Arun & Rother Catchment Habitat Potential Model Update 2016

A Sussex Wildlife Trust report funded by the Heritage Lottery Fund (HLF), through the Arun & Rother Connections (ARC) project.

The Arun Valley © J Dominick

by Fran Southgate and Michael Tink

Acknowledgements

With thanks to :-

Sarah Taylor, Senior Adviser on Climate Change Adaptation for her assistance with climate change modelling and data

Damon Block for his support in acquiring data

Andrew Lawson for advice and technical support

Rowenna Baker for her work on previous HPM's

ARC staff for their patience

Michael Tink for modelling work and editing support

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Executive Summary

In 2012, a Partnership of seven organisations came together to enable local people to tackle big issues like flooding, biodiversity loss, and disconnection to nature, at the landscape scale. Through the Arun & Rother Connnections (ARC) HLF project, these organisations committed to restoring and enhancing wetland habitats and their connectivity across the Arun and Rother catchments in West Sussex. At the start of the ARC project, Habitat Potential Models (HPMs) were developed for nine key wetland habitats, to identify areas where wetland rehabilitation could be most effective. The models were a tool to enable those delivering habitat restoration to target their work to locations and landowners which have the greatest overall benefit, with the least overall negative impact on existing land management. There has been substantial loss of wetland habitat in the UK and in Sussex over recent centuries, and although the multiple benefits that healthy wetlands provide to society are beginning to be recognised, there is a long way to go before we have restored and protected some of our key wetland landscapes.

An extensive range of parameters and datasets were used to make the models as accurate as possible. Exclusions (areas where wetlands definitely cannot be restored or created) and prioritisations (areas where it would benefit landscape connectivity most if wetland was restored) were mapped before the final outputs were generated. The model also used a weighted overlay approach, allowing for different parameters to be assigned scores dependent upon their importance. For each of the nine modelled habitats, the potential for the restoration and creation of new habitat was evidenced. Model validation and sensitivity analysis confirmed the accuracy of the models and their outputs in the original HPM and so it was deemed unnecessary to carry out model validation again. The models were designed to be dynamic, and to be updated and re-run with new data-sets, or to transfer to different target catchments, and this report highlights new updates which have been made to the original HPM's. These Habitat Potential Models should not be used as a panacea, but as a guide.

Five years have passed since the initial Habitat Potential Models were run. During this period, improved data has become available for many of the model parameters. The data-sets have been updated (e.g. habitat layers), or are now available at finer resolutions (e.g. digital elevation models). It is therefore beneficial to re-run the Habitat Potential Models using new data to make the outputs more accurate.

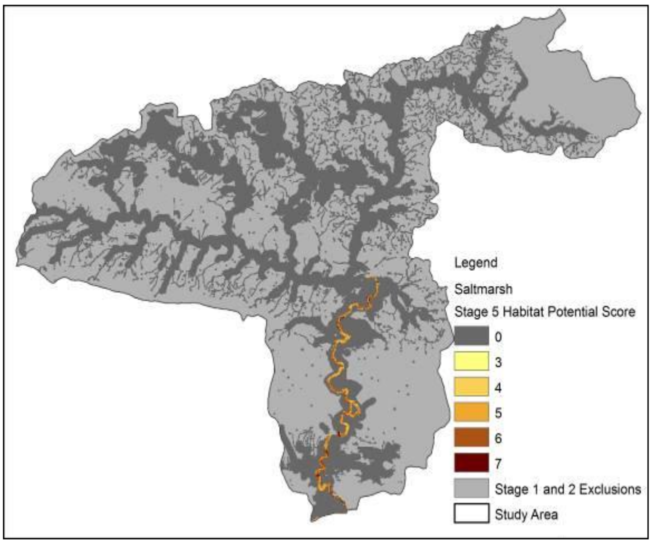
In this model, locations in the catchment were identified where it would be inappropriate to restore floodplain woodland without increasing flood risk, and these were excluded from the model. In addition, two further models were run – one to model flow pathways and water accumulation in the landscape (the Compound Topographic Index of wetness or CTI), and one to show what the effects of predicted climate change might be on the modelled habitats and results.

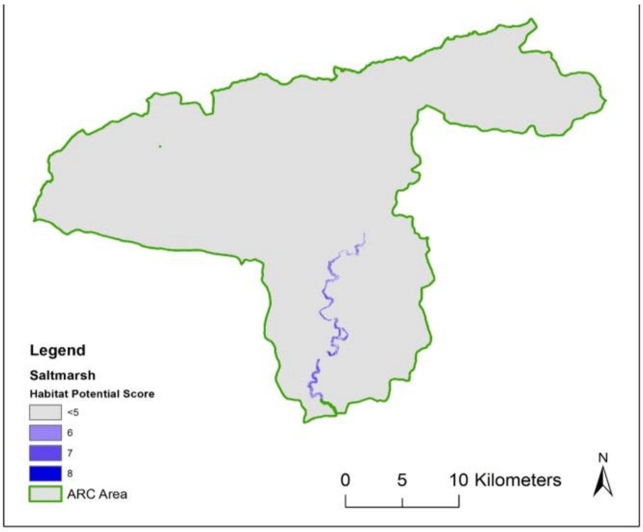
Overall, the new model predicted a number of changes in the habitat potential for the modelled habitats. Changes in the model outputs can now be compared between the 2011 and 2016 data (See saltmarsh example below). On the whole, the changes can be assigned to the inclusion of more accurate datasets to the model. For habitats such as saltmarsh and wet woodland the new data appears to have 'tweaked' the model outputs in a way which should enable more accurate targeting of habitat restoration to appropriate areas. The changes between the predicted areas of habitat between the 2011 and 2016 model are summarised in the table below. The changes include :-

- A slight decrease in the predicted potential for Base rich fen, Species poor tussock pasture and Lowland meadow, some of the more specialist habitats.
- A slight increase in the predicted potential for Saltmarsh and CFGM
- A large decrease in the potential for wet woodland (probably due to the addition of new flood mitigation parameters)
- A large increase in the potential for Purple moor grass and rush pasture – a more common and widespread habitat
- A near doubling of the potential for base poor fen
- A comparatively large (20%) reduction in the potential area for reedbed
- Comparisons of the effect that climate change is predicted to have on the different target habitats.

The new climate change element of the model provides evidence that habitat restoration work that the ARC project carried out has been well targeted to areas which in fact become more suitable for these habitats with climate change (See maps below). Climate change maps should therefore help to facilitate appropriate restoration of the ecological network in the long, as well as the short term.

	Original HPM Area (Ha) (Score >5)	New HPM Area (Ha) (Score >5)
Coastal & Floodplain Grazing Marsh	9673	10084
Fen (Base Poor)	4833	9672
Fen (Base Rich)	1404	1309
Lowland Meadow	23134	21225
Purple Moor Grass & Rush Pasture	16936	21512
Reedbed	8541	6852.5
Saltmarsh	534	610
Species Poor Tussocky Pasture	16232	15335
Wet Woodland	18272	14858

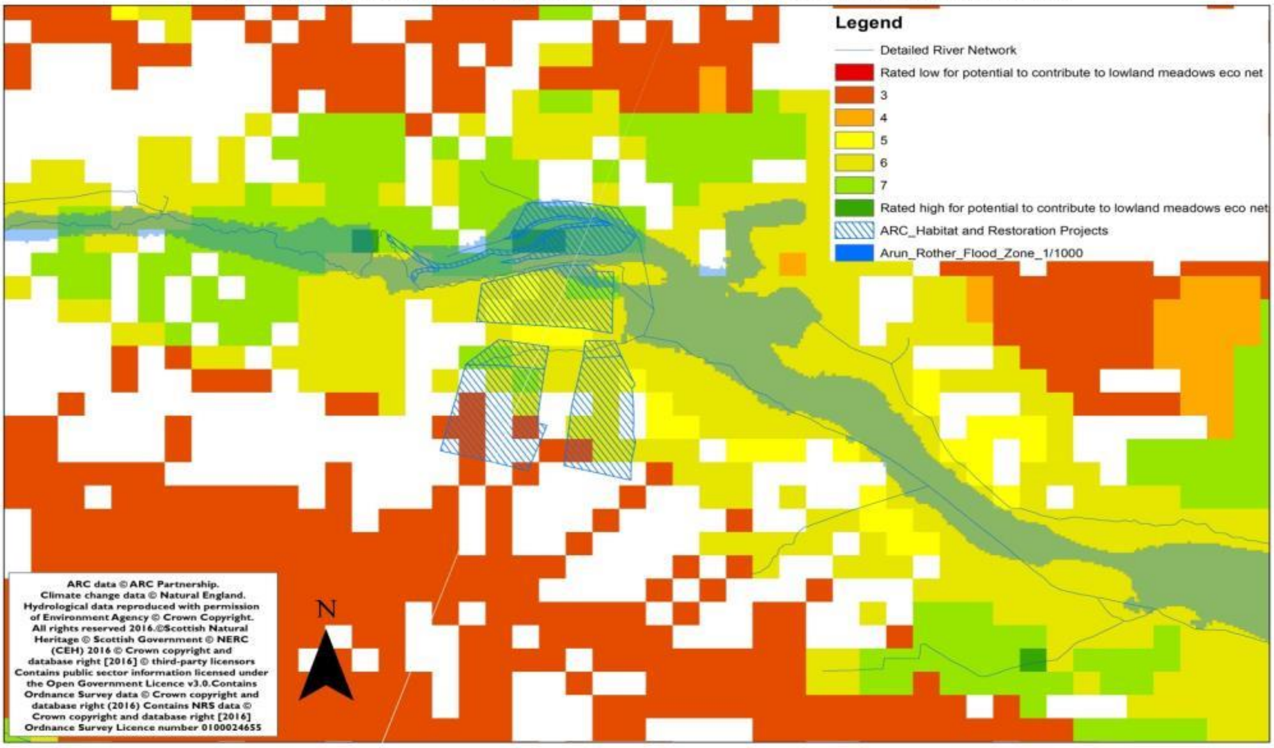




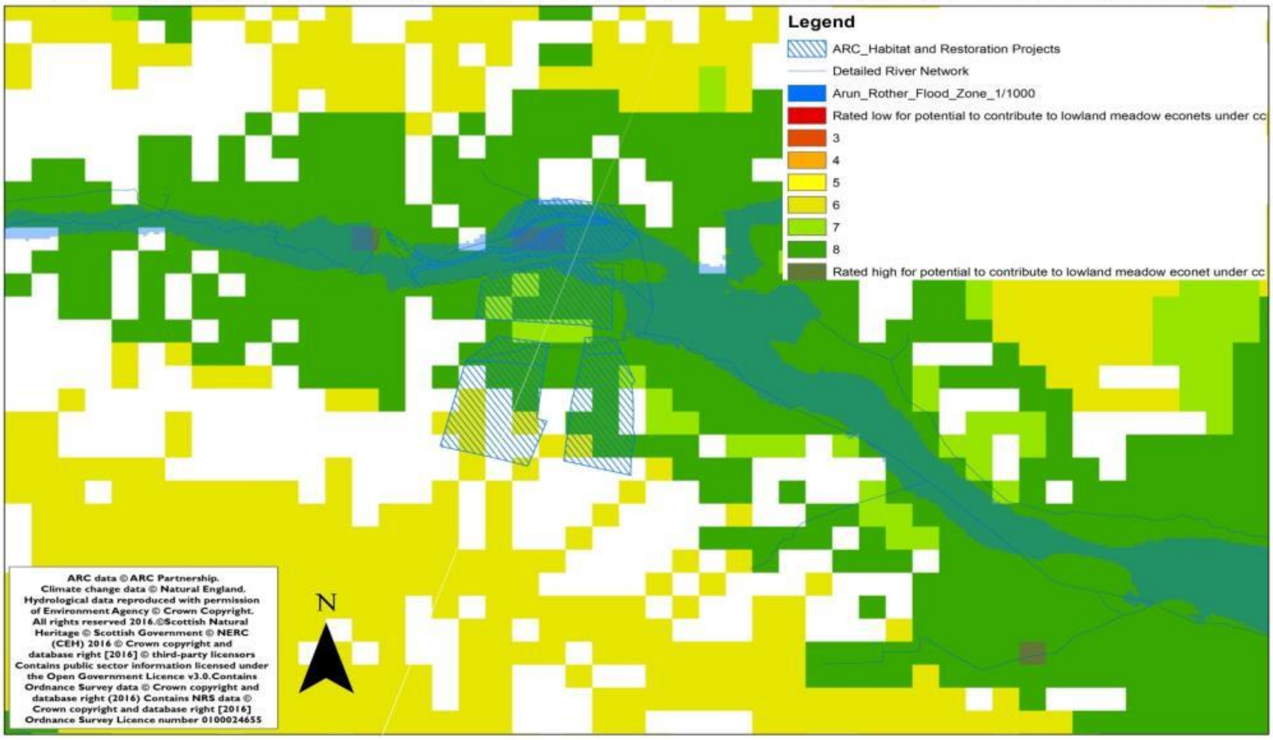
2011 model **2016 model**

A comparison of the final output maps for Saltmarsh between 2011 and 2016 shows that the model predicts a similar potential distribution of saltmarsh across the ARC area for both periods. The new 2016 model shows less potential for saltmarsh restoration but in fact it shows greater potential to restore a greater area of saltmarsh.

ARC Habitat Projects - Contributing to the Lowland Meadows Ecological Network



ARC Habitat Projects - Contributing to the Lowland Meadows Ecological Network under Climate Change Scenarios



The top map above shows the predicted potential for lowland meadows at a site at Bignor, as predicted by the 2011 HPM. If we re-run the model to show the influence that climate change would have on the Bignor meadows site where meadow restoration work was carried out in 2015, we can see that with climate change, this site becomes even more important for its overall contribution to the ecological network due to the resilience of this habitat to climate change (2016 HPM results).

1. Introduction

The Arun & Rother Connections Habitat Potential Model (ARC-HPM) was part of a baseline data gathering and targeting exercise, for a landscape-scale river catchment project for the Arun and Western Rother Rivers. The ARC HPM was used to inform a wider project partnership working on the Arun & Rother Connections (ARC) Heritage Lottery Funded (HLF) project.[1] One of the central aims of the ARC project was to promote more cohesive and resilient catchment management, and the restoration of healthy habitats in a functioning ecological network. This habitat potential model is an update of the original HPM, including additional flooding and climate change parameters.

Habitat restoration has often been targeted to sites where landowners are receptive. However these are not necessarily the most suitable ecological locations for the long term creation of an adaptable ecological network. National guidance often provides targets for habitat expansion, but not for where such expansions should be focused. Habitat Potential Modelling offers a means of identifying where specific habitat characteristics are present for habitat expansion or restoration to be most effective.

The model outputs enable those delivering (wetland) habitat restoration to target their work to locations and land holdings where it will have the greatest overall ecological benefit, with the least overall negative impact on existing land management. The ARC-HPM is only the first stage in the process of identifying appropriate sites for (wetland) habitat restoration. Deliverers of habitat restoration should use this HPM as a tool with which to focus delivery. To make the model as efficient as possible, it is recommended that all sites should be ground-truthed with landowners before any realistic idea of real wetland restoration potential can be developed. This modelling work was hosted by Sussex Wildlife Trust.

[1] Including the Environment Agency (EA), Natural England (NE), Sussex Wildlife Trust (SWT), RSPB, the Arun & Rother Rivers Trust (ARRT), the South Downs National Park Authority (SDNPA), and West Sussex County Council (WSCC).

1.1 The importance of habitat networks

Wetlands[2] and other natural habitats are some of the most important natural resources on Earth. They store and filter water and help control and buffer the effects of flooding. They give us food, fuel and plant fibre, capture carbon from the air and store it, and support a wealth of fascinating and uniquely adapted wildlife. They form landscapes that give enjoyment to millions of people, and contain a unique record of our past where some of the best preserved archaeological remains exist.

Wetlands are also among the world's most productive environments. They are cradles of biological diversity, providing the water and primary productivity upon which countless species of plants and animals depend for survival including humans. They support high concentrations of birds, mammals, reptiles, amphibians, fish and invertebrate species. Wetlands are also important storehouses of plant genetic and medicinal material (Ramsar Convention, 1971).

In the UK, wetland habitats have suffered permanent and widespread declines. Around 40% of England’s reedbeds have been lost since 1945 (RSPB, 2010); 46% of ancient woodland in England and Wales has been converted to plantation or agriculture since 1946 (Woodland Trust, 2000), and ancient floodplain woodlands have seen some of the greatest declines; since 1973 over 1,620ha of saltmarsh has been lost in South and South East England (Natural England, 2008). This is on top of an estimated loss in the UK of around 80% of wetlands since Roman times (pre AD 400) (Hume, 2008). Much of this loss has occurred since the Industrial Revolution, with an estimated 100,000 hectares per year drained between 1840 and 1880 alone (Hume, 2008).

The protection of existing habitat is more ecologically beneficial and cost effective than its restoration. In practice however, the extent of wetland degradation means that it is now necessary. In the State of Nature report 2016, the index of change in the abundance and occupancy of freshwater and wetland species shows a decline of 21% over the long term, and 4% over the short term, with13% of freshwater and wetland species threatened with extinction from Great Britain. Factors which are causing some of these declines include, hydrological change through urbanisation and the drainage of wetlands, upland bogs, fens and lowland wet grasslands; the over-abstraction of water and climate change.

[2] The broad Ramsar definition for wetlands is “areas of marsh, fen, peatland or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water the depth of which at low tide does not exceed six metres”. (Ramsar Convention, 1971).

There have been flaws in historic conservation methods, namely the assumption that species and habitats can survive in silos and isolated pockets. It has been recognised that fenced Nature Reserves and designated sites, although key to the conservation of biodiversity, are only one link in what needs to be a healthy and connected Ecological Network. The majority of species/habitats require an element of connectivity within the landscape to enable migration and DNA exchange, they require buffering from negative impacts such as drought and climate change, and need to be present at sufficient densities and 'scales' to allow the efficient functioning of the entire ecosystem within any given area (e.g. an ecologically 'efficient' area for woodland is considered to be over 50ha in size).

With new threats such as climate change, a healthy ecological network needs to be robust enough to allow species and habitats to react to large scale landscape and environmental change. Adaptive management within an anthropologically influenced landscape is key (Lawton et al., 2010; DEFRA, 2011). The restoration of ecological and landscape function is fast becoming important in the UK (Haines-Young et al., 2006), and this is where a HPM can be a useful aid. The wetland networks provided by the presence of the Arun and Western Rother Rivers are a huge natural resource, furnishing both the landscape and its inhabitants with water and a number of other ecosystem services such as flood storage and climate change buffering.

Previous habitat restoration efforts have had limited targeting to where a habitat should be developed (Lee and Thompson, 2005). Habitat Action Plans have provided targets for habitat expansion, but not guidance for where such expansions should be focused. Habitat Potential Modelling offers a means of identifying areas where specific habitat characteristics are present and therefore where habitat expansion is most likely to be effective. It is the aim of this HPM that it be used to create a more natural wetland ecological network to assist people and habitats to adapt to a changing climate and landscape.

1.2 Habitat Potential Modelling

Knowledge of species and habitat ecology, as well as the factors which affect their interactions with the human and physical environment is essential in effectively targeting land use management and habitat restoration (Cox and Moore, 2005). Predictive modelling is increasingly being used to assess and target areas for habitat rehabilitation and expansion, and the creation of ecological networks (e.g. Burnside et al.; Eyre et al., 2004).

Habitat Potential Models are particularly effective at analysing large amounts of data across large landscape areas. Such large-scale analysis would be inefficient purely using field studies, and so Habitat Potential Models provide important focus on areas where the most gain can be made within any given area. Compared to modelling mobile species, the interaction between habitats and the environment can be modelled with a high level of accuracy, because of their stationary nature (Austin, 2002).

There are numerous approaches to modelling environments and overlaying data, including binary, fuzzy overlay, and weighted overlay. The binary method uses Boolean logic to produce outputs based on answers to yes/no questions (Figure 1.1a). As such only areas that answer yes to all the parameters are identified as having potential, and no alternative or next best sites are proposed.

Weighted overlay is a more sophisticated approach, combining multiple raster layer inputs to generate a single output layer (Figure 1.1b). It allows all values to have relative importance (e.g. in the snow, layer areas are assigned 1, 5, or 9). In addition weighted overlay takes into consideration that not all the input parameters are necessarily of equal importance. Weights can be assigned to each parameter, so that the final output layer is more influenced by the most important parameters (Figure 1.2).

A weighted overlay method therefore has advantages over other modelling techniques, as areas that score lowly in one particular category are not ruled out as potential sites. For example if wetland habitats were determined to be found on slopes less than 5 degrees, a binary approach would rule out any region with a slope greater than 5 degrees. In reality, there is no such hard limit, and the suitability of an area is a combination of multiple variables. Weighted overlay allows each parameter to be scored on a scale, for example slope suitability score can decrease as slope increases. For these reasons a weighted overlay technique was selected for the ARC-HPM.

The selection of model inputs can generally be classified as either correlative or mechanistic (Robertson et al., 2003). The correlative approach makes predictions based upon the characteristics found at existing populations of a particular species or habitat. Mechanistic models are deductive (Burnside and Waite, 2011), with parameters being developed from in depth knowledge of a species or habitat autecology. The ARC-HPM adopted a mechanistic approach, the reasons for which are detailed in section 2.1.

There are, of course, a number of provisos which need to be considered with the creation of any HPM. Not least, an HPM is only as good as the data which is fed into it or the manner in which this data is processed and used. Many of the decisions regarding which data sets are included or excluded from the model may be subjective ‘opinions’ which may vary from person to person. A number of the decisions made with regards to the ARC-HPM are discussed in more detail below.

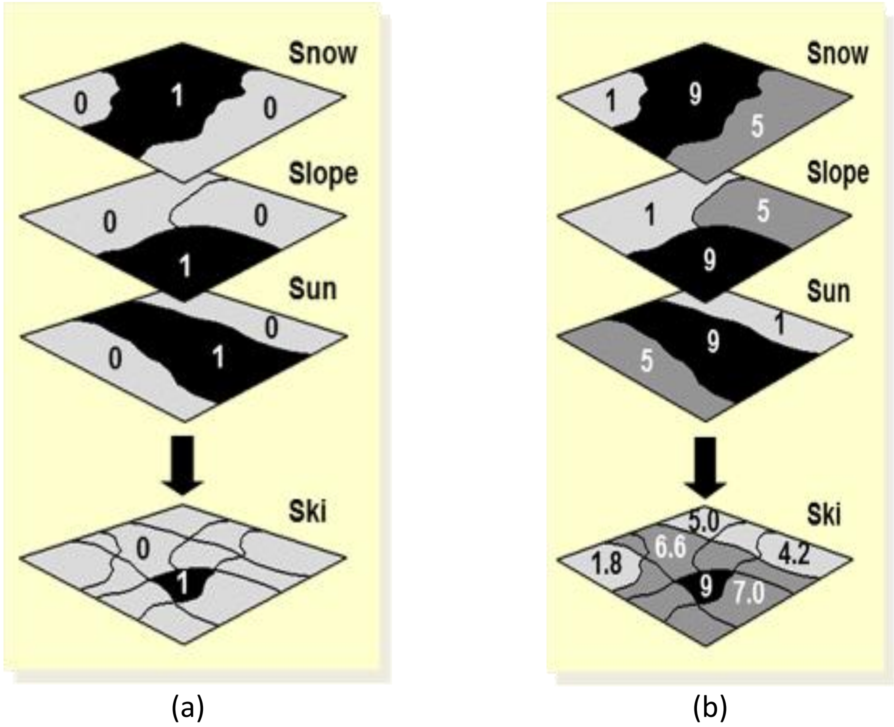


Figure 1.1. **Example of the Boolean logic approach to modelling**
(a), where land areas are classified as suitable or not suitable. Using this approach the only suitable area identified is where all of the parameters (snow, slope, and sun) are scored as suitable (areas scored 1 in the ski layer (a)). Using a weighted overlay approach (b), rather than either being suitable or not suitable, each area is assigned a value between 1 and 9. The final suitability score for an area is calculated by combining scores for all the parameters. While the area identified in (a) is still located as the most suitable area, in (b) other areas with ski-ing potential are identified where they were excluded in the Boolean approach (scoring 9/9 in the ski layer). Source: Johnston and DeBruyn (2010).

