Arun & Western Streams Partnership

A healthier future for our catchment

Arun & Western Streams

Catchment Management Plan

The River Arun

“Our vision is for a healthy river system where all interested sectors, groups or individuals may contribute towards restoring the natural environment to benefit people and wildlife now and in the future”

Contents

What do we want from our rivers

A word from our Chief Executive, Aimee Felus.

Rivers are a home for wildlife. A place for humans to find peace amongst the hustle and bustle of busy life. Providers of water for all living things, and an inspiration for creativity. Meandering their way through our rolling English countryside views, without rivers this beautiful landscape which many of us call home would look entirely different. Without rivers the wildlife we enjoy seeing wouldn't be able to survive and the lush, greenery of our countryside wouldn't be able to flourish.

With a huge strain currently on our water resources and the impacts of climate change now showing, our rivers are struggling with the effects of pollution, drought and flooding. But all is not lost. With the right approach we can help our rivers thrive. Now is the time for action!

Working with landowners, farmers and communities we are focused on using natural solutions to restore and protect our riverscapes for the benefit of both wildlife and people.

This catchment management plan is key to providing an overview of the current state of the Arun & Western Streams catchment, whilst looking in detail at the challenges it is facing. It is a crucial piece of work which will guide us in how we, as a community, work together to take action for our rivers.

Humans are not just the custodians of nature, we are a substantial and significant part of it. We have the ability to harm our natural systems and we have the power to heal them, protecting them into the future.

With your help we are dedicated to improving and protecting these special habitats, restoring vibrant and resilient riverscapes for all to enjoy for generations to come. Are you with us?

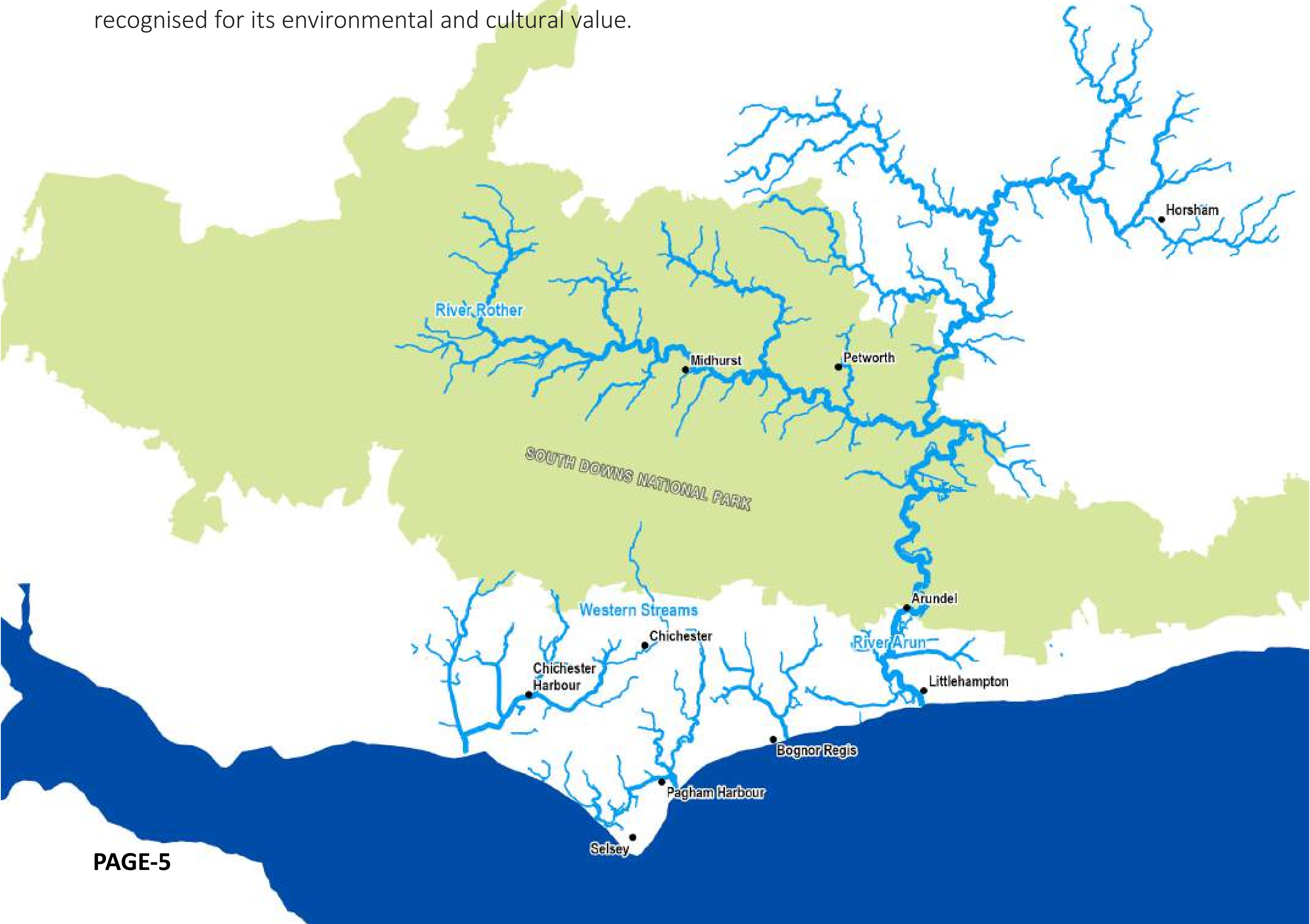
We're the Rivers Trust for Western Sussex, a team striving to protect and restore resilient, vibrant riverscapes for wildlife and people. We're a small but passionate team, packed with knowledge, experience and, most importantly, a strong love for rivers and wildlife. We're proud to be part of the national family of Rivers Trusts - with 65 regional trusts looking after river catchments across the country.

Working closely with partners including landowners, farmers, communities and businesses across our catchment area, our focus is on working collaboratively to help improve river health, enabling the wildlife who live here to thrive, and ultimately ensuring these precious habitats are here for generations to enjoy.

The Arun and Western Streams Catchment

Our catchment area is part of the South East River Basin District and is situated mainly in the West Sussex Districts of Chichester, Arun and Horsham, together with small parts of East Hampshire and the Waverley and Mole Valley in Surrey. Altogether it covers an area of approximately 1484km[2.]

Made up of diverse landscapes from the hills and steep slope escarpments of the South Downs, to the gently rolling hills of the Low Weald and wide Arun Valley floodplain south of Pulborough. Approximately half of our catchment falls within the South Downs National Park which is recognised for its environmental and cultural value.



The Partnership

The Arun & Western Streams catchment partnership was established in 2012. The partnership is chaired by the Western Sussex Rivers Trust and consists of the following members:

Our Catchment and Water Environment

OUR RIVERS

The rain that falls across our catchment is drained by the River Arun and its tributary the Rother, along with the smaller streams to the West of the River Arun that discharge directly into Chichester Harbour. These include the Aldingbourne Rife; the Rifes surrounding Selsey and East Wittering, the Rivers Lavant and Ems and the Bosham Stream, make up the rivers in our catchment area. You can find out more about these rivers on our website www.wsrt.org.uk

GEOLOGY AND SOILS

The diverse nature of our rivers are a result of the geology and soils which in turn have influenced the way that we manage our land. The Chalk and Greensand aquifers that underly our catchment characterise the area's most important features. This geology creates a series of distinct landscapes, from the flat coastal plain in the south, to the rolling chalk hills of the South Downs in the centre, and to the steeper valleys of the Western Rother and River Arun underlain by the Lower Greensand and Weald Clay to the north. The aquifers are also the most important water resource as they support water supply as well as freshwater inputs to our designated conservation sites such as the South Downs National Park, Arun Valley SPA and Pagham Harbour.

LANDCOVER & HABITATS

The majority of our catchment is used for agriculture (pasture, arable and horticulture), but we also have a high coverage of woodland and areas of heathland and wetland. The main urban areas are found along our Sussex coastline which includes east Worthing, Littlehampton and Bognor Regis which are popular seaside resorts. Further north, we also have the market towns of Petersfield and Horsham which are popular commuter towns due to their mainline links to London.

There are many areas within our catchment that are recognised as being important for conservation. These include sites where notably rare or declining species and/or habitats exist or sites which have important geological or historical value. Others encompass the wider landscapes that have significant value for both wildlife and people. Many of these areas are protected under UK law due to their international, national, or regional/local importance.

Key Legislation

This Catchment Management Plan is underpinned by two key pieces of legislation, The Water Framework Directive (WFD) and the Governments 25-year Environment Plan which commit the UK to bring all water bodies (including marine waters up to one nautical mile) to "good health".

THE WATER FRAMEWORK DIRECTIVE

The Water Framework Directive (WFD) was introduced in the year 2000 as a universal approach for European member states to manage water quality. The DIrective requires the protection and improvement of all aspects of the water environment including rivers, lakes, estuaries, coastal waters, and groundwater to ensure that all inland and coastal waters achieve "good' ecological status by 2027. Since leaving the European Union, the WFD has been fully transposed into UK law ensuring that vital services provided to people and wildlife by healthy water environments are protected now and into the future.

RIVER BASIN MANAGEMENT PLANS

A requirement under the WFD is to produce a strategic plan for achieving sustainable use and protection and enhancement of surface waters, groundwater, and coastal waters for each river basin district. There are 11 districts across England and Wales and each plan sets out the current state of, and pressures affecting, the waterbodies within each district, and details the environmental objectives, measures and actions that are required to meet these objectives.

THE 25-YEAR ENVIRONMENT PLAN

The Government's 25-year Environment Plan sets out a framework and strategic goals to provide clean and plentiful water and to reduce the risk of harm from environmental hazards such as flooding and drought. Through a catchment-based approach, the plan specifically aims to achieve the following for our water environment:

Clean and plentiful water:

To have at least three quarters of our waters to be close to their natural state as soon as is practical by:

- Reducing damaging abstraction
- Reaching or exceeding objectives
- Improving bathing waters

Growing a resilient network of land, water and sea that is richer in plants and wildlife:

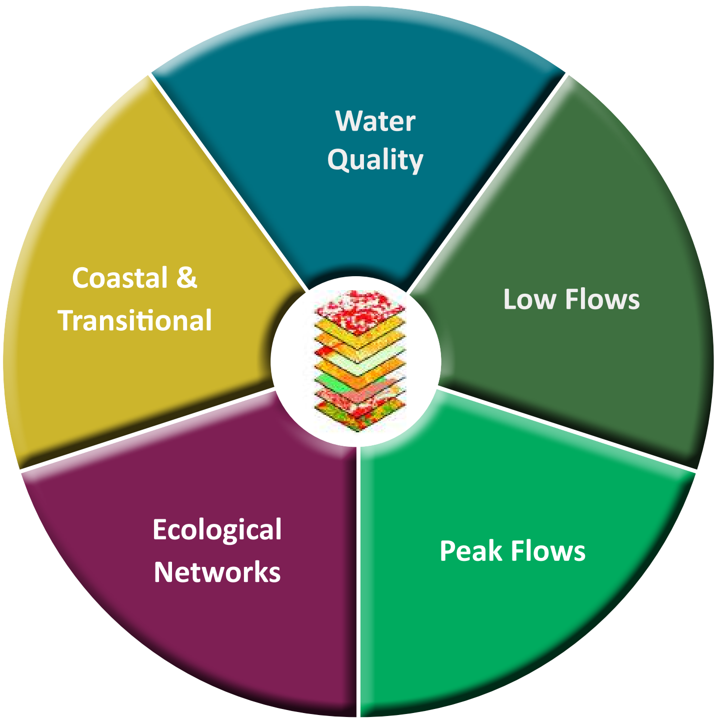
- Restoring 75% of our 1M hectares of terrestrial and freshwater protected sites to a favourable condition.
- Reversing the loss of marine biodiversity and, where practicable, restoring it.
- Enforcing regulations for new farming rules for water.

In addition, the plan identifies key areas for action including using and managing land sustainably, recovering nature and enhancing the beauty of landscapes, connecting people with the environment to improve health and wellbeing, and increasing resource efficiency and reducing pollution and waste.

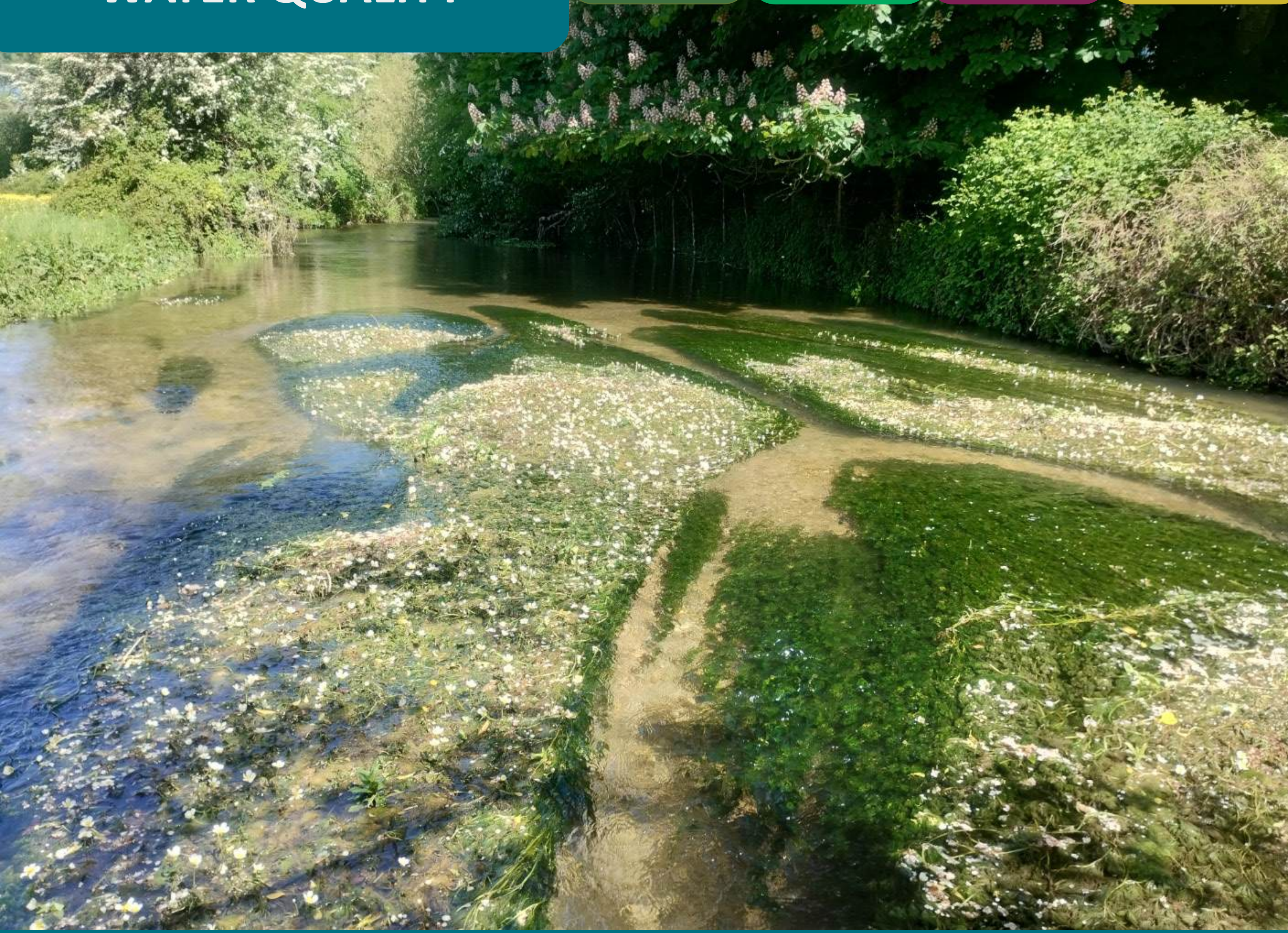
ECOSYSTEM SERVICES ASSESSMENT

Our river catchment landscapes and the nature they support provide us with mutliple benefits such as water, clean air, food and raw materials. These benefits are known as ecosystem services and are dependent on a healthy environment. By understanding the current state of our environment and the issues that may be affecting its health, we are able to identify priority and opporunity areas that seek to enhance provision of multiple services.

This chapter outlines the current status of, and pressures on five ecosystem services provided by the Arun & Western Streams catchment. For each service, we have used conceptual models to identify areas of the catchment most likely to play a critical role in the provision of different services and highlight where the greatest priority exists for enhancement. Click on any of the ecosystem services shown below, or scroll down to find out more....



Full details of the methodology and data used in our ecosystem service analyses is provided in the Appendices



Water Quality

CURRENT STATE

Good water quality is fundamental for sustaining life, supporting ecosystems and promoting economic and social well-being. We need clean water for human consumption, for irrigating crops, promoting good soil health and sustaining agriculture. Pristine waterbodies also contribute to the aesthetic appeal of our catchment promoting recreational activities that contribute to tourism, local economies and the overall well-being of communities. Our aquatic species rely on clean water for survival and our wetlands need good water quality isupport the growth, structure and health of plants which in turn provides habitat and food for our most vulnerable species and enhances the ability of our wetlands to filter contaminants, sequester carbon and absorb and store floodwater.

In-order to achieve and sustain clean water, we need to understand the current state of water quality across our catchment so that individuals, communities and government can work collaboratively in protecting our water environments and the benefits it provides. The Environment Agency monitors the quality of water in our surface, transitional and coastal waters and groundwater for the purpose of reporting under the Water Framework Directive (WFD). You can view this data on the Environment Agency's Catchment Data Explorer.

SURFACE WATERS

There are 40 surface water bodies within our catchment including 35 rivers and five lakes. Of these, only one (Vann Lake) is currently reaching "good" ecological status with the remaining classified as bad (n = 2), poor (n=15), or moderate (n = 22). One of the main reasons for this is water quality, which is assessed directly by measuring pollutants such as nutrients in our rivers, but also indirectly by looking at the condition of aquatic plant and animal communities, whose health depends greatly on the quality of water.

GROUNDWATERS

There are eight main ground waterbodies within our catchment of which four are failing to achieve good chemical status. This means that they have disproportionate burdens of nutrients.

A map showing the status of groundwaters and rivers in our catchment is provided in Figure 2.

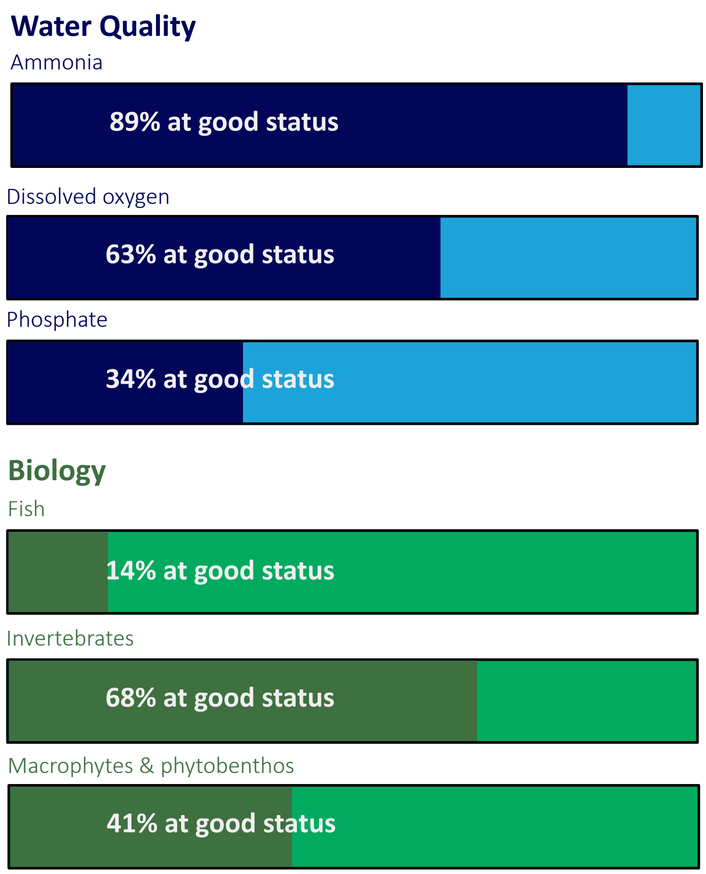


Figure 1.showing the proportion of surface waterbodies that are achieving "good" status for water quality and biological elements

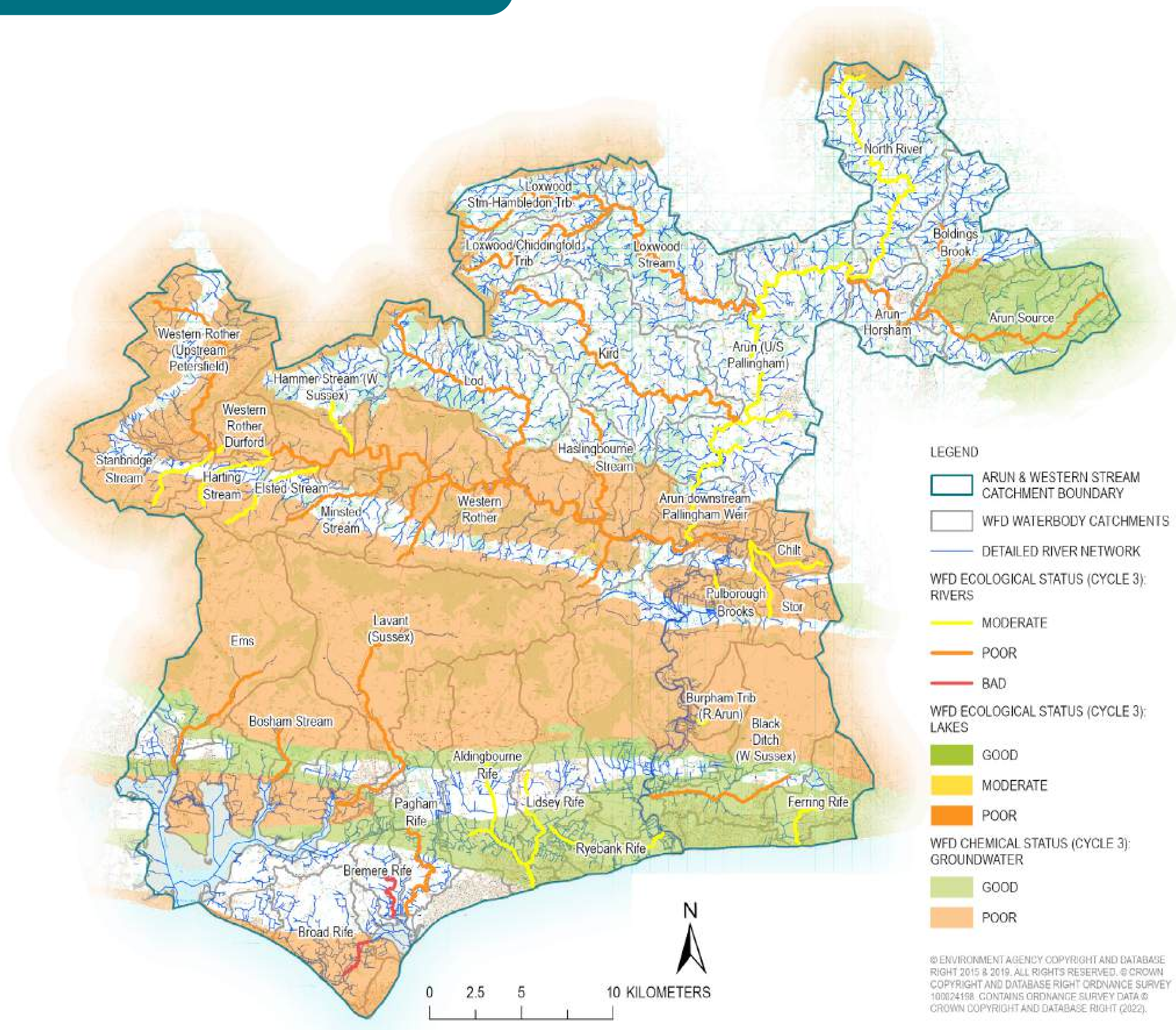


Figure 2.Map showing the ecological status of rivers and lakes and chemical status of groundwater bodies in the Arun & Western Streams Catchment.

PRESSURES

Pollution from wastewater (point sources) and from agriculture and rural land management (diffuse) are the two most significant reasons that our surface waterbodies are not achieving "good" ecological status (Figure 3). The most significant contributing factor for our groundwater is poor nutrient management of rural and agricultural land.

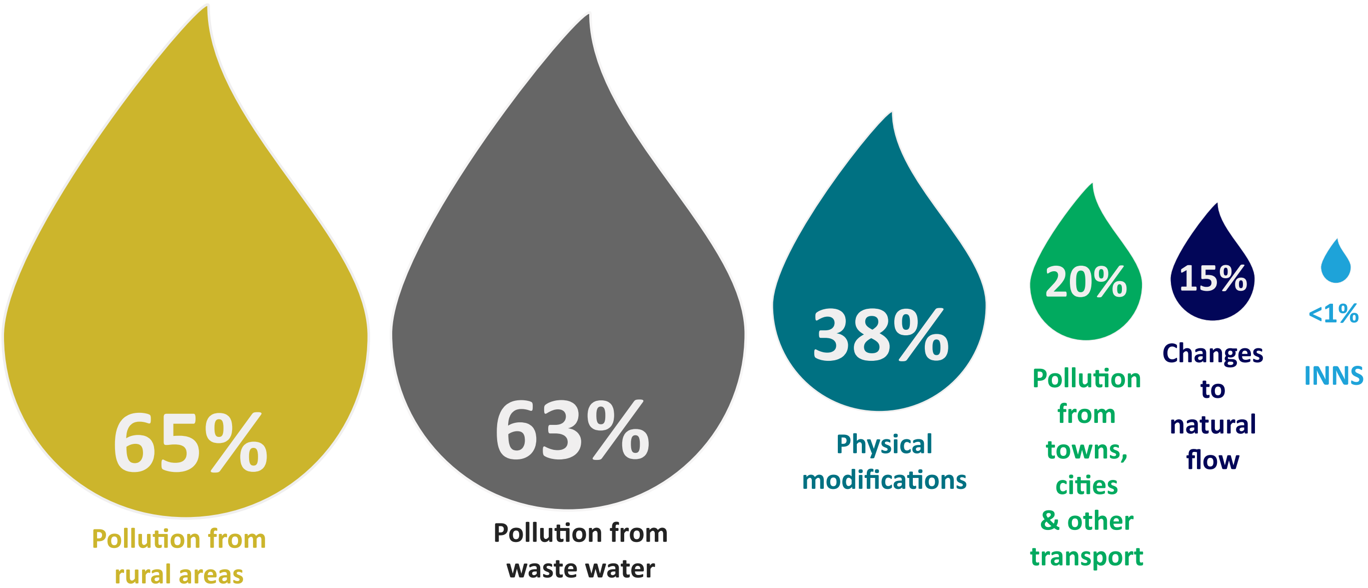


Figure 3.showing the proportion of waterbodes affected by significant water management issues (SWMI's) in our catchment

POINT SOURCE POLLUTION

Point sources of pollution are from one known source such as discharges of waste from sewage, agriculture or trade or where accidental spills have had a serious impact on water quality. There are over 1,100 consented discharges in our catchment and the majority (64%) of these are for private sewage treatment plants. There are also many more private waste water discharges (e.g. septic tanks) that do not require consent and these can also pose a risk to water quality if they are not properly designed, installed and maintained. Pollution may also come from combined storm overflows (CSO's) which discharge surface water run-off and foul sewage into our rivers and sea during heavy rainfall to prevent properties from flooding. In 2022 there were over 2000 spills from CSO's in our catchment which in total discharged for nearly 30,000 hours (Figure 4).

