Landscape opportunity and ecosystem services mapping in the South West Peak

Natural Capital Solutions

SOUTH WEST PEAK
LANDSCAPE AT A CROSSROADS

Landscape Opportunity and Ecosystem Services Mapping in the South West Peak

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Executive summary

The South West Peak (SWP) is an area characterised by a high moorland core flanked by sloping hills, dissected by steep-sided cloughs, descending into lower pastoral landscapes. This distinctive area and its important habitats (e.g. open moor, heathland, and wet rush-pasture) is vitally important for birds of conservation concern (e.g. curlew, snipe and lapwing), and over 5500 ha of the area has UK and EU statutory nature designations (SAC, SSSI, SPA). It is an important area for tourism and recreation due to the extensive open access, network of footpaths, views and tranquillity. Agriculture, upland livestock and some dairy, is a significant land use and important employer in the area, although it is a marginal area with poor grade soils.

The Landscape Opportunity Mapping (LOM) project was commissioned by the South West Peak Landscape Partnership (SWPLP), to deliver an assessment of current and potential habitat opportunity and ecosystem services provision to inform their application for Heritage Lottery Fund (HLF) Landscape Partnership Programme funding. An objective of the HLF SWPLP project is to enhance multiple ecosystem services in the landscape across the 17 sub-projects that are being proposed. The aim of the LOM project was to undertake habitat opportunity mapping of key habitats, and to map the supply (capacity) and demand (beneficiaries) of ecosystem services to answer a specific set of questions (see p.3). This was done using EcoServ, a GIS toolkit, and bespoke modelling.

The natural capital assets (current habitats present) of the SWP were assessed and a base map created from which habitat opportunities and ecosystem services could be mapped. This was achieved using EcoServ, a toolkit developed by the Wildlife Trusts, with bespoke modifications, with MasterMap polygons as the underlying mapping unit. OS vector maps, BAP habitat data, local wildlife sites data, Corrine European habitat data and an urban layer were used to classify each polygon to a specific habitat type. A 5km buffer around the SWP area was used for all analyses. Maps 2-4 (p. 7, 9-10) show the key semi-natural habitat groups, habitat for biodiversity and key historical and archaeological sites. Bog habitats occupy a central and fairly compact swathe of the SWP, and these are typically surrounded by heathland and semi-natural grasslands. Wet grassland is common in the southern half of the SWP, and broadleaved and mixed woodlands are found towards the edges of the core area and widely spread in the buffer zone. The habitat for biodiversity (BAP and wader habitats) and historical sites demonstrate important constraints for habitat creation.

Habitat opportunity mapping used a GIS approach to identify (i) opportunities to expand habitat for biodiversity in areas that are ecologically connected to existing habitat networks, and (ii) to promote habitat features that can attenuate surface water runoff and so reduce downstream flood risk. The mapping for biodiversity enhancement produced maps of landscape permeability, habitat networks, constraints to habitat creation, and habitat opportunity for five key habitats (heathland, mire, semi-natural grassland, wet grassland and woodland). The mapping for surface water attenuation focused on floodplain woodland opportunity and riparian attenuation features. The opportunities for biodiversity enhancement and runoff attenuation were then combined to highlight areas that could deliver multiple benefits.

Seven ecosystem services were mapped (carbon storage, water flow, water quality, agricultural production, tranquillity, accessible nature and green travel) using EcoServ and bespoke models. These were thought to be services that were highly relevant to the natural capital assets of the SWP region. The supply of all services was mapped, and the demand was only mapped where relevant, for water quality and flow,

accessible nature and green travel. Mapping the supply and demand required a range of additional data sets (e.g. digital terrain model, UK census data, Defra June agricultural statistics). Each of the ecosystem services were mapped on a scale from 0 (low provision) to 100 (high provision). Once each service was mapped individually, maps were generated of the supply of them altogether. The delivery of multiple ecosystem services was mapped as average scores and hotspots based on area. Data on the average ecosystem services provision for each Landscape Character Type (LCT) in the SWP was also calculated.

A SWP Landscape Partnership Ecosystem Services Mapping workshop was held to report on the findings of the SWP LOM project. Two break-out group sessions were run to understand what the stakeholders thought that this region should deliver for stakeholders, residents and visitors in coming years, and to weight the importance of the ecosystem services within the context of each of the SWP LCTs. A number of themes emerged from these two sessions, but there were two in particular that generated much discussion. There is a need for the SWPLP to engage effectively with the local communities in the SWP to generate understanding and buy-in to the project. This should generate a sense of place and stewardship for the environment in which they are embedded, to ensure sustainability in environmental improvements. The development of opportunities for Payments for Ecosystem Service (PES) schemes in relation to agriculture was thought to be a priority. The identification of farmers who would be willing to be part of a pilot PES scheme will be an important and challenging part of the wider project.

This project has produced maps at a resolution that allows the examination of the trade-offs and synergies in the provision of multiple ecosystem services, even across small distances. The habitat opportunity mapping can also be used to show the optimal locations for creating habitat for biodiversity conservation and flood risk management. The core swathe of the SWP, the open moorland and to a slightly lesser extent the moorland hills and ridges and the enclosed gritstone uplands, is a hotspot for ecosystem service delivery. The peat bogs particularly are delivering high levels of carbon storage, water quality, and quantity (slowing the flow), while allowing public access to the natural and tranquil surroundings. Coldspots of delivery tend to be in urban areas in the buffer zone, but are important areas of demand for such services. Key synergies, where management can deliver multiple benefits, are between carbon storage, water quantity and quality, accessible nature and biodiversity enhancement. Important trade-offs can be seen between food production and water quality, quantity, carbon storage and accessible nature, although extensifying agricultural production could increase the production of services. Another is the conflict that exists between public access, tranquillity and biodiversity. Woodland opportunity areas for biodiversity can be combined with ones for floodplain woodland runoff attenuation, which shows that both can be achieved.

This work can be used to highlight strategic locations for delivering multiple benefits, by continuing with practices in hotspot areas, and evaluating how enhancement can be achieved in coldspots. It can be used to identify general rules and objectives for managing broad areas of the SWP (e.g. LCTs), and to highlight specific fields where land use change may enhance a number of services or connect habitat. Using this work to inform the broader SWPLP HLF sub-projects will require ground-truthing, and the co-operation of landowners, that will only be achieved through engagement with the local communities. PES schemes may be a key approach for developing stewardship behaviour in the SWP, and this report outlines a number of such opportunities that may be possible in this area. Whilst this work provides an excellent baseline for decision-making, further work refining existing models and maps, mapping impact on ecosystem service provision of proposed land use / management changes, and valuation of the ecosystem services could extend its utility even further.

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Appendix:

1. Introduction

1.1 The South West Peak Landscape

The South West Peak (SWP), an area of ~36,000 hectares, comprises a high moorland core flanked by sloping hills, dissected by steep-sided cloughs descending into lower pastoral landscapes. The strong contrast between uplands and lower land creates a distinctive sense of place. The moorlands are dominated by exposed blanket bog and dry heath, punctuated by dramatic rock outcrops with occasional gritstone-walled enclosures. The peaty moorland soils, in good condition, store significant volumes of carbon and water, bringing important environmental benefits for water quality, climate regulation and habitat conservation.

The landscape is shaped by the underlying geology of Millstone Grit. Its structure and erosion creates landform variation and produces dramatic rocky tors, ridges and slopes such as the iconic Roaches, Ramshaw Rocks and Gib Torr. Axe Edge, in the centre of the area, with annual rainfall over 140cm, is one of the major watersheds of England. It is the source for five rivers: Dove, Manifold, Goyt, Dane and Wye, which flow to both the east and west of England. This is a key area for water supplies to nearby towns.

Grasslands are significant, with wet rush-pasture vitally important for birds of conservation concern such as curlew, snipe and lapwing. Many areas of pasture, however, have been reseeded and are managed intensively for silage production, so once-common unimproved grasslands and hay meadows are now rare. The cloughs are often characterised by scattered trees or linear woodland, supporting important populations of declining woodland birds like redstart, tree pipit, wood warbler, lesser-spotted woodpecker and pied flycatcher. This landscape supports over 5500 ha of land with European statutory nature conservation designation (SAC, SSSI, SPA); characteristic habitat mosaics including moorland with heath and blanket mire, rush pasture with a scatter of species rich hay meadows. These support a number of birds of conservation importance such as merlin, golden plover, short-eared owl, red grouse, dunlin and curlew.

Agriculture is a significant contributor to the landscape character of the area. This is a marginal area with most of the land classified as Grade 5 (very poor) or Grade 4 (poor). Consequently, agriculture is predominantly upland livestock with some dairy farms, with a total agricultural workforce of ~1400 people. A challenge this area faces is the abandonment of upland hill farms, as this way of life becomes uneconomic.

The SWP is important for recreation and visitors due to extensive open access, wide ranging views, a dense network of footpaths, country lanes, and the sense of tranquillity offered for quiet enjoyment of the countryside. The craggy tors, notably the Roaches, are a strong attraction for climbers. There are thought to be fewer visitors here than in other parts of the Peak District National Park, but numbers are increasing. At present most SWP visitors go to a few honey-pot sites.

There is a rural population of around 10,000 people in the SWP, with an economy driven by intensive pastoral farming and SMEs. It has a greater proportion of lower-income, semi-skilled workers that the rest of the Peak District. There exists a disconnect between some neighbouring towns and their local 'wild' greenspace. The location of the SWP and the adjacent urban areas is shown in Map 1 (next page).

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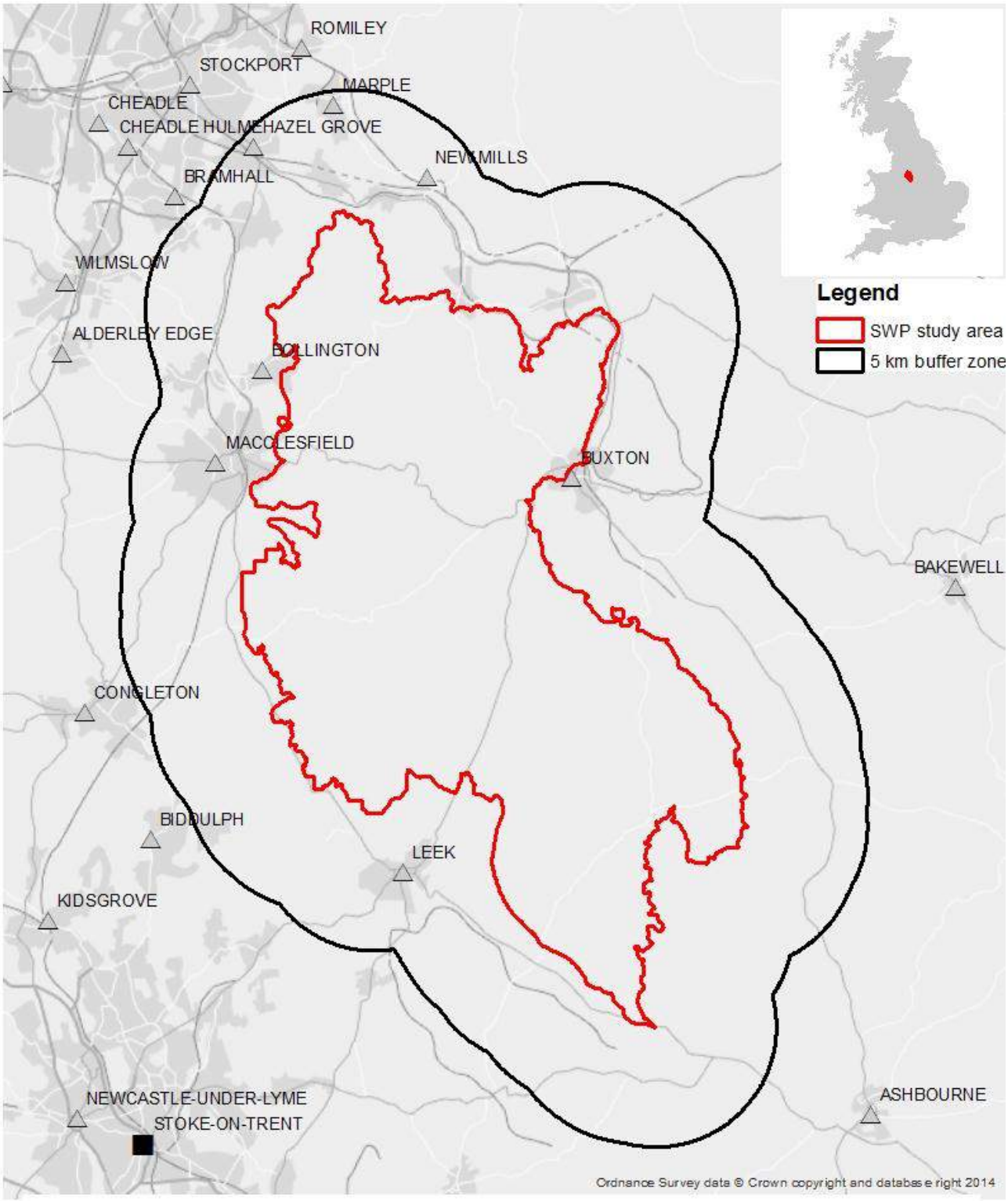
Map 1: South West Peak location map



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1.2 The Heritage Lottery Fund Landscape Partnership Programme

The South West Peak Landscape Partnership formed in May 2013 and submitted a first round application to the Heritage Lottery Fund's Landscape Partnership Programme in May 2014. The Heritage Lottery Fund (HLF) Landscape Partnership Programme is for schemes led by partnerships of local, regional and national interests that aim to conserve areas of distinctive landscape character throughout the UK. HLF fund schemes that make a lasting difference for heritage, people and communities in the UK.

The South West Peak Landscape Partnership Scheme (SWPLPS) received a first round pass to commence its development phase in November 2014 and an earmarked grant of £2.4 million over five years. The SWPLPS comprises 17 proposed projects within a 354 km^2 landscape character area of the Peak District known as the SWP. These individual projects will be integrated and delivered in a way that achieves a long-term legacy for the area. The developed proposal is due to be submitted in July 2016 and assessed in November.

The SWPLPS is championed by Nature Peak District (the Local Nature Partnership for the Peak District) and led by the Peak District National Park Authority in partnership with Cheshire Wildlife Trust, Environment Agency, The Farming Life Centre, Historic England, Natural England, RSPB, Severn Trent Water, Staffordshire County Council, Staffordshire Wildlife Trust, Support Staffordshire and United Utilities.

1.3 Aims and brief

The Partnership aims to enhance multiple ecosystem services in the landscape. As a result they required a contractor to deliver 'Landscape Opportunity Mapping' of the SWP area. The overall aim of this project was to undertake habitat opportunity mapping of key habitats, and to map the supply (capacity) and demand (beneficiaries) of ecosystem services. This was done using EcoServ, a GIS toolkit, and bespoke modelling. The two mapping approaches addressed the following questions:

- Where are the BAP priority habitats?
- Where are the opportunities to connect and enhance these habitats?
- Where are the most appropriate locations to increase and enhance species-rich grasslands?
- Where are the most appropriate locations to increase and enhance wet grasslands to benefit wading birds?
- How can flood risk be managed more naturally and where are the most beneficial locations?
- Where is it appropriate to create new woodland for biodiversity, landscape and flood risk management?
- How can potential conflicts between competing habitat objectives be identified and evaluated?
- Which are the key ecosystem services provided by this landscape and where are these provided?
- Where are the beneficiaries of the ecosystem services provided by the study area?
- What is the potential capacity of the landscape to provide ecosystem services?
- Where could multiple ecosystem service provision be improved, taking account of trade-offs?

The brief also included the design, organisation and execution of a workshop that would present the results of the mapping work to stakeholders, and help provide a vision for the future of the SWP. During the project Natural Capital Solutions liaised with JBA consulting, the contractors chosen to undertake the hydrological modelling element of the project, so that the maps produced provided direct input into the models.

1.4 What are ecosystem services and natural capital?

Natural capital is the stock of natural assets, for example, soils, water and biodiversity that produces a wide range of benefits for people. These benefits are known as ecosystem services and include, for example, food, timber production, regulation of flooding and climate, pollination of crops, and cultural benefits such as aesthetic value and recreational opportunities. Assessing the provision and demand of a number of ecosystem services can reveal actual and potential landscape multifunctionality.

2. The baseline – natural capital assets

2.1 Approach

Before habitat opportunities can be identified or the flow of ecosystem services mapped, it is necessary to obtain an accurate assessment of the current habitats present in the study area – the natural capital assets. To do this we used EcoServ, a toolkit developed by the Wildlife Trusts, with a number of bespoke modifications. This approach uses MasterMap polygons as the underlying mapping unit and then utilises a series of different data sets to classify each polygon to a habitat type and to associate a range of additional data with each polygon. The data that was used to classify habitats is shown in Box 1.

Box 1: Data used to classify habitats in the basemap:

- MasterMap topography layer
- OS vector maps
- BAP habitat – supplied by PDNPA but required extensive pre-processing:
  - 23 data sets merged and clipped to study area
  - Each polygon (5836 unique polygons) classified to habitat list determined following discussions with PDNPA. The data set contained records collected for multiple different purposes such as FEP surveys, Phase 1 habitat surveys, NVC, walkover surveys and species specific surveys, hence multiple and variable habitat classifications were in use.
  - Each polygon also examined to determine if BAP quality or not
  - Habitats further classified to fit with EcoServ requirements
  - Made adjustments to EcoServ model to enable both BAP habitats and non-BAP habitats to be used by model for more accurate classification of habitats
- Local wildlife sites obtained from Staffordshire, Derbyshire and Cheshire Wildlife Trusts
- Corrine European habitat data – modified and used to identify quarries, industry and golf courses, and to distinguish arable from pasture
- Layer that identified urban areas
- Ancient Woodland Inventory data

Polygons were classified into Phase 1 habitat types and were also classified into broader habitat groups. We made multiple modifications to the EcoServ programme code to enable improved classification of habitats. Furthermore, upon initial completion we carefully checked the basemap and made manual alterations in a number of places where miss-classifications had occurred. The basemap was produced for the SWP study area and an additional buffer zone of 5km (shown in Map 1 on p.2)

2.2 Habitats present

2.2.1 Broad habitats

Table 1 (overleaf) shows the percentage cover of broad habitat types across the SWP and the buffer zone, and a map is shown in the Appendix (Map A15). The core SWP study area (35,400 ha) is dominated by improved and semi-natural grassland (making up >70% of the area), and has significant areas of heathland and mire (bog) habitats. Heathland and mire together make up 13.9% of the SWP, or 4,900 ha. Built-up

areas, gardens and infrastructure (roads, railways, pavements and paths) make up just 3.2% of the land area. If the 5km buffer zone is included as well (with a combined area of 94,400 ha) the proportion of semi-natural habitats declines considerably, with a marked increase in the proportion of improved grassland, cultivated land, and artificial exposure (predominantly quarries), and built, gardens and infrastructure now occupy 8.1% of the area.

Table 1: Percentage cover of broad habitat types across the SWP study area and the buffer zone

Broad habitat	SWP	SWP plus buffer
Grassland, improved	46.2	55.8
Grassland, marshy	1.7	0.7
Grassland, semi-natural	24.4	15.6
Heathland	5.6	2.3
Mire	8.3	3.4
Scrub	0.9	1.2
Trees / Parkland	1.9	1.8
Woodland, broadleaved	2.2	3.3
Woodland, coniferous	2.6	1.1
Woodland, mixed	1.2	1.1
Water, fresh	0.6	0.9
Artificial exposure / waste	0.0	1.0
Cultivated / disturbed land	0.8	2.4
Built up areas	0.9	2.4
Infrastructure	1.4	2.4
Garden	0.9	3.3
Other	0.3	1.1

Map 2 (overleaf) shows the location of the key semi-natural habitats found within the SWP and buffer. It is clear that bog habitats occupy a central and fairly compact swathe of the SWP and that these are typically surrounded by heathland and semi-natural grassland habitats. Wet grassland habitats are more common in the southern half of the SWP and tend to be fairly spread out, whilst broadleaved and mixed woodlands are generally found towards the edges of the SWP core area and in the buffer and are highly spread.

2.2.2 Nature conservation designations

Most of the central swathe of bog, heathland and surrounding semi-natural grassland identified in Map 2 is of national and international importance for biodiversity conservation and has multiple designations. In total, 5,359 ha of this central swathe, or 15.1% of the total area of the SWP, is designated as SSSI, and almost all of this (5,302 ha or 15.0%) is designated as SPA. In addition, 4,454 ha of the same area is also designated as SAC, or 12.6% of the land area of the SWP.

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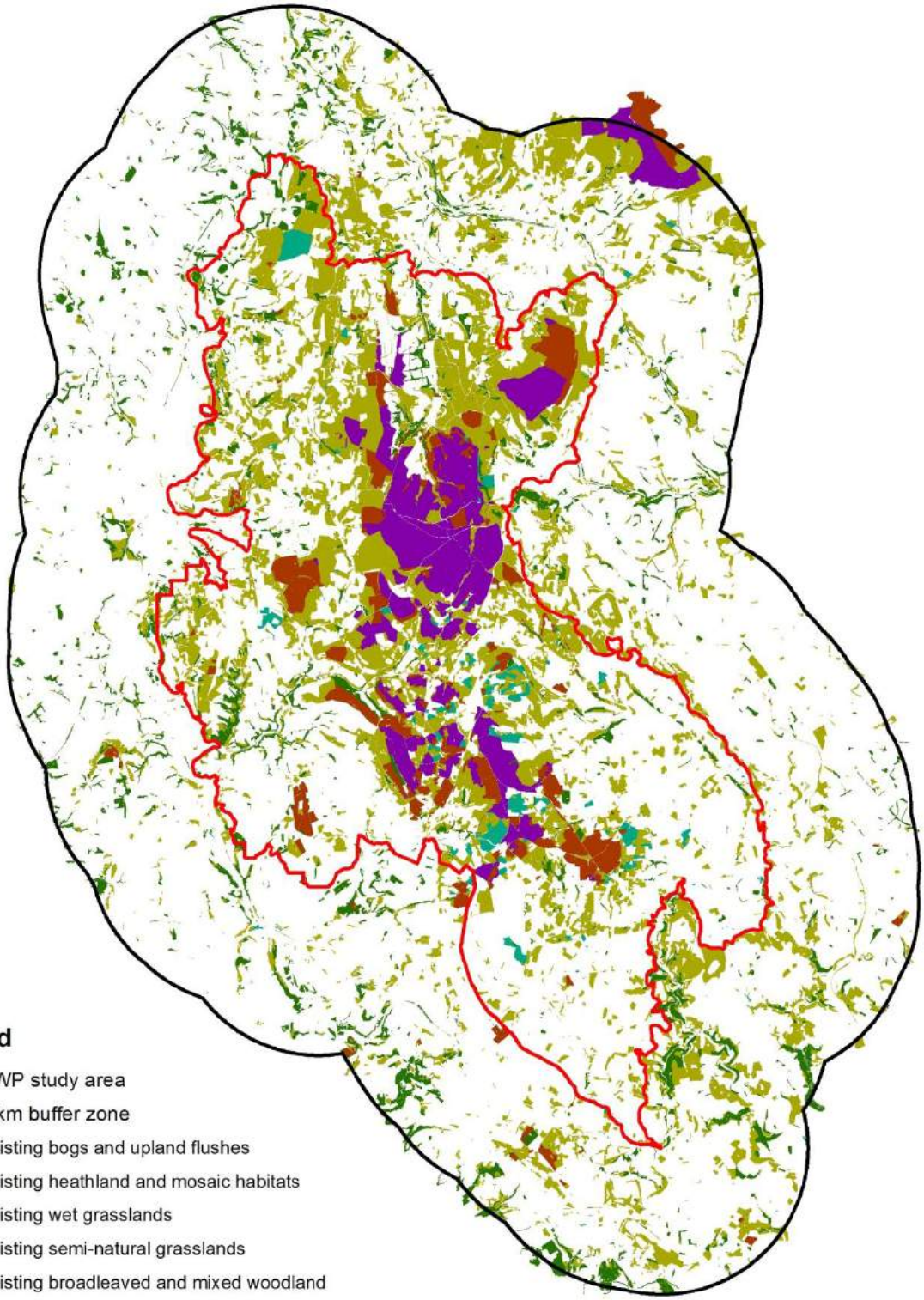
Map 2: Key habitat groups



Legend

- SWP study area
- 5 km buffer zone
- Existing bogs and upland flushes
- Existing heathland and mosaic habitats
- Existing wet grasslands
- Existing semi-natural grasslands
- Existing broadleaved and mixed woodland

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2.2.3 BAP habitats and wader hotspots

High quality semi-natural habitats are classed as BAP (Biodiversity Action Plan) habitats. In total 9,156 ha, which represents 25.9% of the SWP area, was assessed as either definitely, or thought likely to contain BAP quality habitat. In the wider SWP plus buffer area, 12,472 ha or 13.2% of the area was BAP quality. The location of all BAP habitat is shown on Map 3 on the next page.

In addition to habitat surveys, partners have been co-ordinating surveys of breeding waders for a number of years. Breeding waders are suffering major declines nationally and the SWP is an important location for them. Following surveys over the last few years, PDNPA and Natural England have been able to map the location of breeding wader sites and apply a buffer around well-used patches to indicate wader hotpots. These are general areas where breeding waders are likely rather than specific breeding sites. Wader hotpots are shown on Map 3 (next page) and cover an area of 7,700 ha, the vast majority of which is again in the central swathe within the SWP.

2.3 Archaeology and history

The location of archaeological and historic sites is an important factor when carrying out habitat opportunity and ecosystem services mapping. These sites act both as an important contributor to landscape character and sense of history, and also act as constraints for habitat creation opportunities.

To produce a map of archaeological and historic sites we merged different types of site into one layer and applied a 30m buffer around each one. A 30m buffer ensures that sites will not be damaged by any habitat changes occurring immediately adjacent and is recommended by English Heritage. The map included Scheduled Ancient Monuments, barrows, listed buildings, historic parks and gardens, Romano-British field systems, field barns, and a number of other categories. Including the 30m buffer, these sites covered an area of 6,225 ha (17.6%) within the SWP, and 13,583 ha (14.4%) in the wider SWP plus buffer. Map 4 shows the location of these sites.

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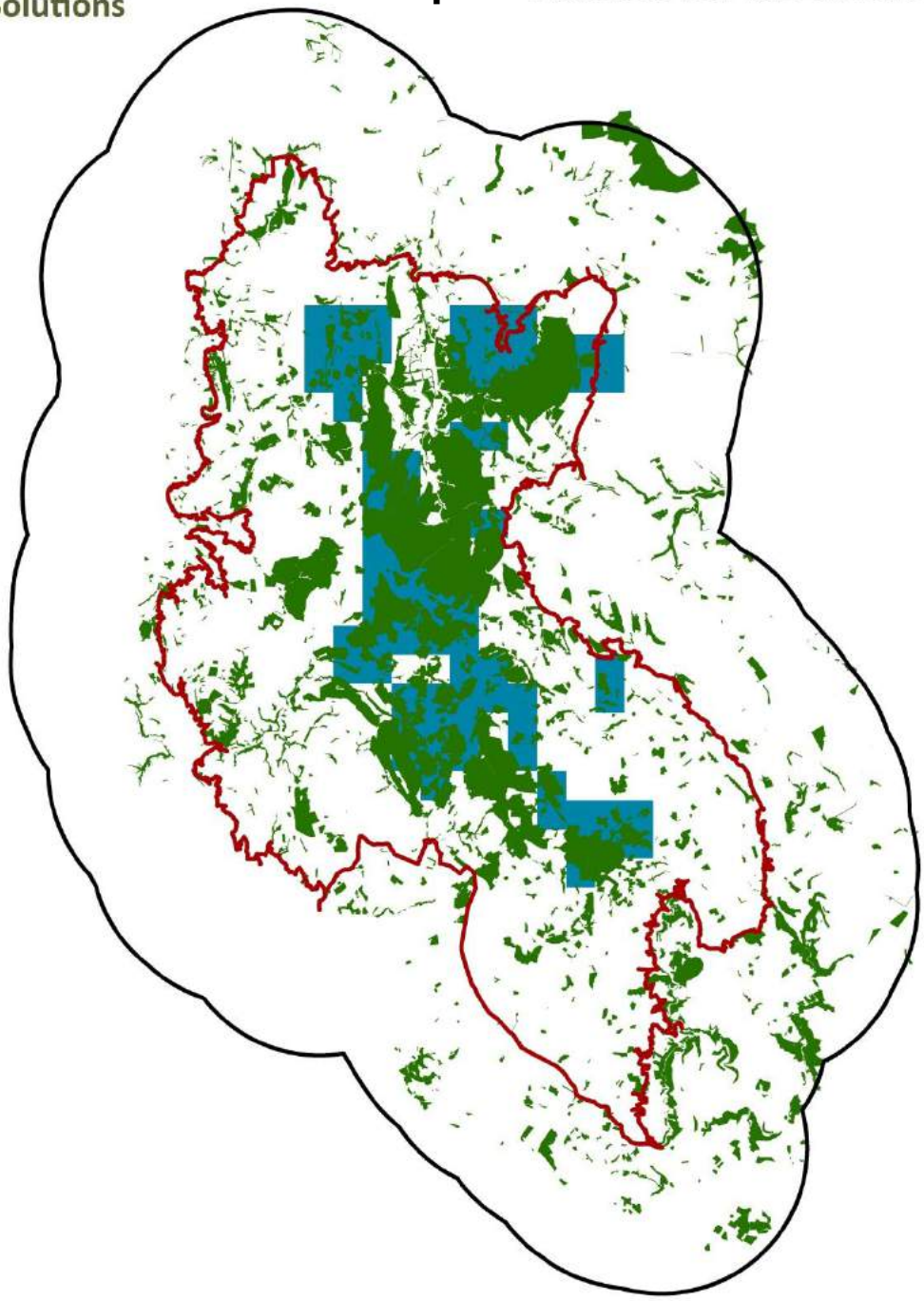
Map 3: Habitat for biodiversity



Legend

- Study Area
- 5 km buffer zone
- BAP habitats
- Wader hotspots

This map shows the provision of habitat for biodiversity, based on the location of Biodiversity Action Plan habitats and wader hotpots. Biodiversity is an important component of natural capital and also contributes to the provision of a number of ecosystem services.