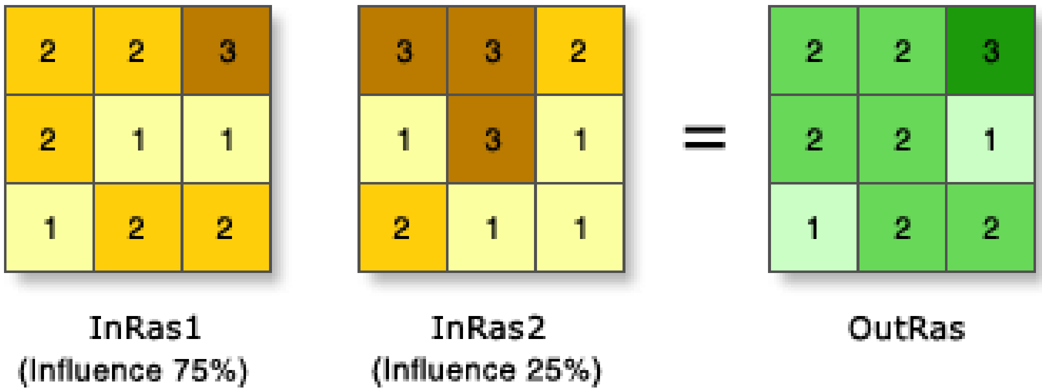
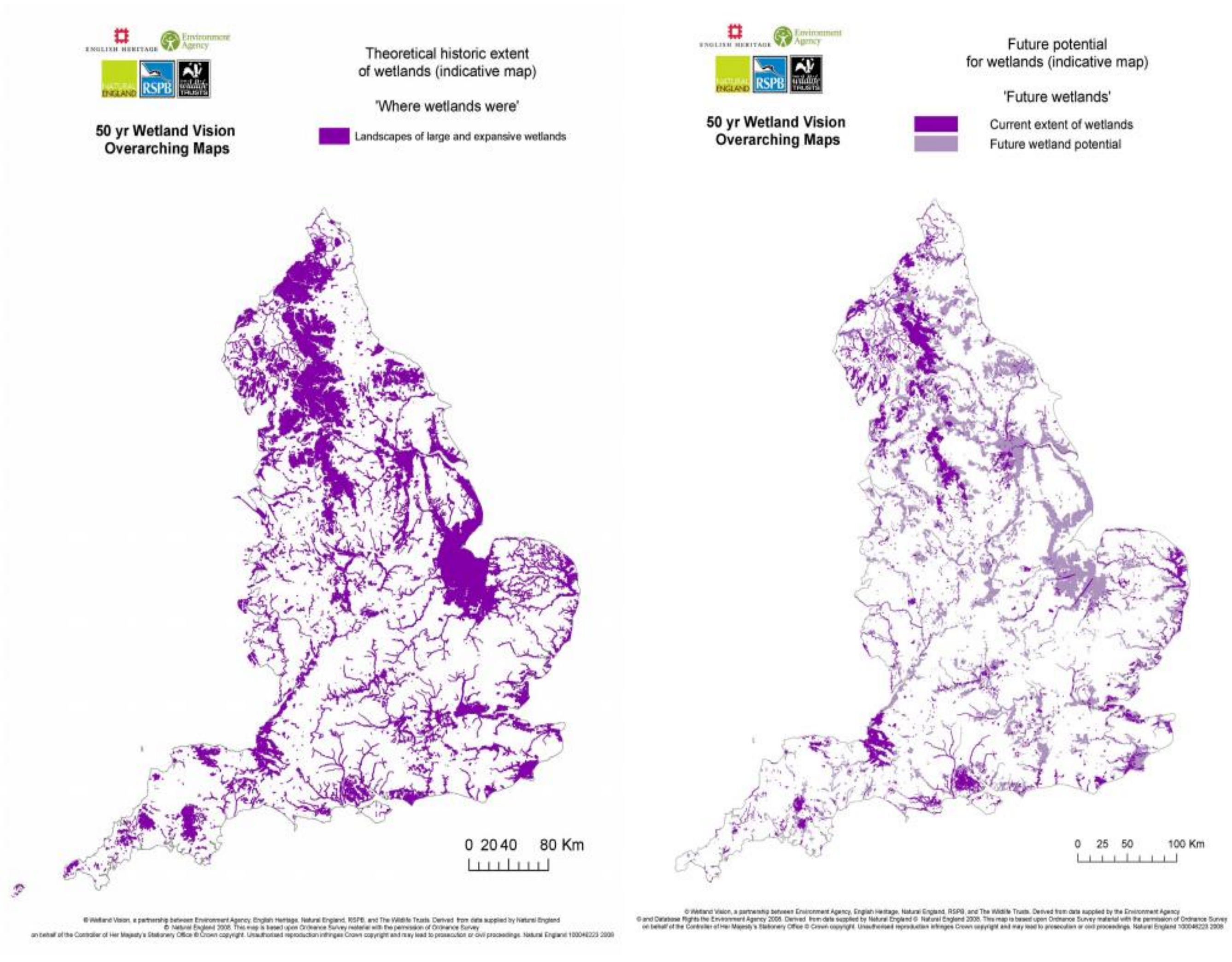


Figure 1.2. Example of the scoring method for a simple weighted overlay model.
The value assigned to the cell in the top right of the output grid (Outras) is 3, derived from a score of 2.25 (3*0.75) in Inras_1 added to the value of 0.5 (2*0.25) in Inras_2. The value of these added together (2.25+0.5=2.75) and rounded to the nearest integer, in this example 3. Source: ESRI (2008).

1.3 Examples of past Modelling work

As the quality of available electronic datasets has improved, habitat modelling has become a valuable means of influencing landscape change. A number of pioneering habitat models have been constructed at both the UK and Regional levels, and more local models are now being developed for specific localities of interest (e.g. Souch et al, 2000; Burnside et al., 2002; Ball et al., 2006; Foy, 2006; Harris, 2007; GeoData Institute, 2009). This project has drawn on the experiences and methodologies of a number of these projects to create the most effective ARC-HPM.

The maps below (Figure 1.3) show the results of the UK Wetland Vision Mapping, a multi-partner project which showed the vision for where UK partners would like England's wetland landscapes to be in 50 years time. Although incredibly valuable at the UK scale, at a local scale the data and outputs of this project are not of sufficient detail to inform the necessary land management decisions about where to optimally locate local wetlands. The ARC-HPM provides an added layer of local detail and precision which is essential to the correct targeting of wetland restoration in the ARC project area.



Historic wetland **Potential wetland**

Figure 1.3. UK Wetland Vision maps showing likely extent of historic wetlands in the UK, and the potential for 'future' wetlands

1.4 ARC Project Area

The Sussex parts of the Arun and Rother catchments stretch from its Northern boundary at Horsham, to Petersfield in the West and South to the coast at Littlehampton (Figure 1.4). The upstream limits of both catchments are excluded from the geographic area covered by the ARC-HPM project, as their location in the neighbouring counties of Hampshire and Surrey meant that a lack of consistent data was available to correctly model the habitats. It is unlikely that this omission will significantly affect the results of the model.

A number of major urban centres are based within the catchment including Arundel, Billingshurst and Horsham. Many more rural towns and villages predominate along the river landscape. Both river catchments possess wetlands which are unique to their individual landscapes and geologies. These include wet heathlands on the Wealden greensands, chalk streams in the South Downs National Park and small areas of saltmarsh around the estuary.

The Arun valley also hosts some of the most biodiverse (although not entirely natural) wetlands in Sussex, and a range of internationally protected sites including Amberley Wildbrooks, Pulborough Brooks and Waltham Brooks. The Western Rother is considered to be a large tributary of the Arun River catchment, although its size and position in the landscape mean that it is effectively a separate river catchment.

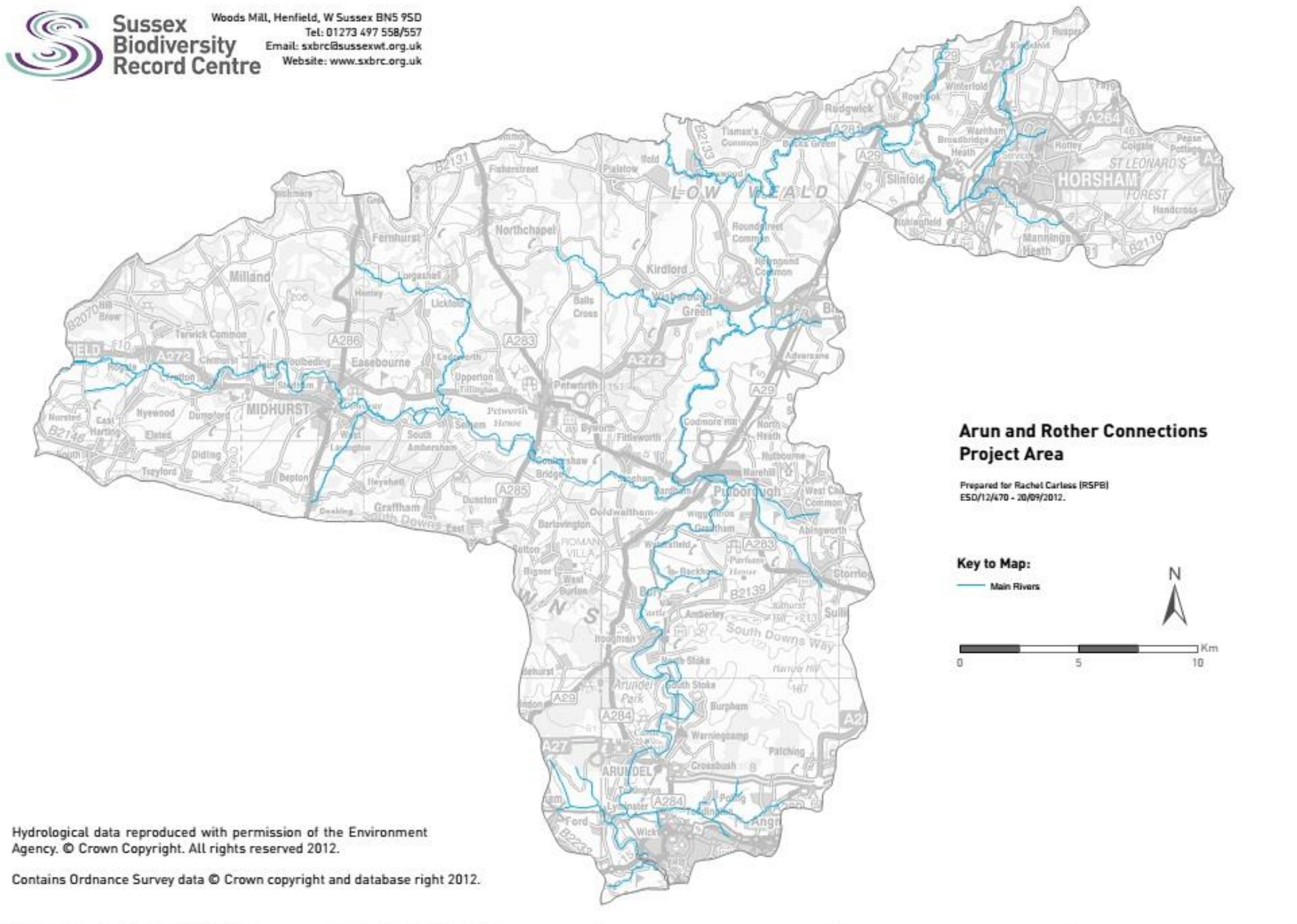


Figure 1.4. The Arun and Rother river catchments and ARC project area in West Sussex

1.5 Target Habitats

Nine wetland habitat types were chosen for the HPM which are rare or characteristic of Sussex wetlands. These habitats occur naturally in the ARC project area, and (other than Coastal and floodplain grazing marsh) are 'naturalistic' wetland habitats which reflect local natural character and processes. A separate ARC pond / standing open water HPM was created in 2013. The following habitats were modelled for the ARC HPM :-

1. Lowland fen – Base rich fen
2. Lowland fen – Base poor fen.
3. Lowland wet meadow
4. Purple moor grass and rush pasture
5. Reedbed
6. Saltmarsh
7. Species poor tussocky pasture
8. Wet woodland
9. Coastal and floodplain grazing marsh

Descriptions of individual habitats are given below :-

Lowland Fen – Base Poor and Base Rich

Fens are characterised by high soil water levels which are often peat forming (McBride et al, 2011). They are fed by surface and/or groundwater, and rainfall. They include a wide range of habitats including swamps on the margins of open water, floodplain sedge beds, floating rafts of sphagnum, and spring flushes. Fens can be split into different types depending on the movement and/or fertility of the water supply that feeds them. Topogenous fens are predominantly fed from water collecting in depressions such as valleys, basins and floodplains whereas soligenous fens are fed from water moving laterally through the soils forming springs or flushes.

For the purposes of mapping potential fen creation areas, lowland fens were separated into base rich fens which are derived from mineral enriched sources such as chalk and limestone streams and springs, and base poor fens which are derived from base-poor rock such including more sandstone and calcareous rocks. Base rich habitat comprises the National Vegetation Classification (NVC) communities S3, S6, S7, S12, S13, S10, S14, S28, S24, S25, OV26, M22 and M27 as defined by Rodwell (1991b; 1995; 2000). Base poor habitat comprises NVC communities M21, S27, S11, S19, S14, and M25, as defined by Rodwell (1991b; 1995).

Lowland wet meadows

Lowland wet meadows incorporate a range of grassland communities which occur on agriculturally unimproved land and un-compacted soils. The habitat tends to be found on periodically inundated land on alluvial, neutral and calcareous soils. Although commonly associated with floodplains, this habitat can also occur below springs, flushes and seepage lines. NVC communities include MG4 and MG8 (Rodwell, 1992), which are both traditionally managed as hay meadows. MG5 meadows are flower rich, nutrient poor meadows which are one of the rarest wet meadow types in Sussex. It is often the management of meadows through grazing or hay cutting which determines the difference between a fen meadow or a lowland wet meadow classification. Due to the draining or ploughing of many floodplains for agriculture, the drilling of more vigorous grasses, and the application of fertilisers and herbicides, this habitat type is now rarely encountered.

Purple Moor Grass and Rush Pasture

Purple moor-grass and rush pasture occurs within lowland areas on poorly drained, acidic soils (Natural England, 2010b). It often establishes within a mosaic of other habitats including heathlands, acid grasslands and woodlands, and within wet hollows, spring flushes or field corners. It also occurs in marginal and drier areas of fens where mean water levels and fertility levels are low. The habitat is often dominated by a diversity of sedges, tussock forming grasses and rushes. Herbaceous flowering plants make it particularly valuable for insects and ground nesting birds. This habitat is maintained by low intensity grazing during summer.

Reedbeds

Reedbeds are characterised by the dominance (< 60% cover) of *Phragmites australis,* a lowland perennial plant that forms extensive stands in permanently wet or periodically waterlogged sites. Water levels can range from 1m below to 2m above the surface and conditions can range from oligotrophic to eutrophic. The mostly healthy reedbeds establish in eutrophic sites which have a consistent hydrological regime of fluctuating or stable water levels. Reedbeds commonly establish along slow flowing watercourses, on open water transitional zones (particularly upstream pond or lake margins), on marginal habitat within fens, estuaries and saltmarshes. This habitat comprises the NVC community S4, as defined by Rodwell (1995).

Saltmarsh

Saltmarshes can form part of estuary, coastal bay and barrier beach systems. They are generally composed of fine mud or sand that settles out of suspension, encouraging saltmarsh vegetation to colonise. Once settled, sediment can only accumulate and saltmarsh develop if sediment particles are not re-suspended by wave or current action. Local sediment supply is key to whether they are able to accrete, or whether they erode. Nowadays, conditions for saltmarsh development are often determined by shelter afforded by large scale natural coast morphology or man-made sea defences.

Currently many coastal areas are eroding and moving sediments into deeper water areas, at least in part due to anthropogenic influences such as the prevention of coastal sediment drift through the creation of coastal sea defences, and the dredging of coastal aggregates. In the South, the vertical accretion of sediments is more or less keeping pace with current sea level rise, however, coastal wetlands are eroding rapidly due to 'coastal squeeze' where coastal land is constrained between natural geographic barriers and anthropogenic influences such as tidal barriers, urban developments and flood embankments.

Four main general types of saltmarsh are recognised: pioneer marsh, low marsh, upper or high marsh and drift line or transitional marsh. This habitat comprises the NVC communities SM4, SM7, SM22, and SM11 as defined by Rodwell (2000).

Species Poor Tussocky Pasture

Species poor tussocky pasture is characteristic of anaerobic conditions where it has a competitive advantage over other neutral grassland communities. It grows most vigorously on gleyed brown earths, gleyed calcareous earths and surface and ground water gleys including alluvium. It occurs within the upper limit of inundation by open water, within wetter areas of pastures and meadows and on the margins of fen. It requires periodic inundation from floodwaters within lowland areas. Although a non-priority habitat, the unpalatable nature of *Deschampsia cespitosa*, often leads to tussocks being un-grazed which therefore provides suitable habitat for a range of ground nesting birds and small mammals.

Wet Woodland

Wet woodland incorporates a range of wooded habitat types which establish under different hydrological and geomorphological conditions. In Sussex, the most prevalent wet woodland communities include W5, W6 and W7, with W8 and W10 occurring within drier areas. All wet woodland communities will occur where the water table is permanently high, including areas within the floodplains of streams and rivers, within open water transitional zones, within wet flushes below seepage lines and in lenses of impermeable soil as part of drier more extensive woodland complexes. Wet woodland is commonly associated with fens and reedbeds which can naturally develop into a more wooded ecosystem. Due to its association with floodplains, wet woodlands can be highly dynamic and diverse ecosystems with multiple niche habitats.

Wet woodland, especially that occurring on river floodplains can have a direct impact on the flooding patterns within a floodplain. It can reduce the risk of flooding downstream by slowing down flood water velocity, reducing the water yield through water absorption and absorbing surface run-off. Wet woodland can also increase flood risk upstream, reduce groundwater recharge and increase river obstructions from woody material. The model therefore included a means of excluding areas which might increase flood risk from the overall model.

Coastal Floodplain Grazing Marsh (C&FGM)

Coastal and Floodplain Grazing Marsh consists of a mosaic of mesotrophic grassland communities which include pastures and meadows, fen, and reedbed habitats. It is characterised by the presence of drainage ditches which manage the water levels to prevent natural flooding within a river's floodplain (Williams, 2004). The land is relatively low lying and flat and subjected to periodic inundation from floodwaters, surface water run-off and/or springs. The water table often remains near to the surface, creating damp soil conditions in many areas. C&FGM's are commonly associated with surface water gley, groundwater gley and peat soils. Coastal Grazing Marshes are generally considered to be drained former bogs, reedbeds, fens and saltmarshes and tend to occur behind embankments, sea walls and other man-made structures.

The C&FGM designation is currently under review, with proposals to recognise floodplain grassland habitats in more naturalised states as priority habitats.

2. Method

2.1 Model Design and Development

Geographical Base

In order to make comparisons for habitat potential between different areas, it was necessary to break the study area down into grid cells which could be scored and weighted according to how each habitat parameter applied to each individual cell. 50m x 50m cells were chosen as a compromise between minimising loss of data and thereby developing a coarse and inaccurate model, and keeping the number of cells within a manageable level in terms of data management within the GIS model. During the modelling process each cell was assigned a value for each parameter, and a weighted combination of these values was used to generate a habitat potential score for each individual cell.

Model Design

A common problem with overlay features in GIS has been that some approaches do not consider that different parameters may not be equally important in a model (Janssen and Rievelt, 1990). To eliminate this weakness the weighted overlay approach was chosen, which allows for weightings to be assigned to parameters so that the most important ones are the most influential in the output layer. The weighted overlay technique used is discussed in section 2.3.3.1.

A mechanistic approach was used for the model, with parameters determined by expert opinion and literature reviews on the target habitats. An element of the correlative approach was used in the model validation stage (in 2013). A slight disadvantage of the correlative approach is that parameters are determined by conditions where the habitat exists, though existing habitats may not reflect the true ecological niche, as they are likely to have been influenced by land management practices. This can lead to an increase in areas being identified in a habitat potential model, that actually offer limited or no potential (Chefaoui et al., 2005). Furthermore correlative models assume that a habitat is in equilibrium with its environment (Burnside and Waite, 2011), which is often not the case for habitats that are contracting (Austin, 2002; Robertson et al., 2004). This point is particularly relevant to the present model, and particularly for saltmarsh habitats, given that much of the river channel and surrounding floodplain in the study area has been artificially channelled, re-seeded, embanked, drained and re-directed.

Modelling Stages

The modelling was carried out in stages as outlined below. The first step was to remove areas that offer no potential for wetland development (Stage 1), and to identify the areas with the broad physical characteristics suggesting they have potential for wetland development (Stage 2). Individual habitat potential models were then developed using habitat specific parameters for each target habitat (Stage 3). The sites identified in Stage 3 were then prioritised further (Stage 5), using sets of habitat specific prioritisation parameters and exclusion criteria. Details of the individual habitat parameters for Stages 3 and 5 can be found in the Appendices. Stage 4, model validation was not performed for this model.

Finally, a new modelling stage was added, (Stage 6), which attempted to show the likely effects of climate change on shifting habitat parameters and geographic locations.

Stage 1: **Excluding areas with no wetland potential.** Removal of areas that offer absolutely no potential for wetlands (All wetlands habitats – with specific criteria excluded for saltmarsh and wet woodland).

Stage 2: **Establishing areas of potential wetland (general).** Identifying the areas which have the physical characteristics that make them potential wetland sites. (All wetlands habitats)

Stage 3: **Identifying areas of potential wetland (habitat specific).** Habitat specific habitat suitability models. The output from this stage highlights areas according to the suitability of the physical characteristics of each of the model cells.

Stage 4: **Model Validation.** Not performed for this model.

Stage 5: **Prioritising Areas.** Habitat specific prioritisation of areas identified in Stage 3. The output from this prioritises areas that could initially be targeted for habitat development.

Stage 6: **Climate change modelling**. Modelling the likely shift in habitat ranges using climate change predictions (Natural England).

Model Development

The models were developed using the ModelBuilder application within ArcGIS 10 (ESRI, 2010). ModelBuilder allows GIS tools to be chained together as a flowing process (Figure 2.1), which can then be run to process a set of chosen actions to produce an output. New data-sets can be included, and model parameters can be added, deleted, or edited relatively easily. This was important as it allows for the model to be updated as new data becomes available, and makes the model transferable for use in future projects. Furthermore, the ModelBuilder interface is more visually accessible and user friendly, and therefore more transferable than using coded programming language to run a model.

Part of the process of developing Stage 3 and Stage 5 models was to prepare the data into raster grids. In these stages each $50m^2$ cell was given a score for each of the parameters. Once completed a weighted overlay of the rasters (explained in section 2.3.3.1) was executed to produce a single layer of habitat potential scores for the cells. A separate model was developed for each of the chosen types of wetland. This was necessary due to the different requirements and parameter of the different habitats.

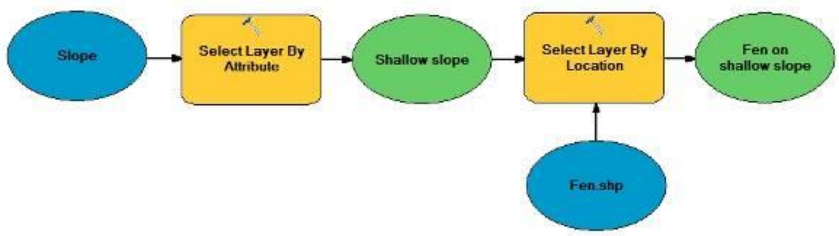


Figure 2.1. **An example of a basic model displayed in the ModelBuilder window.**
This model selects areas that have a shallow slope ('Select Layer By Attribute' bubble) to create a temporary shapefile ('Shallow slope' bubble). From this temporary file areas that intersect fen habitat are then selected ('Select Layer By Location' bubble) to create an output of fen on shallow slopes ('Fen on shallow slope' bubble).