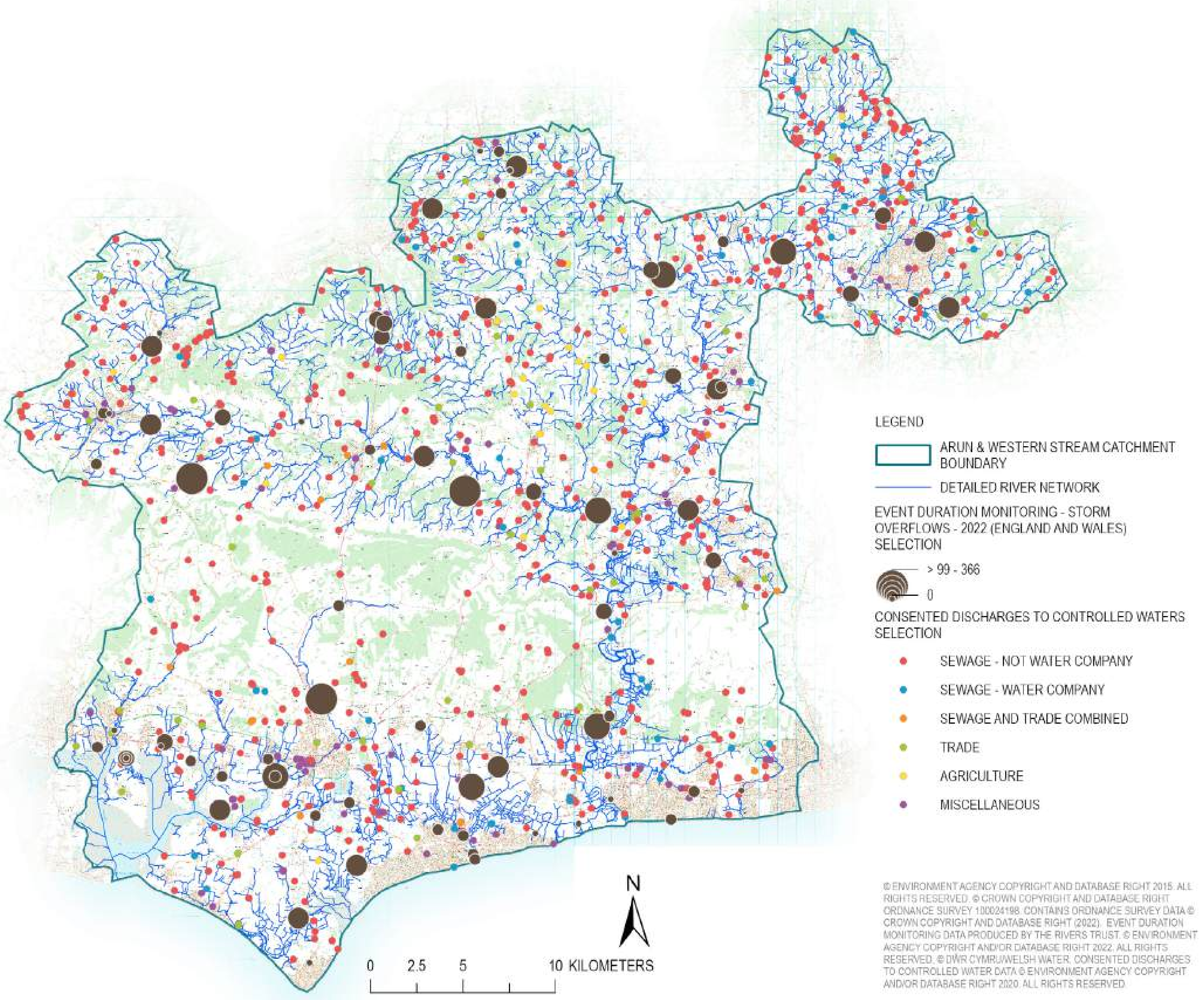


Figure 4. Map showing location of consented discharges and the number of counted spill from Combined Storm Overflows (CSO's) in 2022.

AGRICULTURAL AND RURAL LAND MANAGEMENT

Agricultural land including arable (cereal and leguminous crops) and pasture cover approximately 66% of our catchment and poor management of soils, nutrients and livestock can cause nutrients, pesticides, and herbicides to be transported into our waterbodies via soil and water run-off from fields. This form of pollution comes from multiple sources (diffuse) and is impacting the ecological status of over half (67%) of our surface waters. One of the main pressures from agricultural pollution in the Arun & Western Streams is excess nutrients including phosphates and nitrate.

Phosphate is found in many artificial fertilisers and is also a by-product of human and animal waste. Phosphorus attaches itselft to soil particles and can enter our rivers and lakes when rainwater washes sediment off fields. It can also be discharged from waste-water treatment plants and septic tanks.

Nitrate comes from a variety of sources including inorganic fertilisers and is extremely soluble making it easy for it to be washed into our rivers and lakes after rainfall. It is also one of the main contaminants of our groundwater which provides an important resource of water for human consumption and for our rivers which are fed from springs in our Chalk and Greensand aquifers.

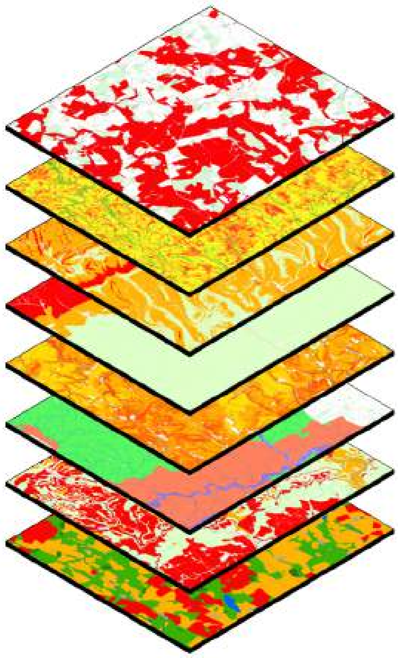
Artificially enhanced levels of nutrients affect the ecological quality of our surface waters through a process known as eutrophication. This is when excess nutrients stimulates the growth of algae and larger plants which can lead to decreased levels of dissolved oxygen levels in the water affecting the survival of invertebrates, fish and other wildlife.

the idea behind the project

High concentrations of nutrients, along with pesticides such as metaldehyde (slug pellets) and herbicides (e.g. Mecocrop and Glyphosate) also have possible health implications to humans and animals. This causes a problem for water companies who need to treat the water they abstract from our surface and ground waterbodies so that it meets strict drinking water standards. As removal of these pollutants is expensive, preventation of agricultural pollution is preferred.

OPPORTUNITIES

To help identify where the greatest opportunities for improving water quality are in the Arun & Western Streams catchment, data on known drivers of pollutants have been modelled to produce opportunity maps of the catchment. These have used the following datasets:



- Field proximity to watercourse
- Hydrological connectivity
- Landcover (excluding urban areas)
- Run-off potential (Hydrology of Soil Types & slope)
- Soil erosion potential (Soil texture and slope)
- Groundwater vulnerability

The layers were then rasterized into a 5m grid cell resolution and scored (0-1) based on their likely influence on water quality. The combined scores from each of theses layers was then calculated to identify where in our rural catchment the greatest opportunities for improving water quality are located.

A full description of the method used is provided in Appendix A.

The opportunity maps are presented by area (cell) and as catchment averages in Figures 5 and 6. At a local scale, there are many areas where the risk of supply (source) and transport (e.g. surface runoff) of pollutants into our rivers and groundwater is high and as such are areas where actions to reduce this risk should be prioritised. These include the hydrologically connected fields along the River Lavant, the headstreams of the Western Rother, the clay dominated pastures across the Upper Arun and extensive areas across our coastal plain.

At a catchment scale, the greatest opportunities for mitigating risks to water quality exist in the Western Streams operational catchment. This area is dominated by arable land of moderate risk to run-off and/or soil erosion and is an area of high vulnerability to groundwater. Many of these waterbodies also feed into important sites for conservation including Chichester and Langstone Harbours, and Pagham Harbour and therefore actions to reduce the risk of pollution would help safeguard the valuable wildlife that exists at sites. Opportunities also exist in the Arun catchment, particularly within the Harting Stream, Arun Horsham and Ryebank Rife catchments.

WATER QUALITY

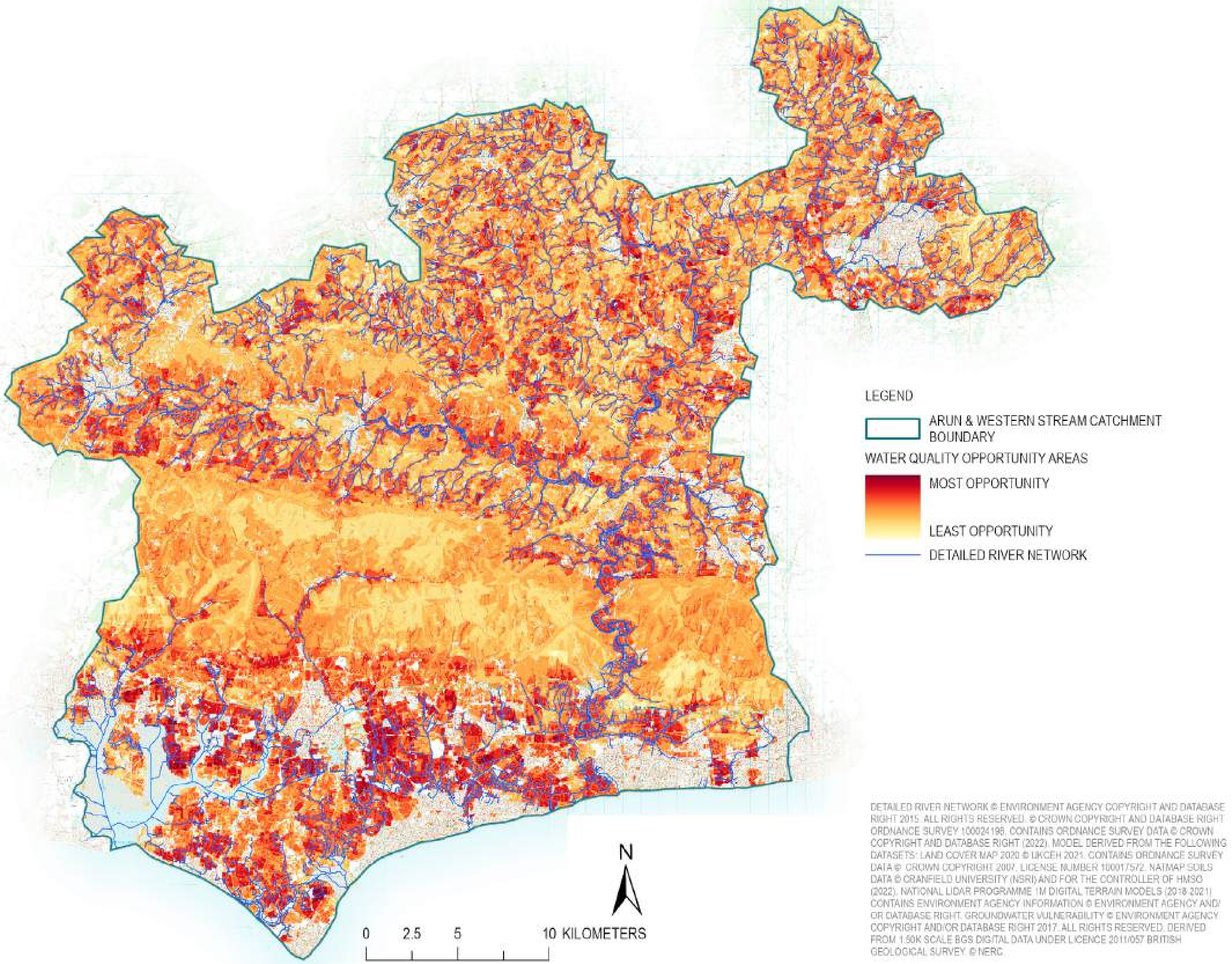


Figure 5.Detailed opportunity map for improving water quality in rural areas of the Arun & Western Streams Catchment at 5m^2. Darker colours show areas where there is the greatest opportunity for targetting interventions to protect the water environment from pollution based on proximity to watercourses, hydrological connectivity, slope, land use, soil erosion and run-off potential, and areas most vulnerable to groundwater contamination.

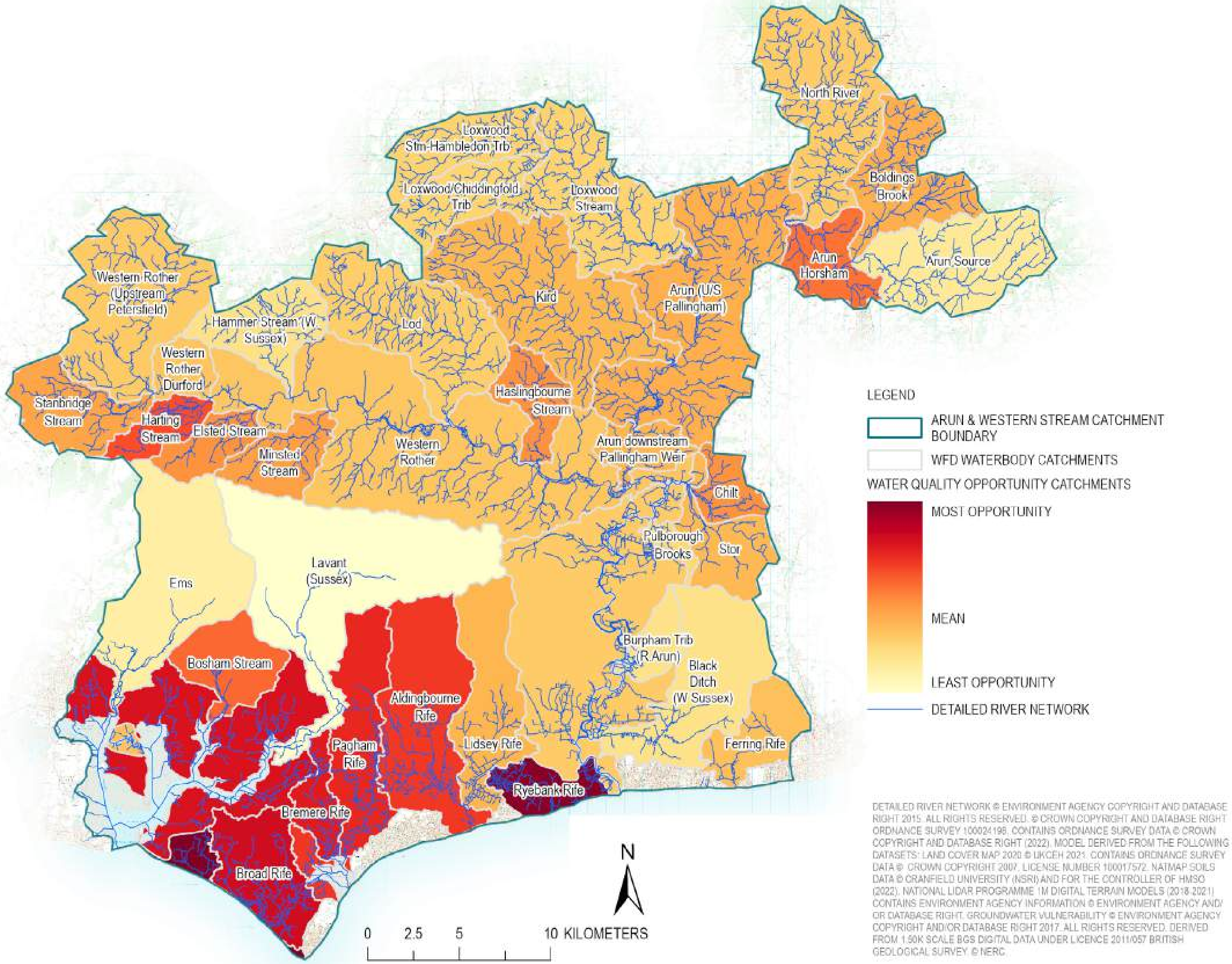


Figure 6.Map showing the average opportunity score for surface waterbody catchments (river and coastal) in the Arun & Western Streams. Darker colours show catchments that are likely to have the greatest opportunity for improving water quality. Urban dominated coastal catchments and TraC waterbodies were not included in the analysis

RESPONSE

The catchment partnership will use existing and emerging evidence to develop and deliver local and catchment wide solutions to lower nutrient and sediment pollution in our rivers, streams, ocean and groundwater. This will include the following actions

- Increase public awareness of what good and bad indicators of water quality are to improve reporting and
- To improve monitoring of water quality both spatially and temporally to where and when the issues are
- Create 'interceptor' and 'buffer' habitat to capture run-off before it hits our rivers or karstic features
- To sharing best practice for rural business owners
- Create a programme that involves school and communities involvement, SuDS, monitoring, informing and educating for change
- Prioritise the use of Integrated Constructed Wetlands as nature based solutions for treating contaminated surface water and discharges from waste water treatment work
- Trial new fertiliser products that have high 'nutrient use efficiency'

PAST AND PRESENT PROJECTS

1. Pesticide amnesties
2. Soil health trials
3. Soil carbon trials
4. Blackgrass mapping
5. Endocrine disruptors conference at Chichester Harbour in 2021 in partnership with Brighton/ Portsmouth Uni (also microfibres research)
6. Water co. catchment management schemes for various hazards, peticides, nitrate, heating oil etc.
7. Capital grant schemes
8. Payment for ecosystem services
9. Citizen science water quality testing programme – CaSTCo (chemical, pollution and wildlife recording)
10. Filter grey water through coppice/reedbeds
11. Monitoring water quality near to farms that are part of the CaSTCo Demo+ project
12. Riverfly monitoring
13. Water quality testing from A, SW, angling clubs, freshwater watch and ARRT
14. In catchment WQ data analysis including crop mapping

Water Quantity:

Regulation of Base Flows

CURRENT STATE

Our catchment lies within one of the driest and most densely populated parts of the country, meaning that the demand for water is high compared to the amount of water we receive through rainfall. Our most important water resource comes from the Chalk and the Lower Greensand aquifers which provide roughly half of our drinking water and supply numerous springs and streams which support surface water flows, particularly for the Western Rother, and our rare chalk streams of the Lavant and Ems. They also help to sustain some of our most precious wildlife species and habitats including the wetlands located in the Arun Valley and Chichester and Langstone Harbours. Water resources along the Arun are more versatile with high winter but low summer flows and have a significant volume of water added from large water treatment works at the top of the catchment. You can view the hydrological situation across our catchment by visiting the UK Water Resources Portal.

Both our aquifers and rivers suffer reduced water levels and flow. The most recent WFD assessment (2022) shows that three of our groundwater bodies are in poor quantitative status meaning that water is being abstracted faster than it can be naturally replenished (Figure 7). There are also 15 rivers in our catchment that are impacted by pressures associated with low flow (Figure 8).

REGULATION OF BASE FLOWS

Rivers and groundwater provide an essential source of water for people, agriculture, and industry and are vital to supporting a healthy ecology. In contrast to the problems associated with high flows, if insufficient water is retained in the catchment, and run-off from land is too rapid during periods of low rainfall, then the reliability of water supply becomes threatened. When the 'base-flows' becomes too low, the health of our rivers can become degraded. Reduced flows can increase water temperatures and the risk of algal blooms, concentrate pollutants, and sediment that would otherwise be transported downstream can settle on the riverbed affecting sensitive species. River morphology can also be altered, disadvantaging species that need fast flowing and/or deeper water and in worst cases, rivers can dry up impacting many freshwater species.

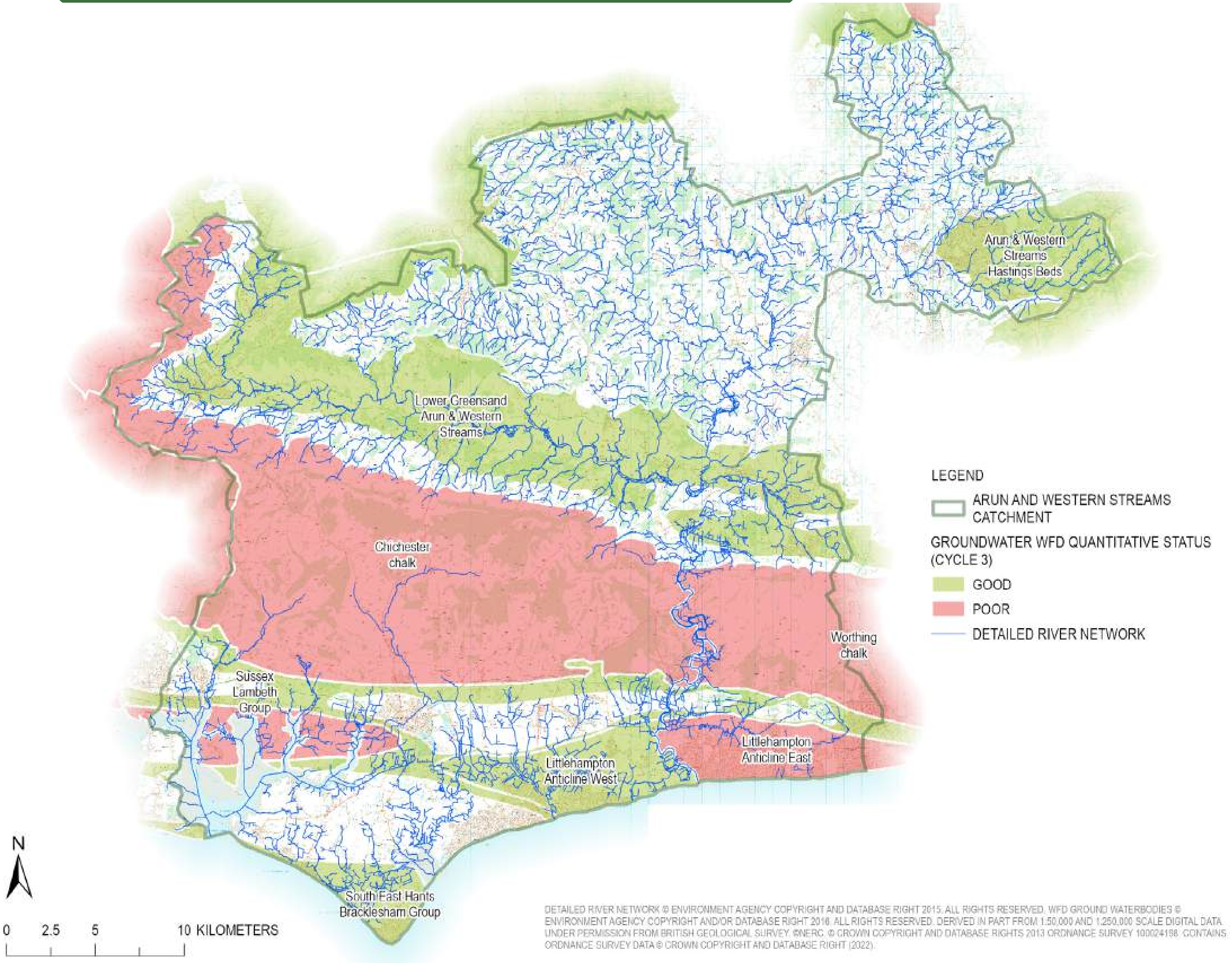


Figure 7.Map showing the WFD Quantitative Status of Groundwater (Cycle 3)

Low Flows

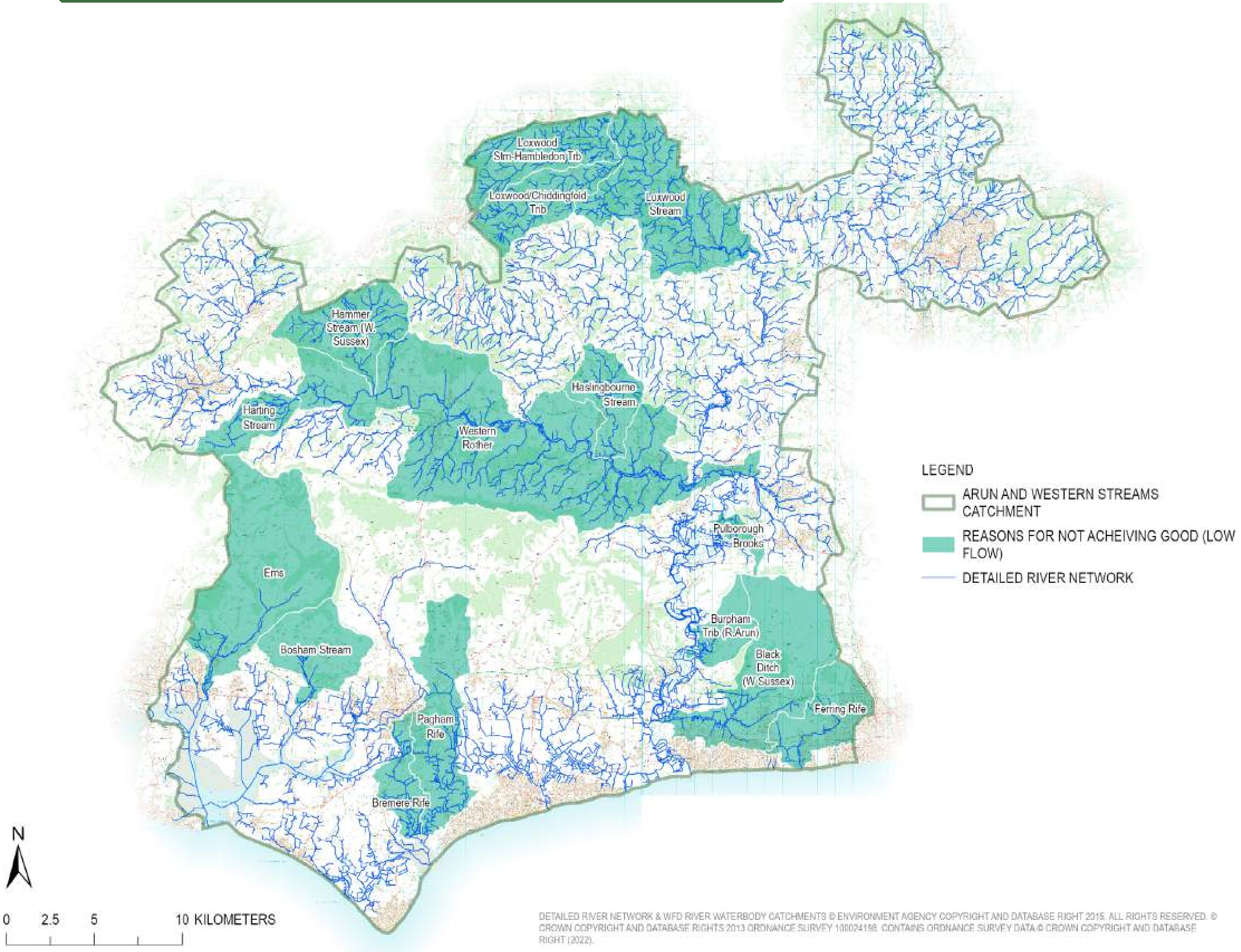


Figure 8.Map showing the river waterbody catchments that are impacted by low flow. This is based on the Significant Water Management Issues (SWMI's) identified in Cycle 3 of the WFD assessment.