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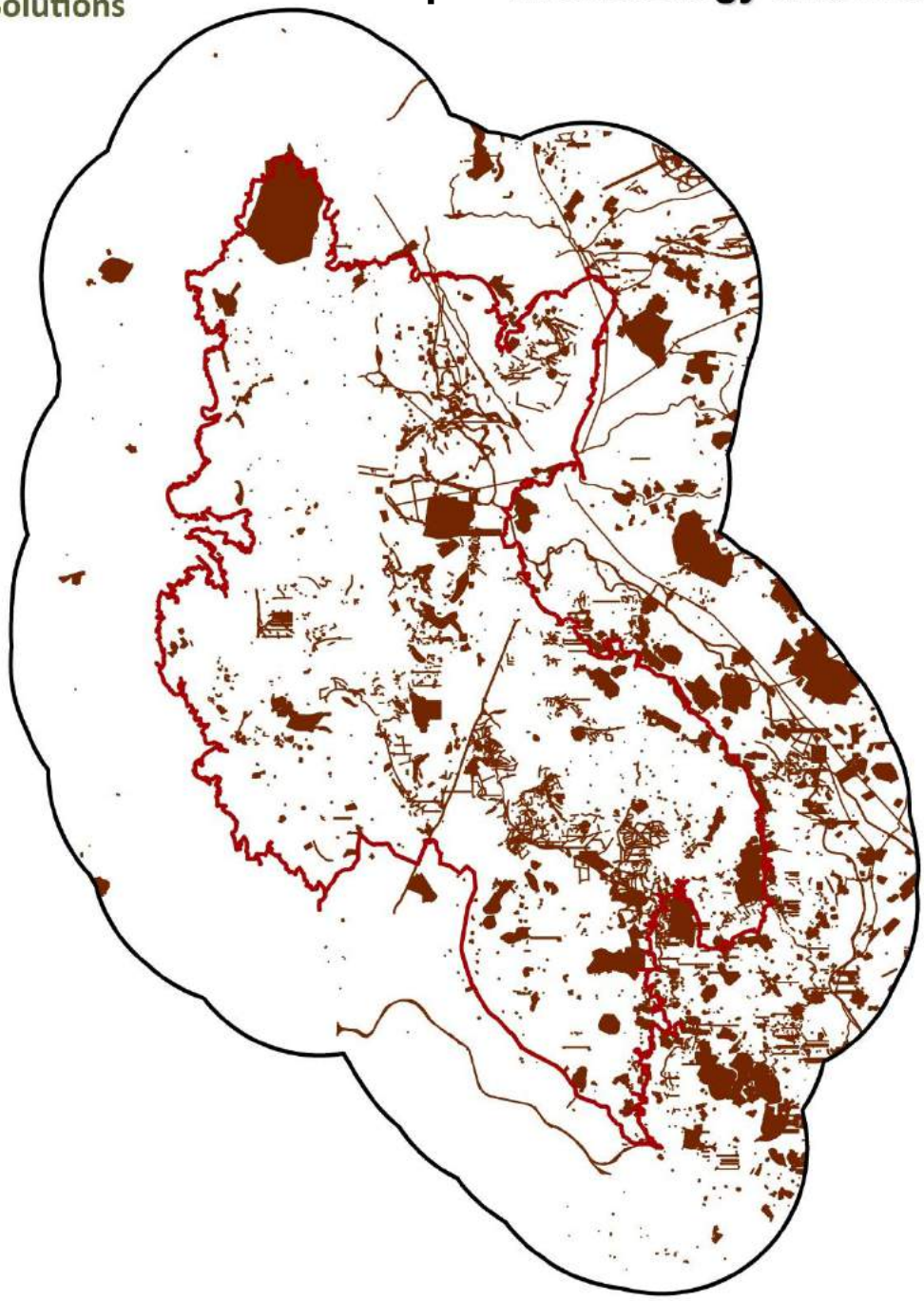
Map 4: Archaeology and history



Legend

- Study Area
- 5 km buffer zone
- Archaeological and historic sites

This map shows the location of all archaeological and historic sites, with a 30m buffer applied around each site. Includes Scheduled Ancient Monuments, barrows, listed buildings, historic parks and gardens, Romano-British field systems, field barns, and a number of other categories.

These features are an important contributor to the sense of history of the landscape and act as constraints for habitat creation opportunities.

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3. Habitat opportunity mapping

3.1 Introduction

Habitat opportunity mapping is a GIS based approach used to identify potential areas for the expansion of key habitats. It can be carried out with a number of different aims, but for the South West Peak project we identified two main types of opportunity:

1. Opportunities to expand habitat for biodiversity in areas that are ecologically connected to existing habitat networks.
2. Opportunities to promote habitat features that can attenuate surface water runoff and so reduce downstream flood risk.

In both cases we used a number of ecological and hydrological principles to identify potential areas for habitat creation. We also created a map showing constraints, where habitat opportunity would not be feasible or desirable. Then by overlaying the potential areas with the constraints we were able to identify habitat opportunity areas with constrained areas removed. However, it should be noted that the mapping identifies areas based on landscape-scale principles and does not take into account local site-based factors that may impact on suitability. Any areas suggested for habitat creation will require ground-truthing before implementation.

In the following sections we present the findings of the opportunity mapping for biodiversity, followed by the opportunity mapping for runoff attenuation across the whole SWP area and buffer zone, before showing how the maps can be brought together at a more local scale using a case study area on the River Manifold.

3.2 Opportunity mapping for biodiversity enhancement

Habitat opportunity mapping to enhance biodiversity was performed for five key habitats groupings, incorporating the main semi-natural habitats found in the South West Peak. The broad habitats and their constituent types are shown in Table 2 below:

Broad habitat	Specific habitats included
Heathland	Includes all heathland types (including wet and dry heaths) and grass-heath mosaics
Mire	Bogs and upland flushes, fens and swamps
Semi-natural grassland	Acid, neutral, calcareous, rough and semi-improved grasslands
Wet grassland	Purple moor grass and rush pasture, other rush pastures, marshy grassland, and lowland fen
Woodland	Broadleaved and mixed woodland types (excludes coniferous woodland)

Opportunity mapping followed a four step process:

- **Step 1**: Assess landscape permeability for typical species from each broad habitat type
- **Step 2:** Map habitat networks based on the dispersal distance of generic focal species, and landscape permeability for those species.
- **Step 3:** Map constraints where habitat could not or should not be altered.

- **Step 4:** Overlay the maps from steps 2 and 3 to identify habitat opportunity areas for biodiversity enhancement. We produced maps showing both potential buffer habitat that is adjacent to existing habitat areas, and potential stepping-stone habitat, that is a little further away but would be ecologically connected and could potentially be used to join up sites that are currently disconnected.

These steps are explained in more detail in the following sections. We illustrate the process with the example of heathland habitats, with the maps from the other habitat types included in Appendix (ii) and available as GIS layers for project partners.

3.2.1 Step 1: Landscape permeability

This step involves assessing the permeability of the landscape to typical species from each habitat type and builds on work carried out by JNCC, Forest Research and others. Generic focal species are assessed for each habitat type as there is a lack of ecological knowledge to be able to repeat the process for multiple different individual species, and generic species provide an average assessment for species typical of each habitat type.

It is assumed that a species will have optimal dispersal capabilities in the habitat in which it is associated and hence the landscape is fully permeable if it consists only of this primary habitat. Each of the remaining habitat types is then assigned a permeability score that shows how likely and how far the species will travel through that habitat. Habitats are scored on a scale from 1 (most permeable) to 50 (least permeable). Permeability scores were based on expert scores complied by JNCC and then adjusted by Natural Capital Solutions for the South West Peak for each habitat type.

Once tables had been compiled showing permeability scores for each habitat, maps were then produced using the EcoServ GIS package showing the permeability of the landscape for generic species from each broad habitat type. The permeability map for typical heathland species is shown overleaf (Map 5), with maps for each of the other broad habitats included in the Appendix (Maps A1-A4).

3.2.2 Step 2: Habitat networks

Step 2 uses the permeability map created above, along with information on average dispersal distances, to map which habitat patches are ecologically connected and which are ecologically isolated from each other. Dispersal distances were obtained from JNCC, which had performed a review of the scientific literature to ascertain the dispersal distances of a range of species for each habitat type. These were typically species of small mammals, birds, butterflies, and plants. The average dispersal distance for each habitat is shown in Table 3 below:

Table 3: Dispersal distance in optimal habitat:	
Heathland	1.2 km
Mire	1.0 km
Semi-natural grassland	2.0 km
Wet grassland	2.0 km
Woodland	3.0 km

An example of the habitat network map for heathland is shown as Map 6 on p.14, with the other habitats shown in the Appendix (Maps A5-A8). Habitats that are ecologically connected are linked within a network shown in grey. White space between habitat patches indicate that the patches are not ecologically connected and dispersal between the patches is less likely to occur.

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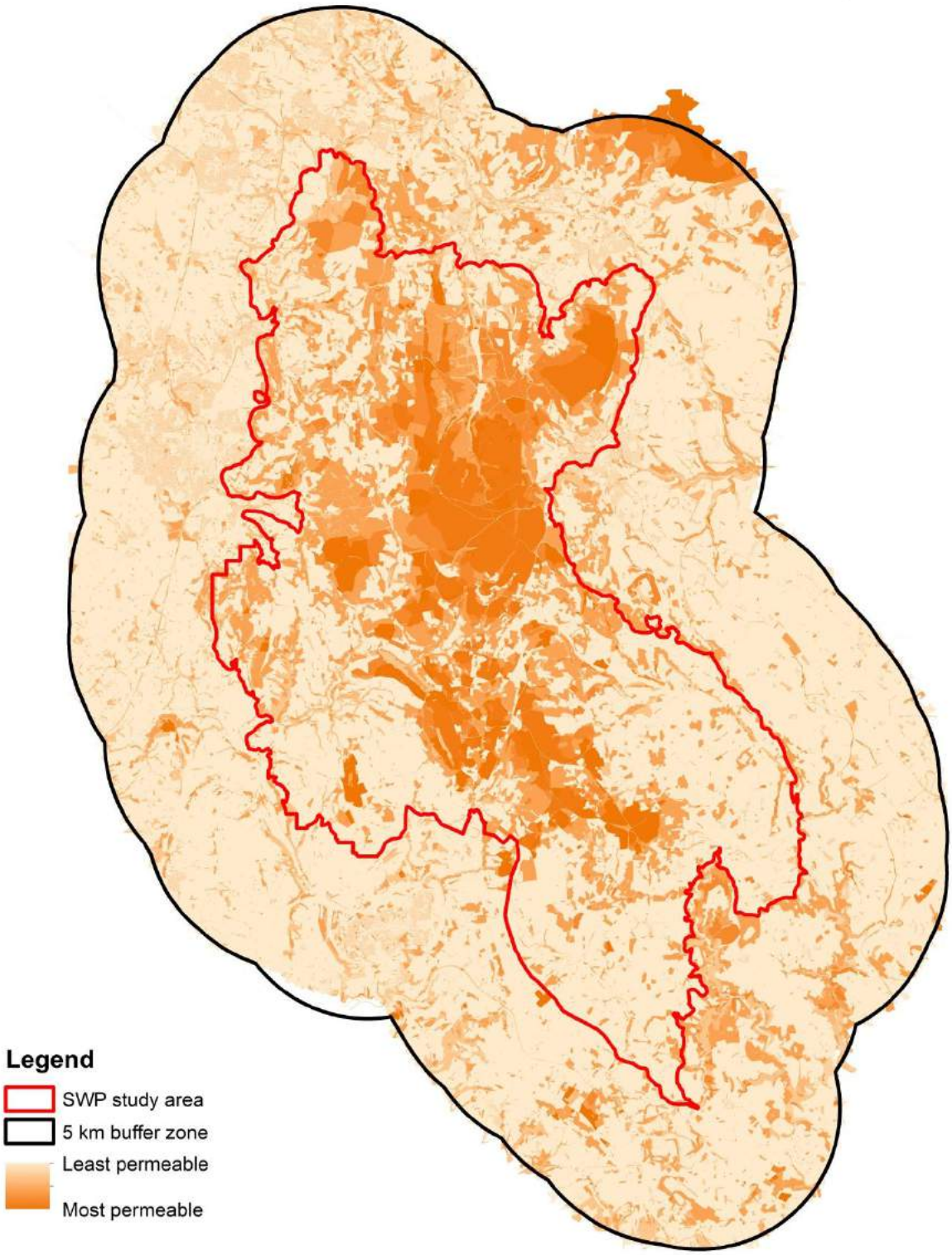
Map 5: Landscape permeability: Heathland and mosaic species



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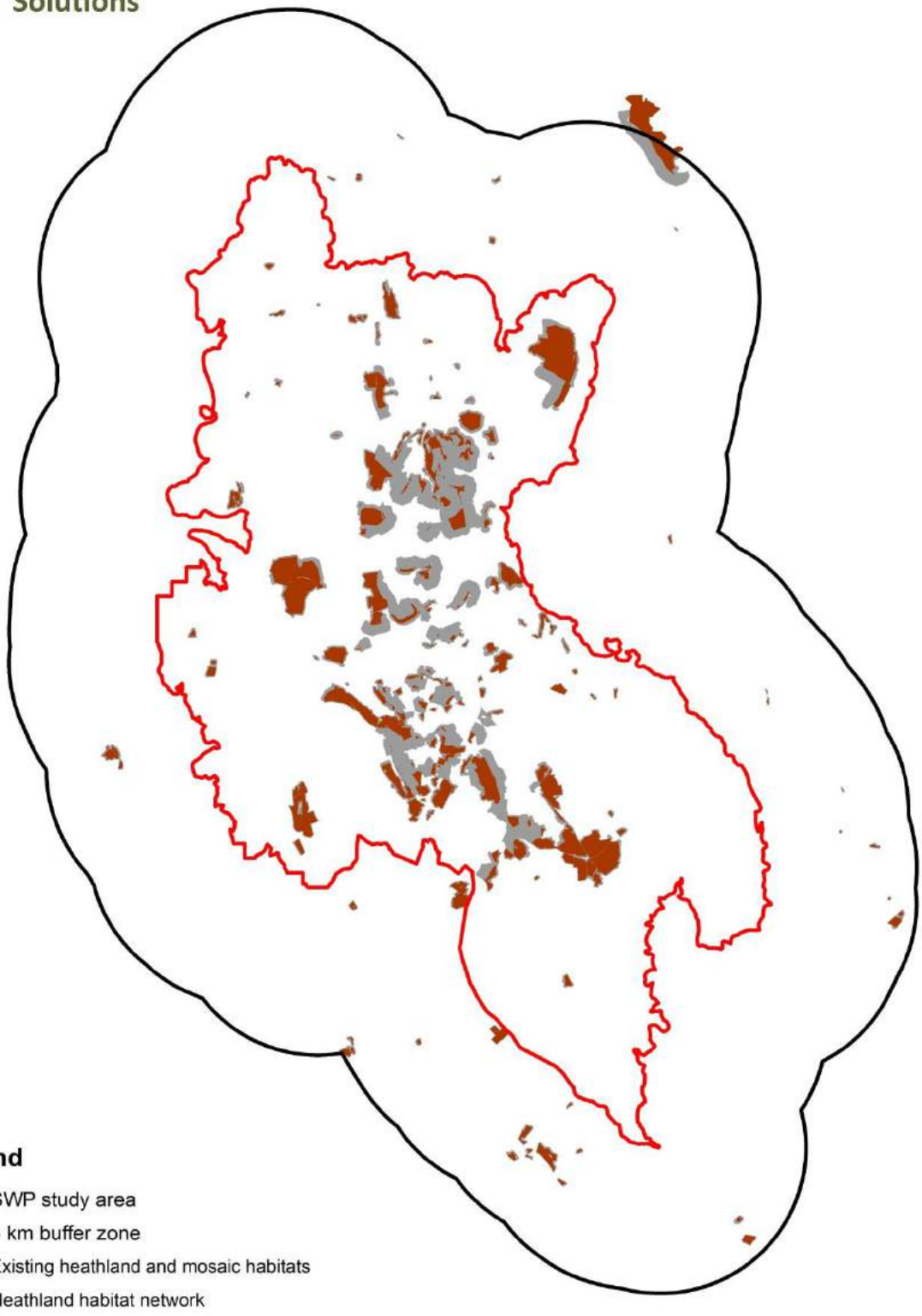
Map 6: Heathland habitat network



Legend

- SWP study area
- 5 km buffer zone
- Existing heathland and mosaic habitats
- Heathland habitat network

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3.2.3 Step 3: Mapping constraints

The habitat network map created in Step 2 can be used to indicate where new habitat could be created; any habitat created within the existing network mapped in grey would be ecologically connected to existing patches. However, in reality a number of constraints exist that need to be taken into account when producing opportunity maps. The aim of this step, therefore, is to produce a map of constraints that can be used to show where habitat cannot or should not be created. We mapped the following land use constraints:

- Infrastructure – roads, railways, and paths
- Urban – including all buildings in towns and villages
- Gardens – linked to the above, it is highly unlikely that these would be available for habitat creation
- Water – standing and running water
- BAP habitats – all existing BAP quality habitat was identified. It was decided that existing high quality habitat should not be sacrificed to create new habitat of a different type
- Archaeology / history – we mapped all archaeological and historic features, applied a 30m buffer around each and joined them together into one layer (see Map 4)

In addition, it was decided that it would be inappropriate to plant new woodlands in areas where breeding waders occurred. We therefore also added a map of wader hotspots, which had been previously collated by the Peak District National Park Authority, and are polygons mapped around known breeding wader locations. Wader hotspots were used as an additional constraint when mapping woodland opportunity, but were not included when mapping the other habitat types, as waders will avoid woodland sites but will potentially use the other habitat types. A map showing the land use constraints and breeding wader hotspots is shown overleaf (Map 7).

3.2.4 Step 4: Habitat opportunity for biodiversity

In the final step, the constraints map was used to exclude areas that would be unsuitable or unavailable for new habitat. Two layers of habitat opportunity were then created:

- Buffer opportunity – this layer identified habitat opportunity areas that are immediately adjacent to existing habitat patches and fall within the previously identified ecological network.
- Stepping-stone opportunity – this layer identified potential sites that fall outside of the ecological network, but are immediately adjacent to it. These areas could potentially be used to create stepping-stone habitats that could link up more distant habitat patches.

For both opportunity layers, a minimum threshold size was set at 0.1 ha, to remove tiny fragments of land and to replicate the minimum sizes of habitat creation grant schemes. A habitat opportunity map for heathland habitats, showing both buffer and stepping-stone opportunities is shown as Map 8, with the opportunity maps for the other habitats in the Appendix (Maps A9-A12).

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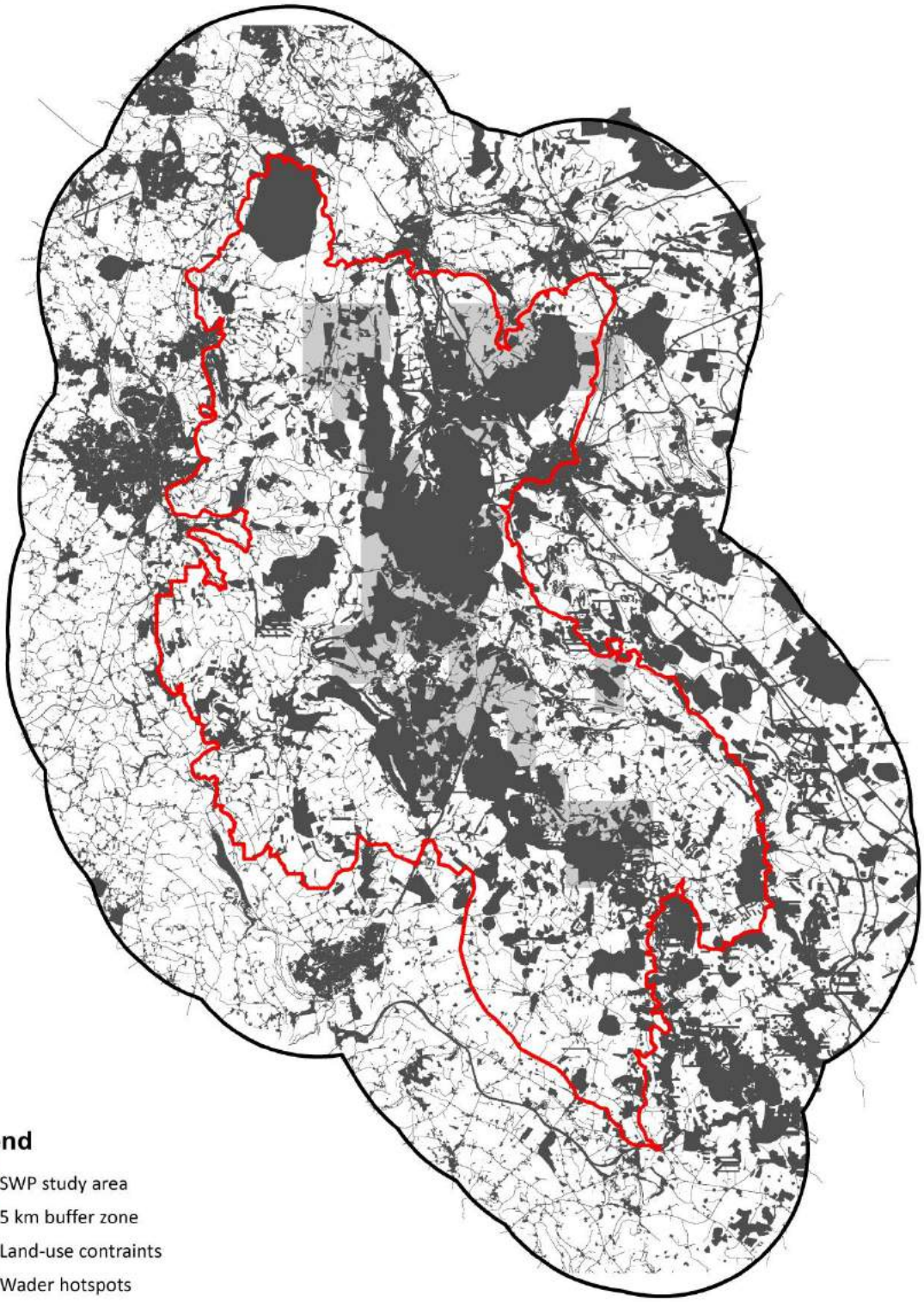
Map 7: Opportunity mapping contraints



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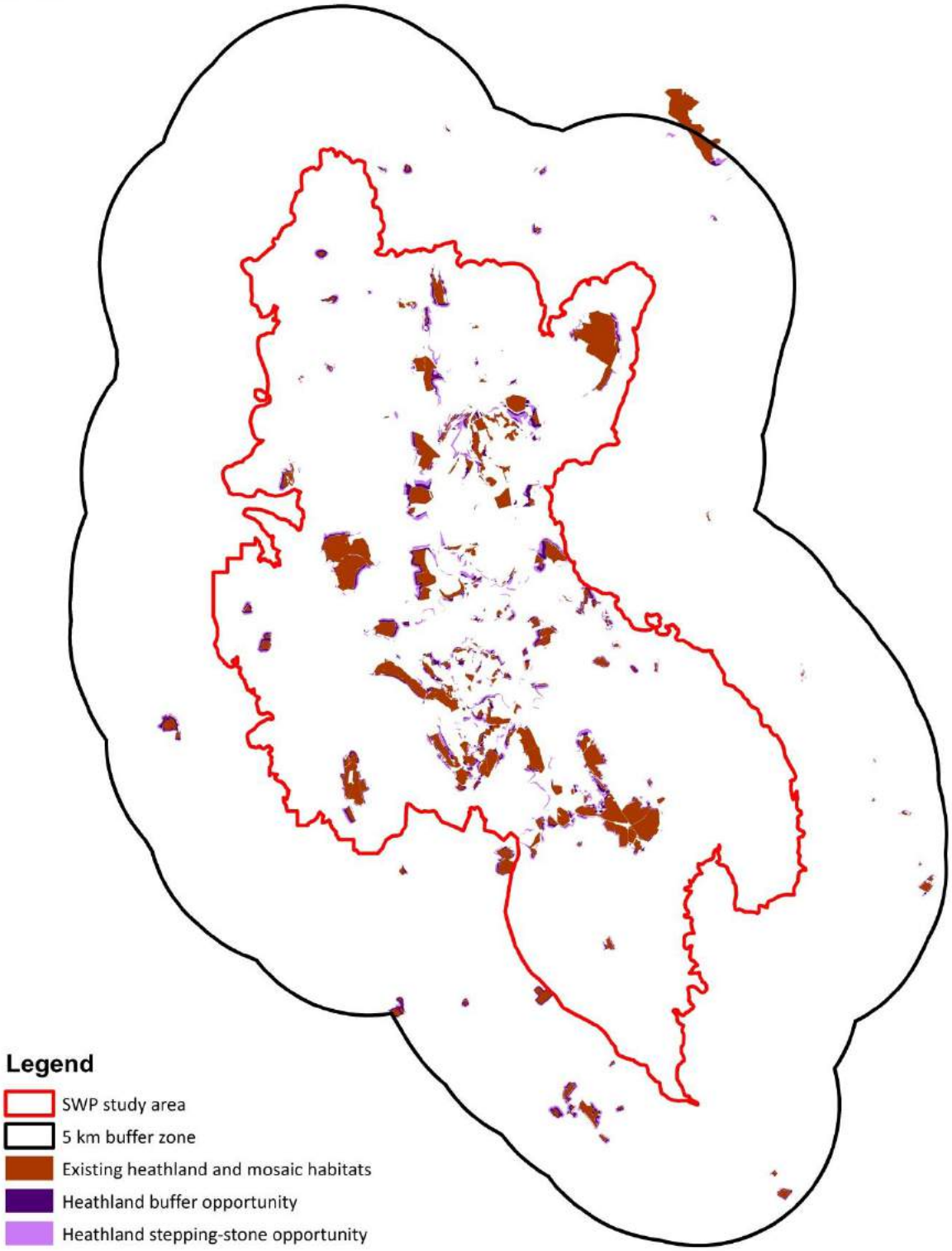
EcoServ-GIS

Natural Capital Solutions

Map 8: Heathland habitat opportunity



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3.3 Opportunity mapping for surface water attenuation

Opportunity mapping for surface water attenuation features was undertaken using methods developed by Forest Research for the Midlands Woodlands for Water project, with additional modifications and constraints applied to make it most relevant to the South West Peak. We mapped:

- **Floodplain woodland opportunity** – opportunity areas where woodland could be planted in the floodplain of the watercourses of the SWP, to slow surface water runoff, absorb water and reduce sediment and pollutant loads flowing into the river network.
- **Riparian attenuation features opportunity** – opportunity areas in the riparian zone of the headwaters where woody debris dams, riparian woodland, or attenuation ponds could be installed to slow the flow of surface runoff.

3.3.1 Floodplain woodland opportunity - method

The following steps were undertaken to map floodplain woodland opportunity across the SWP and buffer zone:

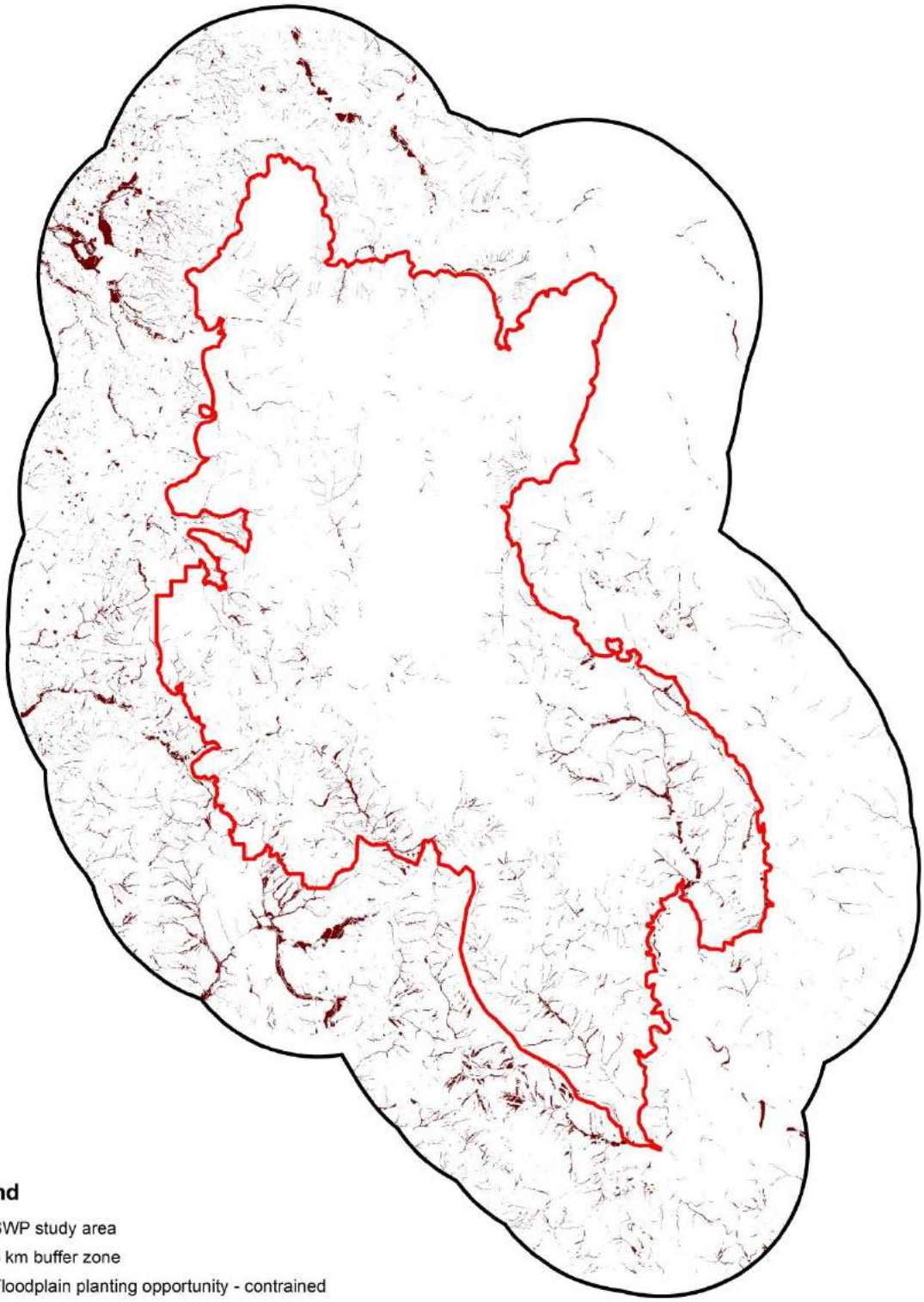
1. A map was produced that identified areas that are susceptible to either river (fluvial) or surface water (pluvial) flooding with a greater than 1 in 1000 risk. To do this, we combined the Environment Agency's updated Flood Map for Surface Water (uFMfSW) showing flooding extent in the Midlands and NW regions, with a map of Flood Zone 2 (river flooding extent).
2. We created a constraints layer, showing where it would be inappropriate or impossible to plant flood plain woodland. The following constraints were mapped:
    - Constraints recommended in the Midlands Woodland for Water Project – built-up areas, infrastructure, existing woodland, water, National Grid gas pipelines and overhead cables (with 10m buffer) and Scheduled Ancient Monuments (with 30m buffer).
    - Additional constraints for the SWP – existing BAP habitats, wader hotspots, all archaeological sites (with 30m buffer).
3. The two maps were then combined and areas identified as being subject to constraints were erased.

3.3.2 Floodplain woodland opportunity - output

The output is shown on Map 9 on the next page. It shows the opportunity areas for floodplain woodland planting, after constraints and habitat sensitivities have been taken into account. For comparison, a map of woodland opportunity with the Midlands Woodlands for Water project constraints taken into account, but excluding the additional SWP constraints, is shown as Map A13 in the Appendix.

Natural Capital Solutions

Map 9: Floodplain woodland opportunity



Legend

- SWP study area
- 5 km buffer zone
- Floodplain planting opportunity - contrained

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EcoServ-GIS

3.3.3 Riparian attenuation features opportunity – method

To map opportunities for woody debris dams, riparian woodland, and attenuation ponds a similar approach was carried out, but this time focussing on the riparian zone:

1. Adhering to the approach outlined in the Midlands Woodlands for Water project, the riparian zone was defined as a 30m wide area along both sides of the Environment Agency's Detailed River Network. Primary rivers (and also canals and lakes) were removed as these are generally more than 5m in width and so become less suitable for woody debris dams. Hence a 30m buffer was applied around the smaller secondary and tertiary river network.
2. We next created a constraints layer. This time, however, we did not include additional constraints for the SWP as attenuation ponds and woody debris dam features do not necessarily require major habitat change and so could be installed within wader hotspot areas or areas of BAP priority habitat. Although please note that if the intention was to plant riparian woodland then it would be recommended to include these additional constraints.
3. The two maps were then combined and areas identified as being subject to constraints were erased.

3.3.4 Riparian attenuation features opportunity – output

The output is shown on Map 10 on the next page. It shows the opportunity areas for woody debris dams and other riparian surface water attenuation features, after the more limited range of constraints have been taken into account.