2.2 Model Parameters

Despite all our chosen habitats being wetlands, environmental determinants, and therefore HPM parameters, vary greatly from one wetland habitat to another. A descriptive overview of all the parameters used can be found below, and comprehensive tables detailing each parameter, weighting, and data-set used are listed in the Appendices.

There is a tendency to attempt to optimise a models performance by including many parameters (Burnside and Waite, 2011). However it is not always true that a complicated model works more effectively than a simple (Hilborn and Mangel, 1997). Indeed as a model becomes more complex it can become more erroneous, as errors in the data can become more exaggerated as a model becomes more complex (Linhart and Zucchini, 1986). As such Hilborn and Mangel (1997) argue that "optimum model size is much smaller that intuition dictates". Ultimately a model is a simplified representation of reality and being too specific may lead to the habitat potential of an area being incorrectly valued.

The intent of this Habitat Potential Model is to be dynamic, to be updated when new data-sets are available, and to be transferable to other study areas. With this in mind, a model that is not overly complex is appropriate, and only parameters that are highly influential to habitat development are included. There is however potential for more complex parameters to be included at a future date.

Stage 1 inclusions / exclusions

In Stage 1, parameters such as urban land, transport networks and historic landfill sites were excluded from the model. New parameters for saltmarsh and wet woodland were also incorporated and are summarised below :-

Saltmarsh Habitat Potential Sussex
A layer derived from assumptions based on land levels at which similar habitats develop around the Chichester Harbour area was used both to exclude areas unlikely to be saltmarsh, and include areas likely to be, if existing flood defences were not present. Despite its potential inaccuracies, it is the 'best guess' available under the current circumstances of what the original extent of saltmarsh and its related habitats may have been in the Arun valley.

In the 2016 HPM, we excluded additional 'non saltmarsh' coastal communities from the model.

Wet woodland exclusions
Due to the potential positive or negative impact of this habitat on flooding regimes (depending on its location in the catchment), a suite of new buffer zones around infrastructure within the floodplain / river corridor were added to the model (such as road bridges). These 'backwater buffers' will ensure that the model does not recommend planting/creating woodland around any infrastructure where it might otherwise cause adverse flood impacts. In addition, land which is already positively wooded was also excluded.

Stage 2 inclusions / exclusions

Parameters such as OS Terrain 50 land levels and wet soils were used at this stage to create a broad overview of where it might be likely for the chosen wetland habitats to occur.

2.2.1 Stage 3 Parameters

The parameters used in the Stage 3 model are outlined below, with a broad explanation of each provided. Habitat specific tolerance for each parameter was reflected in the decision to include or exclude each of these parameters from individual habitat models, and in the individual weightings assigned to individual habitats (fully detailed in **Appendix 3**).

Altitude

Low altitude is a defining feature of wetland habitats such as saltmarsh, and Coastal & Floodplain Grazing Marsh. Including elevation in the model allows the exclusion of land at altitudes known to be unfeasible for the natural occurrence of a specific habitat. For the other habitats modelled there was generally a preference for lower elevations, although higher elevations could be tolerated in more marginal areas and where ponded water or impermeable geology exists. A weighting system was used to weight altitudinally lower areas more favourably than higher areas.

Slope

Wetland areas are generally found on flat land or gentle slopes, with steeper slopes allowing run-off into the wetland area. Wetland habitats such as C&FGM and reedbed are particularly dependant on flat land, whilst other habitats such as wet woodland are more tolerant of moderate slopes and elevations. For all habitats this parameter was weighted so as not to exclude potential habitat areas.

Salinity – Tidal and estuarine

Salinity was used as both an exclusion criteria and as a weighted parameter depending on the habitat. Wetland habitats such as species rich meadow are intolerant of saline conditions and therefore this parameter could be used to eliminate known saline areas for this habitat. Conversely other habitats such as saltmarsh are saline dependent and fresh water areas could be excluded from the habitat analysis. Other habitats such as reedbed are tolerant of both saline and freshwater conditions, and so for these habitats a weighting system was used rather than an inclusion/exclusion system.

Salinity level information was obtained from the flood zone data-set, and the Detailed River Network. Salinity data was only available within the flood zones and river corridors. Inverse Distance Weighting (IDW) was used to interpolate values for areas that were not covered by the initial data. IDW is an interpolation technique within the Spatial Analyst extension of ArcGIS 10, where predictions can be made about characteristics of a landscape based upon data from surrounding areas. The same layer which was created for the original HPM was used in this version of the Model.

Flood Zones

EA flood zone data was used, showing flood zones for 1 in 100 year (frequent flood zone) and 1 in 1000 year (occasional floodzone) flood events. This data is useful in targeting C&FGM and other inundation dependent habitats. This parameter was used with a weighting so as not to exclude marginal areas. Areas which would have flooded in the past (historic flood zones) were also used to highlight areas which may have flooded in the past, and which may have potential to flood now and in the future.

Areas accumulating water in the landscape (Compound Topographic Index of Wetness)

Surface water flood risk areas which receive and store water but which may not be in river flood zones were also included. By using specific layers of the DEM, it can be predicted where most water is likely to accumulate within the landscape, and in which direction it is most likely to flow..

Proximity to River

This parameter was used alongside flood zone data to identify the areas most liable to riparian flooding and a regular supply of water and nutrients through inundation. This parameter was used with a weighting and not as an exclusion criteria, with areas closer to the river scoring a higher weighting for the majority of wetland habitats, except those habitats which may suffer adversely from nutrient enrichment from floodwaters.

Running water / Water flow

Some habitats thrive more in lentic (still water), or lotic (running water) conditions. This parameter enabled some distinction to be made between those habitats.

Ditch Drainage

Of particular relevance to C&FGM as a noted 'characteristic' of the habitat, this parameter can also positively, but usually negatively impact wetland habitats.

Geology

The underlying geology in any landscape plays a significant role in determining the overall habitat and structural characteristics of that landscape. Geology can have a strong influence on soil type, (and therefore vegetation type), water filtration, percolation and flows, the presence of springs and wet flushes, and the nutrient content of soils and water sources. The ARC-HPM catchment covers a number of distinct geological character areas including the South Downs chalk and the Wealden Greensand. Although in lowland, alluvial deposits may mask the influence of geology in floodplain areas, it will still have a significant influence on the likely presence of any given habitat, and particularly in the case of base-rich and base-poor fen habitats.

Current Land Use

Current land use can determine both the relative ease and the likely success of habitat restoration and creation. For example lowland fen communities will struggle to develop on land that has had fertiliser on it in the previous decade (McBride et al., 2011). Therefore in the lowland fen models, non-organic land was given a lower weighting than organic land. This parameter also considered the likely restrictions that the current land use may hold. For example it was considered that it would be unlikely to restore wetland on land that is currently high grade agricultural land. This parameter was used to weight areas and not to exclude them.

Soil Type

Many habitats such as lowland fen are soil dependent, and therefore in the models for these habitats unsuitable soils were excluded from the analyses. For other habitats weightings were used to highlight the most suitable soil type for the specific habitat.

Existing Habitat

Although some existing habitat is in decline, it was assumed that it was unlikely that, for example, woodland can be created on an existing woodland site. Some habitats such as ancient woodlands were therefore excluded from having habitat potential. Existing reedbed, fen and wet heath were also excluded. MG5 grassland is so rare in Sussex this this was also excluded from having any other habitat potential.

Parameters Not Included

Other parameters were considered, including those used in previous habitat potential models, but those which were considered unsuitable within the scenarios for the ARC-HPM were excluded. A brief overview of the excluded parameters is given in the table below.

The presence of indicator species has been used in previous models to help highlight the most suitable locations for a specific habitat type. Foy (2006) used this technique to look at the potential for the creation of calcareous grasslands. While indicator species can be indicative of suitability for a habitat, it was considered in the present model that they would not be significantly influential in determining the success of wetland habitat development. Furthermore, species records are prone to recording bias. The only current model in which a species was used to identify the potential for the habitat was therefore the presence of purple moor grass and rushes for purple moor grass and rush pasture. Invasive species records were also used to show negative impacts on potential habitat restoration.

The spatial data for the national opportunity project [mapping woodland creation target areas for water management] which was used to identify target priority areas in the new Countryside Stewardship scheme is currently unavailable. Other parameters are listed below.

Parameter	Supplier	Why not used?
Areas benefiting from flood defences	EA	No areas within project boundary
National Nature Reserves	NE	Already covered by SAC & SSSI
England Woodland Grant Schemes	Forestry Commission	Interpretation of layers is too subjective
Flood Risk Areas	EA	None in project area
Public Rights of Way	WSCC	Analysis of their effect on potential wetlands is too subjective. Some positive and some negative impacts dependent on location
EA Policy units (Coastal defences)	EA	Refused permission from EA
Airports	OS	Although a factor in deciding locations of wetland restoration projects, this can be decided on a case by case basis. Otherwise this parameter rules out large areas of the catchment
Saline lagoons	NE	None in catchment area
Saltmarsh zonation (EA)	NE	None in catchment area
Groundwater Storage Areas	Natural England	No updates or licence to use
Nature Improvement Areas	SxBRC / NE	Under review
Current Land Use including allotments, railways etc. IHF (Integrated Habitat Framework)	SxBRC	OS mastermap permission not available

2.2.2 Stage 5 Parameters

As with Stage 3, the specific weights used for each parameter varied from one habitat to another. A detailed list of the weightings applied to each habitat can be found in Appendix 3 & 4 (tables list Stage 3 parameters, followed by Stage 5 parameters for each of the chosen habitats).

For Stage 5, the majority of parameters were used with weightings rather than as exclusions. The exceptions to these rules include :-

- Regionally Important Geological Sites (RIGS)
- Scheduled Ancient Monuments (SAMs)

Which were excluded from all HPM's. And :-

- SSSI's destroyed or part destroyed
- Areas with highest suitability for agricultural cultivation
- Existing habitats such as reedbed, ancient woodland and fen
- Some of the Water Framework Directive waterbodies such as canals

Which were excluded to varying degrees from selected HPM's. The following parameters were used to create the Stage 5 Habitat Potential Maps for all 9 habitats, and were used to help prioritise the best locations for the creation/restoration of each of these habitats :-

River catchment flood risk

The Environment Agency (EA) Catchment Flood Management Plan identifies 6 different zone types within the catchment which influence the degree to which the river habitat can be naturalised, or needs to be maintained with heavily engineered flood defences.

Size of Potential Habitat

Areas that scored 7 or above in Stage 3 of the modelling were selected in GIS and where these polygons intercepted or bordered the habitat type modelled, the existing habitat was joined to the potential habitat. If the potential habitat did not border existing habitat then the area was used independently. The areas of these potential habitats were then calculated, with larger areas generating a higher weighting.

Proximity to same Habitat Type

Restoration was considered to be enhanced by connectivity to an existing patch of the same habitat. Creation of habitat adjacent to existing habitat patches was assumed to also create a buffering effect, and an increase in the efficient ecological function of the habitat patch due to an increase in its overall size. Therefore areas bordering existing habitat were weighted highly.

Proximity to other Priority Habitat

It was considered that restoration of wetland habitat would be more successful, and enhance connectivity if it were close to other priority habitats. Existing priority habitats are assumed to be of high quality and to therefore be 'suppliers' of species diversity to created or restored habitat patches.

Presence of Invasive Species

A list of invasive species already identified as posing a threat to wetlands in the catchment area was used. These included Floating pennywort, Hybrid knotweed, Indian balsam, Himalayan balsam, Japanese knotweed, New Zealand pigmyweed, Water fern, Giant hogweed and Parrotsfeather. These particular species are considered to be severe impediments to the creation or recreation of wetland habitats, as the likelihood of these species 'infecting' and severely damaging the habitat integrity of new habitat patches is extremely high.

Within Designated Sites

It was considered that within certain types of designated sites, habitat development would be more plausible than in others. For example it was considered that gaining permission to develop wetland within a Ramsar designated site would be less compromising than developing the habitat within a country park. RIGS were excluded at this stage of the model, as it was considered that it would not be plausible to gain permission to develop these areas as wetlands. New designated sites were added to the list used for this model including Important Bird Areas, SSSI impact zones, Source Protection and Nitrate Vulnerable Zones, River Eutrophic sensitive area maps, WFD waterbody conditions (cycle 2 draft), and Important Areas for Ponds.

SSSI Units, Boundaries and Conditions

Additional information was available for the condition of SSSI sites. Those which were destroyed or part destroyed could be excluded from the analysis.

Adjacent to Designated Sites

Those areas adjacent to designated sites were given a moderately higher weighting applied. This was due to the consideration that being adjacent to, for example, a Ramsar site would increase wetland connectivity and therefore the overall ecological integrity of restored habitats.

Archaeological sites

A ten metre buffer was drawn around scheduled ancient monuments, and these areas were excluded from the model. Due to the archaeological importance of these sites they were considered to be not suitable for wetland habitat development. This is mainly due to the fact that archaeological sites tend to need to either remain wet, or remain dry, but not to oscillate between the two. It is possible that some archaeological sites would benefit from further 're-wetting', however this would need to be determined at the ground-truthing stage with the assistance of County Archaeologists.

Current Land Use including membership of Agri-Environment Scheme

Areas of land that were part of an agri-environment scheme were given a higher weighting, as they were considered to be amenable to and more suitable for habitat development, as well as increasing the overall landscape connectivity and integrity of restored habitats through existing positive land management. Organic sites were given a higher weighting that non-organic. HLS, higher than ELS sites. In some cases, other criteria such as current habitat use were also included.

Rivers at High Risk of Pollution

Particularly for habitats such as lowland meadows and fens, the presence of high levels of additional nutrient from river pollution were considered to be a barrier to habitat restoration. Habitats such as reedbeds are however known to cope much better with pollution.

Presence of Chalk / Greensand Streams

This parameter was only used in a few of the habitat models such as fen, where it was considered that the pure water quality, extreme pH and increased water availability created by these features would increase/decrease the success of lowland (particularly base-rich) fen development. For wet woodland, which overall had far greater potential for habitat creation than for other wetland types, it was considered a factor in determining the creation of a specialist 'niche' woodland type which has a national and international conservation value. For other habitats it was considered that the habitat would develop sufficiently regardless of the presence of this feature.

2.2.3 Stage 6 parameters

Climate change

Natural England climate change data was used to model the potential migration of the 9 chosen habitats under climate change scenarios. For the climate change modelling parameters, the individual habitat layers were used (e.g. Sussex_NBCCVM_LF_NO_VALUE_Export_Output). Within each of these layers the MaxVuln (Vulnerability to climate change) field was weighted (50:50) against the Stage 5 model outputs to produce the climate change output (Stage 6).

2.2.4 Data

In order to assess the desired parameters, data-sets were sourced from the Sussex Biodiversity Record Centre, online from free OS resources and from ARC-HPM partners including the Environment Agency and Natural England (with thanks). A full list of the data-sets used can be found in **Appendix 2.**

The updated ARC HPM model should help us to assess the impact of climate change on key wetland habitat at a landscape scale

2.3 Detailed Method for the Model Stages

2.3.1 Stage 1 Method: Excluding Areas With No Wetland Potential

Expert opinion and literature reviews identified the following areas as unsuitable for wetland habitat development:

- Urban areas including transport networks
- Historic landfill and waste sites
- Artificial geology
- Parks, gardens, allottments (where data was available)

A model was created to identify parts of the catchment (cells) which contained these land uses and which were therefore not able to accommodate wetland habitat. It was decided that only grid cells that were comprised completely of an exclusion criteria, would be excluded from the model **(Figure 2.2).** This ensured that all the included cells had some potential for wetland habitat development**.** In effect this meant that most transport networks were not excluded, as they did not fill a 50m^2 area. They were still included in the development of exclusion criteria to allow exclusion of regions where they contributed to a cell being comprised completely of exclusion criteria, such as on the outskirts of an urban area **(Figure 2.3).**

Future models may wish to reconsider some of the exclusion criteria, as for example, there may be potential to create wetlands in urban areas through the use of SUDS networks.

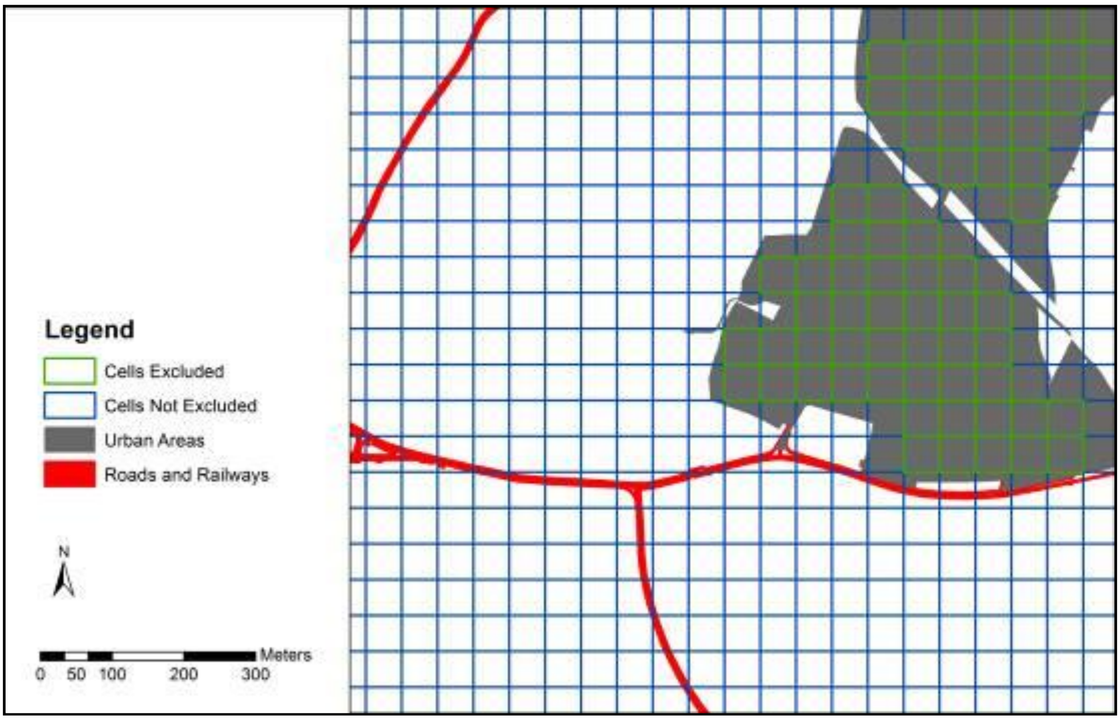


Figure 2.2. Only grid squares that were completely composed of an exclusion feature were excluded.
The grid squares highlighted in green are completely composed of an urban area, and are therefore excluded from the model. Many of the grid squares in blue are partly comprised of exclusion criteria, but also have elements with no exclusion criteria. These cells were included in the model as they offered some potential as wetland habitat.

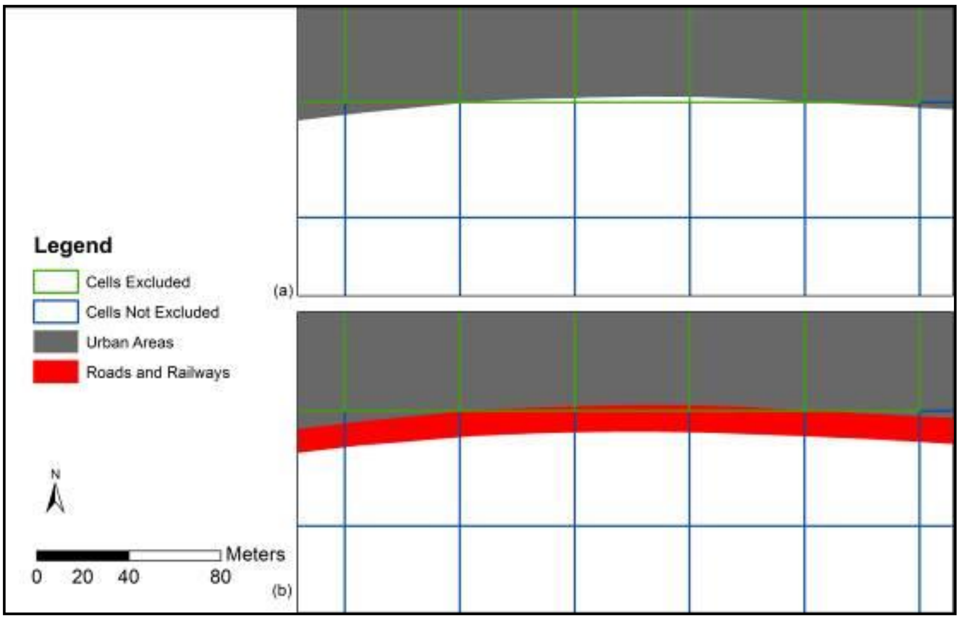


Figure 2.3. Although not large enough to fill a cell on their own, the use of transport networks was still important.
The three cells at the centre of the top row would not have been excluded (a) as the urban area did not completely fill the cell. However the presence of a road at the edge of the urban area ensured these cells were excluded (b) as they offered no potential for wetland habitat restoration.

2.3.2 Stage 2 Method: Identifying Potential Wetland Areas

Expert opinion and literature reviews identified the following areas as inclusion areas offering potential for wetland development:

- Rivers, open and standing water (100m buffer)
- Flood zones (with 100m buffer)
- Naturally wet soils / impermeable geologies (100m buffer)
- Springs and Issues
- Areas accumulating water including surface water flooding
- Historic flood zone areas
- Groundwater flood zones

A model was created to identify cells that contained these criteria. The excluded cells from Stage 1 were then subtracted from Stage 2 grid to produce a final grid of the areas with potential for wetland habitat development **(Figure 3.2).**

2.3.3 Stage 3 Method: Identifying Habitat Specific Potential Wetland Areas

At this stage the model became habitat specific, with the habitat potential assessed using habitat specific parameters and weightings. The initial part of this stage was to develop a model that assigned a score to each cell, for each of the habitat parameters. As such it was necessary to produce a separate model for each habitat based upon the individual parameters and weightings. Once each cell had been allocated a score, the model converted the data to raster grids. This allowed for habitat specific weightings to be applied to each parameter using the Weighted Overlay tool within ArcGIS 10 (see section 2.3.3.1).

Once the models were run with the weightings applied, Stage 3 outputs were produced mapping the areas with the highest potential at this stage i.e. the areas with the most suitable landscape characteristics for a given habitat. A full set of the output maps for this stage are included in the Appendices.

2.3.3.1 Weightings and Multi-Criteria Analysis

Weighted Overlay

The weighted overlay tool in ArcMap 10 was used to add weightings to the models. Initially it was necessary to assign values within each parameter with a value from 0-9. For example a slope of between 0 and 1 degree could be assigned 9, a slope of between 1 and 2 degrees assigned 8, until the least suitable slopes were assigned a value of 1. Areas assigned 0 were excluded from the output layer (e.g. areas were the soil type was unsuitable for the habitat being modelled).

The second step in the weighted overlay was to assign weightings between parameters. For example if slope was more important than elevation, slope may be assigned a 60% weight and elevation 40%.

Both the values and weights assigned varied between habitats based upon literature reviews and expert opinion, with a full list provided in the appendices.

Analytical Hierarchy Process

The Analytical Hierarchy Process (AHP) describes a decision making aid. Designed by Saaty (1990), AHP can be used to increase the objectivity of multi-criteria decision making. For the current method, rather than making comparisons between all the individual parameters together, the parameters were first broken down into groups. Weightings were assigned for individual parameters within each group, and each group was then given a weighting (tables of the breakdown of parameters and the weightings assigned are listed in the Appendices).

2.3.4 Stage 5 Method: Prioritising Areas

Particularly for habitats that are fairly generalist in nature and tolerant to a range of physical environments (such as woodland), the Stage 3 model highlights large geographical areas with the potential for restoration of that habitat. Therefore a further model was developed using the Stage 3 outputs combined with Stage 5 parameters to try and show more locally targeted sites for with the potential for habitat development.

In Stage 5, parameters which were more specific to the individual habitat being modelled could be applied. The method used was similar to that of Stage 3. Habitat specific models were developed, using specific parameters and weightings to produce an output map detailing the final habitat potential of cells within the catchment area.

