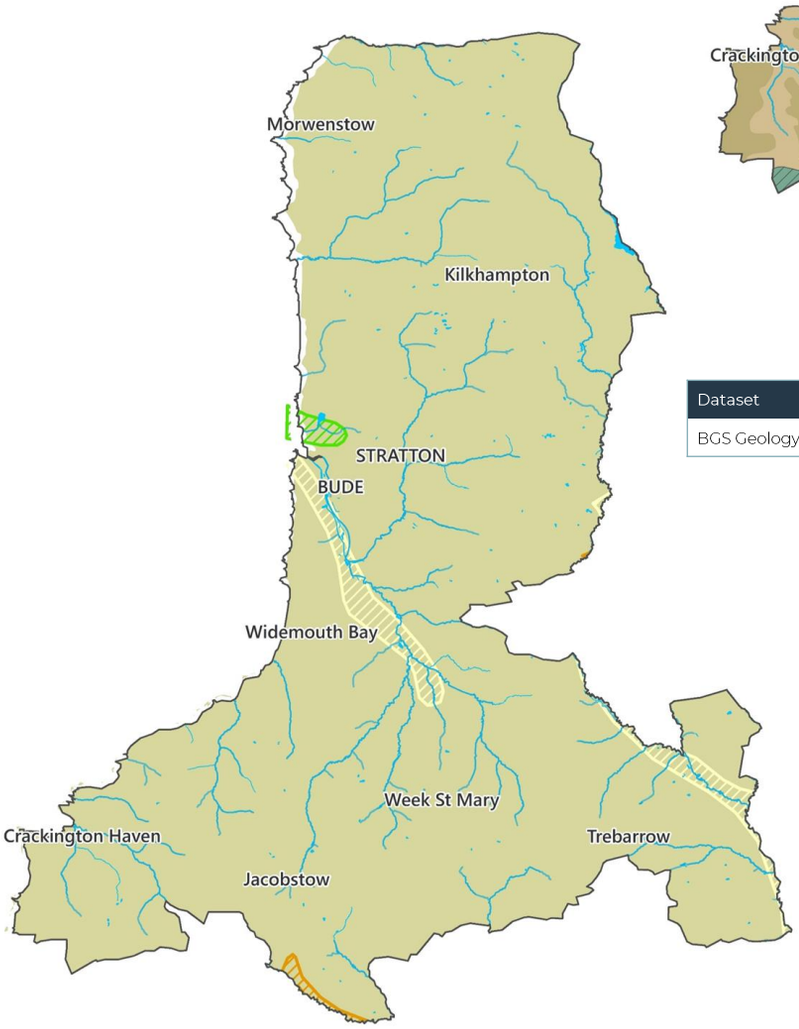
Soil is vital to the support of plant species and as home to a huge diversity of animal species and micro-organisms. Soils also influence the character of a landscape, and provide indications of what habitat types may have been present in the past and perhaps could be restored. Soils contribute to many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

The map to the right 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. ▶



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.



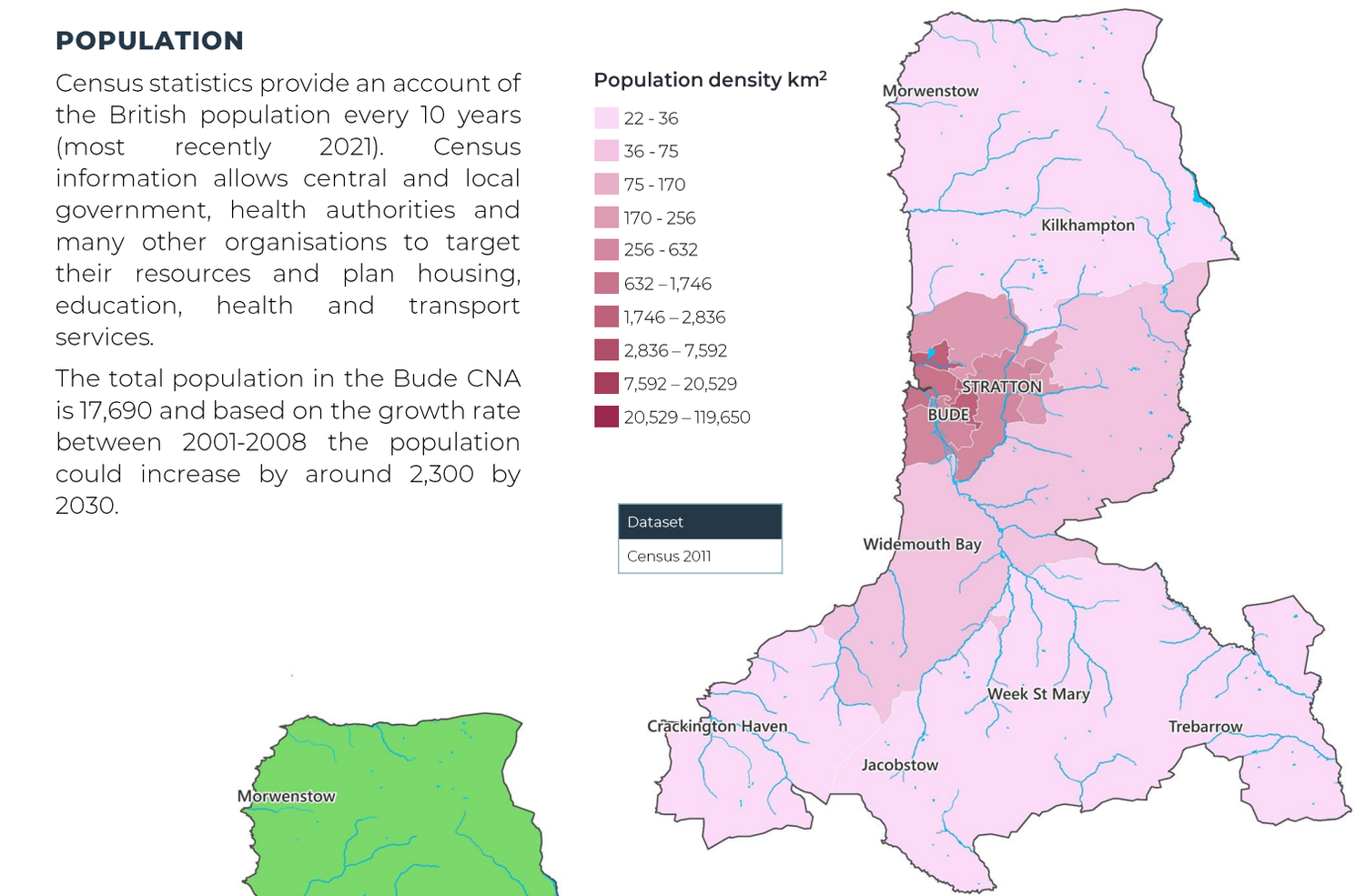
Datasets used in maps: OSVM, OSS, OSOR, BGS, NAT.. For full references see page 59.

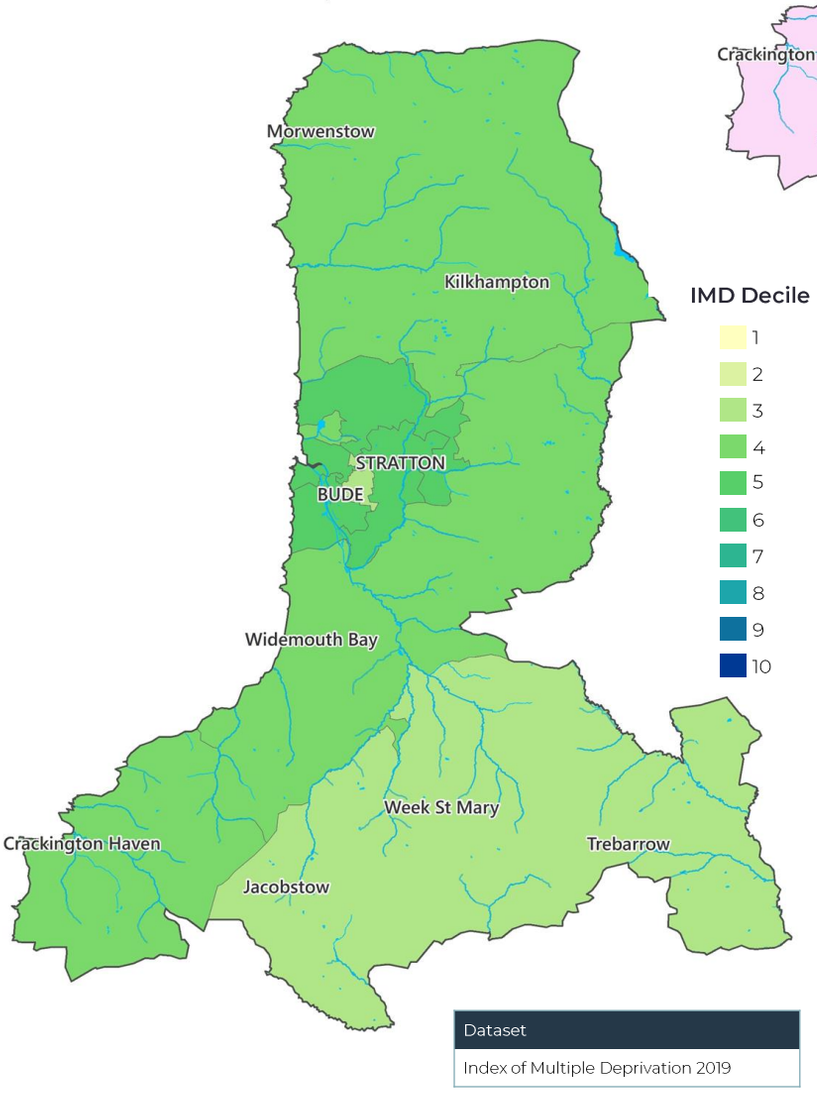
PEOPLE IN THE COMMUNITY NETWORK AREA

POPULATION

Census statistics provide an account of the British population every 10 years (most recently 2021). 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.

The total population in the Bude CNA is 17,690 and based on the growth rate between 2001-2008 the population could increase by around 2,300 by 2030.





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 Bude CNA 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.

The average Index of Multiple Deprivation Decile is 4 which is the average for neighbourhoods in Cornwall.

Datasets used in maps: OSVM, OSS, OSOR, CEN-P2011, IMD. For full references see page 59.

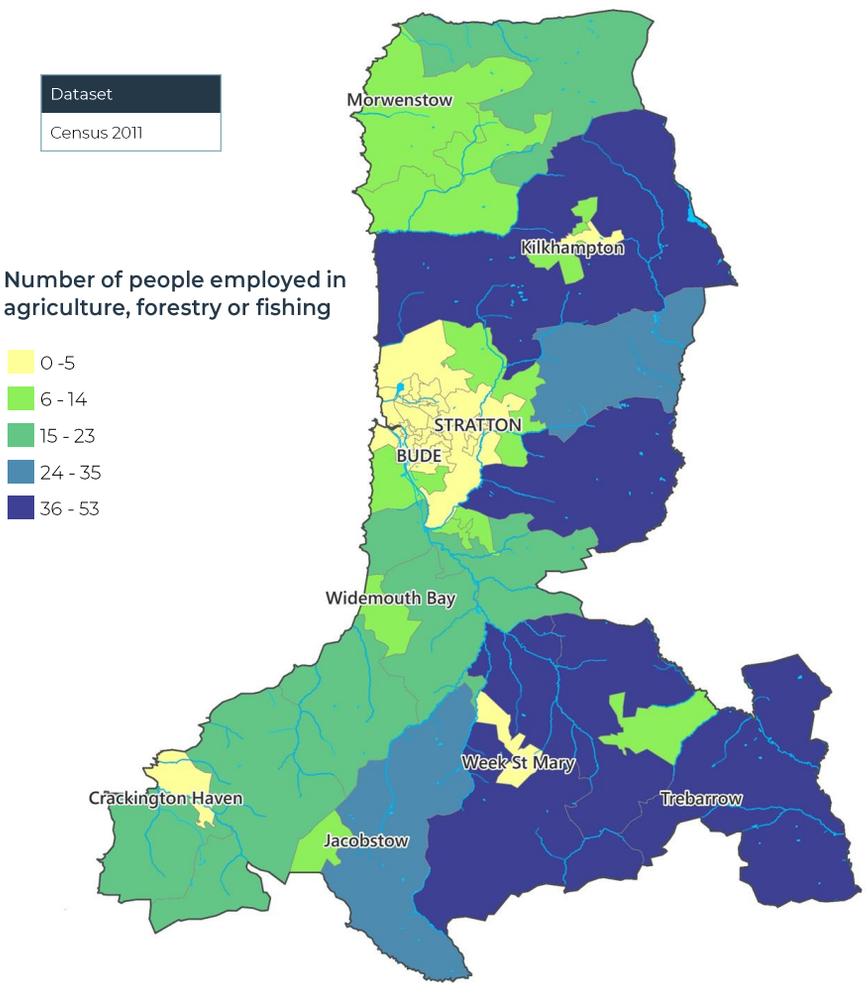
AGRICULTURE IN THE COMMUNITY NETWORK AREA

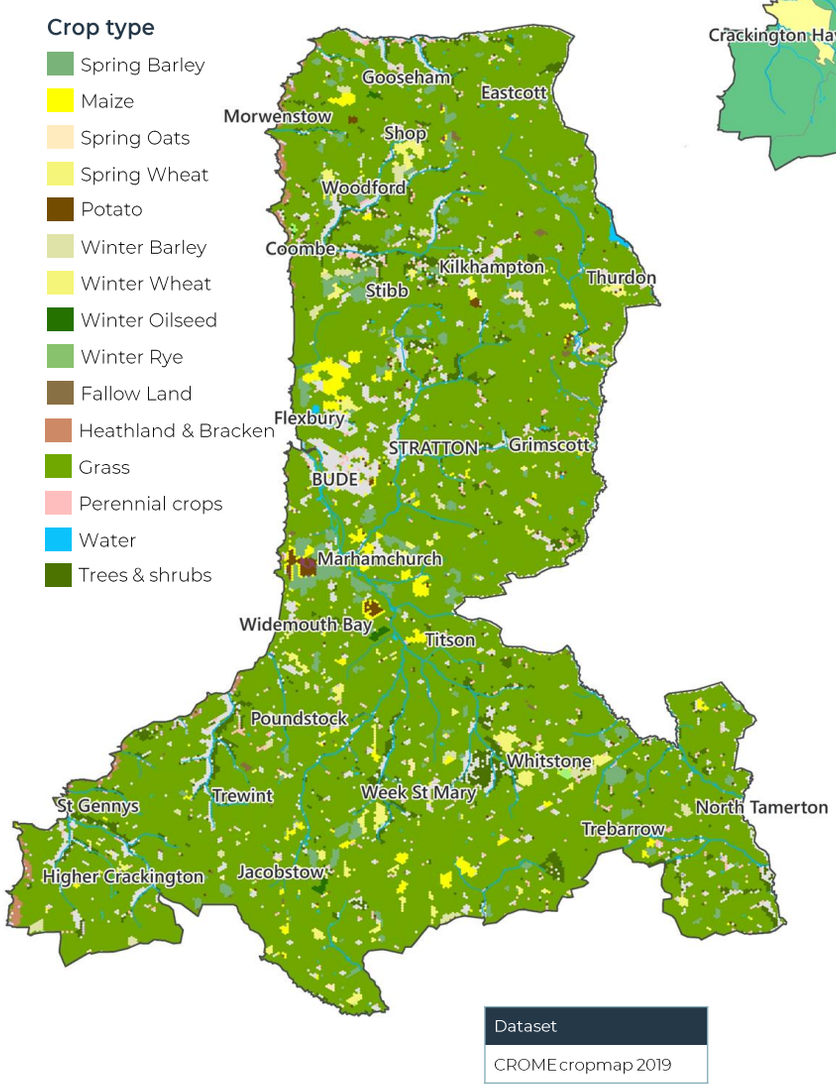
AGRICULTURAL EMPLOYMENT

Census statistics provide an account of the British population every 10 years (most recently 2021).

The Bude CNA is one of the most isolated in Cornwall, being a considerable distance from major centres of employment, further education, training and retail.

Tourism is the single largest employment sector in Bude, with agriculture and construction having the highest number of (VAT paying) businesses.





CROPS

Open access agricultural information is limited. In order to help improve the opportunity mapping for nature based solutions to improve resilience to climate change a additional study involving on the ground data collation and engaging with the local farming community would be beneficial.

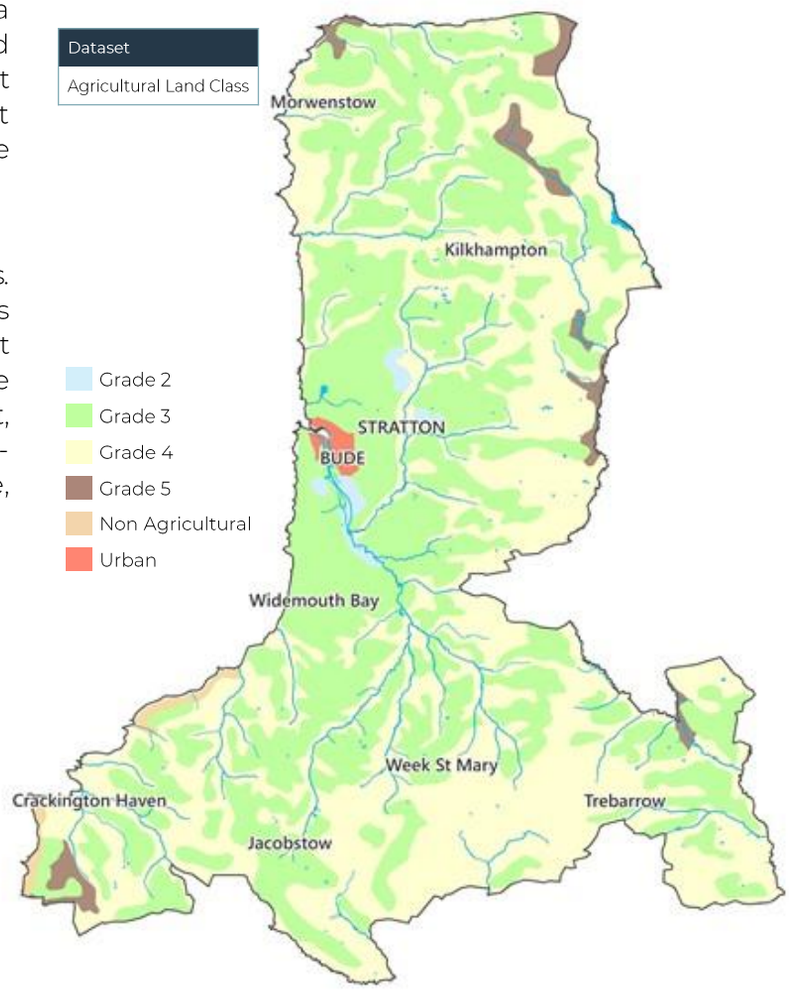
This crop data comes from the 2019 Crop Map of England. The data was generated automatically from radar and satellite images. The majority of the Bude CNA is set to pasture with some areas of Maize and other cereals.

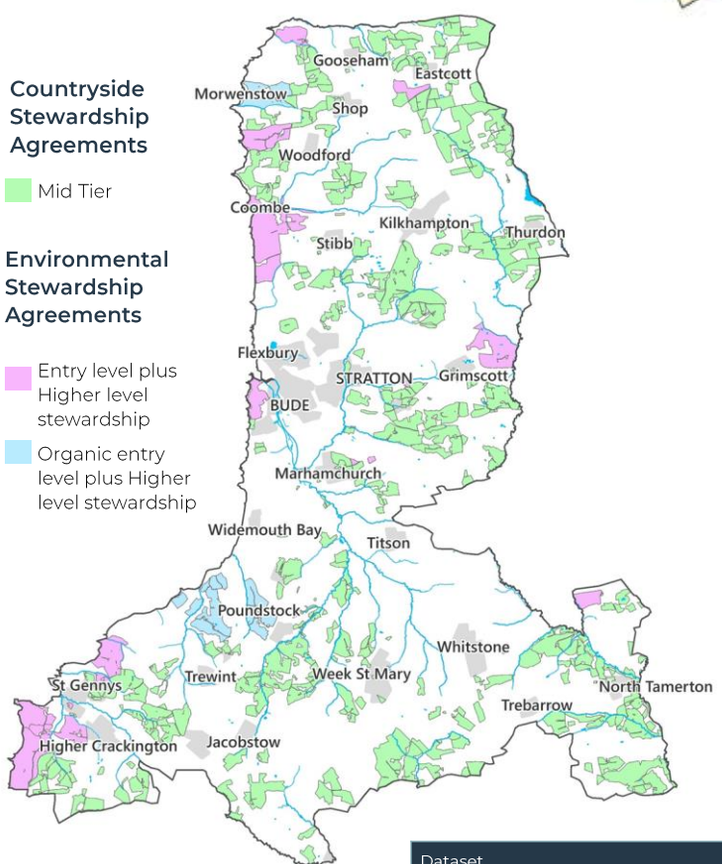
Datasets used in maps: OSVM, OSS, OSOR, CEN-I2011, CROME. For full references see page 59.

AGRICULTURAL LAND CLASSIFICATION

The Agricultural Land Classification provides a method for assessing the quality of farmland to enable informed choices to be made about its future use within the planning system. It helps underpin the principles of sustainable development.

Agricultural land is classified into five grades. Grade one is best quality and grade five is poorest quality. A number of consistent criteria used for assessment which include climate (temperature, rainfall, aspect, exposure, frost risk), site (gradient, micro-relief, flood risk) and soil (depth, structure, texture, chemicals, stoniness).





STEWARDSHIP

Countryside Stewardship provides financial incentives for farmers, foresters and land managers to look after and improve the environment.

Environmental Stewardship is a scheme under which farmers and land managers are paid for effectively managing their land in a manner which protects and enhances the environment and wildlife.

These schemes are currently available via the EU's Common Agricultural Policy and due to Brexit they will be replaced in 2024 by the new Environmental Land Management scheme that will reward:

- Sustainable Farming
- Local Nature Recovery
- Landscape Recovery

Dataset
Countryside Stewardship Scheme 2016 Management Areas (England)
Environmental Stewardship Scheme Agreements (England)

Datasets used in maps: OSVM, WBL, WBC, CEN-2011, CEN-COA, CEN-LSOA, ESA, CSSMA IMD. For full references see page 59.

FLOODING

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

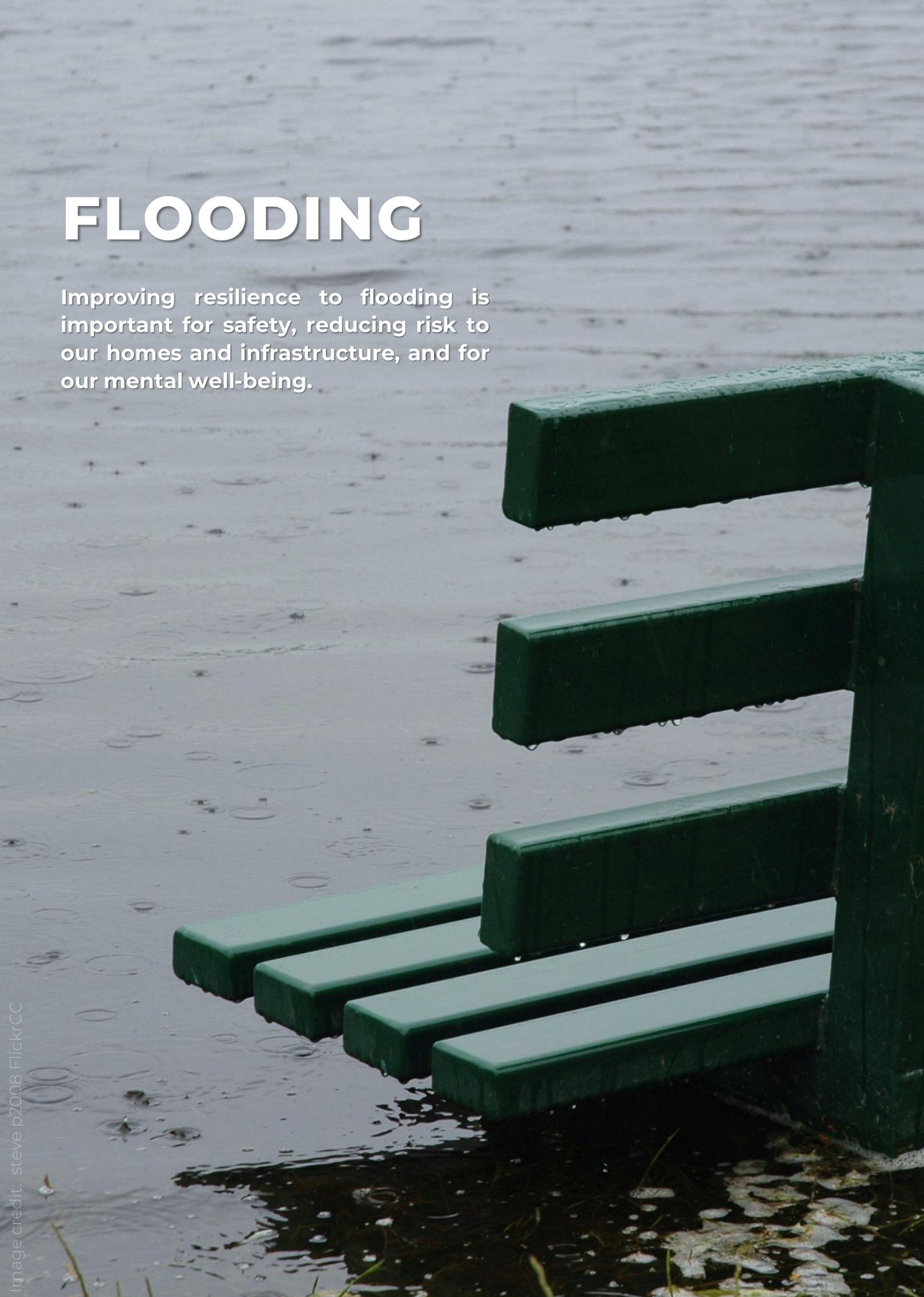


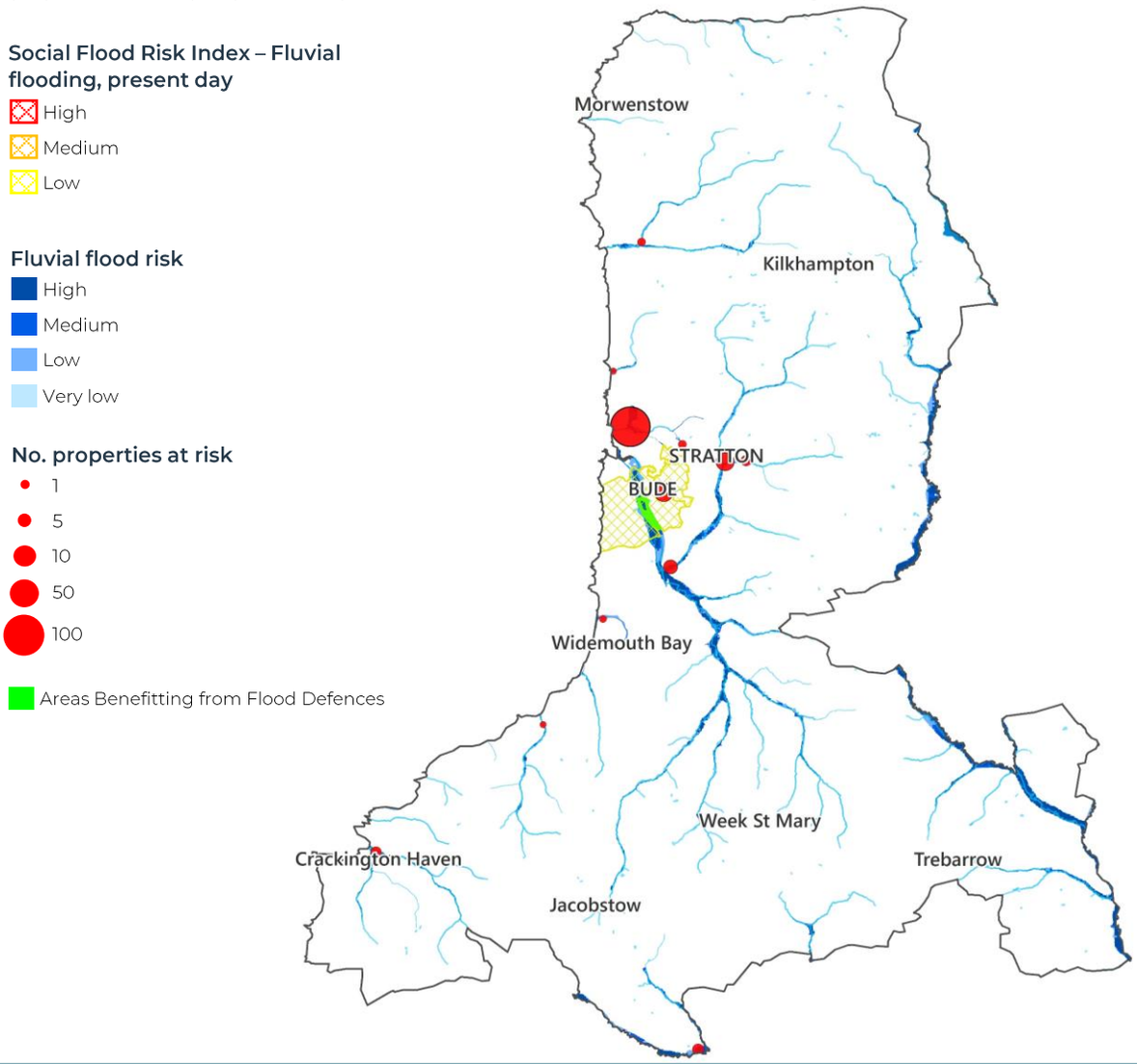
Image credit: steve p2008 FlickrCC

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
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 Bude CNA (FZ2 and OSVM)
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.