PRESSURES

ABSTRACTION

Around 180 million m^3 of water is licensed to be abstracted per year from our rivers and groundwater, of which drinking water accounts for the most significant volumes (Figure 9). Southern Water, South East Water and Portsmouth Water all have public water supply abstractions in our area and most of the water is taken from groundwater supplies. Some of this water is used also used by water companies to augment water back into our rivers where abstraction is consered to be compromising natural flows. Individuals and businesses are also permitted to take up to 20,000 litres of water per day from a single source without a license.

In 2022, five of our river waterbodies were recognised as being ecologically impacted by abstraction. This includes the groundwater dependent chalk river Ems and the Hammer and Haslingbourne Streams, as well as the Western Rother and Bosham Stream which are both under pressure from excess surface water abstraction. In 2021, it was also recognised that groundwater abstraction for public supply is likely to be having a detrimental impact on a number of designated sites in the Arun Valley, which is one of the most biodiverse floodplain wetlands in England.

The Environment Agency are responsible for issuing licenses for abstraction and carry out water availability assessments of each surface water body and groundwater management unit to ensure that there is enough available without comprising the water environment. This shows that three of our surface waterbodies (Lavant, Bosham Stream & Burpham Tributary of the Arun) have no water available for abstraction due to annual flows falling below the required level to support good ecological status. This rises to 18 and 22 waterbodies when the river levels are at low (Q70) and very low flows (Q90), respectively. Restrictions also apply to our groundwater, including at Hardham where the unit balance shows more water has been abstracted than is available, and for the Lower Greensand and Chalk aquifers, where restrictions apply due to more water being licensed than the amount available. You can view the Arun & Western Streams Catchment Abstraction Licensing Strategy by clicking HERE.

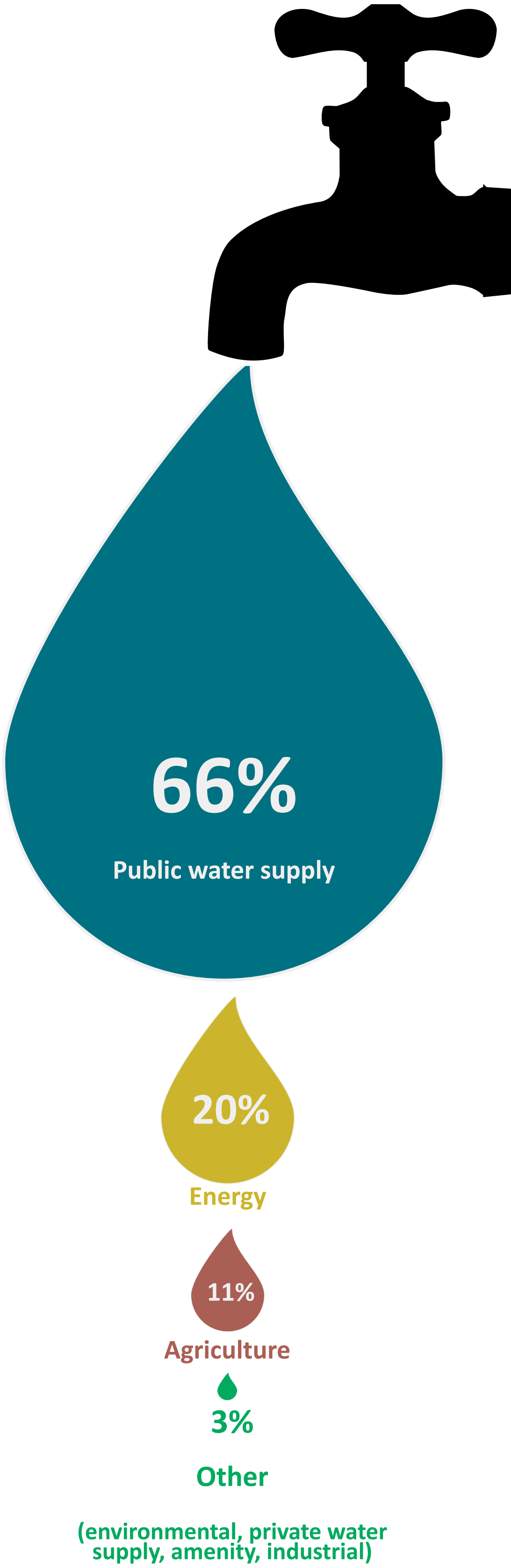


Figure 9.Shows the maximum annual volume of water licensed to be abstracted by sector.

CLIMATE

Climate change can impact on our water resources by affecting the amount of water that is available in the environment and the demand for water. We are already experiencing a climate that is an average 1°C warmer than pre-industrial levels and the top ten warmest years since 1884 have all occurred in the last 20 years. Since the start of the 21st century our catchment has experienced four prolonged periods of drier weather than normal (2005-2007, 2012, 2017 and 2022) which has subsequently impacted river flow (Figure 10). In 2012 this was followed by higher-than-normal levels of precipitation which led to widespread flooding exacerbated by soils being too dry and hardened from the drought to absorb precipitation.

Further change is inevitable and under a low mitigation scenario (RCP 6), it is predicted that by 2100 our average summer temperatures will be 3.61 degrees warmer than 1981-2010, and we could see a decrease in rainfall of around 30%. A drier climate will see a marked increase in drought risk and, whilst our winters will be wetter, it is expected that they will be shorter than our summers. These seasonal changes will see less 'effective' rainfall entering our rivers due to increased evaporation and could also impact on the crucial recharge season for groundwater, meaning that aquifers may not always be replenished during the winter months. At the same time, our demand for water will also likely increase as more water will be needed for public supply, agriculture, and other uses, and this will only be exacerbated by population growth. We also expect to see pressures worsen due to sea level rise, reducing the reliability of supplies from some boreholes in coastal aquifers and at assets located close to estuaries because of saline intrusion. Population migration away from areas at risk of coastal change may also occur, potentially affecting local demand for water and requiring changes to the distribution network and water resources.

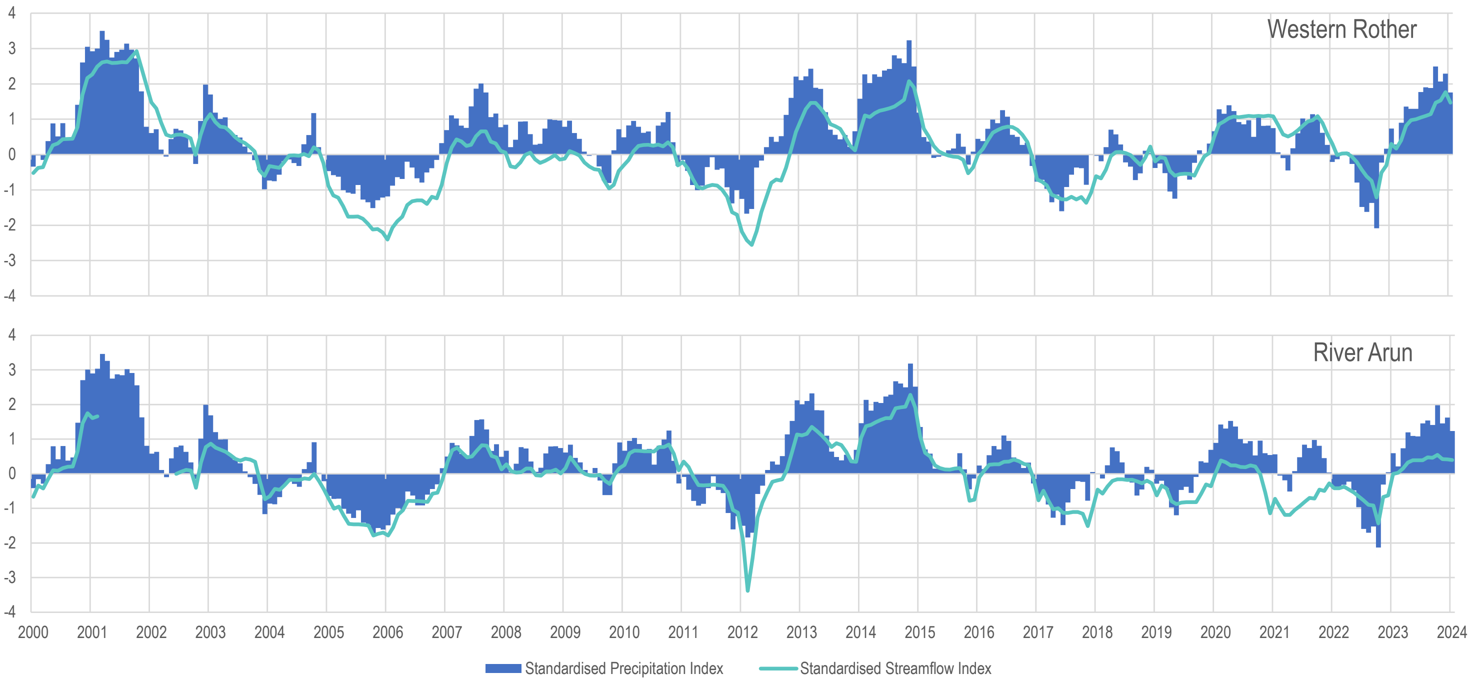


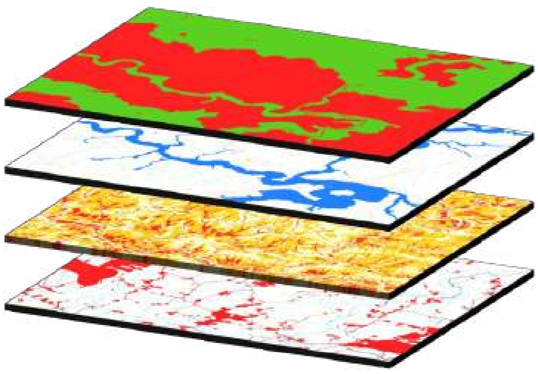
Figure 10.Standardised Precipitation Index (SPI) and Standardised Stream Index (SSI) for the Western Rother (at Hardham) and the River Arun (at U/S Pallingham) from 2000 – March 2023. This normalises rainfall and stream flow deficits based on historic records identifying times when precipitation and stream flow has been above or below normal levels for that location for the time of year.

OPPORTUNITIES

Our catchment partners are already implementing actions to address rising water demands (see Response) and here we consider how we can enhance the water quantity regulation for drought alleviation by holding water in the landscape for longer and releasing it more slowly after cessation of rainfall.

Wetland habitats have the potential to buffer extremes of water availability. This mainly comes from their ability to store water, and the delayed movement of water out of a wetland but is also dependent on the connectivity to the catchment's hydrological system, wetland vegetation, surface roughness, and seasonal variability in their storage capacity (e.g. providing water in times of drought). Healthy floodplain wetlands such as fens, swamps and meadows, for instance, have water tables aligned to the level of water flow within the adjacent watercourse. During periods of low river flow, a hydraulic gradient between the floodplain and watercourse tends to exist and this directs groundwater into the watercourse, thus helping to sustain base flow (Burt et al. 2002).

Our catchment includes around 12,500 Ha of floodplain, 70,000Ha of naturally wet soils, and has around 23,000Ha of hydrologically connected land based on the Surface Flow Index model. However, there is currently under 3,000 ha of wetland in our catchment (excluding rivers and lakes), and the majority of this is poor habitat quality (Sussex Widlife Trust, 2012). To help identify where the greatest opportunity exists for restoring or creating wetlands in the Arun and Western Catchment, we have used a criteria similar to the UK Wetland Vision Initiative to capture areas that are most suitable for supporting wetland habitats whilst accounting for factors that are likely to limit wetland creation. This has used the following datasets:



- Soil Hydrology
- Hydrological connectivity (Floodplain)
- Hydrological connectivity (Surface flow)
- Factors limiting wetland creation including:
  Human infrastructure
  Agricultural Land Grade
  Scheduled Ancient Monuments
  Landfill sites (historic and active)

The opportunity maps are presented by area (cell) and as catchment averages in Figures 11 and 12. These show that localised opportunities exist, particularly along the floodplains of the Arun and Rother rivers, the southern tributaries of the Western Rother, in the Upper Arun and in coastal areas outside of high grade agricultural and urban areas. Across our surface water catchments 16 river waterbodies and two coastal catchments scored higher than average. The greatest opportunities are in the catchments of the Broad, Bremere and Ryebank Rifes, despite large areas also being unsuitable for wetland creation.

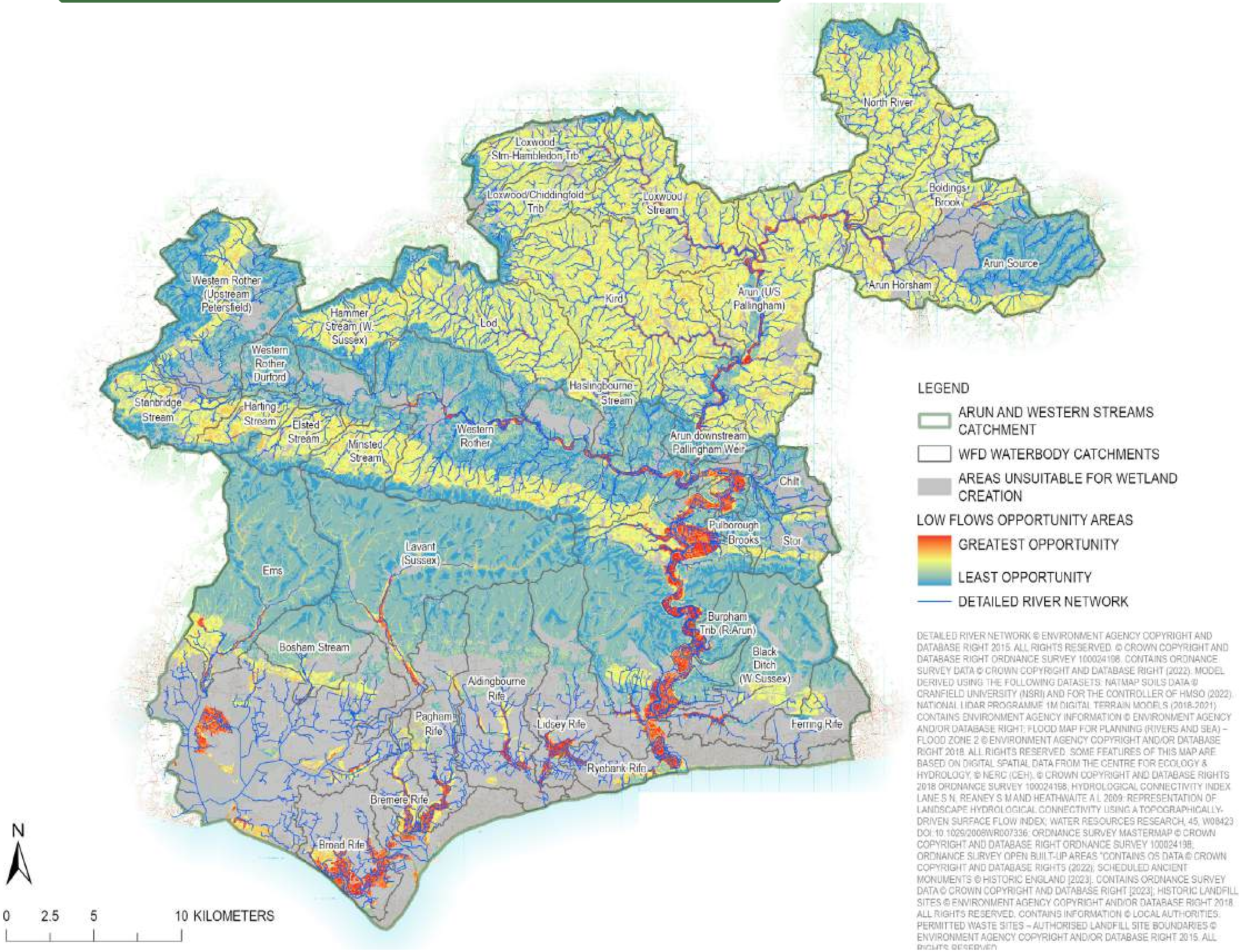


Figure 11.Opportunity map for wetland creation to regulate base flows in the Arun and Western Streams catchment at 5m^2. Red shows areas with greatest opportunity based on highest scores as a result of soil hydrology, floodplain hydrological connectivity and surface flow connectivity.

Low Flows

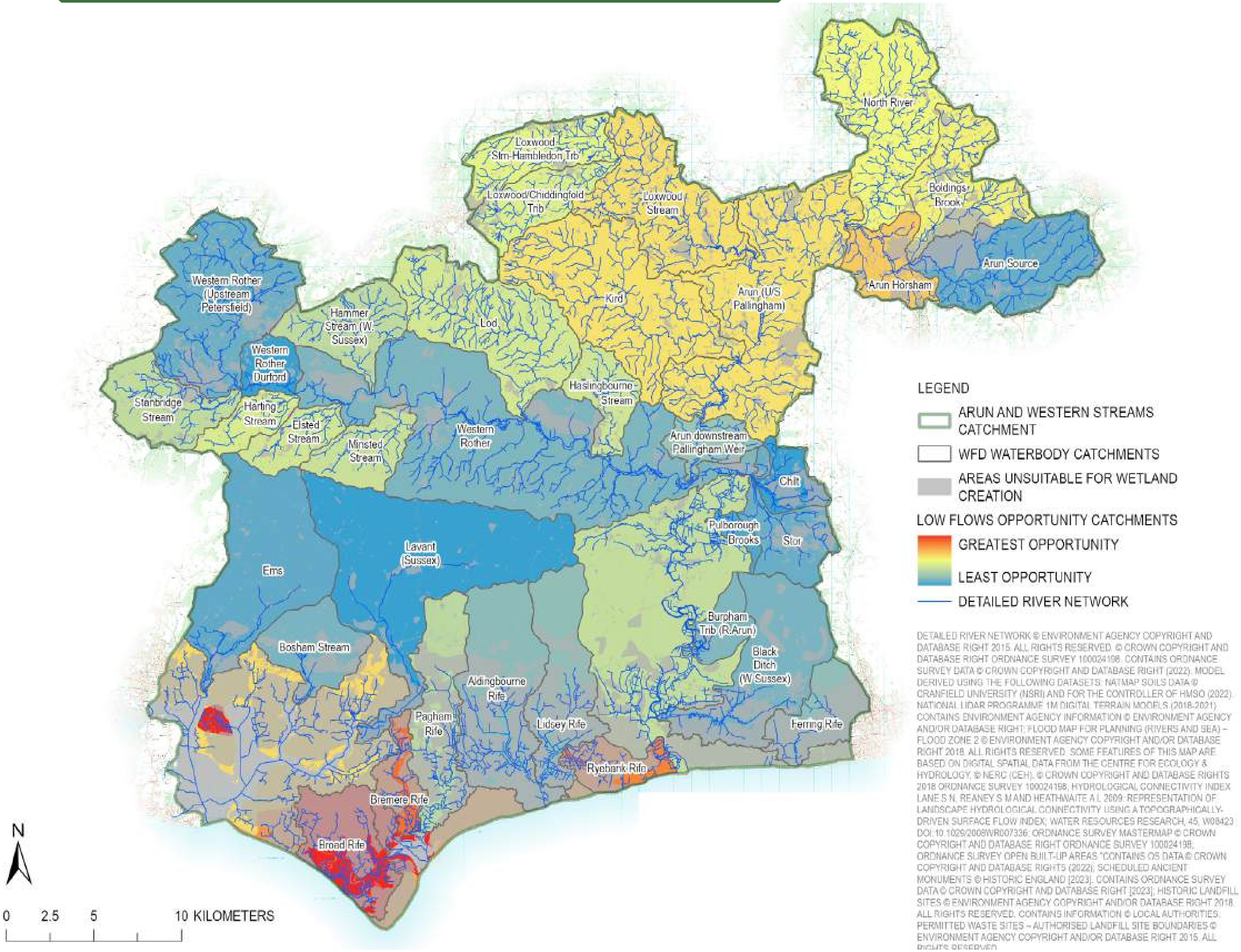


Figure 12.Map showing the average opportunity score for river and transitional waterbody catchments in the Arun & Western Streams. Red shows catchments that are likely to have the greatest areas of opportunity for creating/restoring wetlands to regulate base flows

RESPONSE

1. Public awareness of leaky taps/reducing usage in general, not just in summer – response section
2. On farm storage solutions-grants and funding- response section
3. Opportunity for water storage identified within LNRS as opportunity for nature – where is the LNRS for Sussex?
4. Hydrogen production for power/energy – will increase demand (James Bucknall) – can add this into pressures section but can somebody point me in the right direction for this information
5. Portsmouth Water will be undertaking water resource investigations on all of our abstractions during AMP8 (2025-2030) – early start funding for 2024? Analysis and monitoring, detailed impact assessments, options appraisal – response section

New project ideas:

1. Working in upper catchments to store, slow the flow of water in smaller streams and ditches – can reduce and slow peak flows
2. Flow monitoring using telemetry for live data streamed to website
3. Rainwater harvesting – cheap and easy reducing demand
4. Demand reduction from consumers
5. Monitoring of WQ in ordinary watercourses by local residents
6. River restoration – meanders, leaky dams etc.
7. Water monitoring – flows, levels and groundwater – greater spatial and temporal resolution. Open source data to encourage users to consider use.
8. Downs to the Sea – increasing resilience in wetland habitats and pond restoration/creation

Water Quantity:

Regulation of Peak Flows

CURRENT STATE

Flooding in the Arun and Western Streams catchment comes from multiple sources including rivers, sea (tidal and coastal), surface water and groundwater. In the past 50 years, there have been at least seven significant (>20 properties flooded) flood events with the most serious being June 2012, when around 1000 properties were flooded following extreme rainfall that exceeded 400% of the monthly average in some areas.

Based on the Environment Agency's national assessment of flood risk from rivers and sea, there are around 11,000 residential and commercial buildings at potential risk of fluvial and tidal flooding across the catchment when considering flood defences and their condition. The areas with the highest density of properties include Arundel, Bognor, Chichester and Selsey (Figure 13). There are also a number of assets and critical infrastructure at risk of fluvial/tidal flooding including ~170km of our road network, 2 emergency services, 6 schools, 4 wastewater treatments works, 9 electricity sub stations, and 4 hospitals/clinics (AWS CFMP, 2018).

Using the extent of areas modelled by the Environment Agency to be at potential risk of surface water flooding, there are around 30,000 residential and/or commercial buildings in our catchment susceptible to flooding (Figure 14). The areas most at risk include heavily urbanised areas located on the flat coastal plain, the major conurbations of Horsham, Chichester, and Petersfield, and settlements adjacent to drainage systems at the bottom of the south downs hillslopes. This data also shows that around 950km of our road network is also at risk of surface water flooding, including significant road links of the A29, A283, A281 and the A27.

REGULATION OF PEAK FLOWS

The volume and speed at which water moves through the catchment following periods of intense or prolonged rainfall has important consequences for flood risk. If water arrives in our rivers too rapidly then the 'peak flows' can cause floodwater to spill out across adjacent land causing fluvial flooding. This can also result in surface water flooding when the capacity of our drainage systems and smaller watercourses become overwhelmed, and water which is unable to enter a drainage system or infiltrate into the land (e.g. due to land use or high groundwater) flows or ponds over the ground. Flooding can also be exacerbated by constrictions or blockages in watercourses and by the incoming tide (tide locking). Flooding becomes a risk when flood water affects people, property, agricultural land, or other important infrastructure and therefore regulating the rate at which water moves through the catchment is an important consideration for managing this risk.