3. Results

3.1 Stage 1

The exclusion areas which were identified as having no potential for wetland habitats were converted to grid cells to produce the final exclusion grids for this stage **(Figure 3.1).** This excluded area accounted for 920.5 ha (1.2%) of the catchment area.

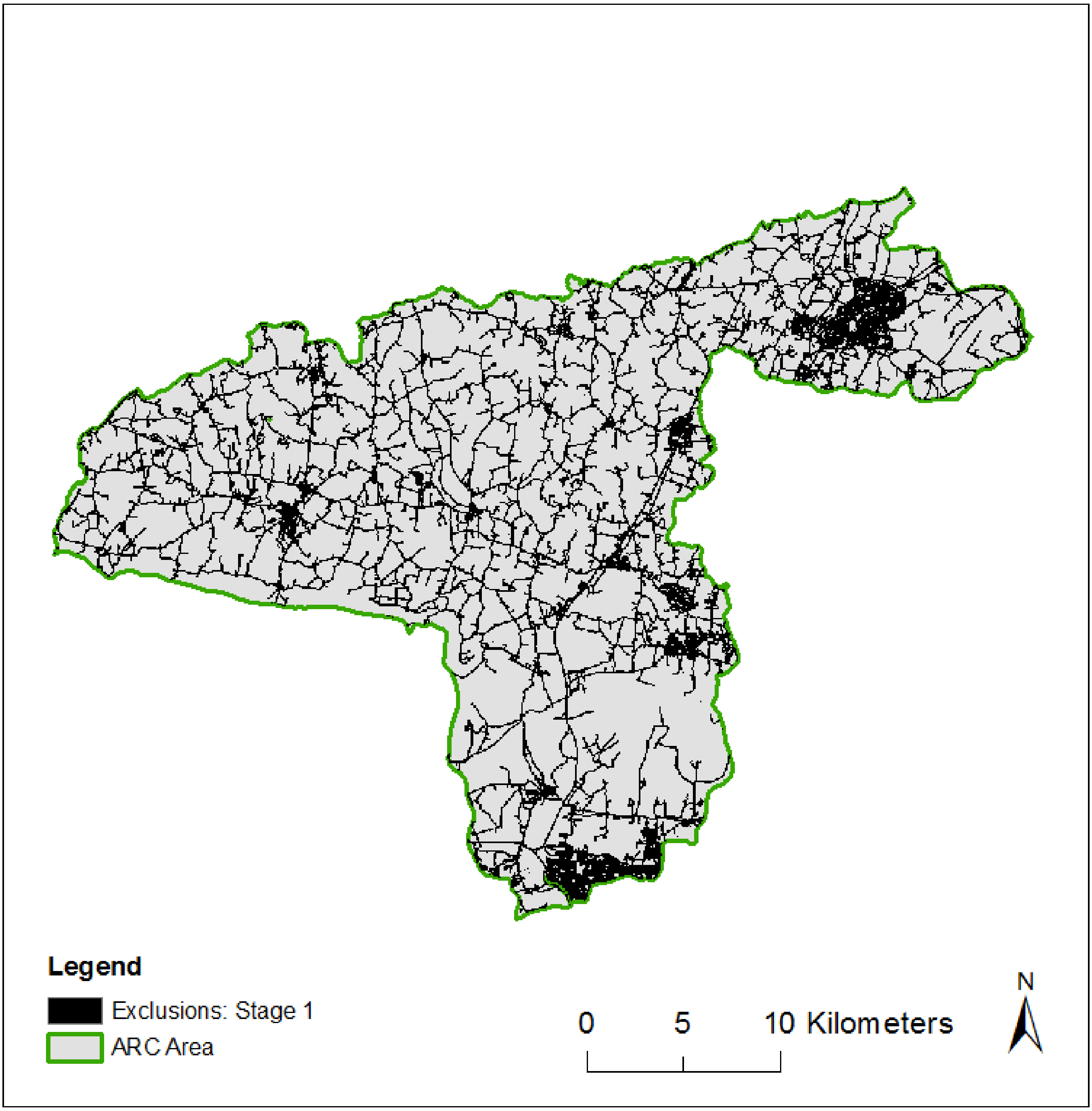


Figure 3.1. Sites excluded as 'unsuitable' for wetland restoration in Stage 1.
Catchment boundary reproduced with permission of Environment Agency.

3.2 Stage 2

The Stage 2 process identified criteria in order to map the areas which could be included in the model as having potential for wetland creation. **(Figure 3.2).** After subtracting the Stage 1 exclusion grids from the Stage 2 inclusion grids, an area of 30,194 ha, or 39.2% of the study area, was deemed suitable in principle for wetland habitat.

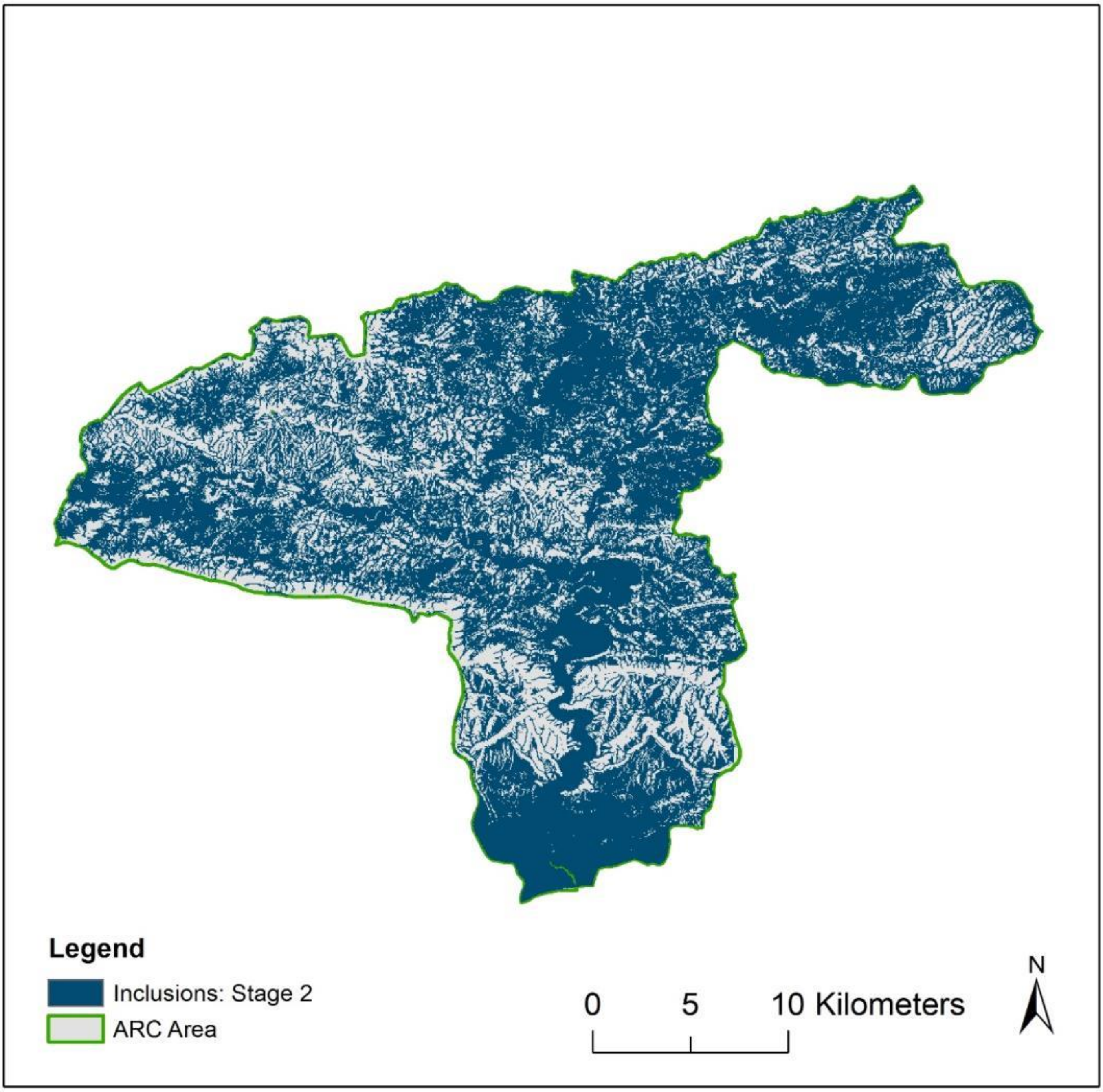


Figure 3.2. Wetland features in catchment likely to support wetlands

3.3 Stage 3

Within this stage, fairly broad areas of wetland habitat potential were identified. Stage 3 parameters were intended to identify the areas with the physical characteristics making them likely overall to have potential for the restoration of each of the wetland habitats. For the more generalist habitats, such as grasslands and woodlands, large areas have the potential to be 'restored' at this stage, although this assumption is based on a number of common sense stipulations at the ground truthing stage. The Stage 3 maps can be found in **Appendix 1.**

The results of this stage do not mean that we could or should restore for example woodland, to every location where it is shown to have potential in the HPM. It does however allow for some objectivity and flexibility in interpretation of the results, whereby these more generalist habitats can be restored outside of the areas shown as being suitable for the restoration of specialist habitats which can only be restored to very limited geographical areas.

For the habitats modelled with more specific niche requirements, such as lowland fens, the outputs highlight much more limited geographical areas with the potential for restoration of these niche habitats.

3.4. Stage 4

In the previous Habitat Potential Model, a Stage 4 of model validation was carried out, to assess the accuracy of the Model outputs in relation to the locations of existing habitats. As the previous HPM was validated, it was deemed unnecessary to carry out at Stage 4 process for this HPM.

3.5 Stage 5

The Stage 5 habitat models include more detailed inclusion and exclusion parameters for each of the modelled wetland habitats – for example specific soil sets which are only suitable for fen establishment are highlighted and weighted highly at this stage. Output maps from this stage highlight much more precise areas of potential for the nine target habitats than were identified in Stage 3 (**Figures 3.3 - 3.11**).

The outputs are shown using colour scales with the areas of highest potential for each habitat highlighted. By focusing on the areas with the highest potential (highest scoring areas) for each of the chosen habitats, the optimum potential niche or geographical area for each habitat to occupy can be highlighted. Habitats can still be restored in lower scoring areas, but they will be slightly less appropriate in terms of location, and the amount of 'connection' that they provide to the existing network of that habitat. In any given area, it is likely that more than one type of habitat *could* be restored, but local expertise and local conditions should be assessed to decide which habitat *should* be restored.

The model highlights the potential for developing a much more effective wetland habitat network within the catchment landscape. This targeted information can be used in a number of ways including as a means by which to approach willing landowners with land in the target land parcels to see whether they are able to restore the target habitat.

As a means of superficially assessing the practical applications of this model to the real world, **Figure 3.12** zooms in (arbitrarily) to the largest area highlighted as having the potential for multiple wetland habitat types.

It is worth noting that the habitat potential score theoretically ranged from 0-9. However, because of the differences in the weightings and parameters included, for many of the habitats the full range of values (0-9) was not achieved. The colour range in each map covers the range of scores produced for each particular habitat - direct comparisons between colours grades for different habitat maps should therefore not be made.

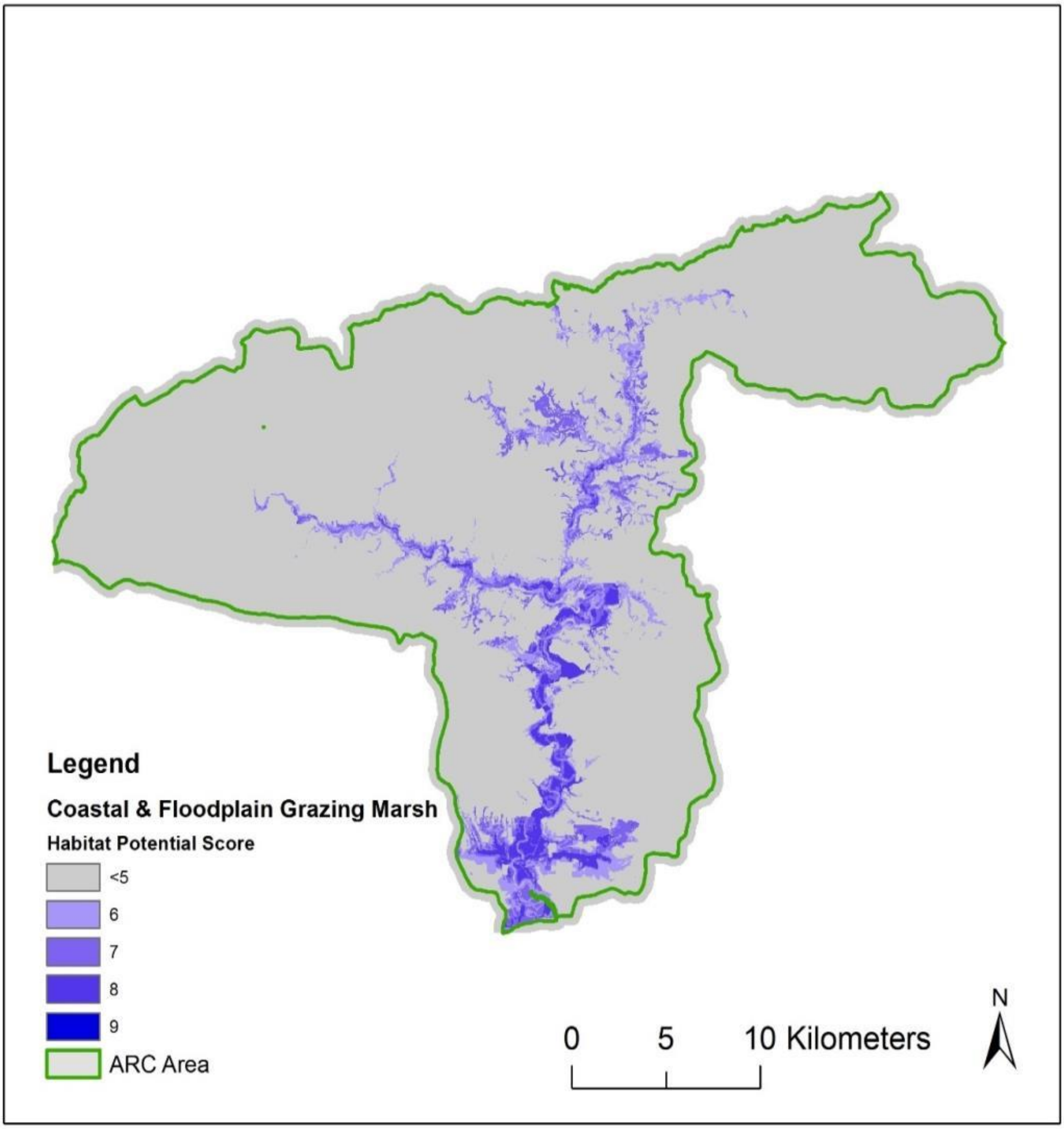


Figure 3.3. Final output maps for Coastal & Floodplain Grazing Marsh showing all scores
Catchment boundary reproduced with permission of Environment Agency.