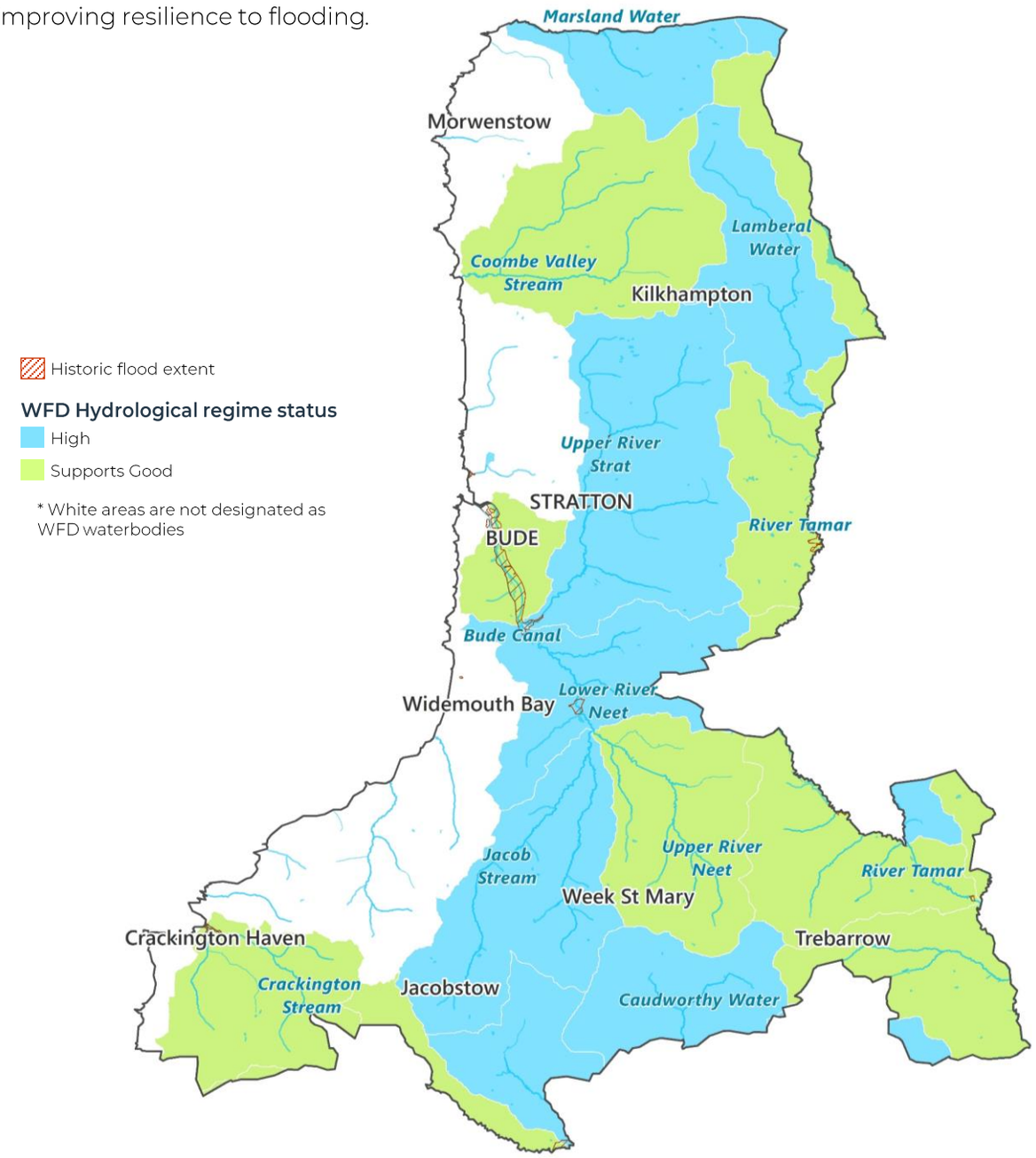
Datasets used in maps: OSVM, OSS, OSOR, FFR, SFRI, ABFD. For full references see page 59.

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
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
WFD Hydrological Status 2019	Water Framework Directive 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, OSS, OSOR, CDE-RNAG, HFE. For full references see page 59.

OPPORTUNITIES FOR ENHANCEMENT

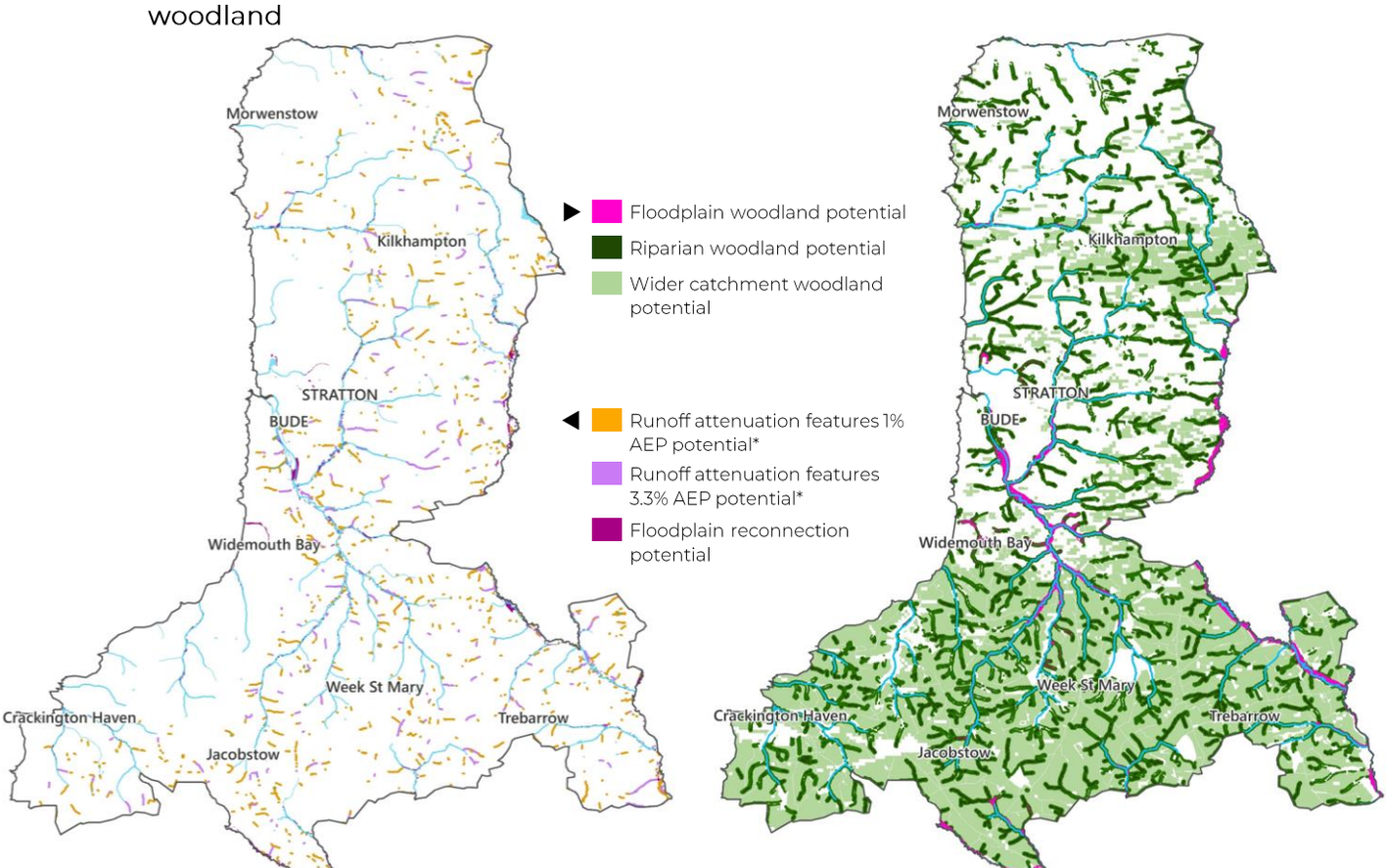
The Environment Agency has created a set of strategic maps that identify potential locations for Working with Natural Processes (WWNP) across England. The maps are indicative, and signpost a range of locations where there is the potential for managing flood risk by protecting, restoring and emulating the natural regulating function of catchments and rivers.

They highlight the potential for WWNP derived from national datasets such as the Environment Agency's Risk of Flooding from River and Sea, and Risk of Flooding from Surface Water datasets. They have been used to target areas where rivers have been disconnected from their floodplain, or areas of high flow accumulations where it would be effective to temporarily store and hold back water to reduce flood peaks further downstream. The maps introduce new science on characterising slowly permeable soils, based on geological datasets, where tree planting could increase hydrological losses and reduce surface run-off to limit flooding.

The maps do not cover a comprehensive list of WWNP measures and they are not prescriptive as to how these measures could be designed. Wider environmental and societal benefits are not included in the maps, but need to be considered in addition to flood risk mitigation. Care should be taken to seek out experts to help understanding of catchment processes and to select the appropriate solution as a result.

The maps identify potential areas for:

- floodplain reconnection
- run-off attenuation features and gully blocking
- woodland planting covering floodplain planting, riparian planting and wider catchment woodland



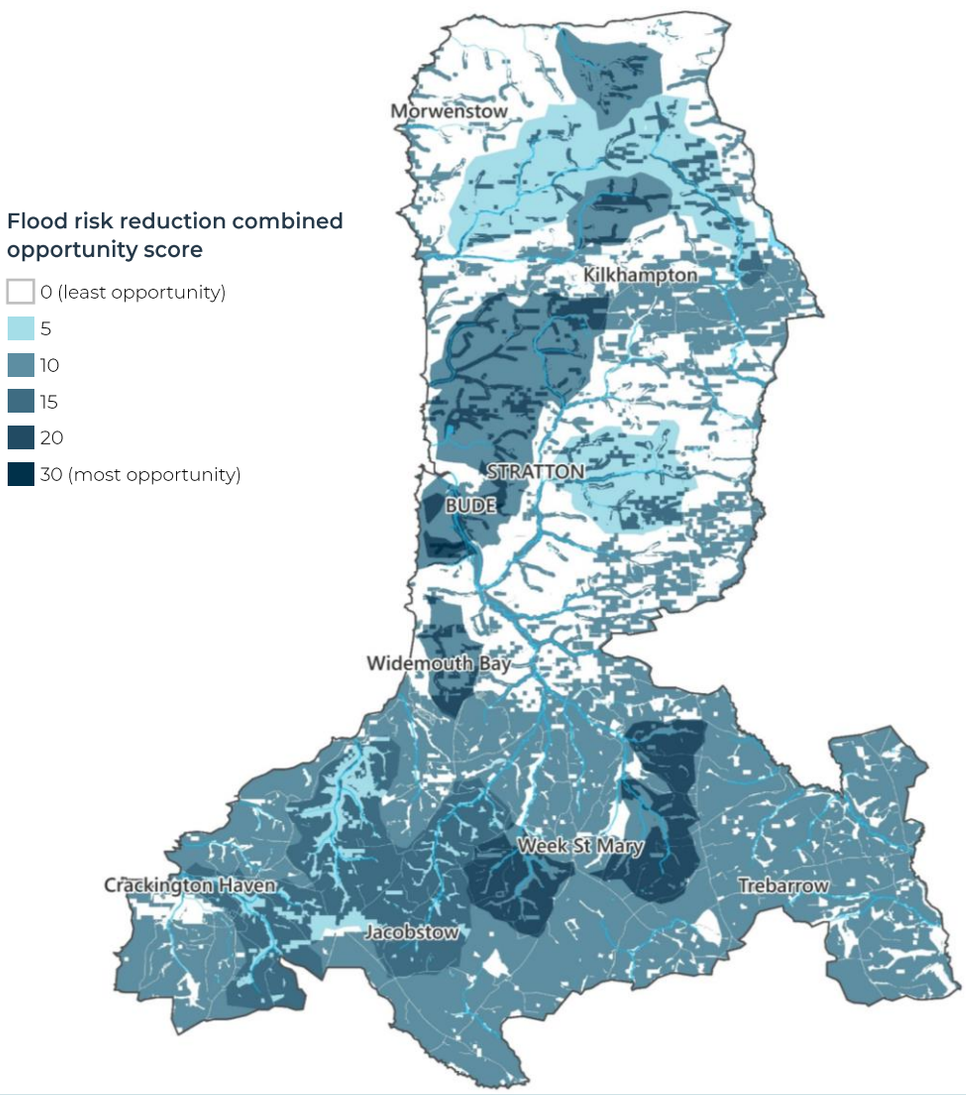
Historic flooding	
Dataset	Description
Working with natural processes	Strategic maps that identify potential locations for Working with Natural Processes (WWNP). The maps are indicative, and signpost a range of locations where there is the potential for managing flood risk by protecting, restoring and emulating the natural regulating function of catchments and rivers. *AEP - the Annual Exceedance Probability is the chance or probability of a natural hazard event (usually a rainfall or flooding event) occurring annually and is usually expressed as a percentage.

Datasets used in maps: OSVM, OSS, OSOR, WWNP. For full references see page 59.

OPPORTUNITIES FOR ENHANCEMENT

The EA maps on the previous page highlight areas where Nature-Based Solutions (NBS) for flood management may be possible in the Bude CNA. To further refine and prioritise areas for potential NBS, 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 WWNP opportunities 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
 WWNP Opportunity for NBS = 10 Outside = 0	As shown in the previous page, areas of opportunity for nature-based solutions (NBS) based on EA modelling.
 Small Catchments Catchment < 5km^2 = 10 Catchment 5-20km^2 = 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, OSS, OSOR, SMC, WWNP, SFRI. For full references see page 59.

DROUGHT

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

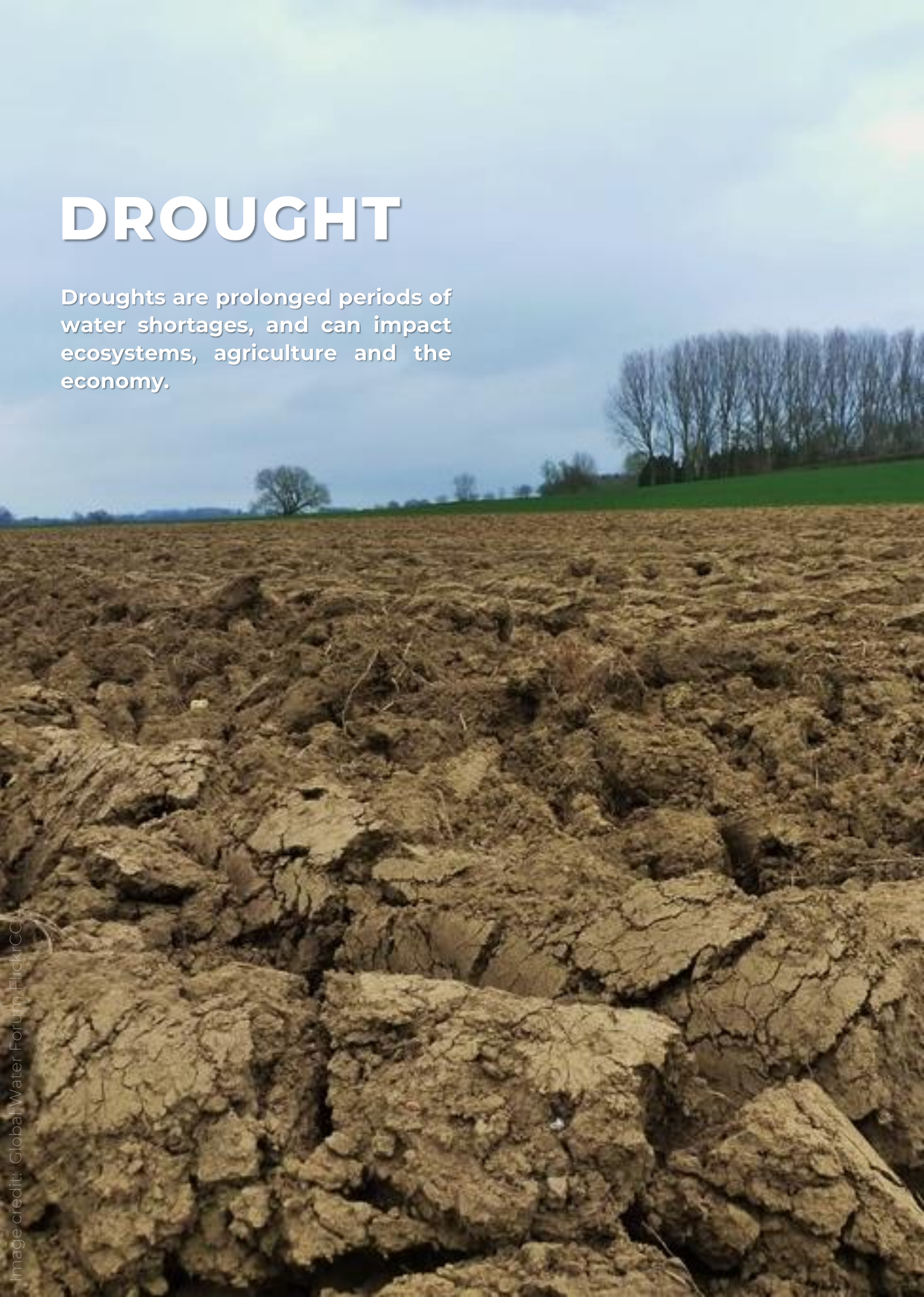


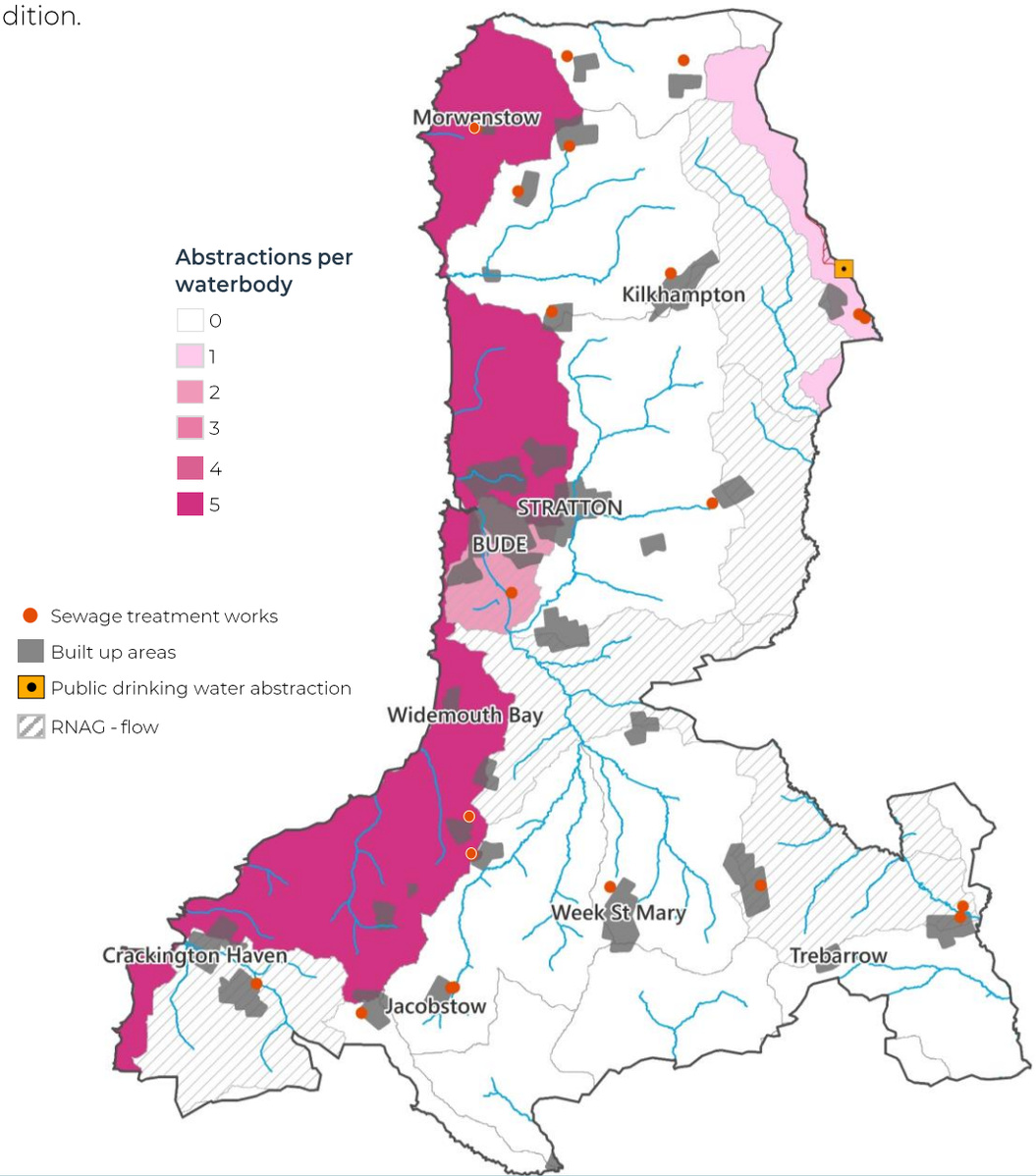
Image credit: Global Water Forum Flickr CC

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 have 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
Drinking Water Protected Areas	WFD waterbody catchments where drinking water for public supply occurs are designated as Drinking Water Protected Areas
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.

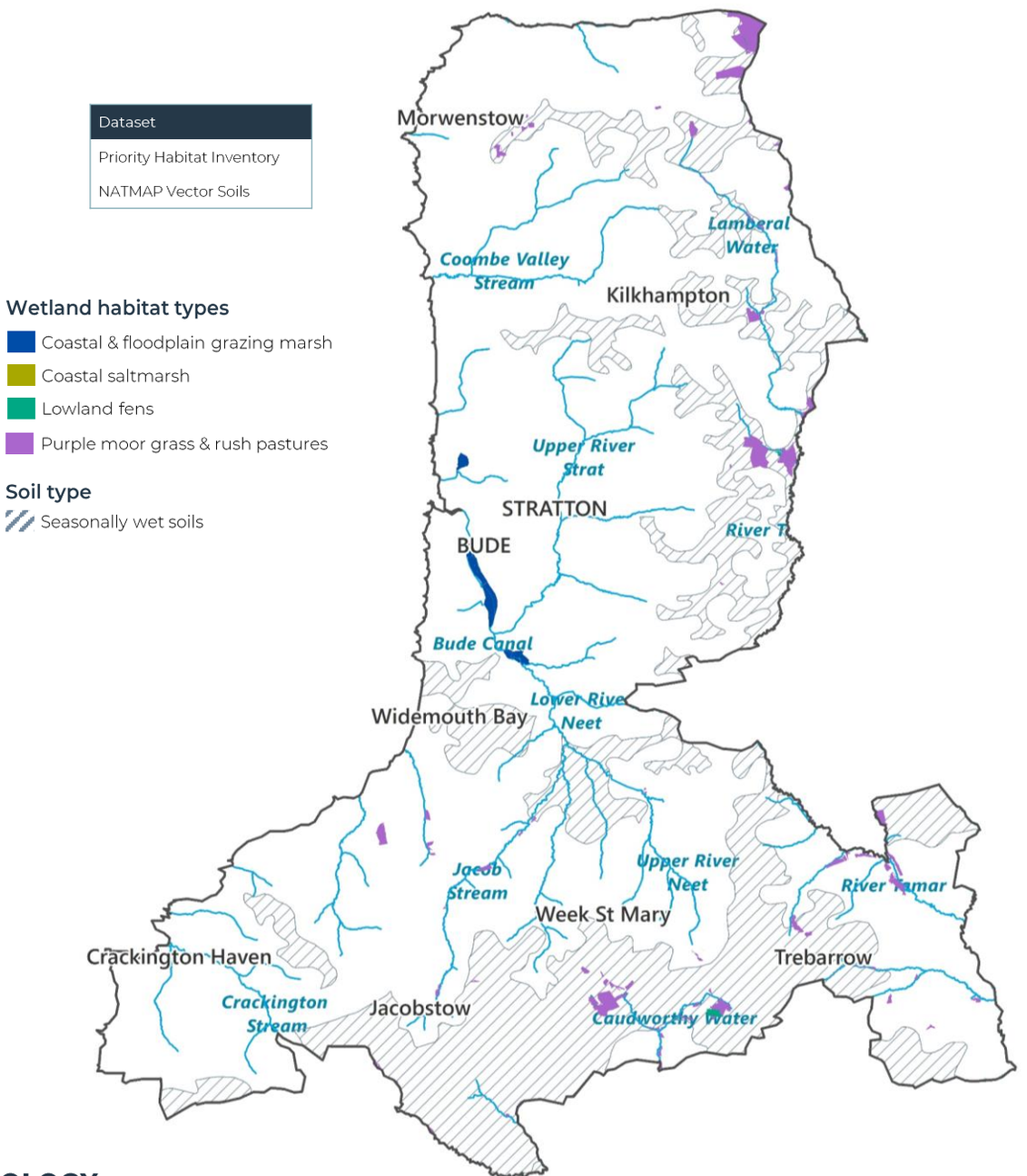
Datasets used in maps: OSVM, OSS, OSOR WBL, WBC, ABS, CDE-RNAG. For full references see page 59.