Peak Flows

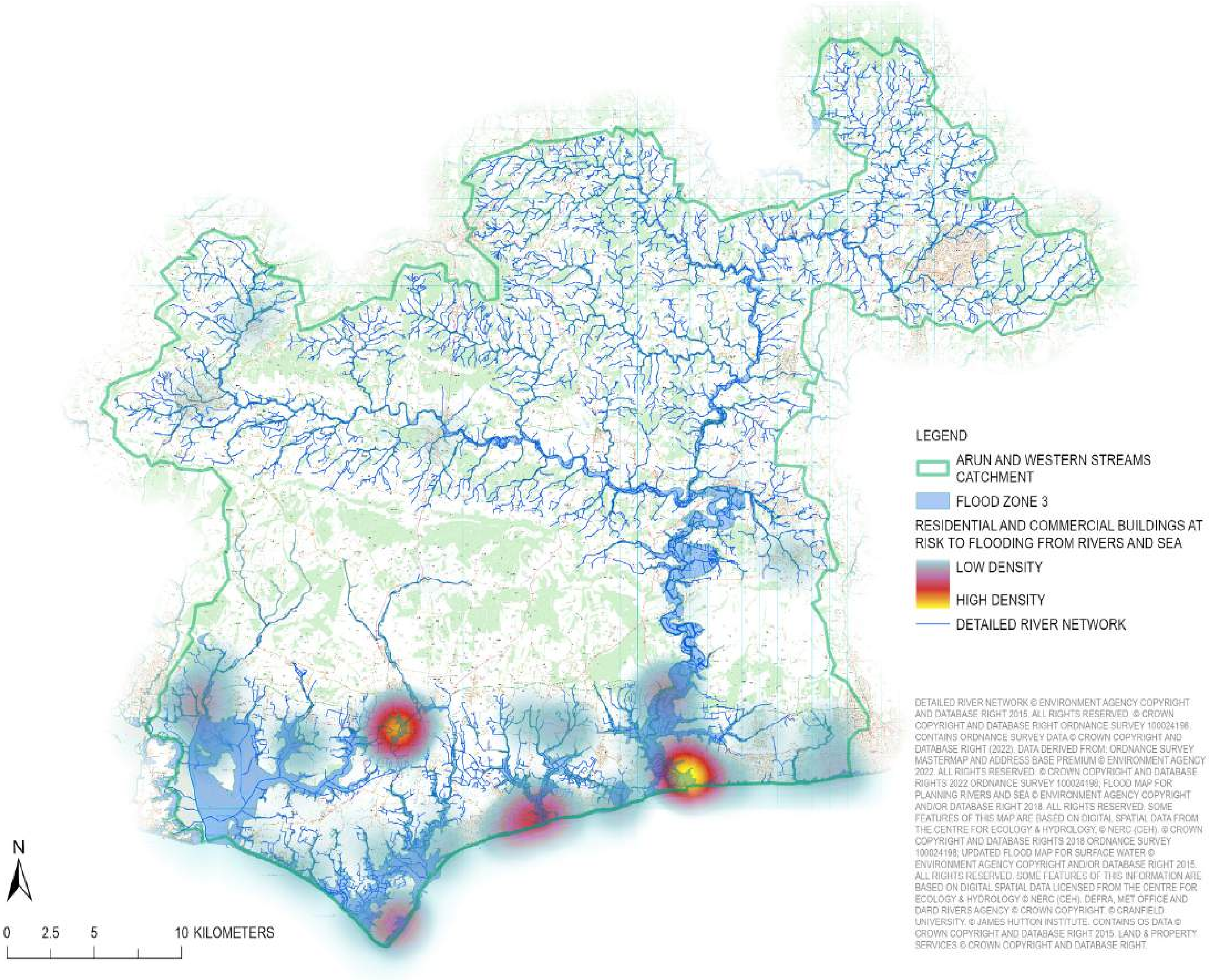


Figure 13.Heat map showing residential and commercial properties that are at potential risk of flooding from river and sea.

Peak Flows

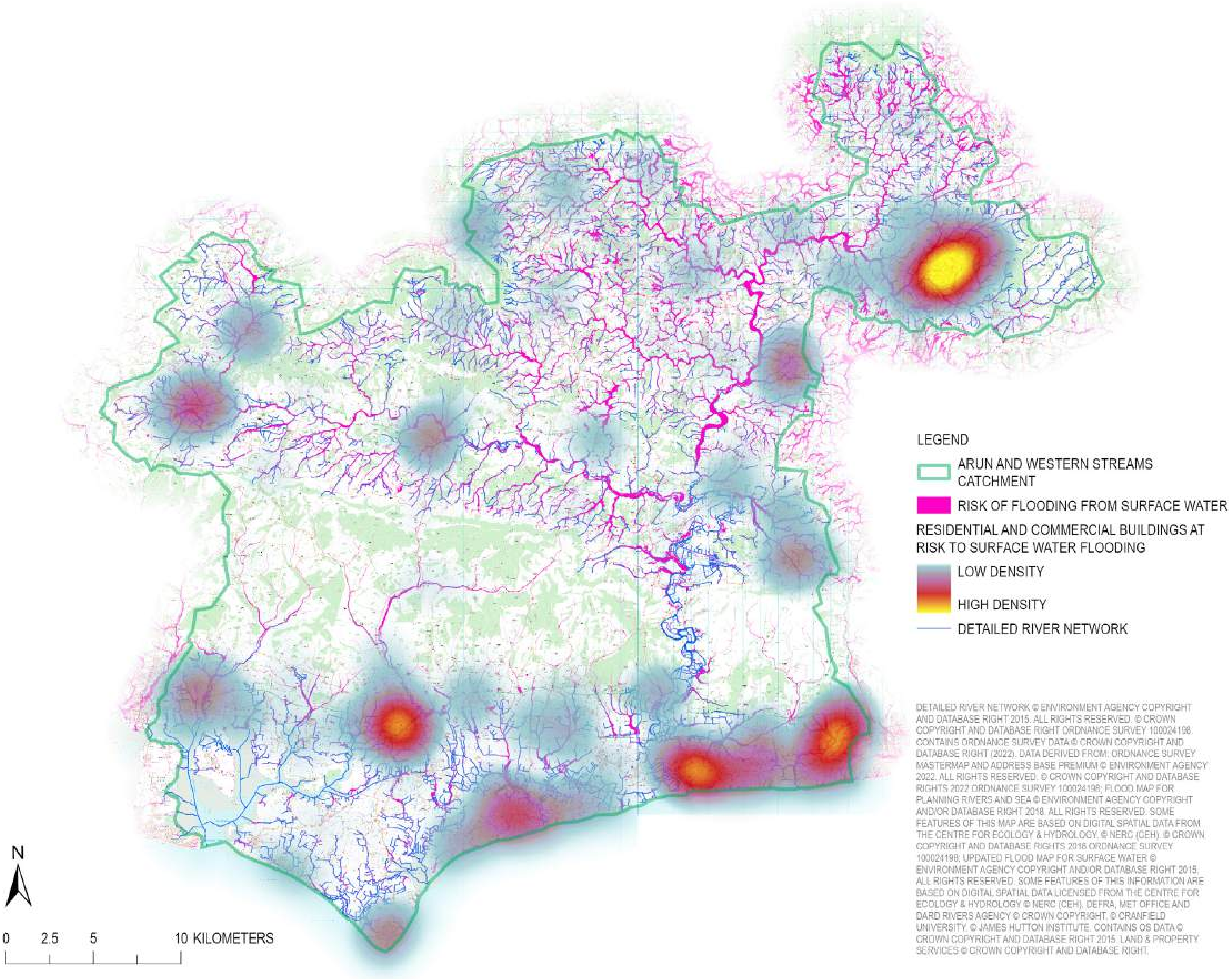


Figure 14.Heat map showing residential and commercial properties that are at potential risk of flooding from surface water.

PRESSURES

Flood generation depends on multiple factors such as the intensity, volume and timing of precipitation, antecedent conditions of the catchment (e.g. soil wetness and topography), river morphology, land use, and flood control measures. As such there are a number of climatic and socio-economic drivers that influence current and future flood risk including climate change, land use change, deterioration of defences, and river modifications.

CLIMATE CHANGE

The most recent climate projections for the UK (UKCP18) suggest that we are likely to see a shift to warmer wetter winters and an increase in the frequency and magnitude of intense precipitation events. The Arun and Western Streams Catchment Flood Management Plan suggests that climate change poses the greatest threat to future flood risk, with the number of properties at risk of the 1% annual probability event expected to increase from 1576 to 2066 by the year 2100. Peak river flows are estimated to increase by up to 36% by 2050s and this is likely to result in an increase in river flooding, particularly in the Arun catchment. Flooding is also expected to be exacerbated by an increase in tide-locking events caused by sea level rise, and regular flooding from drainage systems is likely due to more frequent after intense storm events. The majority of properties expected to be affected by future flood risk are located in Arundel, Littlehampton, Bognor Regis, Horsham, Bosham, and Westbourne.

The UK Climate Projections (UKCP18) for median % change in daily winter (December-February) precipitation in the Arun & Western Streams under different global warming levels.

1.5°C	2.0°C	2.5°C	3.0°C	4.0°C
+7%	+14%	+11%	+19%	+23%
(-2% to +20%)	(-1% to +19%)	(+5% to +22%)	(+8% to +25%)	(+15% to +34%)

Percentage change is relative to the average daily winter preciptation between 1981 and 2000. The uncertainty in predicted values is provided as upper and lower bounding values in parethesis. These are based on the second highest and second lowest ranked winter precipitation values from each group of models (maximum of 12) that have been used to model climate change projections. Predictions are calculated based on the highest emmission scenario (RCP8.5) where greenhouse gases continue to grow.

RURAL LAND MANAGEMENT & URBANISATION

In addition to the impact of climate change, human impacts on water retention across river catchments and extensive alterations to floodplains can also influence the generation of flood waters. There is currently around 50% of our catchment and nearly 70% of our floodplain that is urbanized or used for arable or improved grassland (Land Cover Map, 2020). Intensive land uses and artificial surfaces associated with built-up areas can reduce infiltration and increase surface water runoff. Agricultural intensification can also degrade soil, reducing porosity and the volume of organic matter that both influence infiltration rates, soil water storage, and saturated hydraulic conductivity. Furthermore, the intensive use and modification of our floodplains reduces their capacity to dissipate hydraulic energy from floodwaters and attenuate peak flow and also places more people and assets at risk of flooding events. Figure 15 shows land cover in our catchment based on its risks to generating surface water flow.

RIVER MODIFICATIONS

Many of our rivers and smaller watercourses have been physically modified to allow our water environment to be used and valued for a variety of purposes. The lower reaches of both the rivers Arun and Rother were historically straightened, by cutting off meanders, to improve navigation and various structures were built along many of our watercourses to control water supply to industries and for farming. Over 100km of our river network, including nearly 17km of main river, has also been culverted to allow water to pass under artificial obstructions such as roads. These alterations impact the natural flow of our rivers and can excacerbate flooding. Straightened, uniform channels typically transfer waters downstream much more effectively and this can redistribute flood risks in the catchment from upstream to downstream areas. Conversely, excessive widening or deepening can initiate channel instabilities resulting in erosion and sedimentation which reduces the channels capacity to convey flow. Structures such as weirs and culverts can promote sedimentation reducing the channels capacity to contain flood water and can back up or become blocked by debris to cause localised flooding upstream.

Many alterations and built structures now play a key role in managing current flood risk and the Environment Agency alone, currently owns, manages, or inspects over 250 of our assets that help to prevent river and tidal floodwater from flowing inland. There are, however, many modifications that no longer serve a purpose, or are deteriorating such that alternative solutions to flood risk management need to be considered.

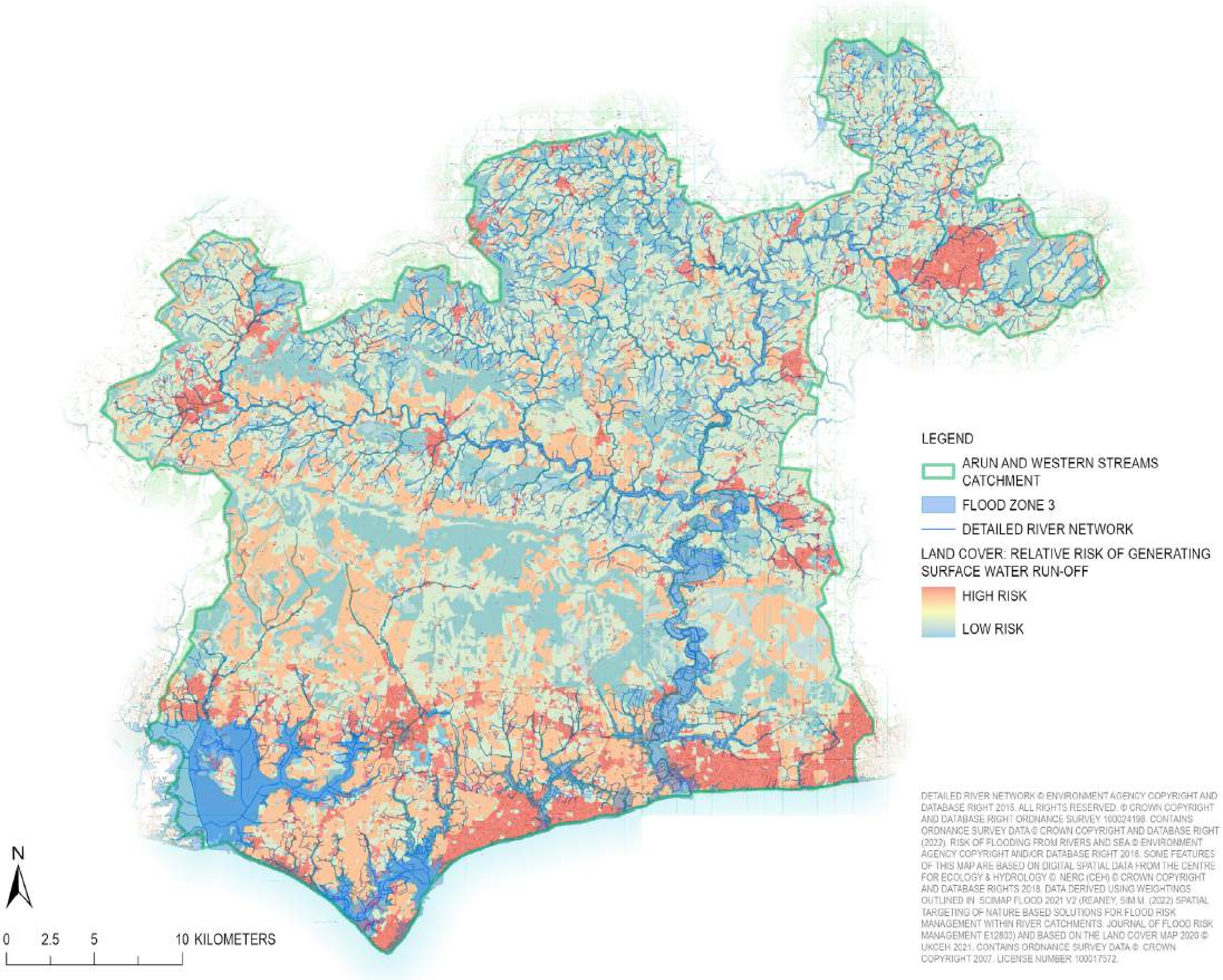


Figure 15.Map showing land use weighted by potential risk of generating surface water run-off (as described in methods detailed in Appendix A)

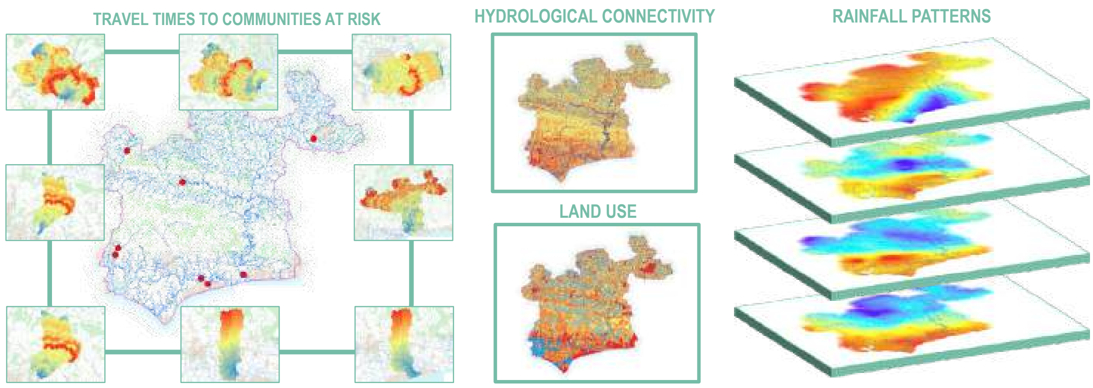
OPPORTUNITIES

It is now widely accepted that flood risk cannot be eradicated through defensive structures alone and that a broader range of actions that work with the natural process of flooding should be implemented at all spatial scales within a catchment. The most recent National Flood and Coastal Erosion Management Strategy for England calls for the nation to embrace a broad range of resilience action which includes using Natural Flood Management (NFM) to reduce flood risk, build resilience into hard defences, and reduce the impacts of climate change.

"NFM aims to reduce flood risk by protecting, restoring and emulating the natural hydrological and morphological processes, features and characteristics of catchments using environmentally sensitive and beneficial techniques to manage sources and flow pathways of flood waters."

NFM includes a range of techniques that cumulatively work to reduce flood peaks by storing water in the landscape, increasing water infiltration, slowing the flow of water and reducing hydrological connectivity within the landscape. Before implementing NFM, it is important to understand where in the catchment interventions would be most effective at reducing flood risk. This is because flood waters and hazards are not produced in a uniform way across the landscape, and instead are a product of where rain that generates flooding, falls, and the factors that influence how the water subsequently moves across the landscape to contribute towards flood peaks.

We used SCIMAP-Flood (Reaney, 2022) to identify the most likely locations that contribute towards flood peaks at some of our most 'at risk' communities. This targeting tool uses spatial information on rainfall patterns, land cover, hydrological connectivity, and the estimated travel time of surface water to 'at risk' assets (e.g. communities or other infrastructure) to capture how flood events develop within catchments and, in doing so, identifies potential source areas for flood water that could be suitable for NFM interventions. We identified eight communities at current or future risk of flooding across our catchment that included Liss, Midhurst, Horsham, Littlehampton, North Bersted, Bognor Regis, Emsworth and Westbourne. Each dataset was processed at a 5m grid cell resolution and, other than rainfall, was weighted based on the location's likely contribution to peak flows. A full description of the method used is provided in Appendix A.



ARUN CATCHMENT

The opportunity maps for NFM interventions in the Arun catchment are presented by area and by catchment in Figures 16 and 17. These show that the greatest opportunities are located in the headstreams of the Western Rother upstream of Midhurst. Opportunities for NFM interventions within Horsham have also been identified suggesting that there is scope for engagement with the community to implement urban interventions such as rain gardens, planters, and ponds.

EMS RIVER CATCHMENT

The opportunity maps for NFM interventions for the Ems river catchment are presented in Figure 18. This shows opportunities are present on the steeper slopes in the upper part of the catchment, and in the middle part of the catchment at the source of the River Ems at Stoughton and at West Marden.

ALDINGBOURNE RIFE CATCHMENT

The opportunity maps for NFM interventions for the Aldingbourne Rife catchment are presented in Figure 19. This shows that the low-lying farmland between the villages of Aldingbourne and Westergate, and the steeper slopes lying north of the A285 trunk road would benefit from NFM interventions to reduce surface water runoff. It also shows that there are potential opportunities for urban NFM interventions across the village of North Bersted.

Natural flood management techniques

1. In stream structures for example woody debris
2. Blocking of moorland drainage channels
3. Woodland planting
4. Land and soil management practices, cover crops, hedgerows, suitable crops
5. River morphology and floodplain restoration for example removal of embankments and remeandering
6. Inland storage ponds and wetlands
7. Protecting riverbanks for example stock fencing
8. Sustainable urban drainage systems for example swales, wetlands in urban areas, green roofs, permeable pavements, detention ponds, filter strips
9. Saltmarsh restoration
10. Coastal managed realignment
11. Coastal change management

Taken from the National Flood and Coastal Erosion Risk Management Strategy for England

Peak Flows

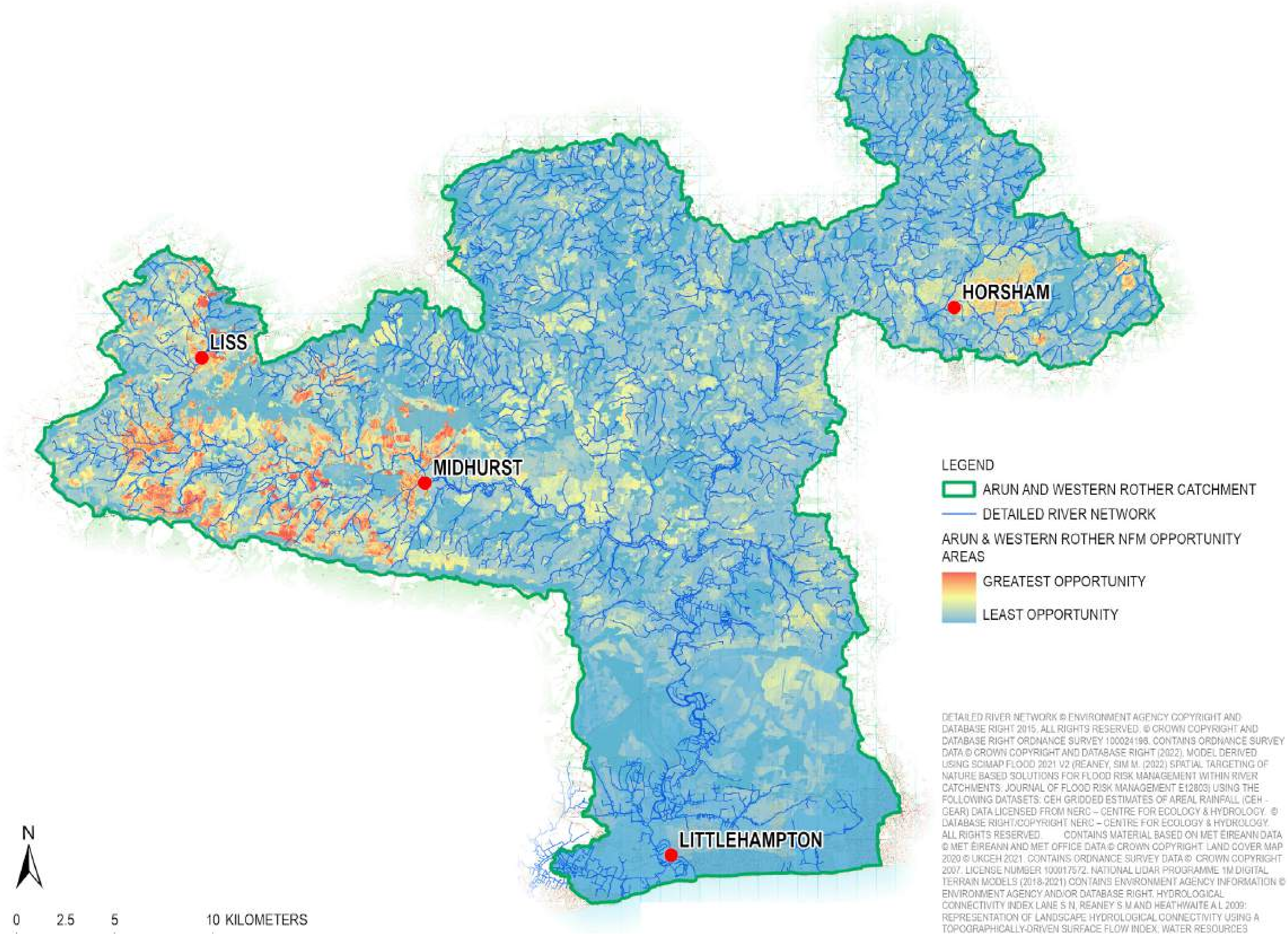


Figure 16. Opportunity map for reducing peak flows in the Arun river catchments at 5m². Red shows areas with greatest opportunity based on highest frequency predicted travel times of overland flow to four communities, hydrological connectivity, land use and 14 rainfall patterns that have contributed towards peak flows across the rivers Arun and Rother.