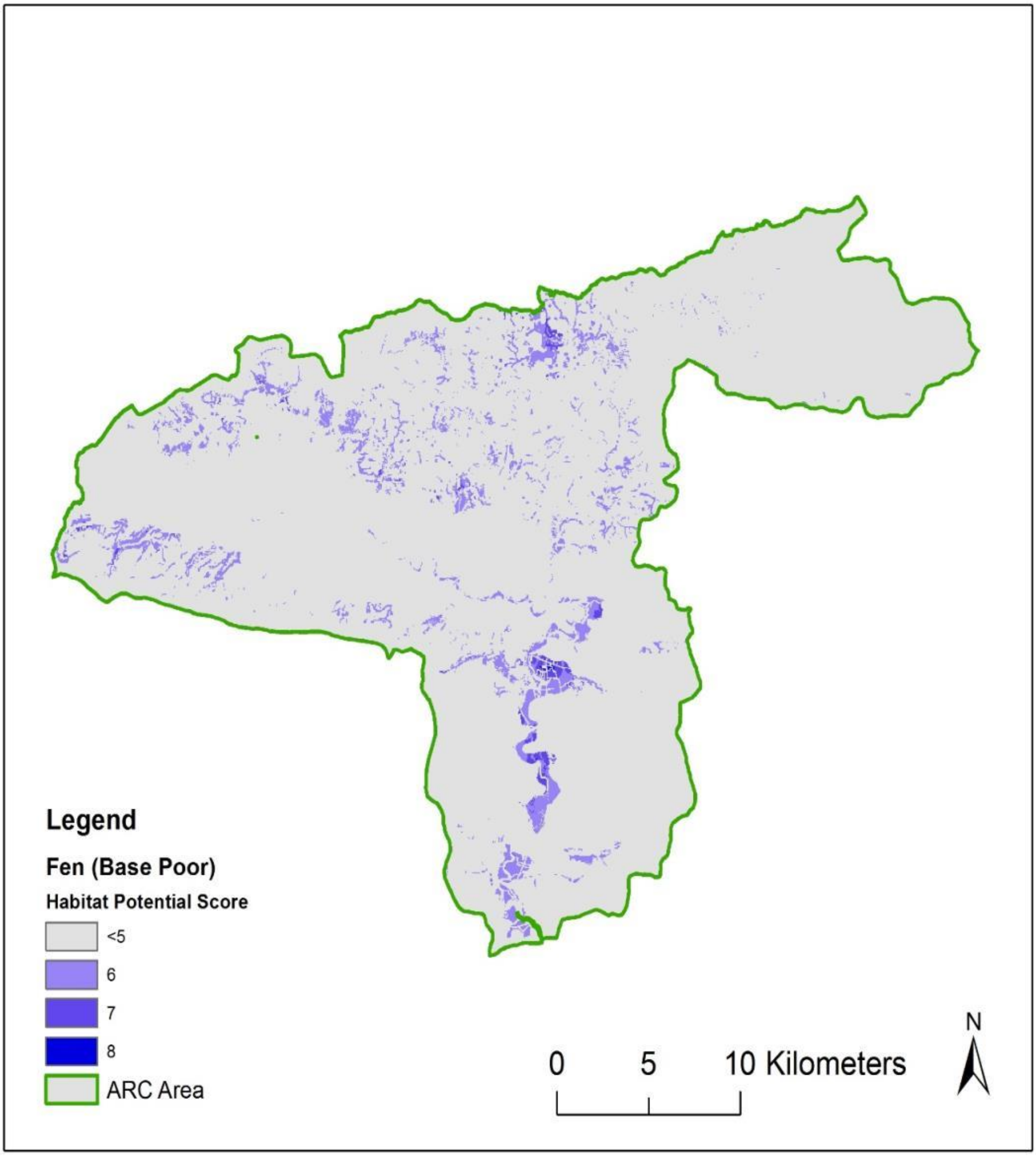


Figure 3.4. **Final output maps for Fen (Base Poor) showing all scores**

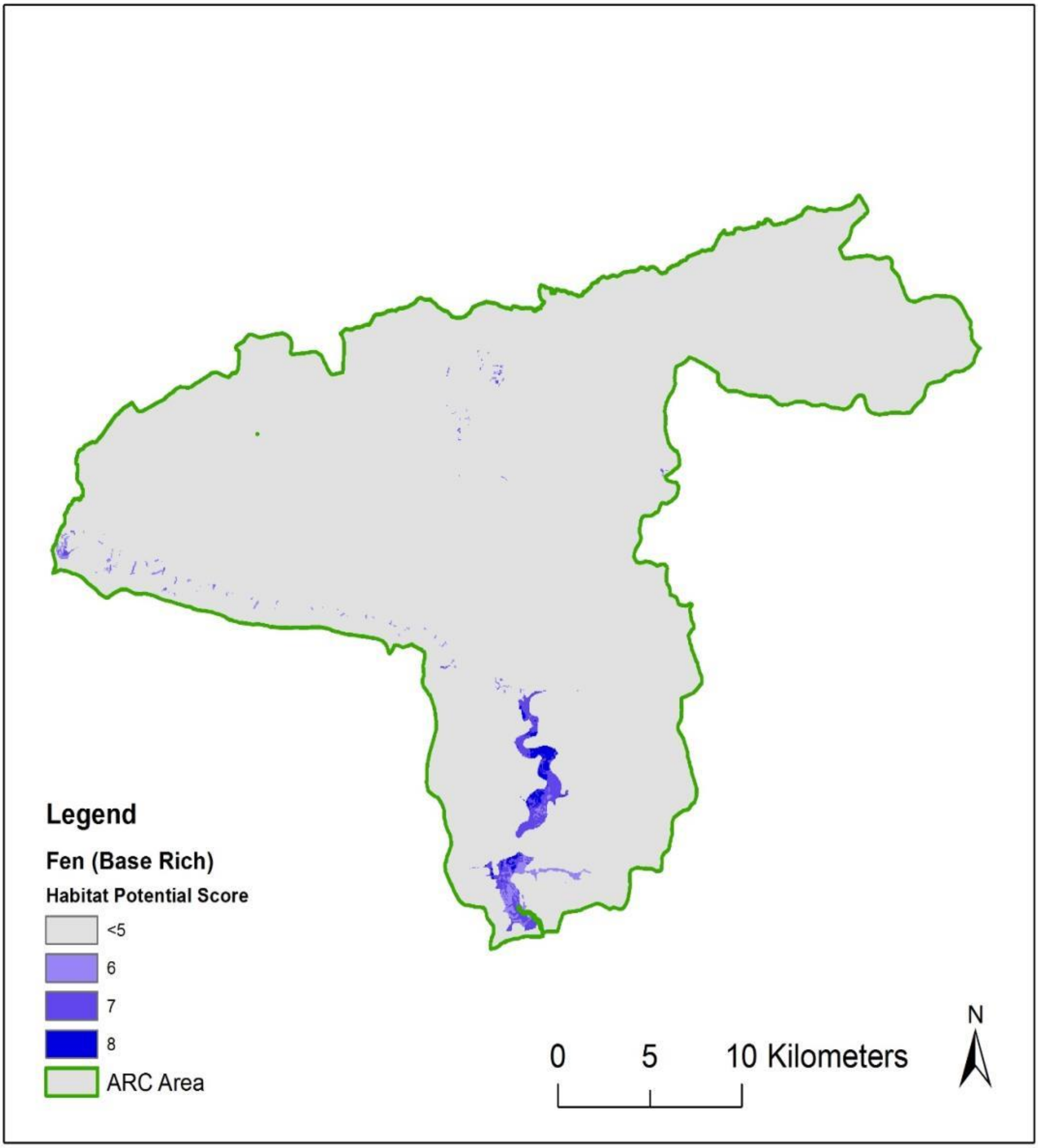


Figure 3.5. Final output maps for Fen (Base Rich) showing all scores

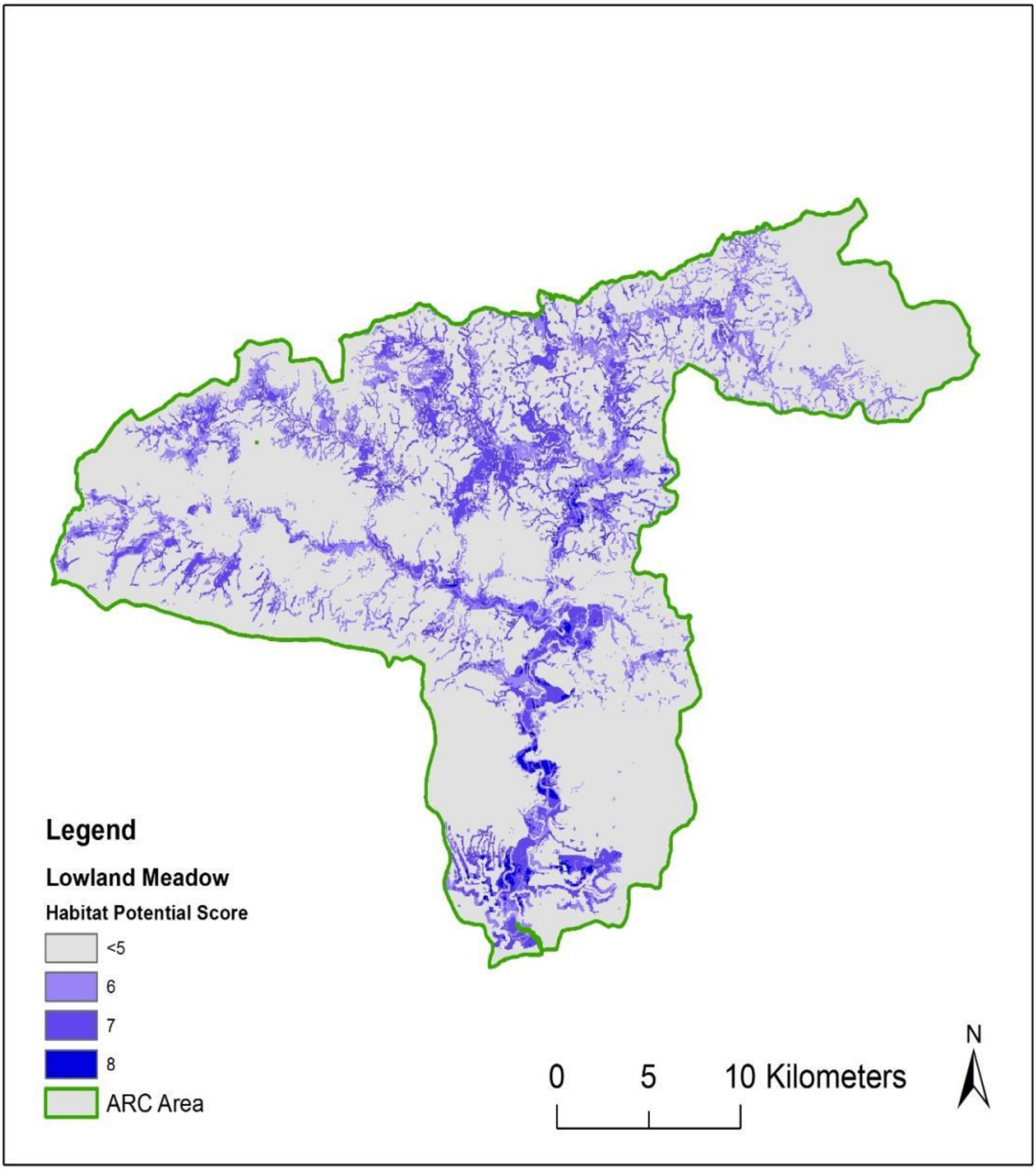


Figure 3.6. **Final output map for Lowland wet meadow showing all scores**

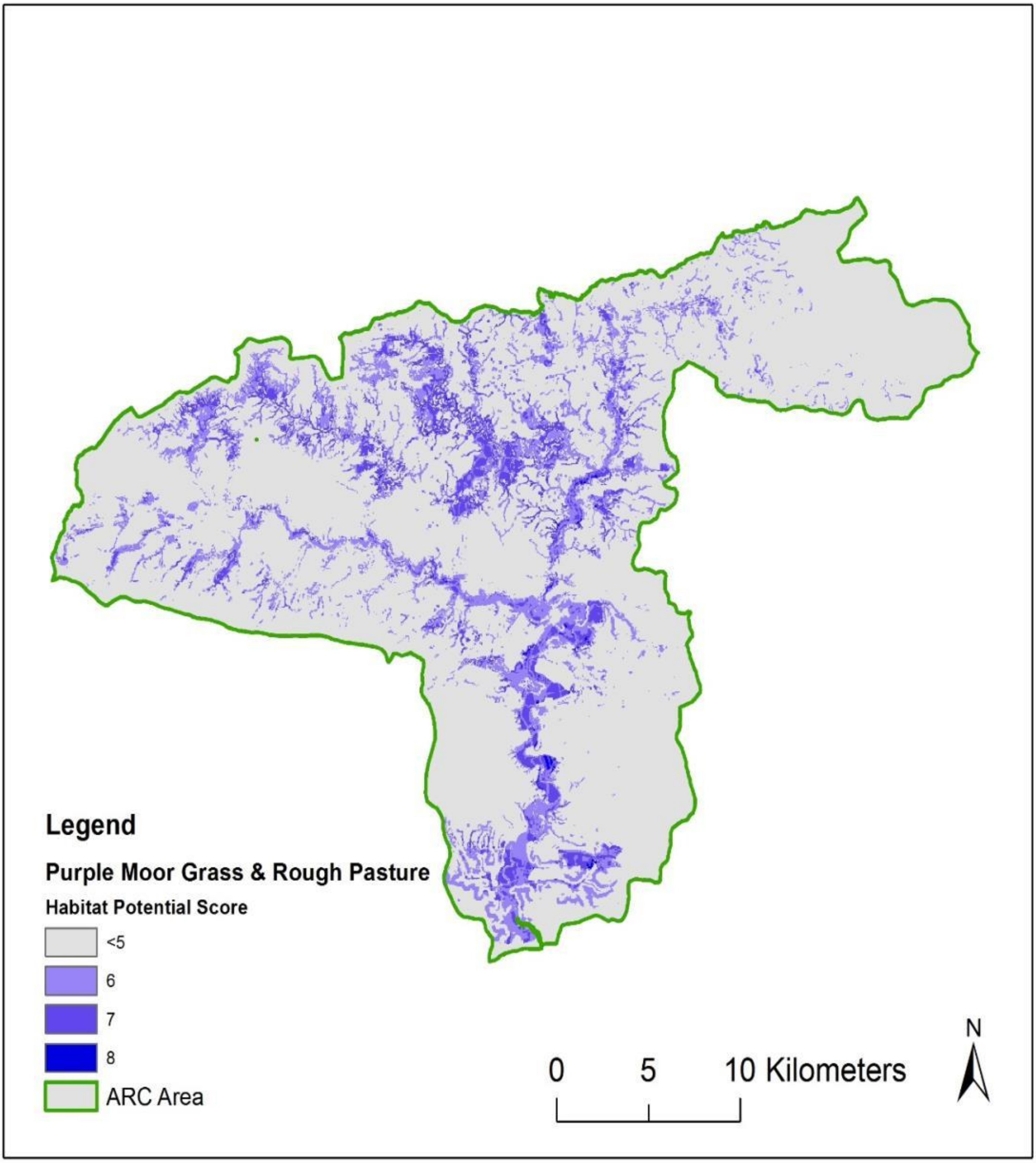


Figure 3.7. **Final output map for Purple Moor Grass and Rush Pasture showing all scores**

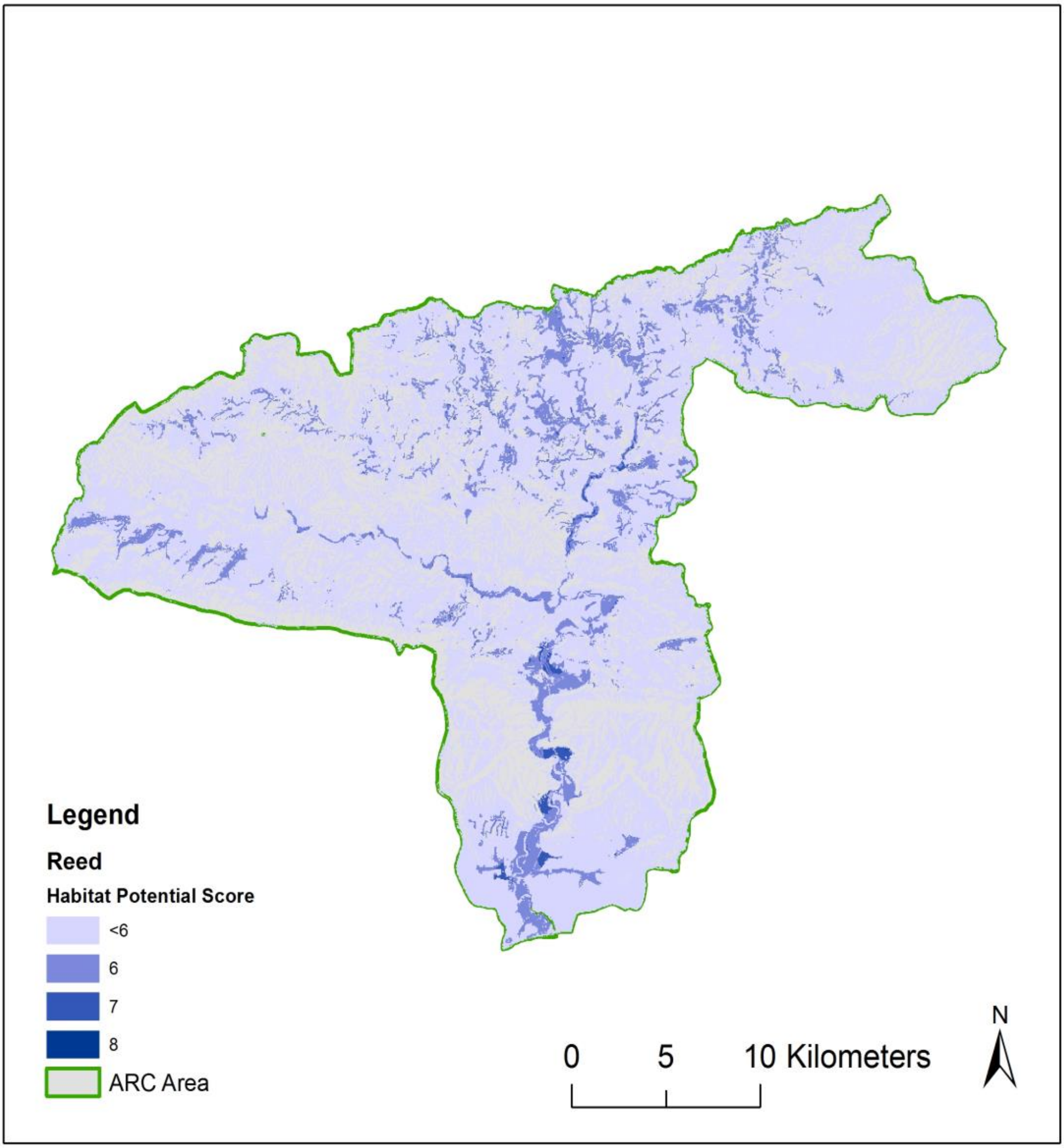


Figure 3.8. **Final output maps for Reedbed showing all scores**

Catchment boundary reproduced with permission of Environment Agency. Contains Ordnance Survey data.

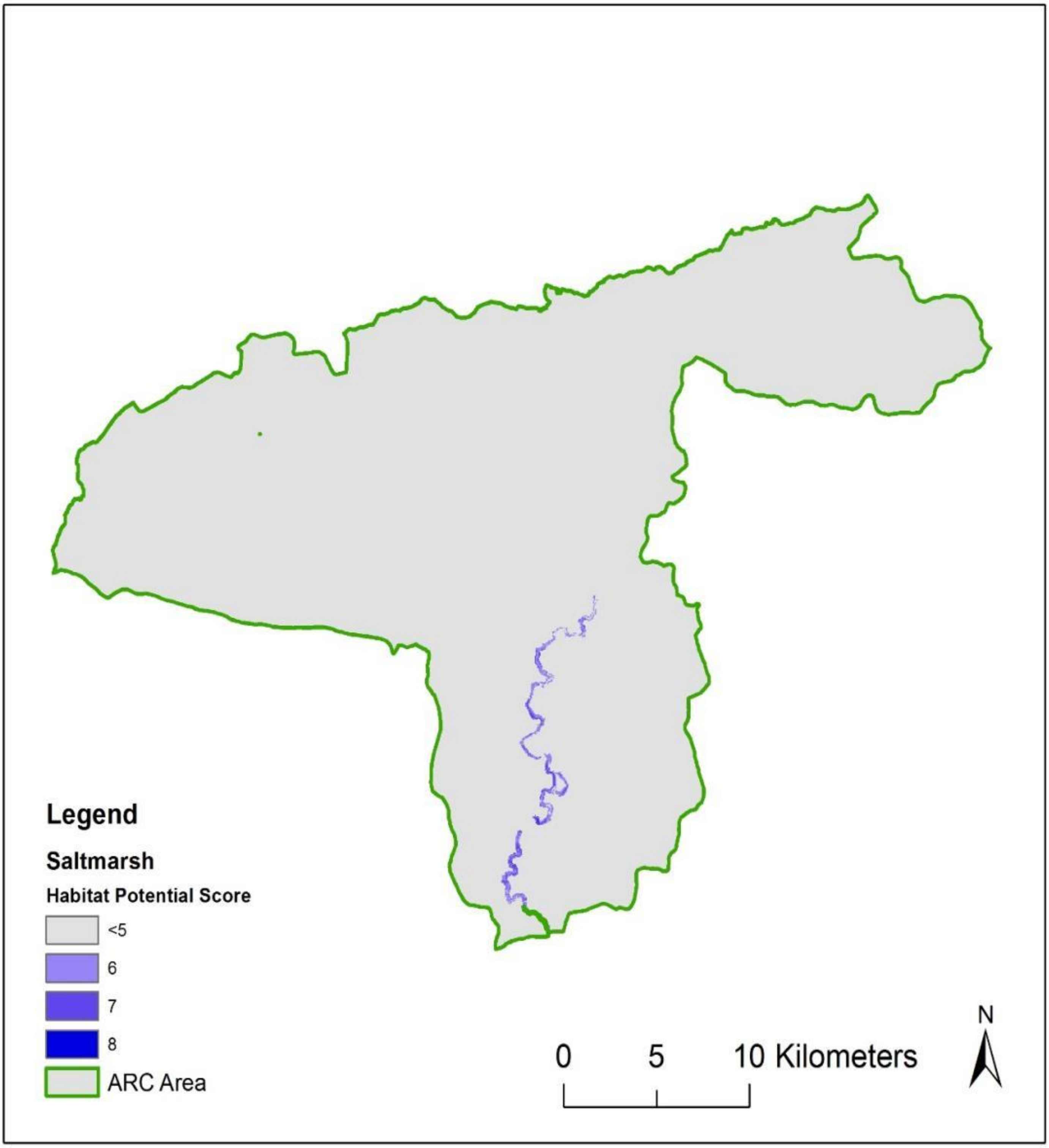


Figure 3.9. **Final output maps for Saltmarsh showing all scores**
Catchment boundary reproduced with permission of Environment Agency. Contains Ordnance Survey data.

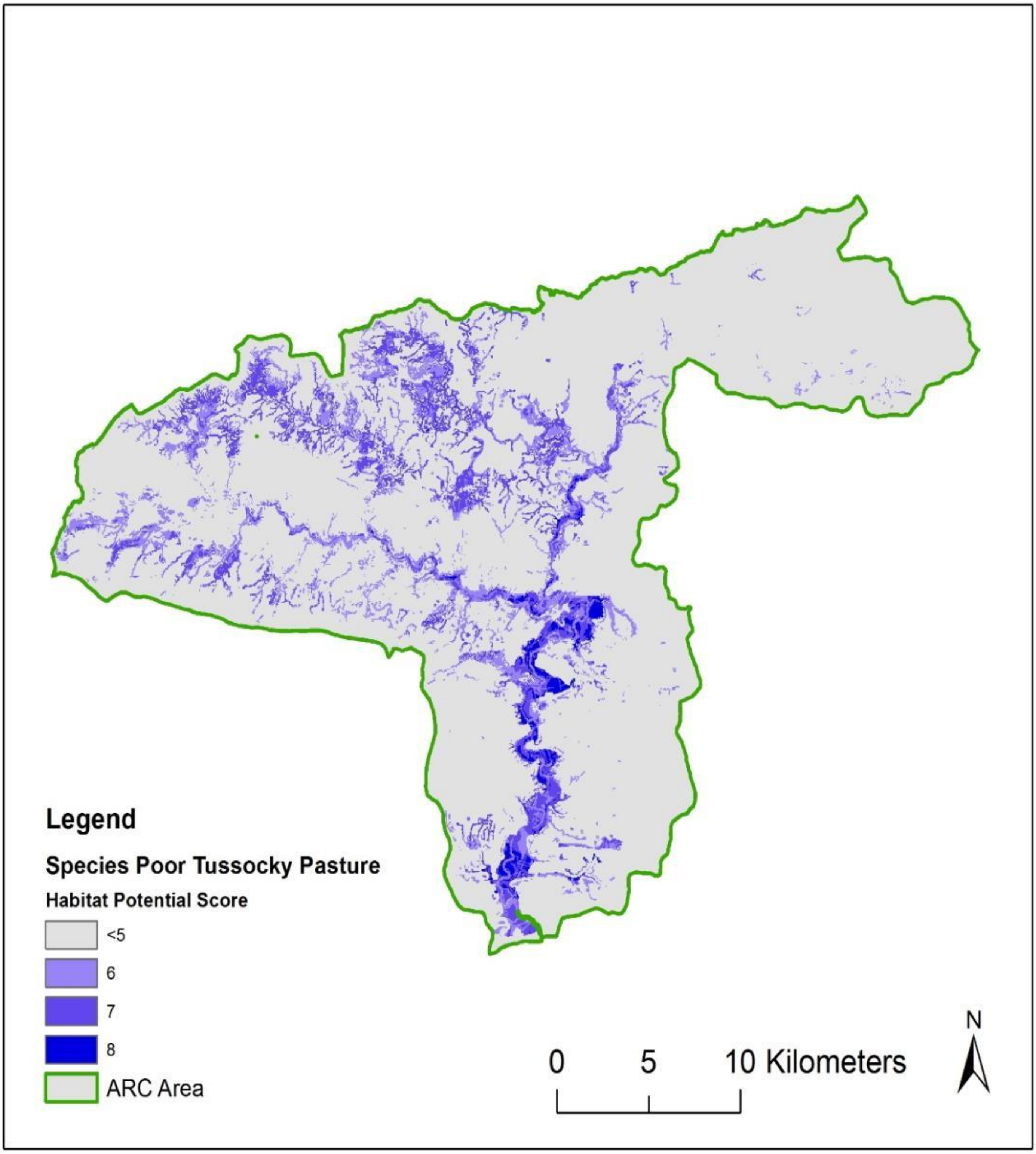


Figure 3.10. **Final output maps for Species Poor Tussocky Pasture showing all scores**

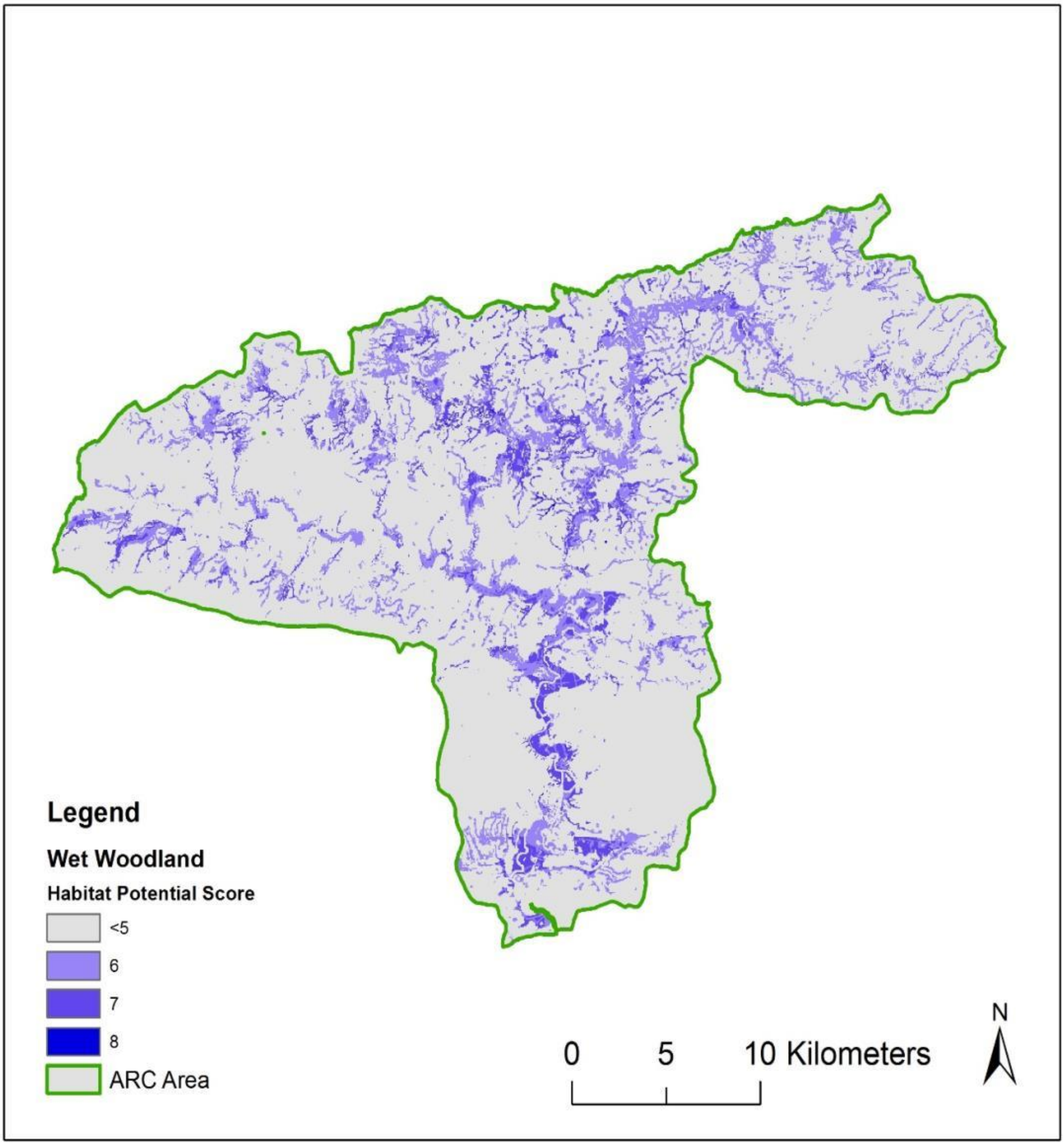


Figure 3.11. Final output maps for Wet Woodland showing all scores
Catchment boundary reproduced with permission of Environment Agency. Contains Ordnance Survey data.

3.6 Largest sites with optimum potential for modelled habitats

At this stage it is useful and interesting to use the model to start 'targeting' which sites are most appropriate for the restoration of each of the nine chosen wetland habitats. The HPM can be used to provide a visual guide to where each individual habitat could be developed. For **Figures 3.12 - 3.20 (Figures 3.13 – 3.20** can be found in **APPENDIX 5)** the best (highest scoring) site for each habitat was selected based on its potential size (larger is assumed to be better) and its ability to create optimum connectivity to an existing area of the same habitat. The following map shows the 'best site in the catchment' for the restoration of base rich fen habitat according to the new Model. **PLEASE NOTE:** that these maps are subjective and should be subject to ground truthing.