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.



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.

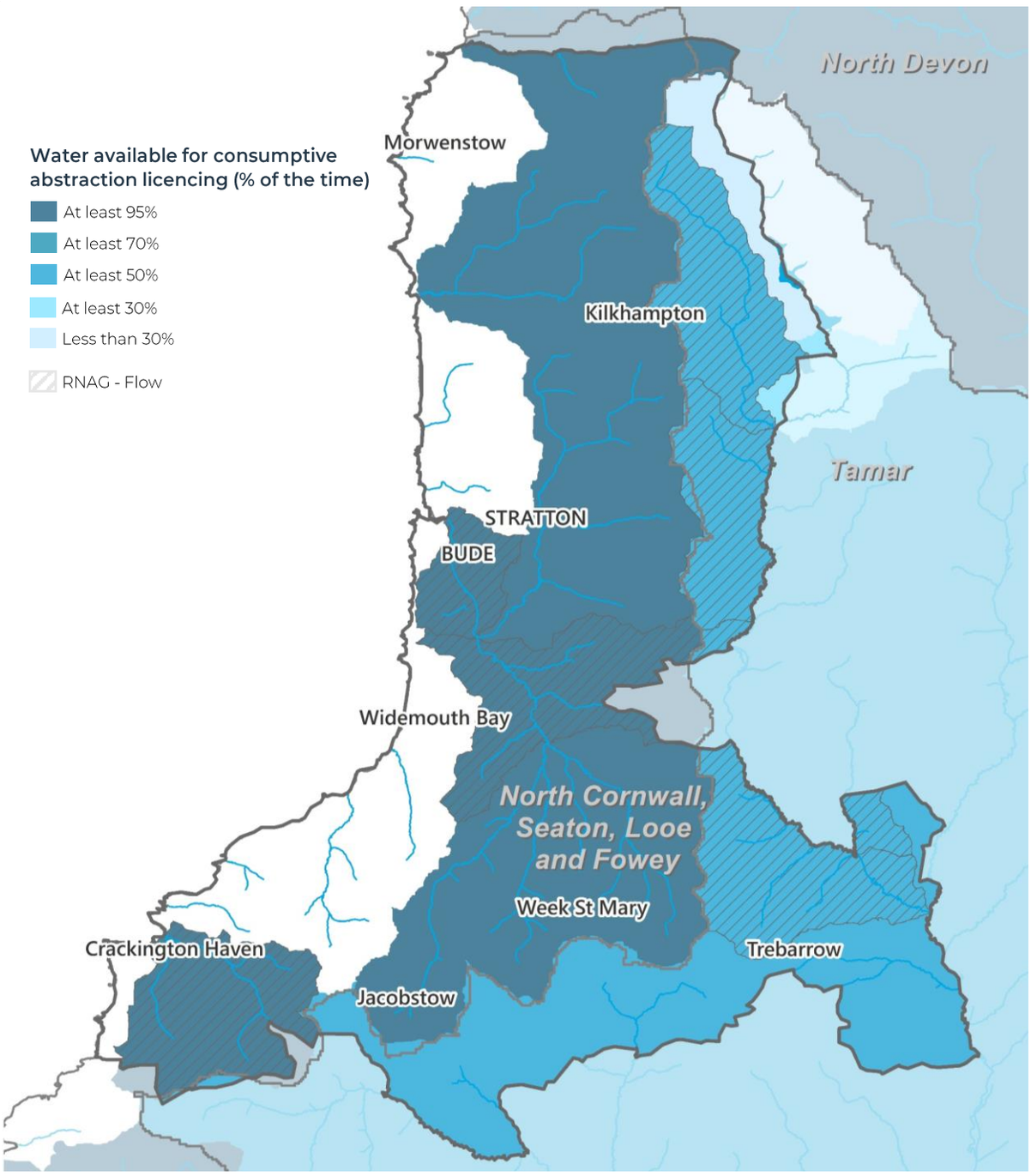
Datasets used in maps: OSVM, OSS, OSOR, PHI, NAT. For full references see page 59.

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
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.

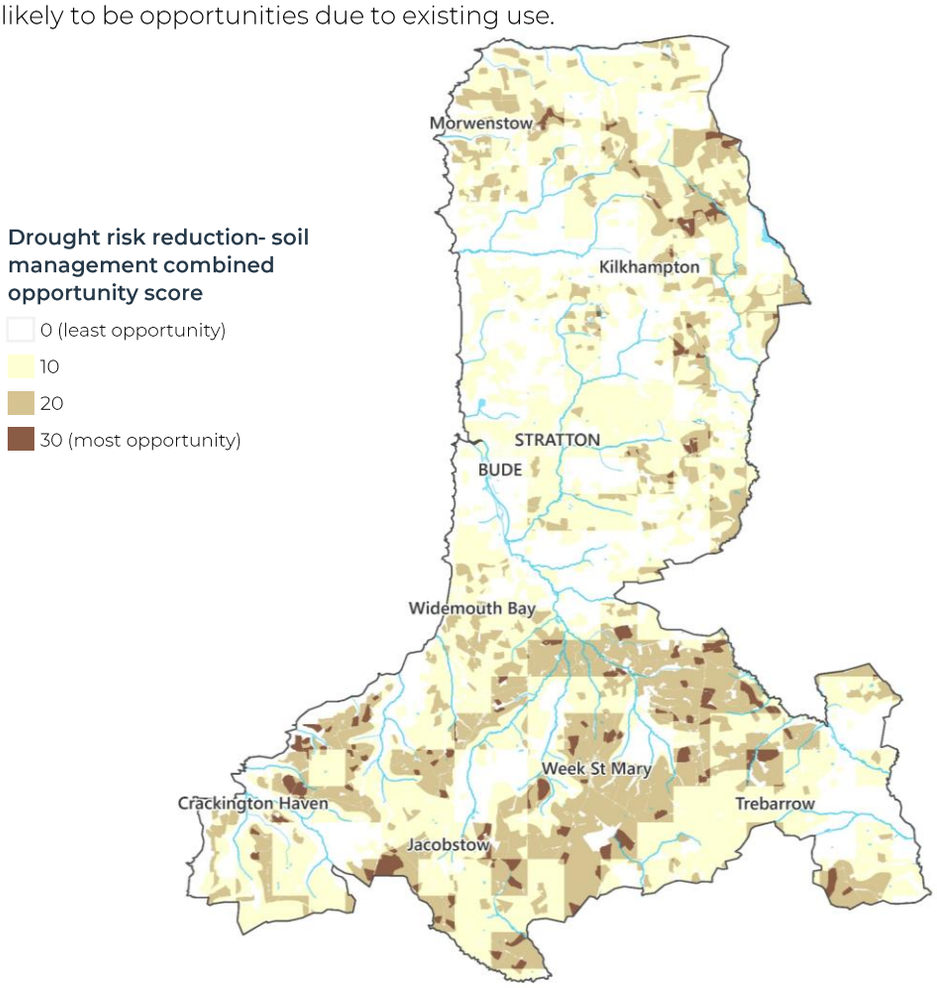
Datasets used in maps: OSVM, OSS, OSOR WBL, WBC, CAMS. For full references see page 59.

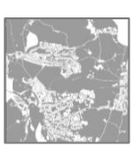
OPPORTUNITIES FOR ENHANCEMENT

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.

SOIL MANAGEMENT

The highest scoring opportunity areas for improved soil management are identified by combining information about soil carbon storage, arable land areas, and soil type, while excluding areas which are highly unlikely to be opportunities due to existing use.



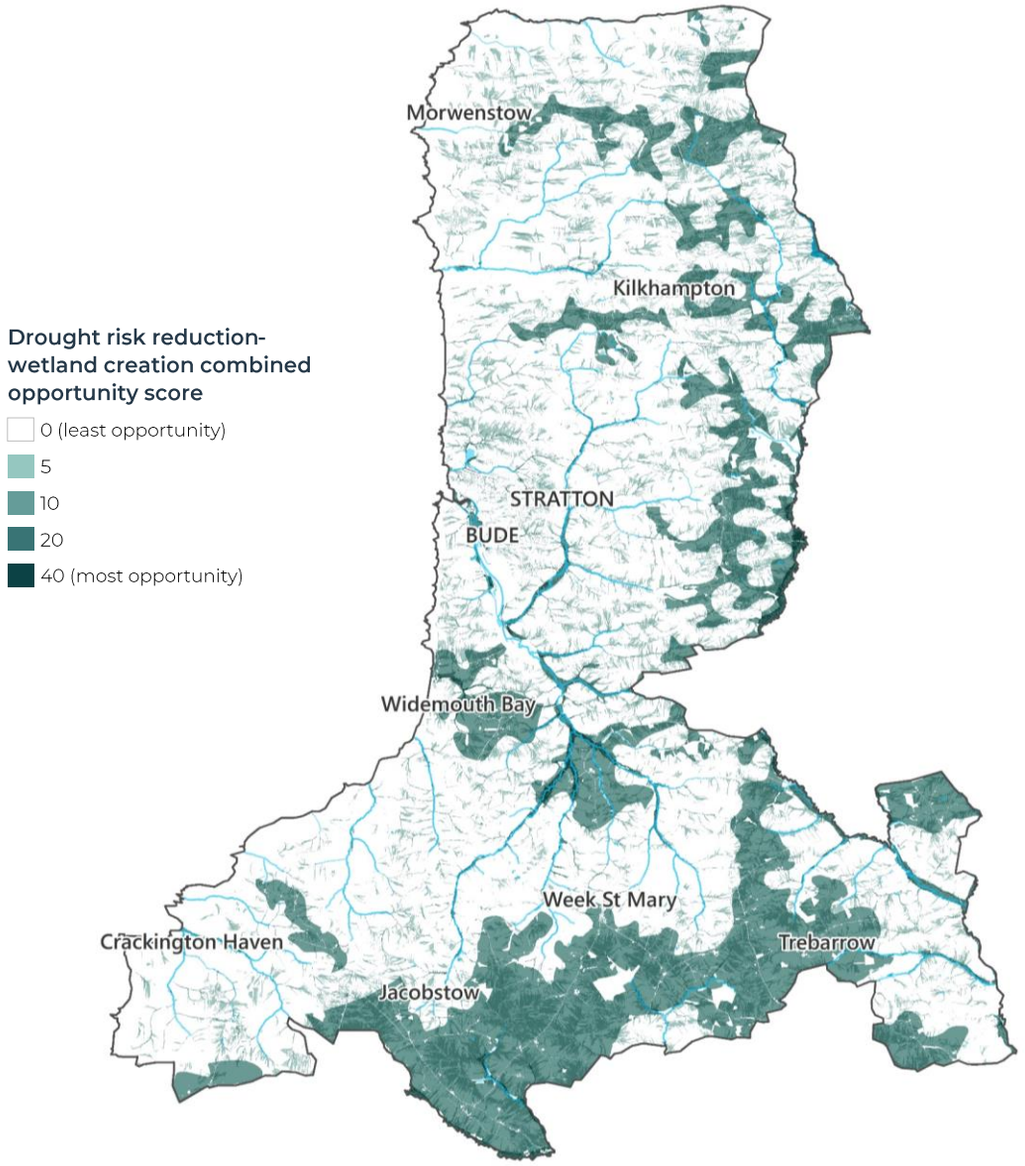
Relevant factors & scoring	Description
 Soil carbon storage Low = 10 Medium = 0 High = 0	Soil organic matter (SOM) especially in the topsoil plays an important role in nutrient retention and provision to plants as well as soil particle aggregation, and so influences aeration, structure, drainage and other functions. SOM can hold up to 20 times its weight in water and makes soils more drought resistant. It is linked to soil organic carbon and is often measured in terms of Soil organic carbon (SOC) content.
 Arable land areas Arable = 10 Other = 0	Arable systems can be at higher risk of compaction due to the frequent use of heavy machinery. Different practices can be introduced to help reduce the cause of compaction along side measures specifically aiming to reduce existing compaction. Arable systems provide opportunities to increase the soil organic matter which can be lower in these soils, through various measures such as cover cropping.
 Soil type Clays = 20 Loams/silts/sands = 10 Peat = 0	Some soils are particularly prone to compaction due to their composition they may require certain measures to help keep a health soil structure and therefore support infiltration.
 Exclusion areas Areas with exclusion criteria are reset to 0	Factors that make it less likely that soil management methods will be implemented are excluded. These include urban areas, main road and railway infrastructure, productive agricultural land, protected sites and priority habitats.

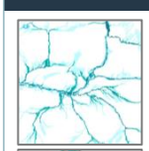
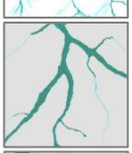
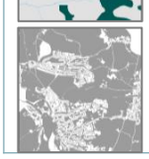
Datasets used in maps: OSVM, OSS, OSOR, CEHSC,LCM-2019, NAT ALC, SCH, SSSI, AW, PHI. For full references see page 59.

OPPORTUNITIES FOR ENHANCEMENT

WETLAND RESTORATION AND CREATION

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.



Relevant factors & scoring	Description
 **Hydrological connectivity** [8] Land scored 0, 5, 10, 15 or 20 based on 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 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. Free draining soils are not suitable for wetland creation.
 **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, OSS, OSOR, WBL, WBC, TELSW, FZ2, NAT ALC, SCH, SSSI, AW, PHI. For full references see page 59.

WATER QUALITY

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

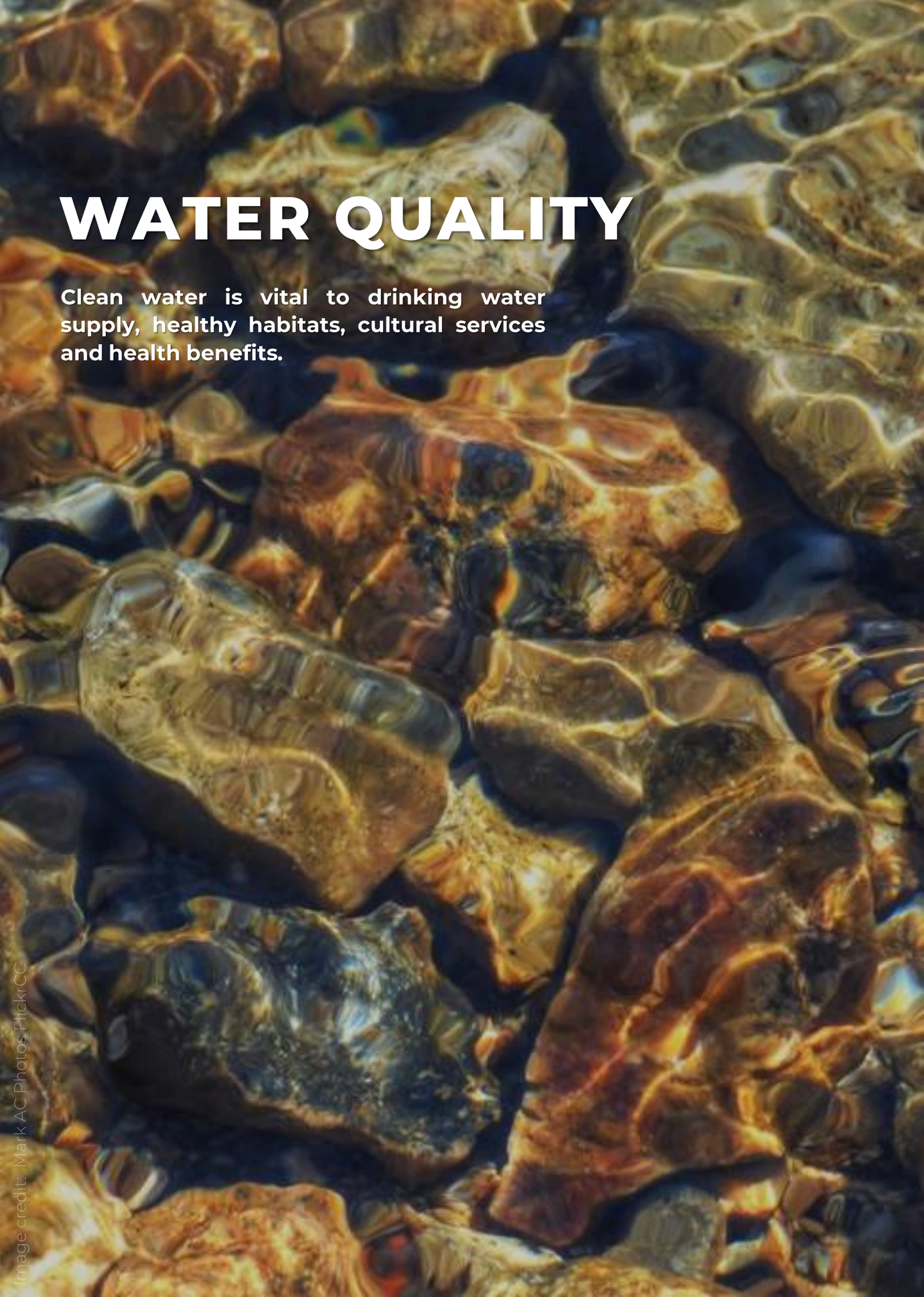


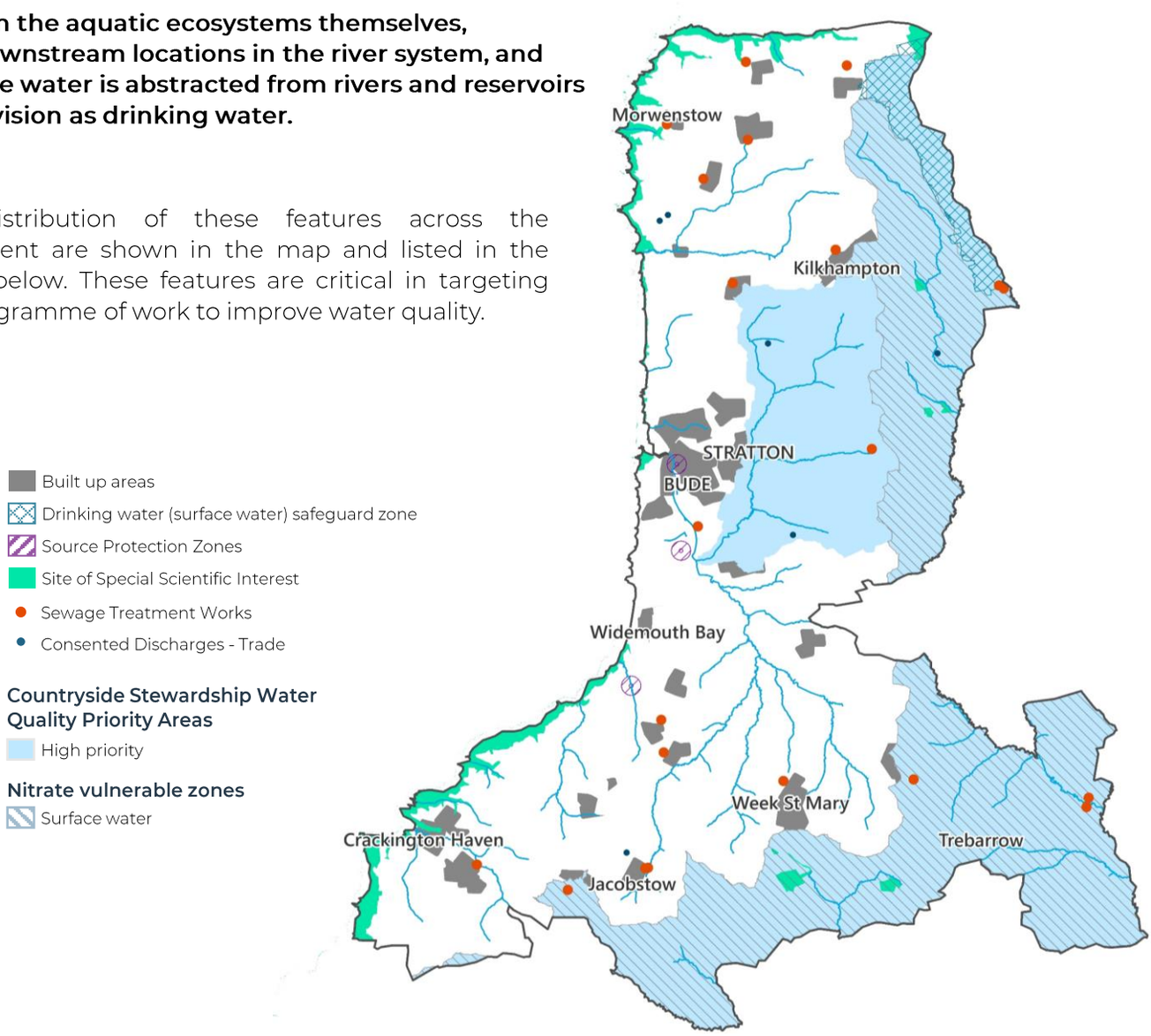
Image credit: Mark AC Photos FlickrCC

PRIORITY AREAS & DRIVERS FOR WATER QUALITY

There are three key areas in a catchment where degradation of the water can occur:

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
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. *Note: there are no HE priority areas in the CNA*
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, OSS, OSOR, CON, SSSI, SPZ, NVZ, HEP, CSP, ONS. For full references see page 59..

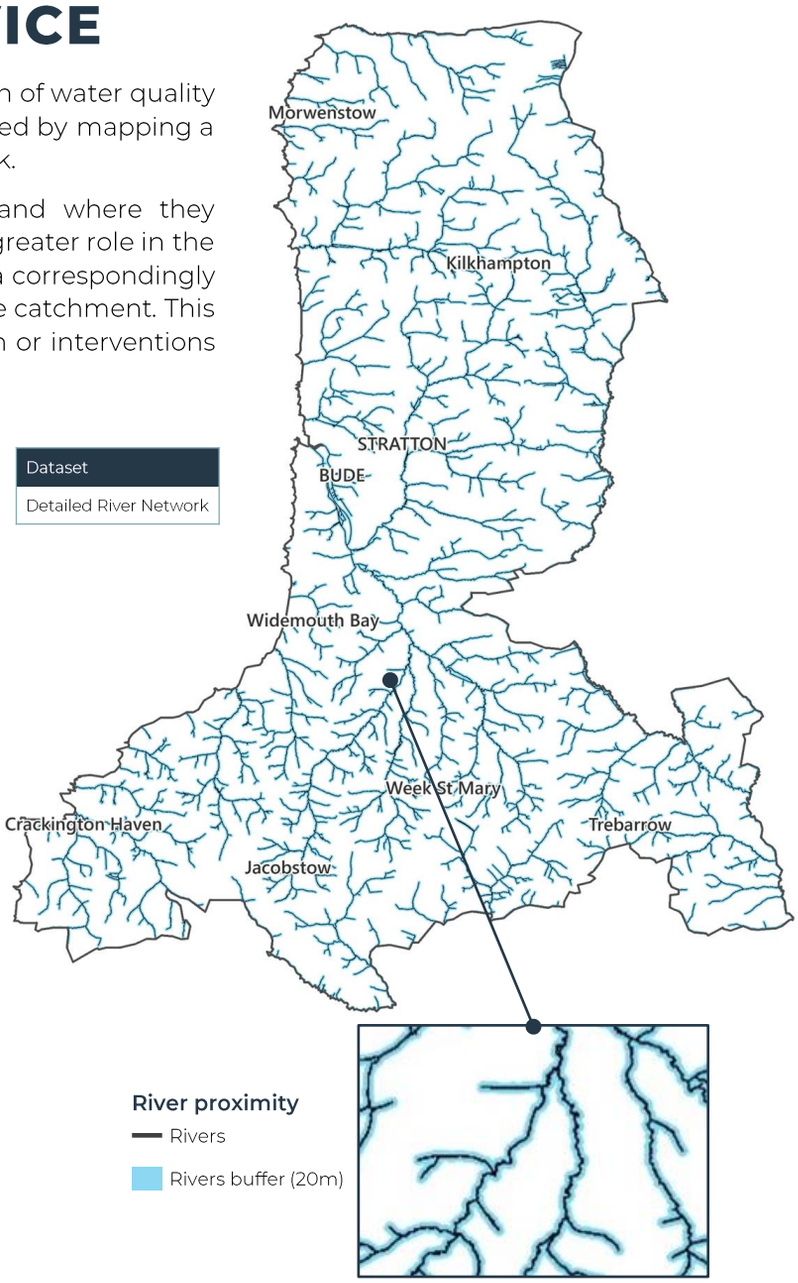
NATURAL ASSETS & INFRASTRUCTURE THAT REGULATE THE SERVICE

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.