Peak Flows

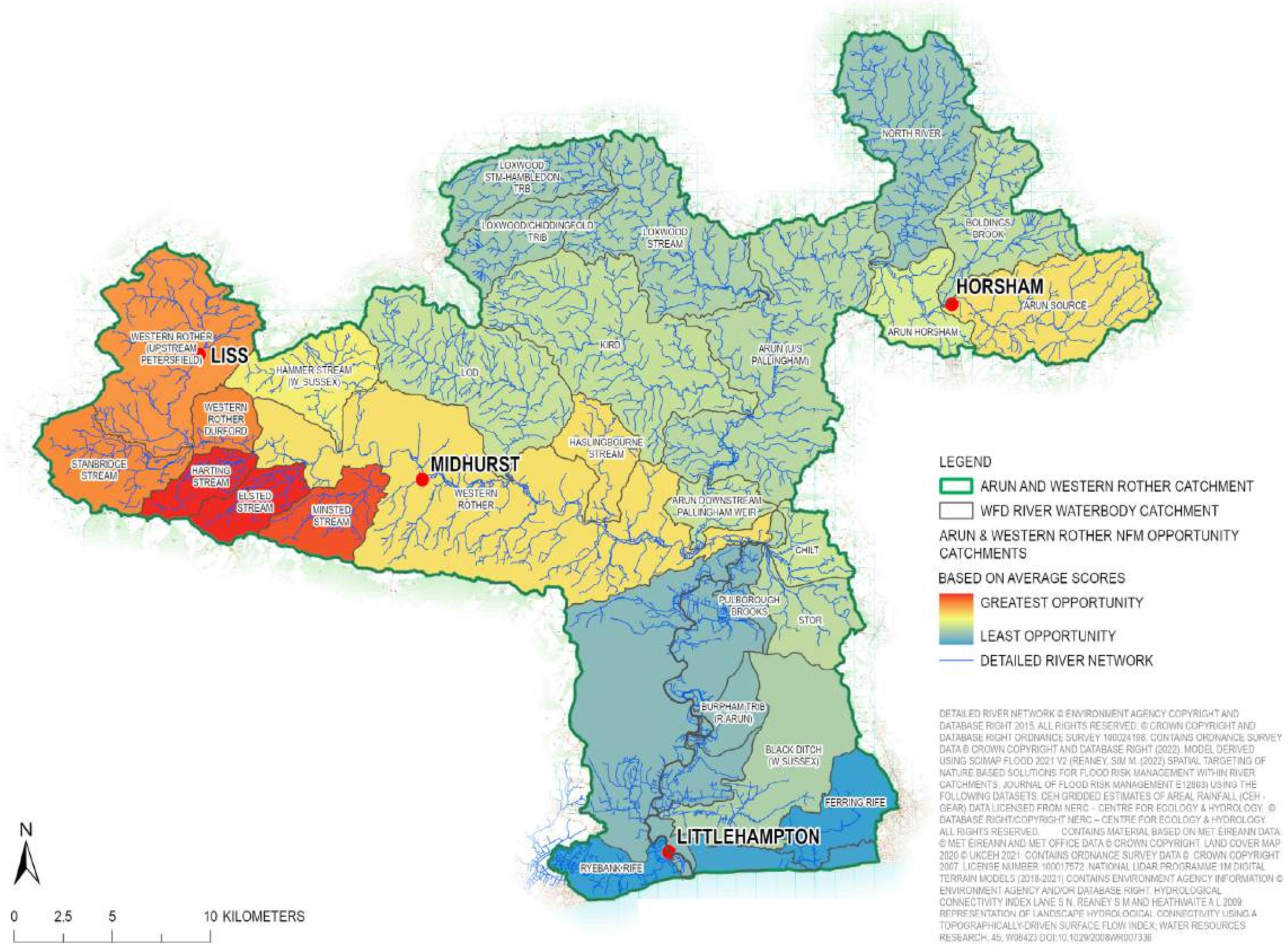


Figure 17.Map showing the average opportunity score for 21 river waterbody catchments in the Arun catchment. Red shows catchments that are likely to have the greatest opportunity for delivering NFM interventions to reduce peak flows to four communities at risk

Peak Flows

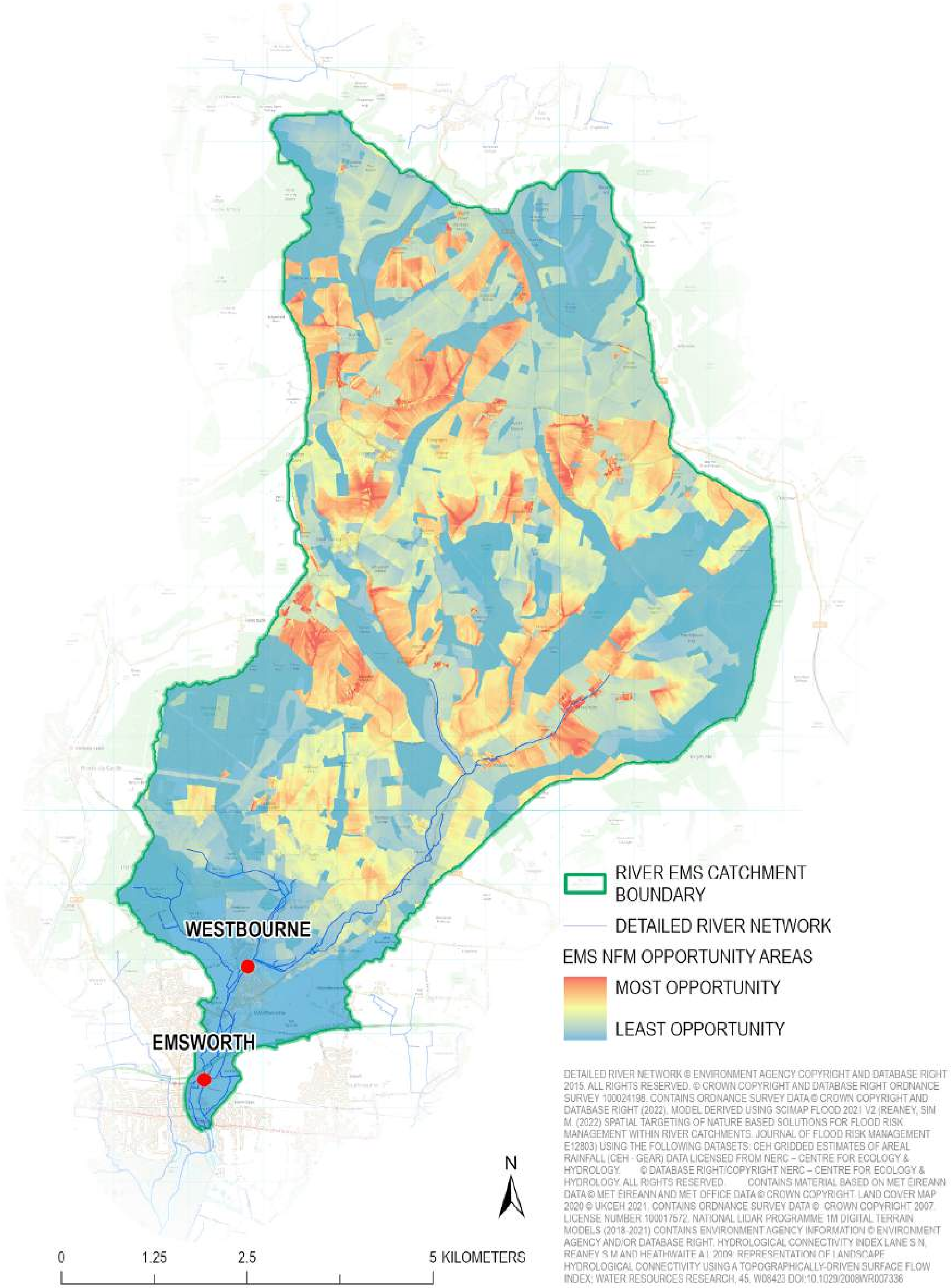


Figure 18.Opportunity map for reducing peak flows at Emsworth and Westbourne in the Ems river catchment at 5m2. Red shows areas with the highest potential to reduce overland flow based on highest frequency of predicted travel times, hydrological connectivity, land cover and rainfall that have contributed to high flows and/ or community flooding

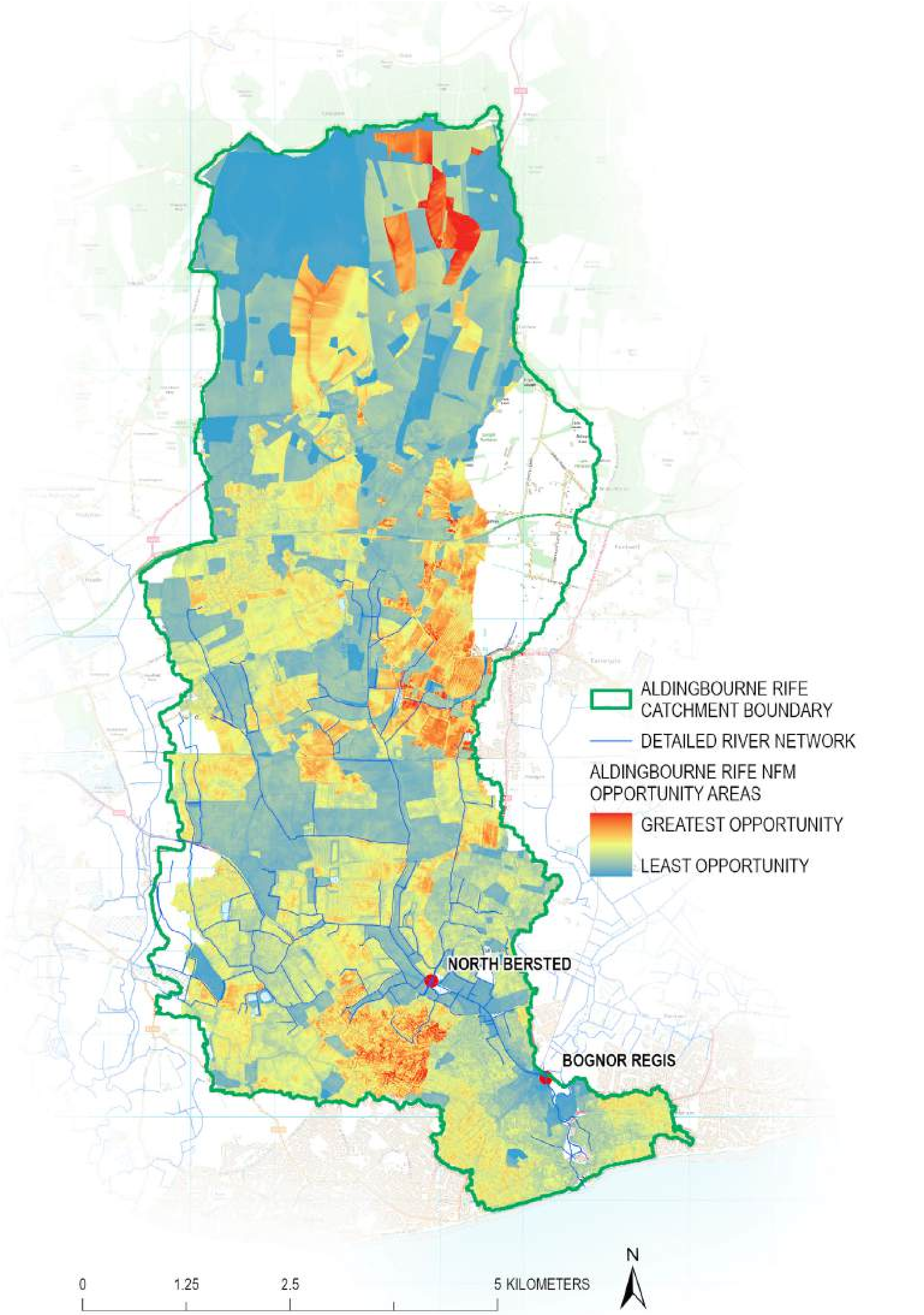


Figure 19.Opportunity map for reducing peak flows in North Bersted and Bognor Regis in the Aldingbourne Rife catchment at 5m2. Red shows areas with the highest potential to reduce overland flow based on highest frequency of predicted travel times, hydrological connectivity, land cover and rainfall patterns that have contributed to high flows and/or community flooding., hydrological connectivity, land cover and rainfall that have contributed to high flows and/or community flooding

RESPONSE

Past and present projects:

1. WSCC Flood Risk Management Team projects (not announced to public yet)
2. Riparian buffers
3. Coastal partners projects (5 district/borough councils working together)

New project ideas:

1. More riparian buffers
2. Water harvesting
3. Water storage
4. Slow the Flow, leaky dams (£20m)
5. SuDS – rain gardens, tree pits, swales etc.
6. Ditch management and clearing – public and landowners responsibility
7. Winter storage on farms:
8. Increase biodiversity, slow the flow, reduce abstraction (Summer)
9. Block land drains and itches to create wetlands, flow the flow and absorb nutrients

Ecological Networks

CURRENT STATE

"Ecological networks comprise a suite of high-quality sites which collectively contain the diversity and area of habitat that are needed to support species and which have ecological connections between them to enable species, or at least their genes, to move."

Lawton et al. 2010

There are many areas in our catchment that are important for biodiversity. We have over 100 protected sites which contain some of our rarest and most threatened species, populations and/or habitats of international, national, or regional/local importance. Around 900km^2 of our catchment is also part of wider landscapes that are designated for their natural beauty and cultural importance and have wildlife conservation as part of their statutory purpose. A further 344 sites are designated for their high biodiversity value (Local Wildlife Sites) but do not receive full protection. A summary of the number of sites by level of designation is provided in Table 1 and a map showing their location is provided in Figure 21.

Table 1.Showing the number and area (in km^2) of international, national, and local sites of conservation importance. Some sites have more than one designation.

Designation	Number of sites	Total Area (Km^2)
Sites of International Importance		
Special Protection Areas (SPAs)	4	65
Special Areas of Conservation (SACs)	11	
RAMSAR Wetlands	3	
Sites of National Importance		
Sites of Special Scientific Interest (SSSIs)	67	91
National Nature Reserves	4	
Sites of Local Importance		
Local Nature Reserves	15	97
Local Wildlife Sites	344	
Protected Landscapes		
National Park	1	901
Areas of Outstanding Natural Beauty	3	

Our catchment also has a high diversity and coverage of semi-natural 'priority' habitats that are recognised as being of principal importance for the purpose of conserving our national biodiversity (Figure 21). Nearly a quarter (21%) of our catchment is covered by 16 terrestrial, wetland, or coastal priority habitat types. This includes large areas of deciduous woodland, extensive intertidal saltmarsh, and mudflats at Chichester, Langstone and Pagham Harbours, and significant areas of coastal and floodplain grazing marsh situated along the lower Arun Valley. We also have a number of priority freshwater habitats that represent our 'most natural' sites. This includes 7 priority lakes, 21 priority ponds and a total of 65km of priority river that includes the unique chalk rivers of the Lavant and the Ems.

The purpose of these sites, landscapes and habitats is to represent and/or protect our wide variety of landscapes, habitats, species, and populations. However, only half of the units that make up our Sites of Special Scientific Interest are in favourable condition and nearly two thirds of our priority habitats fall outside of our network of protected sites (including Local Wildlife Sites).

Ecological Networks

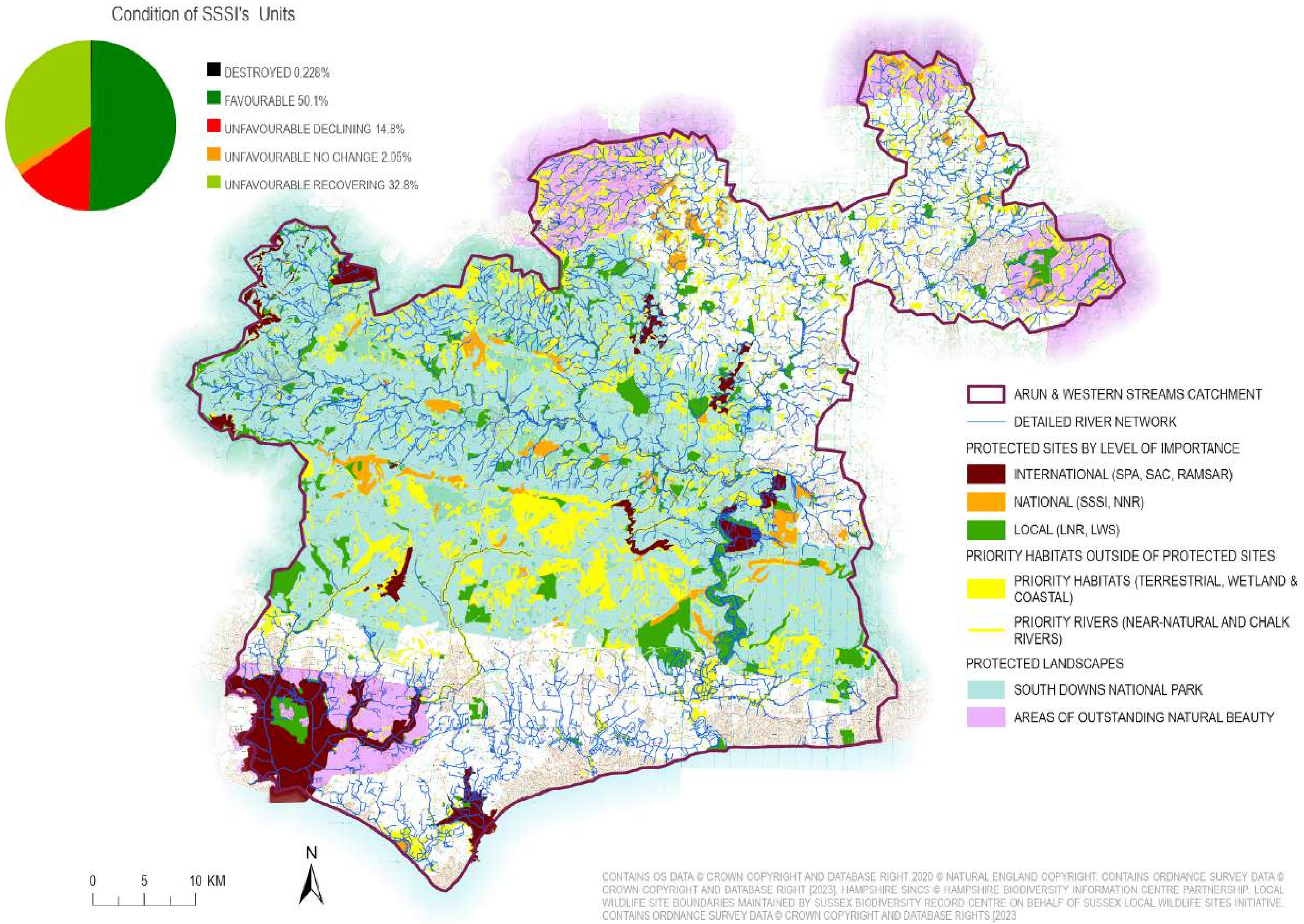


Figure 20.Map showing the distribution of protected sites and landscapes by level of importance in the Arun and Western Streams Catchment. Inset graph shows the proportion of Sites of Special Scientific Interest Units meeting each condition category.

Ecological Networks

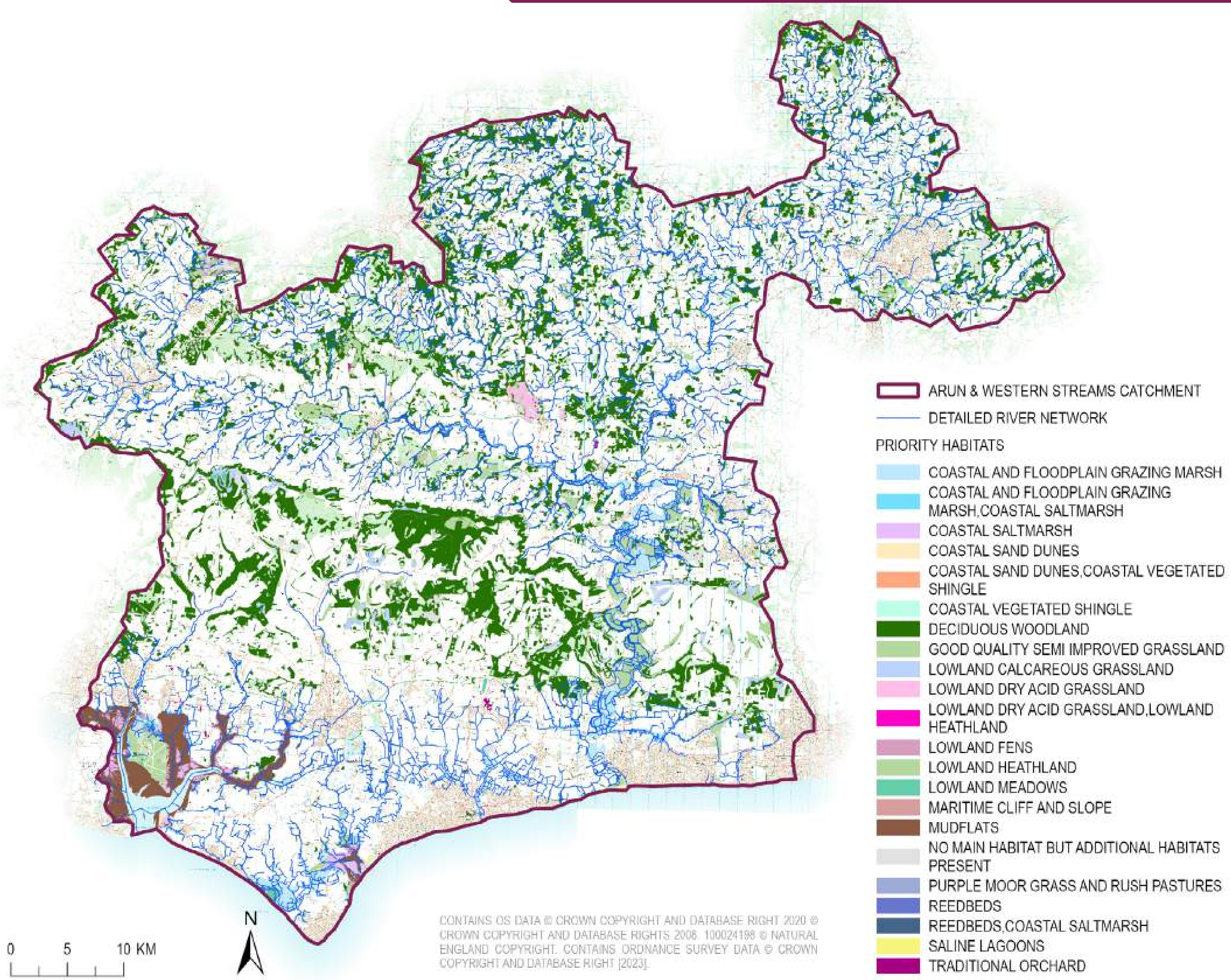


Figure 21.Map showing the distribution of priority habitat in the Arun & Western Streams Catchments, as defined by the Priority Habitat Inventory V3.

SPECIES AS KEY INDICATORS OF RIVER AND WETLAND HEALTH

Fish are a key indicator of healthy freshwater environments as they are sensitive to changes in water quality (including temperature) and quantity and require physical habitat diversity and connectivity within the wider surroundings for their survival. They all play a vital role as scavengers, predators and prey and are central to the natural balance of our freshwaters.

Our catchments rivers support a number of ecologically important fish species. The courser substrates, riffles, pools and glides located in upper reaches and tributaries of the Western Rother support good populations of wild brown trout and brook lamprey (Lampetra planeri). Sea trout also run the tidal River Arun to spawn in the headwaters of the Upper Arun and Rother. Our smaller, slower flowing coastal streams support flounder and good populations of the critically endangered European eel, and Bullhead, which are protected under the European Habitats Directive, occur across our catchment.

The Environment Agency monitor our fish populations and compare the observed composition, abundance, and prevalence of fish species from their surveys, against what would be expected if the river was in pristine condition. The resulting Ecological Quality Ratio (EQR) score is then used as an indicator of the ecological health of the river for reporting under the WFD. The most recent classification for 25 of our rivers monitored for fish show that nearly three quarters (72%) are failing to achieve good status for fish (Figure 22) and four waterbodies, including the Chilt, Boldings Brook, the Loxwood Stream and Pagham Rife have all showed a deterioration since the last reporting cycle.

Water voles are another important indicator species of healthy rivers, ditches and wetlands as they require dense marginal vegetation for food and cover, natural banks for burrowing, stable water levels to evade predation and good connectivity between wetlands to enable disperal. We are fortunate to have two key areas for water voles in our catchment that includes the Arun Valley and the Manhood Peninsula. The National Water Vole Database and Mapping Project (NWVDMP) run by the Hampshire & Isle of Wight Wildlife Trust (HIWWT) uses national data to maps trends in water vole distribution (Figure 23). This shows that our water vole population is one of few in the UK that are increasing in size thanks to ongoing conservation efforts by the Manhood Wildlife & Heritage Group.

Water voles are ecological engineers. Their burrowing along riverbanks changes soil conditions allowing a wider range of wildflowers and grasses to grow. As herbivirores, they control the growth of plants, enabling a greater diversity of species to flourish. Their burrows, feeding platforms and above ground nests are also used by other small mammals reptiles, emphibians and insects.

Ecological Networks

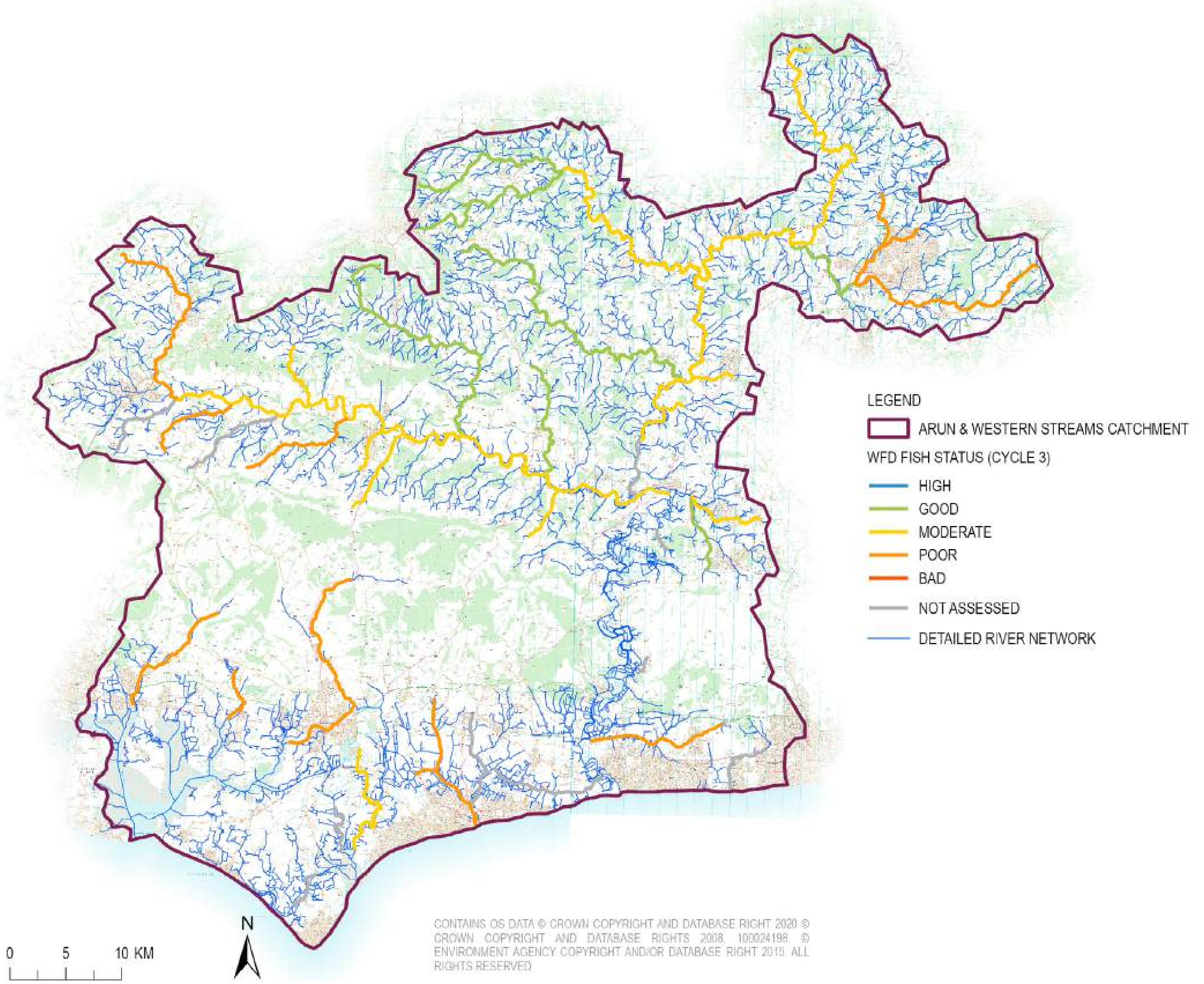


Figure 22.Map showing the WFD Status (Cycle 3) for fish across the 25 rivers in the Arun & Western Streams Catchment.