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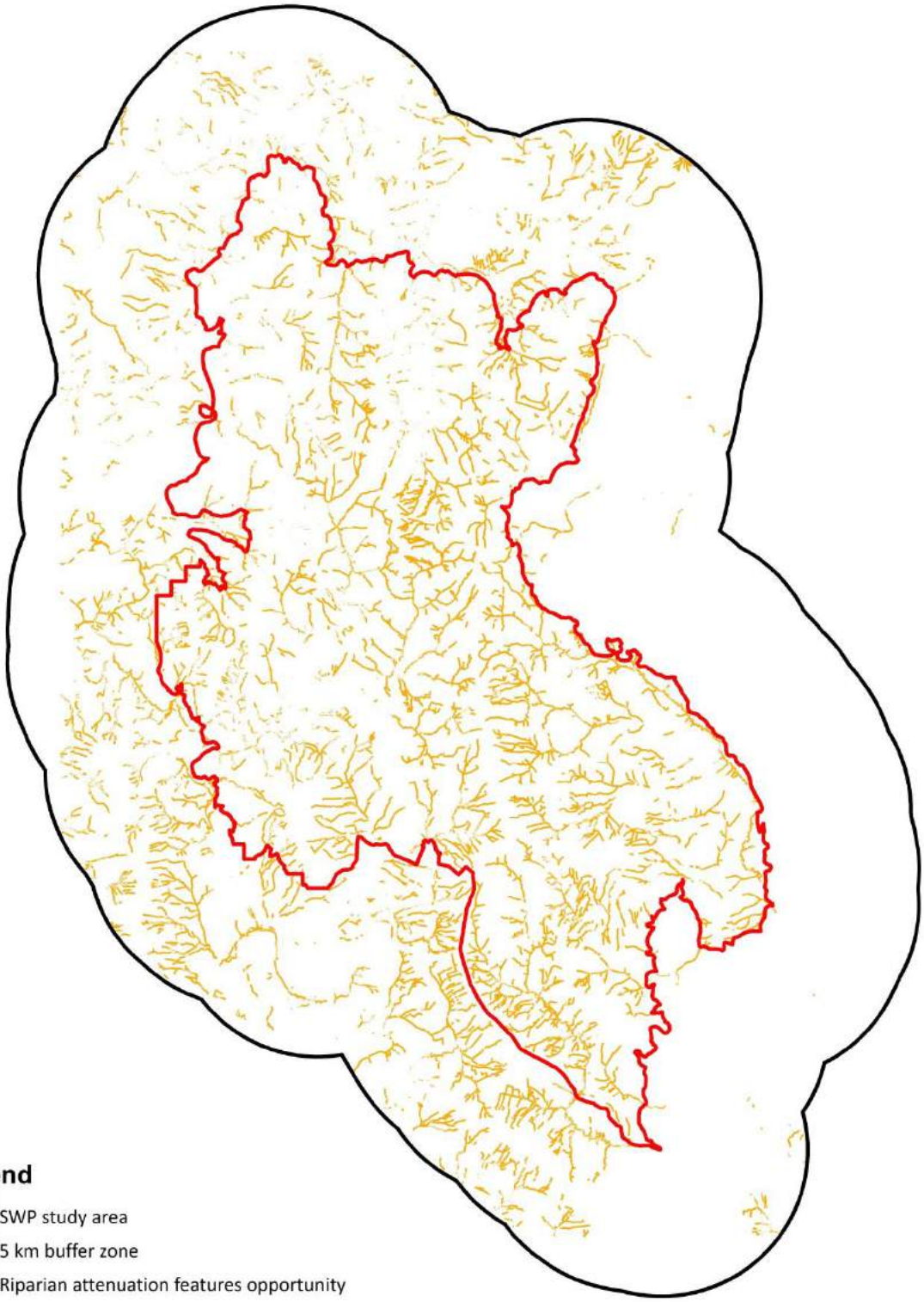
Map 10: Riparian attenuation features opportunity



Legend

- SWP study area
- 5 km buffer zone
- Riparian attenuation features opportunity

0 6Km

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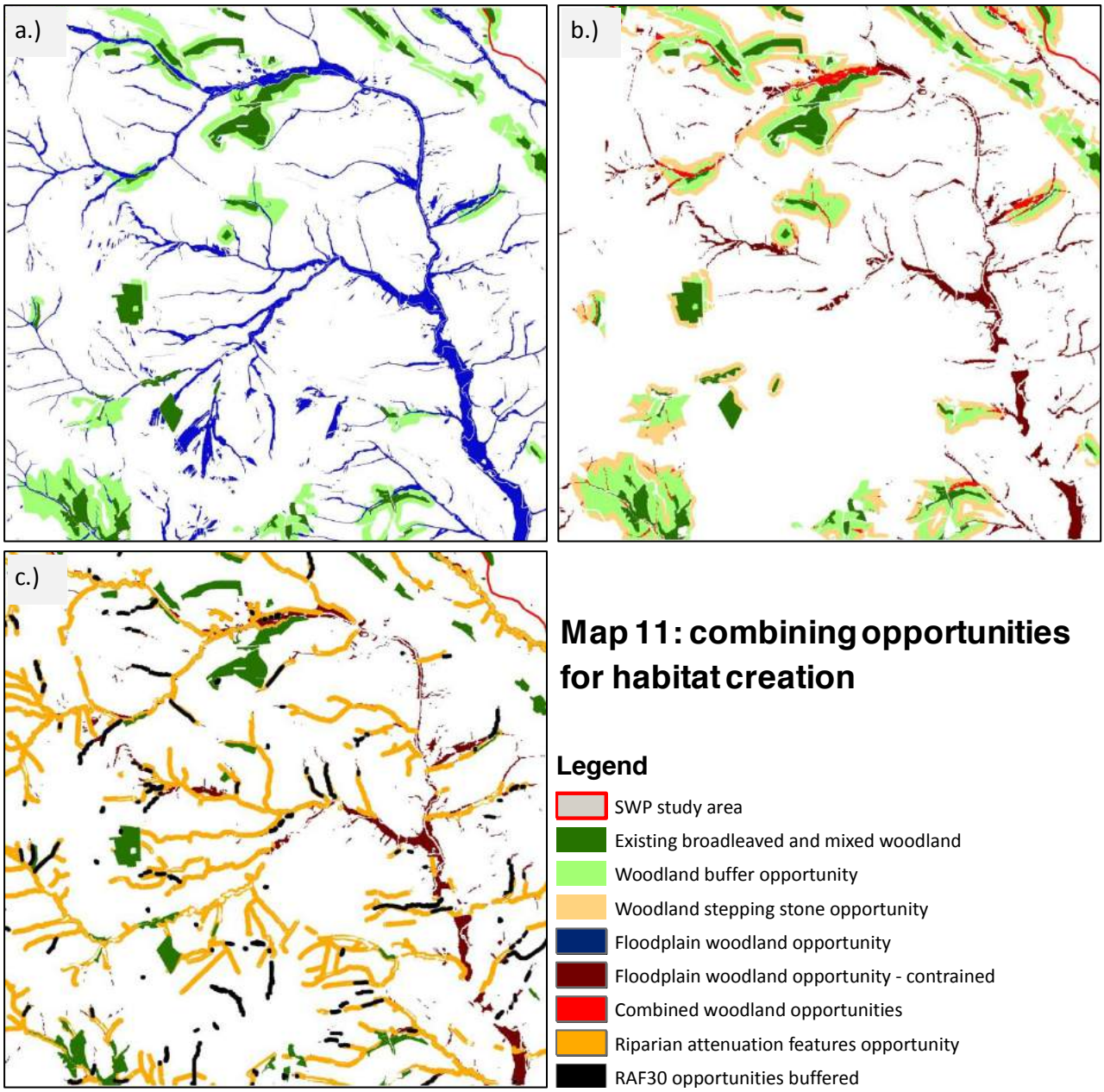
EcoServ-GIS

3.4 Combining opportunities for habitat creation

The opportunity maps for biodiversity enhancement can be combined with the opportunity maps for runoff attenuation to highlight areas that could deliver multiple benefits. To illustrate the different outputs that have been created and some of the possibilities for combining these, in Map 11 (below) we display a series of maps for a part of the River Manifold catchment in the south east part of the SWP study area.



The first map above (a.) shows the existing stock of woodland, opportunities to create buffer habitat for biodiversity, and unconstrained floodplain woodland opportunities. The second map (b.) then shows the additional stepping stone habitat that could be created and the floodplain woodland opportunities once constraints have been applied. It also shows (in red) the areas of overlap between these layers; these are floodplain areas where woodland could potentially deliver flood attenuation benefits and be ecologically connected to the existing woodland network. Finally, map (c.) shows all the different opportunities for surface water attenuation features, including floodplain woodland, riparian attenuation features, and attenuation features (RAF30 opportunities) modelled by JBA in Phase 2 of the project.

4 Modelling and mapping ecosystem services

4.1 Introduction

Mapping the benefits that the natural environment provides to people can follow a number of different approaches and be performed at different spatial resolutions. We have based our approach on the EcoServ GIS toolkit developed by the Wildlife Trusts, but have modified and adapted many of the EcoServ models to better suit the situation in the South West Peak. In addition, for several ecosystem services we have created our own bespoke models. The following ecosystem services have being mapped:

- Carbon storage
- Water flow
- Water quality
- Food production
- Tranquillity
- Accessible nature
- Green travel

These were the ecosystem services that had been identified by the SWPLP as being of most importance in the context of the SWP. In all cases the models are applied at a 10m by 10m resolution to provide extremely fine scale mapping across the area. The models are based on the detailed habitat models determined in the basemap. In addition they require lots of other external data sets in order to run, and these data sets are outlined in Box 2. Note, however, that most of the models are indicative (showing that certain areas have higher capacity or demand than other areas) and are not process-based mathematical models.

For all of the ecosystem services listed we have mapped the capacity of the natural environment to deliver that services – or the current supply. Wherever possible, we have also mapped the local demand (beneficiaries) for each ecosystem service. This has not, however, been possible for services where the demand is considered to be national or international, such as carbon storage or food production and mapping of local demand does not make sense.

Maps have been created for the SWP study area plus the 5km buffer zone shown in Map 1. This allows us to map accurately right to the edge of the SWP and also allows us to include the nearby towns in the buffer zone which are driving local demand for some of these services. In all cases the capacity and demand for ES is mapped relative to the values present within the SWP and buffer zone.

Box 2: Additional data sets used to model and map ecosystem services:

- Digital terrain model
- UK census 2011 data and Index of Multiple Deprivation data
- Public Rights of Way data from Derbyshire, Staffordshire and Cheshire
- Open space (green infrastructure) data sets for each local council
- Woodlands for Water national data set
- Updated Flood Map for Surface Water (uFMfSW) and river flooding maps (Flood Zones 2 and 3)
- Land designations – SSSI, NNR, SAC, SPA etc.
- Countryside Rights of Way access areas, Sustrans routes and other national routes
- CPRE National Tranquillity Data set 2007
- Detailed River Network, Communities@risk, and WFD data sets from the EA
- Wader hotspots, Landscape Character Types, and archaeological and historic sites from PDNPA
- Defra June agricultural statistics

4.2 Carbon storage capacity

4.2.1 Why is it important?

Carbon storage and sequestration is seen as increasingly important as we move towards a low-carbon future. The importance of managing land as a carbon store has been recognised by the UK government and land use has a major role to play in national carbon accounting. Changing land use from one type to another can lead to major changes in carbon storage, as can restoration of degraded habitats. Carbon is increasingly being given a monetary value and forms the basis of Payments for Ecosystem Services (PES) schemes such as the Woodland Carbon Code and the Peatland Code.

4.2.2 How is it measured?

We used the EcoServ carbon storage model. This model estimates the amount of carbon stored in the vegetation and top 30cm of soil. It applies average values for each habitat type taken from a large number of previous studies in the scientific literature. As such it does not take into account habitat condition or management, which can cause variation in amounts of carbon stored. It is calculated for each 10m by 10m cell across the study area. Scores are scaled on a 0 to 100 scale, relative to values present within the mapped area.

In all the ecosystem services maps that follow, the highest amounts (hotspots) are shown in red, with a gradient of colour to blue, which shows the lowest amounts (coldspots).

4.2.3 Results for the South West Peak

Carbon storage capacity is shown on Map 12 (next page). Peat soils in active bogs form the largest carbon store in the UK and this is reflected in the South West Peak where the central core of bog habitat provides the hotspot for the provision of this ecosystem service. Woodlands, and especially broadleaved woodlands, provide the second largest amount of carbon storage and these can be seen as the smaller orange patches dotted around the periphery of the SWP and in the buffer area. Areas of bare ground (principally quarries) and urban sealed surfaces provide the least capacity for carbon storage and are shown in dark blue on the map. Note that the carbon storage values provided are based on average values taken from the scientific literature and there may be some local discrepancy. For example, the average carbon storage value for heathland in the UK is quite low, but where heathland occurs locally on deep peat soils, the carbon storage value could be considerably higher but will not be accounted for in this map.

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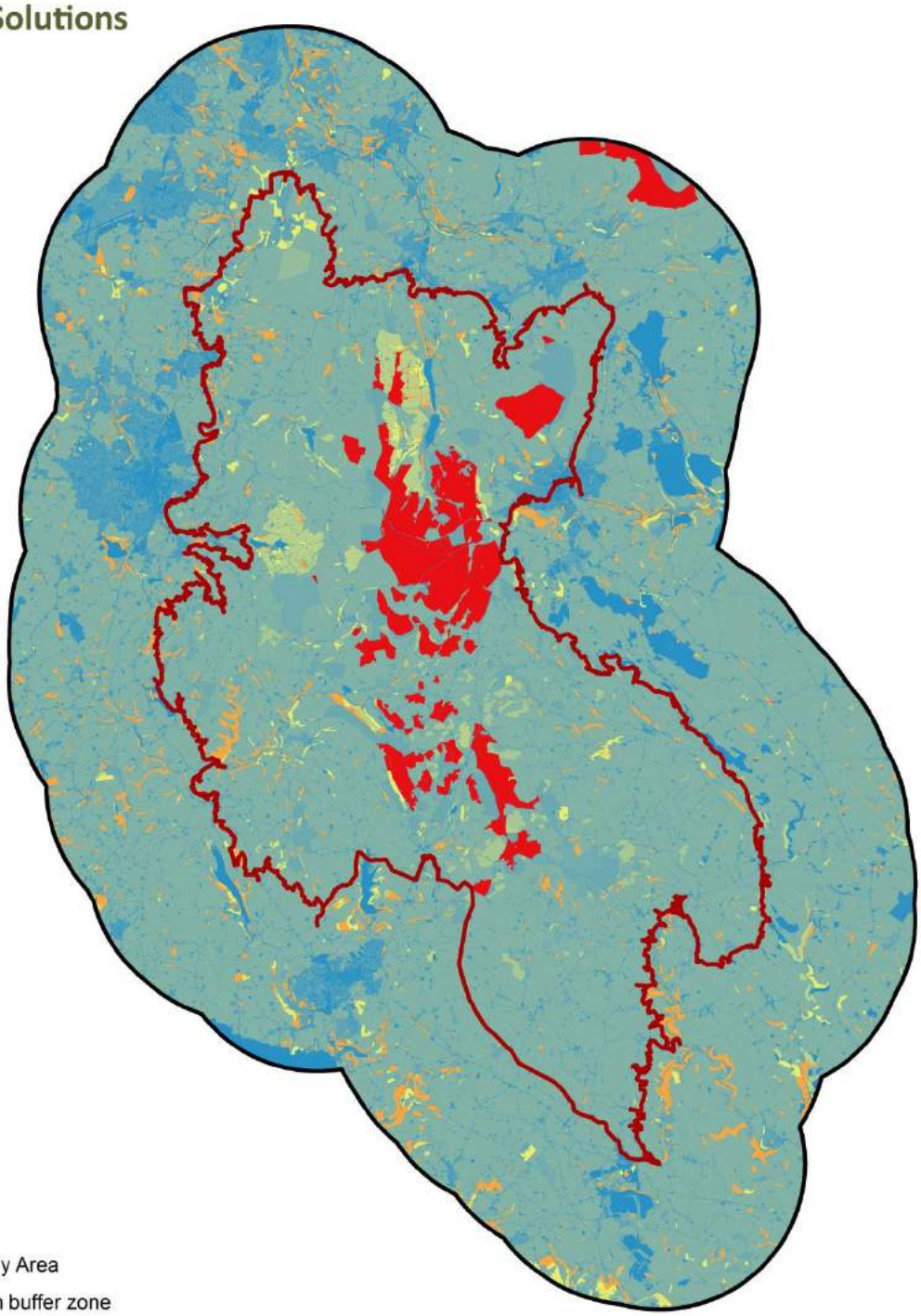
Map 12: Carbon storage capacity



Legend

Study Area

5 km buffer zone

Carbon storage capacity

Value

High : 100

Low : 0

Scores are on a 0 to 100 scale, relative to values present within the Study Area.

Models the amount of carbon stored in vegetation and top 30 cm of soil. Applies average values for each habitat type based on scientific literature. Soil type is assumed to be typical of the mapped habitat. Habitat age and management is not considered.

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EcoServ-GIS

4.3 Water flow capacity

4.3.1 What is it and why is it important?

Water flow capacity is the capacity of the land to slow water runoff and thereby potentially reduce flood risk downstream. Following a number of recent flooding events and the expectation that these will become more frequent over the coming years due to climate change, there is growing interest in working with natural process to reduce downstream flood risk. These projects aim to 'slow the flow' and retain water in the upper catchments for as long as possible. Maps of water flow capacity can be used to assess relative risk and help identify areas where land use can be changed. It can also form the first step in setting up a Payment for Ecosystem Services (PES) Scheme.

4.3.2 How is it measured?

A bespoke model was developed, building on an existing EcoServ model and incorporating many of the features used in the Environment Agency's catchment runoff models used to identify areas suitable for natural flood management. Runoff can generally be assessed based on three factors: land use, slope and soil type and so the following indicators were developed and mapped for each 10m by 10m cell across the SWP and buffer area:

- Roughness score – Manning's Roughness Coefficient provides a score for each land use type based on how much the land use will slow overland flow.
- Slope score – based on a detailed digital terrain model, slope was re-classified into a number of classes based on the British Land Capability Classification and others.
- Standard % runoff – was obtained from soil data and modified to reflect soil hydrological properties and their sensitivity to structural degradation from agricultural use. This was integrated with a layer showing impermeable areas where no soil was present (sealed surfaces, water and bare ground).

Each indicator was normalised from 0-1, then added together and projected on a 0 to 100 scale, as for the other ecosystem services. Note that this is an indicative map, showing areas that have generally high or low capacity and is not a hydrological model. An alternative version of the model, with only the first two indicators, hence ignoring differences in runoff caused by soil, is shown in the Appendix (i).

High values (red) indicate areas that have the highest capacity to slow water runoff.

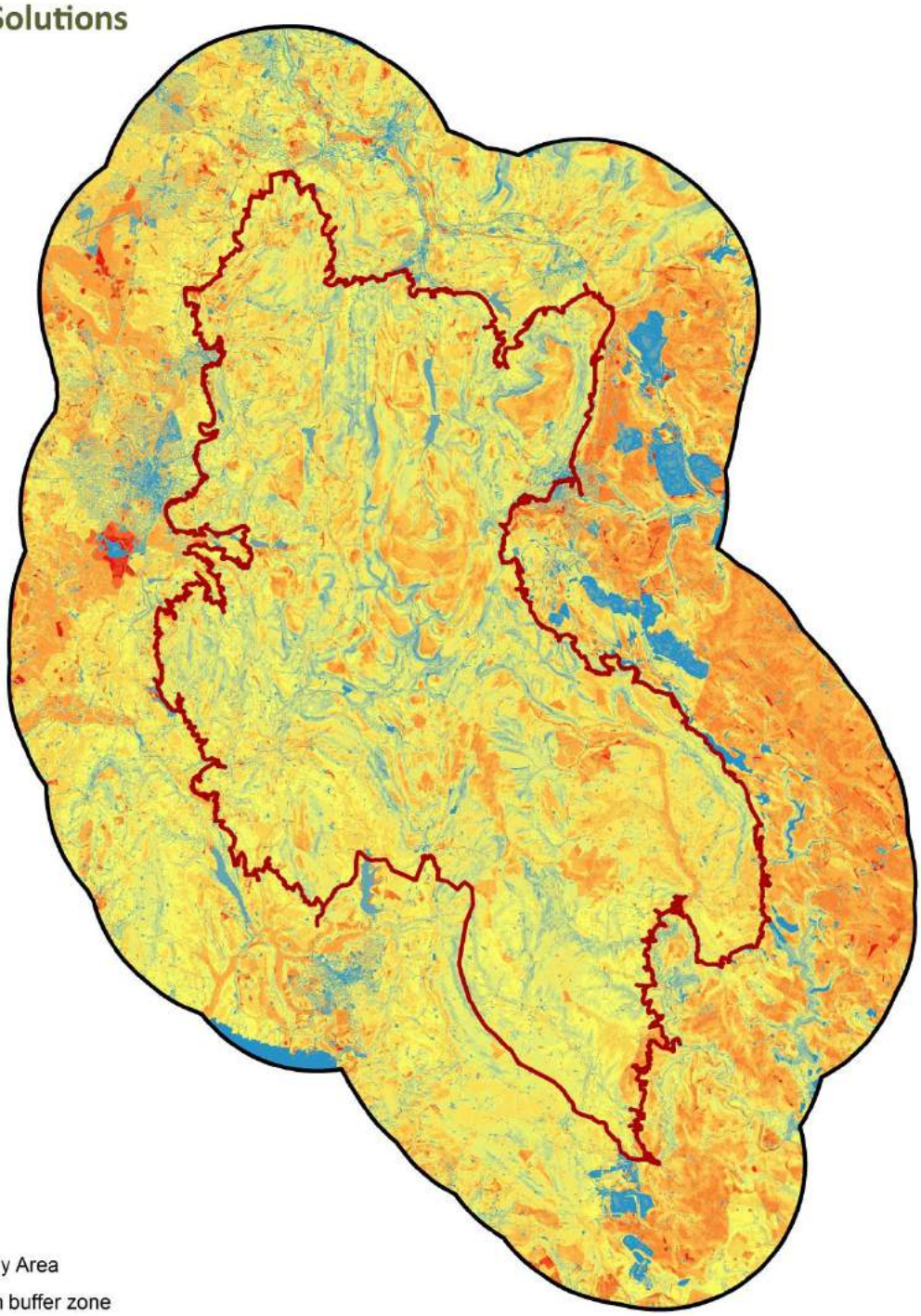
4.3.3 Results for the South West Peak

Water flow capacity is shown on Map 13 (next page). The best areas for slowing water runoff are areas of woodland and bog on flat land and permeable soils. In general the highest values occur in the buffer zone to the east, on the highly permeable limestone soils, but areas of quite high capacity occur in numerous locations throughout the mapped area. As slope is a key factor, water flow capacity can be highly variable across short distances. The worst areas (blue on the map) are areas of impermeable surface due to buildings, roads and quarries.

The map can be used to highlight opportunity areas that would be most suitable for natural flood management projects. These are likely to be areas that are relatively poor at the moment but by changing land use, the capacity could be enhanced.

Natural Capital Solutions

Map 13: Water flow capacity



Legend

Study Area

5 km buffer zone

Water flow capacity

Value

High : 100

Low : 0

Models the capacity of the land to slow the flow of water, or natural flood risk management potential. Based on three indicators: roughness, slope, and standard percentage runoff (dependent upon soil type).

Scores are on a 0 to 100 scale, relative to values present within the Study Area.

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EcoServ-GIS

4.4 Water flow demand

4.4.1 What is it?

This shows the relative demand for measures that reduce water runoff and is focussed around flood risk. Flooding can be caused by multiple sources, but the primary factors away from the coast are river (fluvial) and surface water or rainfall (pluvial) sources. Groundwater and reservoir sources can also cause flooding, but were not assessed here.

4.4.2 How is it measured?

A map of flood risk was produced that combined the Environment Agency's updated Flood Map for Surface Water (uFMfSW) with river flooding maps (Flood Zones 2 and 3). Maps that showed flood risk at greater than 1 in 100 and greater than 1 in 1000 risk were obtained for both surface water and river flooding and merged to show the relative combined risk from both sources. Note, however, that risks are not independent so could not be calculated mathematically; the maps merely show areas that are at risk of flooding from one or both sources and at which level. Note also that in an upstream area such as the SWP, there may be considerable flood risk further downstream in the lower catchment, but this was not assessed here. Downstream flood risk was assessed in greater detail in Phase 2 of the project.

High values (red) indicate areas that have the highest demand for reductions in water runoff (i.e. highest potential flood risk). Note that this map does not include the impact of flood defences, so actual risk may be considerably lower.

It would be possible to develop this indicator further in the future by including relative need of different land use types to be protected. For example, buildings require greater protection than other land uses, and naturally wet habitats require the least protection of all. The number of buildings and area at risk could also be assessed using the Environment Agency's Communities@Risk dataset and similar sources.

4.4.3 Results for the South West Peak

Map 14 shows water flow demand for the SWP and buffer zone. Due to the upland nature of the SWP, the overall area at risk of flooding is relatively small. Nevertheless, it's possible to zoom into the layers to determine exactly which areas are at risk at a very fine scale. Few communities are at risk in the SWP itself, although some are affected in the buffer zone to the west and larger communities are at risk further downstream, outside of the study area.

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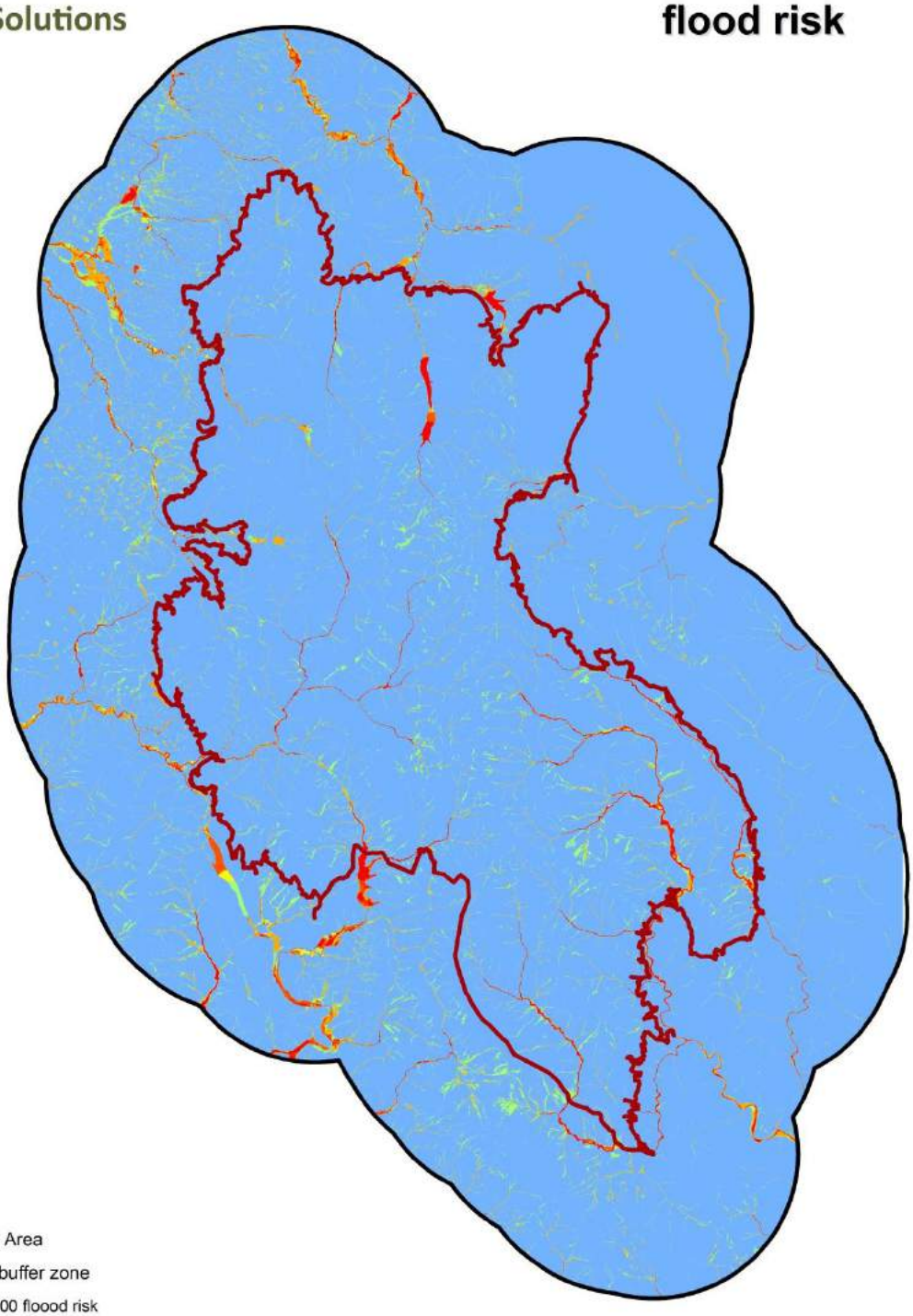
Map 14: Water flow demand: flood risk



Legend

- Study Area
- 5 km buffer zone
- < 1:1000 floood risk
- > 1:1000 fluvial or pluvial flood risk
- > 1:1000 fluvial and pluvial flood risk
- > 1:100 fluvial or pluvial flood risk
- > 1:100 fluvial or pluvial and 1:1000 fluvial or pluvial flood risk
- > 1:100 fluvial and pluvial flood risk

Shows demand for slowing water flow from land by mapping flood risk.

Combines EA's surface water flooding maps and river flooding maps (flood zones). Shows relative combined risk from both sources (but risks will not be independent).

0 6 Km

Date: 08/02/2016

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EcoServ-GIS

4.5 Water quality capacity

4.5.1 What is it and why is it important?

Water quality capacity maps the risk of surface runoff water becoming contaminated with high pollutant and sediment loads before entering a watercourse, with a higher water quality capacity indicating that water is likely to be less contaminated. Agricultural and urban diffuse pollution are assessed.

4.5.2 How is it measured?

A modified version of an EcoServ model was developed, which combines a coarse and fine-scale assessment of pollutant risk.

At a coarse scale, catchment land use characteristics were used to determine the overall level of risk. The percentage cover of sealed surfaces and improved agriculture in each sub-catchment was calculated and the values were re-classified into a number of risk classes. There is a strong link between the percentage cover of these land uses and pollution levels, with water quality particularly sensitive to the percentage of sealed surface in the catchment.

At a fine scale, a modification of the Universal Soil Loss Equation (USLE) was used to determine the rate of soil loss for each cell. This is based on the following three factors:

- Distance to watercourse – using a least cost distance analysis, taking topography into account.
- Slope length – using a flow accumulation grid and equations from the scientific literature. Longer slopes lead to greater amounts of runoff.
- Land use erosion risk – certain land uses have a higher susceptibility to erosion and standard risk factors were applied from the literature. Bare soil is particularly prone to erosion.

Each of the three fine scale indicators and the catchment-scale indicator were normalised from 0-1, then added together and projected on a 0 to 100 scale. As previously, this is an indicative map, showing areas that have generally high or low capacity and is not a process-based model.

High values (red) indicate areas that have the greatest capacity to deliver high water quality.

This model could be refined further, particularly in urban areas, which are not well catered for in the existing model.

4.5.3 Results for the South West Peak

Water quality capacity is shown in Map 15. Parts of the buffer zone to the east of the SWP have the highest capacity as these occur on limestone, where the distance to watercourses can be great. Within the SWP area itself, capacity can be highly variable across short distances as it is partly dependent upon slope, but in the flatter areas, such as on the tops and valley bottoms, capacity is generally high. Lower capacity occurs in sub-catchments containing urban areas, in arable farmland and quarries (in the buffer zone), and on slopes close to watercourses.