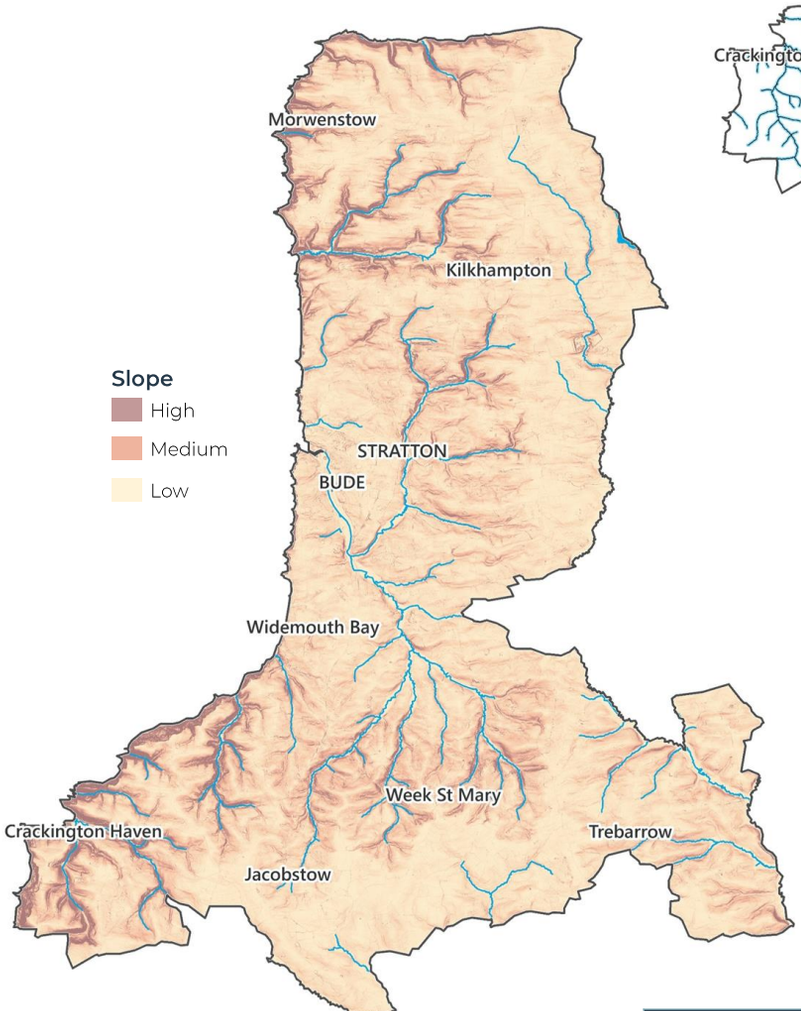
By documenting where these features occur and where they coincide we can identify areas of land that play a greater role in the improvement of water quality and where there is a correspondingly greater risk of water quality being degraded in the catchment. This then allows us to target these areas for 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
Detailed River Network



SLOPE

Steeper slopes are a risk factor that poses a threat to water quality. Surface water flows rapidly over steep slopes with little time for infiltration and it is often carrying a greater load of surface pollutants that enter into waterways.

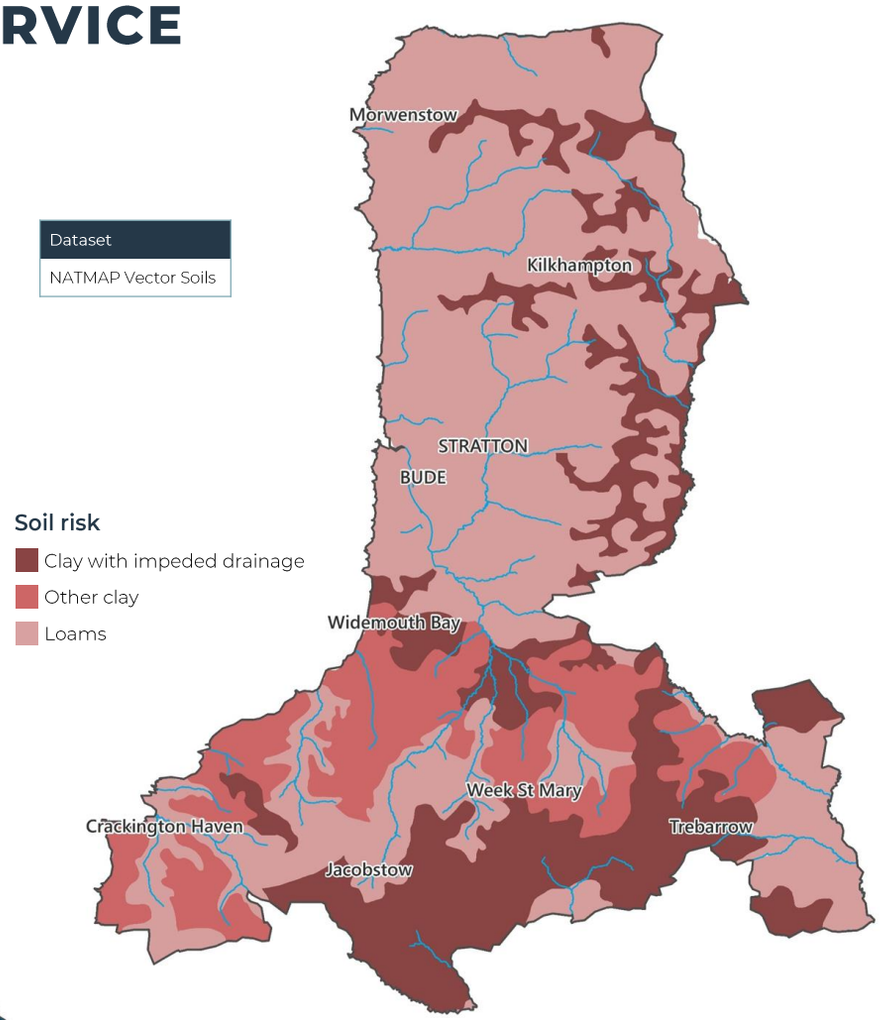
Dataset
Slope (calculated from 2m terrain data)

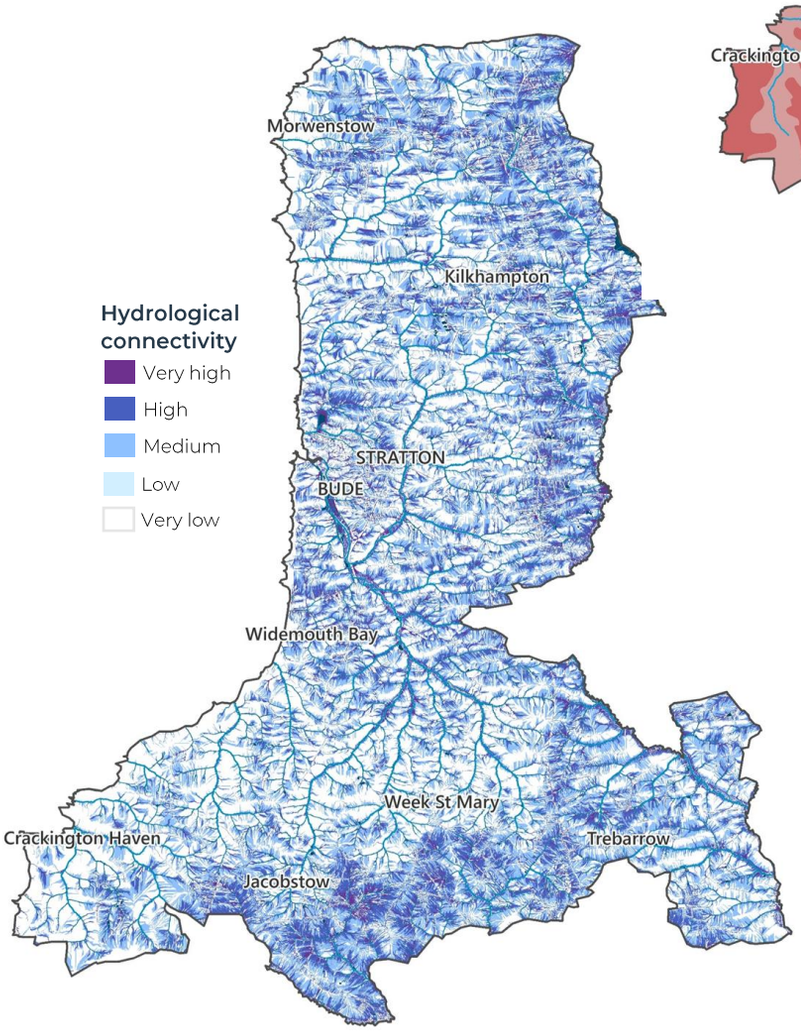
Datasets used in maps: OSVM, OSS, OSOR, TELSW, DNR. For full references see page 59.

NATURAL ASSETS & INFRASTRUCTURE THAT REGULATE THE SERVICE

SOIL TYPE

England has many different types of soil due to variations in geology, climate, plant and animal ecology and land use. Most soils contain sand, silt, clay, organic matter, water and air. The make-up of different soils determines the uses and activities they can support. 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, by picking up contaminants on the ground and sediment through erosion. These areas may highlight pathways of contaminated water reaching rivers and streams.

This hydrological connectivity has been modelled using SCIMAP[8].

Dataset
Network Index (modelled using 2m terrain data)

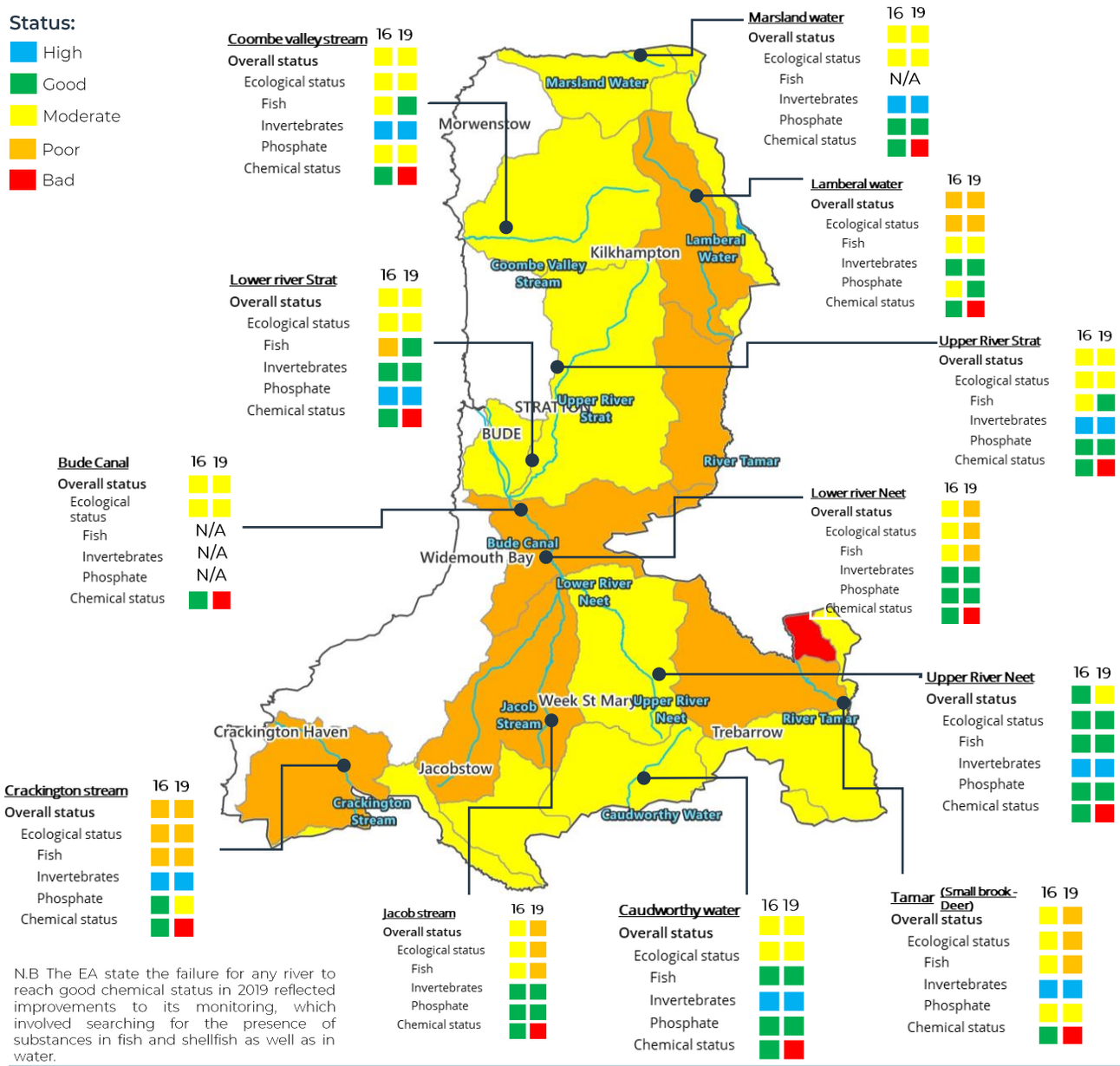
Datasets used in maps: OSVM, OSS, OSOR, TELSW, NAT,. For full references see page 59.

ASSESSING THE PROVISION OF THE SERVICE

WATER FRAMEWORK DIRECTIVE

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 Bude CNA (and across England) now fail to reach good chemical status.



N.B The EA state the failure for any river to reach good chemical status in 2019 reflected improvements to its monitoring, which involved searching for the presence of substances in fish and shellfish as well as in water.

Dataset	Assessment level	Description
Water Framework Directive waterbody assessment	Overall status	WFD is a hierarchical system, with overall status being comprised of an ecological and chemical component, which 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 nutrients 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, OSS< OSOR, WBL, WBC, CDE-WFD16, CDE-WFD2019. For full references see page 59.

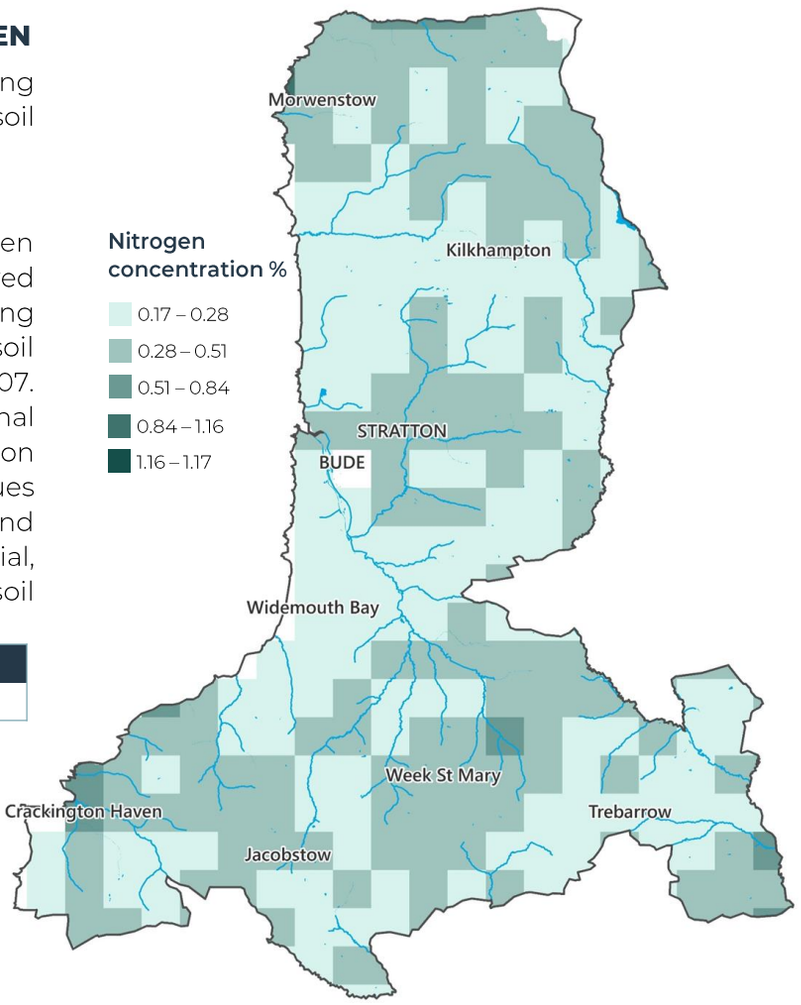
ASSESSING THE PROVISION OF THE SERVICE

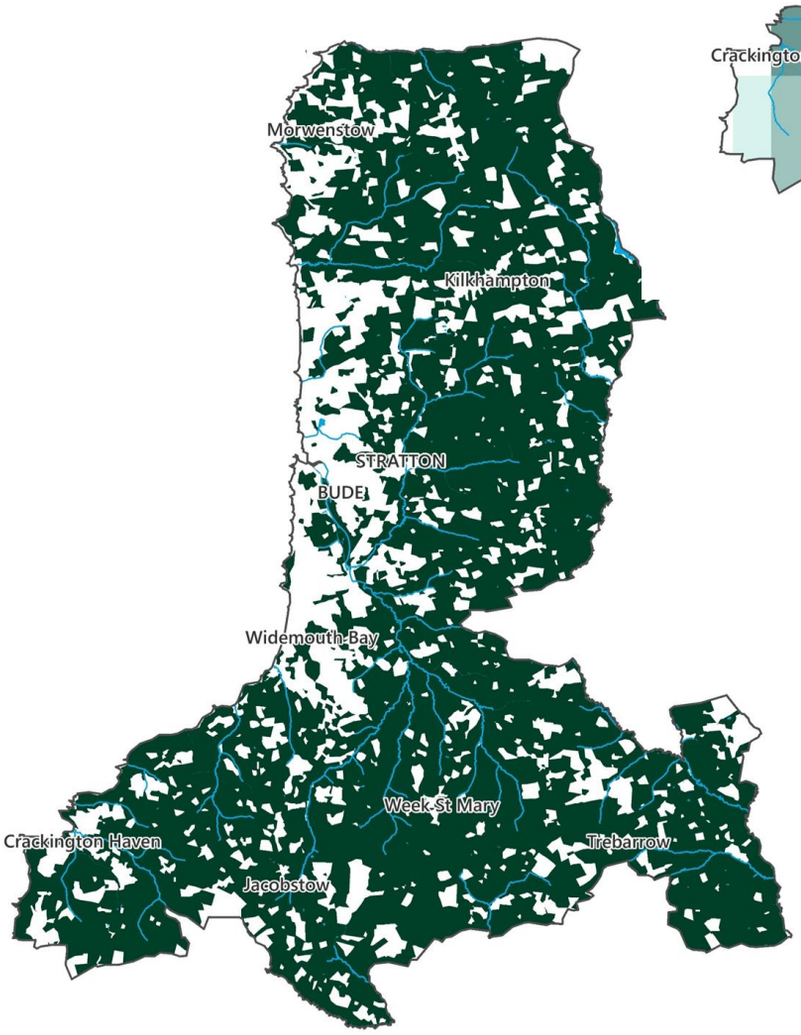
NUTRIENT STATUS OF SOIL - SOIL NITROGEN

The nutrient status of soil can be indicated using the Centre for Ecology and Hydrology (CEH) soil nitrogen spatial dataset[9].

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).

Dataset
CEH Soil Nitrogen





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.

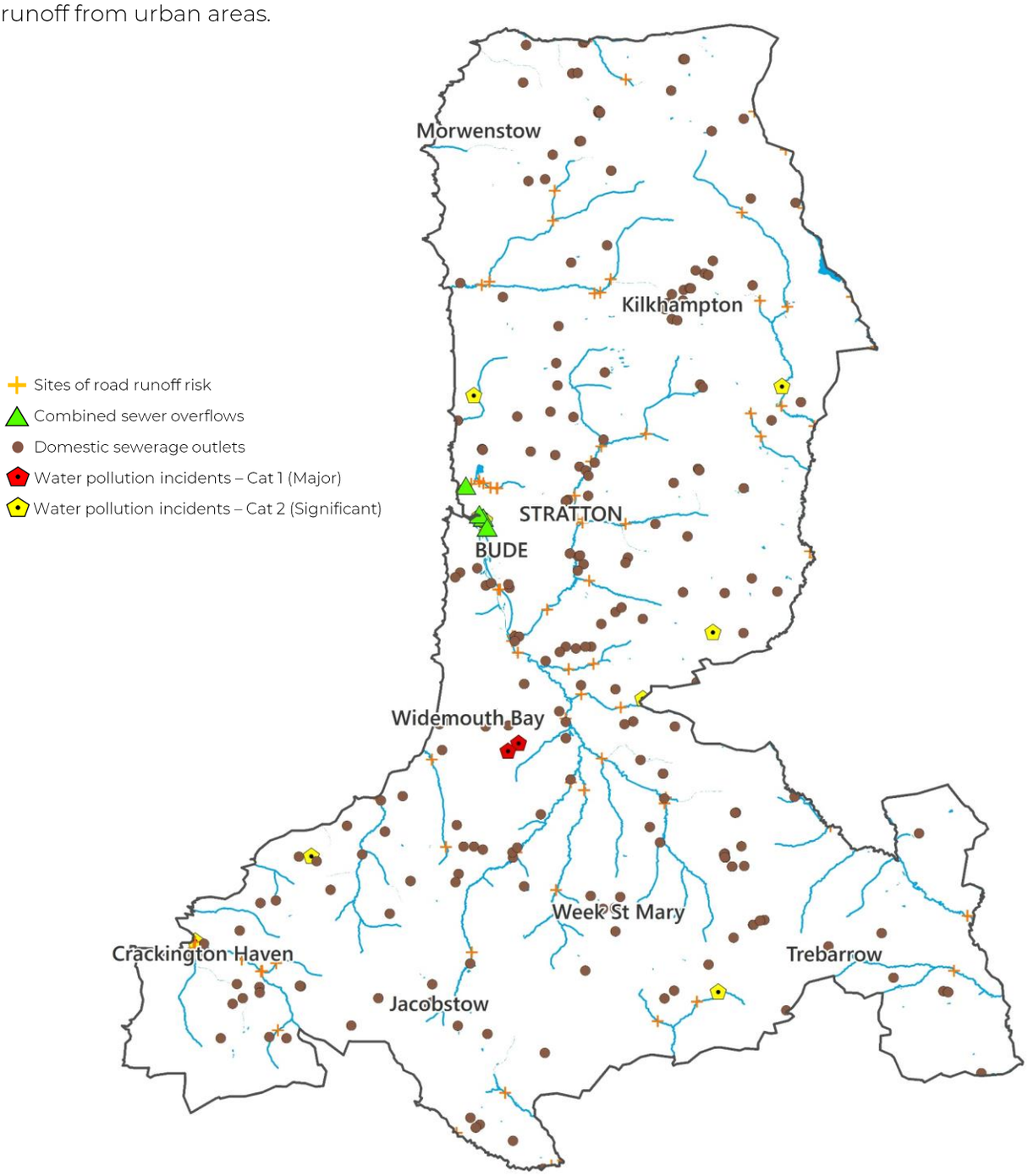
Dataset
Land Cover Map 2015

Datasets used in maps: OSVM, OSS, OSOR, CEHN, LCM2019. For full references see page 59.

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.

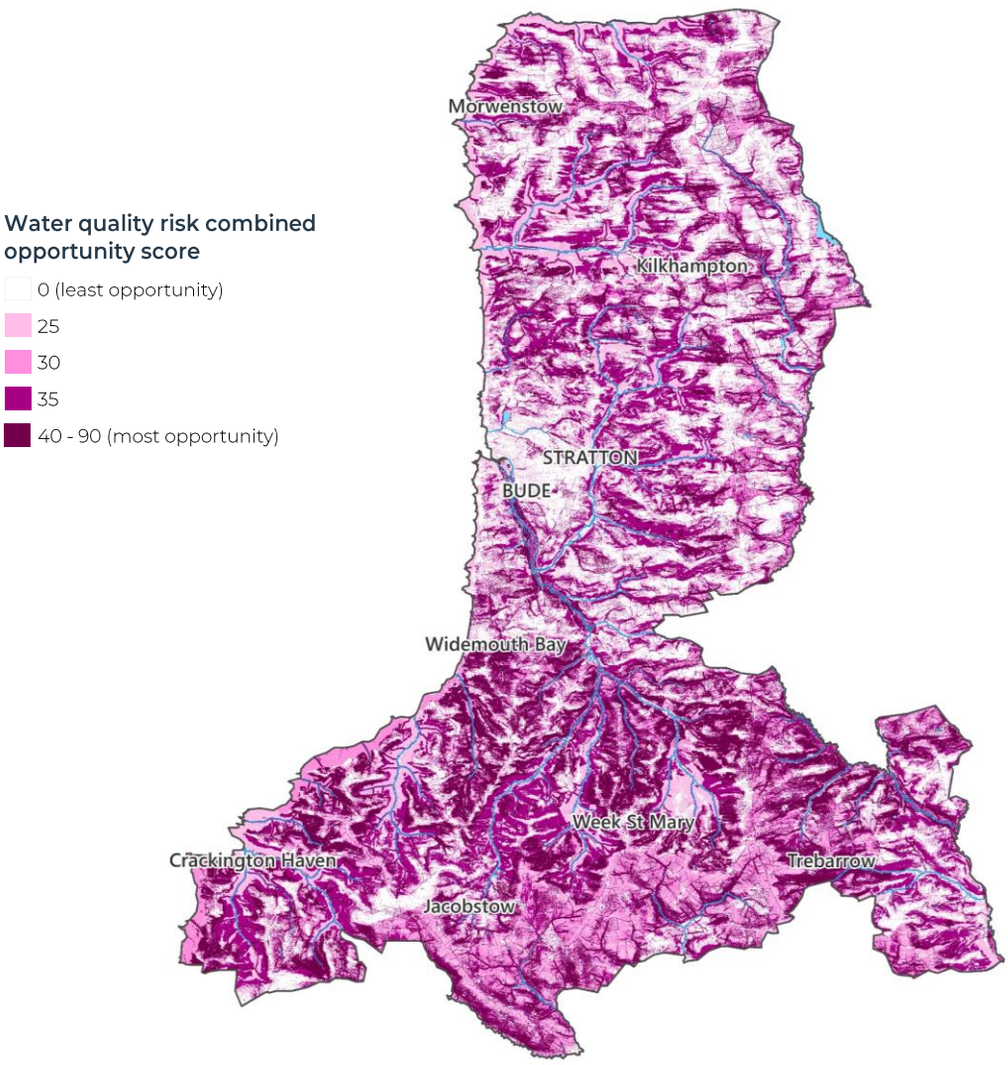


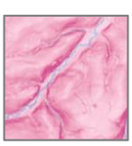
Potential point sources of water pollution	
Dataset	Description
Domestic Sewerage Outlets	Consented discharge point attributed to sewage from domestic properties.
Combined Sewer Overflows (CSOs)	During exceptionally heavy rain, combined sewer systems can overflow at these points, discharging untreated sewage and waste-water.
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 by the Environment Agency as having a significant impact on water quality.

Datasets used in maps: OSVM, OSS, OSOR, CON, CSO, POL. For full references see page 59.