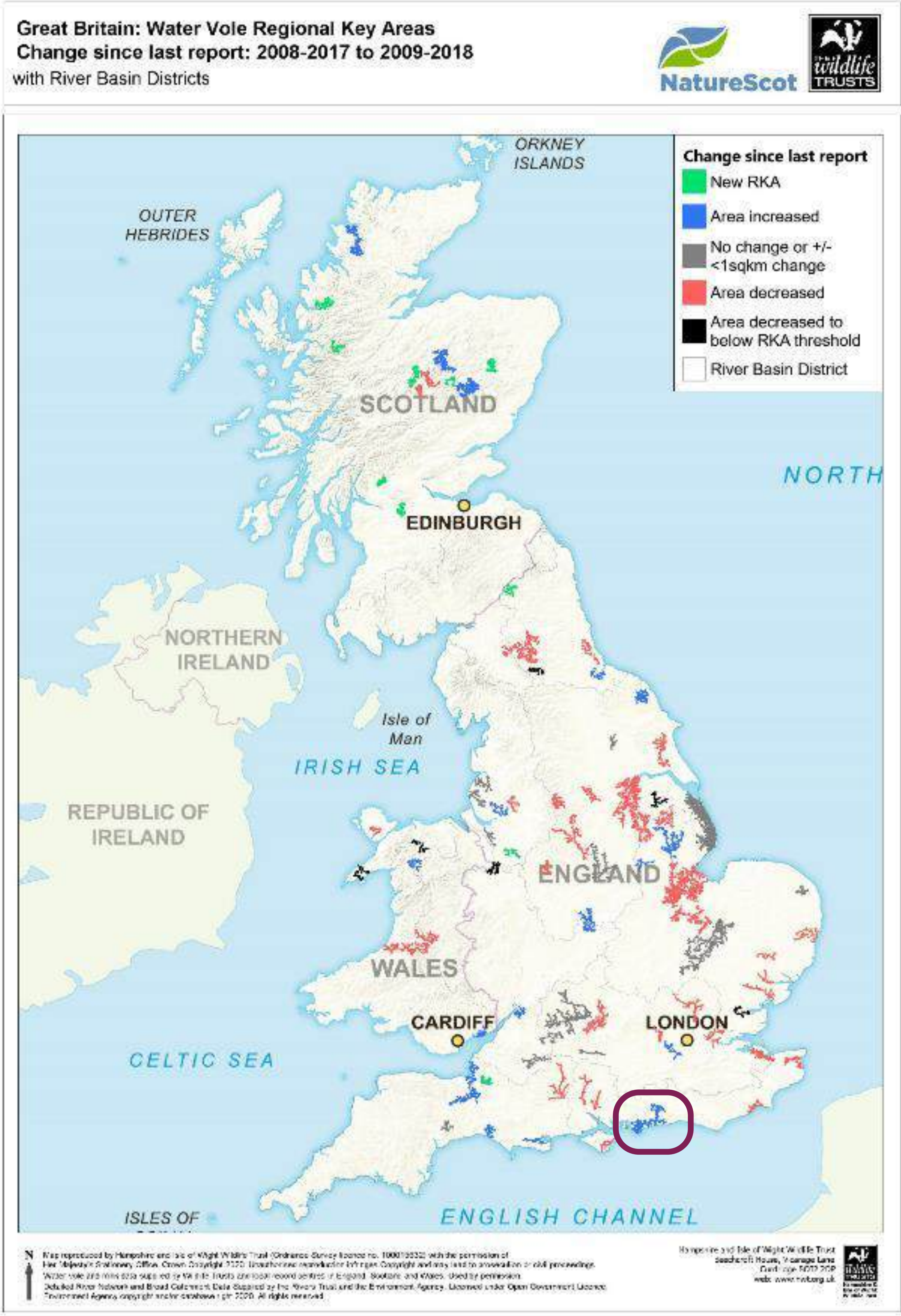


Figure 23.The National Water Vole Mapping and Database Project Map showing Regional Key Areas for Water Voles. The Manhood Peninsula and Arun Valley are circled in deep red.

PRESSURES

FRAGMENTATION AND LAND MANAGEMENT

Habitat fragmentation occurs when habitat is reduced in size and the distance between remaining habitat patches increases and this can negatively affect ecosystem function and the species they support. In our catchment, 22% of our protected sites[1] are less than the size of two football pitches (2ha) and 90% of all sites are less than 100ha in size. Furthermore, over a third (35%) of our semi-natural habitats exist in discrete patches (either as individual habitats or a group of habitats) that are geographically separated from protected sites, and 90% of these are smaller than 6ha in size. Smaller patches generally have less topographic, geological, and hydrological diversity and support smaller populations of individual species that are more likely to fluctuate to local extinction due to extrinsic events (e.g. extreme weather). Smaller sites also have proportionally more edge than larger sites making them more susceptible to degradation from neighbouring, more intensive land use (e.g. spray drift, scrub encroachment). Maps showing the relative fragmentation of our rivers and wetlands, and other terrestrial priority habitats are provided in Figures 24 and 25. These show that our rivers and wetlands are most fragmented in the Upper Rother and Upper Arun and along our precious chalk streams of the Ems and Lavant, whilst terrestrial habitats most at risk of fragmentation occur to the south of the South Downs.

Agricultural intensification and built development between our protected sites and habitats can also create a barrier to movement for many species and can indirectly reduce the quality of our habitats. Pollution from agricultural run-off, discharges and water abstraction present notable threats to our most valuable wetland and intertidal habitats. Nearly half of the SSSI Units at Chichester Harbour are in unfavourable condition due to reasons that include freshwater pollution, whilst groundwater pollution and abstraction present the biggest threat to the condition of the Arun Valley RAMSAR and SPA.

Macroalgea on mudflats © Gareth Williams

1 *Protected Sites include spatially explicit areas of land that are designated as RAMSAR's, SPA's, SAC's, SSSI's, NNR's, LNR's and/or LWS's. Some areas have multiple designations and where abutting have been combined to represent total area.*

Ecological Networks

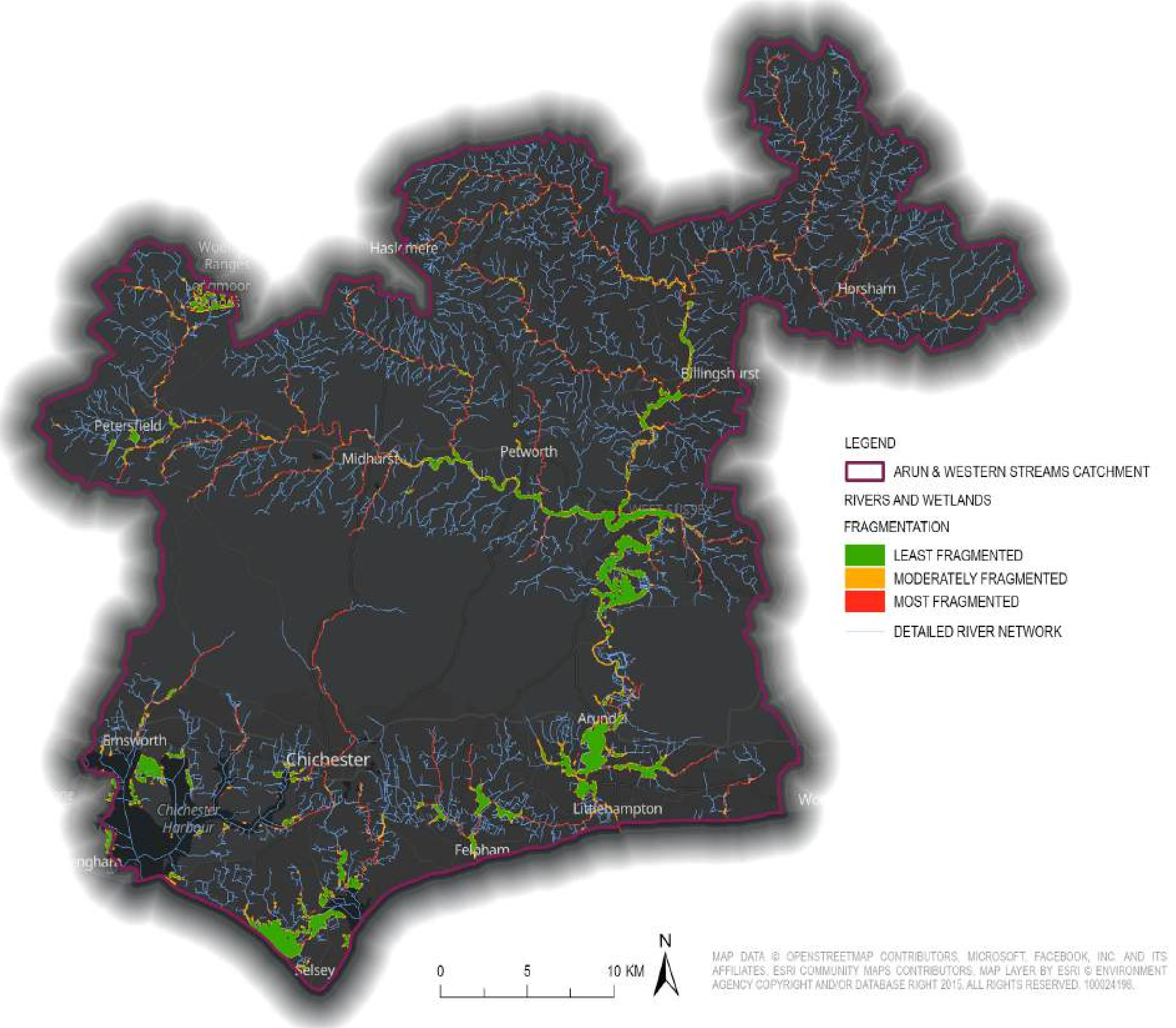


Figure 24.Map showing relative fragmentation for rivers and wetlands (coastal and floodplain grazing marsh, lowland fen, reedbeds, lowland wet meadows, purple moor grass and rush pasture, priority lakes) produced using the Natural England's Climate Vulnerability Tool. This uses habitat aggregation (weight x 6) and surrounding land use (matrix x 1) to derive fragmentation scores (0-3). Fragmentation for rivers uses all freshwater (flowing and standing) as the matrix discounting cells that include potential barriers to movement. Fragmentation for wetlands includes all freshwater and other priority habitat as the matrix. Each cell represents that highest scoring (most fragmented) habitat that is present.

Ecological Networks

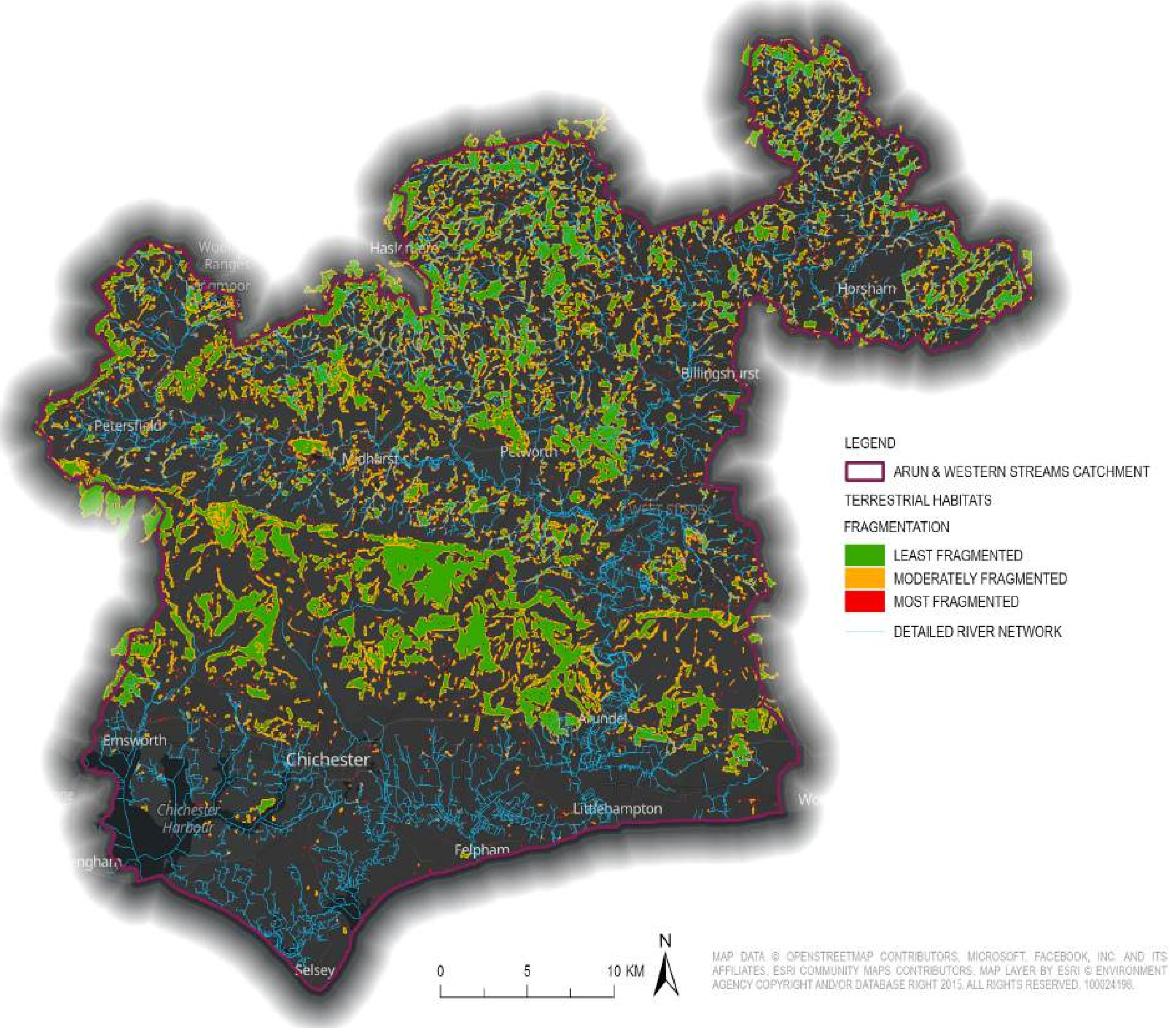


Figure 25.Map showing relative fragmentation for terrestrial habitats (deciduous woodland, calcareous grassland, lowland acid grassland, lowland heathland, lowland dry meadows) produced using the Natural England's Climate Vulnerability Tool. This uses habitat aggregation (weight x 6) and surrounding land use (matrix x 1) to derive fragmentation scores (0-3). This model used all freshwater (flowing and standing), all priority habitat types and all semi-natural habitat as the matrix and discounted natural habitat cells that included major roads. Each cell represents that highest scoring (most fragmented) habitat that is present.

PRESSURES

BARRIERS TO FISH

Fish often travel considerable distances between distinct habitats for feeding and growth, to find refuge from changing environmental conditions and/or to access suitable spawning habitat. However, many of our rivers have been modified by the installation of structures such as weirs and culverts which can impede the movement of fish between critical habitats and alter the hydrological conditions and habitat quality which further increases the degree of fragmentation along our watercourses.

There are approximately 240 structures recognised by the Environment Agency as being a potential barrier to fish and/or eels in our catchment. Many of our Western Streams including the Aldingbourne Rife, River Lavant and River Ems have tidal sluices/flaps at the seaward end, limiting the migration of anadromous species such as sea trout that migrate from the sea into our freshwaters to spawn and catadromous eels that migrate from our rivers to spawn out at sea. Large structures such as locks and weirs are also located along the upper river Arun and Western Rother which impede salmonids and other fish reaching high quality spawning grounds located in the rivers' headwaters and tributaries. The number of structures and average length of river between structures is provided for each WFD waterbody in Figure 26. This shows that all of our 35 WFD rivers are fragmented by structures with over half having an average distance of <5km between barriers.

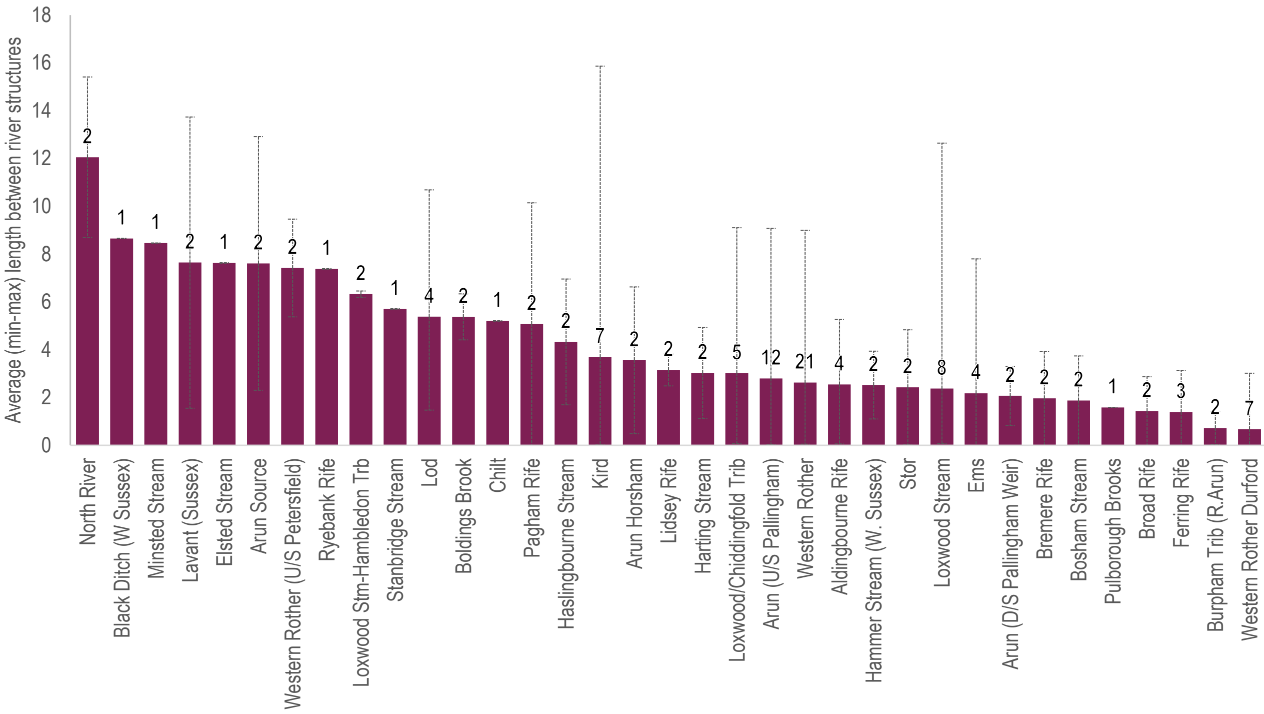


Figure 26.Chart showing the average length of river (+/- min and max) between structures for each of our 35 WFD waterbodies in the Arun & Western Streams.

NON-NATIVE (INVASIVE) SPECIES

A total of 75 invasive non-native species (INNS) listed under Schedule 9 of the Wildlife and Countryside Act (1980 as amended) are known to exist in the Arun & Western Streams catchment. Plants make up the highest proportion of species (n = 37) and of these, over a third are associated with freshwater where they are easily spread by flowing water or inadvertently by wildlife or people (Figure 27). Species such as Himalayan balsam *(Impatiens glandulifera)*, Giant hogweed *(Heracleum mantegazzianum)* and Japanese knotweed *(Fallopia japonica)* are particularly problematic along our riverbanks where they outcompete our native flora and leave the banks exposed overwinter making them vulnerable to soil erosion. Water fern *(Azolla filiculoides)*, New Zealand Pygmyweed *(Crassula helmsii)* and Floating pennywort *(Hydrocotyle ranunculoides)* are also present, and form dense mats on the water surface, depleting oxygen levels and light which threatens our fish and invertebrate populations.

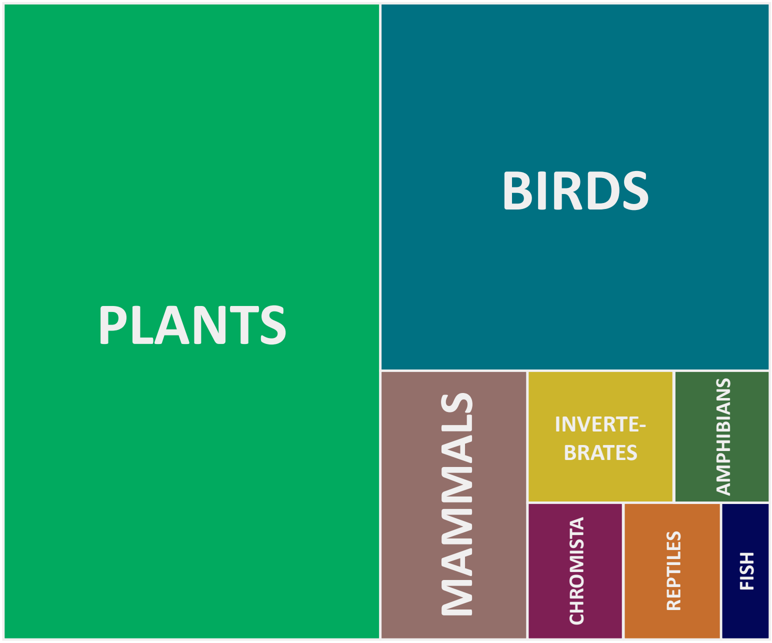


Figure 27.Tree map showing the relative abundance of records for major taxonomic groups of invasive species in the Arun & Western Streams Catchment

Some of our most vulnerable native fauna is also threatened by species such as American mink (Neovison vison) and Signal crayfish (Pacifastacus leniusculus). American mink are widespread across our catchment and have historically contributed to the loss of water voles in the Arun valley and continue to threaten populations across our Western Streams. In the Upper Rother, one of the last populations of white clawed crayfish in the south is believed to have been lost due to crayfish plague brought in by non-native signal crayfish that have slowly colonised this part of the catchment. Figure 28 shows the widespread problem of INNS within our catchment and highlights how our river corridors are particularly impacted due to their natural suitability as dispersal corridors.

Giant hogweed along the River Arun © R Baker

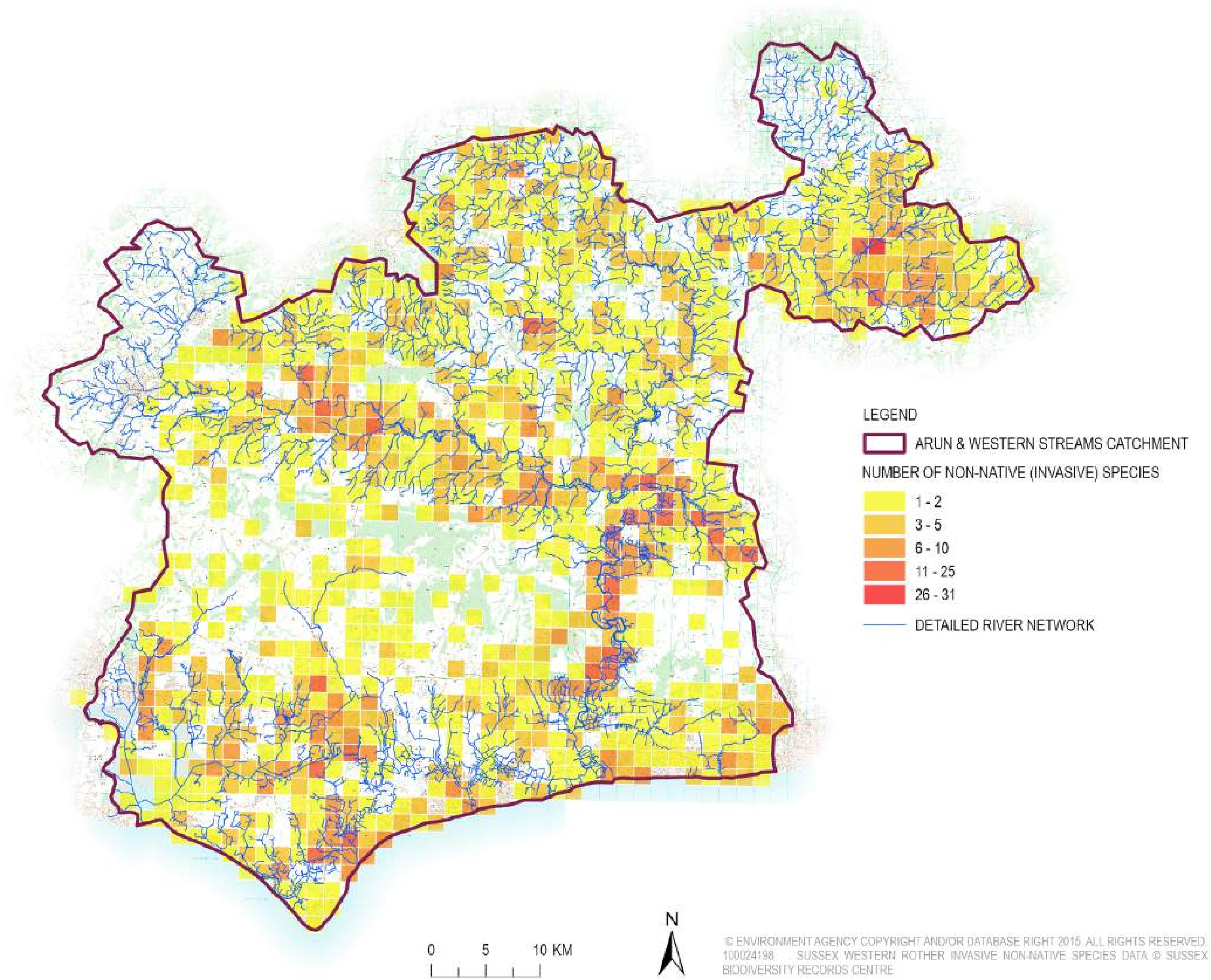


Figure 28.Map showing the the number and distribution of Schedule 9 non-native (invasive) plants recorded in the Arun & Western Stream catchment since year 2000.

CLIMATE CHANGE

Climate change presents a substantial risk to our biodiversity. Rising temperatures have already caused a northward shift in many species in the UK and we are seeing changes in the timing of life-cycle events such as flowering and leafing of plants and egg laying in birds. Whilst certain species and habitats are more vulnerable than others, it is expected that, as our climate continues to warm, we will likely see changes in survival, and the timing and success of reproduction, growth, and migration of individual species. This, in turn, will result in changes in communities and ecological processes which underpin our catchments biodiversity.

The risk posed by climate change on our species and habitats is further influenced by other pressures such as land use, habitat fragmentation, adverse management practices and recreational pressures. For instance, the northward expansion of species will be influenced by whether suitable habitat exists and is accessible (not fragmented by major barriers) as species shift their ranges in response to increases in temperature. Our coastal habitats will also be impacted to a greater extent where man-made sea defences restricts the landward migration of habitat in response to sea-level rise. Some of the main risks of climate change to our terrestrial, freshwater, and coastal ecosystems are summarised below.

Terrestrial Ecosystems

Species will continue to **shift to higher latitudes and altitudes,** both within the UK and internationally. This may benefit some species and lead to increases in diversity, however other species may be negatively impacted where their dispersal is limited or where suitable habitat conditions are not present (e.g. chalk grassland specialists).

Spring events will continue to advance and may lead to **phenological mismatches** in which the interactions between species such as pollination and competition no longer match up.

Drier summers **have affected species composition of semi-natural lowland grassland** with increases in plants that colonise bare ground such as field thistle and prickly ox-tongue.