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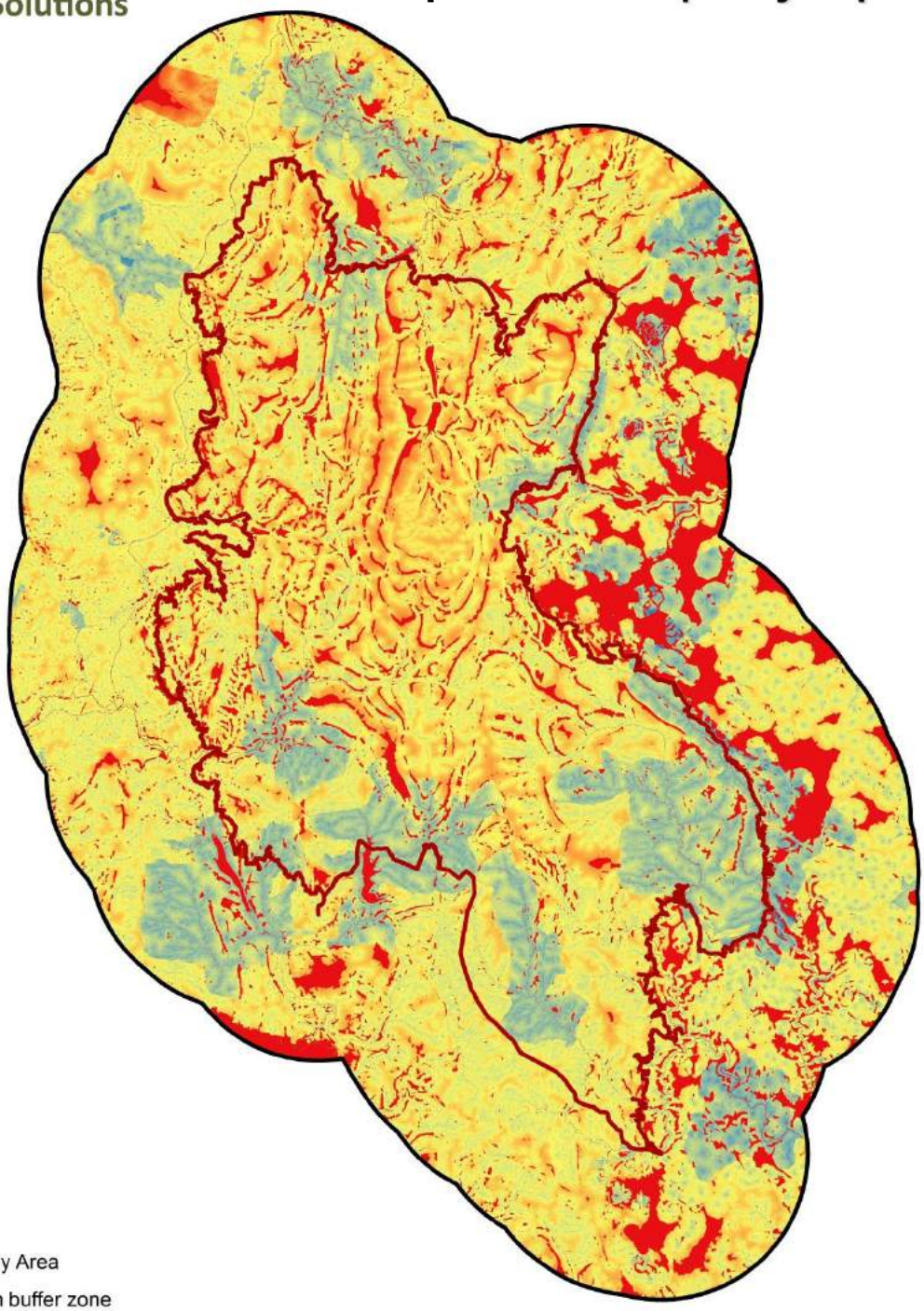
Map 15: Water quality capacity



Legend

Study Area

5 km buffer zone

Water quality capacity

Value

High : 100

Low : 0

Models the capacity of the land to regulate diffuse pollution and sediment loading across catchments.

Based on 4 indicators: percentage cover of sealed surfaces and improved agriculture in each sub-catchment, distance to watercourse, slope length, and land use erosion risk.

Scores are on a 0 to 100 scale, relative to values present within the Study Area.

0 6 Km

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EcoServ-GIS

4.6 Water quality demand

4.6.1 What is it and why is it important?

Water quality demand provides a map of the regulatory need for high water quality in each sub-catchment.

4.6.2 How is it measured?

A very simple bespoke map was developed by dividing the area into the finest-scale sub-catchments used by the Environment Agency under the Water Framework Directive, and then determining the number of protected area designations in place in each sub-catchment. Protected areas designations were mapped for the following EU Directives:

- Drinking Water Directive
- Fresh Water Fish Directive
- Habitats and Species Directive
- Nitrates Directive
- Urban Waste Water Directive

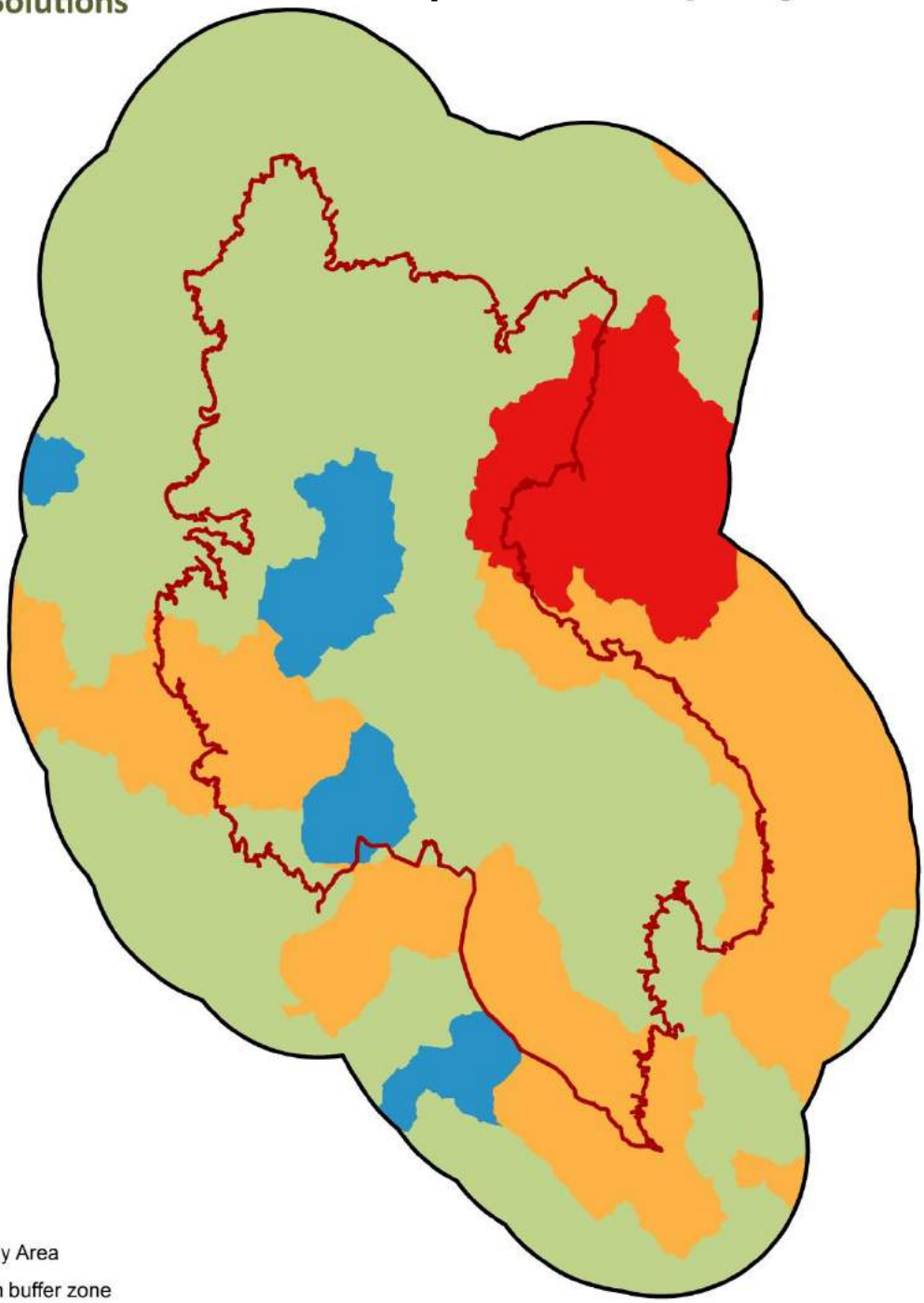
All of these Directives are concerned with water quality to some degree and it is assumed that the greater the number of designations in place, the higher the demand for high water quality. Initially the Birds Directive was also included, but this was dropped following feedback received at the stakeholder workshop, as there is no explicit water quality component to that Directive.

4.6.3 Results for the South West Peak

Water quality demand is shown on Map 16. All of the SWP study area and buffer zone are designated under at least one EU Directive, and most of the area under at least two, hence there is some demand for water quality throughout. High demand (with 3 or 4 designations) generally occurs in the periphery of the SWP, away from the tops, with the very highest demand in the River Exe catchment, which is a tributary of the River Derwent.

Natural Capital Solutions

Map 16: Water quality demand



Legend

- Study Area
- 5 km buffer zone

Number of designations

- 1
- 2
- 3
- 4

Illustrates the demand for high water quality by mapping the number of protected area designations in place in each sub-catchment. It is assumed that the greater the number of designations in place, the higher the demand for high water quality.

Protected areas designations for the following EU Directives have been mapped: Drinking Water Directive, Fresh Water Fish Directive, Habitats and Species Directive, Nitrates Directive, Urban Waste Water Directive.

0 6 Km

Date: 24/02/2016

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EcoServ-GIS

4.7 Food production capacity

4.7.1 What is it and why is it important?

Food production models the capacity of the land to produce food under current farming practices. Although much of the SWP is marginal for agriculture, farming remains important in terms of rural livelihoods and as a significant contributor to the local economy. It is important that the impact on farming and rural livelihoods is taken into account when considering options and opportunities for land use change.

It should be noted that food production is reliant upon a combination of the natural environment and human inputs, in the form of machinery and other manufactured inputs, labour and expertise. Hence a value for food production capacity includes more than simply natural capital and does not attempt to disentangle natural from human inputs.

4.7.2 How is it measured?

A bespoke model was created that models the gross margin of agricultural production for each grid square. This involved a number of steps:

1. Crop areas and livestock numbers were obtained from agcensus, which is itself obtained from Defra's June agricultural census.
2. These were then multiplied by typical yields (for crops) and farm gate prices, to give gross output.
3. Typical variable costs (e.g. fertilizers, seeds, sprays, husbandry, feed and forage costs) were obtained from agricultural budgeting books for each crop and livestock type, and were subtracted from gross output to provide a calculation of gross margin.
4. The data was projected across the study area, resampled at a 1 ha resolution and normalised on a 0 to 100 scale relative to values present within the study area.

Note that this does not take into account fixed costs such as buildings and machinery. However, gross margin is the usual way in which agricultural outputs are reported in government statistics and in the scientific literature.

4.7.3 Results for the South West Peak

The map showing food production capacity is shown on the next page (Map 17). There is very little arable farming in the SWP or buffer zone, hence food production is dominated by cattle and sheep farming. The highest values occur in the buffer zone to the west and south-west of the SWP and, to a slightly lesser extent, in the buffer zone to the south-east. These are predominantly areas of dairy farming. The SWP area itself has highest food production in the areas adjacent to those already described, and is also predominately dairy farming. The core central and northern parts of the SWP are dominated by extensive sheep farming on the hills, where output per hectare is low.

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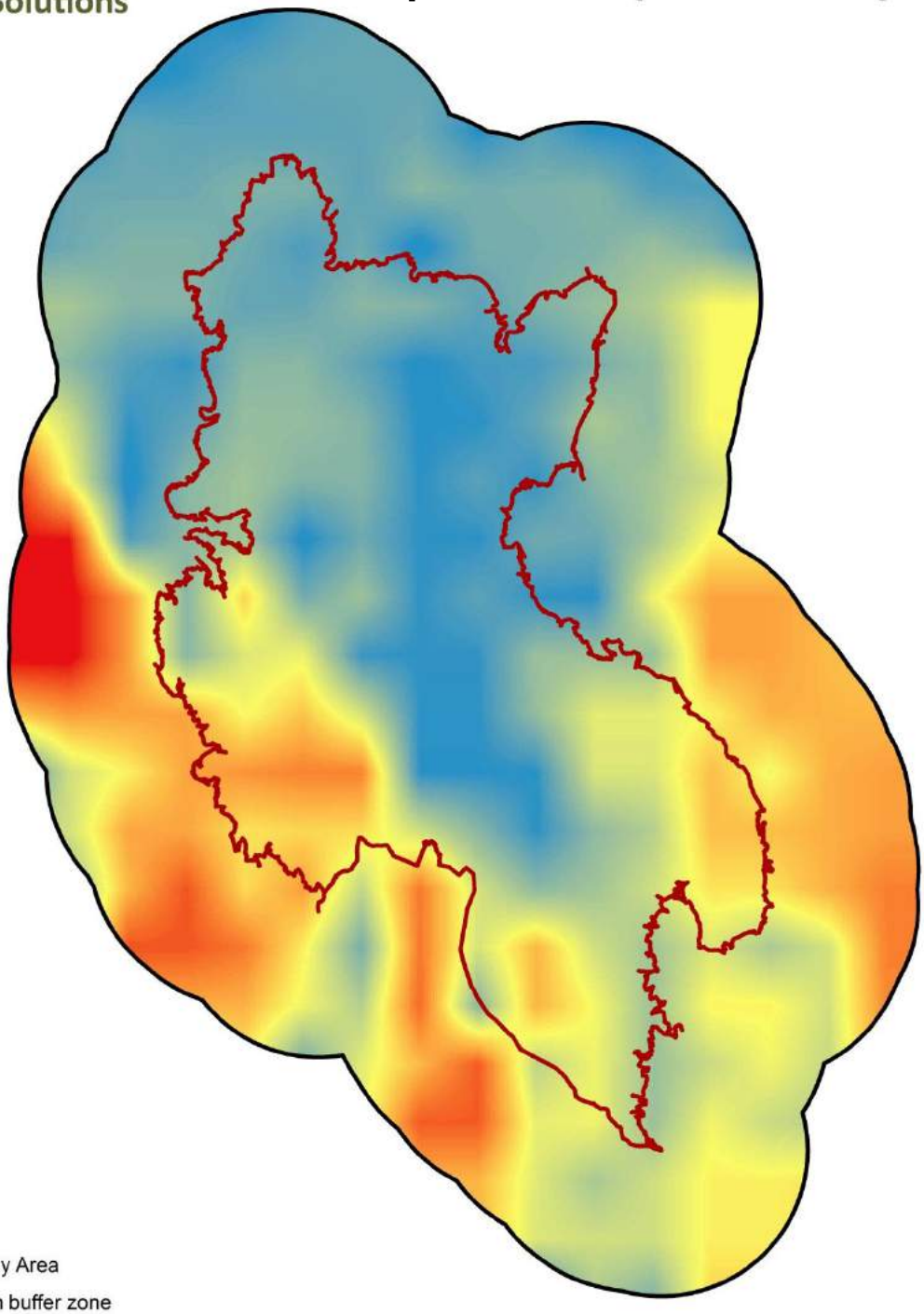
Map 17: Food provision capacity



Legend

Study Area

5 km buffer zone

Food provision capacity

Value

High : 100

Low : 0

Models the gross margin of agricultural production for each grid square.

Crop areas and livestock numbers were obtained from agcensus, based on Defra June agricultural statistics. These were multiplied by typical yields (for crops) and farm gate prices to give gross output. Gross margin then calculated by subtracting typical variable costs (e.g. fertilizers, sprays, feed and forage costs). Does not take into account fixed costs such as buildings and machinery.

Scores are on a 0 to 100 scale, relative to values present within the Study Area.

0 6 Km

Date: 15/02/2016

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(at A4 paper size)

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EcoServ-GIS

4.8 Tranquillity capacity

4.8.1 What is it and why is it important?

According to the Campaign to Protect Rural England (CPRE) tranquillity is "*a quality of calm that people experience in places full of the sights and sounds of nature*". It is generally associated with the countryside and can be impacted "*by the intrusive sights and sounds of man-made structures*". Tranquillity is considered to be an important cultural service delivered by the natural environment and access to tranquil places has been linked with enhanced health and wellbeing. Furthermore, tranquillity is one of the most stated reasons for visiting the countryside in general, and the South West Peak in particular, and so has particular significance in the study area.

4.8.2 How is it measured?

CPRE and Natural England commissioned a major study into tranquillity in the 2000s, involving an extensive public consultation to discover the components that contributed to an experience of tranquillity. Positive factors included the openness of the landscape, perceived naturalness of the landscape, presence of rivers, and areas of low noise, whilst negative indicators included presence of other people, visibility of roads and urban development, general signs of overt human impact, and road, train and urban area noise. Following this consultation a composite indicator was developed based on 44 positive and negative factors that contribute towards tranquillity and this was turned into a national map.

The National Tranquillity Mapping Data 2007 was obtained under licence from CPRE. The original data was resampled at 10m by 10m resolution and normalised across study area on a 0 to 100 scale relative to values present within the study area including buffer.

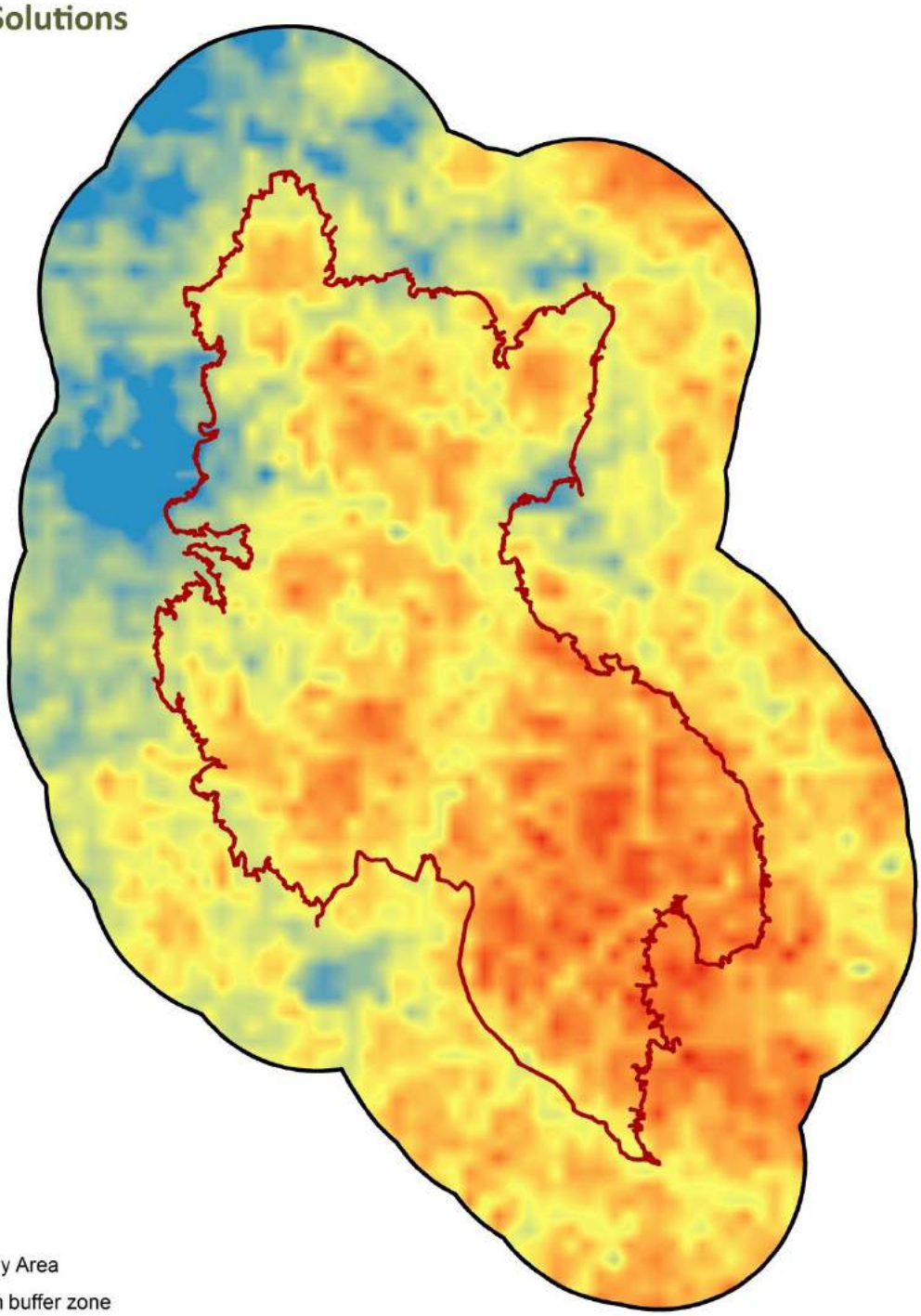
4.8.3 Results for the South West Peak

Much of the core SWP study area delivers high levels of tranquillity (see Map 18), with the south-east portion of the SWP providing the very highest levels. This corresponds to the less visited parts of the National Park, away from major roads.

The least tranquil areas are in and around the towns, particularly in the buffer zone around Macclesfield and the edge of Greater Manchester. It is also possible to make out the major road corridors that pass through the SWP, which have reduced tranquillity scores compared to the areas through which they pass.

Natural Capital Solutions

Map 18: Tranquillity capacity



Legend

Study Area

5 km buffer zone

Tranquillity capacity

Value

High : 100

Low : 0

Derived from CPRE's National Tranquillity Mapping Data 2007

Composite indicator based on 44 positive and negative factors that contribute towards tranquillity. Scores are on a 0 to 100 scale, relative to values present within the Study Area

National Tranquillity Mapping Data 2007 developed for the Campaign to Protect Rural England and Natural England by Northumbria University. OS Licence number 100018881.

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EcoServ-GIS

4.9 Accessible nature capacity

4.9.1 What is it and why is it important?

Access to greenspace is being increasingly recognised for the multiple benefits that it can provide to people. In particular there is strong evidence linking access to greenspace to a variety of health and wellbeing measures. Research has also shown that there is a link between wellbeing and perceptions of biodiversity and naturalness. Natural England and others have published guidelines that promote the enhancement of access, naturalness and connectivity of greenspaces.

The two key components of accessible nature capacity are therefore public access and perceived naturalness. Both of these components are captured in the model, which maps the availability of natural areas and scores them by their perceived level of naturalness.

4.9.2 How is it measured?

We used an EcoServ model to map accessible nature capacity. In the first step, accessible areas are mapped. These are defined as:

- Areas 10m either side of linear routes such as Public Rights of Way, pavements and Sustrans routes.
- Publicly accessible areas such as country parks, CRoW access land, local nature reserves and accessible woodlands.
- Areas of green infrastructure marked as accessible, including parks, playgrounds, and other amenity greenspaces.

These areas were then scored for their perceived level of naturalness, with scores taken from the scientific literature. Naturalness was scored in a 300m radius around each point, representing the visitors experience within a short walk of each point.

The resulting map (next page) shows accessible areas, with high values representing areas where habitats have a higher perceived naturalness score. Scores are on a 1 to 100 scale, relative to values present within the study area and buffer. White space shows built areas or areas with no public access.

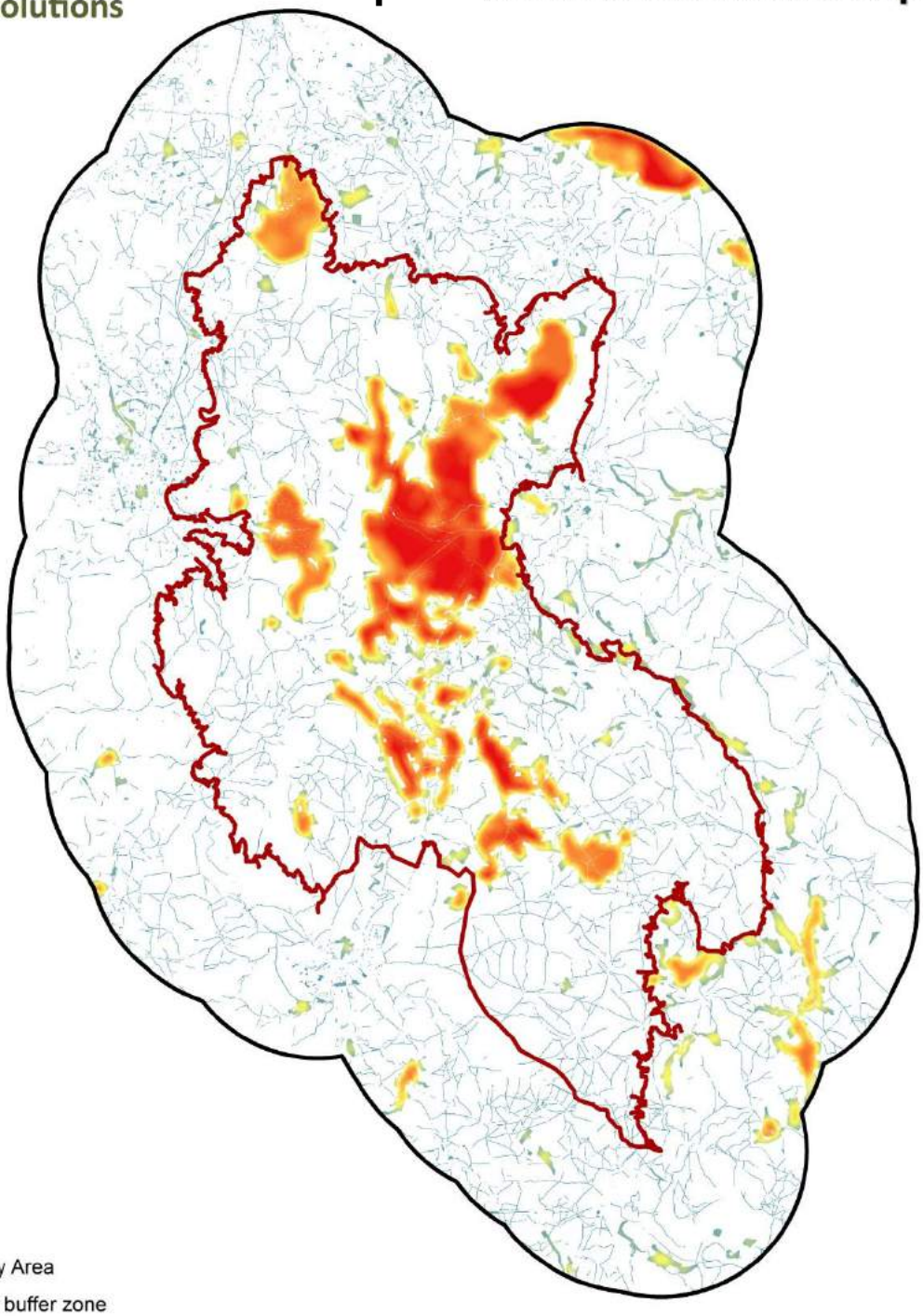
Larger continuous blocks of more natural habitat types will have higher scores than smaller isolated sites of the same habitat type. One consequence is that linear routes, such as footpaths, that pass through land with no other access do not usually score highly. This was raised at the stakeholder workshop as an area of possible concern. It would be easily possible to adjust the score so that it provided a score simply for the habitat that the path passes through, rather than a 300m focal distance around the path, most of which is inaccessible. An alternative would be to produce an indicator of path network density, which could be combined with the naturalness indicator.

4.9.3 Results for the South West Peak

Accessible nature capacity is shown in Map 19. The public access land in the centre of the SWP area and predominantly consisting of bog and heathland habitats, provides much the highest scores. There is an extensive network of paths and linear routes throughout the SWP and buffer, which can be clearly identified from the map, although these are all low scoring due to the use of 300m focal buffers around each point (see paragraph above).

Natural Capital Solutions

Map 19: Accessible nature capacity



Legend

Study Area

5 km buffer zone

Accessible nature capacity

Value

High : 100

Low : 1

Models the perceived naturalness of the area and whether it is publicly accessible. Access to greenspace or semi-natural habitats has been shown to enhance health and wellbeing.

High values represent areas where habitats have a higher perceived naturalness score. Larger continuous blocks of more natural habitat types will have higher scores than smaller isolated sites of the same habitat type. Scores are on a 1 to 100 scale, relative to values present within the Study Area. White space shows built areas or areas with no public access.

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EcoServ-GIS

4.10 Accessible nature local demand

4.10.1 What is it and why is it important?

This map shows where there is greatest demand for accessible nature, which is strongly related to where people live. Research, including large surveys such as the Monitor of Engagement with the Natural Environment (MENE), has shown that there is greatest demand for accessible greenspace close to people's homes, especially for sites within walking distance. Furthermore, Natural England have published Accessible Natural Greenspace Standards (ANGSt), which set out guidelines on the on the size and proximity of greenspace in relation to where people live.

4.10.2 How is it measured?

There are two types of demand map that can be produced for accessible nature; demand based on destination areas (sites) and demand based on trip sources (homes). To be compatible with the other ecosystem services maps, we have produced a demand map based on trip sources by modifying a model in the EcoServ toolkit. The model maps local demand based on three indicators:

- Population density – based on 2011 census data, as larger population have greater demand for accessible nature.
- Health scores – taken from the Index of Multiple Deprivation general health scores, with the assumption that those in worse health have the greatest need and would benefit most from access to greenspace.
- Estimated visitation likelihood – based on distance at three different scales as demand is strongly related to distance. The distances chosen (and rationale) were: 600m (approx. 10 minute walk), 3.2 km (median distance travelled by all visitors using all modes of transport in the MENE survey), and 30 km (based on work published by Defra examining distance travelled to higher quality sites).

Note that this is a model of local demand and does not take into account demand from people living outside of the study area.

4.10.3 Results for the South West Peak

Local demand for accessible nature is shown on Map 20. It is strongly focussed around the urban areas in the buffer zone, especially Macclesfield, Buxton, and the periphery of Greater Manchester, and this high demand spreads into the fringes of the SWP core area. There is still some demand throughout the SWP, although local demand will be lower in these areas that are further away from population centres. As already stated, however, the model does not take into account the high levels of demand generated by specific honeypot sites, or demand from people living outside the area who travel much greater distances to visit the South West Peak.