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 34 and 35) 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	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 of high hydrological connectivity are important for the regulation of water quality as this highlights potential flow pathways from contaminated sources or erosion pathways that may be loaded with sediment particles.
 **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, OSS, OSOR, TELSW, NAT, LCM2017. For full references see page 59.

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.

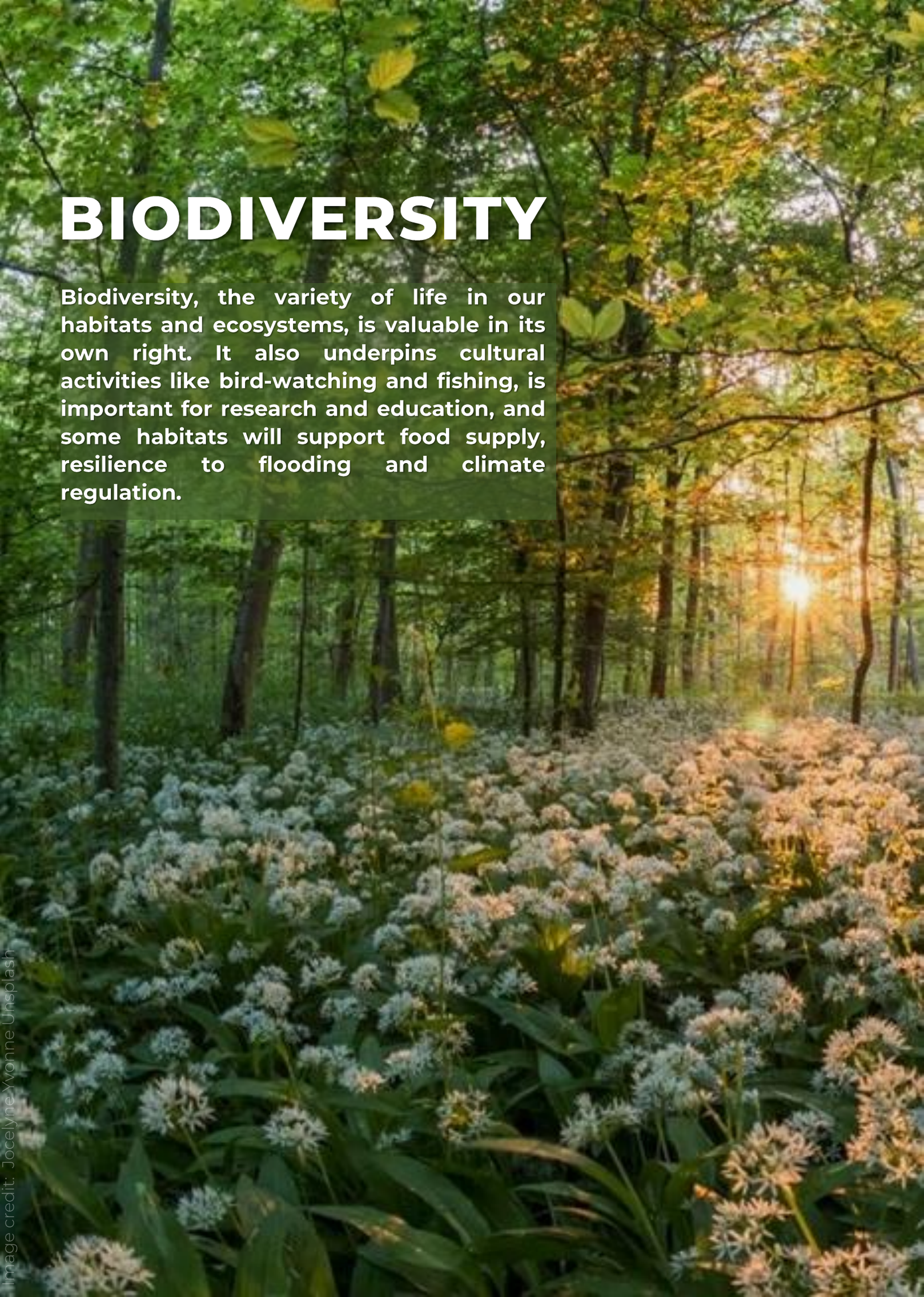


Image credit: Jocelyne Yvonne Unsplash

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

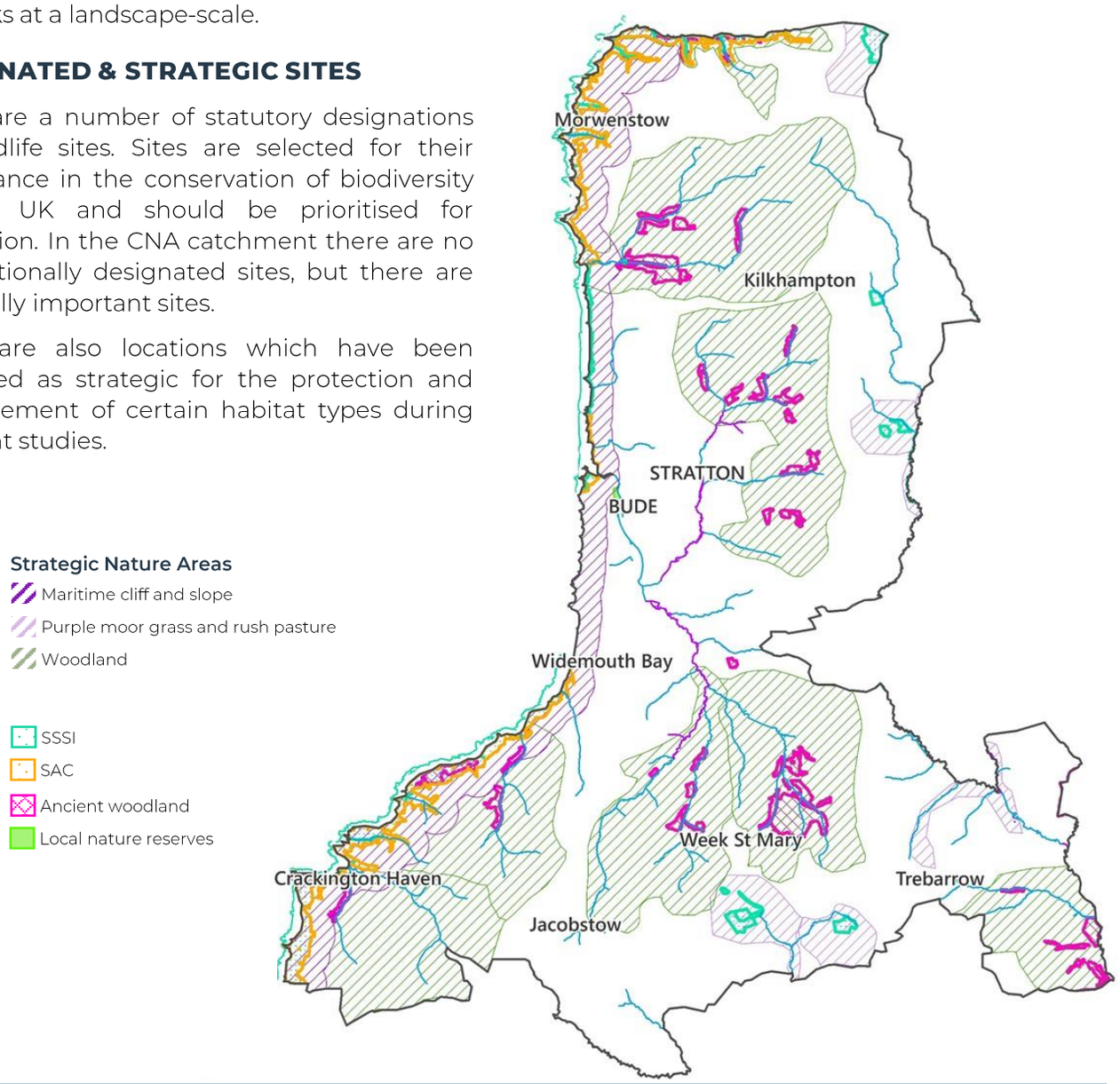
(3) the protection or creation of green spaces in urban areas through local planning processes.

The priority areas highlighted on this page focus on the first of these approaches. In addition, mapped below are the outcomes of strategic mapping exercises that 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 CNA 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
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
Strategic Nature Areas	Areas assessed to offer the best potential to maintain and expand terrestrial wildlife habitats at a landscape scale.

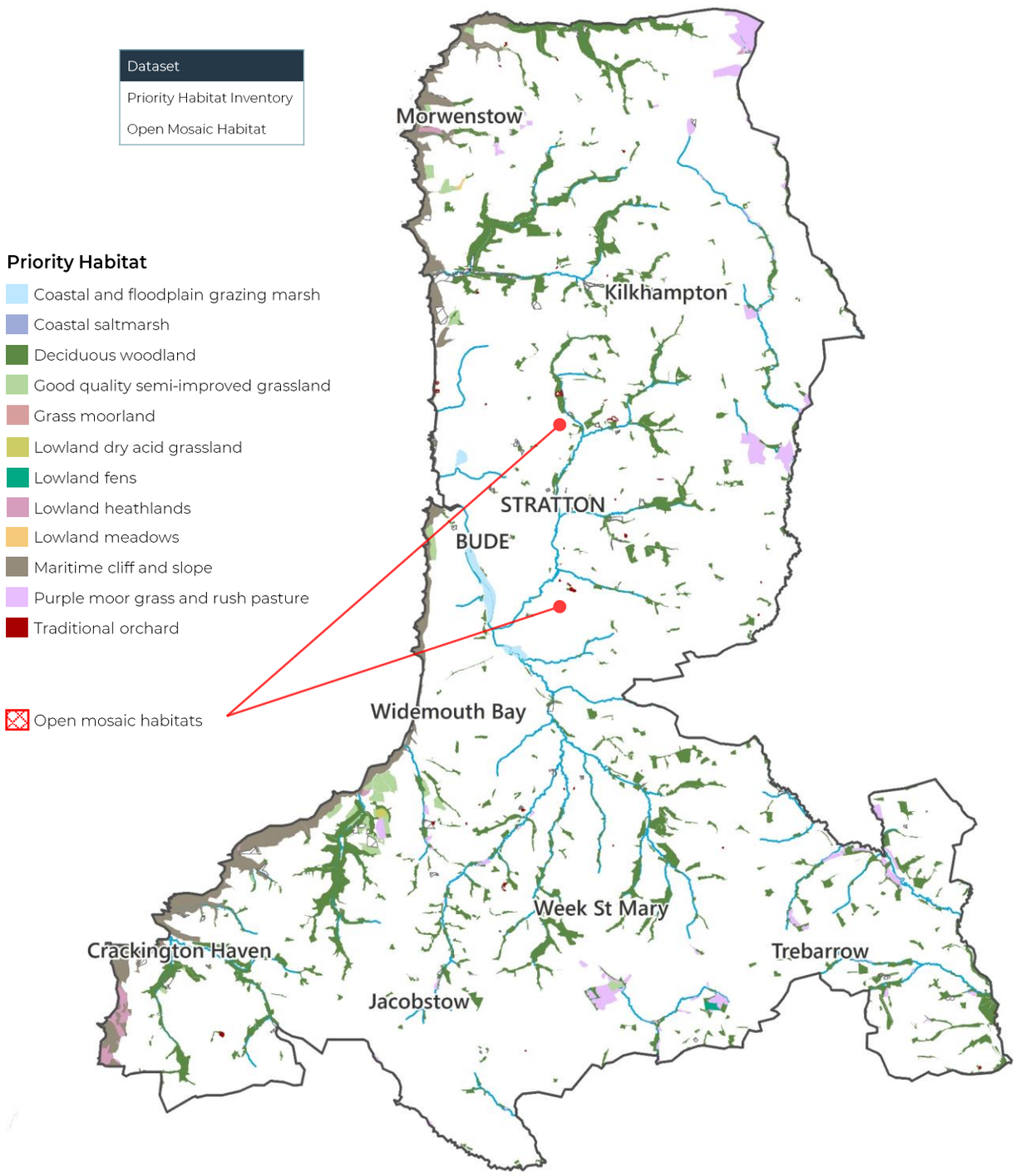
Datasets used in maps: OSVM, OSS, OSOR, AW, SSSI, LNR, ECO, SNA. For full references see page 59..

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 wider 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.

Some current environmental assets are shown in more detail on pages 16 and 17 (e.g. woodland and freshwater). The map below shows priority habitats and small areas of open mosaic habitat, which arise on previously developed land. 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.



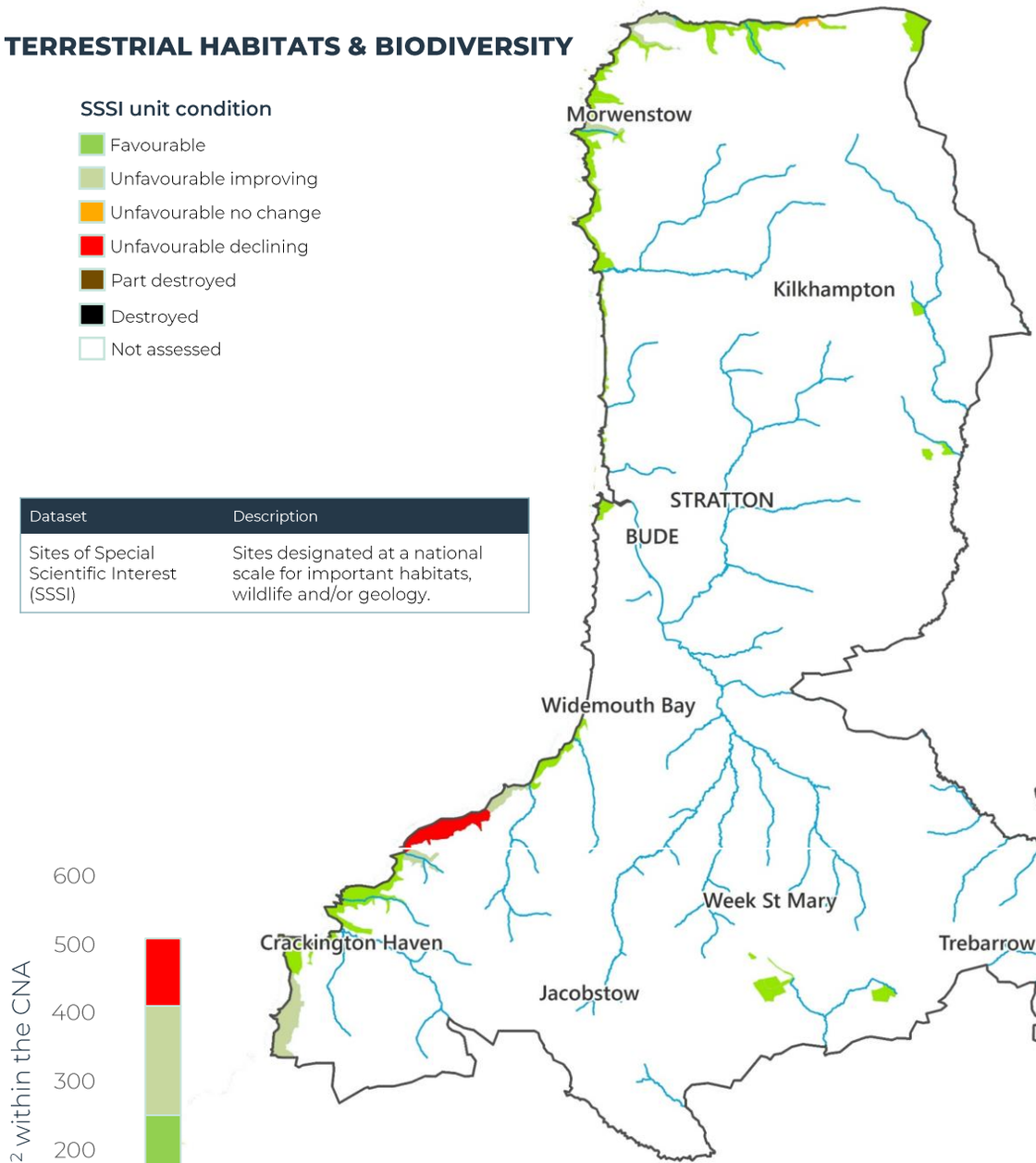
Datasets used in maps: OSVM, OSS, OSOR, PHI, OMH. For full references see page 59.

ASSESSING THE PROVISION OF THE SERVICE

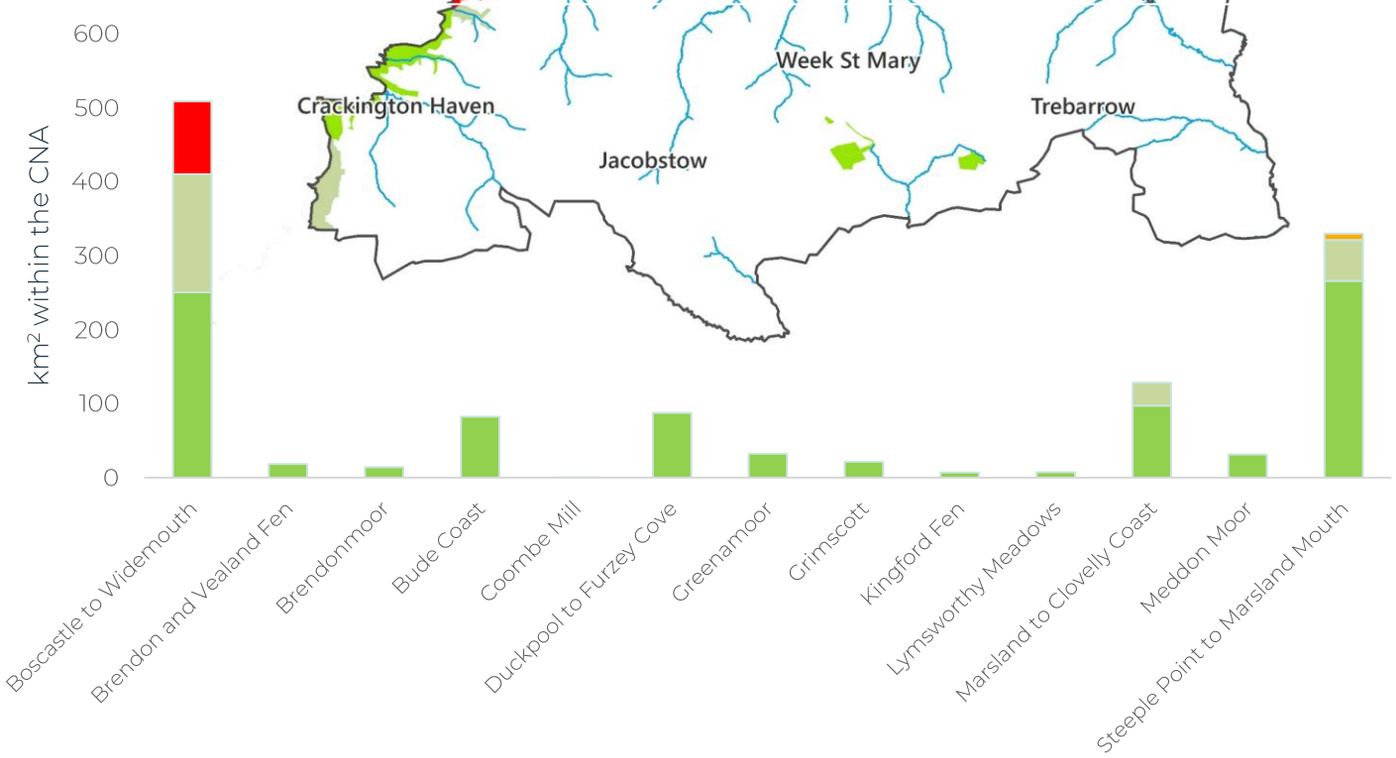
There are numerous sources of data and evidence for the assessment of ecological health across a catchment landscape. Designated sites are classified according to their condition and rivers and other aquatic ecosystems are assessed via a number of metrics, including the Water Framework Directive ecological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



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



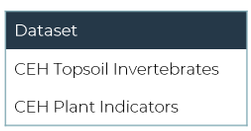
Datasets used in maps: OSVM, OSS, OSOR, SSSI. For full references see page 59.

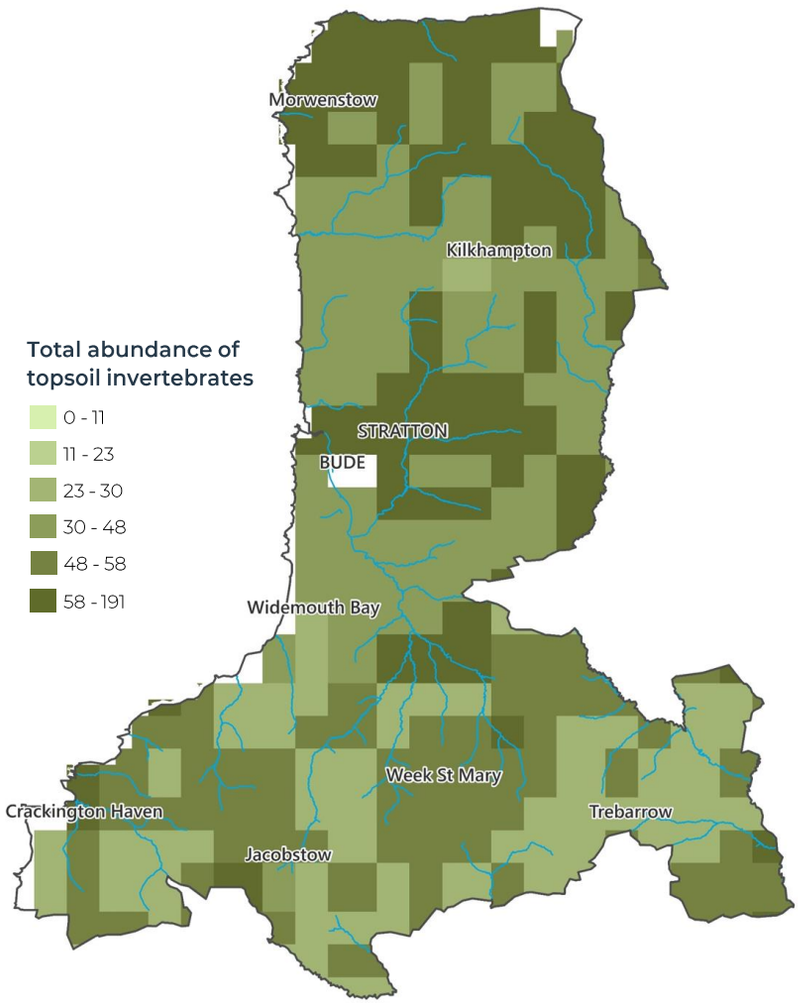
ASSESSING THE PROVISION OF THE SERVICE

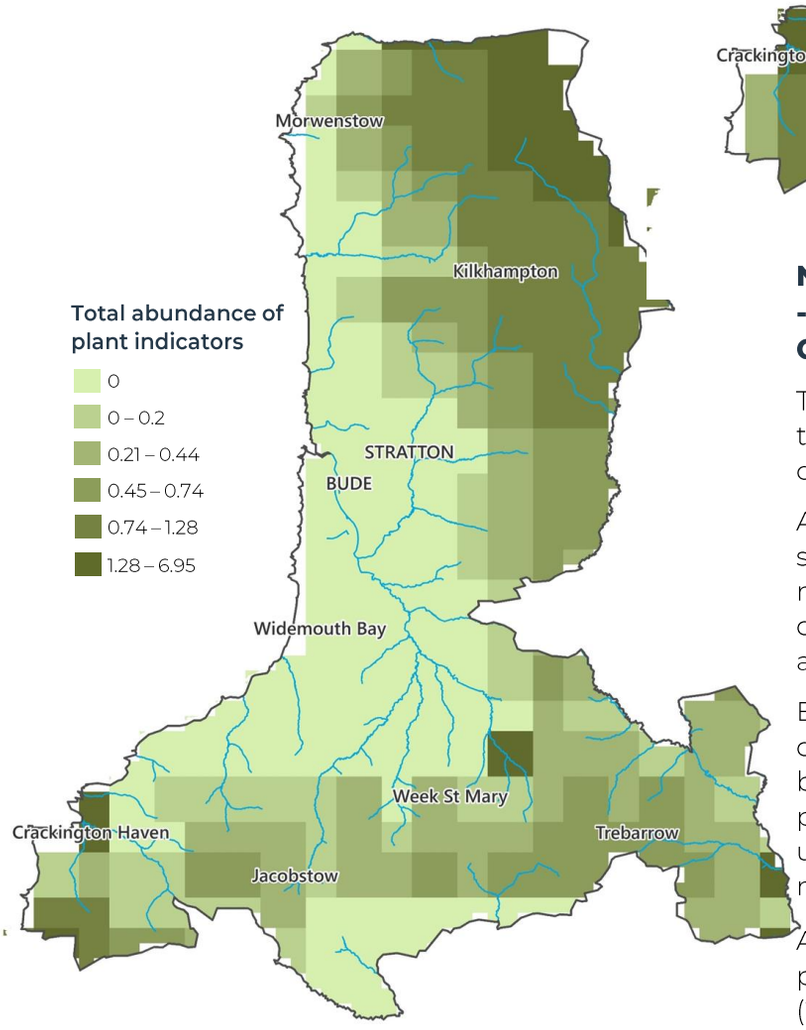
SOIL BIOTA - TOPSOIL INVERTEBRATES

The map below shows mean estimates of total abundance of invertebrates in topsoil (0-8cm depth)[10].

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[11].

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.