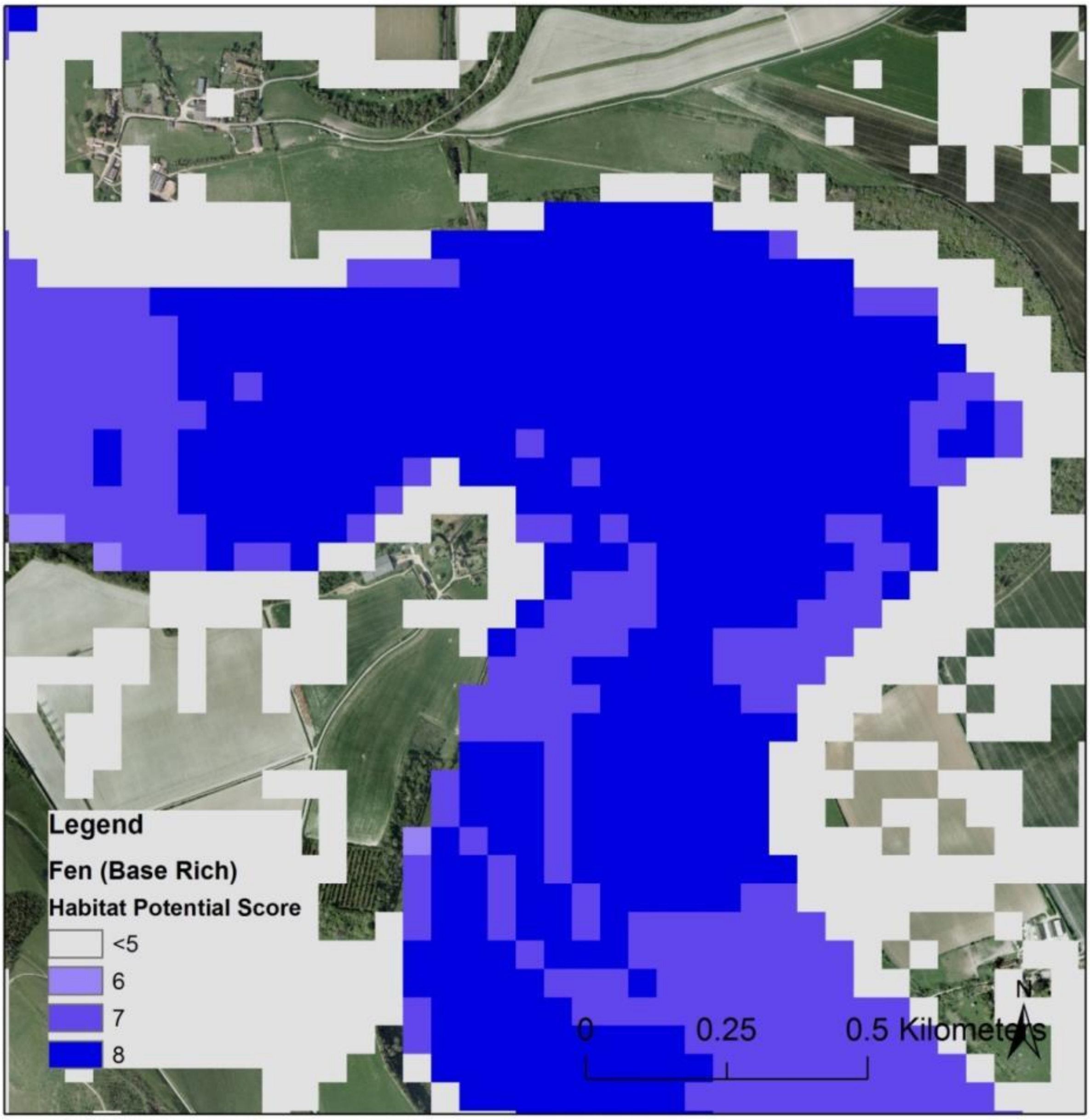


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Figure 3.12. Zooming in to the location with the most potential to restore a large area of fen (base rich) around South Stoke

3.7 Stage 6 – Climate change modelling

Climate change is one of the key factors likely to exacerbate pressures on priority habitats across Sussex and the UK. In fact it is likely that climate change is already influencing the niches which can support keystone species and habitats, and this is particularly relevant to the water environment. Climate change is bringing new challenges in terms of enabling sites, species, humans and habitats to adapt to a changing landscape.

Adaptation to climate change is therefore a priority for conservation and environmental management, and it was deemed important to include a measure of climate change adaptation in the ARC HPM. The best available electronically represented data on climate change at the time of the creation of the new ARC HPM, was a model created by Natural England. This model has been used to generate some initial assumptions around what may happen to wetland habitats in the ARC project area, if climate change proceeds as predicted. As with the whole HPM model however, specialist knowledge is essential in interpreting how this information can be used on the ground.

Natural England (NE) Climate change model

In 2013, Natural England developed a model that allows non-specialists to assess the vulnerability of areas of priority habitat to climate change based on widely accepted principles of climate change adaptation for biodiversity. They produced two versions of a National Biodiversity Climate Change Vulnerability Assessment (NBCCVA) model. The NBCCVA provides a high level indication of the relative vulnerability of priority habitats to climate change in different places. It identifies why areas are vulnerable and which possible interventions can have the biggest impact in increasing resilience in a changing climate. This is intended to inform the prioritisation of adaptation actions and assist in the development of adaptation strategies for biodiversity both within Natural England externally.

The Aims of the NBCCVM are :-

- to provide a spatially explicit assessment of the relative vulnerability of priority habitats, based on established climate change adaptation principles;
- to create a suite of map-based GIS outputs at a variety of scales, which can be used (in conjunction with other relevant spatial data) to target action to build biodiversity resilience;
- to provide a GIS based decision support tool that allows the user to incorporate locally specific datasets and select how adaptation principles are combined to reflect local circumstances and priorities.

The NBCCVM uses a 200 x 200m grid to assess areas of priority habitat for a range of parameters including :-

1. **Intrinsic Sensitivity to Climate Change**
   The model assigns high, medium or low sensitivity to direct climate change impacts – reflecting the habitat itself on the basis of expert judgement and scientific literature.
2. **Adaptive capacity**
   A range of different local factors can increase or decrease the ability of the habitat to adapt to climate change – to reflect this the model includes measures of fragmentation, topographic variation and management and condition.

3. **Conservation Value**
   This assigns a relative value to (i) priority habitat only, (ii) priority habitat within a national designation, or (iii) priority habitat within an international designation – with the latter valued highest.

These elements are then added together to produce an overall assessment of vulnerability. Key outputs are maps showing the results for individual and combined metrics and the range of relative vulnerability, giving a visual representation of the areas vulnerable to climate change.

Version 1 of the data includes four of the five metrics used in the assessment – sensitivity to climate change, habitat fragmentation, topographic heterogeneity and management and condition. This first version is the 'Overall Vulnerability' (sensitivity + fragmentation + topography + management) for the All Habitats dataset. Where all priority habitats are included in the run, and when 2 or more habitats are found within a 200m grid square the most vulnerable habitat overall gives its score to that square.

Version 2 includes a fifth metric of 'conservation value' which helps those using the model to prioritise action to mitigate potential climate change effects. As the assessment is one of relative vulnerability the scores change depending on the metrics included. The addition of the 'conservation value' metric (sensitivity + fragmentation + topography + management + value) alters the overall vulnerability scores attributed to each of the modelled habitats.

The following habitats modelled using the Natural England NBCCVA extracted for Sussex use were:-

- CGM – Coastal Grazing Marsh
- FGM – Floodplain Grazing Marsh (Merged with CGM)
- LF – Lowland Fen (the ARC HPM Base Rich and Base Poor fen data can be merged to
- LMW – Wet Lowland Meadows
- SM – Salt Marsh
- PMG – Purple Moor Grass and Rush Pasture
- DW – Deciduous Woodland (covers wet woodland)
- RB - Reedbed

There were no appropriate layers to match to our species poor tussock grassland layer, but by merging the NE CGM/FGM layers, the ARC HPM data could be compared, and by merging the ARC HPM fen layers, they could be integrated with the NE NBCCVA model. The rivers (RIV) layer and the Dry Lowland Meadows layer (LMD) could not be appropriately matched with ARC-HPM data and so these were excluded.

NE classify the data within the NBCCV Assessment in 3 ways. These classification types are a) 1/2/3 or H/M/L, b) 1/3 or Y/N and c) Quartiles (breaking the data in to 5 sections) using Natural Breaks. The assessment and the classifications created using the method in c) are relative and as such they change when you change the area of data you are classifying (i.e. the natural breaks in the data identified by the GIS software will be slightly different when looking at the national dataset to when looking at the more local cut of the data, as there is a different spread of data). Both of these relative classifications are relevant and valid, but need to be used appropriately depending on the model purposes.

The natural break values representing the national spread of data (the natural breaks values identified when looking at the whole dataset for England) are detailed in a separate spreadsheet. These enable us to see how the vulnerability data for the Sussex area looks in the national context. When creating the display (symbology in the maps) for the Sussex cut, this provides relative local values, creating the ability to look at relative vulnerability across the area of data you have. The classes and therefore the maps will look exactly the same for Sensitivity, Management & Condition and Conservation Value as these are not relative values (they are H/M/L or Y/N etc). However, the values for Habitat Fragmentation, Topographic Heterogeneity and the 2 versions of MaxVuln (overall vulnerability and overall vulnerability plus conservation value) are relative and will therefore be slightly different for national and local data cuts.

A full manual explaining the NE climate change model can be found here http://publications.naturalengland.org.uk/publication/5069081749225472.

The datasets used by Natural England for their climate change model can be found in **APPENDIX 6**. The datasets highlighted in bold, are similar or the same as those used in the updated ARC HPM. There is therefore an element of 'double counting' with regards to the use of these similar datasets to generate two separate models which have then been re-merged to create a new output. The nature of the datasets is such however that it was assumed that these data would not overly bias the outputs of the new Climate change HPM model.

Using the NE model, a map can be generated (**Figure 3.21**) of the overall vulnerability of key habitats/landscapes to climate change in the ARC catchment.

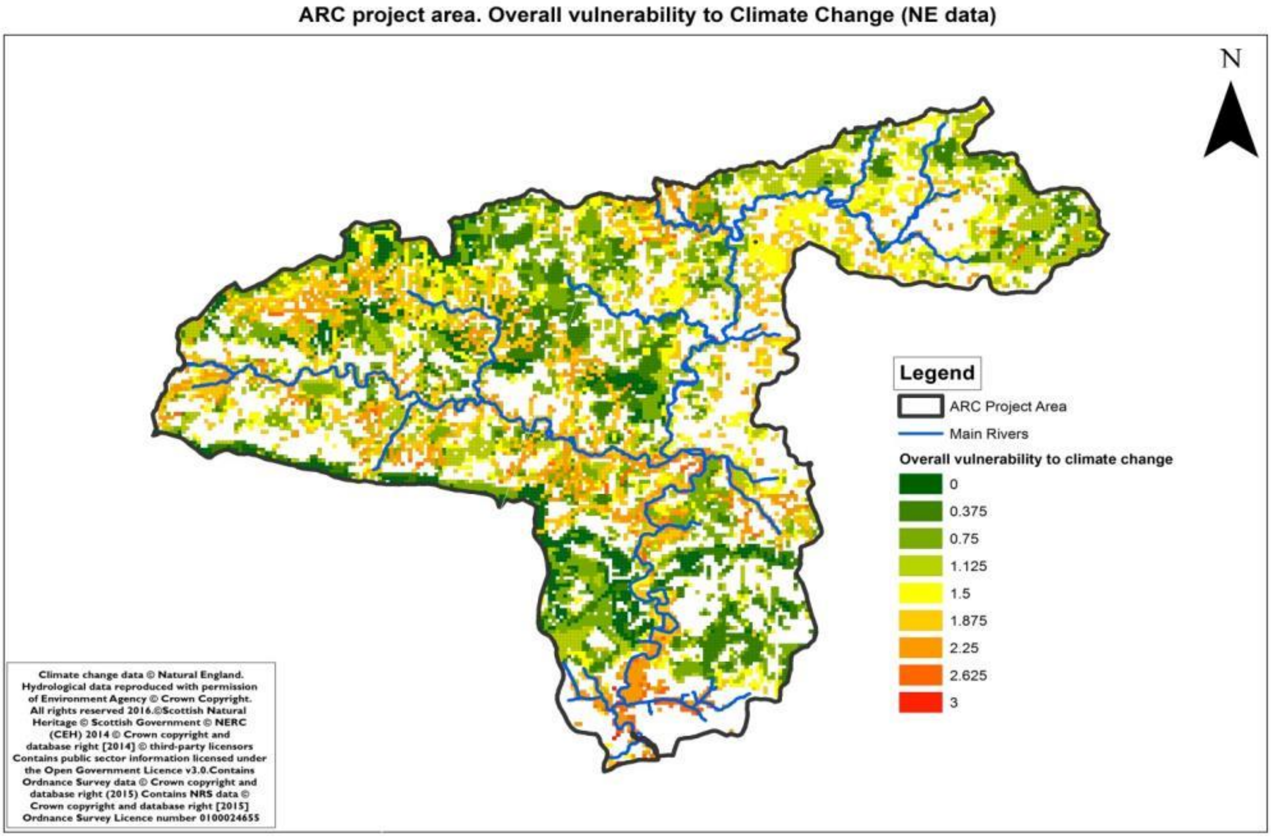


FIGURE 3.21. Map showing the overall vulnerability of habitats in the ARC catchment to climate change. Large areas of floodplain in the lower catchment are unsurprisingly vulnerable to climate change (most likely through sea level rise), whilst there are notable areas of the Western Rother catchment in particular which are predicted to be affected.

Maps of the anticipated changes in habitat niches modelled using the modelled climate change scenarios can be created for each of the ARC HPM modelled habitats. An example of the NBCCVA outputs can be seen below (**Figure 3.22**). Large areas of the North East and mid East of the catchment show a higher likelihood of deciduous woodlands being affected by climate change. Deciduous woodlands to the South and West of Horsham on the River Arun are predicted to be the most heavily impacted by climate change.

Devising a land and catchment management strategy which enables key ecosystem services and functions such as local climate regulation (See ARC Ecosystem Services report) and biodiversity networks to be maintained (or even enhanced) in the face of a changing climate would be a useful and revealing exercise, particularly in this area. Parts of this area have been highlighted by the ARC HPM as having the potential to create better networks of (wet) woodland and there may be opportunities to limit or work with the effects of climate change to enhance the woodland ecological network in this area in order to make it more connected and more resilient to climate changes. Interestingly, the diverse and interconnected ancient woodland complexes around Ebernoe common / the Mens appear to be relatively resilient to climate change at the moment. It is possible that this is partially because the woodland network here is already well connected, healthy, diverse and geographically able to adapt to predicted climatic changes (FS pers. comm).

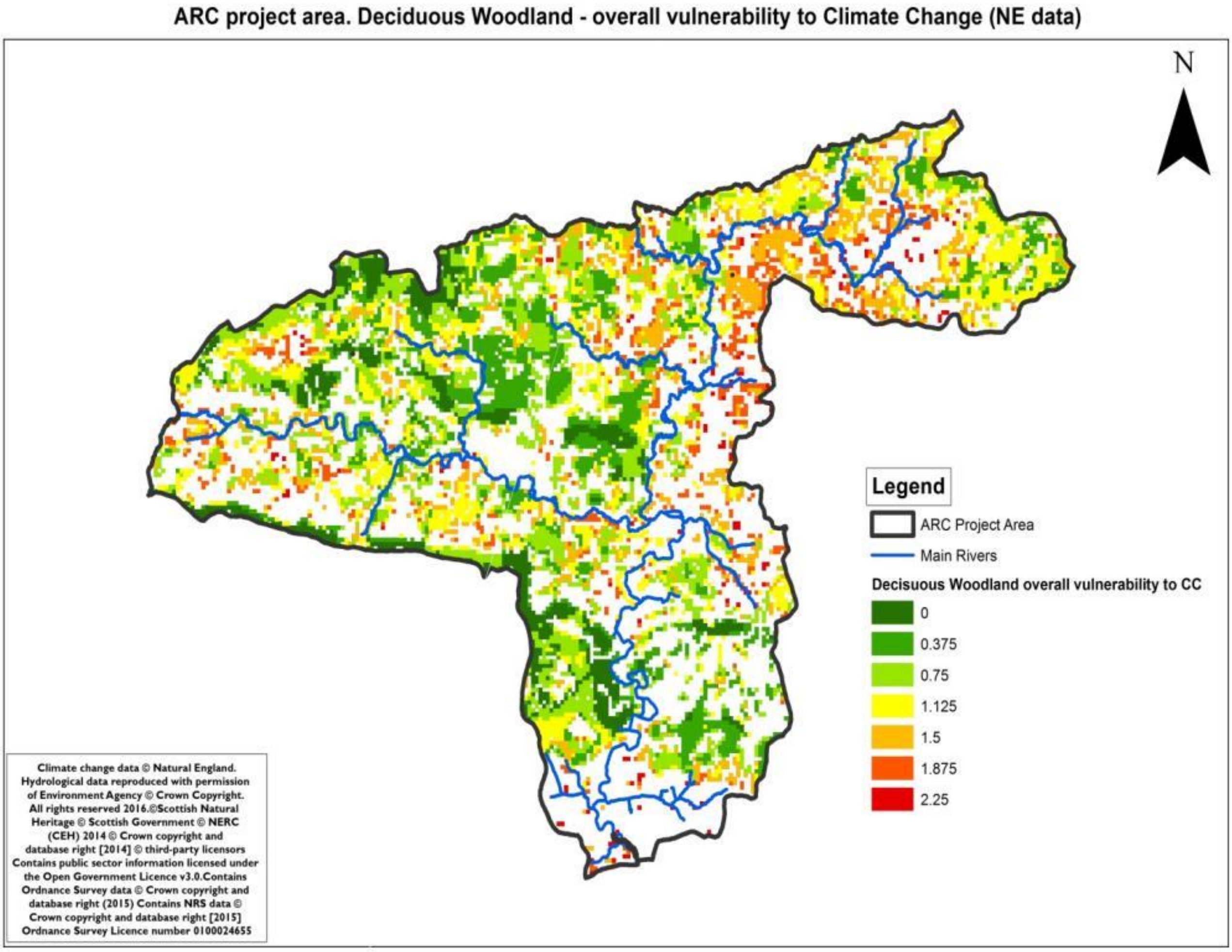


FIGURE 3.22. Overall vulnerability of deciduous woodland to climate change in the ARC catchment.

In addition to the individual target maps which can be produced for each habitat, the NBCCVA also assesses the overall vulnerability of key sites and habitats to climate change. The map below (**Figure 3.23**) shows that sites such as Amberley Wildbrooks, Pulborough brooks and Ebernoe common may not need as much action to mitigate the effects of climate change as other sites along the Wealden greensand ridge.

ARC project area. Target areas for conservation action for Climate Change (NE data)

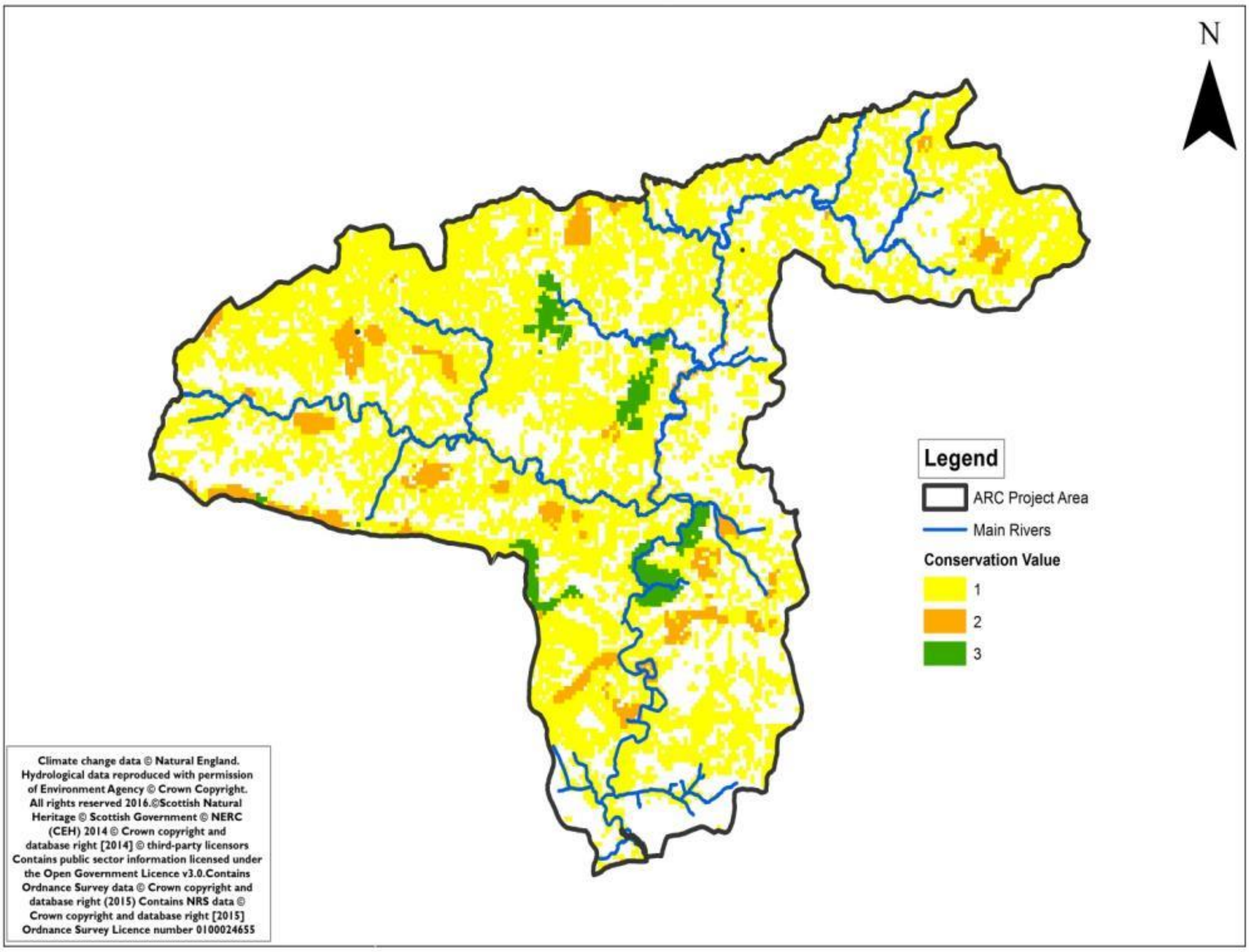


FIGURE 3.23. Target areas for conservation action highlighted using the NE Climate change model.

Using the ARC HPM, the Stage 5 Habitat Potential Maps were adapted to include the NE climate change modelled data.

Final output maps can be found in **APPENDIX 7** which show the new Habitat Potential Scores for each of the modelled Habitats following changes made to accommodate predicted climate change impacts on the ecological networks for each habitat. An example / comparison between the original ARC HPM output maps and the new climate change adjusted maps is show below (**FIGURE 3.24).** You can see from the maps that there are likely to be areas where the existing habitat and ecological networks will either a) be enhanced by climate change or b) where habitat and ecological networks will suffer.