Lowland heathland is threatened by reduced precipitation and by **increased fire risk** and could be **replaced by grasslands.**

Shallower rooted tree species such as **beech may be replaced by deeper rooted species** that are less sensitive to drought and **earlier tree-leafing may have adverse impacts on woodland ground flora**.

Mild winters and movement of species may **increase the spread and colonisation by non-native species, including pests and pathogens.**

Freshwater Ecosystems

Warmer, drier summers are likely to **increase the risk of low flows** in our rivers and reduced water levels will **exacerbate the impact of pollutants** on freshwater species.

More frequent periods of heavy rainfall **increases the risk of runoff/discharge of pollutants** into our rivers and wetlands, further degrading the quality of habitat for freshwater species.

Many freshwater species have a specific thermal tolerance range as they cannot regulate their body temperature independently. This makes them **particularly sensitive to changes in water temperature** which can alter their metabolism and associated physiological and life history traits.

Reduced precipitation is likely to impact wetlands which support species that are adapted to saturated conditions, either seasonally or all year round. **Lowland fens are particularly sensitive to changes in the quantity, quality and seasonality of water supply.** Drying out of wetlands may have major impacts on migratory birds.

Altered seasonal rainfall patterns may **change plant communities as specialist wetland species are outcompeted by generalist species** adapted to drier and/or fluctuating conditions. **Unseasonal summer flooding could also affect the breeding success** of waders.

Coastal Ecosystems

Increases in air and sea surface temperatures have and will continue to alter the range sizes and distribution of a number of coastal animals (e.g. the mollusc Osilinus lineatus).

Erosion due to sea-level rise and sediment depletion is steepening inter-tidal profiles which results in **more wave energy reaching sensitive habitats** such as saltmarsh.

Natural migration of intertidal habitats inland, in response to rising sea levels is limited by manmade coastal defences. This has and will continue to cause **significant loss of intertidal habitat and associated species** of overwintering birds and invertebrates which will further exacerbate fragmentation and limit opportunities for species to colonise new locations.

Warmer coastal waters may **increase the risk of harmful algal blooms and hypoxia** from eutrophication due to nutrient runoff from land sources. Rising sea temperatures also risk changing the timings of life-cycle events of dependent species, e.g. bivalves and phytoplankton.

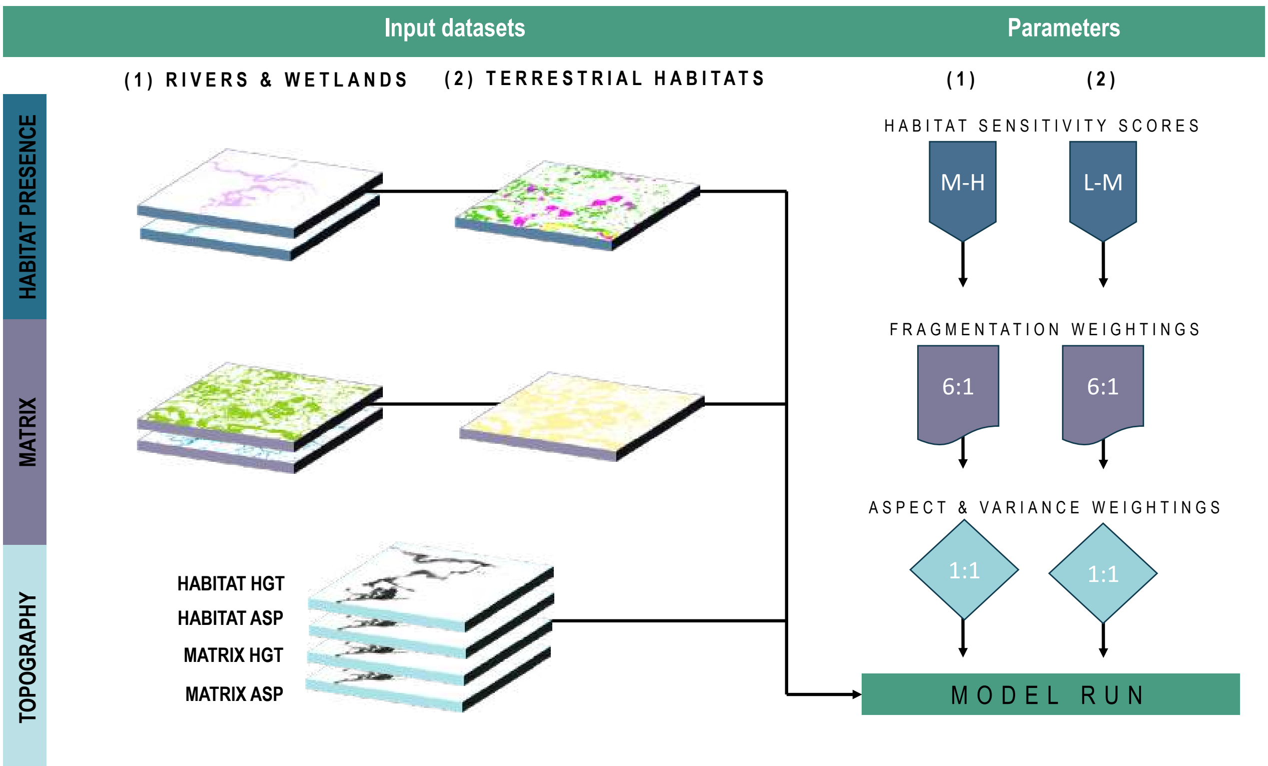
Habitats such as coastal grazing marsh and saline lagoons are at significant risk from sea-level rise and **increased saline incursion**, with consequences for modification of vegetation communities and implications for overwintering and migratory birds.

OPPORTUNITIES

We used the Climate Vulnerability Tool, developed by Natural England, to help identify areas of greatest opportunity for improving resilience of our ecological networks, particularly in the face of climate change. This tool uses data on the current distribution of our most valuable 'priority' habitats alongside drivers that are likely to affect each habitat's vulnerability to the expected changes in future climate. The model uses the following framework for considering the components of climate vulnerability:

- Sensitivity based on expert judgement and scientific literature
- Adaptive capacity including measures of:
    - fragmentation (habitat aggregation of priority habitat and landscape permeability (e.g. semi-natural habitat)
    - topographic variation (aspect and height of habitat and permeable intersecting land)
    - current management and condition (mitigated against other sources of harm, or not)
- Conservation value (designated for biodiversity, or not)

The layers used in the assessment were rasterised to 50m grid cells resolution and scored (1-0) based on their presence/absence within the catchment. The relative weightings of each component were set within the model which re-assigns each component scores and sums the values to obtain an overall score for the relative vulnerability of each habitat, or habitat group, to climate change. We chose to run one model that included all our priority habitats and a separate model for rivers and wetland habitats (excluding coastal/transitional habitats) and selected a suite of datasets for each habitat or habitat group that best represented landscape permeability, management, and condition. A full description of the datasets and method used for each model is provided in Appendix A.



The climate vulnerability map for rivers and wetlands is presented by area (cell) in Figure 29. This shows that the coastal grazing marsh in the Arun Valley and around Chichester and Pagham Harbours are particularly vulnerable to climate change. The individual component scores for these areas reveal that vulnerability is due to the habitat being characteristically homogenous in terms of aspect and height and is highly sensitive to climate change. These areas are also of high conservation value, supporting a significant amount of our catchment's biodiversity. Opportunities for increasing resilience of these area should focus on increasing the network to facilitate movement of habitats and species from climate change impacts (e.g. sea level rise and erosion).

The map also highlights that the rifes and rivers along our coastal plains and the rivers Kird, Arun Horsham and Rother upstream Petersfield, are also vulnerable to climate change impacts. Based on the component scores for each of these waterbodies, the main factors contributing to vulnerability include habitat fragmentation, unmitigated threats, and topographic homogeneity (coastal rivers and rifes).

The climate vulnerability maps for terrestrial priority habitat are presented by area (cell) in Figure 30. This shows that the most vulnerable areas are in the Upper Arun around Billingshurst and Horsham, along the River Rother Valley and on our coastal plains where only small, highly fragmented patches of terrestrial habitat exist.

Based on the highest mean component scores for the most vulnerable patches of each habitat, topographic homogeneity, unmitigated threats (deciduous woodland, calcareous grassland, and lowland dry meadows) and fragmentation (calcareous grassland and lowland meadow) are the main factors contributing to vulnerability. This suggests that actions that increase connectivity and improve management to mitigate other sources of harm would be most beneficial for improving climate resilience of our terrestrial habitats. Actions should also be focused on preserving our least vulnerable areas, such as the habitat network found across the South Downs National Park.

Macroalgea on mudflats at Prinsted Point © Bob Parks

Ecological Networks

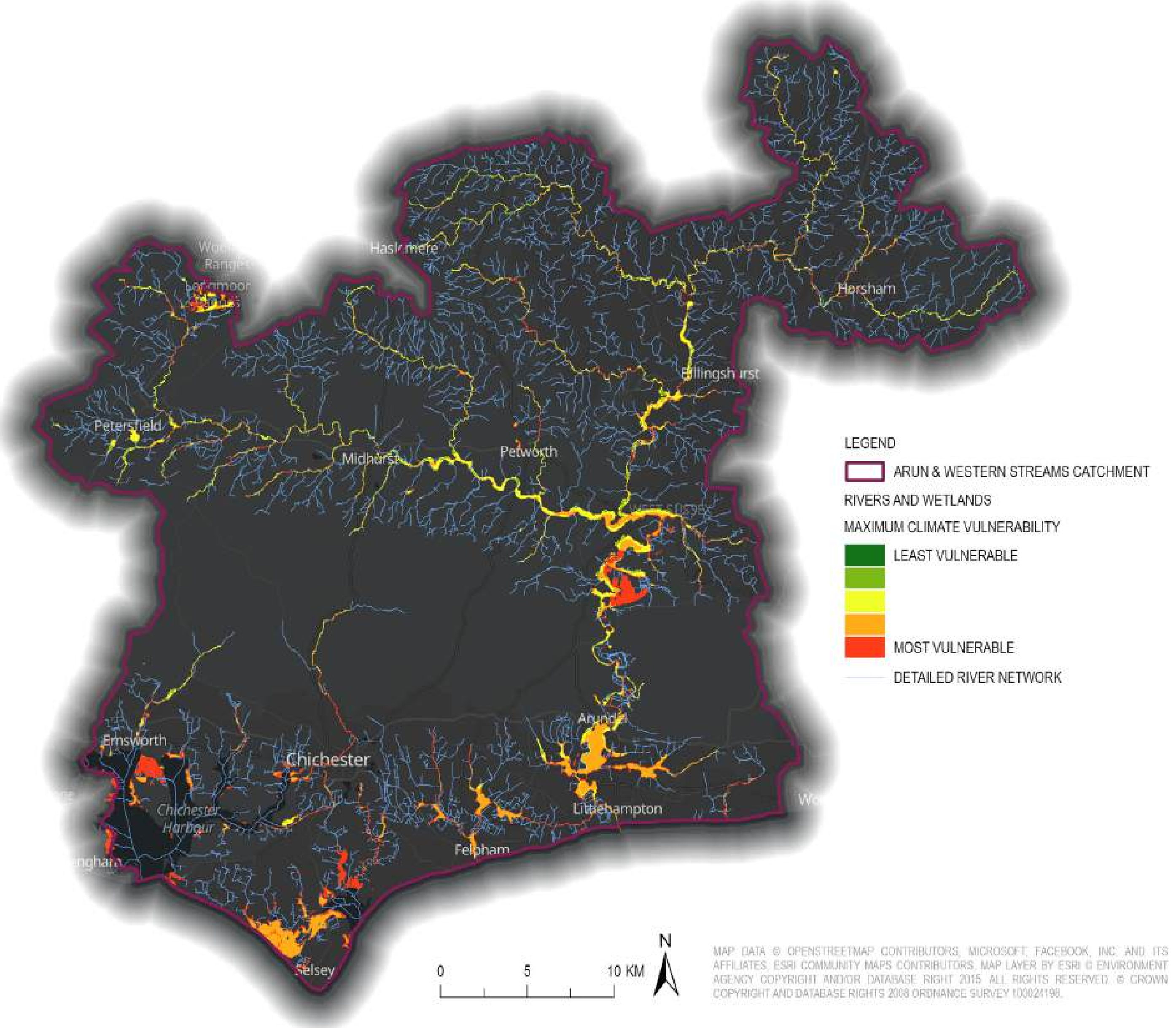


Figure 29. Detailed climate vulnerability map for rivers and wetlands (coastal and floodplain grazing marsh, lowland wet meadows, reedbeds, priority lakes, lowland fen) for the Arun & Western Streams Catchment at 50m2. Vulnerability is shaded green (low) to red (high) for the most vulnerable habitat overall in that cell where vulnerability is based on the sum of component scores for sensitivity, adaptive capacity (topographic heterogeneity, fragmentation, condition, and management) and conservation value.

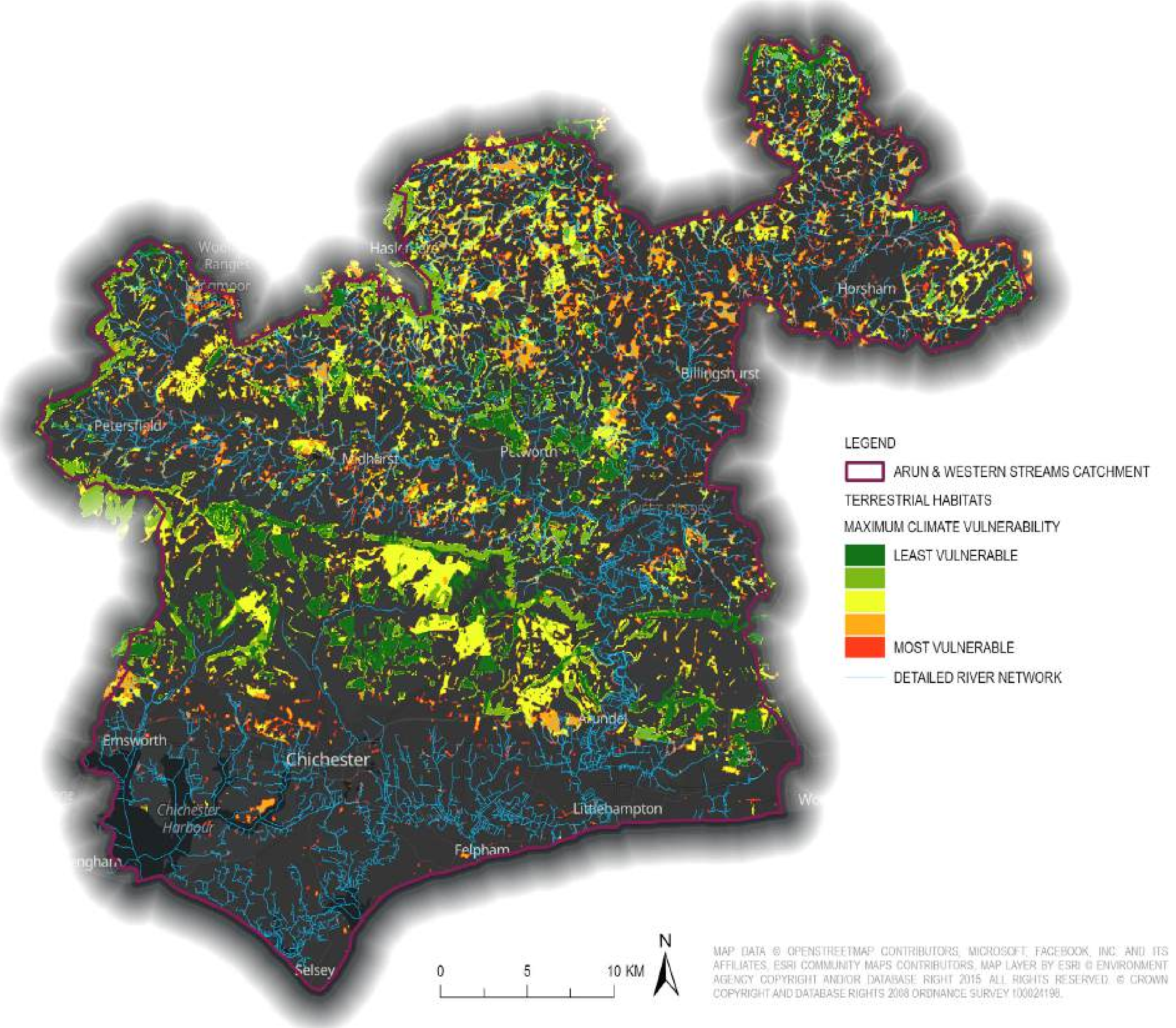


Figure 30.: Detailed climate vulnerability map for terrestrial habitats (deciduous woodland, lowland calcareous grassland, lowland heathland, lowland acid grassland, lowland dry meadows) for the Arun & Western Streams Catchment at 50m2. Vulnerability is shaded green (low) to red (high) for the most vulnerable habitat overall in that cell where vulnerability is based on the sum of component scores for sensitivity, adaptive capacity (topographic heterogeneity, fragmentation, condition, and management) and conservation value.

RESPONSE

Past and present projects:

1. Chichester tree project
2. Elm trees on the Manhood – river valleys
3. Walkover surveys of Upper Arun, Upper Rother and River Lod – INNS and wildlife
4. Chichester Ecological Corridors in Chichetser Local Plan
5. Portsmouth Water Biodiversity Capital grant scheme and WINEP biodiversity requirents on operational sites

New project ideas:

1. Volunteer public action groups – see ARK in Wiltshire for examples
2. INNS investigation and mitigation
3. Hedging our Future – 380km of missing or gappy hedges on Manhood Peninsula. MWHG has 2 locally sourced shrub and tree nurseries
4. Landscape recovery bid Arun Valley – TBC
5. LNRS contribution
6. MoRPH surveys by volunteers – modular rivers surveys
7. Joined up land advice/management to deliver in an area across organisations

Our Coast and Transitional Waters

CURRENT STATE

Our coastal zone stretches from Langstone to Goring on the mainland and encompasses a diverse array of features including limestone and sandstone reefs, coastal inlets, shingle spits, harbours, exposed coastal plains and the extensive alluvial floodplain and estuary of the River Arun. The fertile soils and flat terrain around our coast and estuaries support important managed ecosystems, and the economy is intricately linked to maritime and recreational activities such as sailing, boat-building, fishing and tourism.

> "Coastal and transitional waters are delicate and ever-changing environments that have significant ecological, geological, cultural and economic significance. Lying at the boundary between land and sea, they support some of the most diverse and productive ecosystems that include both terrestrial and freshwater, brackish and marine aquatic habitats"

HABITATS AND SPECIES

Chichester and Langstone Harbours sit on the western side of our coastal zone and contain a mosaic of narrow inlets and rithes that wind through extensive intertidal mud and sand flats, eelgrass Zostera spp. beds and large areas of mixed saltmarsh and Spartina swards. The harbour is fringed by shingle spits and beaches, sand dunes, lagoons, reedbeds, coastal grazing marsh and woodland, making it amongst the most diverse harbours of its size in the UK. The area supports important overwintering populations of migratory wildfowl, over 200 maritime taxa and is one of the only known rookery of harbour seals and grey seals in the Eastern English Channel.

Bracklesham Bay lies to the east of the harbour and forms the western side of the Manhood Peninsula, a highly fertile coastal plain valued for its agriculture and for its impressive network of ditches, rifes and ponds that support a significant population of endangered water voles. The bay is dominated by shingle banks and is adjoined by rough unimproved grassland, rifes and reedbeds that support lapwings and wintering fowl and short-eared owls. The coastline has been realigned at Medmerry, creating 183Ha of new intertidal habitat, reedbeds, freshwater ditches and ponds.

Off the coast of Bracklesham Bay there are a number of features and habitats of conservation importance including the **Bracklesham Balls** (large spherical/hemispherical boulders), **The Hounds** (limestone outcrops) and the **Utopia reef.** These support a wide variety of species including fragile sponges, anemone, sea squirts and soft corals. The Utopia reef is thought to be an important pupping ground for Tope Sharks.

Selsey Bill lies at the southernmost tip of the Peninsula and is well known for its marine biodiversity. Short-snouted seahorses, squat lobsters and craps as well as bottlenose dolphins have been recorded here. The **Mixon Hole**, a dramatic 20m drop in the seafloor associated with an ancient river gorge is located approximately 2km off Selsey Bill. A popular dive spot, this sits supports numerous species including lobsters, crabs, gobies, slipper limpets and sea squirts.

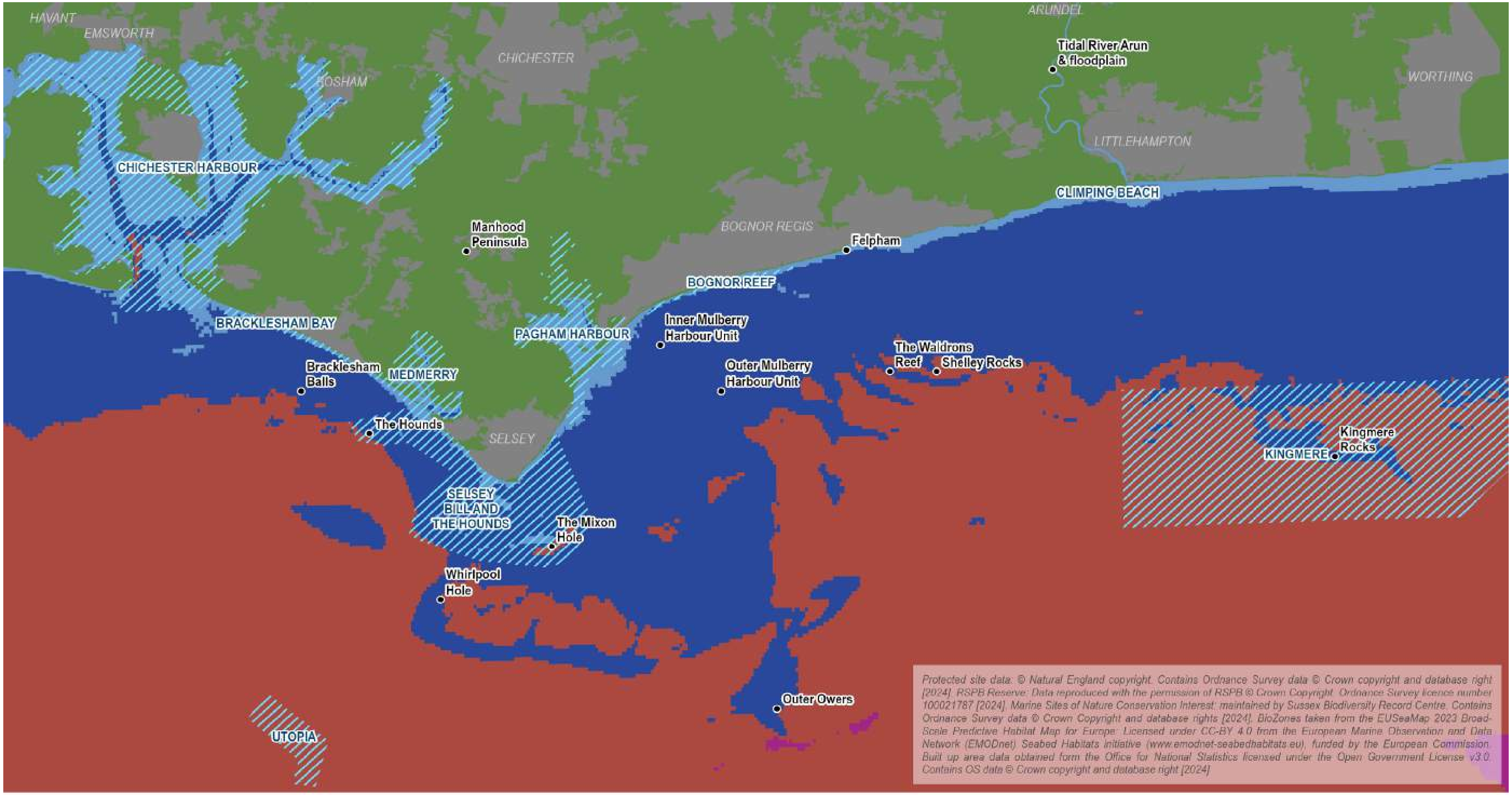
Pagham Harbour lies on the western side of the Peninsula which is the start of the stretch of coastline known as the Sussex Bay. The Harbour is a tidal inlet that supports a range of protected habitats including shingle spits/islands, saltmarshes, mudflats, seagrass beds and coastal lagoons. It is one of only three places in the UK where the exceptionally rare Defolin's Lagoon Snail occurs and is also home to sea anemones, native oysters and eels. The Harbour is protected by two dynamic shingle spits that are continually changing in response to the tides, waves and storms.

The **Bognor Reef** lies on the eastern boundary of the Harbour and supports extensive areas of vegetated shingle and remnants of a historic sand dune system. The foreshore comprises London Clay and sandstones and are key sites for plant and invertebrate fossils. Also of interest is the shoreline at **Felpham** which is only one of three in Britain to have fossils of flora dating to the Paleocene (56-66 mya).

The tidal **River Arun** enters the sea towards the east of our coastal zone. The river here is heavily modified for flood defence, however coastal marshes adjoining the river support a variety of dragonflies, water voles and birds including mute swans. **Climping Beach** lies on the western side of the estuary and has one of only two sand dune systems in West Sussex and supports important populations of sand lizards and four nationally scarce burrowing bees and wasps. It is also of high recreational value owing to the long sandy beach which is relatively rare along the Sussex Bay coastline.

Hidden beneath the waves of the Sussex Bay there are a numerous features and habitat mosaics that are rich in marine life. **Kingmere** has some excellent examples of rocky habitat and one of the most important spawning sites for Black seabream in the UK. Extensive areas of sandstone bedrock outcrops and boulders are also present at the **Waldron Reef** which support a variety of sessile organisms including sponges, soft coral, sea squirts and dead mans finger. A mix of rocky and soft sediment at the close-by **Shelley Rocks** support a particularly rich variety of animals including slipper limpets, sand mason worms and crab species and approximately 10km off the coast of Selsey Bill is the Limestone Reef of the **Outer Owers** where the seabed drops steeply from 0-67m.

A map showing the distribution of our natural assets is provided in Figure 31.



Marine & Coastal Conservation Areas

These areas include some of our most important coastal and marine habitats and species. These areas are protected or managed for conservation and include Marine Conservation Zones, Sites of Special Scientific Interest, Special Protection Areas, Special Areas of Conservation, RAMSAR Wetlands, RSPB Reserves

• Important features & landscapes

These include Marine Sites of Nature Conservation Importance (mSNCIs) which are non-statutory sites identified on account of the special interest of their marine habitats, the fauna and flora, or for unusual geological and geomorphological features. It also includes landscapes that provide connectivity and habitat for coastal species.