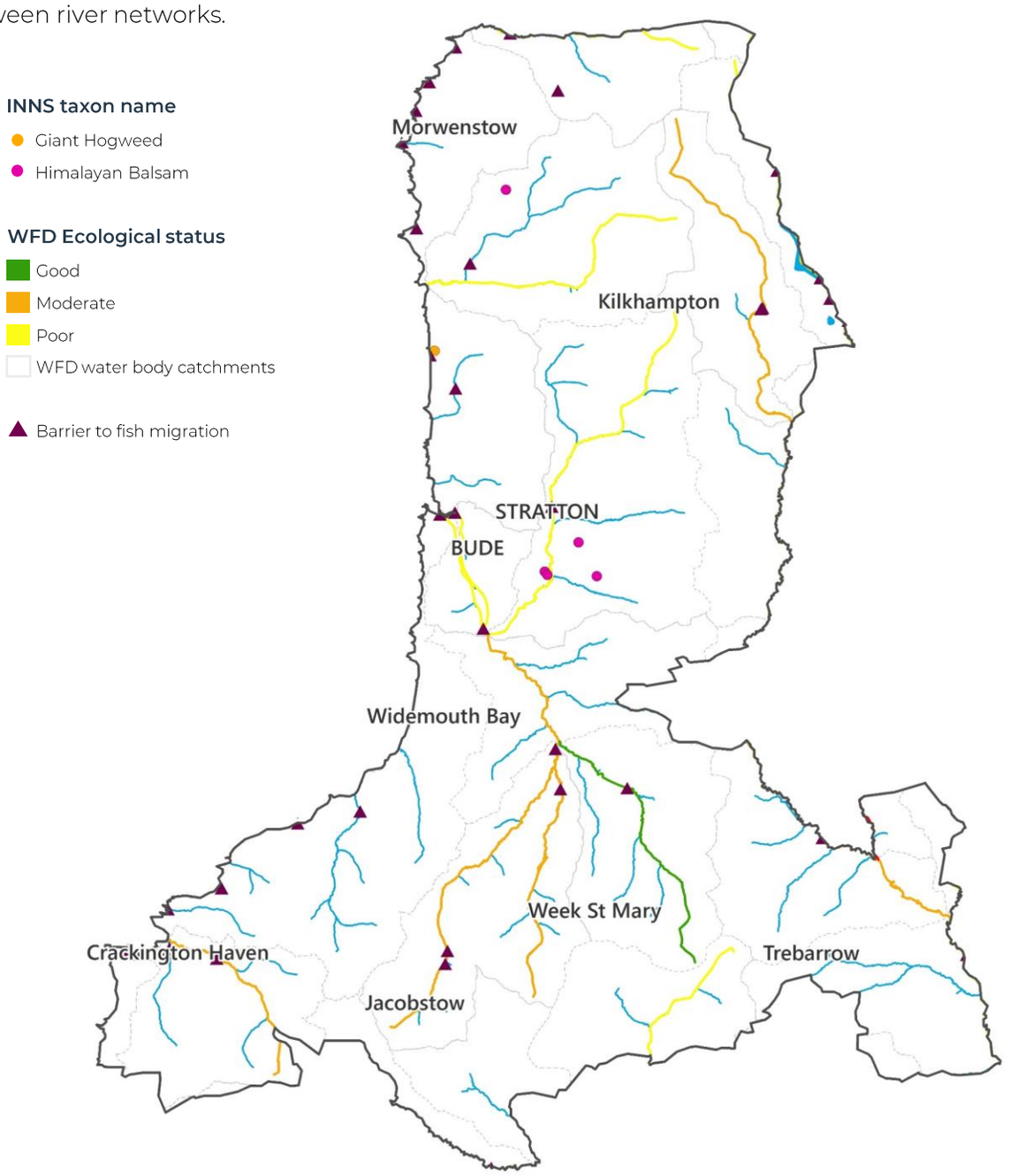
As with the previous map, the mapped dataset was produced by CEH using the Countryside Survey (2007) and extrapolated up to a national level using statistical analysis.

Datasets used in maps: OSVM, OSS,OSOR, CEHTI, CEHPI. For full references see page 59.

ASSESSING THE PROVISION OF THE SERVICE

FRESHWATER HABITATS & BIODIVERSITY

WFD Ecological status is an assessment of the quality of the structure and functioning of surface water ecosystems. It shows the influence of pressures (e.g. pollution and habitat degradation) on the identified quality elements. Ecological status is determined for each of the surface water bodies of rivers, lakes, transitional waters and coastal waters, based on biological quality elements and supported by physico-chemical and hydromorphological quality elements. Other indicators of reduced biodiversity include Invasive non-native species, which outcompete local species, and barriers to fish migration which limits habitat availability for spawning fish and reduces connectivity between river networks.



Indicators of the condition of freshwater habitats	
Dataset	Description
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 Bude CNA during river surveys.

Datasets used in maps: OSVM, OSS, OSOR, WBL, WBC, CDE-STAT, CDE-RNAG, BAR, INNS. For full references page 59.

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.*

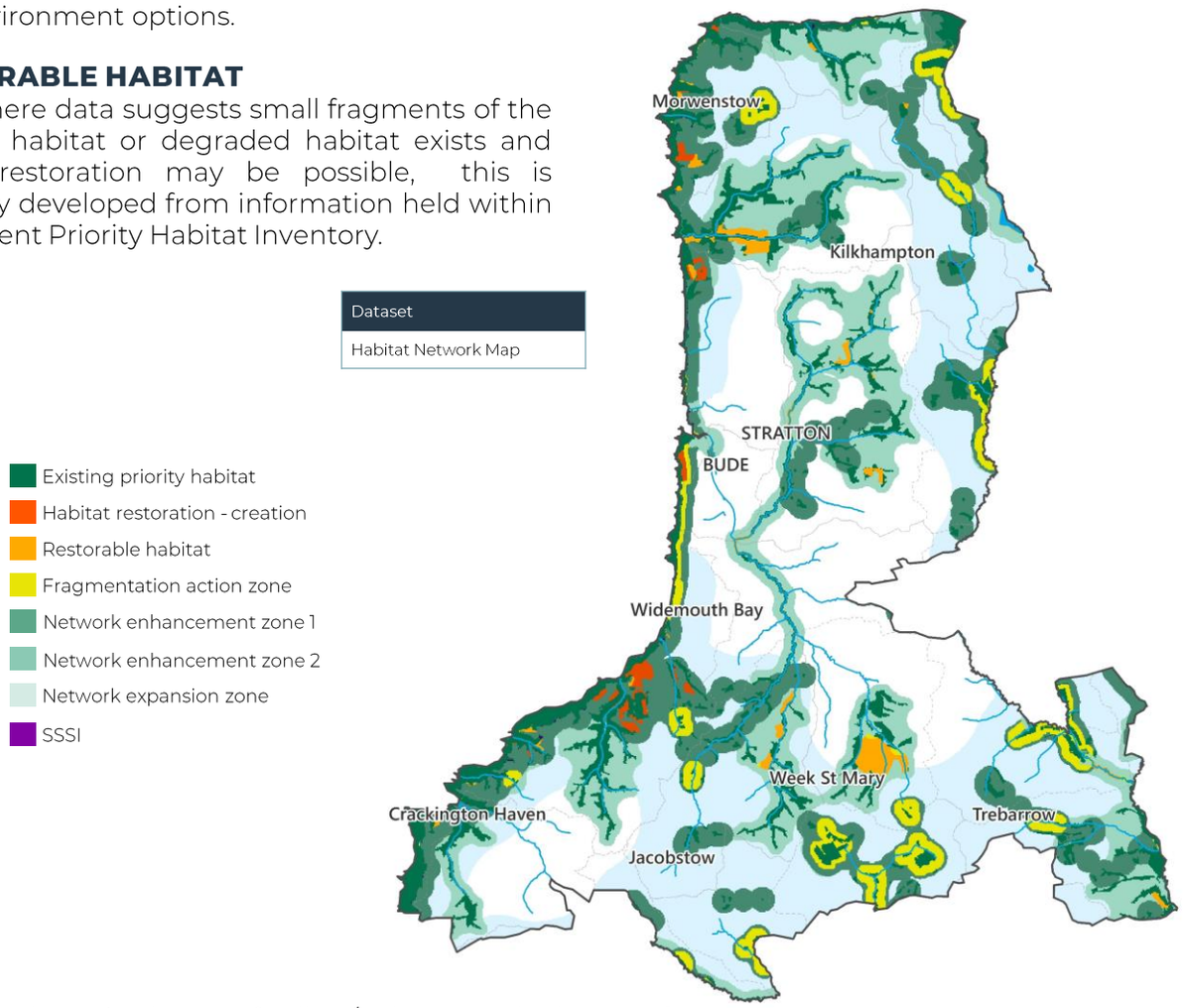
The map shows, in shades of orange, two '**Habitat Components**' of the mapping system:

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 is 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 is 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 is 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, OSS, OSOR, WBL, WBC, HNM. For full references see page 59.

OPPORTUNITIES FOR ENHANCEMENT

Natural England has developed a model that allows non-specialists to assess the vulnerability of areas of priority habitat to climate change based on widely accepted principles of climate change adaptation for biodiversity[15]. The assessment provides a high level indication of the relative vulnerability of priority habitats to climate change in different places. It identifies why areas are vulnerable and which possible interventions can have the biggest impact in increasing resilience in a changing climate. This can inform prioritisation of adaptation actions and assist in the development of adaptation strategies for biodiversity.

INTRINSIC SENSITIVITY TO CLIMATE CHANGE

The model assigns high, medium or low sensitivity to direct climate change impacts – reflecting the habitat itself on the basis of expert judgement and scientific literature.

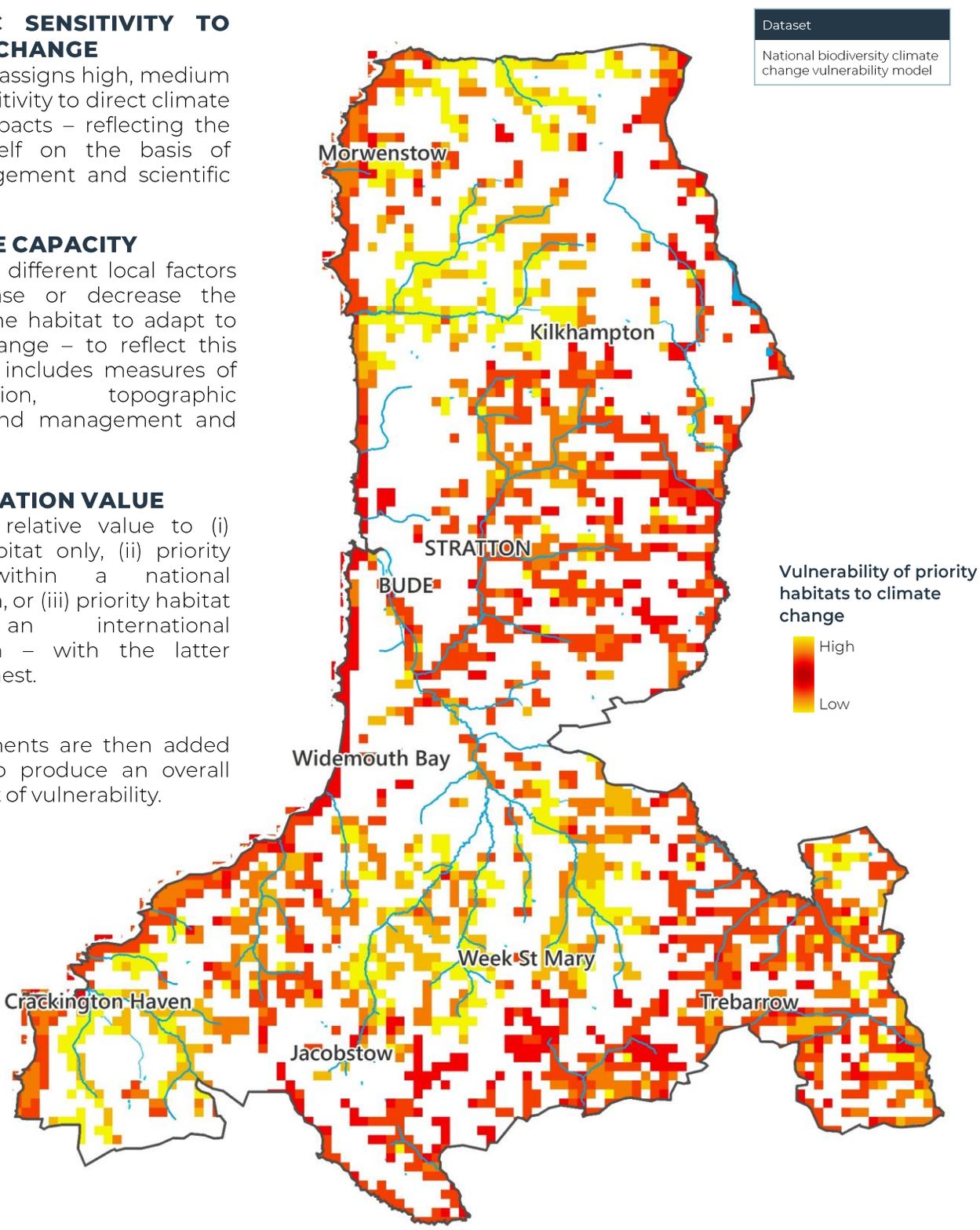
ADAPTIVE CAPACITY

A range of different local factors can increase or decrease the ability of the habitat to adapt to climate change – to reflect this the model includes measures of fragmentation, topographic variation and management and condition.

CONSERVATION VALUE

Assigns a relative value to (i) priority habitat only, (ii) priority habitat within a national designation, or (iii) priority habitat within an international designation – with the latter valued highest.

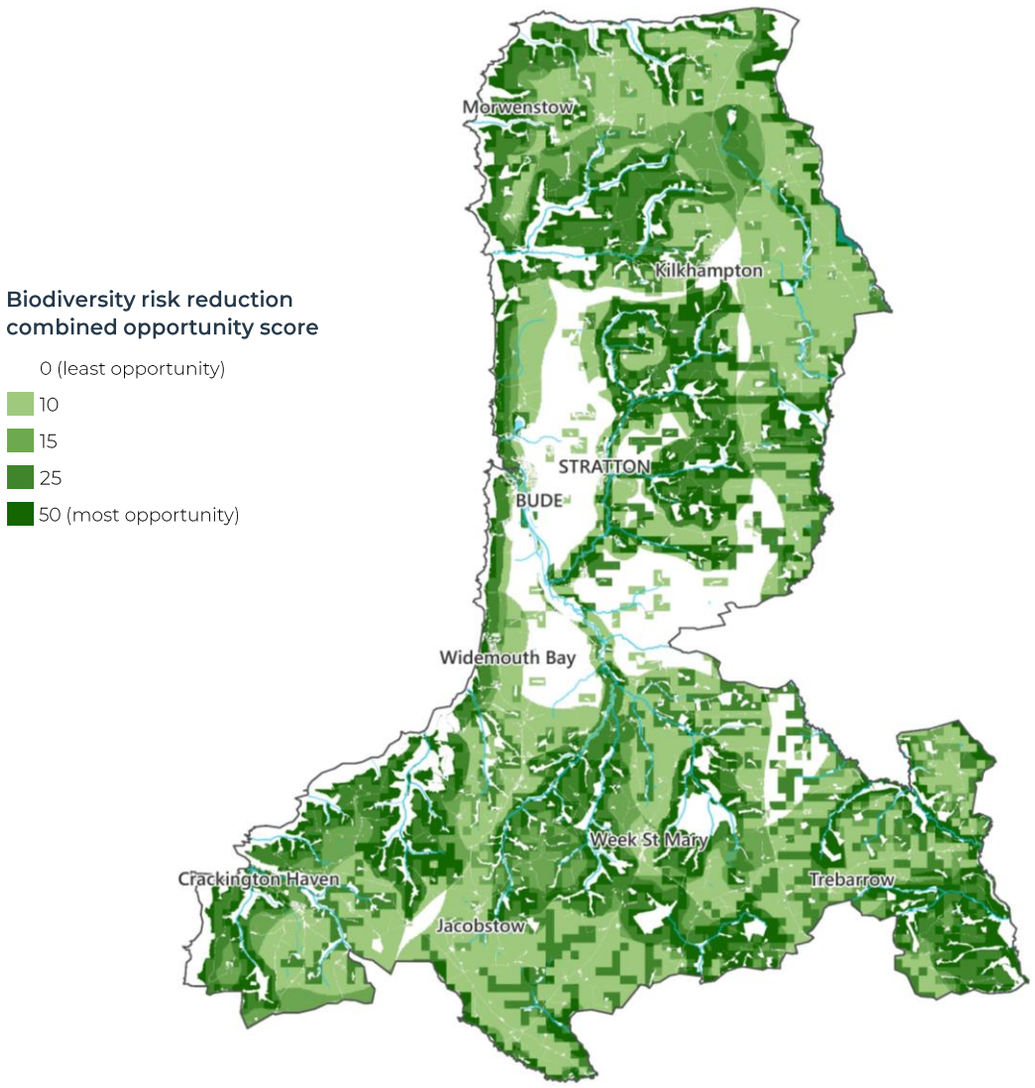
These elements are then added together to produce an overall assessment of vulnerability.

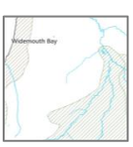
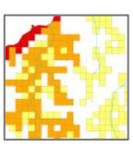


Datasets used in maps: OSVM, OSS, OSOR, NBCCV For full references see page 59.

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 page 47, which is scored and combined with the strategic areas highlighted on page 42 and a number of other criteria (shown below).



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 42 are given priority.
 **Habitat Vulnerability to Climate Change** High = 30 Medium = 20 Low = 10	Natural England has developed a model that allows non-specialists to assess the vulnerability of areas of priority habitat to climate change based on widely accepted principles of climate change adaptation for biodiversity. The assessment provides a high level indication of the relative vulnerability of priority habitats to climate change in different places.[15]
 **Exclusion areas** Areas with exclusion criteria are reset to 0	Factors that make it less likely that ecological networks can be established are excluded. These include urban areas, main road and railway infrastructure, productive agricultural land, protected sites and priority habitats.

Datasets used in maps: OSVM, OSS, OSOR, CEHSC,LCM-2019, NAT ALC, SCH, SSSI, AW, PHI. For full references see page 59.

CARBON

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 they 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.

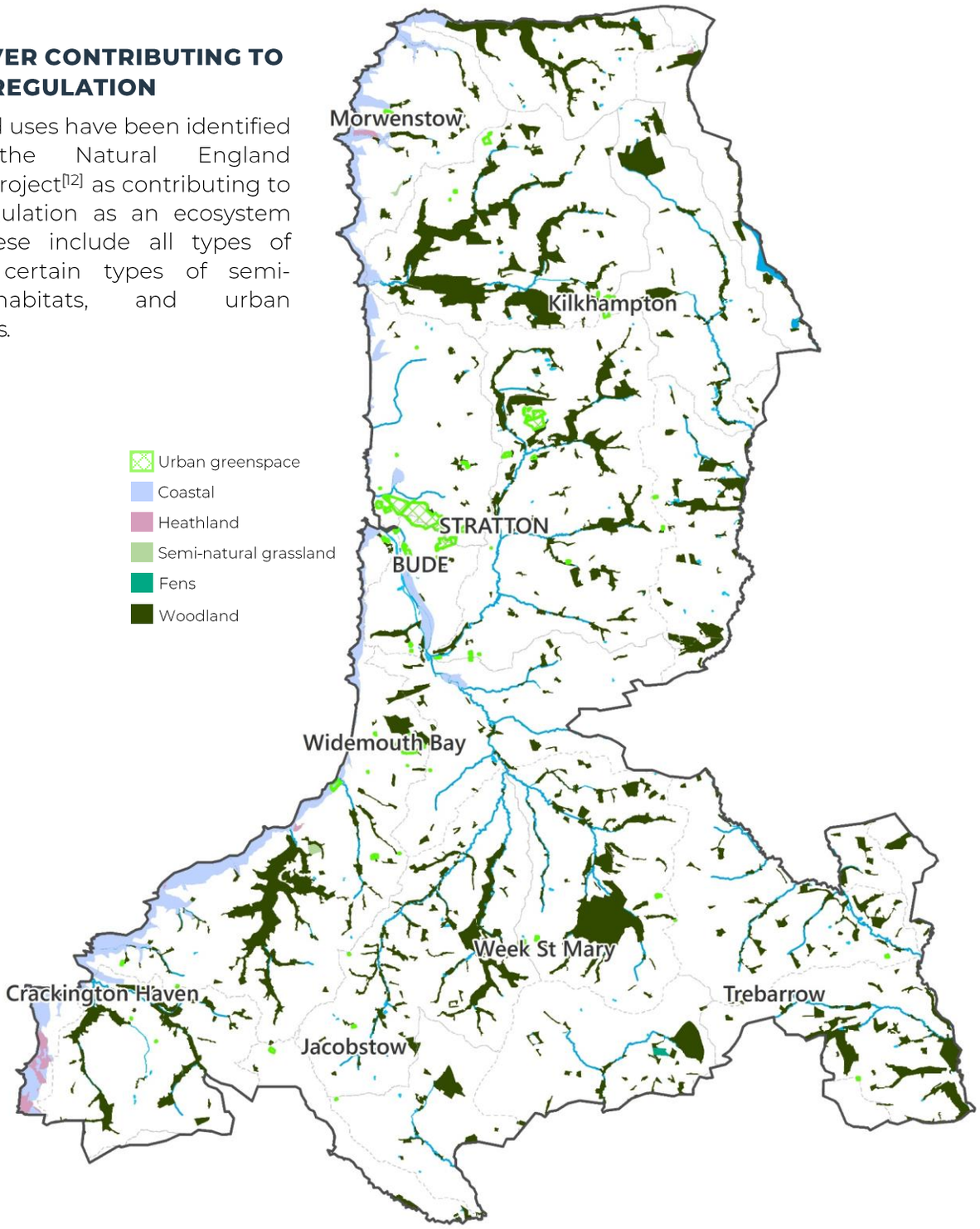
Image credit: Tom Barrett Unsplash

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 COVER CONTRIBUTING TO CLIMATE REGULATION

Certain land uses have been identified through the Natural England Indicators project[12] 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
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, OSS, OSOR, NFI, PHI, OSG. For full references see page 59.

ASSESSING THE PROVISION OF THE SERVICE

CARBON STORAGE

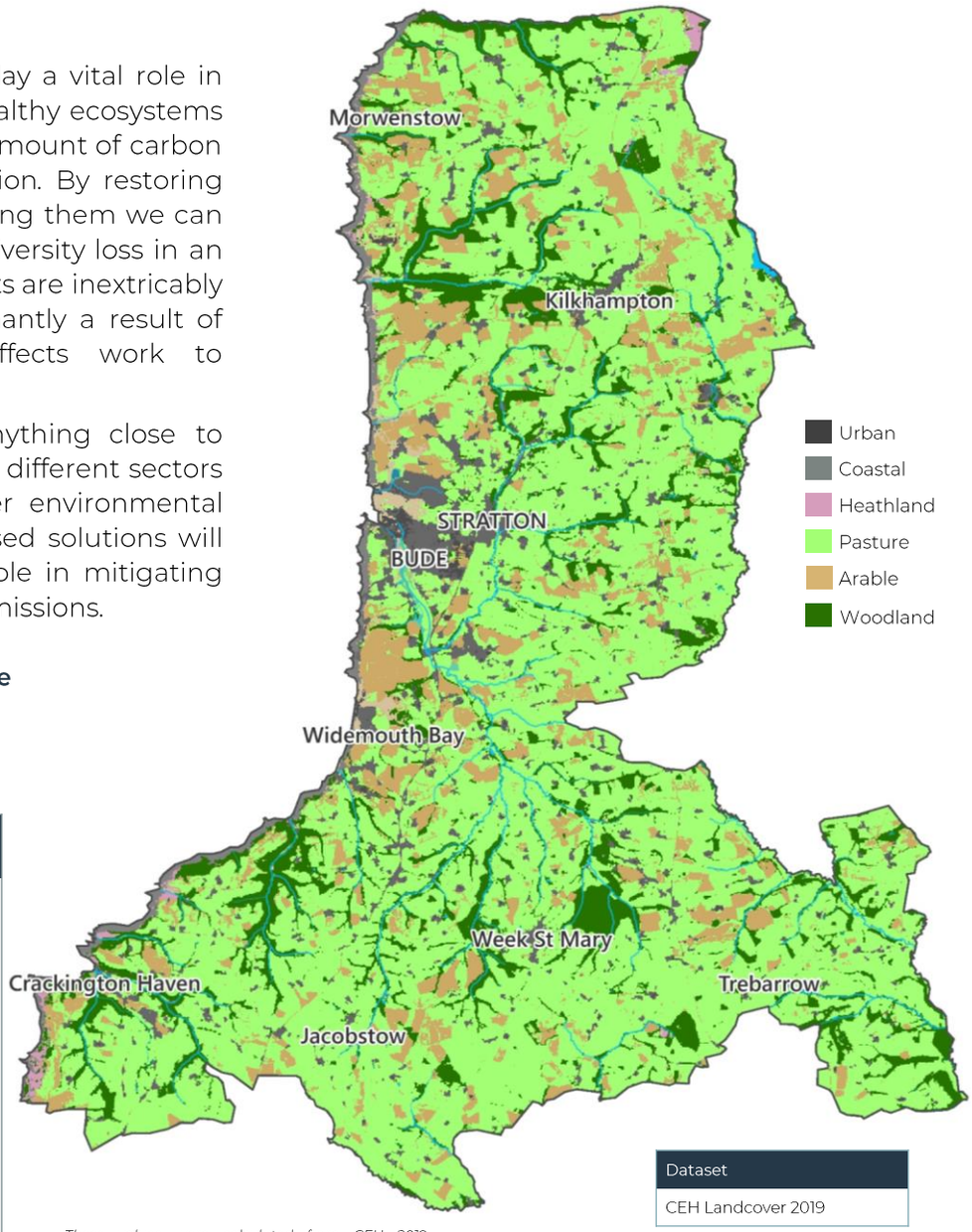
The natural environment can play a vital role in tackling the climate crisis as healthy ecosystems take up and store a significant amount of carbon in soils, sediments and vegetation. By restoring degrading habitats and expanding them we can tackle climate change and biodiversity loss in an integrated way. These two threats are inextricably linked, they are both predominantly a result of human action and their effects work to exacerbate each other.

It is not possible to offset anything close to current UK emissions across the different sectors of the economy through better environmental management alone. Nature based solutions will be able to play an important role in mitigating the residual, hard to-eliminate emissions.

Approximate carbon storage in the Bude CNA soil and vegetation

3.6 million tonnes

Habitat type	Carbon (tonnes)	Ha
Improved grassland	2, 075, 277	15, 964
Broadleaved woodland	1, 105 ,278	3, 122
Arable	371, 114	3, 093
Coniferous woodland	67, 772	191
Fen	30, 984	16
Heathland	11, 860	119
Supra littoral sediment	1, 928	161
Saltmarsh	1, 308	23
Littoral sediment	84	7
Acid grassland	28	<1
Neutral grassland	7	<1



These values were calculated from CEH 2019 Landcover data and the 'Carbon storage and sequestration by habitat: a review of the evidence (second edition)[53] report by Natural England. The amount of carbon being stored in different habitats depends on many factors including the condition of it. Therefore these values are rough approximations and should be viewed as an indication of the amount of carbon stored in the CNA only.

The amount of carbon stored in the Bude CNA landscape could be increased by:

- Protecting, restoring and expanding protected sites and semi natural habitats
- Planting new broadleaved woodland
- Wetland creation
- River restoration (where rivers have been heavily modified)
- Improved soil management on farmland and forestry sites
- Protecting and restoring coastal processes and intertidal habitats

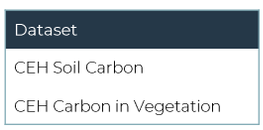
To be effective, it is important that these measures are located in suitable areas in the landscape and then designed and managed in a way that will ensure they can continue to be effective under future climatic conditions.