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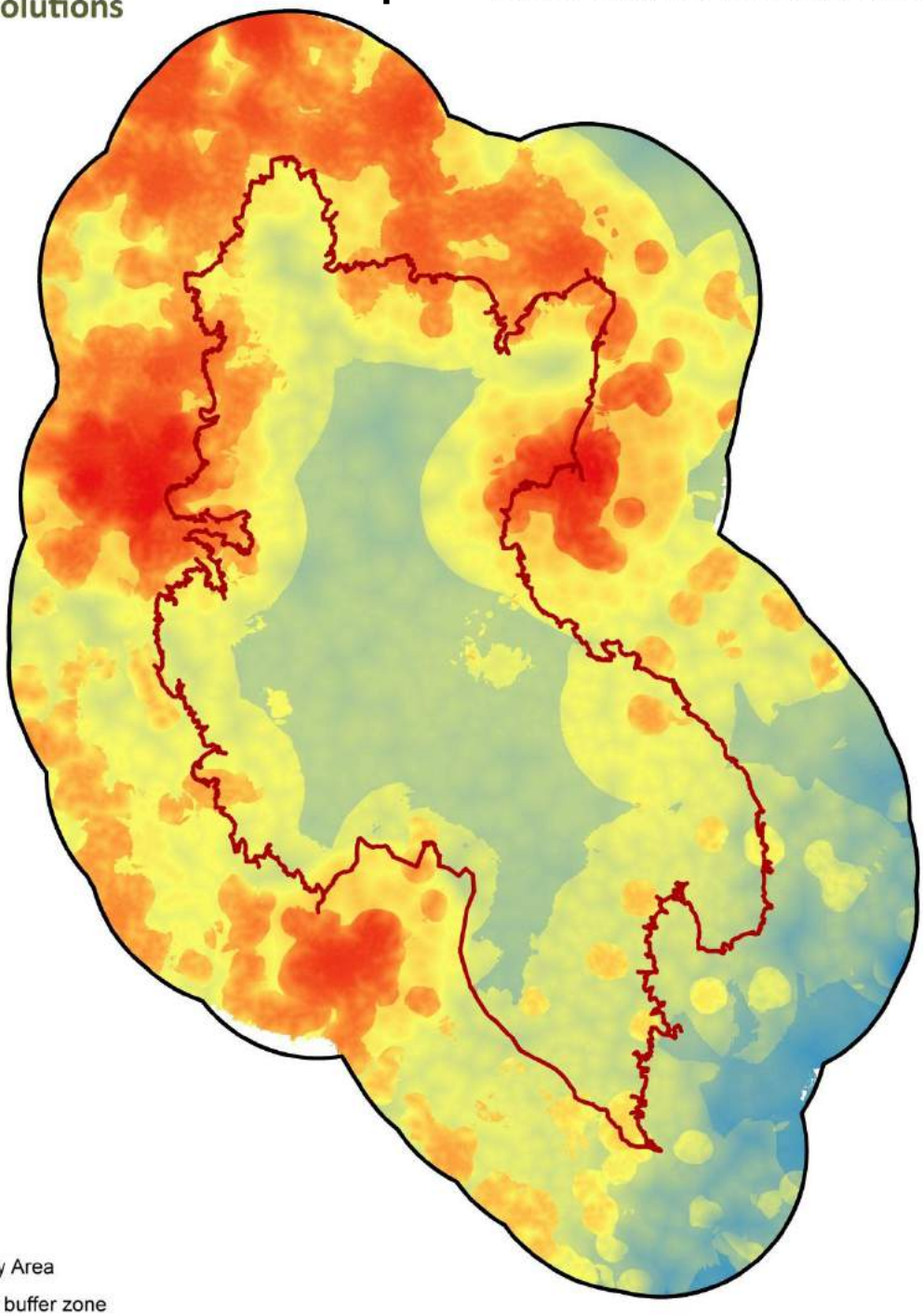
Map 20: Accessible nature demand



Legend

Study Area

5 km buffer zone

Accessible nature demand

Value

High : 100

Low : 1

Models the local demand for accessible natural greenspace. Demand is based on three indicators: population density. health scores, and estimated visitation likelihood (based on distance).

Research has shown that there is greatest demand for sites close to peoples homes. This model does not take into account demand for accessible natural greenspace from people living outside of the stuidy area.

Scores are on a 1 to 100 scale, relative to values present within the Study Area.

0 6 Km

Date: 08/02/2016

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EcoServ-GIS

4.11 Green travel capacity

4.11.1 What is it and why is it important?

Green travel routes are linear travel networks that pass through natural areas, and green travel capacity maps the availability of such networks. Availability of such routes is associated with multiple benefits including increasing physical exercise, reducing pollution and congestion, and general health and wellbeing benefits.

4.11.2 How is it measured?

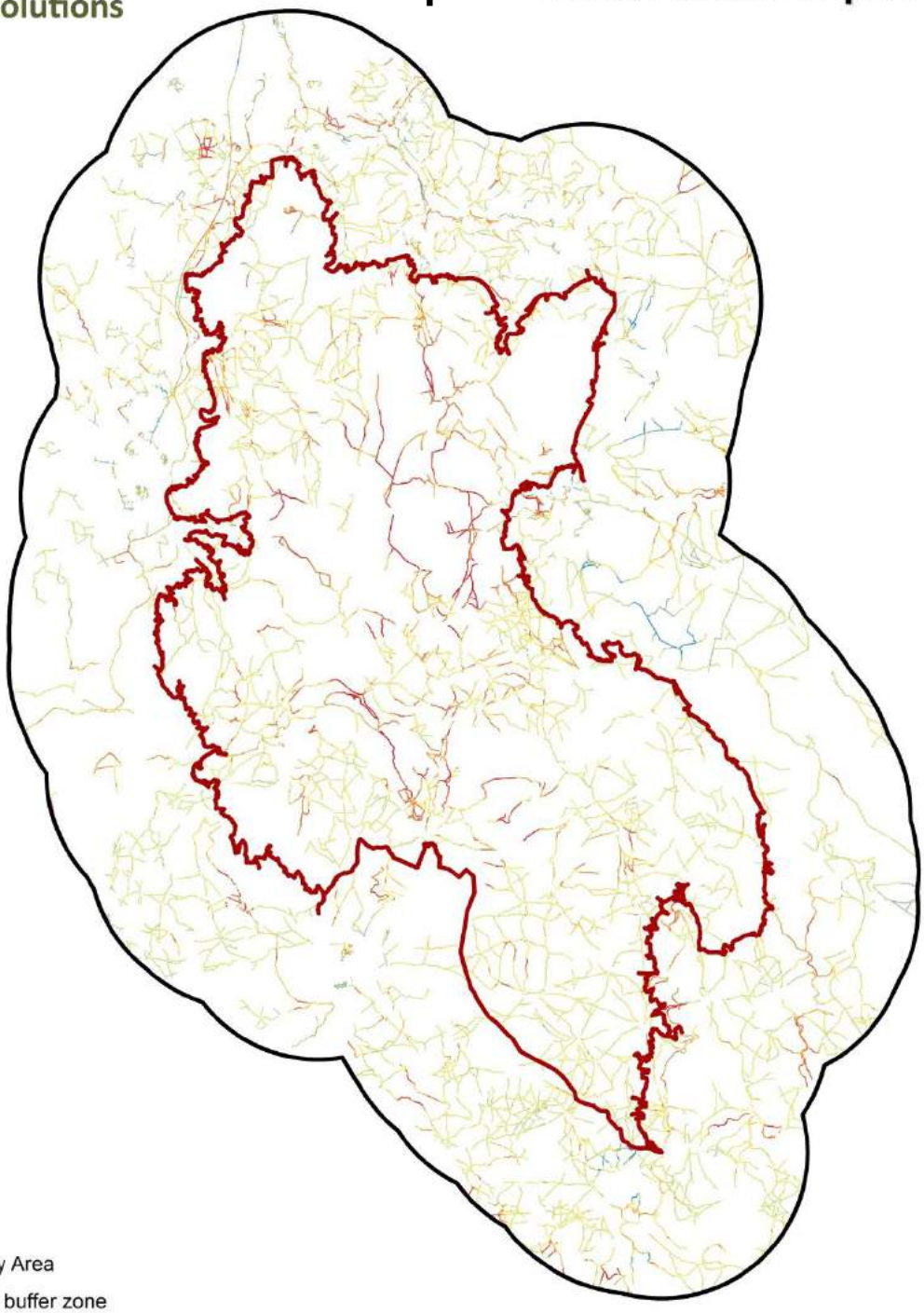
We used an EcoServ model to map green travel capacity. The method has some similarities to the accessible nature capacity model as the first step identifies travel routes and the second step assesses their naturalness. Travel routes were identified from Sustrans cycle routes, Public Rights of Way / Core paths and all pavements and paths. Small areas of isolated paths were excluded. The perceived naturalness of the habitat through which the travel route passes was then determined. Scores are on a 1 to 100 scale, relative to values present within the study area and buffer.

4.11.3 Results for the South West Peak

Green travel capacity is shown on Map 21. The map highlights the travel network of paths, pavements and cycle routes that spreads throughout the SWP and buffer zone. The highest scores (red coloured routes) occur in the centre of the SWP, where routes travel through the most natural habitats, such as bog, heathland, wet grasslands and broadleaved woodland.

Natural Capital Solutions

Map 21: Green travel capacity



Legend

Study Area

5 km buffer zone

Green travel capacity

Value

High : 100

Low : 1

Green Travel routes are linear travel networks that pass through natural areas where people may benefit from a safer, calmer or more aesthetically pleasing travel route.

Routes are identified from Sustrans cycle routes, public footpaths / Core paths and all pavements and paths mapped by OS MasterMap data. The model determines how "natural" habitat types are along linear travel networks based on perceived naturalness scores.

Scores are on a 1 to 100 scale, relative to values present within the Study Area.

0 6 Km

Date: 08/02/2016

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(at A4 paper size)

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EcoServ-GIS

4.12 Green travel demand

4.12.1 What is it and why is it important?

This model estimates the societal demand for green travel routes, based on the location of popular travel destinations. It is focussed more around frequent regular travel such as commuting to school and work, rather than infrequent leisure journeys.

4.12.2 How is it measured?

We carried out modifications to an EcoServ model to map green travel demand. Initially we mapped potential travel destinations, which were taken to be town and village centres, railway stations, schools and colleges. These points were buffered and connected to the travel network identified in the green travel capacity model. Travel along the network was then modelled using a least-cost analysis, based on distance, up to a maximum distance of 10 km. Scores are on a 1 to 100 scale, relative to values present within the study area.

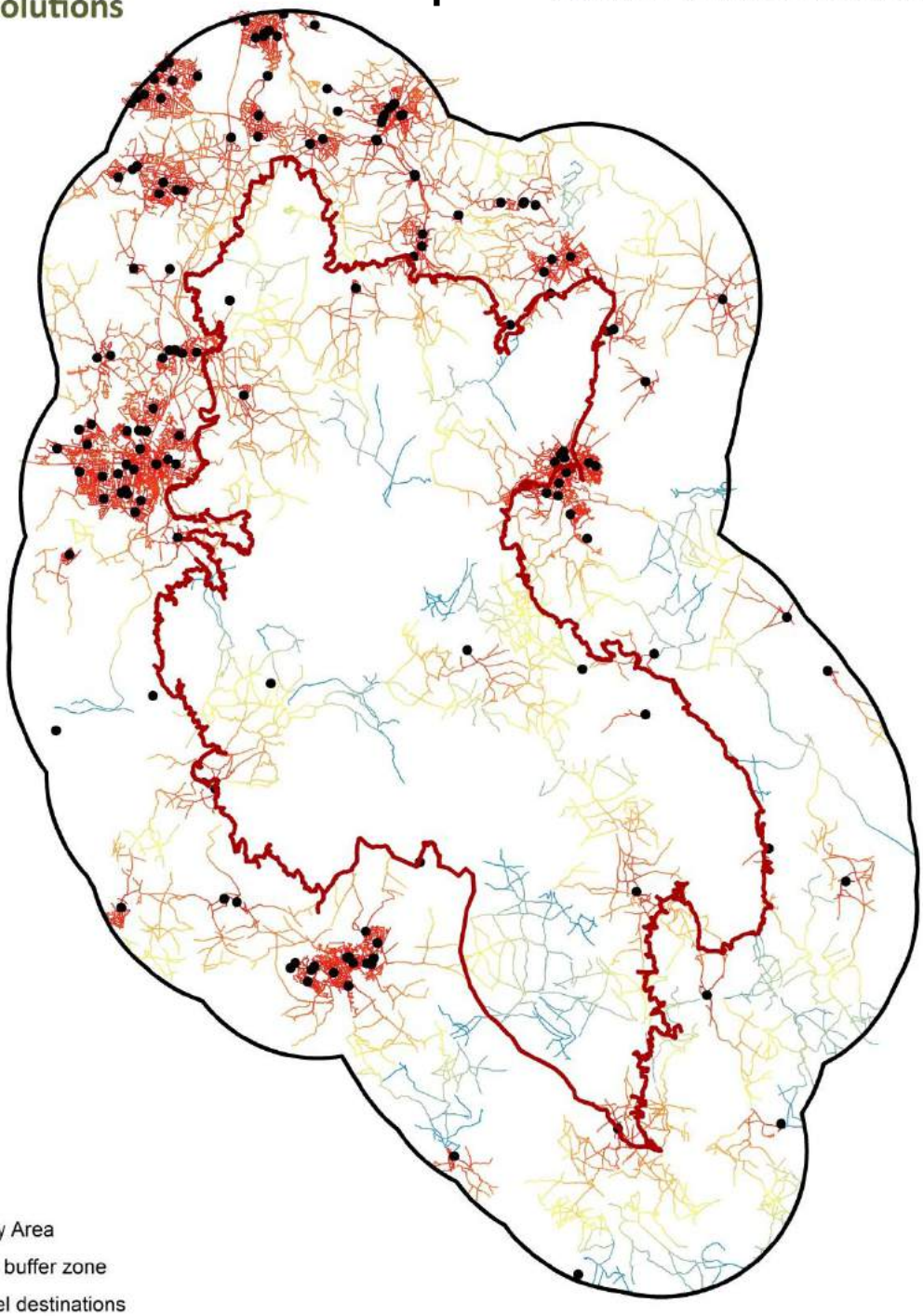
4.12.3 Results for the South West Peak

Travel destinations are shown as black diamonds on the map opposite (Map 22). These are clustered in the towns and hence the greatest demand is very much centred on and immediately around these urban areas. However, there is still strong demand for green travel routes in the parts of the SWP core area that are close to these urban centres. There is also at least some demand mapped for green travel routes that cross right over the SWP area, connecting the more distant towns and villages to one another.

Note that all of the travel destinations used in this study were urban destinations. It would be interesting to add the key visitor locations within the SWP and then to repeat the analysis.

Natural Capital Solutions

Map 22: Green travel demand



Legend

- Study Area
- 5 km buffer zone
- Travel destinations

Green travel demand

Value

High : 100

Low : 1

Green Travel routes are linear travel networks that pass through natural areas where people may benefit from a safer, calmer or more aesthetically pleasing travel route.

Demand for green travel routes is mapped using a least-cost analysis, along the linear travel network. Travel destinations used (shown as black diamonds) are railway stations, town / village centre locations and schools and colleges.

Scores are on a 1 to 100 scale, relative to values present within the Study Area.

0 6 Km

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EcoServ-GIS

5. Delivering multiple ecosystem services

5.1 Overall supply of ecosystem services

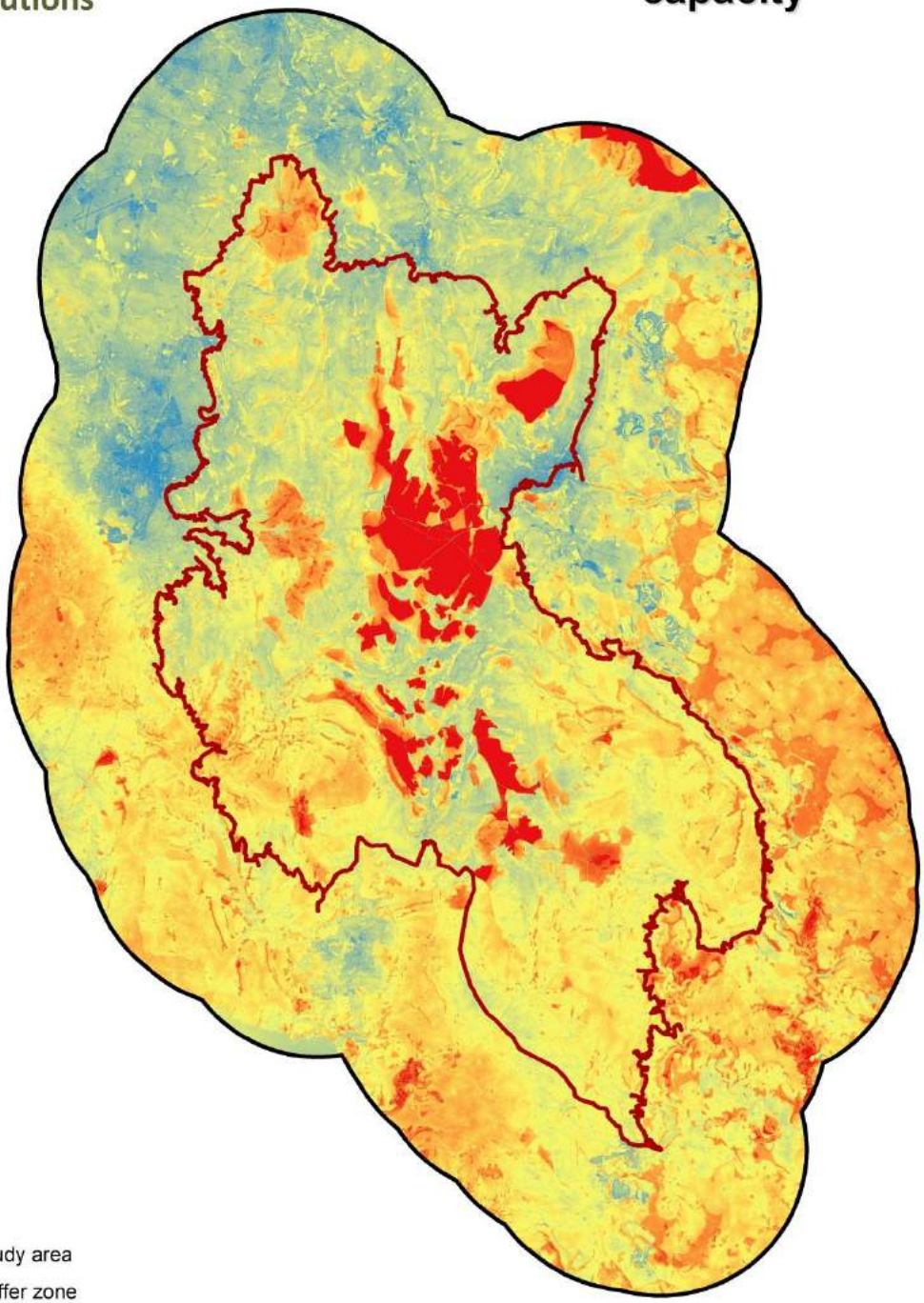
The average provision across six ecosystem services modelled in this project is shown in Map 23. Green travel capacity was not included in this average map as it is measured in a similar way to accessible nature capacity and so was excluded to avoid double counting. Average ecosystem service capacity is highest predominantly in the bog and heathland habitat at the core of the South West Peak. This is due to the peaty soils being particularly good as a carbon store, accessible and tranquil, as well as being reasonably good for water storage and quality capacity. There are also areas of reasonably high provision to the west and north of this core, the latter is mixed broadleaved woodland, that reflects high accessible nature and tranquillity capacity. There are few areas of low provision with the SWP boundary. East of the SWP in the area of limestone within the buffer area there are also high average values of provision largely due to high water quality and flow, and tranquillity capacity.

5.2 Hotspots of ES supply

The capacity to which the SWP is able to provide hotspots of multiple ecosystem services is shown in Map 24. Here each polygon can supply between 1 and 8 ecosystem services. A hotspot is defined as the top 20% of the area of the SWP that has the highest provision of ecosystem services for the six ecosystem services included above, or the presence of a key location for habitat for biodiversity (Map 3) or archaeology / history (Map 4). The bog and heathland core of the area is a hotspot of ecosystem service provision, showing an ability to provide up to 7 ecosystem services. An area in the north of the region is also a hotspot, an area of mixed broadleaved woodland, parkland and reservoirs (Lyme Park). Note that the blue areas do not indicate that there is no service provision, only that they are not areas where service provision is high.

Natural Capital Solutions

Map 23: Average ecosystem service capacity



Legend

SWP study area

5 km buffer zone

Average ES capacity

Value

High : 79.6

Low : 0.2

This map shows the average ecosystem service provision (capacity) across 6 ecosystem services: carbon storage, water flow, water quality, food production, tranquillity, and accessible nature capacities.

Scores are relative to values within the SWP and buffer zone and are the average of the 6 individual ecosystem service maps for each 10m by 10m grid square.

0 6 Km

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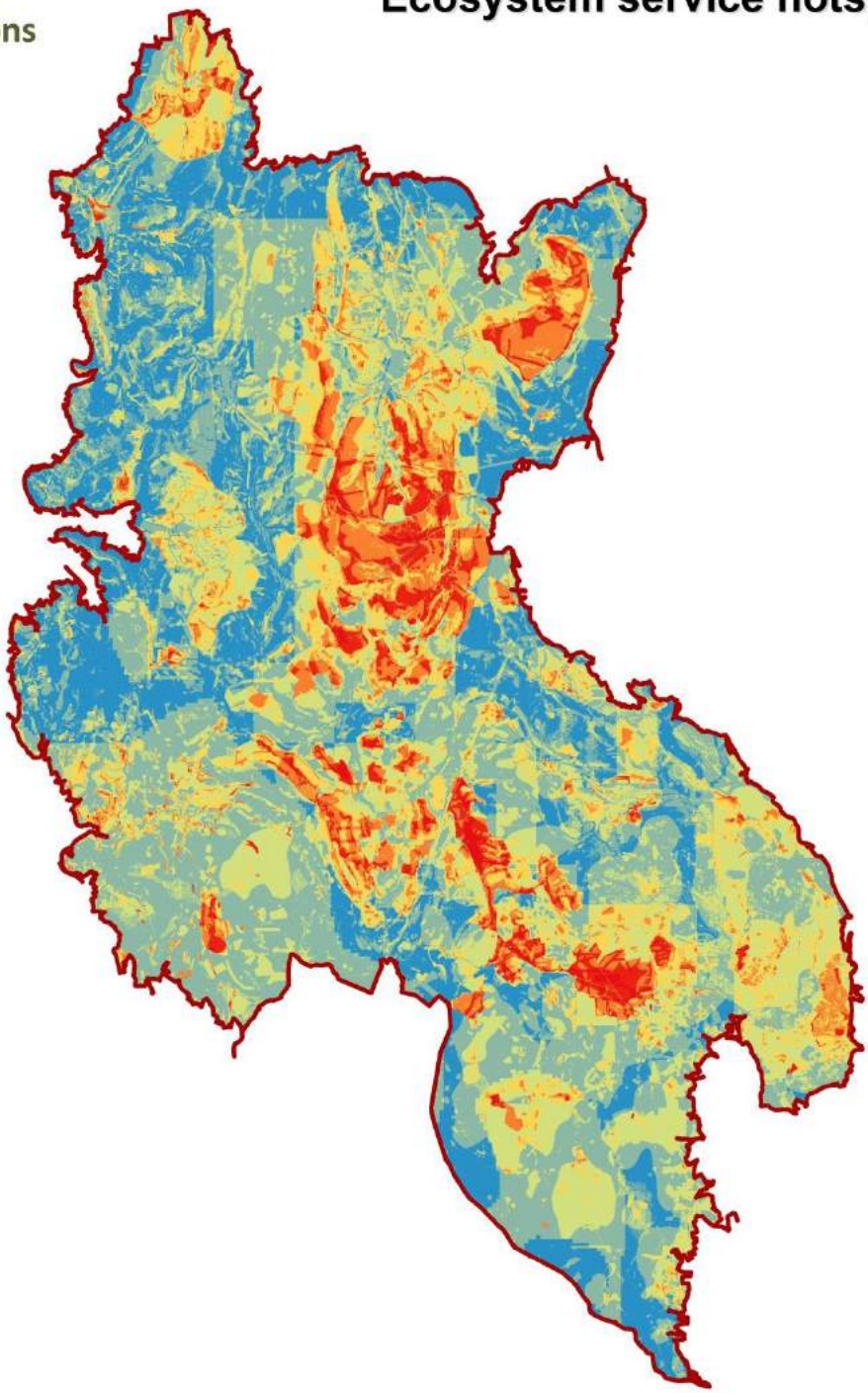
EcoServ-GIS

Natural Capital Solutions

Map 24:
Ecosystem service hotspots



Legend

SWP study area

Value

High : 7

Low : 0

This map shows the hotspots of ecosystem service (ES) capacity in the core SWP study area. The value shown relates to the number of different ES for which that grid square is a hotspot (out of a maximum possible of 8). A hotspot is defined as the top 20% area for carbon storage, water flow, water quality, food production, tranquillity, and accessible nature capacities, or the presence of abkey location for archaeology and history, and habitat for biodiversity.

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EcoServ-GIS

5.3 Ecosystem services and Landscape Character Types

The SWP area is comprised of eight main landscape character types (Map 25), densely enclosed gritstone upland, enclosed gritstone upland, moorland hills and ridges, open moors, reservoir valleys with woodland, slopes and valleys with woodland, upland pastures and upper valley pastures. In Table 4 below we show a summary of the level of provision of each modelled service, and the proportion of each that is wader and BAP habitat, and of historic and archaeological importance.

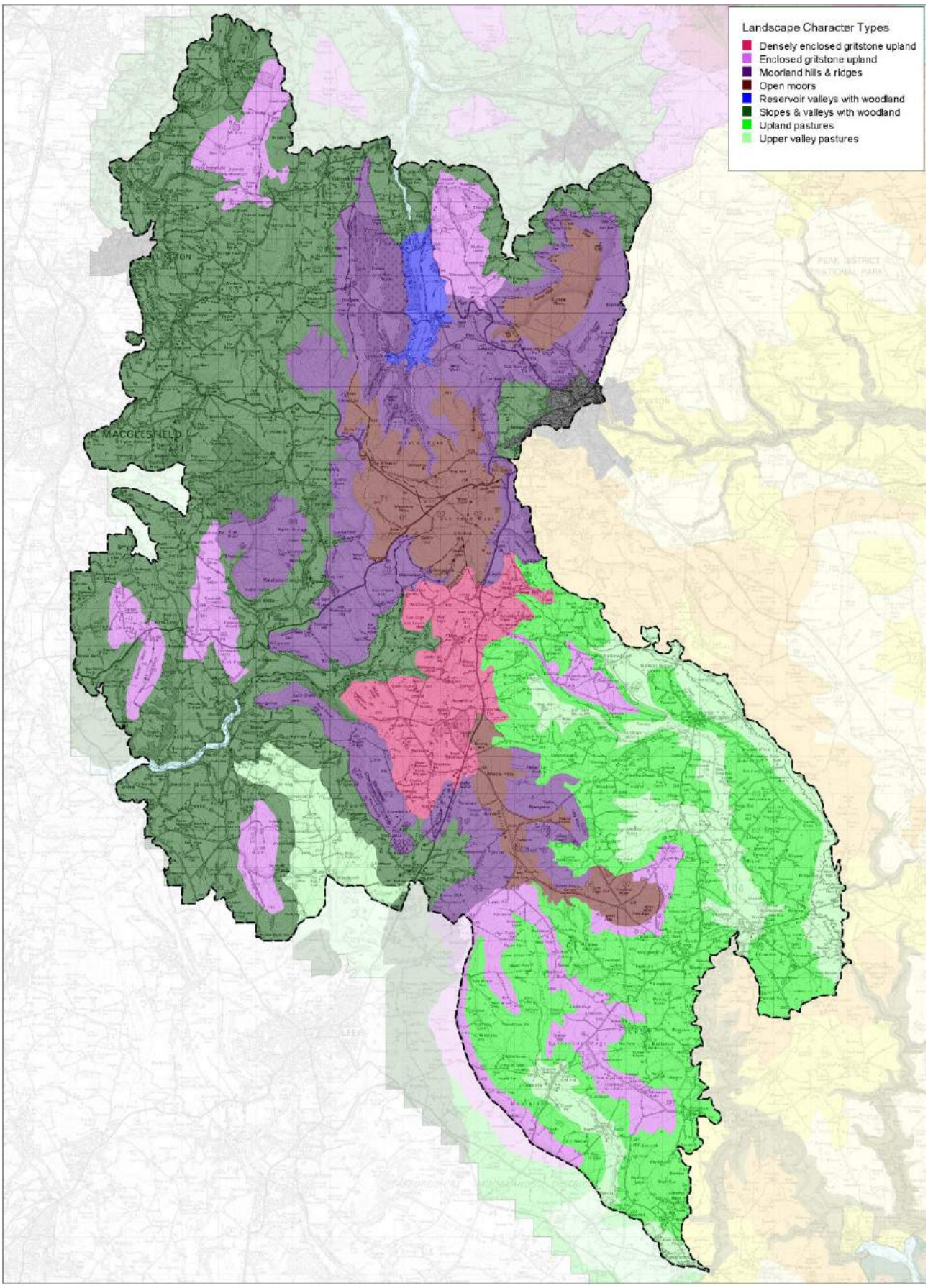
Table 4. Average ecosystem service provision in each Landscape Character Type and percentage of habitat that is important for biodiversity and history / archaeology.

LCT	Ecosystem service	Production score 0 (low) – 100 (high)	% Wader / BAP habitat	% Historic / archaeological importance
Open moors	Accessible Nature	79.34	95	37
	Carbon Storage	68.61		
	Food provision	10.92		
	Tranquillity	67.77		
	Water flow	65.19		
	Water Quality	64.56		
Moorland hills and ridges	Accessible Nature	36.20	71	18
	Carbon Storage	24.36		
	Food provision	16.72		
	Tranquillity	66.99		
	Water flow	55.75		
	Water Quality	63.16		
Enclosed gritstone uplands	Accessible Nature	93.37	25	20
	Carbon Storage	11.17		
	Food provision	41.86		
	Tranquillity	67.33		
	Water flow	58.22		
	Water Quality	57.73		
Densely enclosed gritstone uplands	Accessible Nature	26.65	83	22
	Carbon Storage	28.85		
	Food provision	7.05		
	Tranquillity	64.52		
	Water flow	58.21		
	Water Quality	60.25		
Slopes and valleys with woodland	Accessible Nature	5.29	22	10
	Carbon Storage	11.35		
	Food provision	37.52		
	Tranquillity	57.89		
	Water flow	56.73		
	Water Quality	56.50		

Table 4 cont.

LCT	Ecosystem service	Production score 0 (low) – 100 (high)	% Wader / BAP habitat	% Historic / archaeological importance
Upper valley pastures	Accessible Nature	0.45	13	19
	Carbon Storage	10.00		
	Food provision	63.00		
	Tranquillity	77.11		
	Water flow	60.92		
	Water Quality	39.04		
Reservoir valleys with woodland	Accessible Nature	3.44	45	39
	Carbon Storage	12.07		
	Food provision	3.79		
	Tranquillity	65.57		
	Water flow	54.33		
	Water Quality	69.03		
Upland pastures	Accessible Nature	1.36	20	19
	Carbon Storage	10.40		
	Food provision	48.48		
	Tranquillity	78.48		
	Water flow	57.17		
	Water Quality	49.88		

Map 25: South West Peak Landscape Character Types



6. South West Peak Landscape Partnership Ecosystem Services Mapping Workshop

The ecosystem services mapping workshop was held on 18th February 2016 at the PDNPA's Aldern House in Bakewell, from 10.00-16.00. A list of Attendees is in Appendix (i). The aim of the workshop was to report on the findings of the SWP Landscape Opportunity Mapping Project carried out by Natural Capital Solutions. It was also to understand what the stakeholders thought that the SWP region should deliver them, the residents and visitors to the area, and to discuss the relative weighting of importance of the different ecosystem services that were modelled and mapped in the area as part of the project.

6.1 Workshop introduction

Karen Shelley-Jones gave an introduction to the SWPLPS and outlined the state of play with the Heritage Lottery Fund application. She illustrated how the Landscape Opportunity Mapping Project was one component of the baseline information that was going to be collected to inform the partnership proposal. JBA consulting are completing the flood risk modelling for the SWP. This will provide recommendations for the strategic location of water storage features that can be incorporated into the management of the landscape to reduce the risk of flooding.