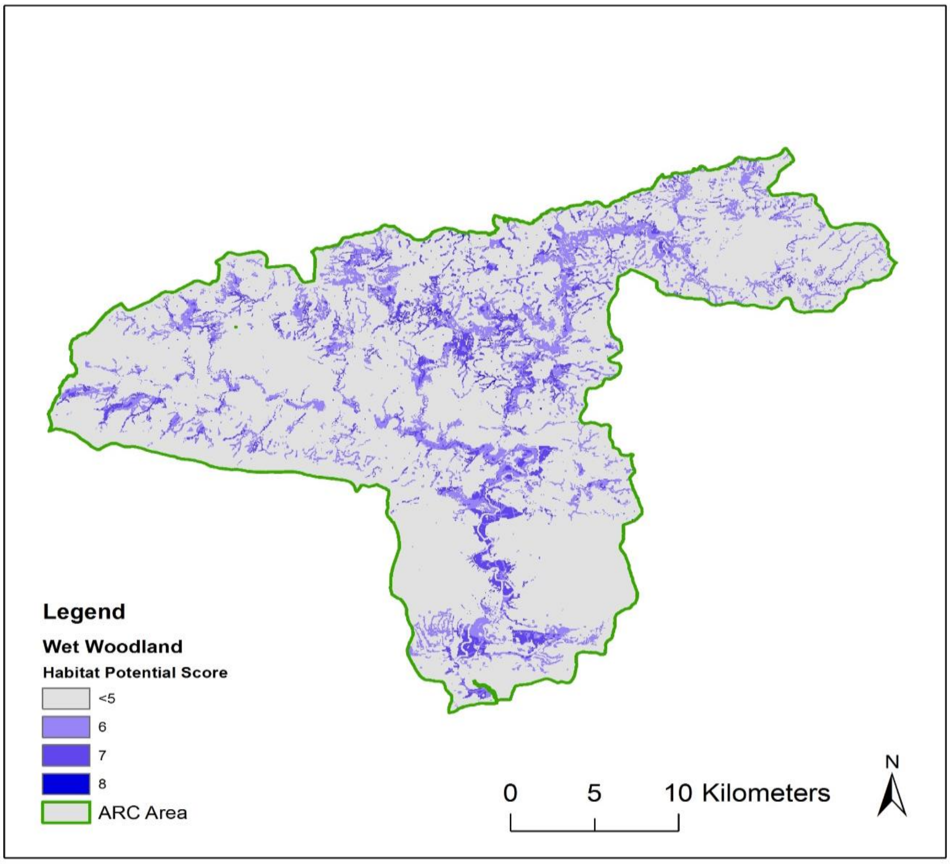
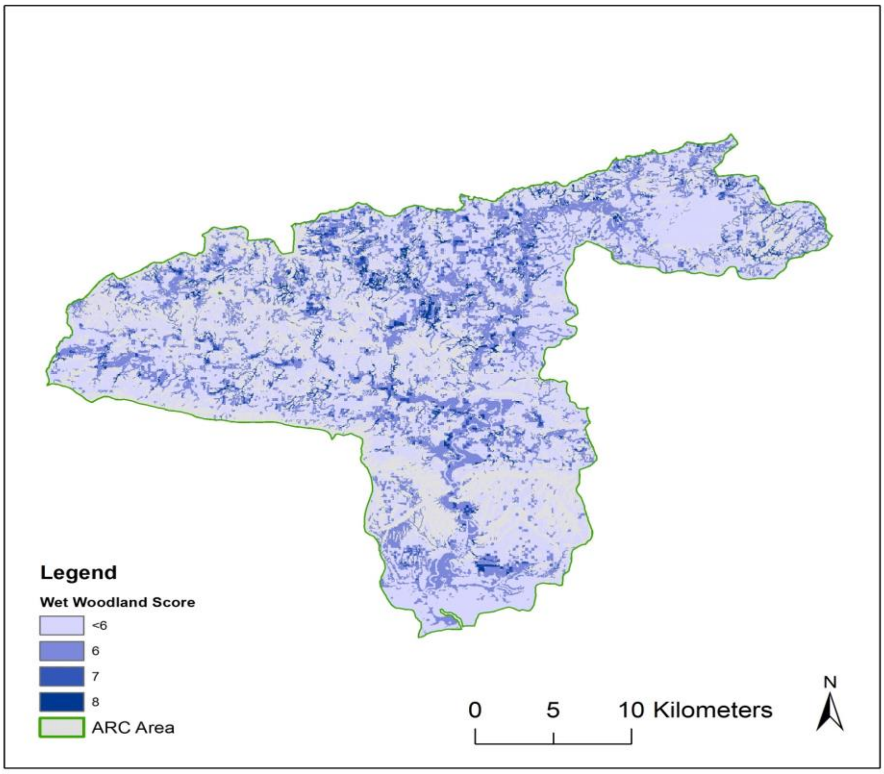


Figure 3.24. **Final 2016 ARC HPM output maps for Wet Woodland showing Habitat Potential score prior to inclusion of climate change model The map below shows amended outputs of the same model once climate change adjustments have been made**



3.8 Spatial Relationships and Connectivity Analysis

Analysis of the spatial relationships between habitats, show that there is potential for both the total area and the mean area of each habitat to be dramatically increased.

In the case of all the modelled habitats, the model predicts that it is possible to increase the overall area of each habitat, the mean size of these areas, and the number of patches of each habitat. It also suggests that it is possible to reduce the mean distance between each patch of some habitats such as reedbed.

Coastal and Floodplain Grazing marsh and wet woodland are the only habitat for which the number of patches would be reduced, however this is due to 1) the fact that the model predicts such a significant potential rise in the size of available habitat patches and 2) the potential to replace CFGM / wet woodland with rarer or more naturalised habitats such as fen.

A comparison with the table from the last Habitat Potential Model shows that the model has been able to identify an increased area for lowland wet meadow and species poor tussock grassland. Although it doesn't appear significant in scale, the model has also doubled the potential area for saltmarsh, and the mean size of the habitat patch for saltmarsh, through the restoration of only 5 more patches. There is also an indicated potential to increase the number of patches of fen.

		Reedbed	**Fen (Base Rich and Base Poor combined)**	**Saltmarsh**	**Coastal Flood Plain Grazing Marsh**	**Purple Moor Grass and Rush Pasture**	**Lowland wet meadow ***	**Species Poor Tussocky Pasture ****	**Wet Woodland**
Total Area (ha)	*Observed*	4.3	12.1	1.3	2339.1	43	0	819.3	7388.8
	Modelled	6852.5	10980	610.3	10084.3	21512	21224.8	15335	14858.3
Mean area (ha)	*Observed*	0.3	0.2	0.1	3.6	0.5	0	1.1	2
	Modelled	5.5	6	35.9	24.2	10.9	9.8	8.8	4.8
Mead SD (ha)	*Observed*	0.2	0.2	0.1	8	0.7	0	2	1.7
	Modelled	107.8	50	77.4	452	284.3	255.8	222.6	49.9
Number of patches	*Observed*	15	63	12	650	93	0	761	3656
	Modelled	2702	2193	17	416	1964	2159	1736	3075
Average Nearest Neighbour (metres)	*Observed*	996.3	476.5	0***	131	474	N/A	73.8	189.5
	Modelled	192	218.4	765.7	318.5	242.6	229.8	227.6	212.2

* The data used for lowland wet meadow did not highlight any of this habitat in the catchment area. This is primarily due to weaknesses in the habitat recording system

** Due to weaknesses in the data-set being used for existing habitat for species poor tussocky pasture, the observed values are likely an overestimate.

*** There were too few patches to carry out Average Nearest Neighbour analysis for Saltmarsh

Table 3.1. Summary of spatial relationships and connectivity analysis. This shows a general pattern of potential for increased habitat area and increased number of habitat patches across the catchment.

4. Discussion

The final outputs of the Habitat Potential Models highlight that there is good scope for the creation of a more extensive and dynamic corridor of wetland habitat in the Arun and Rother catchment. The original outputs of the model have been refined and appear to be more geographically and ecologically precise than before. The model also shows the potential for different habitats to occur adjacent to each another, thus ensuring a significant increase in potential habitat connectivity, and patch size.

The initial process of developing the HPM demonstrated that roughly 40% of the catchment area has potential as wetland habitat. Though this does not by any means suggest that such a high proportion should be developed into wetland, it highlights the fact that there are multiple opportunities to improve the wetland ecological network through the buffering of existing habitat as well as the creation of new habitats.

Stage 3 assessed the physical characteristics of cells within the catchment to highlight habitat specific areas with habitat potential. The outputs show the areas that are most highly suited in terms of physical characteristics, to the specific habitat. The results at this stage vary greatly between habitats. For habitats such as saltmarsh, large areas are deemed as unsuitable, leaving only small pockets of potential. The initial impression gleaned from such outputs may be that the model is overly restricted and the sparsity of the potential for development of habitat is of limited value. However, with these habitats requiring very specific conditions, such outputs are realistic as the habitat is necessarily contained by the physical suitability of the environment. For the habitats modelled with more specific niche requirements, the outputs highlight smaller areas that characterise the niche.

Conversely the outputs for other habitats such as wet woodland, may give the impression that huge areas are being highlighted, and that therefore little in terms of targeting can be gleaned. As woodland requires less specific habitat requirements, it is to be expected that large areas could be potential woodland. Therefore the output is valid given the generalist nature of the habitat, and the model can still be used to target woodland restoration. It will still be possible to further focus wet woodland habitat creation, through the exclusion of the areas indicated as suitable for the other wetland habitats, through the targeting of woodland creation to those areas most likely to create the largest interconnected matrixes connecting areas of ancient woodland, and through the targeting of woodland to reduce flooding and pollution, increase river shading for fish etc.

Examination of the characteristics of existing reed highlighted that some patches were located on slopes of 10 degrees or more. This probably highlights the fact that reedbeds can occur at higher slopes than usual due to the presence of ponded water features and lakes at higher altitudes. It may also be a factor of the 'generalising influence' of the 50m grid cells, where due to the size of the cells a broad slope value was assigned for each cell, when in reality there may be great variation in topography within an area of $50m^2$.

It should be noted that it could be assumed that existing habitats are located on the most suitable areas for them. However, this is not necessarily the case, especially when considering the amount of wetland depletion which has occurred historically, and the influence of anthropomorphological factors such as the insertion of weirs and embankments which create unnatural ponding influences, or widespread drainage and ditching of wetland features. It is also true that habitats may remain in locations that were once optimal for them, but have become less optimal due to changes in environmental conditions over time. This habitat potential model can be used to identify areas where a habitat is more naturally suited, and therefore to focus the restoration of these habitats on these areas.

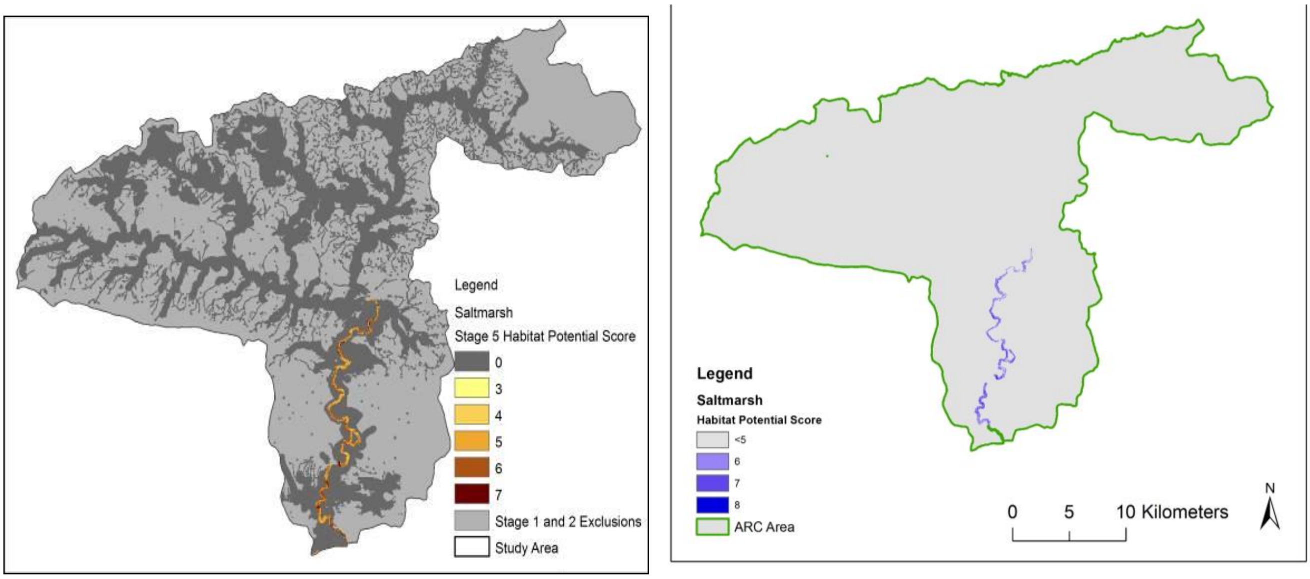
The outputs of Stage 5 **(Figure 3.3-3.11)** are the final outputs from the models, highlighting the areas that the model believes should be targeted for wetland habitat development. As with Stage 3, the outputs are habitat specific and there is great variation in the areas highlighted as suitable for restoration between habitats. The output for base rich fen, for example, highlights only a few localised sites as being suitable, and as such it may be necessary to prioritise fen restoration and creation to these areas, even though they also have high potential for other habitat types.

Overall, the new model predicted a number of changes in the habitat potential for the modelled habitats. On the whole this can be assigned to the inclusion of more accurate datasets for each habitat. For habitats such as saltmarsh and wet woodland this appears to have 'tweaked' the model outputs in a way which will hopefully enable more accurate targeting of habitat restoration. The changes between the predicted areas of habitat between the 2011 and 2016 model are summarised in **Table 4.1** below. The changes include :-

- A slight decrease in the predicted potential for Base rich fen, Species poor tussock pasture and Lowland meadow, some of the more specialist habitats.
- A slight increase in the predicted potential for Saltmarsh and CFGM
- A large decrease in the potential for wet woodland (probably due to the addition of new flood mitigation parameters)
- A large increase in the potential for Purple moor grass and rush pasture – a more common and widespread habitat
- A near doubling of the potential for base poor fen
- A comparatively large (20%) reduction in the potential area for reedbed – hopefully providing a more realistic means of targeting this habitat to the most hydrologically and geographically suitable areas.
- Interesting comparisons of the effect that climate change is predicted to have on the different target habitats. In some cases the model provides good evidence that the habitat restoration work that the ARC project has completed has been well targeted to areas which in fact become more suitable for these habitats with climate change. (**Figure 4.2)**

	Original HPM Area (Ha) (Score >5)	**New HPM Area (Ha) (Score >5)**
Coastal & Floodplain Grazing Marsh	9673	10084
Fen (Base Poor)	4833	9672
Fen (Base Rich)	1404	1309
Lowland Meadow	23134	21225
Purple Moor Grass & Rush Pasture	16936	21512
Reedbed	8541	6852.5
Saltmarsh	534	610
Species Poor Tussocky Pasture	16232	15335
Wet Woodland	18272	14858

TABLE 4.1 Showing the changes in the predictions made by the model for the potential of each individual habitat



2011 model **2016 model**

Figure 4.1

A comparison of the final output maps for Saltmarsh between 2011 and 2016 shows that the model predicts a similar potential distribution of saltmarsh across the ARC area for both periods. The new 2016 model shows less potential for saltmarsh restoration but in fact it shows greater potential to restore a greater area of saltmarsh.

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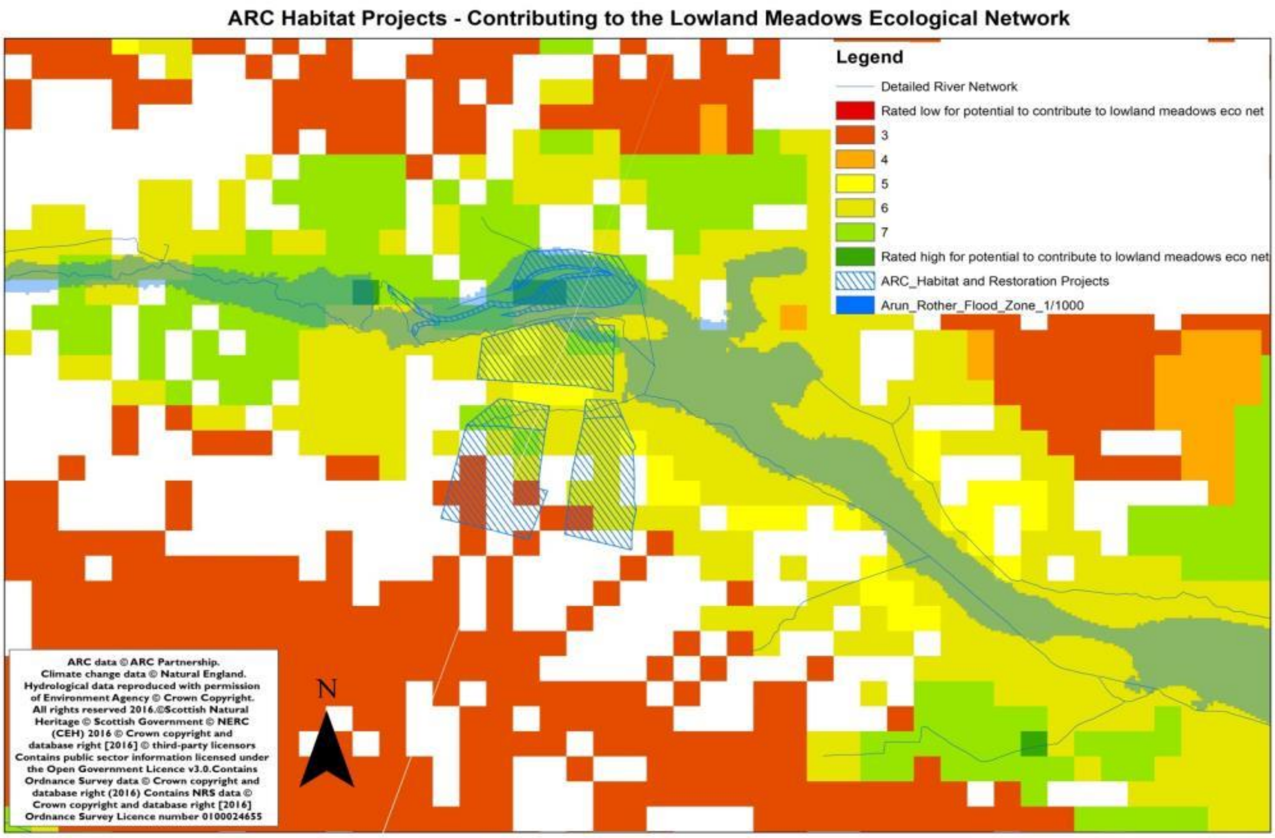
It is easy to compare the outputs of the 2011 and 2016 maps, such as in the maps above in **Figure 4.1.** We can now also assess the relative change in suitability for these habitats with climate change as in the maps below (**Figure 4.2**).



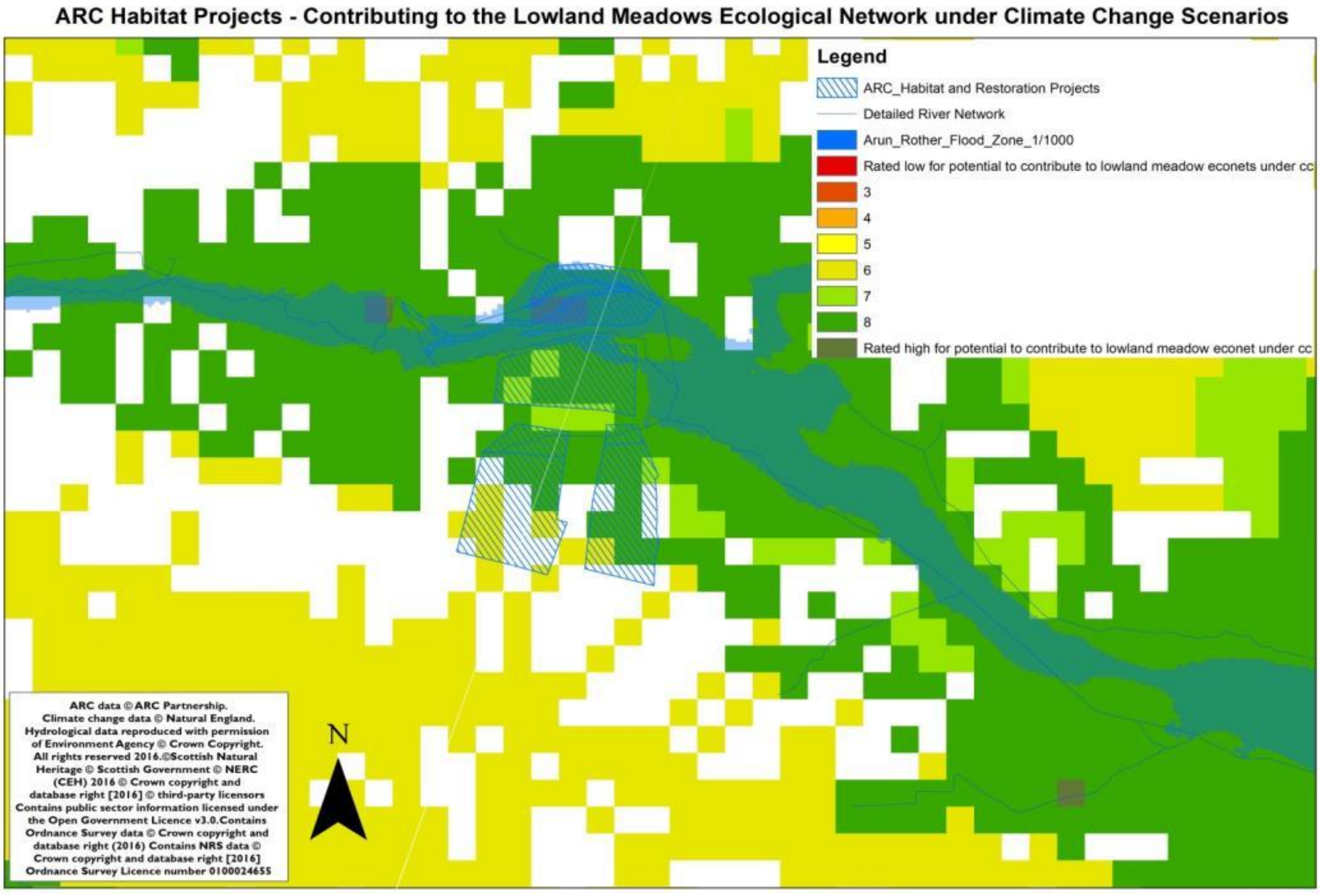


Figure 4.2 The map above shows the predicted potential for lowland meadows predicted at a site at Bignor, as predicted by the 2011 HPM. If we re-run the model to show the influence that climate change would have on the Bignor meadows site, then we can see that with climate change, this site becomes even more important for its overall contribution to the ecological network and the resilience of this habitat to climate change.

Analysis of spatial relationships and connectivity in the model shows that there is great potential for improving connectivity both on a habitat specific basis, and a wider landscape connectivity basis. It would not be plausible to develop large chains of connectivity between the more niche habitats modelled such as fen, however these habitats can still play an important part in wider (wetland) habitat networks by enabling the geographical connection of two separate wetland habitats, and by creating islands of species richness / speciation within the overall habitat network.

Restrictions

Though a less coarse scale of data was used than in many previous habitat modelling exercises, the use of a 50m x 50m cell size does bring some restrictions. Openshaw (1984) defines ecological fallacy as the assumption that the statistic or value assigned to an area, is true across all the component parts within that areas. To use the parameter slope as an example, within a cell the slope may often have been varied, but for the purposes of comparing cells it was necessary to assign an average slope value to the cell. Therefore in reality there may have been areas in a cell that were highly suitable and other areas that were unsuitable, though the value for the cell would have been a single generalised value. Though breaking down the area into smaller polygons may have produced finer results it was considered that the processing time / capacity taken to achieve this did not outweigh the benefits of the possible increase in accuracy.

As with this model re-run, the availability of additional data-sets in the future may improve the model, and if appropriate data-sets become available they should be included and the model re-run. In particular, data for the location of sea defences would be a valuable addition to the saltmarsh model, allowing the identification of areas with potential for coastal saltmarsh creation as well as riparian saltmarsh.

Humphrey et al., (2005) point out that all habitat potential models make assumptions that all the necessary variables have been included in the model, which is not necessarily the case, as no Habitat Potential Model can ever completely replicate or realistically represent natural conditions in the field. They further criticise that models are unable to take into account temporal changes in habitats. Ensuring that the ARC-HPM model did not suffer from this weakness, the model was designed to be transferable and easy to re-run with updated data-sets to produce up to date outputs. The inclusion of parameters which prioritise connectivity between habitats also helps ensure that the derived habitat network is more resilient to temporal and climatic habitat changes which will be more able to be accommodated spatially within the habitat network.

As with any model of this type, the output is heavily dependent upon the methods used and the data inputs. The model outputs are largely a representation of the reclassified values and the weightings applied to the parameters. If different parameters and weightings had been used, any number of different outputs could be possible. However, in order to minimise the impact of subjectivity, extensive literature reviews and expert opinions were used to assess the dataset inputs into the model, thus ensuring some degree of consistency and objectivity in their use. The nature of all computer modelling however, dictates that full objectivity is not achievable, and this should be acknowledged at the delivery stage of habitat creation and restoration.

It should be remembered that this model is only ever intended to be used as a guide to focus habitat development on areas within the landscape network where it is most likely to be successful. Before decisions are made regarding physical alterations to local habitats and land management, ground-truthing of the model is essential. The model outputs should never be viewed as a definitive answer as to where to focus restoration, but rather as a preliminary filtering tool which is then strengthened by other layers of research and consultation with landowners and managers.

Future Research

The model was designed to be interactive and therefore can be re-run when more accurate or up-to-date data-sets become available. Whilst the model has been developed using data for the Arun and Rother catchment area, by entering different data, the models can be used to produce outputs for different regions as and where appropriate. Furthermore, the model structure could be used to map different habitat types.

Future research could carry out more in depth analysis on connectivity. Analysis of the functional connectivity of habitats would be valuable, as well as a more detailed analysis of the relationship of wetland habitats to the dryland habitat network. HPM outputs could also be reviewed in more detail with new Ecosystem Service models to see if there are any correlations / connections to be made between Ecosystem Service provision and ecological network creation.