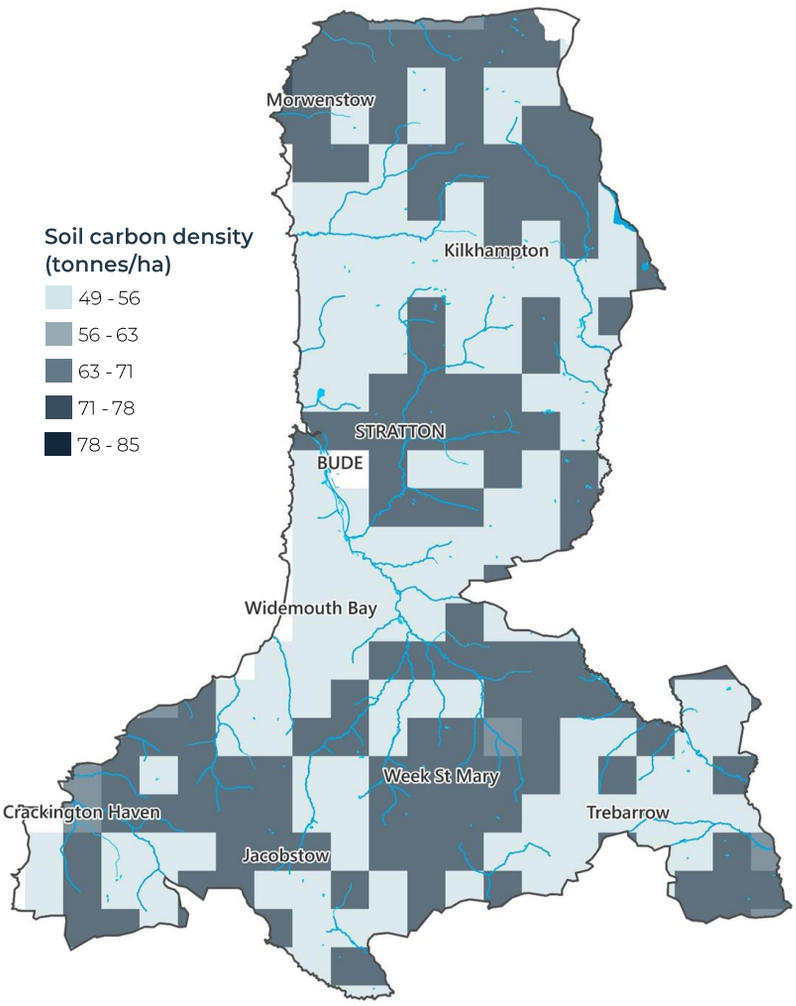
Datasets used in maps: OSVM, OSS, OSOR, LCM2019. For full references see page 59.

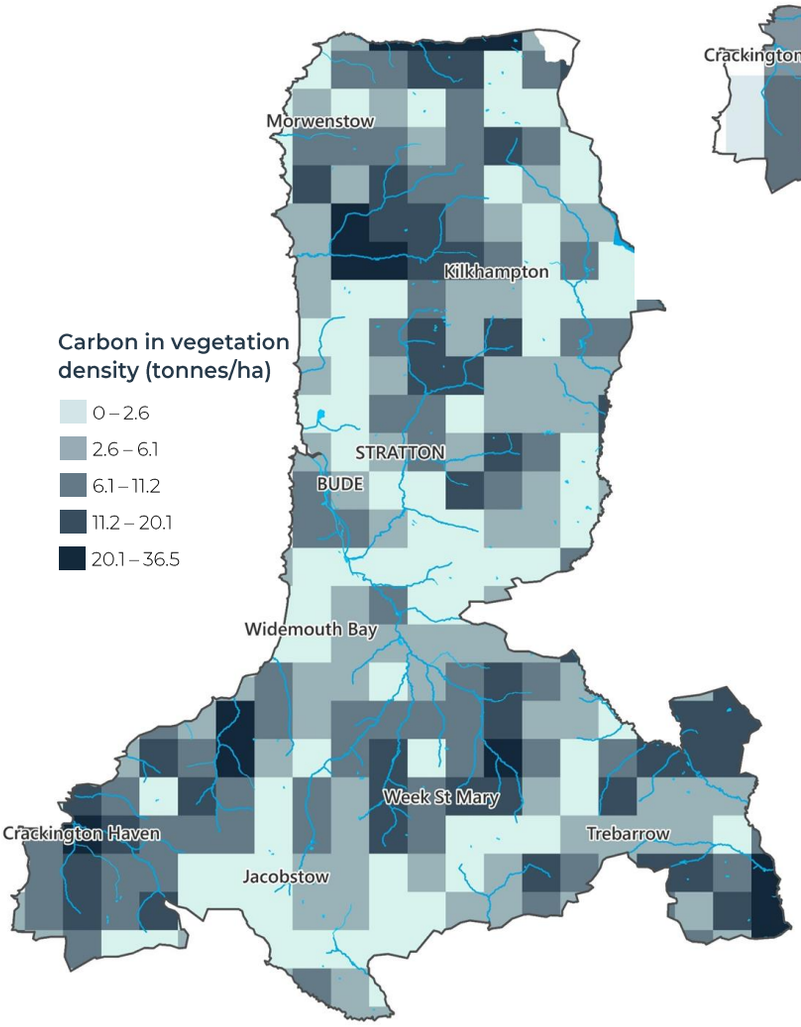
ASSESSING THE PROVISION OF THE SERVICE

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 to the right shows mean estimates of topsoil (0-15cm depth) carbon density in tonnes per hectare[13].







CARBON IN VEGETATION

Although soil 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 to the left shows mean estimates of carbon stocks, in tonnes per hectare, stored in above-ground vegetation[14].

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.

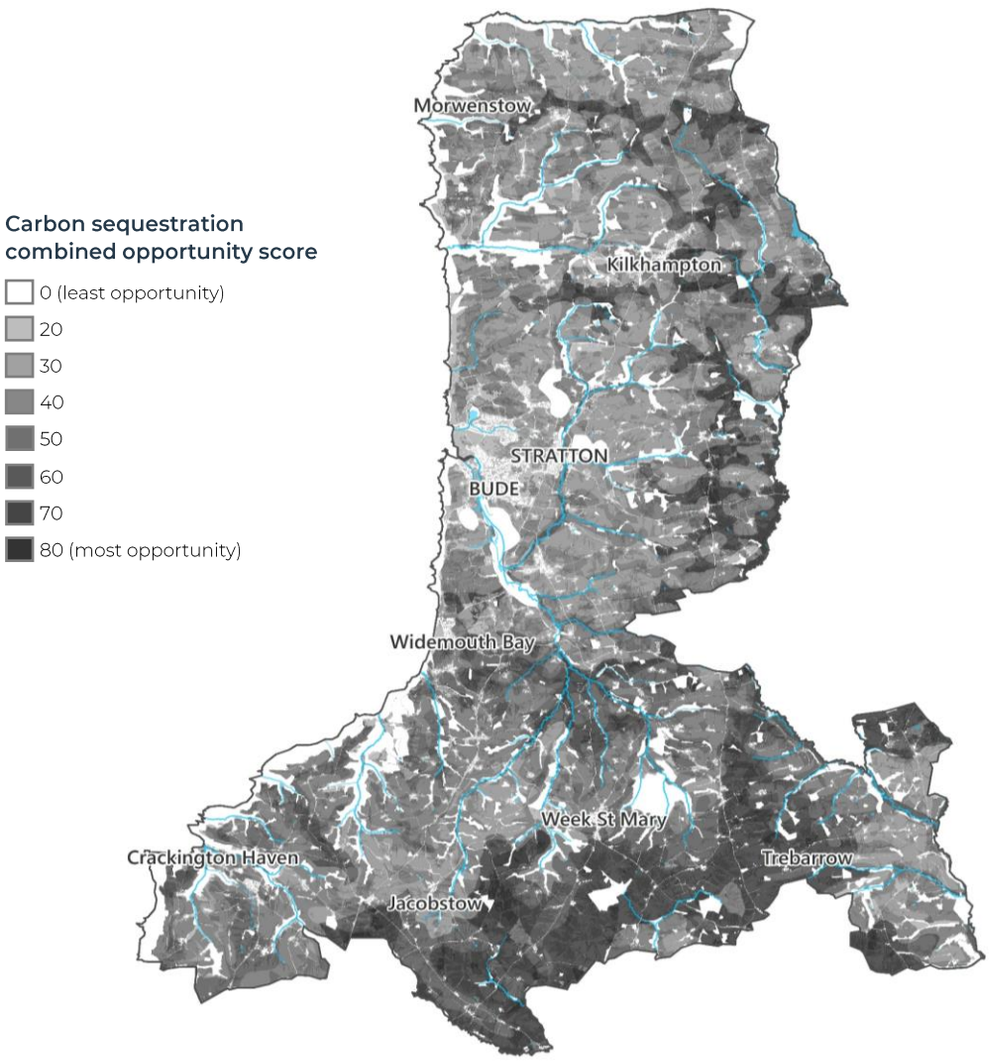
EXTENT OF PERMANENT VEGETATION

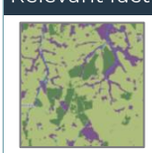
Page 38 shows extent of permanent vegetation which is also an indicator of how well the catchment may be providing climate regulation services.

Datasets used in maps: OSVM, OSS, OSOR, CEHSC, CEHCV. For full references see page 59.

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 an 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 32).
 **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, OSS, OSOR, LCM2019, ALC, NAT, DTM2, FZ2, ALC, SCH, SSSI, AW, PHI. For full references see page 59.

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.

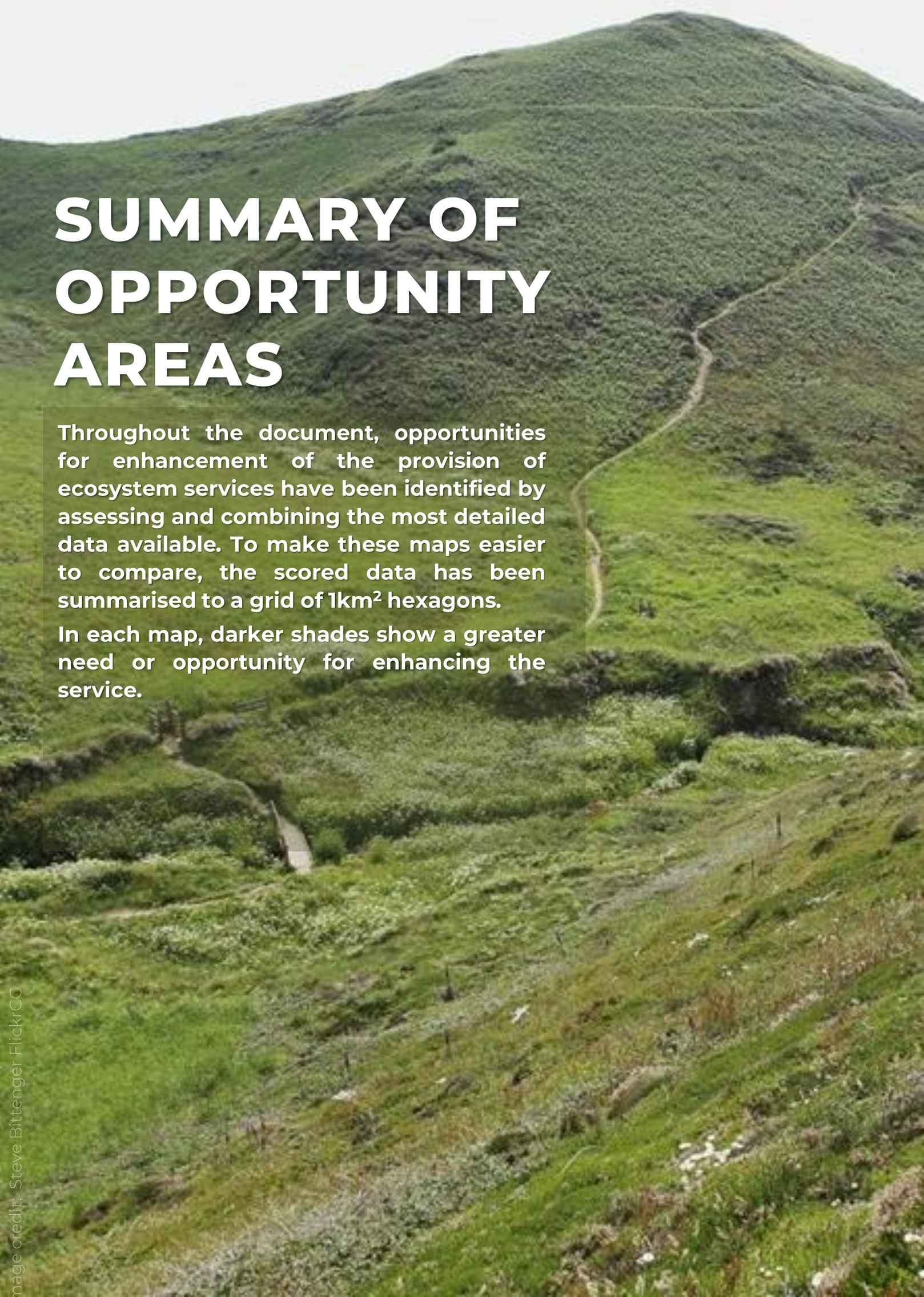


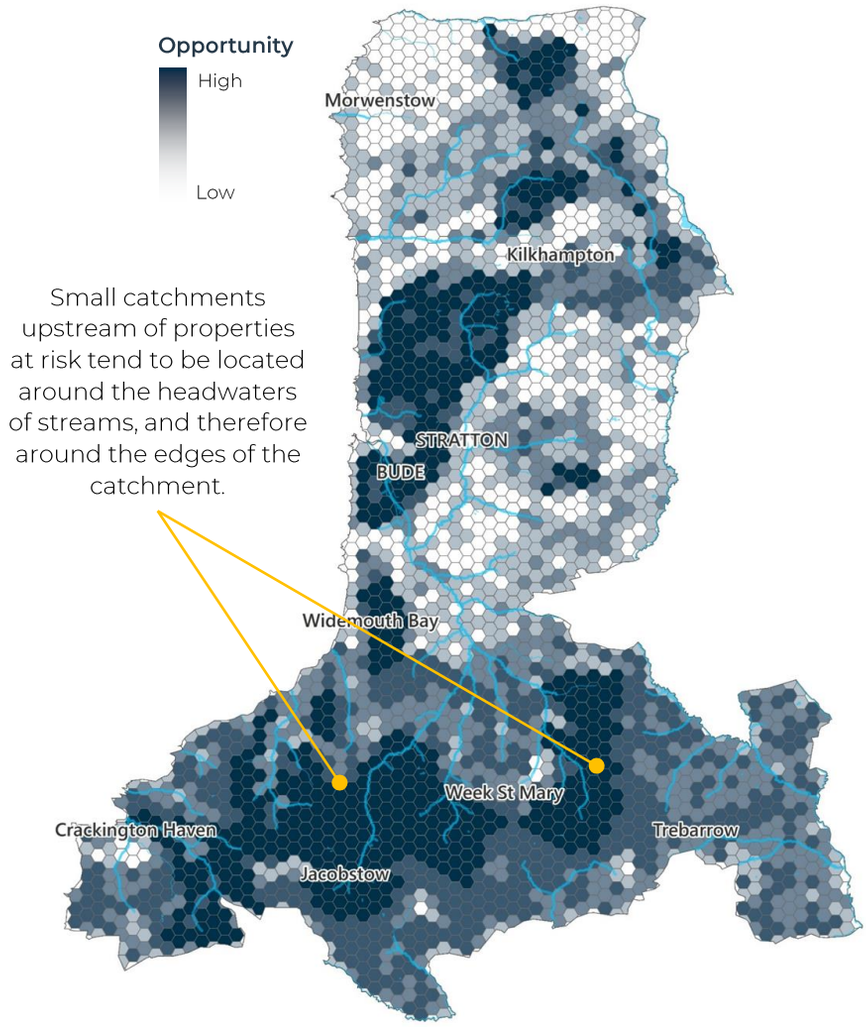
Image credit: Steve Bittenger FlickrCC

OPPORTUNITIES FOR ENHANCEMENT

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.

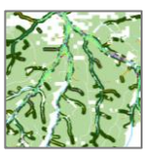
'POTENTIAL AREAS FOR IMPROVED RESILIENCE'
+
SMALL CATCHMENTS
+
SOCIAL FLOOD VULNERABILITY



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

OPPORTUNITY SCORING

POTENTIAL AREAS FOR IMPROVED RESILIENCE



High score
Areas that have been identified by the Environment Agency's NFM opportunity modelling
Low score
Areas identified as not suitable by the above model *see page 25 for more information on the model*

SMALL CATCHMENTS

High score
<5km^2
Medium score
5-20km^2
Low score
>20km^2

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 VULNERABILITY

High score
Areas connected to neighbourhoods of above average SFRI
Low score
Other areas

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

CLIMATE CHANGE

Increasing periods of intense rainfall and extreme storms

FLOODING

Increasing resilience to FLOODING

RESTORE NATURAL HYDROLOGICAL REGIMES

Humans have been altering the pathways of water across the landscape for centuries, many of these changes now result in the landscape being less resilient to climate change

Tree planting

Wetland creation

Soil management

River restoration

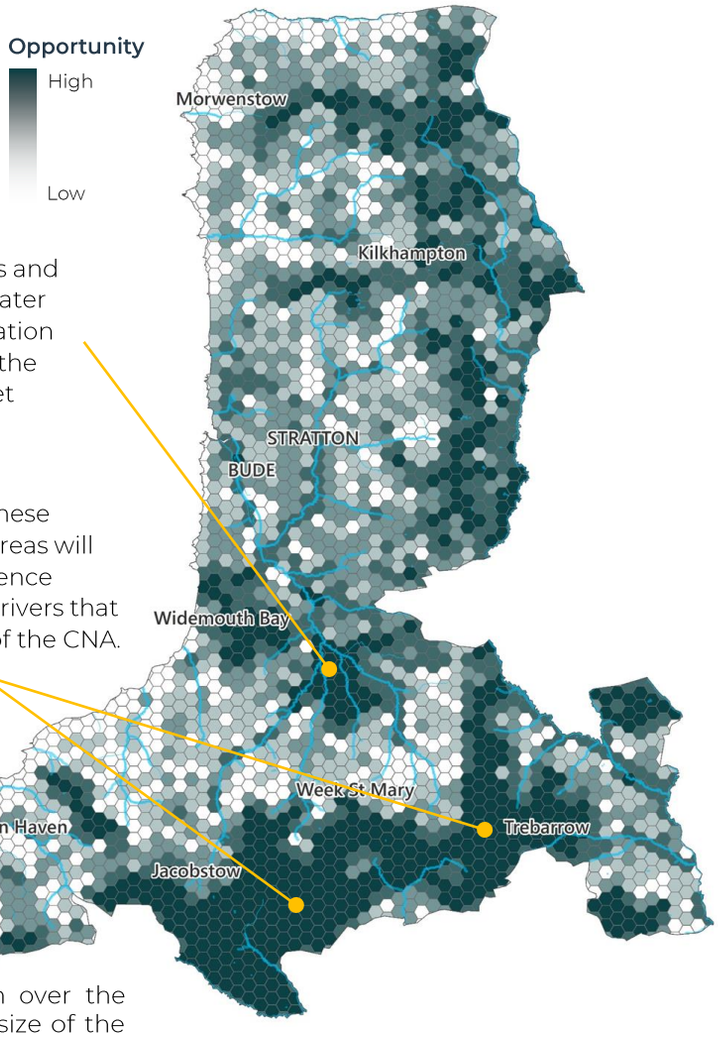
Datasets used in maps: OSVM, OSS, OSOR, SMC, WWNP, SFRI. For full references see page 59.

OPPORTUNITIES FOR ENHANCEMENT

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

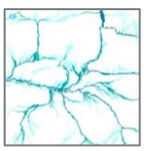


Seasonally wet soils and areas of surface water flow and accumulation coincide around the lower River Neet

Much of these opportunity areas will have influence downstream of rivers that flow south out of the CNA.

OPPORTUNITY SCORING

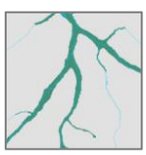
HYDROLOGICAL CONNECTIVITY



High score
Areas that have high hydrological connectivity
Low score
Areas that have low 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 of high hydrological connectivity are important for the regulation of water flow as this is where water can be slowed as it moves through the landscape.

FLOODPLAIN



High score
Within 1 in 100 year flood extent
Low score
Not within 1 in 100 year flood extent

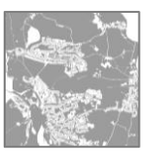
Wetland restoration or creation is most successfully achieved on land with a high natural propensity to be seasonally or permanently wet or water-logged. In many strategic mapping approaches this land is primarily identified as being on the floodplain.

SOIL HYDROLOGY

High score
Seasonally wet soils
Low score
Other soils

Soil hydrology is a key factor when examining an areas ability to hold water for longer and release it slowly to maintain base flows. Free draining soils are not suitable for wetland creation.

EXCLUSION AREAS



Areas with exclusion criteria are set 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.

CLIMATE CHANGE

Increasing frequency of extended dry periods and low rainfall

DROUGHT

Increasing resilience to DROUGHT

RESTORE NATURAL HYDROLOGICAL REGIMES

Humans have been altering the pathways of water across the landscape for centuries, many of these changes now result in the landscape being less resilient to climate change


Tree planting


Wetland creation


Soil management

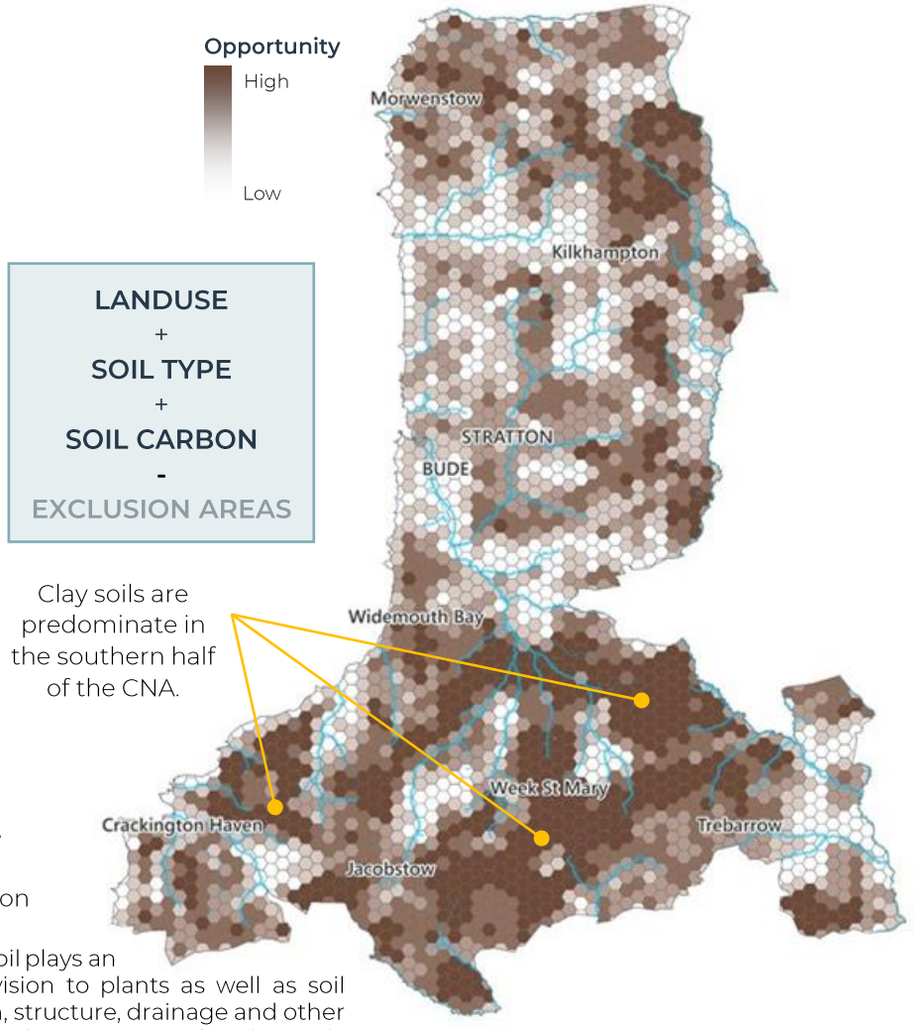

River restoration

Datasets used in maps: OSVM, OSS, OSOR, SMC, WWNP, SFRI. For full references see page 59.

OPPORTUNITIES FOR ENHANCEMENT

DROUGHT

Healthy soils allow rainfall to infiltrate through soil layers where it can be stored. This helps to mitigate the effects of droughts, as water is remains available to plants below the surface and river flows are supported through the slow release of water via sub-surface pathways. Healthy soils can also reduce peak flows during extreme rainfall events as more water is held in the landscape. Clay soils are more prone to compaction which prevents water being able to be absorbed into the soil. Healthy clay soils have a naturally higher organic matter content which helps to hold onto water.



LANDUSE
+
SOIL TYPE
+
SOIL CARBON
-
EXCLUSION AREAS

Clay soils are predominate in the southern half of the CNA.

OPPORTUNITY SCORING

SOIL CARBON STORAGE

High score
Areas with low carbon storage
Low score
Areas with medium/high carbon storage

Soil organic matter (SOM) especially in the topsoil plays an important role in nutrient retention and provision to plants as well as soil particle aggregation, and so influences aeration, structure, drainage and other functions. SOM can hold up to 20 times its weight in water and makes soils more drought resistant. It is linked to soil organic carbon and is often measured in terms of Soil organic carbon (SOC) content.

LAND USE

High score
Arable land
Low score
Other

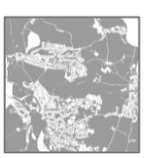
Arable systems can be at higher risk of compaction due to the frequent use of heavy machinery. Different practices can be introduced to help reduce the cause of compaction along side measures specifically aiming to reduce existing compaction. Arable systems provide opportunities to increase the soil organic matter which can be lower in these soils, through various measures such as cover cropping.

SOIL TYPE

High score
Clay soils
Medium score
Sand/loam
Low score
Other soils

Some soils are particularly prone to compaction due to their composition they may require certain measures to help keep a health soil structure and therefore support infiltration.

EXCLUSION AREAS



Areas with exclusion criteria are set to 0

Factors that make it less likely that soil management methods will be implemented are excluded. These include urban areas, main road and railway infrastructure, productive agricultural land, protected sites and priority habitats.