6.1.1 Landscape opportunity and ES mapping

Jim Rouquette (NCS) presented the results of the habitat opportunity mapping. This covered the habitats included and a presentation of the maps (landscape permeability, habitat network, constraints and habitat opportunity) for heathland, mire, semi-natural grassland, wet grassland and woodland habitats. This included the floodplain woodland planting and woody debris dam opportunity maps, along with the JBA run-off attenuation features maps. Following this presentation was a brief discussion where the workshop participants asked questions and shared their thoughts on the work. There was interest in the landscape permeability scores and which species were used in each habitat by the JNCC to derive these scores. There was discussion around the utility of the modelling. The habitat opportunities analyses point the partnership to the areas that are the best candidates for, e.g., floodplain tree planting. These opportunity locations would have to be ground-truthed to see whether the area and the habitat around it was suitable for planting. Practical issues and/or barriers to these areas being 'real' opportunities may be land ownership, and habitat that might be important for ecological reasons other than those taken into consideration in the modelling. There was also discussion over how to expand habitat, should it be improving the quality of existing areas and making them larger, or concentrating on connecting habitat through the planting of new areas (the modelling suggested the former).

6.1.2 Ecosystem services mapping

Jim also presented the results of the ecosystem service mapping. Maps of the provision of and demand for seven ecosystem services (carbon storage, water flow, water quality, agricultural production, tranquillity, accessible nature and green travel) were shown, along with maps of the provision of habitat for biodiversity and the location of archaeological and historic sites. He explained briefly how the indicators were derived for each service and the main characteristics of the pattern of provision and demand. The overall supply of ecosystem services and hotspots of ecosystem service supply (top 10% of area for each ecosystem service) maps were also described. The proceeding discussion touched on whether the water flow modelling could

be extended to areas outside the SWP, to understand the implications for sites lower down the catchment. There were comments about the way some of the services were measured. For instance the bog measure assumes a set depth of peat, and some of the upland bog sites in the SWP have considerably more peat than this. This would have implications for actual carbon and water storage capacity. The valuation of these ecosystem services was identified as an important next step. The discussions also touched on the importance of this modelling as a way of identifying the multiple functions of this landscape and for prioritising which ecosystem services should be enhanced given the pressures on the environment, local economies and communities.

6.2 Break-out session 1

The question for discussion in the 3 break-out groups was: 'What do you want the SWP to deliver for you, residents and visitors in the next 20 years?' The following sub-questions were considered:

(i) What benefits do you want the management of the SWP to deliver over the next 20 years?

(ii) Outline the environmental management that would be required to achieve this.

(iii) How can this enhance local communities and the economy?

Key facts about the SWP region were then presented:

- Rural population of ~10,000 within an area of ~36,000 ha.
- Tourism: Less visitor pressure than other areas of the PDNP, valued for landscape diversity and tranquillity. A few honey-pot sites take most of the visitors. In general visitor pressure is increasing.
- Habitats and biodiversity: SPA, SAC, SSSI and local sites, internationally important breeding bird community associated with blanket mire, 12 BAP priority habitats, 3247 ha woodland, 438 ha of which is ancient woodland, good water quality that declines towards lowland valleys.
- Agriculture: Land Classification of very poor (Grade 5) and poor (Grade 4), with a few areas of good to moderate (Grade 3). Agriculture is predominantly upland livestock with some dairy farms (total agricultural workforce ~1400).
- Economy: driven by intensive pastoral farming and SMEs. This area has a greater proportion of lower-income, semi-skilled workers than the rest of the PNDP.

The regional challenges were identified as climate change, bringing an increased occurrence of extreme weather events, wetter winters, heavier rainfall and hotter/dryer summers, and land use change through shifts in agriculture driven by political and economic changes, and pressure from housing and renewable energy development.

6.2.1 Summary of outcomes

Each of the three break-out groups reported back and Table 5 gives a summary of the themes that emerged. The benefits that they would like the SWP to deliver are structured under two headings: social and economic, and environmental, a third heading outlines the environmental management required to achieve the delivery of these benefits.

Table 5. Break-out session 1 outcomes: benefits to be delivered by the SWP and environmental management required

Benefits	
Social and economic	**Environmental**
Community: low cost housing for young people, to ensure they are retained in local communities, better schools and shops, improved social structure and viable communities Informed and engaged communities, more cohesive social communities, stronger sense of place. Higher level of rural skills, stronger local identity, happy and healthier people, more diverse economy, a landscape that supports more employment. Better connectivity with the outside world – broadband and mobile reception improvements. **Tourism:** opportunity for sustainable tourism, outdoor experiences improved visitor numbers, income and management, better visitor experience, better access to the landscape **Sustainable agriculture:** improve viability of farm businesses to make upland farming a more attractive prospect, but to deal with soil/water/nutrient issues. Traffic management. Lower water bills	**Biodiversity:** a landscape generally richer in it. More curlew, waders in general, grassland with flowers. Designated sites in a more favourable condition Better stability and diversity of species, more robust and connected habitats. Links may be hedges, walls or water courses. **Landscape character:** field barns and walls in a better condition, enhanced and maintained character of the landscape, so it appears as a 'cared for' landscape. Heritage in better condition and better understood. Wider landscape – bigger, better and more connected. **Ecosystem services:** improvement in tranquillity, resilience to effects of climate change. Improved water quality, flood alleviation at catchment scale. Maximise landscape function and provision where possible. **Stewardship and practical management:** building the bridges between those who visit and those who look after the area. Greater understanding of the landscape so people look after it and invest in it. Local volunteering to do some of the practical work in looking after the landscape.
Environmental management to deliver benefits	
Conservation: high nature value farming/land management. River restoration and naturalisation (slowing the flow). More sustainable water management, e.g. restoration of the original form of the River Manifold. Rewilding. Invasive species management and protection of native species e.g. predator control for waders. Build on the heritage and restore it. **Catchment management:** catchment scale solutions to flooding, deal with soil nutrient, stock management and pesticide use issues. **Tourism management:** provide environmentally sustainable visitor infrastructure and destination management. Better education and communication of residents and visitors. Boundary features – incentives and training **Agricultural management:** product accreditation and branding from High Nature Value, effective marketing and promotion **Payments for Ecosystem Services:** more markets and visitor payback. **Overall comments:** Remove individual organisational targets and jargon. Deliver a vision that is inclusive and united.	

It was agreed that 20 years is rather short-term thinking, and that if any meaningful and sustainable change was going to occur in the area, any management recommendations over the life of the project would need to have impact over a much longer timescale. Some important themes that came from the discussion after the break-out groups report back was around the importance of engaging the local community. Managed environmental changes will only be sustainable if they have the understanding and support of the local community. This means creating and supporting vibrant, happy and healthy communities that are connected to their environment and have a sense of place. If the local community can see that being stewards of the environment brings social and economic benefits, they may feel more inclined to do it. It will be a big challenge to the project to find new and effective ways of achieving engagement. This is going to be key to any success. How to measure the successes of the project was also thought to be a challenge.

There was also an in depth discussion about how Payments for Ecosystem Services (PES) schemes might work in the area, particularly in relation to farming. Stakeholders could see how a PES scheme might work during the life of the project, where farmers are paid to manage their land to deliver certain ecosystem services (e.g. improving habitat for biodiversity, decreasing pesticide use to enhance water quality), but it is the long term sustainability of such a scheme that caused concern. It is not viable to include farmers in such an experiment if their livelihood depends on farming, it could possibly be piloted on those land owners that have other incomes, so that they are not losing out if the payment comes to an end. There is an issue over who pays for these ecosystem service benefits. However, this is seen as a potential opportunity for the SWP.

6.3 Break-out session 2

This break-out session focused on weighting the importance of ecosystem services in each of the SWP Landscape Character Types (LCT) (see Map 25). Six ecosystem services were considered: **accessible nature** - public accessibility and perceived naturalness, **carbon storage** - storage of carbon in above and below ground biomass, **food provision** – gross margin, **tranquillity** - positive and negative factors (e.g. naturalness of landscape, road noise) that contribute to tranquillity, **water flow** - ability of landscape to reduce water flow (roughness, slope and run-off retention) and **water quality** - ability of landscape to purify water (proportion of sealed surface, improved agriculture, erosion risk). These services were derived from the ones that have been modelled as part of the project. Working in three break-out groups the participants weighted the importance of each of the six ecosystem services within each LCT according to the following classification: 1 = extremely important, 2 = important, 3 = moderately important, 4 = slightly important, 5 = not at all important. To help inform the weighting, each group was supplied with a description of each LCT, e.g. location, habitats and main land uses, and figures on the current level of production of each ecosystem service within each LCT, and the proportion of each that is wader and BAP habitat and of historic and archaeological importance (see Section 5.3). They were also asked to consider the types of land use change or management that might be necessary to enhance the ecosystem services they thought were important, and examples of what these might be were given for each service in each LCT.

6.3.1 Summary of outcomes

Table 6 below shows the results of the weighting scores of each of the six services in each LCT.

Table 6. Weightings of each ecosystem service in each LCT (1 = extremely important, 2 = important, 3 = moderately important, 4 = slightly important, 5 = not at all important).

LCT	Ecosystem service	Group 1	Group 2	Group 3
Open moors	Accessible Nature	2/3	4	2
	Carbon Storage	1	1	1
	Food provision	5	4	5
	Tranquillity	3	1	2
	Water flow	1	1	1
	Water Quality	1	1	1
Moorland hills and ridges	Accessible Nature	4	4	2
	Carbon Storage	2	3	2
	Food provision	4	4	5
	Tranquillity	2	1	2
	Water flow	1	2	2
	Water Quality	2	1	2
Enclosed gritstone uplands	Accessible Nature	3	4	2
	Carbon Storage	3	4	3
	Food provision	3	3	4
	Tranquillity	2	1	3
	Water flow	1	2	2
	Water Quality	1	1	2
Densely enclosed gritstone uplands	Accessible Nature	2	5	2-4
	Carbon Storage	2/3	3	3
	Food provision	3	4	4/5
	Tranquillity	2	1	2
	Water flow	2	2	2
	Water Quality	2	1	2
Slopes and valleys with woodland	Accessible Nature	2	2	1/2
	Carbon Storage	2	4	2
	Food provision	3	1	4
	Tranquillity	4	3	3
	Water flow	1	1	2
	Water Quality	1	1	2
Upland pastures	Accessible Nature	3	4	2
	Carbon Storage	4	4	2/3
	Food provision	2/3	2	4
	Tranquillity	3	1	2
	Water flow	2	2	2
	Water Quality	1	1	2

Table 6 Cont.

LCT	Ecosystem service	Group 1	Group 2	Group 3
Upper valley pastures	Accessible Nature	3	3	2
	Carbon Storage	3	4	3
	Food provision	2	1	3
	Tranquillity	2	2	2
	Water flow	1	2	2
	Water Quality	1	1	1
Reservoir valleys with woodland	Accessible Nature	2	2	2/3
	Carbon Storage	1	3	4
	Food provision	4	4	5
	Tranquillity	3	3	3
	Water flow	1	2	3
	Water Quality	1	1	3

In general there was good agreement among the groups in their scoring of the moorland LCTs. There was more divergence in the enclosed gritstone uplands and the reservoir valleys with woodland. One group saw the latter LCT as a perfect area to enhance visitor numbers and gain economic investment from private organisations, whereas another group could not see how this area could be enhanced any further, especially as it is already a popular site for tourists. The ecosystem services that had the most consistently variable scores were accessible nature, tranquillity and food provision. There was a good level of agreement on the importance of water flow and quality, and these services were considered important or extremely important in all LCTs. It was thought that enhancing these services could bring the most added value across all the LCTs, for instance restoring bog for increasing water holding capacity and reducing erosion, would also be good for carbon storage, as would planting trees on the floodplain for slowing the flow. Those services that showed trade-offs were accessible nature and tranquillity, but also food production and all other services. The former was because most people considered making wild areas more accessible, and therefore increasing visitor numbers, would lower the tranquillity they offer. Land management for farming was considered to have the most negative effects on the water ecosystem services that were weighted so highly, and any significant enhancement of this service would bring with it implications for other services. The weightings also reflect the opportunities that the landscape types present for enhancing services. For instance, while carbon storage is thought important in moorland areas, where peat can effectively produce this service, there are fewer opportunities in other LCTs for such effective storage, apart from where woodland habitat exists on the slopes and around flood plains.

However, it must be noted that there were differences between the groups in the way that the weights were assigned, but also within groups as they adapted their approach through the task. There was also some disagreement with the indicator for the service accessible nature, as it made it difficult for the groups to make clear weighting decisions. The two main aspects of accessible nature, naturalness and accessibility, were not seen as compatible. One group decided to score biodiversity as a separate element of this and saw increasing access to nature as a potential threat to some elements of biodiversity.

6.4 Overall workshop conclusions

One theme that emerged consistently throughout the discussions was the need to engage well with the local community if the partnership project is to be a success. There needs to be a great deal of thought put into new and effective ways of engaging the local community and helping them understand what the benefits are to managing the area for multiple functions. There needs to be co-operative working between the partners and the local communities. It is also important for the project partner organisations to work collaboratively, not to push individual agendas, and to take care to provide clarity when proposing approaches.

The opportunities for PES schemes in relation to farming was another theme that generated much discussion. The ideal situation would be to have a pilot scheme as part of the project with buy-in from a landowner that does not rely solely on the income from farming. If this is successful and sustainability of the scheme can be demonstrated, then this might be something that is realistic for farmers in the region. Diversification of income, in terms of farmers having other projects as well as farming, and also finding niche markets for superior products is limited in the SWP, the market for instance for locally produced ice cream is saturated.

Overall participants could see the advantages of taking an ecosystem service approach to understanding what the SWP does and should deliver. There was a consensus that there are real opportunities for success if a catchment management approach was taken to enhancing water quality and flow, because this could indirectly enhance other ecosystem services at the same time.

7. Ecosystem services and habitat opportunity in the South West Peak

The South West Peak (SWP) is a cherished landscape, delivering a range of benefits to people, both locally and from much further afield. As part of the oldest national park in the UK, it has long been necessary to consider the balance between different functions and benefits, well before terms such as 'ecosystem services' and 'natural capital' became vogue. The needs of recreational access, biodiversity conservation and rural livelihoods have all been part of the original aims and purposes of the national park, as enshrined in law. More recently the role of such areas for carbon storage and sequestration, delivering water quality benefits and reducing downstream flood risk have also become recognised and are now highly topical.

The aim of the work presented in this report has been to assess these ecosystem services (the benefits) delivered by the SWP across the landscape, in a spatially accurate way and to highlight potential areas for habitat creation opportunities. By producing highly detailed maps at a resolution much beyond anything previously undertaken in the SWP, it is possible to start examining trade-offs and synergies, and the hotpots and coldspots in the provision of multiple ecosystem services. The habitat opportunity mapping can also be used to show where habitat could best be created for a given purpose such as biodiversity conservation or flood risk management, or by overlapping opportunity maps can highlight areas that will benefit multiple objectives.

7.1 Hotspots and coldspots, trade-offs and synergies

Maps 23 and 24 provide excellent summaries of the key areas delivering multiple benefits in the SWP (the hotpots), or delivering very little across a range of services (the coldspots). It is quickly apparent that the central swathe of the SWP is delivering the most benefits. These are the Open Moors, and to a lesser extent the surrounding Moorland Hills and Ridges, and Enclosed Gritstone Uplands. The peat bogs especially, are delivering high levels of carbon storage, water quality and water quantity (slowing the flow) benefits, and are also largely publicly accessible, delivering high levels of tranquillity and accessible nature, in an area that is rich for biodiversity and cultural heritage.

Many other parts of the SWP are also delivering fairly high levels across multiple ecosystem services (ES). The high resolution of the mapping can be used to distinguish changes in ES delivery across small distances in the landscape. For example, valley sides, valley bottoms and hill tops can score quite differently, even when spread over short distances, due to changes in slope, land use, soils and other factors. This level of detail is important when planning the most appropriate management actions at a local (field) scale. This level of detail also highlights areas of relatively poor delivery, even close to the hotpots. This may be due to, for example, sub-optimal land use on a steep slope close to a river and the maps can be used to highlight such areas for improvement.

The most significant coldspots for overall ES delivery are the urban areas of Buxton and the buffer zone towns of Macclesfield, Leek and the fringes of Greater Manchester. However, these areas are providing the key demand for the services provided. Demand for ES is generally centred in urban areas and the areas of countryside surrounding towns are often subject to high levels of public use. By enhancing access to and management of areas within a few kilometres of the urban areas, it would be possible to significantly enhance local benefits, without negatively impacting on the central parts of the SWP. Please note,

however, that we only mapped local demand and not the demand from people who travel form much further afield to visit the SWP.

The hotpots described above, also highlight the clearest synergies in delivering multiple benefits. It is apparent that management can be put in place to deliver carbon storage benefits, together with water quality, water quantity, and accessible nature benefits, whilst achieving biodiversity enhancement.

In terms of potential trade-offs, the most obvious example is between food production and most of the other services. Converting land for intensive dairy production (the most suitable intensive agricultural system in the area) would generally lead to a reduction in water quality, water quantity, carbon storage and accessible nature. Conversely, extensifying agricultural production and converting improved grassland to less intensive land uses would generally increase the production of those same ecosystem services. There is, of course, a balance to be struck between environmental enhancement and rural (farmer) livelihoods, and the opportunities of paying farmers for the enhancement of environmental benefits (Payments for Ecosystem Services) is a key to the long term viability and sustainability of such approaches (see Section 7.3 below for more on this).

Another important trade-off, that was also raised in the stakeholder workshop, is that between public access and tranquillity and biodiversity. It was noted by the stakeholders that the area scored as having the highest tranquillity was the south eastern part of the SWP, an area away from the high moorland in the centre and north, which was expected to score most highly, but which is more visited and has main roads running across it. Breeding waders are also particularly sensitive to public access (especially dogs) and so increasing access and hence accessible nature, could have a detrimental impact on these species.

In addition to the multiple benefits and synergies revealed by the ecosystem services mapping, it is also possible to combine the habitat opportunity mapping to highlight opportunity areas that would deliver multiple benefits. As shown in Section 3.4, woodland opportunity areas for biodiversity can be combined with floodplain woodland opportunities for runoff attenuation to indicate areas where both objectives could be achieved. Woodland planting in these strategic locations would also improve water quality and sequester carbon. Likewise, attenuation features on the open moorland, where woodland is not desirable, are likely to deliver water quality and biodiversity benefits (and possibly carbon benefits), in addition to flood risk management benefits.

7.2 How can the work be used to inform decision making and planning?

As described above, the opportunity maps can be used to highlight strategic locations for delivering multiple benefits. In addition, the ecosystem services maps highlight hotspots, where current land use should be continued and supported, and coldspots where change could be beneficial. The maps can be used at a broad scale or at a very fine local scale. At a broad scale, especially using the Landscape Character Types (LCTs) discussed in Section 5.3, they can be used to identify general rules and objectives for the management of these swathes of landscape. In some LCTs, it highlights the need to preserve what is there or to promote management that delivers certain ecosystem service objectives, whereas in other LCTs there may be different priorities. At a very fine scale the maps can be used to highlight particular fields that would benefit from land use change or should be kept how they are. For example, land on slopes close to watercourses may particularly benefit from a land use that is able to slow the flow and deliver water quality, biodiversity and other benefits at the same time. Overall, the information could be used to produce general rules and guidelines for the most appropriate management in different locations and specific opportunities for habitat change. In all cases, however, opportunities require ground-truthing as

local conditions have not been incorporated into the mapping work. Other factors, particularly the views of the land-owner will also become paramount in taking opportunities forward.

Engaging with the local community is of key importance and was clearly highlighted at the stakeholder workshop. Some land-owners / tenants will be in a much better position to undertake land use change than others. Stakeholders at the workshop suggested that initial focus should be placed on large landowners and those with alternative income, who are not financially so dependent upon a particular parcel of land. There is growing awareness of the idea of multi-objective land management amongst government agencies and NGOs, but there is a need to really promote these ideas to land-owners and tenant farmers. In addition, there will need to be financial incentives to promote the uptake of these ideas, and this is where the idea of Payments for Ecosystem Services Schemes becomes important.

7.3 Payment for Ecosystem Services Schemes

Payment for Ecosystem Services Schemes, commonly referred to as PES Schemes, are simply any scheme where the land holder / manager is paid to deliver an ecosystem service or bundle of services, by the beneficiaries of that service. There has been a lot of government interest in such schemes over the last few years, with a number of pilot projects supported by Defra and Natural England. Some of the key PES approaches that are relevant to the SWP are:

- **Woodland Carbon Code** – the amount of carbon that can be sequestered by planting woodland can be accurately estimated and this carbon has a monetary value. Polluters pay for woodland to be planted to offset their emissions. This scheme is well developed now and fully operational, but there is a lack of compulsion for polluters to pay at present.
- **Peatland Code** – this works in exactly the same way as the Woodland Carbon Code, but focussing on carbon sequestration through peatland restoration. The scheme is less well established than the Woodland Carbon Code, but has recently been launched and could be really promising for the SWP.
- **Slowing the Flow** – the recent flooding events in the north of England have given added impetus to the idea of natural flood risk management in the headwaters and this is an area that is being actively pursued by the Environment Agency, Natural England and others. A number of successful pilots have been run over recent years and have shown great promise, but again the challenge is to persuade beneficiaries to pay for this type of scheme.
- **Water quality** – the idea here is that water companies pay for upland management works to improve water quality and thereby reduce the cost of water treatment. There are very good examples from the Upstream Thinking Project funded by South West Water and the SCaMP project paid for by United Utilities in the Pennines. In addition, many actions for the Water Framework Directive (WFD) require catchment scale approaches that focus on improving water quality through appropriate land management.
- **Countryside Stewardship** – the government's agri-environment scheme is effectively a type of PES scheme. The focus is predominantly around biodiversity conservation and lower intensity farming, but it can also incorporate other elements such as enhancing public access, water quality (through WFD measures) and flooding issues.
- **Biodiversity offsetting** – this is where any loss of habitats through new development has to be offset through habitat creation or restoration elsewhere. The government has not yet decided on

whether to pursue this policy and how local the offsets have to be to the habitat being lost, but it has the potential to deliver a lot of money for biodiversity conservation projects. One to watch.

- **Community Infrastructure Levy and Section 106** – also known as planning gain; this is the means by which developers pay for green infrastructure (and other community benefits) in areas close to new developments. This is more relevant to suburban areas, but could be useful in the fringes of the SWP, in the areas surrounding towns.

The key challenges in delivering many of these PES schemes are in encouraging or forcing beneficiaries to pay for environmental benefits that they have previously received for free. This is an area of active development at present but may ultimately depend on government legislation.

Another challenge is around security of payment for the long term. In most cases, significant land use change to more semi-natural habitats requires a long-term commitment by the land manager and is not quick or cheap to reverse. Land managers are likely to be reluctant to do so when future funding is so uncertain. This may resolve once (if) PES schemes become established, but is a challenge at present. Even Countryside Stewardship is often only available for 5 years now, rather than 10, with no certainty of how it will operate in the future.

7.4 Further work

The habitat opportunity and ecosystem service mapping presented here provides a detailed baseline and evidence base to inform decision making in the South West Peak. It also provides an opportunity to carry out further studies that builds on this work. Here we present what we consider to be the most useful ideas of how additional work could provide further benefits and added value to that already done, although please note that this list is not exhaustive.

7.4.1 Further refinement of the existing models and maps

Although much time was put into developing and refining the ecosystem service models, there are a number of areas in which they could be improved. For example, the models apply national average values across each habitat type. This could be made more locally specific and spatially accurate. An example here is carbon storage, which applies an average value for carbon storage in bog, whereas the actual value will vary greatly depending upon the depth, condition and management of the peat. In addition some of the other ES models could be developed further, especially the water flow demand model which could consider flooding further downstream and the relative need for flood protection of different habitats. The water quality capacity model could also be improved and the accessible nature model could be refined further, based on points raised at the stakeholder workshop. Finally, additional ES models could be developed, of which recreational use is probably the most beneficial to add in the context of the SWP.

7.4.2 Assessing the impact of the South West Peak Landscape Partnership Scheme (SWPLPS)

The SWPLPS is developing 17 projects for delivery in the second phase of the project, several of which involve land use or management change. Once the details of these projects have been decided, it would be possible to incorporate all the changes onto a map and then re-run the ecosystem services models to show the impact of the proposed changes on the range of ecosystem services. This would provide powerful evidence either in project planning, or to assess the impact of change after they have been implemented.

7.4.3 Joining-up landscape opportunities

There is great potential to do further work on combining the various opportunity maps and the ecosystem services maps to highlight key locations and optimal land uses in different parts of the SWP. In addition, the importance assigned to different ES in each Landscape Character Type at the workshop could be used to assign priority and rules relevant to different parts of the SWP. Ultimately, it would be possible to produce an optimal land use plan for the area, or a number of scenarios, and it would be then be possible to re-run the ES assessment to determine the likely impact of such changes on ES provision.

7.4.4 Monetary valuation / ecosystem accounting

The ecosystem service values presented in this report are almost all measured in physical units (such as tons of carbon) that were then normalised onto a 0-100 scale to show the relative production across the SWP. They have not been measured in monetary terms, but it would be interesting and possible to do so for at least some of the ES. Monetary values could be developed for services including carbon storage / sequestration, agricultural production, recreation, agricultural emissions and overall greenhouse gas balance. This would provide important further evidence and can form the basis for developing Payments for Ecosystem Services (PES) schemes. Note that it is not possible to provide a monetary value for all ecosystem services.

7.4.5 Natural Capital Investment Plan

Natural Capital Investment Plans (NCIP) are just starting to be undertaken in the UK. NCIPs bring together much of what we have already developed for the current project (natural capital asset accounts, ecosystem service flows), together with monetary flow accounts (monetary valuation) and suggestions on the development of Payments for Ecosystem Services (PES) schemes and other opportunities for investment, including costs and benefits of habitat creation and improvement works.

7.4.6 Repeat the work in the Dark and White Peak areas

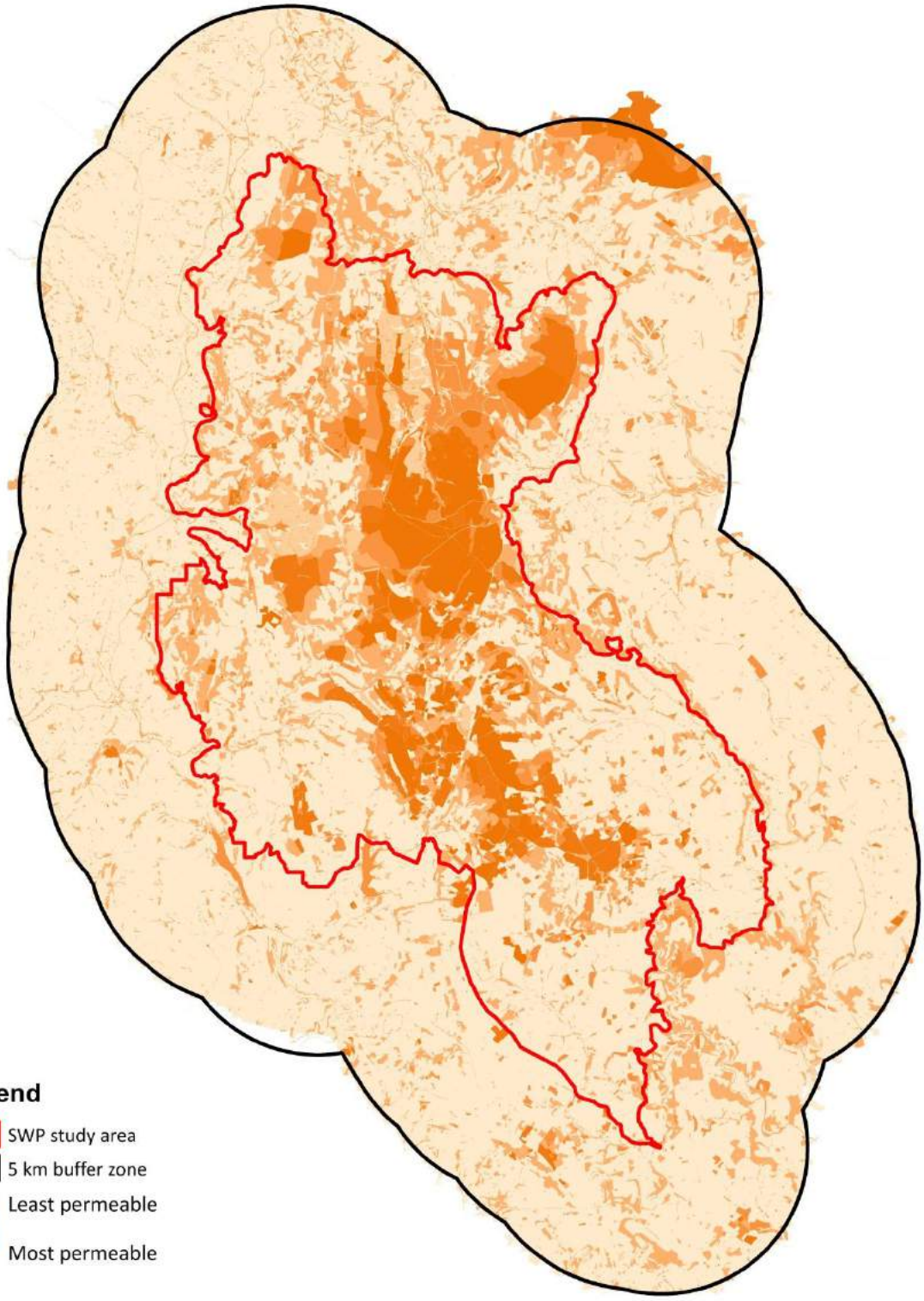
It would be relatively straightforward to repeat the existing work on habitat opportunity and ecosystem services mapping in a different area, and the prime candidates would appear to be the Dark Park and / or White Peak areas in the National Park. It would be really interesting to compare and contrast the issues and outcomes in these other areas. The White Peak, for example, has very different geology and soils, which would make the results of the water quantity and water quality models quite different, and both the White and Dark Peak receive considerably greater visitor pressure than the SWP.