Intertidal/Littoral zone

The intertidal/littoral zone is the area closest to the coast and includes a variety of habitats, such as rocky shores, sandy beaches, soft sediments, salt marshes, sea grass beds and mussel beds.

Infralittoral Zone

The infralittoral zone is is the shallow sub-tidal or tidal area below the mean water level where there is sufficient light to support seaweed communities such as kelp forests. The lower limit has traditionally been considered to coincide with 1% light penetration

Circalittoral Zone (Shallow & Deep)

The Circalittoral zone is the area where there is insufficient light to support vascular plants and green algae. This zone is subject to tidal streams and is typically dominated by fauna including sponges, hydroids, bryozoans and barnacles. The deep circalittoral has insufficient light for photosynthesis.

Figure 31.Map showing the distribution of important sites for conservation across the Arun & Western Streams coastal zone

FISHERIES

Our coastal zone is an important resource for both commercial and recreational fishing. Most commercial fishing boats that operate off the Sussex coast are <10m in length and operate inshore, usually within six nautical miles off the coast. These boats land their catch daily using a variety of methods including gill, trammel and entangling nets and to a lesser extent, trawling, beam trawling, pair trawling, drift netting and scallop and oyster dredging. We also have an important potting fishery for whelk, lobster, brown crab and cuttle fish. Most of the fleet are multi-purpose, operating throughout the year in pursuit of whichever stock (and or quota) is available during the season. For example, sole are fished in spring and autumn, bass are targeted in summer and cod in winter.

Until recently Chichester Harbour contained our only classified oyster bed, supporting a small scale commercial fishery. Unfortunately, despite a Byelaw introduced to limit population decline by stopping fishing when numbers dropped below a set level, the fishery was closed in 2022 as oyster numbers were so low.

RECREATION

The diversity of natural assets across our coastal zone attract millions of visitors each year and provide a wealth of recreational opportunities. Our extensive network of footpaths, designated cycle routs and byeways connecting our coastal reserves provide important access to nature and seascape views. Chichester Harbour is one of the country's most popular recreational harbours in the UK with a resident fleet of over 12,000 leisure vessels. An estimated 25,000 people enjoy the harbours waters for racing, cruising and fishing each year. Our bass and Black seabream populations attract recreational fishing by shore and boat anglers and our locally strong population of Undulate Rays sees fishers travel to the district to target (catch & release) this species as it is endangered and nationally rare. Selsey Bill is a popular spot for diving, with over 100 wrecks that attract a rich diversity of sea life, and the rocky shoreline at Bognor is popular with fossil hunters.

PRESSURES

Our coastal environment is under increasing pressure from a number of complex and interconnected environmental and anthropogenic factors which, together, are impacting on the rate and scale of biodiversity loss within coastal habitats.

HARD DEFENCES AND COASTAL PROCESSES

Hard sea defences such as sea walls and revetments cover approximately 65% of our shoreline and have shaped the character of our coastal zone, allowing land that would otherwise be eroding and shifting in response to sediment accretion, to be fixed and claimed for agriculture and human development. Today, our sea defences play a critical role in protecting communities and important infrastructure from coastal flooding and erosion. They also help safeguard landward priority habitats such as coastal grazing marshes and wetlands that make up our network of internationally important sites for nature conservation.

The construction and maintenance of coastal defences, however, is economically expensive and has deleterious effects on our coastal ecosystems and do not contribute equivalent services to the natural habitats they replace. The hardened faces of shoreline structures can increase energy at the shoreline by reflecting waves. This increases nearshore erosion and deepening of the littoral zone resulting in a loss of intertidal and shallow-water habitats. The associated erosion also increases suspended sediments that reduce growth and survival of submerged aquatic vegetation such as sea-grass beds that provide important habitat for small fish. Defences can also eliminate or reduce natural sediment supply which nourish and replenish naturally eroding coastal habitats such as dunes, shingle, and saltmarsh. They also prevent the landward migration of habitats in response to rising sea levels, a phenomenon known as "coastal squeeze". This leads to a loss in habitat extent, affecting a myriad of dependent species as well as the capacity of these habitats to provide natural coastal defence.

Natural England estimates that Chichester Harbour has **lost 58% of saltmarsh** habitat since 1946 and that it **continues to lose 2.54ha per year.** Coastal squeeze is a significant factor contributing to this loss and its impact is predicted to increase as sea levels rise at an accelerating pace.

As flood risk is expected to increase in the future as a result of rising sea levels, wave energy, storm surges and higher rainfall events, there is a strong demand to maintain and/or improve coastal flood protection for the benefit of people and wildlife. Yet at the same time, our intertidal habitats that help protect our coast by attenuating wave energy are under increasing threat from the same forces. This places our coastal partners in a juxtaposition of how to protect communities and habitats on the hinterland without an ecological cost on the seaward side.

This is particularly pertinent as existing sea walls begin to fail (such as highlighted in the recent report on Apuldrum Meadow and which states that "much of the sea defences [in this area] are failing"), raising opportunities for new approaches to coastal management to be investigated. Whilst the majority of recommendations within the current Shoreline Management Plans are to hold the existing line of defence through ongoing management and maintenance, opportunities for realignment are highlighted along the east coast of the Manhood Peninsula and to the west of Littlehampton at the mouth of the River Arun. These are big projects requiring multi-stakeholder decision making which will shape and impact the coastal area of our catchment into the future and will need to balance the benefits which each option provides (e.g. increase in coastal habitat, flood mitigation) against the cost and impacts associated with them (e.g. disruption to public access routes, loss of agricultural land).

Figure 32 shows the extent of existing hard defences in relation to intertidal and terrestrial coastal habitats.

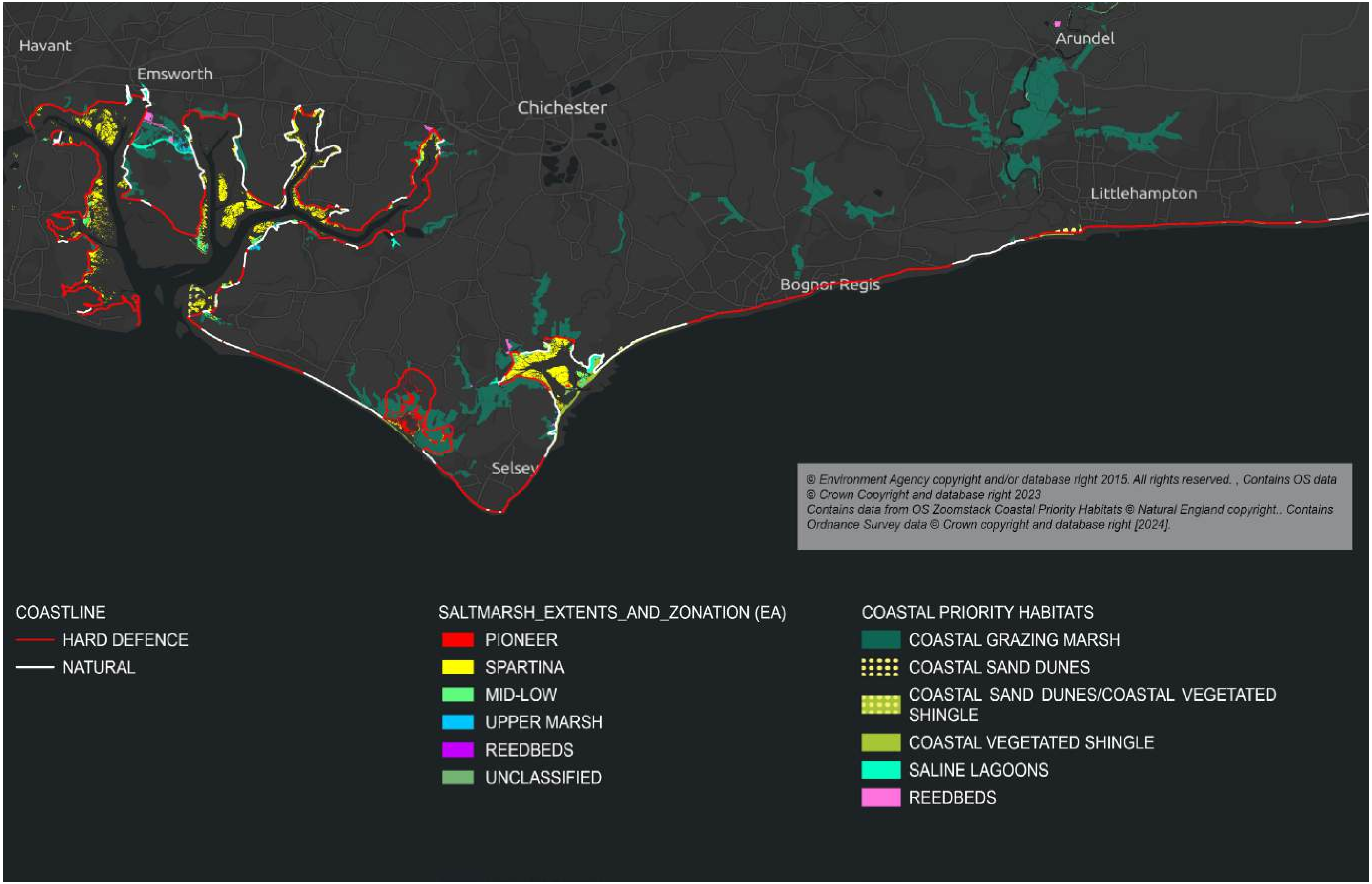


Figure 32.Map showing the distribution of hard sea defences (sea walls, embankments, revetments), saltmarsh extent and coastal priority habiat on the landward side of defences.

WATER QUALITY

The most recent assessment of our coastal and transitional waters (Cycle 3, 2022) showed that three of five transitional and coastal waters assessed for physico chemical status (measured as Dissolved Oxygen and Inorganic Nitrogen) were failing to achieve good status. This includes Chichester and Pagham Harbours and the Solent. Pollutant inputs into our coastal zone include public and private sewage discharges of both treated and untreated effluent, agricultural, industrial, and infrastructure runoff from across the catchment area reaching the coast via our rivers and streams, and the high level of human activity (e.g. leisure boating). These sources contribute to a range of contaminants including bacteria, nitrates, chemicals & metals and microplastics that each have a direct impact on the health of our coastal environment.

Bacteria

Microbial pollution (bacteria and other microorganisms) of coastal areas can harm aquatic wildlife as well as human health, thus reducing the benefits that coastal environments provide to the community. The Environment Agency monitor bacteria (including E. coli and intestinal enterococci) that indicate whether there is faecal matter in the water across nine designated bathing water sites along our coast to ensure our coastal waters are safe for swimming and other activities.   Since 2020, eight of our bathing waters have achieved good or excellent water quality standards, whilst Bognor Regis (Aldwick) received Poor quality in the last two years (2022/23) meaning that the water has not met the minimum standard. You can view live Bathing Water Status information on the Environment Agency's Swimfo app. Bacteria is also of particular problem for shellfish which bioaccumulate and concentrate bacteria through their filter feeding habits leading to disease and mortality as well as presenting risks to human health from their consumption. Chichester Harbour is designated as a shellfish water and despite predominantly “excellent” results from bacteriological water testing (when measured against Bathing Water Directive standards) E. coli appears to show up more readily in shellfish, filter feeding on the seabed. In addition a recent study, led by the University of Exeter and involving researchers from the University of Portsmouth, found two Vibrio species that have never been recorded in UK waters before. This increase in diversity of Vibrio species along our coast is likely to increase as sea temperatures rise, creating conditions under which these bacteria thrive.

Nutrients

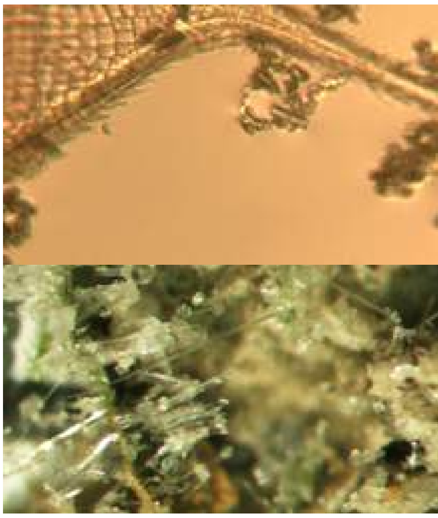
Coastal nutrient input, in particular nitrogen, have been shown to have direct effects on coastal habitats and is impacting the ecological status of Chichester and Pagham Harbour and the Solent. Nutrient enrichment results in the excess reproduction of epiphytic algae and macroalgae. This can outcompete and inhibit photosynthesis of seagrass habitat which, when healthy, provide shoreline stabilisation and function as important nursery and foraging habitat for a range of fauna. Excess nitrogen can also lead to destabilisation of saltmarsh and cause changes in sediment structure and deposition of mudflats leading to changes in benthic fauna and prey availability for bird populations.

Chemicals and metals

Chemicals and heavy metals come from a mixture of industrial, agricultural, boating and wastewater treatment activities. Of particular concern are chemicals that interfere with endocrine (or hormonal) systems causing reproductive and behavioural problems that limit the production of fish and mollusc along our coast. These include flame retardants known as Polybrominated diphenyl ethers (PBDEs), pharmaceuticals, antibacterium (commonly used in soaps and shampoos), chemicals used in plastics and food storage materials, fungicides, and pesticides. All seven of our transitional and coastal waters have elevated levels of PBDE's.

Marine litter, microplastics and microfibres

Marine litter can include anything from plastics, metals, timber, rope, fishing gear and, of particular concern, their degraded components that include microplastics and microfibres that are ingested and retained by marine organisms. The University of Brighton have studied microfibres extensively in Chichester Harbour's waters and sediments and have identified 10,000 microfibres per litre on the surface of the harbour. They also identified 7000 microscopic pieces of boat fibreglass in oysters at Chichester Harbour and that particulate glass and plastics accumulate in the stomach of shellfish which can block their intestinal tracts leading to death through malnutrition and starvation.



Top shows microplastics attached to the tail of water fleas, increasing their weight and ability to swim © C. Ciocan Bottom shows fibreglass shards present in sediment at Chichester Harbour © C. Annels.

SHORELINE MANAGEMENT

Dredging

Dredging impacts marine organisms through entrainment, habitat degradation, noise, remobilization of contaminants, and increasing concentrations of suspended sediment. Within our Catchment approximately 13,000m³ of sediment is removed from Chichester Harbour annually and deposited to the east of the Isle of Wight. Whilst this facilitates navigation there is insufficient sediment to sustain normal salt marsh growth, a key factor in the downgrading of the SSSI to unfavourable, declining condition. A new project being delivered by the Chichester Harbour Protection and Recovery of Nature (CHaPRoN) is trialling Beneficial Use of Dredged Sediment (BuDS) within the harbour to restore salt marsh habitats, offsetting the impact of this essential maintenance of the harbour.

The mouth of the River Arun is also dredged and the impacts of this are similar to those offshore. Much of the material dredged from the river mouth accumulates from longshore drift of shingle and is recycled for coastal defence works in the immediate area. Beach recycling impacts the natural supply of sand and shingle to beaches downdrift of the extraction point and if undertaken to excess, can lead to shoreline retreat and flooding. However, alternative methods of maintaining coastal defences, such as beach renourishment, require the dredging of the seabed for marine aggregate to be brought to shore which exerts negative pressures on the marine environment.

HUMAN DISTURBANCE

Our coastal zone provides a diverse mix of recreational opportunities which provide important health and well-being benefits for people as well as supporting the local economy, yet human activities can place pressures on our coastal environment in a number of ways.

Disturbance by recreationists can affect habitat composition as well as impacting sensitive wildlife such as seals and birds. Research by Bird Aware Solent found that 47% of all 'major flights' (birds flying more than 50m to escape) of wintering birds on the Solent Coast was caused by interaction with dogs. This escape behaviour can have strong fitness implications by causing birds to move away, reducing in the amount of food eaten, and impacting on the bird's energy reserves. If disturbance is substantial, birds may move to less disturbed areas causing higher density and competition for available food. Non-motorised watercraft including small sailing boats and paddlesports can also cause visual disturbance of fish, including sensitive species such as basking shark

Recreational Boating

Chichester Harbour has a resident fleet of c.12,000 leisure vessels with approximately half being larger vessels at the 2,000 marina berths and 3,200 swinging moorings in the harbour making it one of the busiest recreational harbours in the UK with 25,000 visits annually. The popularity of the area for recreational boating exerts pressure on the marine environment from pollution (boat cleaning and waste disposal), increased turbidity, and physical damage from anchoring and mooring.

Anchoring and mooring can cause abrasion/disturbance to the seabed and penetrate the substratum below the seabed, disturbing and eroding subsurface habitat. In addition, anchors can damage seagrass fronds and roots when embedded and uproot plants through dragging along the seabed. Once moored, anchor chains can scrape the seabed as they pivot around the anchor point with changes in wind direction and tide. These impacts erode the seabed making it unsuitable for future colonisation by marine species.

A further impact of recreational boating is the risk of introducing invasive non-native species to the catchment area, many of which will go undetected until populations have expanded beyond the point where eradication is a viable option.

Non-motorised watercraft

This includes small sailing boats and paddlesports such as kayaking and SUPing. The main impacts from non-motorised craft are due to their ability to access shallow waters causing abrasion of intertidal and shallow subtidal habitats from trampling, grounding, and/or dragging equipment during launch/recovery. These watercraft can also create visual disturbance of fish (sensitive features such as basking shark), marine mammals, and birds, along with above water noise disturbance relating to user noise during launch or activity.

Onshore Recreation

The primary pressure from onshore recreation is the trampling of vegetation by walkers, beach visitors or those accessing the water, which can impact habitats such as vegetated shingle, salt marsh, and sand dunes. These habitats rely on vegetation for stability, the provision of nutrients to the ground and the capture of sediments and sand which increases their resilience. Trampling reduces vegetation structure and cover increasing vulnerability to erosion. The impacts of trampling are exacerbated by dog walkers as dogs will often leave formal pathways running across wider areas of habitat creating disturbance to the ground and a variety of sensitive species, particularly on breeding and over-wintering birds.

Other onshore activities such as bait digging and hand gathering of species such as clams, cockles and mussels for fishing removes large volumes of shellfish annually from Chichester Harbour, potentially impacting on food resources and population viability of target species. Recently new by-laws, restricting the levels of removal, have been introduced by Sussex IFCA. Additionally, the collection of bait can cause bird disturbance and create desire lines/trampling across sensitive habitats not impacted by other recreational users.

OPPORTUNITIES

There are already a wide range of actions are being implemented by our catchment partners to address coastal pressures particularly around the area of Chichester Harbour or through involvement in projects across the wider Solent or South Coast area (see Responses). Unlike previous chapters, modelling and mapping of opportunities within the marine and coastal environment is complex and unlikely to produce meaningful actions. Here we assess gaps in current focal areas to highlight where future opportunities exist to compliment or enhance existing workstreams.

Assessment of the 18 projects emphasised by the catchment partners indicates that over half (11) have habitat creation, enhancement or connectivity as a core focus, whilst four are directed at water quality. Many of these projects span multiple topics as shown in Figure 33.

Figure 33. showing the focus areas of 18 active projects currently being delivered in our coastal zones by our coastal partners. Boxes are scaled by the number of projects that had that core focus.

When looking at current actions against identified pressures there are apparent gaps, and therefore, opportunities to develop focal areas for future response.

There is a desire amongst partners to bring the successes of other catchments to our area and one such example is the Poole Harbour Nutrient Management Scheme which uses the Environment Agency Nitrate Leaching Tool for annual farm audits combined with targeted funding and a nutrient trading scheme to achieve targeted nitrate levels at a catchment scale. Nutrient trading has also been successfully implemented for levels of phosphate within the Wye & Usk Catchment and these examples could set a pathway for a similar scheme across the Arun & Western Streams.

It is clear that human behaviour is a major contributor to the degradation of the marine environment and whilst some of the current responses have an engagement angle there is the opportunity to create joined up, multi-faceted, awareness raising materials and events which are relevant and accessible to all recreational users of the area. Positive engagement to instigate behavioural change at scale can be complex and the expertise within the partnership is well placed to create a communication plan which strives to achieve consistent messaging in a co-ordinated manner which cuts across all areas of interest.

Invasive Non-Native Species pose one of the biggest threats to global biodiversity and have a significant economic impact resulting from the cost of management and damage to infrastructure. Whilst the Solent Forum website hosts a Biosecurity Action Plan for our area this could be co-developed into a user friendly and accessible format by building on existing messaging (Check, Clean, Dry) to increase awareness and implementing a biosecurity code of conduct for all recreational and commercial users of the marine environment. Developing monitoring protocols within the marine and transitional waters (e.g. settlement panels) will enable rapid response to species entering the catchment and enable cross-catchment collaboration in understanding and tackling the growing threat from INNS along the south coast.

There will undoubtedly be many more opportunities to expand upon or compliment existing responses to coastal pressures over the next 10 – 20 years as the impacts of sea level rise, warming temperatures and coastal squeeze become ever intensified and maintaining connections with wider coastal and marine projects will ensure that the Partnership can respond to emerging pressures and pilot new ideas into the future.

RESPONSE

Past/present projects (see interactive graphic overleaf):

1. Sussex Bay Initiatve
2. Sussex Kelp Recovery
3. Chi Harbour Salt Marsh Restoration Trail (BuDs)
4. Solent Seagrass Retoration Project
5. IFCA Fishing byelaws
6. Return of the Terns
7. Project RedPol
8. 3-Harbours Project
9. Abandoned Boats
10. ReMeMaRe Restoring Meadows, Marsh and Reefs
11. Habitat Compensation and Restoration Project (HCRP) formerly Regional Habitat Compensation Programme

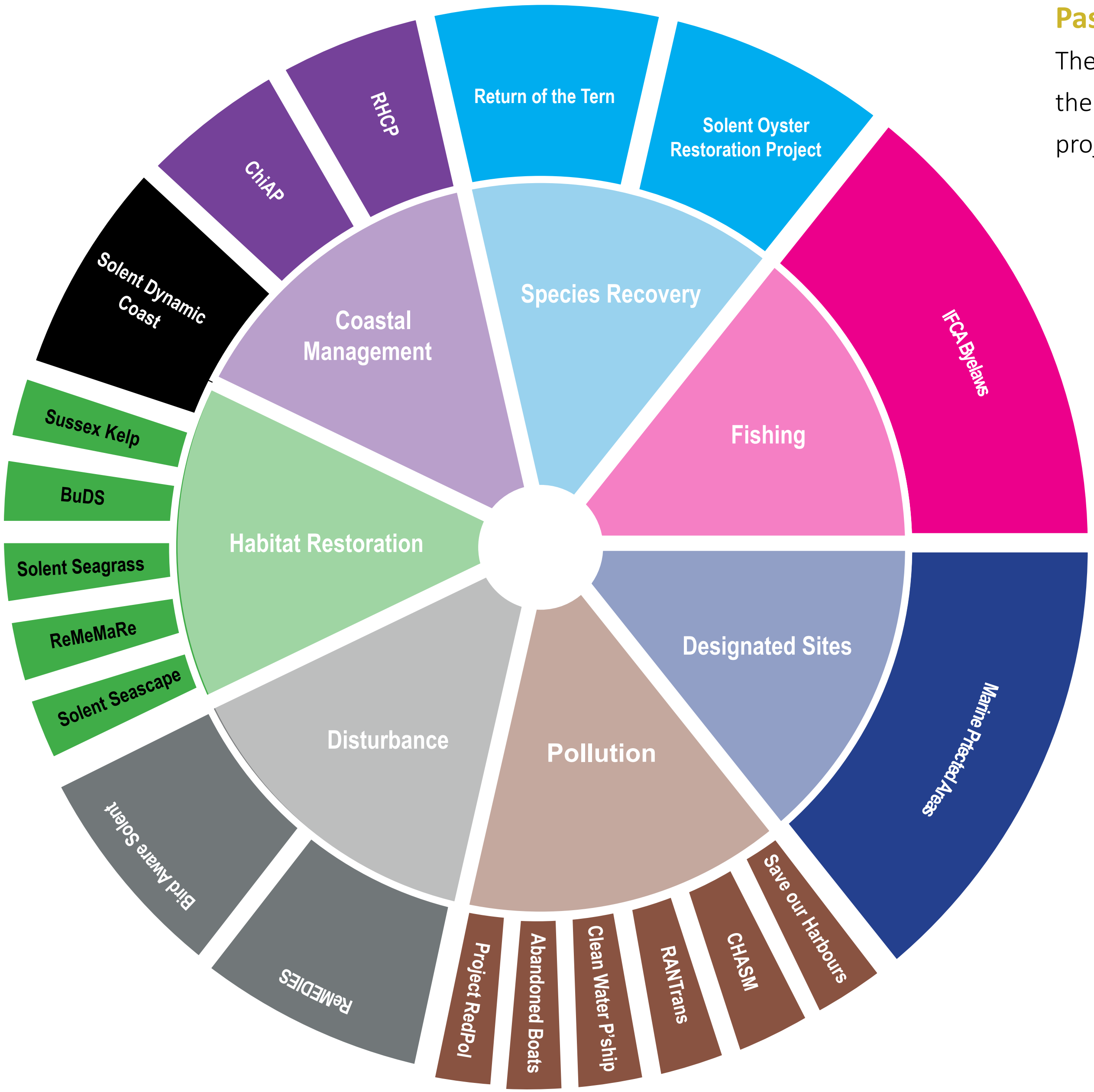
12 Solent Oyster Restoration Project

13. CHOPI – Chichester Harbour Oyster Partnership Initiative
14. CHaPRoN – Chichester Harbour Protection and Recovery of Nature
15. The Solent Seascape Project
16. Solent Dynamic Coast Project
18. Bird Aware Solent
19. Downs and Harbours Clean Water Partnership
20. Reducing and Mitigating Erosion and Disturbance Impacts Effecting the Seabed (ReMEDIES)
21. Rapid reduction of Nutrients in Transitional Waters (RaNTrans)

New project ideas:

1. Coastal sites have some of the best opportunities for public engagement as generally have higher recreational users
2. Video journey form source to coast highlighting issues and wins along the way (education!)
3. Interact with coastal recreational users to educate about fragility of habitats
4. Invite coastal action groups to these meetings to build relationships and awareness

Coastal & Transitional



Past and Present Projects

There have and continue to be a wealth of projects that are addressing the issues facing our coastal zone. Use the graphic on the left to select a project to learn more.

Close information panel