CLIMATE CHANGE

Increasing frequency of extended dry periods and low rainfall

DROUGHT

Increasing resilience to DROUGHT

RESTORE NATURAL HYDROLOGICAL REGIMES

Humans have been altering the pathways of water across the landscape for centuries, many of these changes now result in the landscape being less resilient to climate change

- **Tree planting**
- **Wetland creation**
- **Soil management**
- **River restoration**

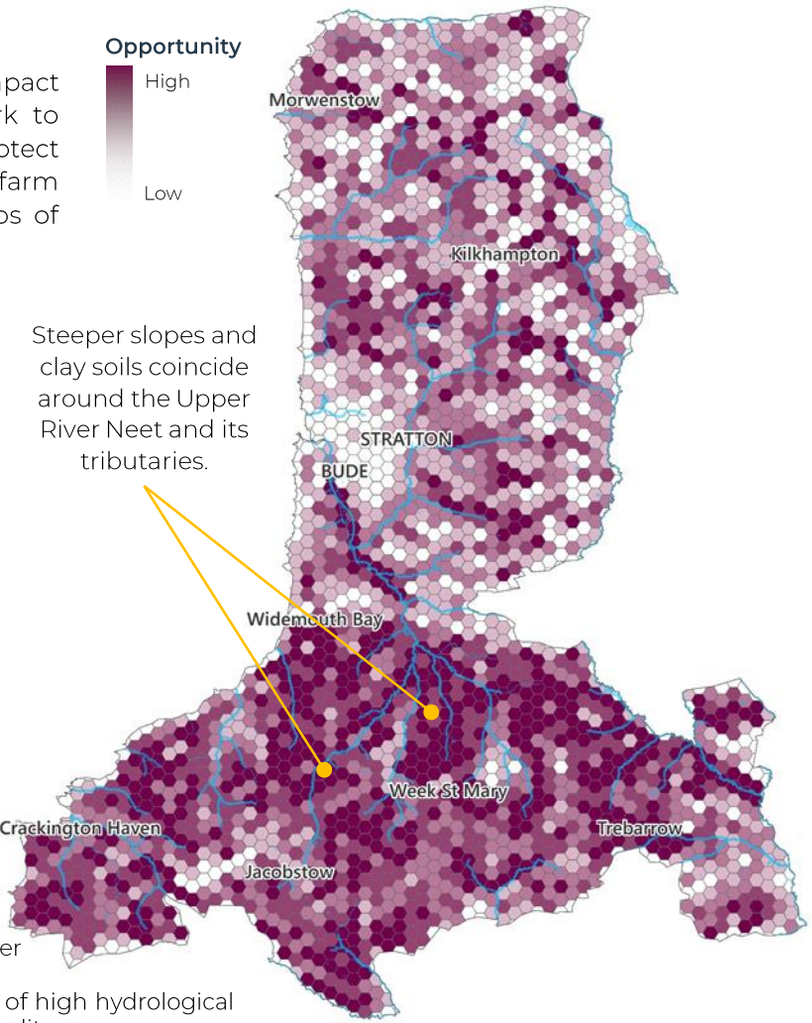
Datasets used in maps: OSVM, OSS, OSOR, SMC, WWNP, SFRI. For full references see page 59.

OPPORTUNITIES FOR ENHANCEMENT

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. This could involve changes to farm management practices and creating buffer strips of vegetation along watercourses.

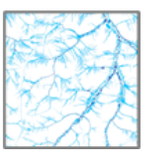
PROXIMITY TO RIVERS
+
SLOPE
+
LAND USE
+
SOIL TYPE
+
SURFACE RUNOFF ZONES



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

OPPORTUNITY SCORING

HYDROLOGICAL CONNECTIVITY



High score
Areas that have high hydrological connectivity
Low score
Areas that have low hydrological connectivity

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 of high hydrological connectivity are important for the regulation of water quality as.

SLOPE

High score
Steep slope
Low score
Other

Slope is a risk factor that poses a threat to water quality. Steeper slopes pose greater erosion potential, which has a negative impact on water quality.

SOIL TYPE

High score
Sandy soils
Medium score
Clay soils
Low score
Other

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

High score
Within 20 m
Low score
Other

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

High score
Arable
Medium score
Grassland
Low score
Other

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, OSS, OSOR, SMC, WWNP, SFRI. For full references see page 59.

CLIMATE CHANGE

Rising water temperature decreased oxygen availability, low water levels, reduce dilution of pollutants, increased sediment loads from increased erosion

POOR WATER QUALITY

Improving WATER QUALITY

IMPROVE EXISTING HABITAT & WATER QUALITY

Climate change impacts such as rising temperatures are amplified when the baseline condition is already compromised

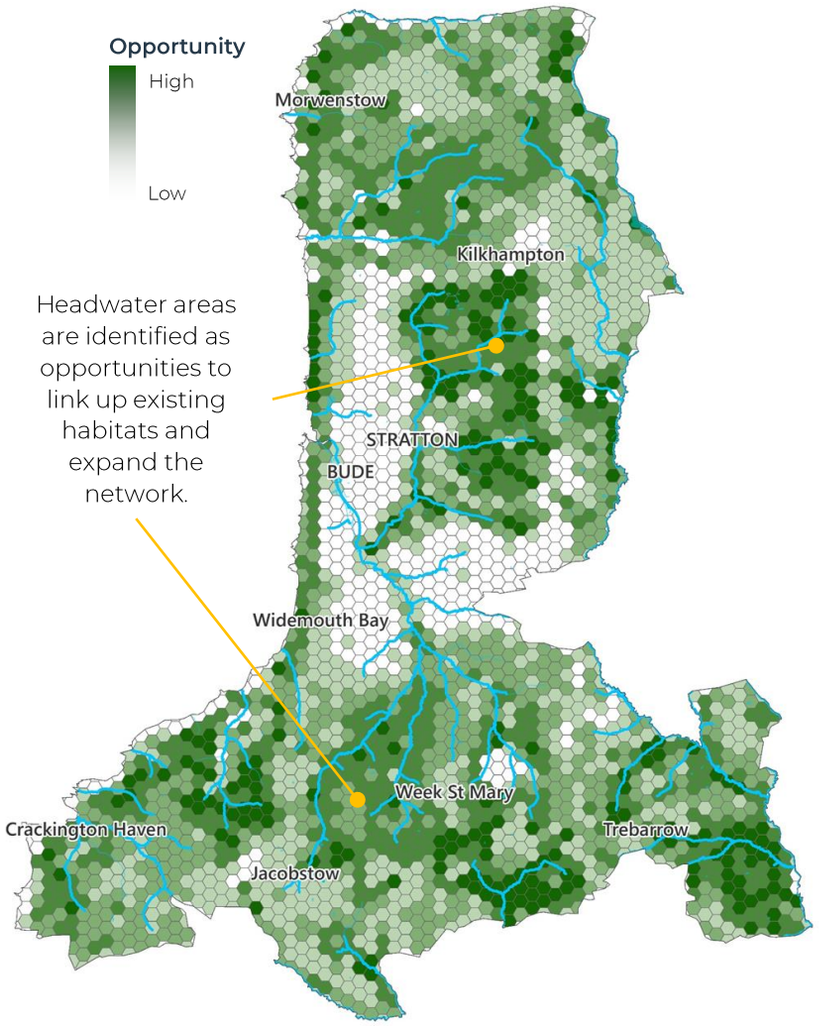
- **Riparian buffers**
- **Wetland creation**
- **Sustainable Farming methods**
- **Sustainable water management**
- **Soil management**

OPPORTUNITIES FOR ENHANCEMENT

BIODIVERSITY

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

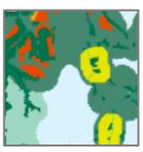
HABITAT NETWORK ENHANCEMENT OPPORTUNITIES
+
STRATEGIC NATURE AREAS
+
HABITAT VULNERABILITY TO CLIMATE CHANGE
-
EXCLUSION AREAS



Headwater areas are identified as opportunities to link up existing habitats and expand the network.

OPPORTUNITY SCORING

HABITAT NETWORK MAP



High score
Areas for new/restored habitat
Low score
Existing habitat and excluded areas

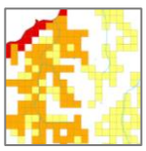
See page 49 for more information. Priority was given to habitat restoration and creation, followed by the improvement of fragmented habitats, and then the extension of the habitat network.

STRATEGIC AREAS FOR HABITATS

High score
Econet and/or Strategic Nature Areas
Low score
Other

The strategic areas shown on page 47 are given priority

HABITAT VULNERABILITY TO CLIMATE CHANGE



High score
High vulnerability
Medium score
Medium vulnerability
Low score
Low vulnerability

Natural England's assessment of climate change vulnerability provides a high level indication of the relative vulnerability of priority habitats to climate change in different places.

EXCLUSION AREAS

Areas with exclusion criteria are set to 0

Factors that make it less likely that ecological networks can be established are excluded. These include urban areas, main road and railway infrastructure, productive agricultural land, protected sites and priority habitats.

Datasets used in maps: OSVM, OSS, OSOR, SMC, WWNP, SFRI. For full references see page 59.

CLIMATE CHANGE

Competition from invasive non native species, New pests and diseases, Local extinction due to range shifts, Life cycle disruption from seasonal variation, Trophic cascades

BIODIVERSITY LOSS

Improving BIODIVERSITY

IMPROVE EXISTING HABITAT & WATER QUALITY

Climate change impacts such as rising temperatures are amplified when the baseline condition is already compromised

&

RESTORE HABITAT NETWORKS

allowing movement of species in adaptation to new climatic ranges and recolonisation after disturbance events

Riparian buffers

Habitat creation & restoration

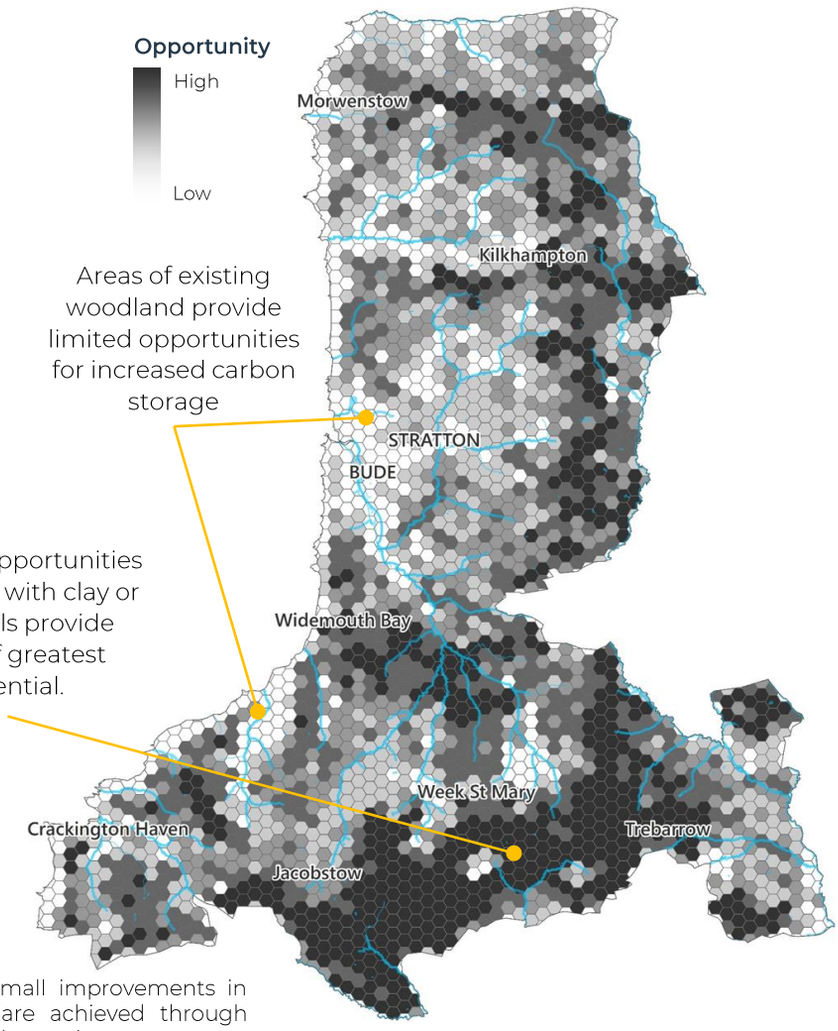
Sustainable Farming methods

OPPORTUNITIES FOR ENHANCEMENT

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.

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



OPPORTUNITY SCORING

LAND USE CHANGE

High score
Arable
Medium score
Grassland
Low score
Other

Changing land management practices can achieve small improvements in carbon sequestration, but significant improvements are achieved through permanent land use change along an arable > rotational cropping > temporary grassland > permanent pasture > woodland > wetland continuum.

AGRICULTURAL LAND CLASS

High score
Grade 4/5
Medium score
Grade 3
Low score
Grade 1/ 2

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

High score
Clay soils
Low score
Other soils

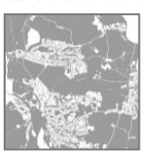
Some soils have a higher natural capacity to sequester carbon than others. While any soil can sequester carbon, clay-based soils have a greater capacity to lock up organic material, compared to lighter sandy or loamy soils. Soils will reach maximum capacity for sequestration and a healthy peat-based soil may have limited potential for further sequestration.

WETLAND OPPORTUNITY

High score
High opportunity
Low score
Low opportunity

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 32) as wetland habitats sequester carbon.

EXCLUSION AREAS



Areas with exclusion criteria are set to 0

Factors that make it less likely that carbon sequestration measures will be undertaken. These include urban areas, main road and railway infrastructure, productive agricultural land, protected sites and priority habitats.

Datasets used in maps: OSVM, OSS, OSOR, SMC, WWNP, SFRI. For full references see page 59.

CLIMATE CHANGE

Greenhouse gases released from burning fossil fuels and degraded habitats

CARBON LOSS

Increasing CARBON SEQUESTRATION

RESTORE NATURAL CARBON SINK HABITATS

Maximise natural carbon storage alongside de-carbonising energy and infrastructure, these habitats also provide many other ecosystem service benefits

Soil management

Sustainable farming methods

Woodland planting

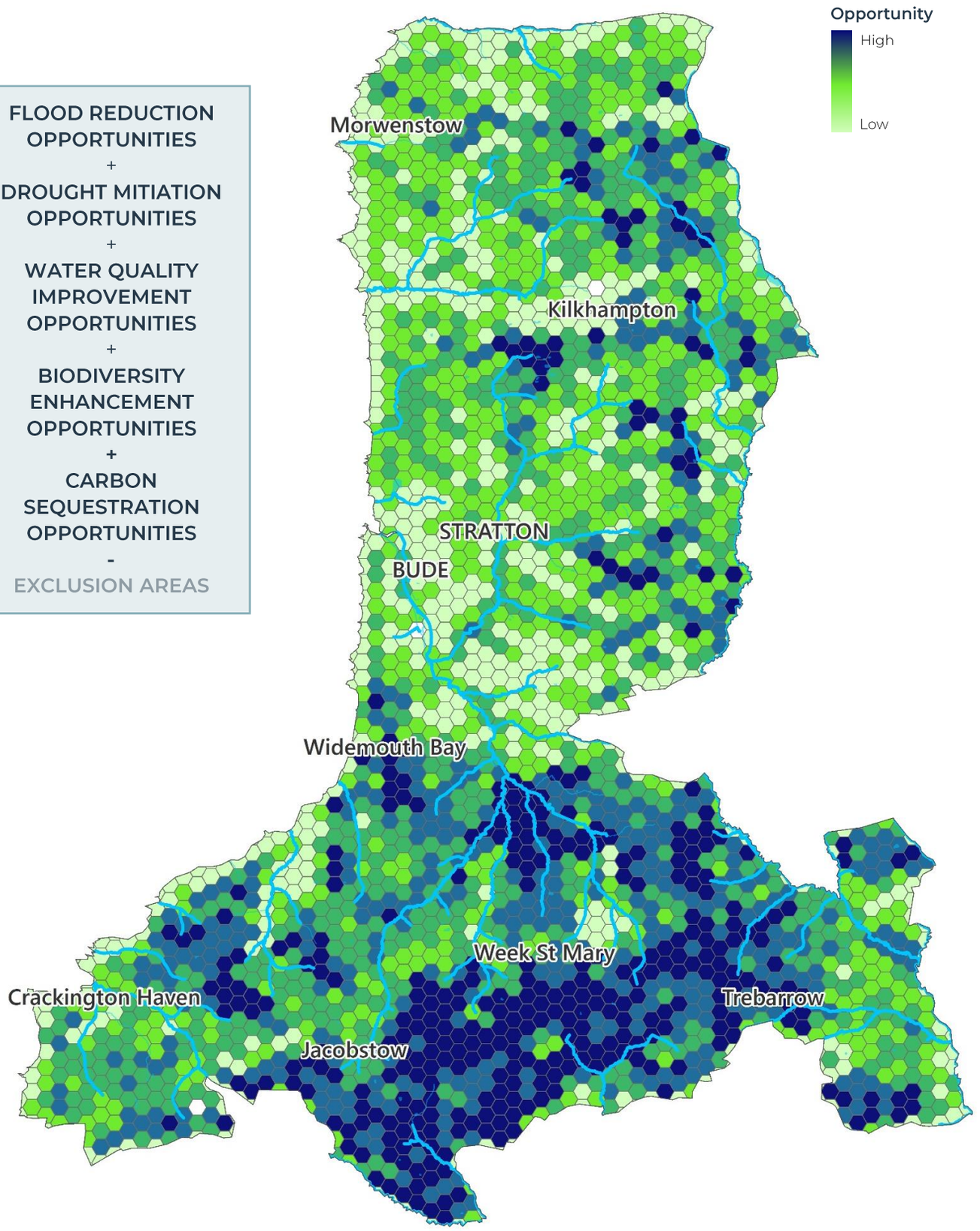
Peatland restoration

OPPORTUNITIES FOR ENHANCEMENT

COMBINED OPPORTUNITIES

This map shows areas where nature based solutions can have the greatest impact on the resilience of the landscape to climate change. The areas of highest opportunity are suitable for nature-based solutions that address multiple threats. These areas should be targeted first as they will achieve the greatest number of benefits..

FLOOD REDUCTION OPPORTUNITIES
+
DROUGHT MITIATION OPPORTUNITIES
+
WATER QUALITY IMPROVEMENT OPPORTUNITIES
+
BIODIVERSITY ENHANCEMENT OPPORTUNITIES
+
CARBON SEQUESTRATION OPPORTUNITIES
-
EXCLUSION AREAS



NEXT STEPS

Following discussion and refinement with stakeholders, and alongside more detailed information, these maps will be used to guide prioritisation and implementation plans for nature-based solutions across the community network area.

High Cliffs, Crackington Haven, Cornwall. Credit Flickr/C.C/Giuseppe Milo

DATA SOURCES

Dataset	Code	Source	Attribution Statement		Resolution
Abstraction Licences	ABS	Environment Agency via CaBA	Contains Environment Agency information © Environment Agency and/or database right	2019	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.	Revised 2019	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.		
Ancient Woodland	AW	Natural England	© Natural England copyright. Contains Ordnance Survey data © Crown copyright and database right 2020.	Created 2013, revised 2020	Detailed mapping
Areas benefiting from flood defences		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	Created 2004, revised 2021	Detailed mapping
Bedrock Geology & Superficial Deposits	BGS	British Geological Survey	Reproduced with the permission of the British Geological Survey ©UKRI. All rights Reserved		1:625 000 scale
Cams	CAMS	Environment Agency	© Environment Agency copyright and/or database right 2015. All rights reserved.	Revised 2019	Based on WFD waterbody catchments
CEH Carbon In Vegetation	CEHCV	Centre for Ecology and Hydrology	Contains data supplied by Natural Environment Research Council © NERC (Centre for Ecology & Hydrology)	Created in 2016, based on 2007 data	1km grid
CEH Soil Nitrogen	CEHN	Centre for Ecology and Hydrology	Contains data supplied by Natural Environment Research Council © NERC (Centre for Ecology & Hydrology)	Created in 2012, based on 2007 data	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)	Created in 2016, based on 2007 data	1km grid
CEH Soil Carbon	CEHSC	Centre for Ecology and Hydrology	Contains data supplied by Natural Environment Research Council © NERC (Centre for Ecology & Hydrology)	Created in 2012, based on 2007 data	1km grid
CEH Topsoil Invertebrates	CEHTI	Centre for Ecology and Hydrology	Contains data supplied by Natural Environment Research Council © NERC (Centre for Ecology & Hydrology)	Created in 2012, based on 2007 data	1km grid
Census - Population	CEN-P2011	NomisWeb	Data sourced from NomisWeb	2011	Most detailed census output areas
Census - Industry	CEN-I2011	NomisWeb	Data sourced from NomisWeb	2011	Most detailed census output areas
Census Output Areas	CEN-COA	Office for National Statistics	Contains both Ordnance Survey and ONS Intellectual Property Rights.	Spatial data only, joined to other datasets as relevant	Most detailed census areas
Consented Discharges	CON	Environment Agency via CaBA	Contains Environment Agency information © Environment Agency and/or database right	Unconfirmed	Point location
Countryside stewardship management arears	CSSMA	Natural England	© Natural England copyright. Contains Ordnance Survey data © Crown copyright and database right 2020.	Created 2016, revised 2021	Detailed mapping
CROME crop map	CROME	Rural Payments Agency	© Rural Payments Agency	2019	Based on roughly 1 acre hexagonal cells
Detailed River Network	DRN	Environment Agency via CaBA	Contains Environment Agency information © Environment Agency and/or database right		Detailed mapping
Environmental Stewardship Scheme Agreements (England)	ESA	Natural England	© Natural England copyright. Contains Ordnance Survey data © Crown copyright and database right 2020.	Created 2016, revised 2021	Detailed mapping
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	2018	Detailed mapping
Historic Flood Extent	HFE	Environment Agency	© Environment Agency copyright and/or database right 2018. All rights reserved	Regularly updated	Detailed mapping
Habitat Network Map	HNM	Natural England	© Natural England copyright. Contains Ordnance Survey data © Crown copyright and database right 2020	2020	Created from high resolution habitat data

Dataset	Code	Source	Attribution Statement	Age	Resolution
Index of Multiple Deprivation	IMD	Ministry of Housing, Communities & Local Government	Data sourced from Ministry of Housing, Communities & Local Government	2019	Joined to LSOA
Invasive Non-Native Species	INNS	Environment Agency	Contains Environment Agency information © Environment Agency and/or database right	2016	Data collected during river surveys so skewed towards aquatic/riparian species
Land Cover Map 2015	LCM-2015	Centre for Ecology and Hydrology	© NERC (CEH) 2017	2015	Detailed mapping
Land Cover Map 2019	LCM-2019	Centre for Ecology and Hydrology	© NERC (CEH) 2017	2015	Detailed mapping
Local Nature Reserves	LNR	Natural England	© Natural England copyright.	Regularly updated	Detailed mapping
NATMAP Vector Soils	NAT	Cranfield University NSRI	Copyright © 2019 Cranfield University | All Rights Reserved		1: 250,000 scale
National Forest Inventory	NFI	Forestry Commission	Contains Forestry Commission information licensed under the Open Government License v3.0	2018	Detailed mapping
National biodiversity climate change vulnerability model	NBCCV	Natural England	© Natural England copyright.	2014	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.	2017	Detailed mapping
Open Mosaic Habitat	OMH	Natural England	© Natural England copyright. Contains Ordnance Survey data © Crown copyright and database right 2020	Created 2010, revised 2017	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		
WFD Operational Catchments	OPC	Environment Agency	© Environment Agency copyright and/or database right 2014. All rights reserved.		
OS BoundaryLine	OSBL	Ordnance Survey	Contains OS data © Crown Copyright and database right 2020		
OS Greenspace	OSG	Ordnance Survey	Contains OS data © Crown Copyright and database right 2020	Regularly updated	Detailed mapping
OS Strategi	OSS	Ordnance Survey	Contains OS data © Crown Copyright and database right 2014		
OS Open Rivers	OSOR	Ordnance Survey	Contains OS data © Crown Copyright and database right 2014		
OS VectorMap	OSVM	Ordnance Survey	Contains OS data © Crown Copyright and database right 2020	Regularly updated	Detailed mapping
Priority Habitat Inventory	PHI	Natural England	© Natural England copyright. Contains Ordnance Survey data © Crown copyright and database right 2020	Created 2014, revised 2019	Detailed mapping
Priority River Habitat	PRIV	Natural England	© Natural England copyright. Contains Ordnance Survey data © Crown copyright and database right 2020	Created 2014, revised 208	Detailed mapping
Pollution incidents	POL	Environment Agency via CaBA data package	Contains Environment Agency information © Environment Agency and/or database right	Unconfirmed	Point locations
River Obstacle	RIVOB	River obstacles	Sourced from Catchment Data Explorer https://environment.data.gov.uk/catchment-planning/	2021	Point data
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	2018	Based on 50m cells

Dataset	Code	Source	Attribution Statement		
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.	Regularly updated	Detailed mapping
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	2017	Based on Lower Super Output Areas
Small Catchments Upstream Of Properties At Risk	SMC	Westcountry Rivers Trust	Westcountry Rivers Trust		
Strategic Nature Areas	SNA	Biodiversity South West	© Biodiversity South West	2005	Detailed mapping
Source Protection Zones	SPZ	Environment Agency	© Environment Agency copyright and/or database right 2016. All rights reserved.	2016	Detailed mapping
Sites of Special Scientific Interest	SSSI	Natural England	© Natural England copyright. Contains Ordnance Survey data © Crown copyright and database right 2020	Regularly updated	Detailed mapping
Tellus SW	TELSW	Environment Agency	©NERC Environnemental Information Data Centre © Crown copyright and database right 2010		2m
WFD Waterbody Catchments	WBC	Environment Agency	© Environment Agency copyright and/or database right 2015. All rights reserved.		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.		Main rivers are assessed
Water Framework Directive – Reasons For Not Achieving Good	CDE-RNAG	Environment Agency	Sourced from Catchment Data Explorer https://environment.data.gov.uk/catchment-planning/	2019	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/	2019	Main rivers are assessed
Water Framework Directive – River, canal and surface water transfer water bodies cycle 2	CDE-WFD19	Environment Agency	Sourced from Catchment Data Explorer https://environment.data.gov.uk/catchment-planning/	2019	Main rivers are assessed
Water Framework Directive – River, canal and surface water transfer water bodies cycle 2	CDE-WFD16	Environment Agency	Sourced from Catchment Data Explorer https://environment.data.gov.uk/catchment-planning/	2016	Main rivers are assessed
WWNP	WWNP	Environment Agency	© Environment Agency copyright and/or database right 2015. All rights reserved.	2015	Detailed mapping

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