Appendix

(i) Additional maps

Natural Capital Solutions

Map A1: Landscape permeability: Bog and upland flush species



Legend

- SWP study area
- 5 km buffer zone
- Least permeable
- Most permeable

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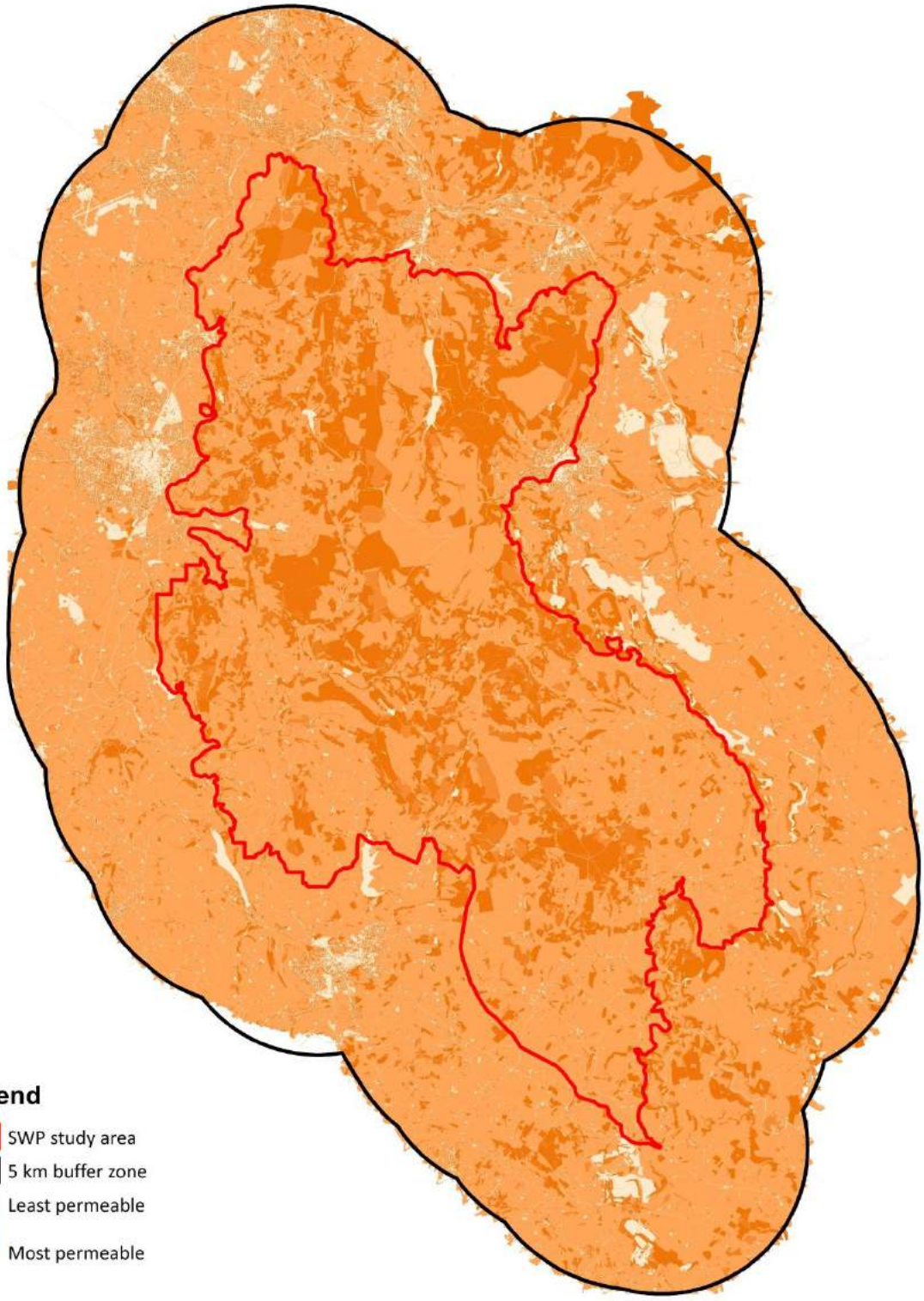
N

EcoServ-GIS

Natural Capital Solutions

Map A2: Landscape permeability: Semi-natural grassland species



Legend

- SWP study area
- 5 km buffer zone
- Least permeable
- Most permeable

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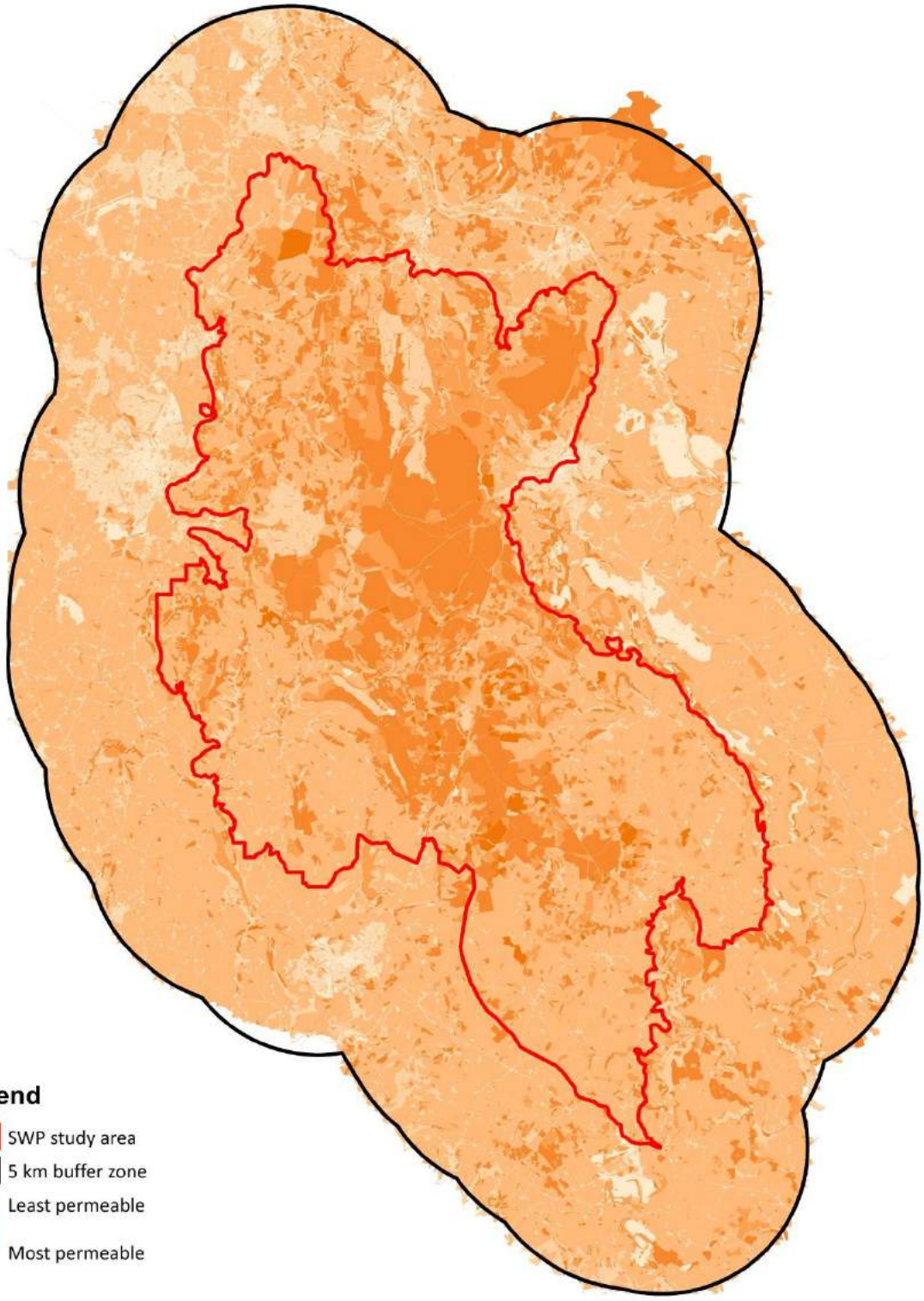
EcoServ-GIS

Natural Capital Solutions

Map A3: Landscape permeability: Wet grassland species



Legend

- SWP study area
- 5 km buffer zone
- Least permeable
- Most permeable

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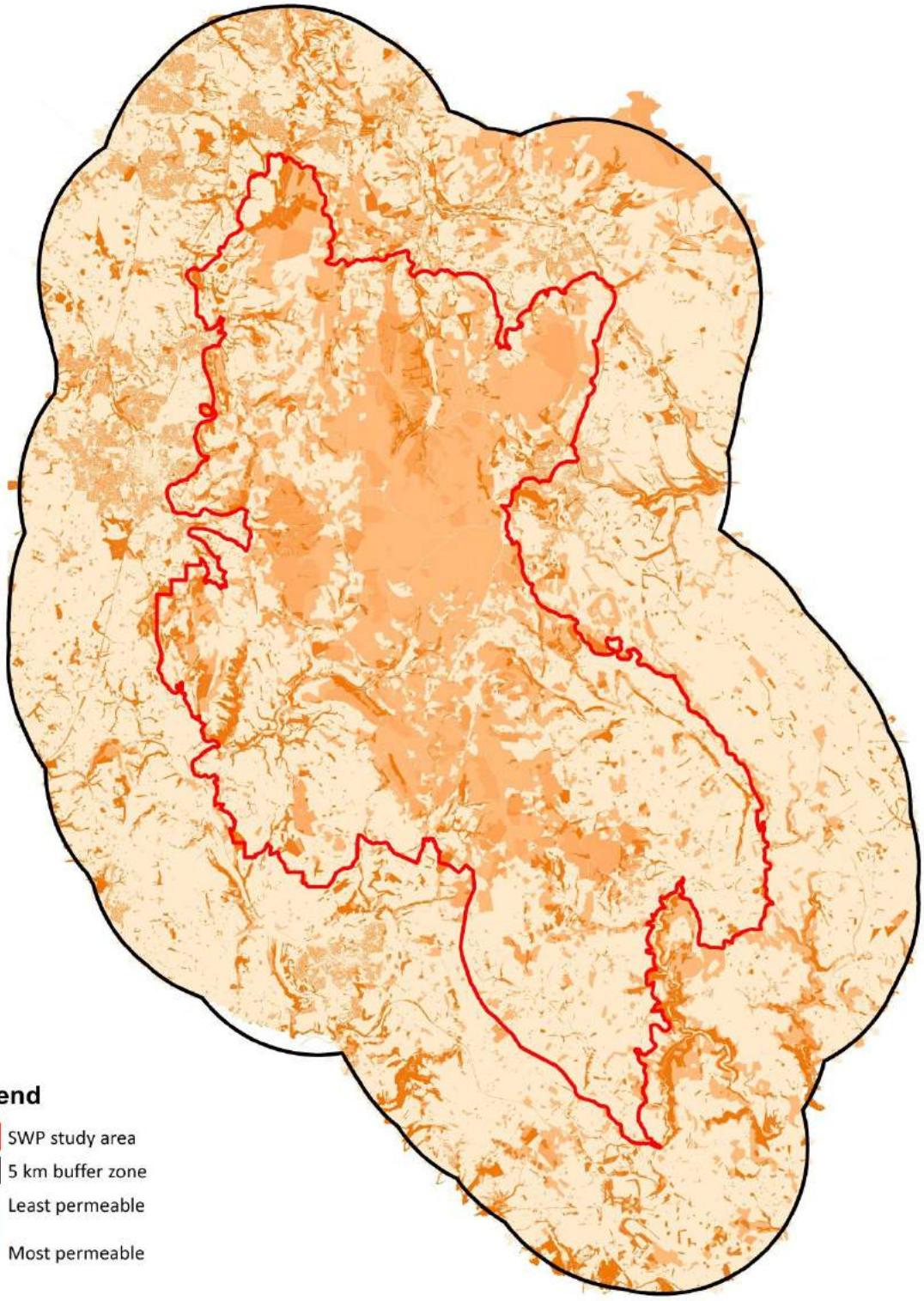
Natural Capital Solutions

Map A4: Landscape permeability: Broadleaved and mixed woodland species



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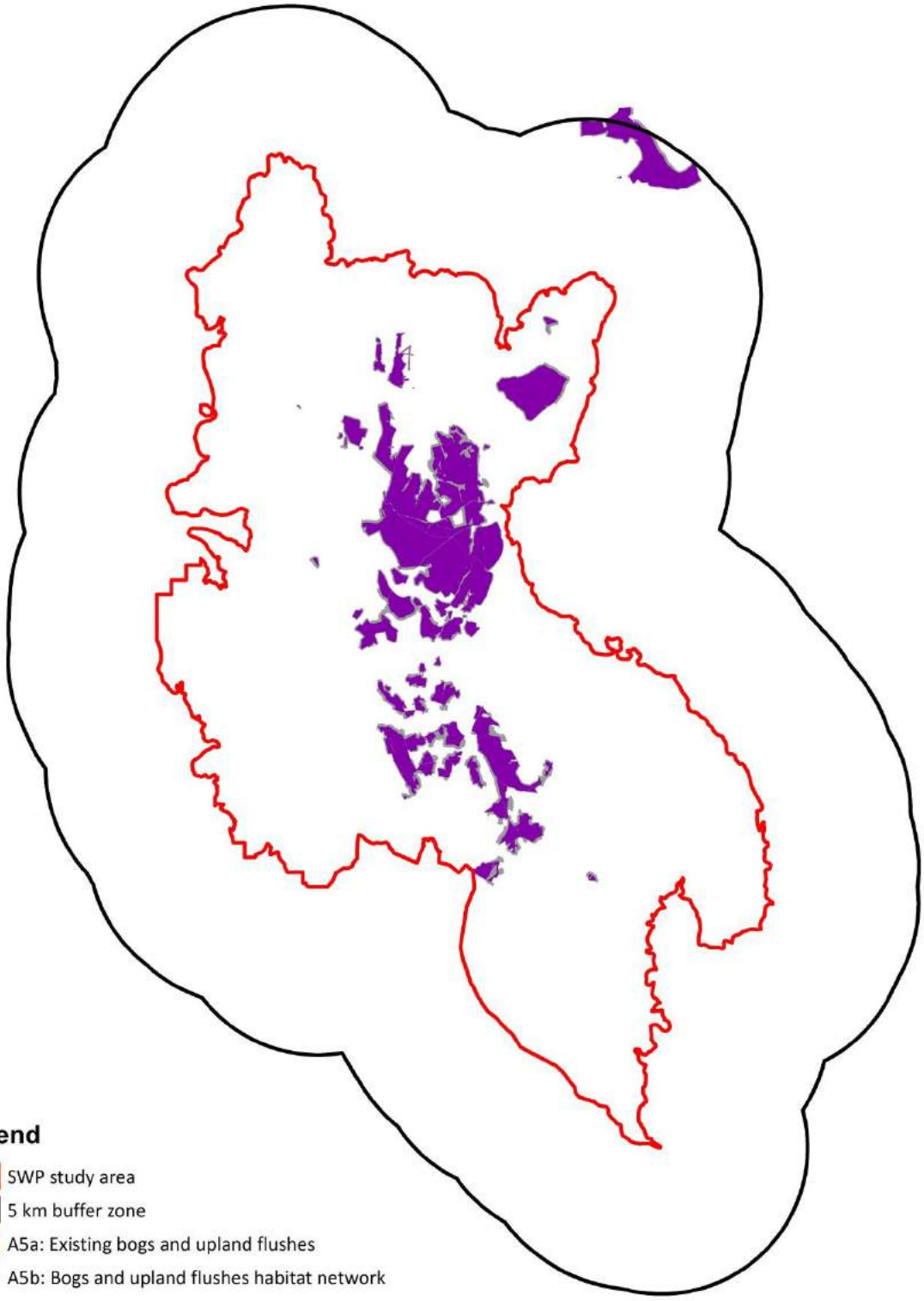
Natural Capital Solutions

Map A5: Bogs habitat network



Legend

- SWP study area
- 5 km buffer zone
- A5a: Existing bogs and upland flushes
- A5b: Bogs and upland flushes habitat network

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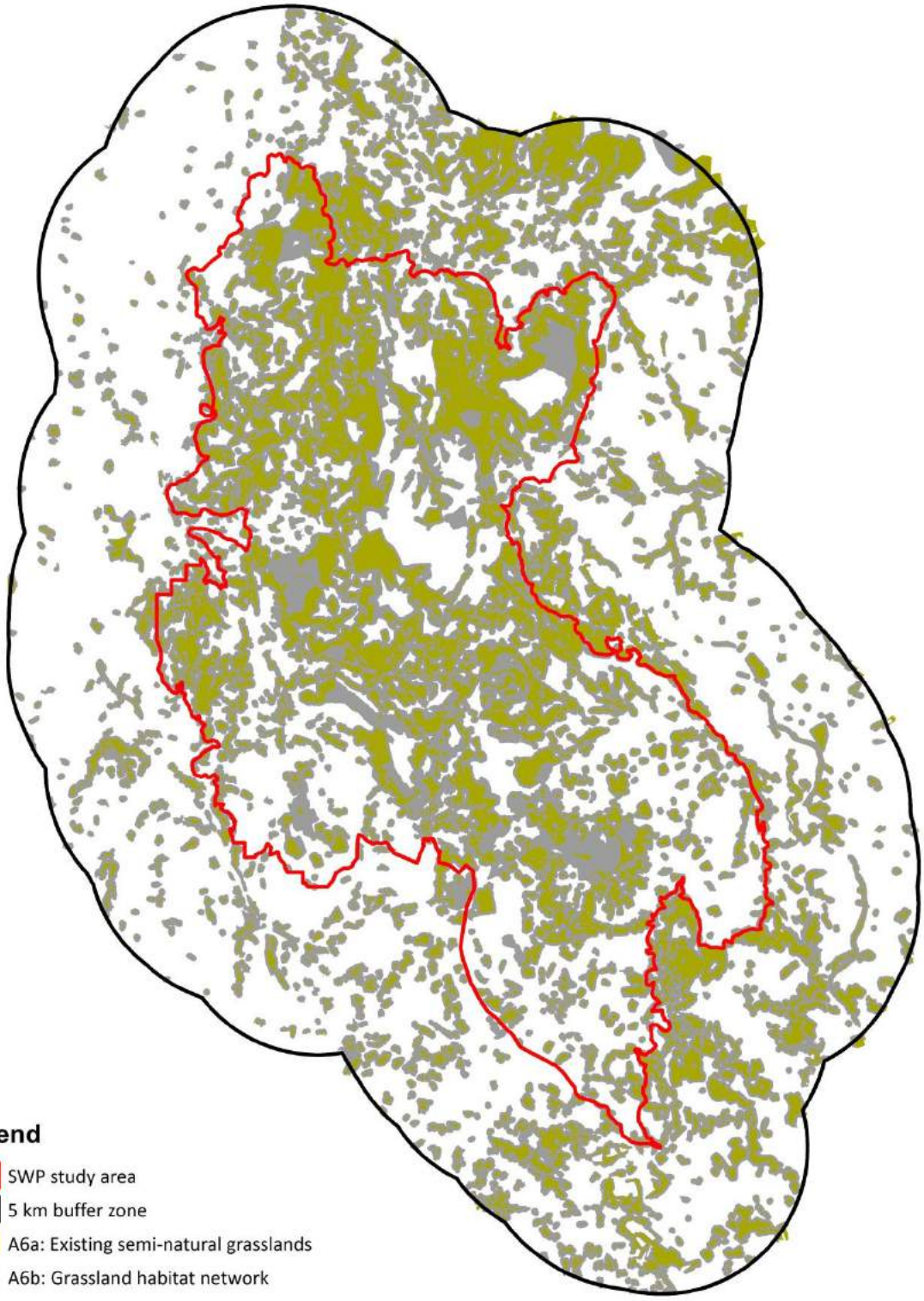
Natural Capital Solutions

Map A6: Semi-natural grasslands habitat network



Legend

- SWP study area
- 5 km buffer zone
- A6a: Existing semi-natural grasslands
- A6b: Grassland habitat network

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(at A4 paper size)

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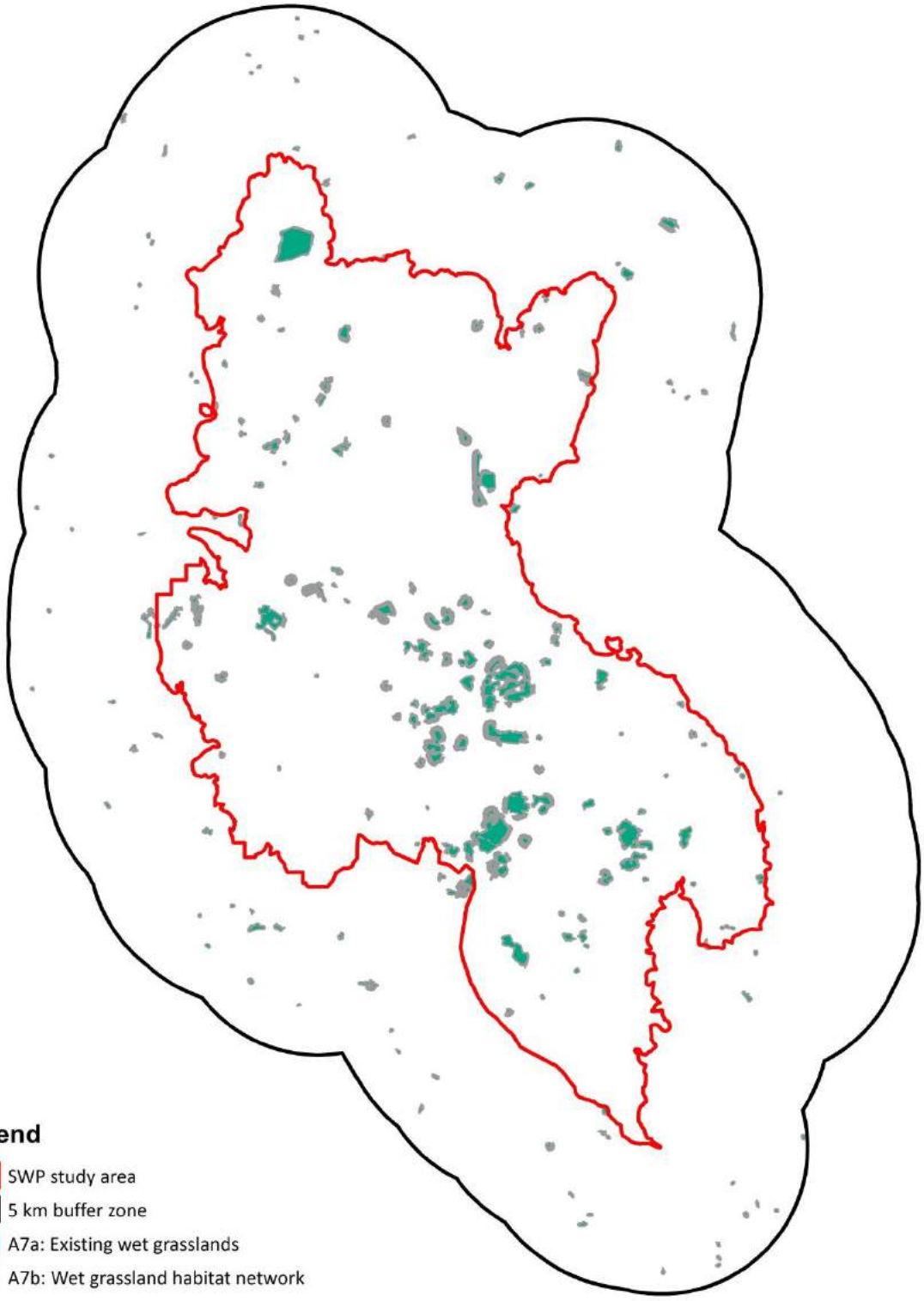
Natural Capital Solutions

Map A7: Wet grasslands habitat network



Legend

- SWP study area
- 5 km buffer zone
- A7a: Existing wet grasslands
- A7b: Wet grassland habitat network

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(at A4 paper size)

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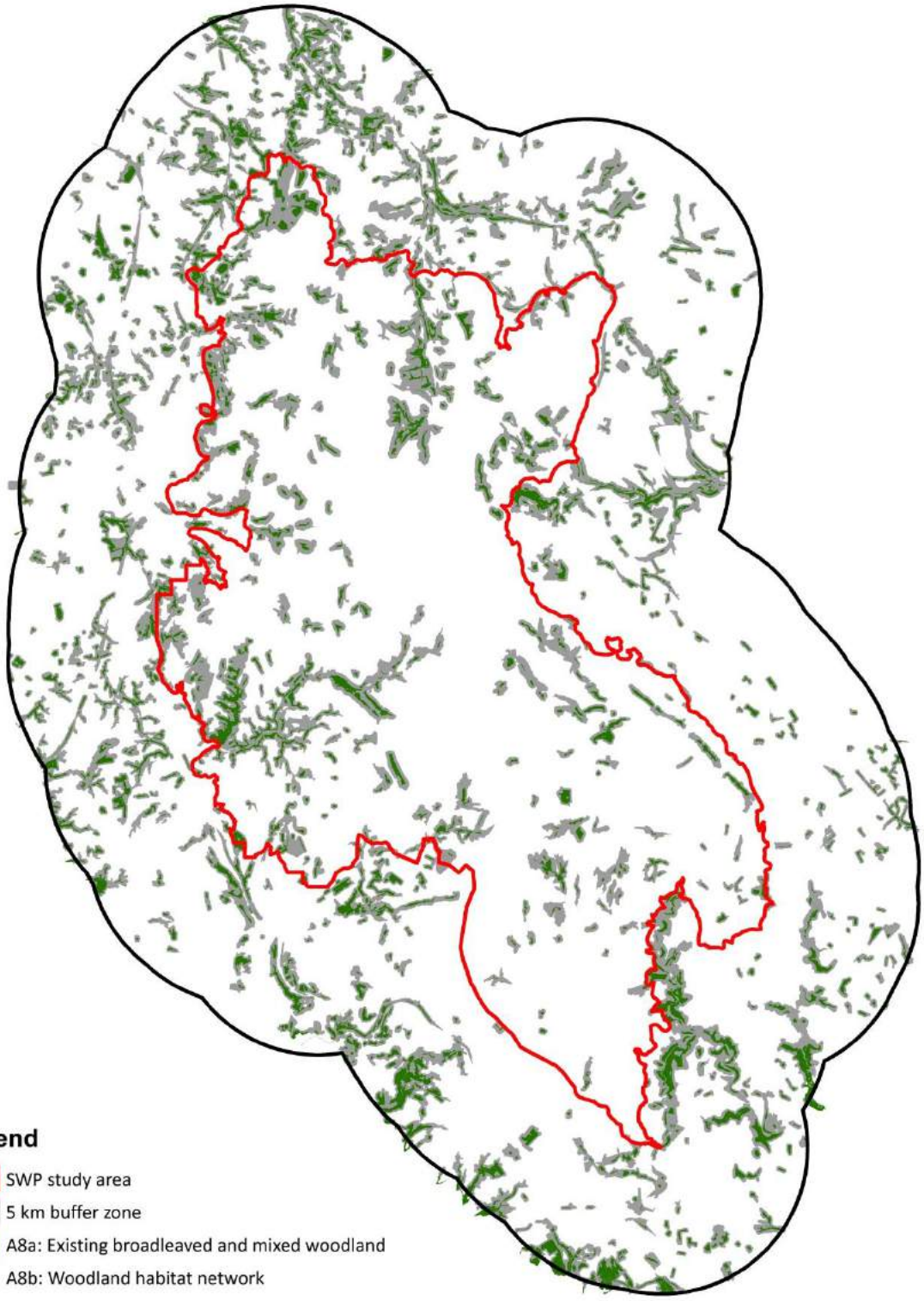
EcoServ-GIS

Natural Capital Solutions

Map A8: Broadleaved and mixed woodland habitat network



Legend

- SWP study area
- 5 km buffer zone
- A8a: Existing broadleaved and mixed woodland
- A8b: Woodland habitat network

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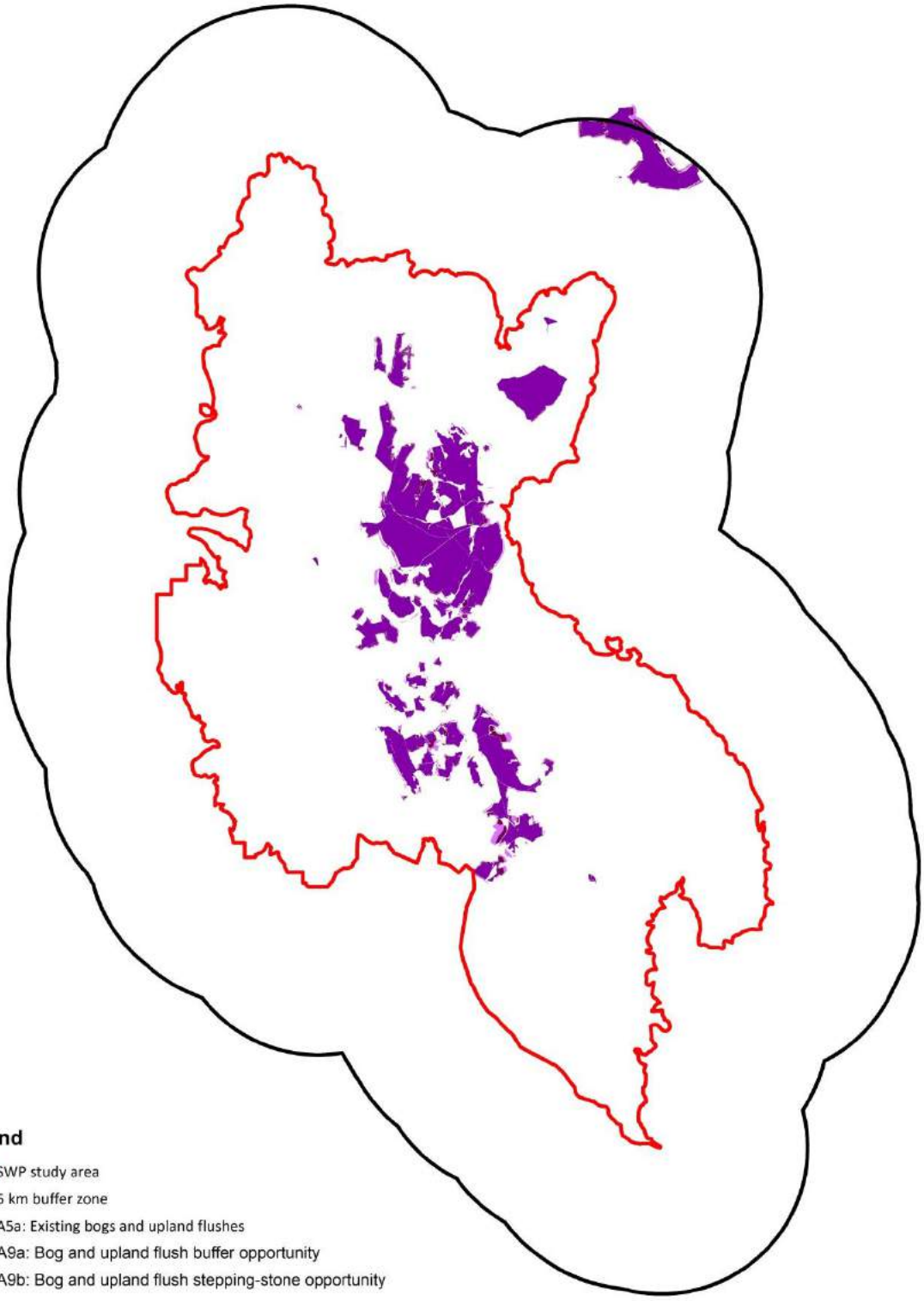
N

EcoServ-GIS

Natural Capital Solutions

Map A9: Bogs and upland flushes habitat opportunity



Legend

- SWP study area
- 5 km buffer zone
- A5a: Existing bogs and upland flushes
- A9a: Bog and upland flush buffer opportunity
- A9b: Bog and upland flush stepping-stone opportunity

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(at A4 paper size)

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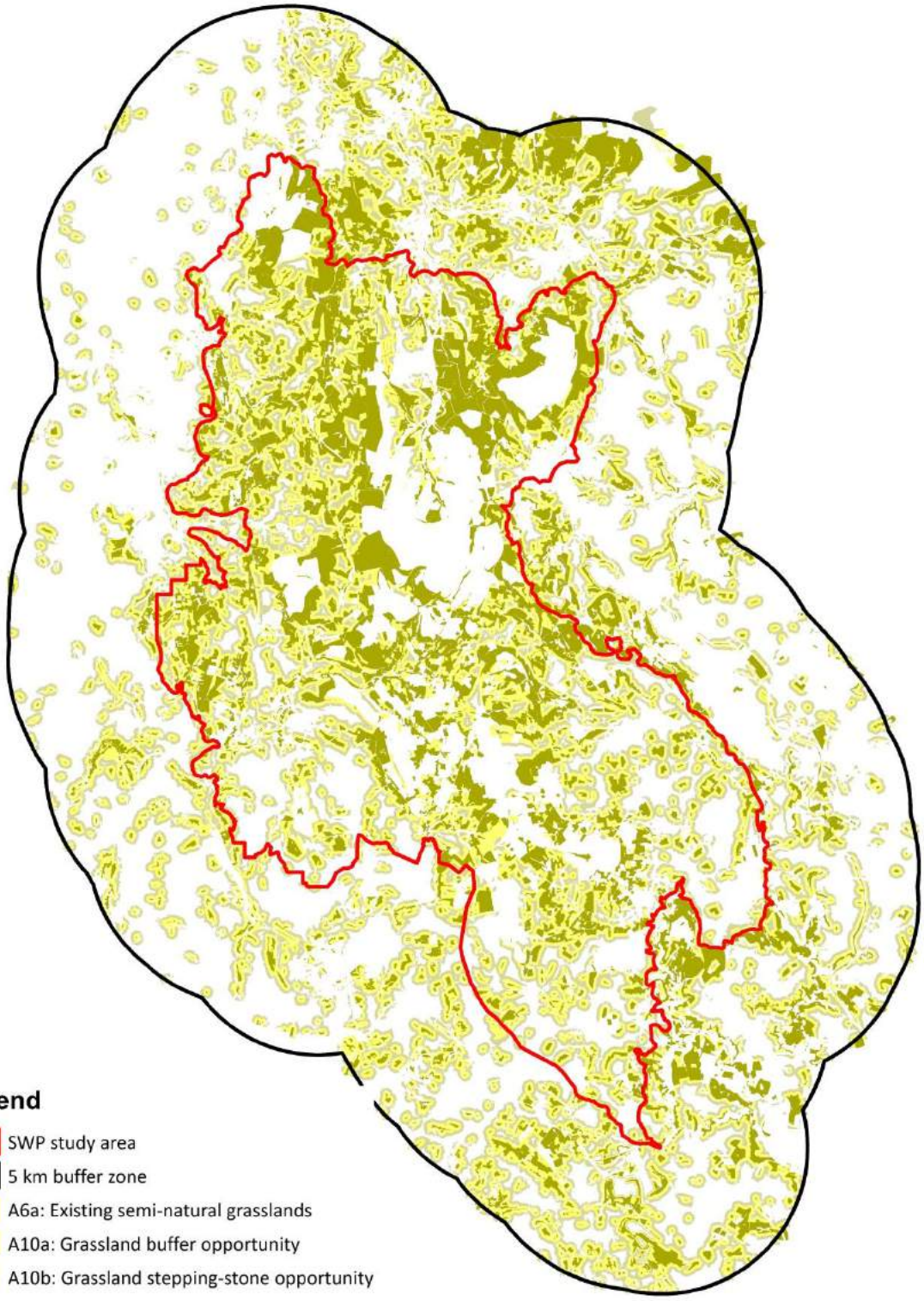
EcoServ-GIS

Natural Capital Solutions

Map A10: Semi-natural grassland habitat opportunity



Legend

- SWP study area
- 5 km buffer zone
- A6a: Existing semi-natural grasslands
- A10a: Grassland buffer opportunity
- A10b: Grassland stepping-stone opportunity

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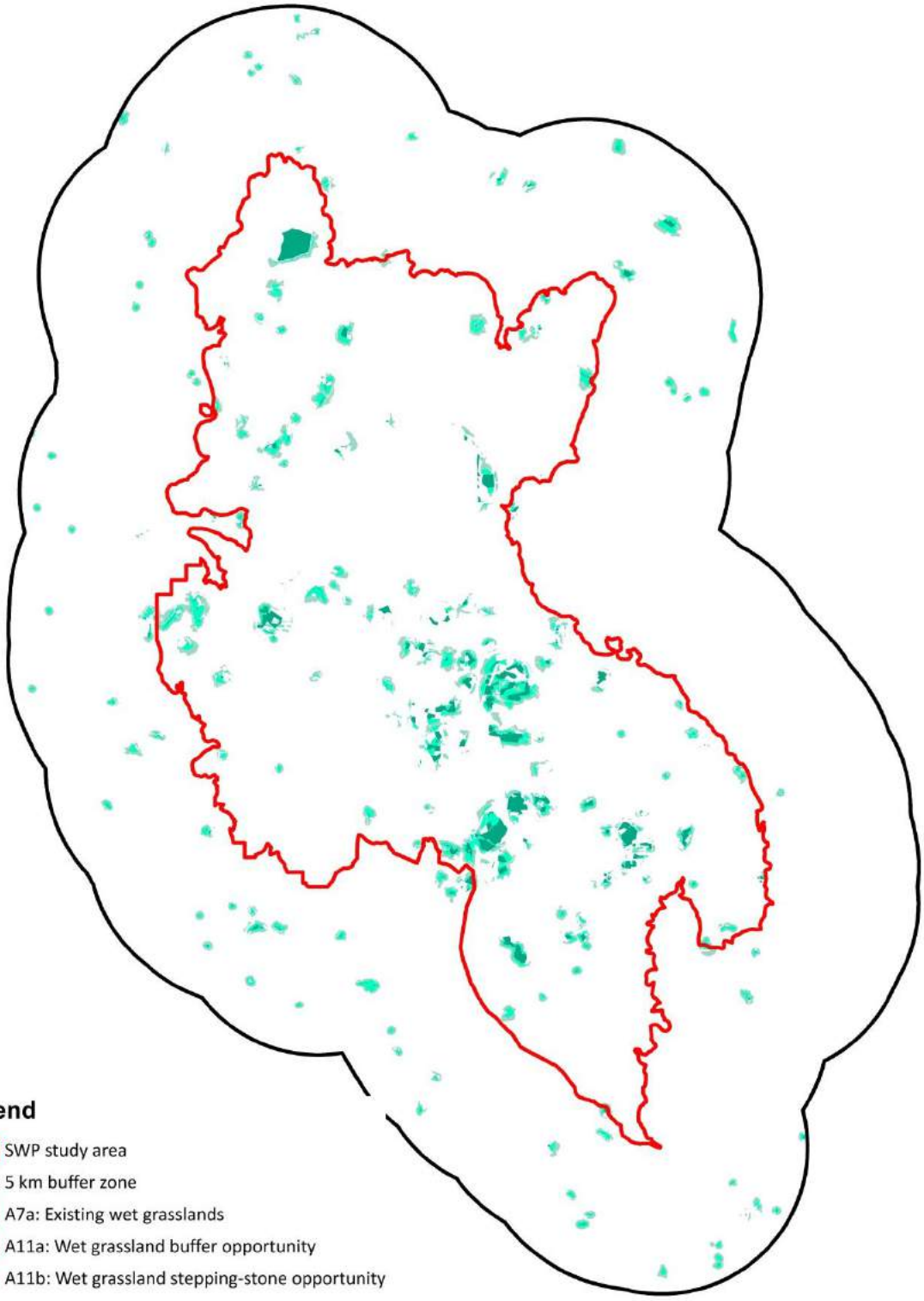
Natural Capital Solutions

Map A11: Wet grassland habitat opportunity



Legend

- SWP study area
- 5 km buffer zone
- A7a: Existing wet grasslands
- A11a: Wet grassland buffer opportunity
- A11b: Wet grassland stepping-stone opportunity

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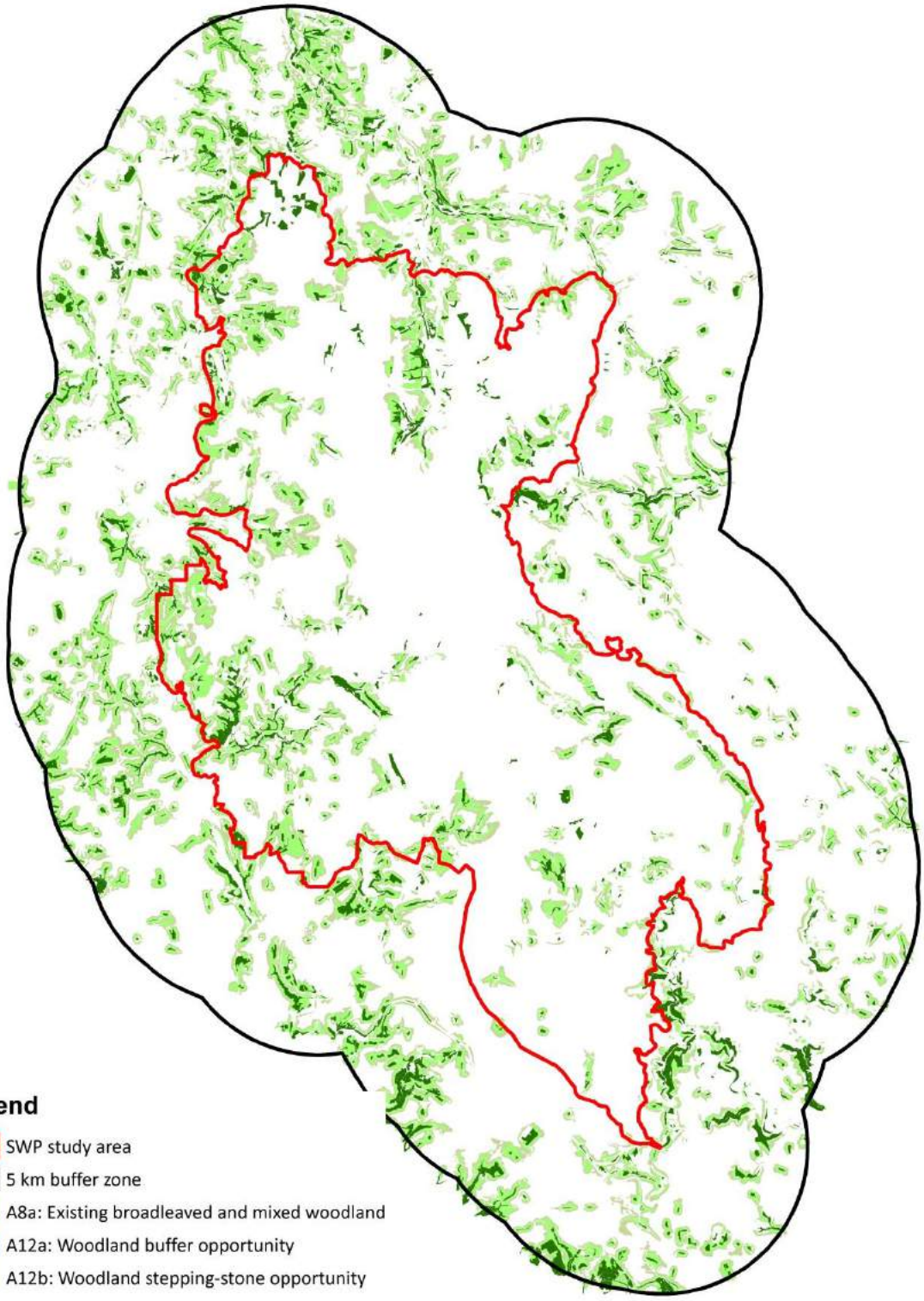
EcoServ-GIS

Natural Capital Solutions

Map A12: Broadleaved and mixed woodland habitat opportunity



Legend

- SWP study area
- 5 km buffer zone
- A8a: Existing broadleaved and mixed woodland
- A12a: Woodland buffer opportunity
- A12b: Woodland stepping-stone opportunity

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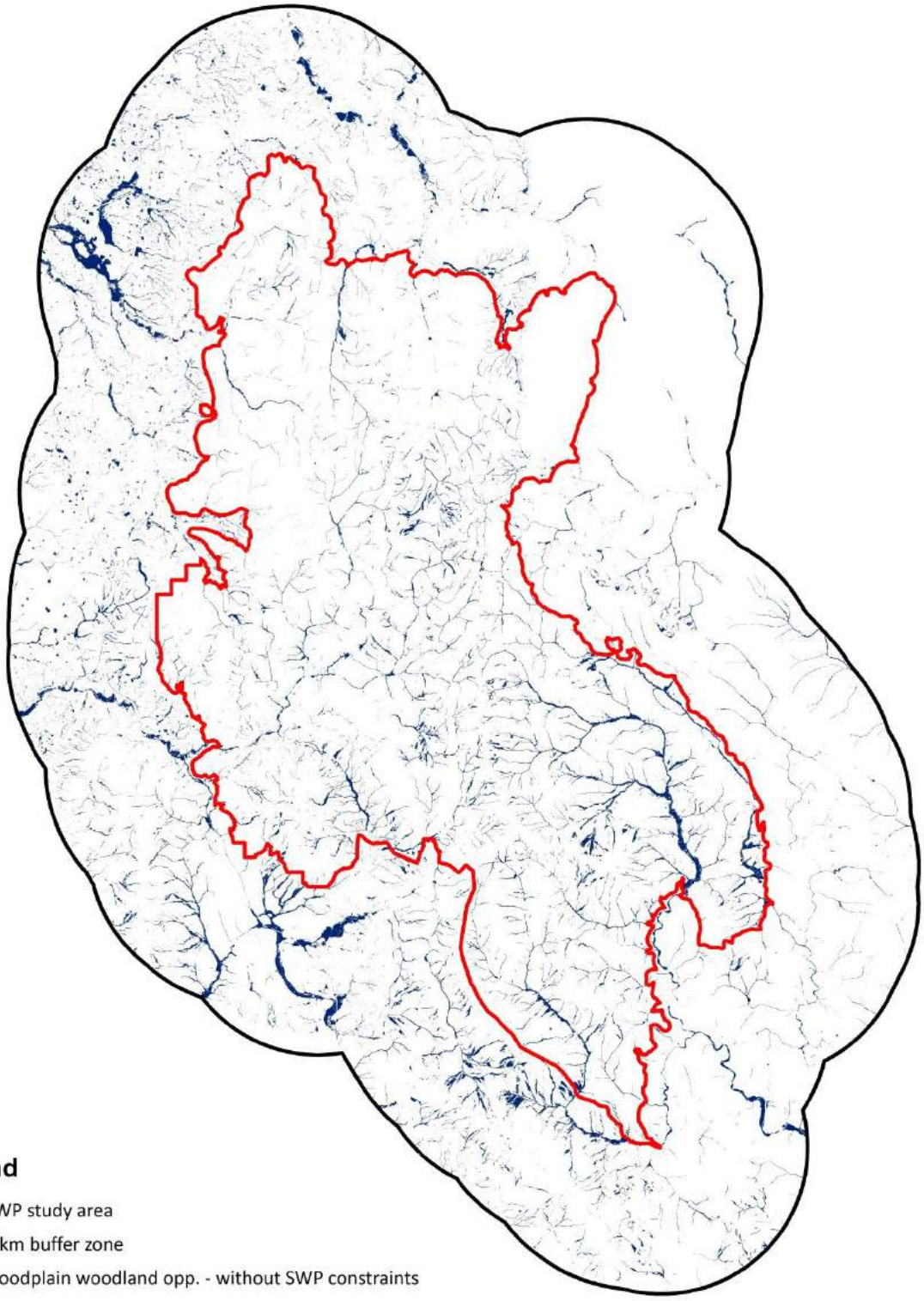
EcoServ-GIS

Natural Capital Solutions

Map A13: Floodplain woodland opportunity without SWP contraints



Legend

- SWP study area
- 5 km buffer zone
- Floodplain woodland opp. - without SWP constraints

0 6Km 1:180,000 (at A4 paper size)

N

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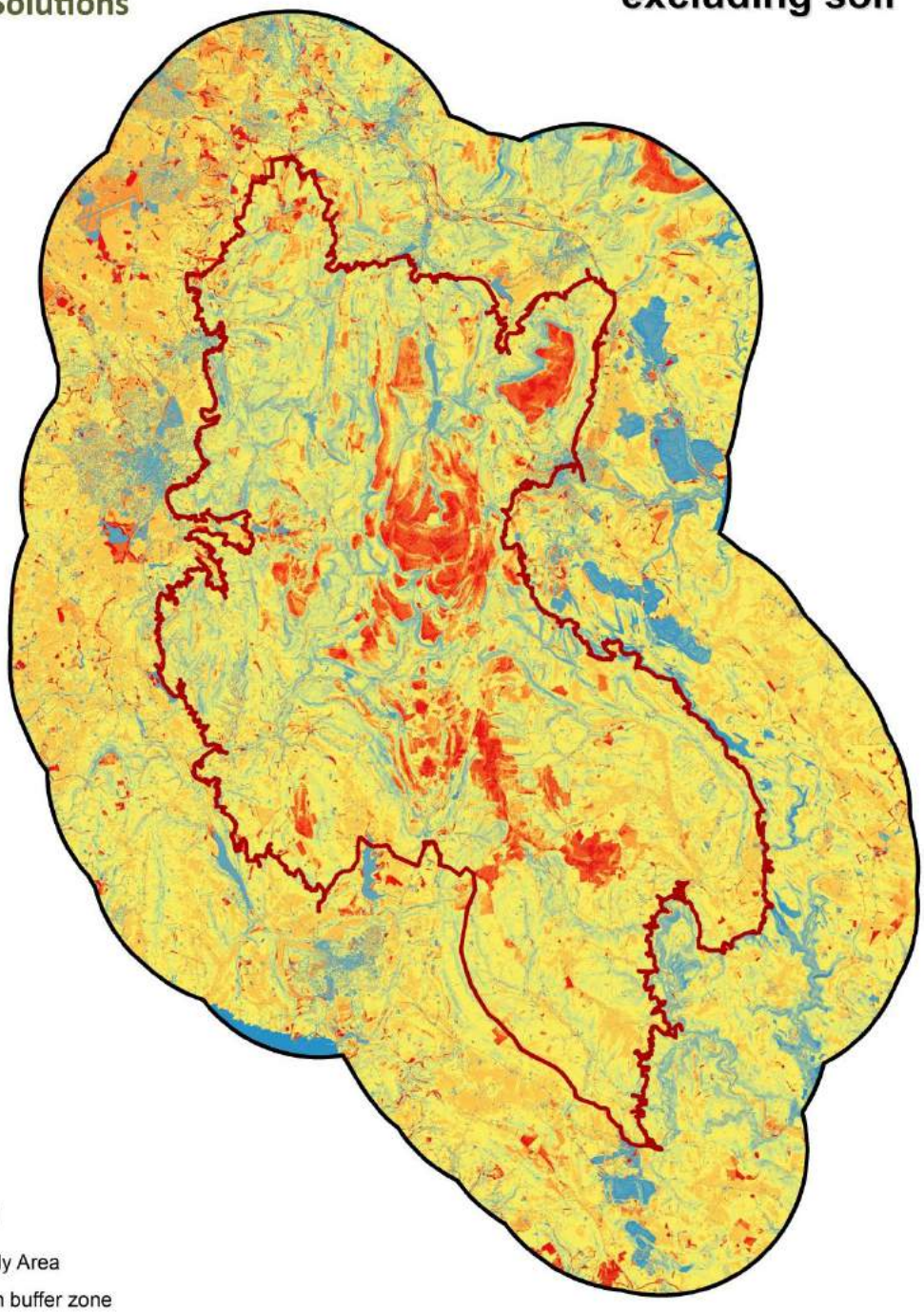
Map A14: Water flow capacity: excluding soil



Legend

Study Area

5 km buffer zone

Water flow capacity - excluding soil

Value

High : 100

Low : 0

Models the capacity of the land to slow the flow of water, or natural flood risk management potential. Based on two indicators: roughness (dependent upon landuse), and slope. This model takes no account of runoff due to soil type.

Scores are on a 0 to 100 scale, relative to values present within the Study Area.

0 6 Km

Date: 08/02/2016

1:200,000

(at A4 paper size)

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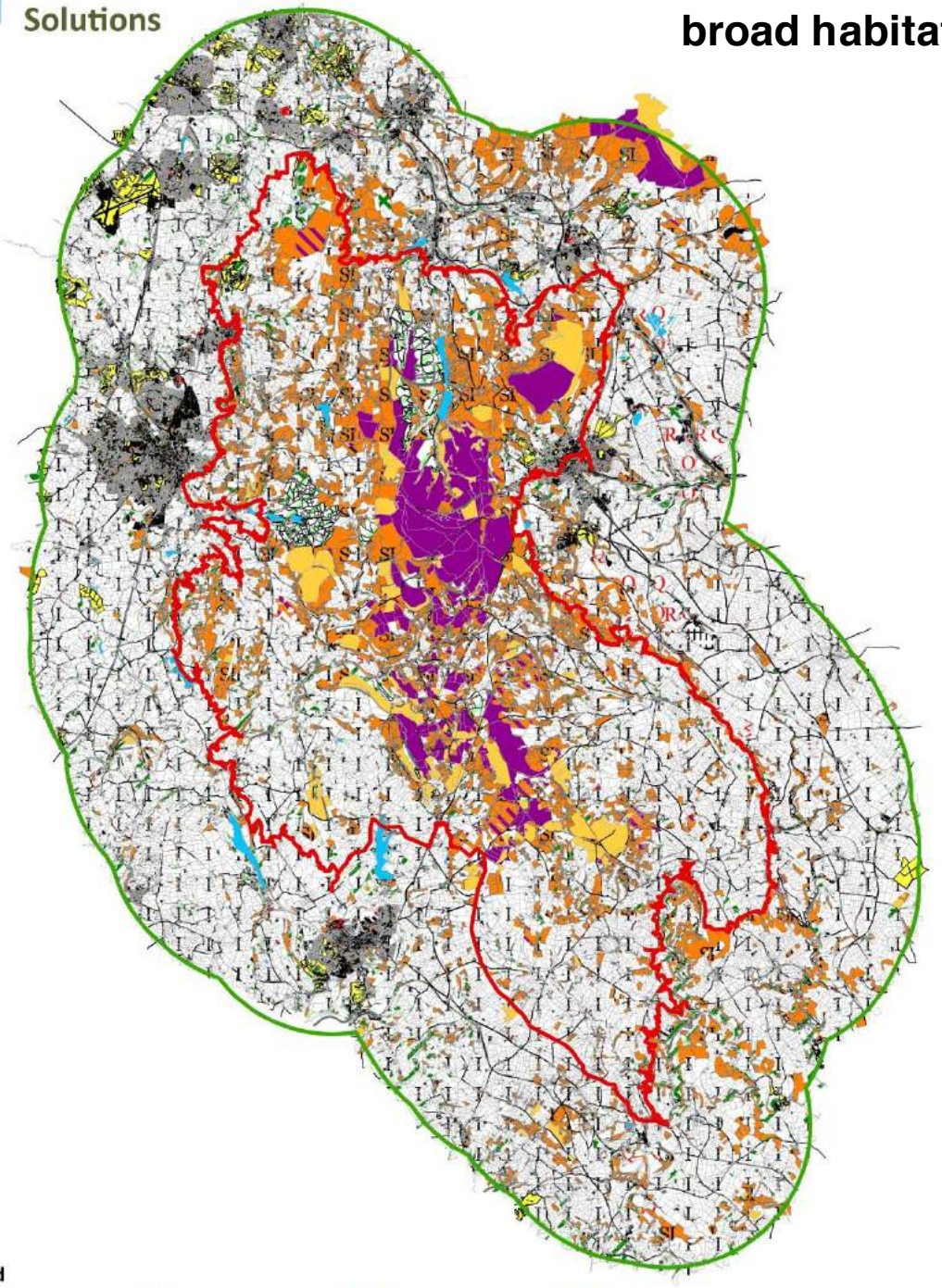
Map A15: Existing broad habitats



Legend

- StudyArea
- SA_buffer

Base Map

Broad Habitats

- Woodland, broadleaved
- Woodland, coniferous
- Woodland, mixed
- Scrub
- Trees / Parkland
- Grassland, semi-natural
- Grassland, improved
- Grassland, marshy
- Grassland, unknown
- Heathland
- Mire
- Water, fresh
- Natural rock
- Artificial exposure / waste
- Cultivated / disturbed land
- Built up areas
- Garden
- Gardens / Parks / Brownfield
- Other
- Mixed habitats
- Path
- Pavement
- Railway
- Roads
- Unclassified

0 6 Km

Date: 11/01/2016

1:200,000 (at A4 paper size)

N

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(ii) List of workshop attendees

Penny Anderson	Nature Peak District
Sara Barrett	Natural England
Sarah Bentley	Staffordshire County Council
Tim Brooks	Environment Agency
Andrew Critchlow	Derbyshire NFU
Andy Collins	Borderland Voices
Julia Cook	Farming Life Centre
Hazel Crowther	PDNPA
Sarah Gould	Severn Trent Water
Alison Holt	Natural Capital Solutions
Matt Lawrence	Environment Agency
Jim Rouquette	Natural Capital Solutions
John Scott	PDNPA
Karen Shelley-Jones	SWPLP
Mike Shurmer	RSPB
Martin Varley	Cheshire Wildlife Trust
Sue Weatherley	Local Access Forum

(iii) List of GIS data layers

List and brief description of GIS data layers supplied by Natural Capital Solutions Ltd to PDNPA. Numbers shown in the layer name match the map number in this final report wherever possible. These data are available to project partners by contacting Karen Shelley-Jones at the Peak District National Park Authority.

LAYER NAME	DESCRIPTION
1a: SWP study area	Boundary of SWP study area
1b: 5km buffer zone	Boundary of SWP study area plus 5km buffer zone
Mean elevation	Mean elevation for each polygon in the SWP and buffer zone
Mean slope	Mean slope for each polygon in the SWP and buffer zone
BAP habitats	BAP habitat data for the SWP, compiled and processed from multiple PDNPA data sets by Natural Capital Solutions Ltd. Excludes sites not meeting BAP quality criteria.
Non-BAP habitats	Non-BAP habitat data for the SWP, compiled and processed from multiple PDNPA data sets by Natural Capital Solutions Ltd. Shows habitats that have been surveyed but are not believed to be of BAP standard.
All habitat data	Habitat data for the SWP, compiled and processed from multiple PDNPA data sets by Natural Capital Solutions Ltd. This combines the BAP habitat data set and the non-BAP habitat data set.
Green infrastructure	Green infrastructure (open space) data for the SWP and buffer zone
Broad habitats	Broad habitat types derived from basemap for SWP and buffer zone (Map A15 in the final report).
Habitat class	Habitat class for SWP plus buffer zone
2a: Existing bogs and upland flushes	Existing bogs and upland flushes in the SWP plus buffer zone
2b: Existing heathland and mosaic habitats	6a: Existing heathland and mosaic habitats in the SWP plus buffer zone
2c: Existing wet grasslands	Existing wet grasslands in the SWP plus buffer zone
2d: Existing semi-natural grasslands	Existing semi-natural grasslands in the SWP plus buffer zone
2e: Existing broadleaved and mixed woodland	Existing broadleaved and mixed woodland in the SWP plus buffer zone
3a: BAP habitats	BAP habitats in the SWP and buffer zone
3b: Wader hotspots	Wader hotpots in the SWP plus buffer zone
4: Archaeological and historic sites	Archaeological and historic sites in the SWP and buffer zone, with 30m buffer applied around each site
5: Landscape permeability: heathland and mosaic species	Shows the landscape permeability for typical heathland and mosaic species (scored from 1 to 50) for the SWP and buffer
6a: Existing heathland and mosaic habitats	Existing heathland and mosaic habitats in the SWP plus buffer zone
6b: Heathland habitat network	Heathland habitat network in SWP and buffer
7a: Land use constraints	Land-use constraints in the SWP plus buffer zone. Comprises infrastructure, urban, gardens, water, BAP habitats, and sites of archaeological or historic importance (with 30m buffer).
7b: Wader hotspots	Wader hotpots in the SWP plus buffer zone
8a: Heathland buffer opportunity	Opportunities for habitat creation at sites that are immediately adjacent to existing habitat and fall within the ecological network.
8b: Heathland stepping-stone opportunity	Identifies sites that fall outside of the ecological network, but are immediately adjacent to it. These areas could potentially be used to create stepping-stone habitats that could link up more distant habitat patches.
9: Floodplain woodland opportunity - constrained	Opportunities for woodland planting in the floodplain of the watercourses of the SWP, to slow surface water runoff, absorb water and reduce sediment and pollutant loads flowing into the river network. Map shows sites once constraints have been applied.

10: Riparian attenuation features opportunity	Opportunity areas in the riparian zone of the headwaters where woody debris dams, riparian woodland, or attenuation ponds could be installed to slow the flow of surface runoff.
11: Combined woodland opportunities	Shows the overlap between floodplain woodland opportunities (constrained) and either woodland buffer opportunities or woodland stepping-stone opportunities.
12: Carbon storage capacity	Carbon storage capacity for SWP and buffer
13: Water flow capacity	Water flow capacity including soils data (standard percentage runoff) for SWP and buffer
13b: Water flow capacity - no soil	Water flow capacity excluding soils data for SWP and buffer (shown as Map A14 in the final report)
14: Water flow demand - flood risk	Water flow demand for the SWP and buffer indicating flood risk
15: Water quality capacity	Water quality capacity for SWP and buffer
16: Water quality demand	Water quality demand for SWP and buffer
17: Food provision capacity	Food provision capacity for SWP and buffer
18: Tranquillity capacity	Tranquillity capacity for SWP and buffer
19: Accessible nature capacity	Accessible nature capacity for SWP and buffer
20: Accessible nature demand	Accessible nature demand for SWP and buffer
21: Green travel capacity	Green travel capacity for SWP plus buffer
22: Green travel demand	Green travel demand for SWP and buffer
23: Average ES capacity	Average ecosystem service capacity for SWP and buffer, based on 6 ecosystem services
24: Ecosystem service hotspots	Ecosystem service hotspots for the SWP, showing the number of different ES for which that grid square is a hotpot. Includes 6 previously mapped ES plus archaeology / history and habitat for biodiversity.
A1: Landscape permeability: bog & upland flush species	Shows the landscape permeability for typical bog and upland flush species (scored from 1 to 50) for the SWP and buffer
A2: Landscape permeability: semi-natural grassland species	Shows the landscape permeability for typical semi-natural grassland species (scored from 1 to 50) for the SWP and buffer
A3: Landscape permeability: wet grassland species	Shows the landscape permeability for typical wet grassland species (scored from 1 to 50) for the SWP and buffer
A4: Landscape permeability: woodland species	Shows the landscape permeability for typical broadleaved and mixed woodland species (scored from 1 to 50) for the SWP and buffer
A5a: Existing bogs and upland flushes	Existing bogs and upland flushes in the SWP plus buffer zone
A5b: Bogs and upland flushes habitat network	Bogs and upland flushes habitat network in the SWP and buffer zone
A6a: Existing semi-natural grasslands	Existing semi-natural grasslands in the SWP plus buffer zone
A6b: Grassland habitat network	Grassland habitat network in SWP plus buffer zone
A7a: Existing wet grasslands	Existing wet grasslands in the SWP plus buffer zone
A7b: Wet grassland habitat network	Wet grassland habitat network in SWP and buffer
A8a: Existing broadleaved and mixed woodland	Existing broadleaved and mixed woodland in the SWP plus buffer zone
A8b: Woodland habitat network	Habitat network for broadleaved and mixed woodland in the SWP plus buffer zone
A9a: Bog and upland flush buffer opportunity	Opportunities for habitat creation at sites that are immediately adjacent to existing habitat and fall within the ecological network.
A9b: Bog and upland flush stepping-stone opportunity	Identifies sites that fall outside of the ecological network, but are immediately adjacent to it. These areas could potentially be used to create stepping-stone habitats that could link up more distant habitat patches.
A10a: Grassland buffer opportunity	Opportunities for habitat creation at sites that are immediately adjacent to existing habitat and fall within the ecological network.
A10b: Grassland stepping-stone opportunity	Identifies sites that fall outside of the ecological network, but are immediately adjacent to it. These areas could potentially be used to create stepping-stone habitats that could link up more distant habitat patches.
A11a: Wet grassland buffer opportunity	Opportunities for habitat creation at sites that are immediately adjacent to existing habitat and fall within the ecological network.

A11b: Wet grassland stepping-stone opportunity	Identifies sites that fall outside of the ecological network, but are immediately adjacent to it. These areas could potentially be used to create stepping-stone habitats that could link up more distant habitat patches.
A12a: Woodland buffer opportunity	Opportunities for habitat creation at sites that are immediately adjacent to existing habitat and fall within the ecological network.
A12b: Woodland stepping-stone opportunity	Identifies sites that fall outside of the ecological network, but are immediately adjacent to it. These areas could potentially be used to create stepping-stone habitats that could link up more distant habitat patches.