As future flooding and climate change models are improved, these too could be compared more accurately to habitat potential and review further to establish climatically robust ecological networks across large landscape areas.

5. Conclusion

The model outputs highlight that there is great scope to restore and enhance wetland habitats in the Arun and Rother Catchment. Potential for increases in habitat size, as well as enhanced connectivity between habitats were identified. Sites with high potential for all nine modelled habitats are highlighted. Such outputs suggest that a diverse and connected corridor of wetland habitats within the catchment area is a genuine prospect.

The output maps are intended to be used to target sites for habitat development, to ensure that attentions are focused on areas that offer the best opportunity for success. The model outputs should be used as guides to identify sites, with ground-truthing essential before any decisions on habitat development are made.

As a dynamically designed model, it was intended that these Habitat Potential Models should be up-dated and periodically re-run, when new or updated data-sets became available for inclusion. A vast range of new data has become publically available since the last ARC HPM. This ensures that the updated ARC HPM results are more accurate in both scale and geographical targeting. New data models have also enable climate change and flooding parameters to be included which helps to make the model more dynamic, adaptable and realistic at a landscape scale.

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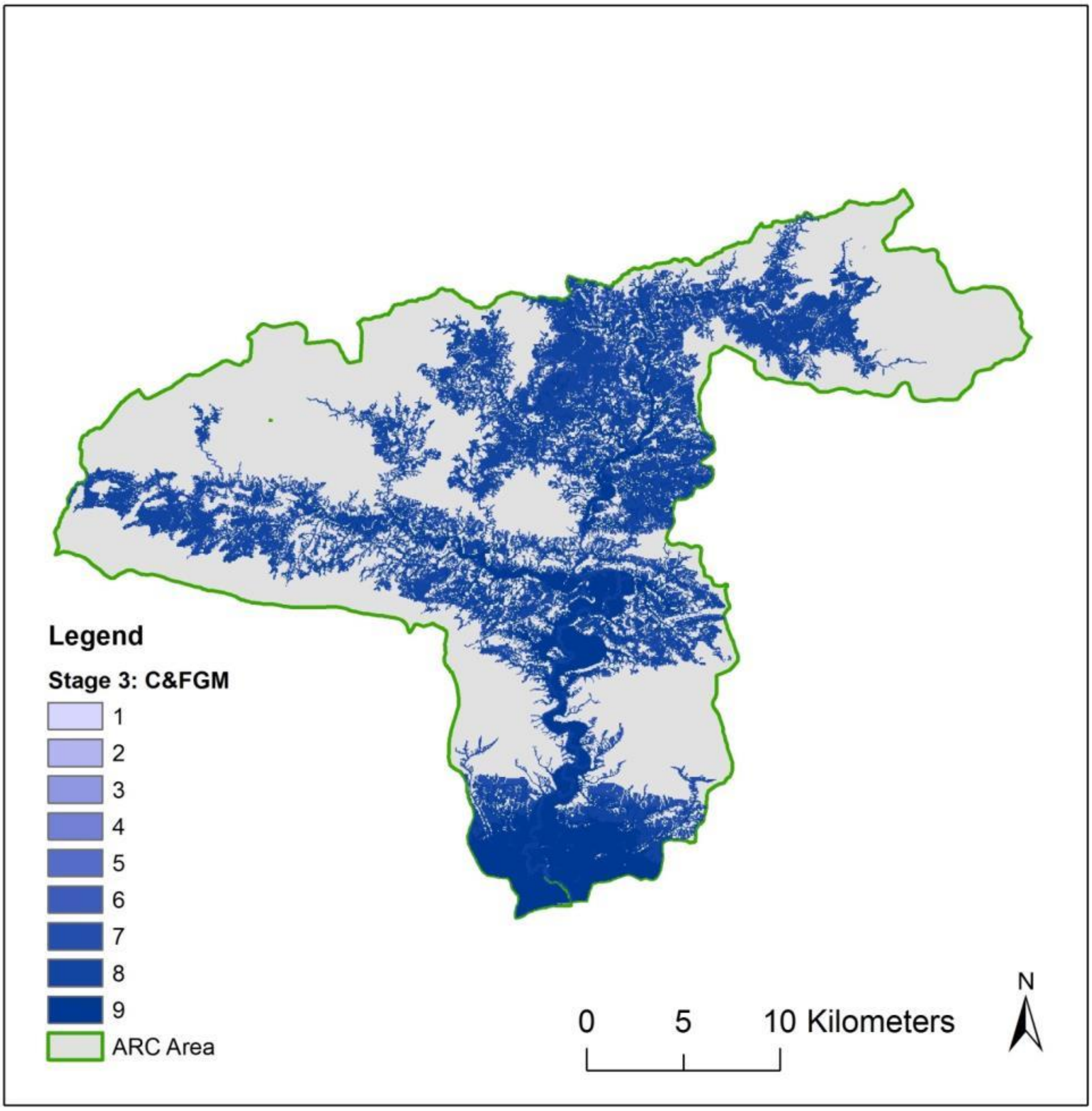
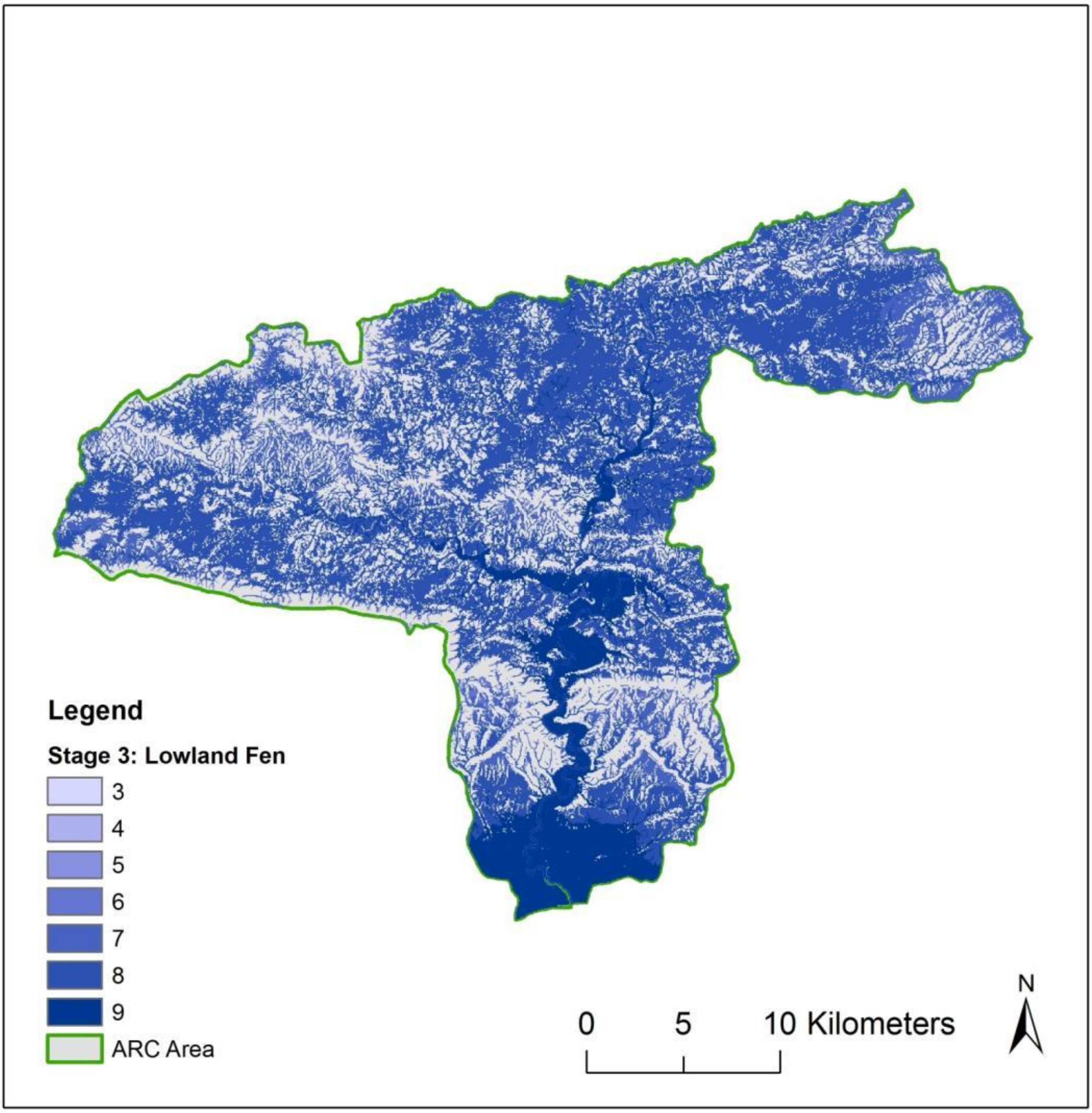
Appendices

Appendix 1: Stage 3 Outputs

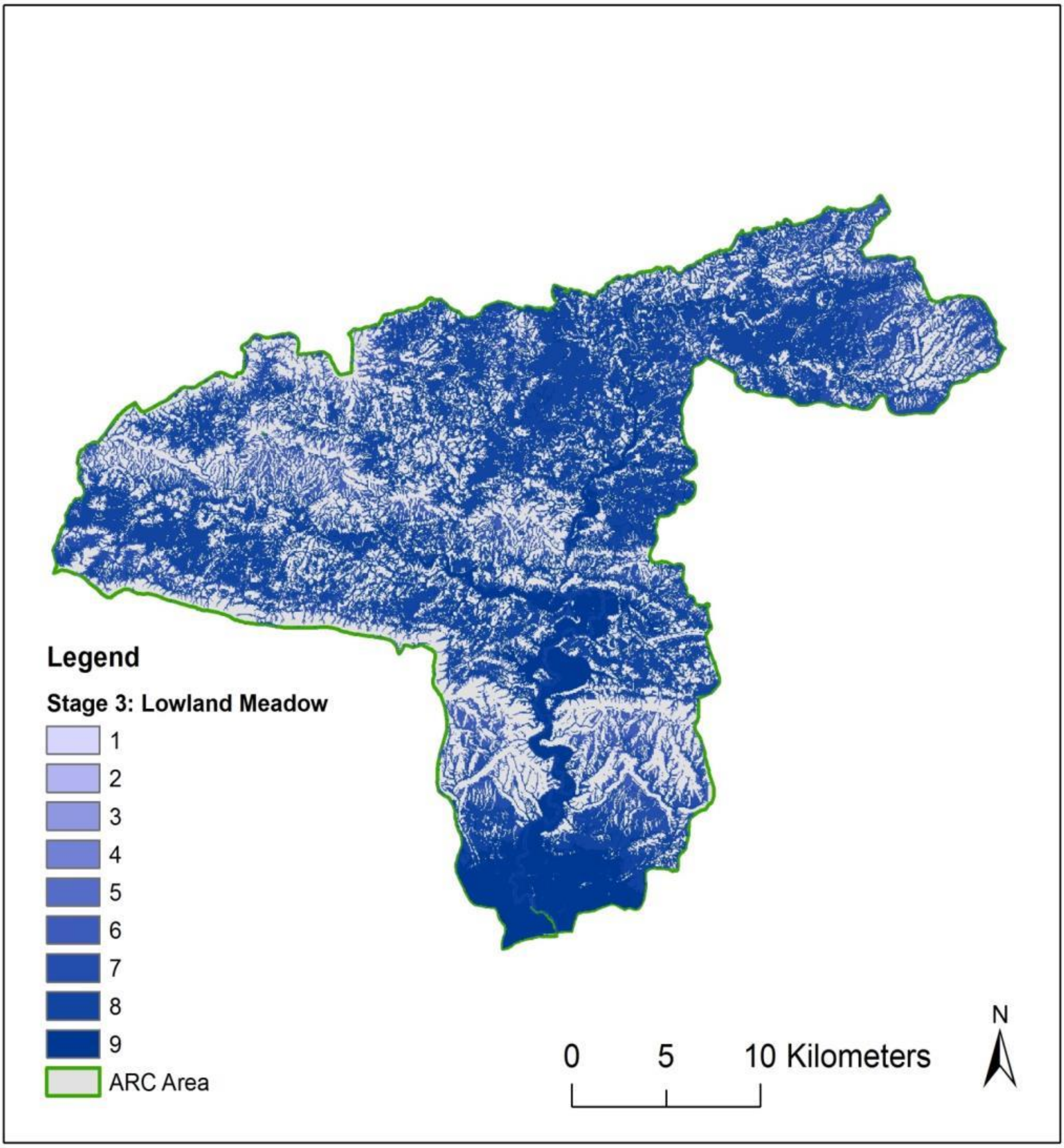
It should be noted that colour scales for these output maps vary slightly, as not all outputs generated scores of 0-9 (for example for species poor tussocky grassland has no scores under 4).



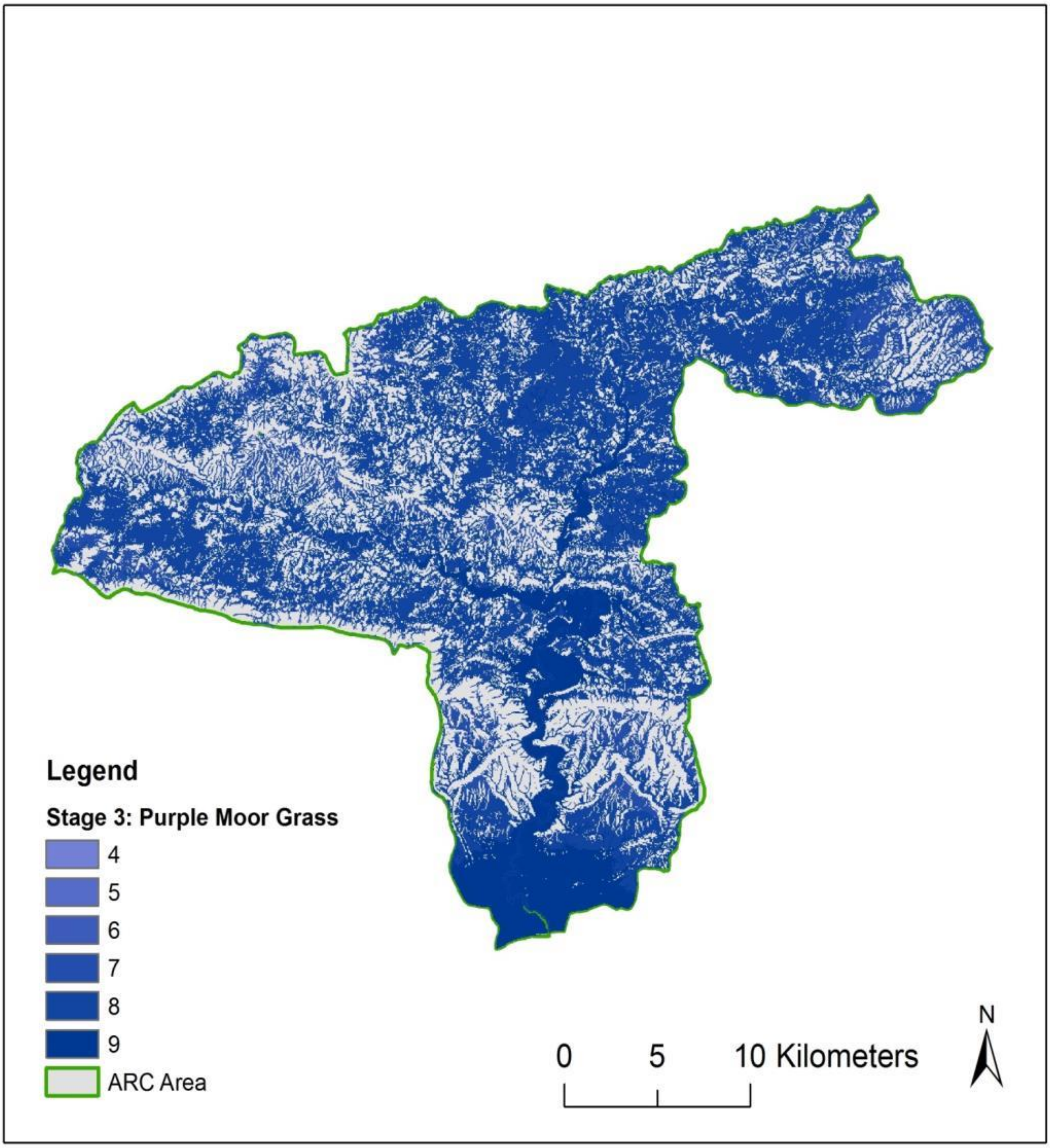
Coastal Flood Plain Grazing Marsh outputs from Stage 3.



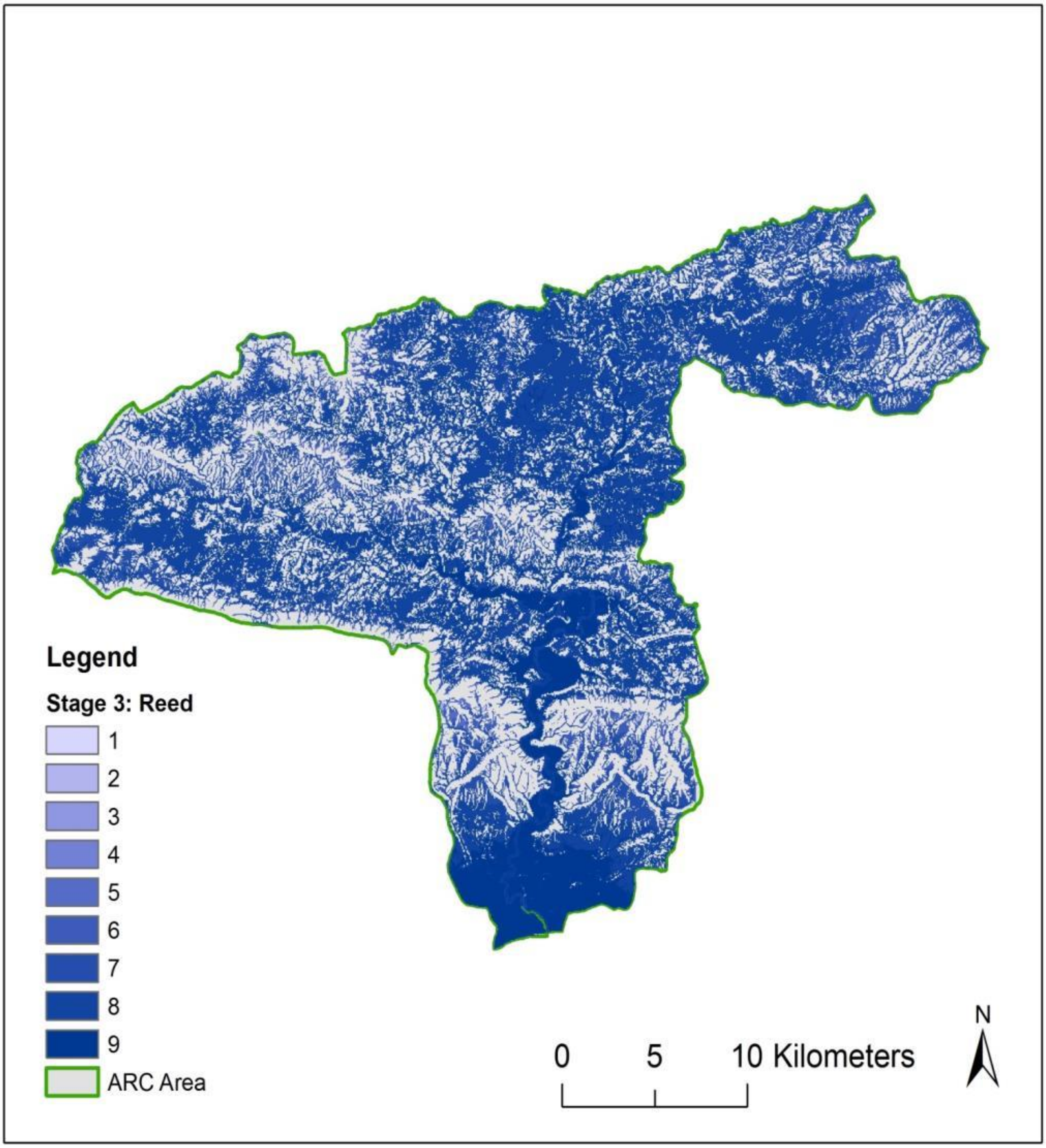
Fen outputs from Stage 3.



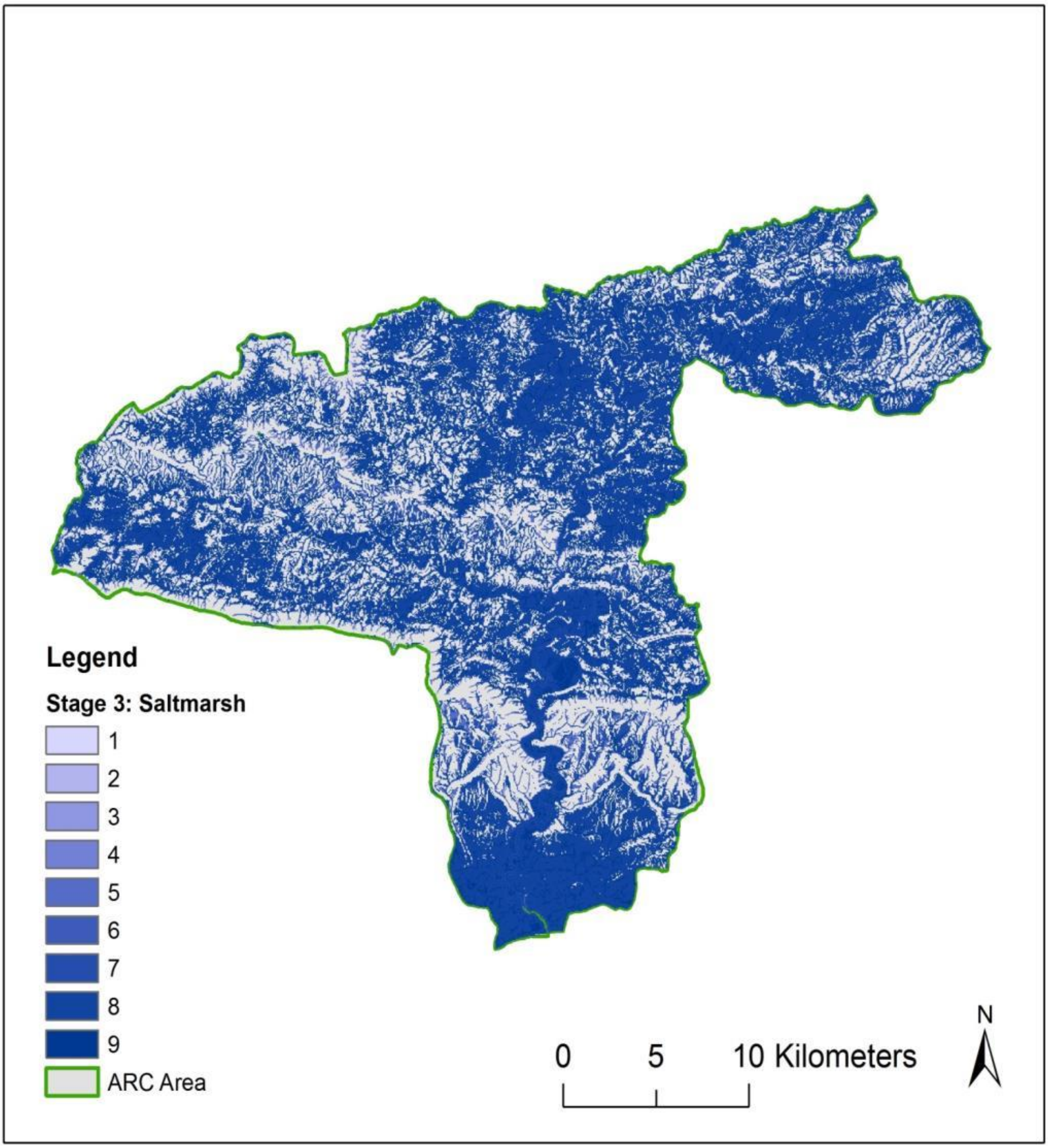
Lowland wet meadow outputs from Stage 3.



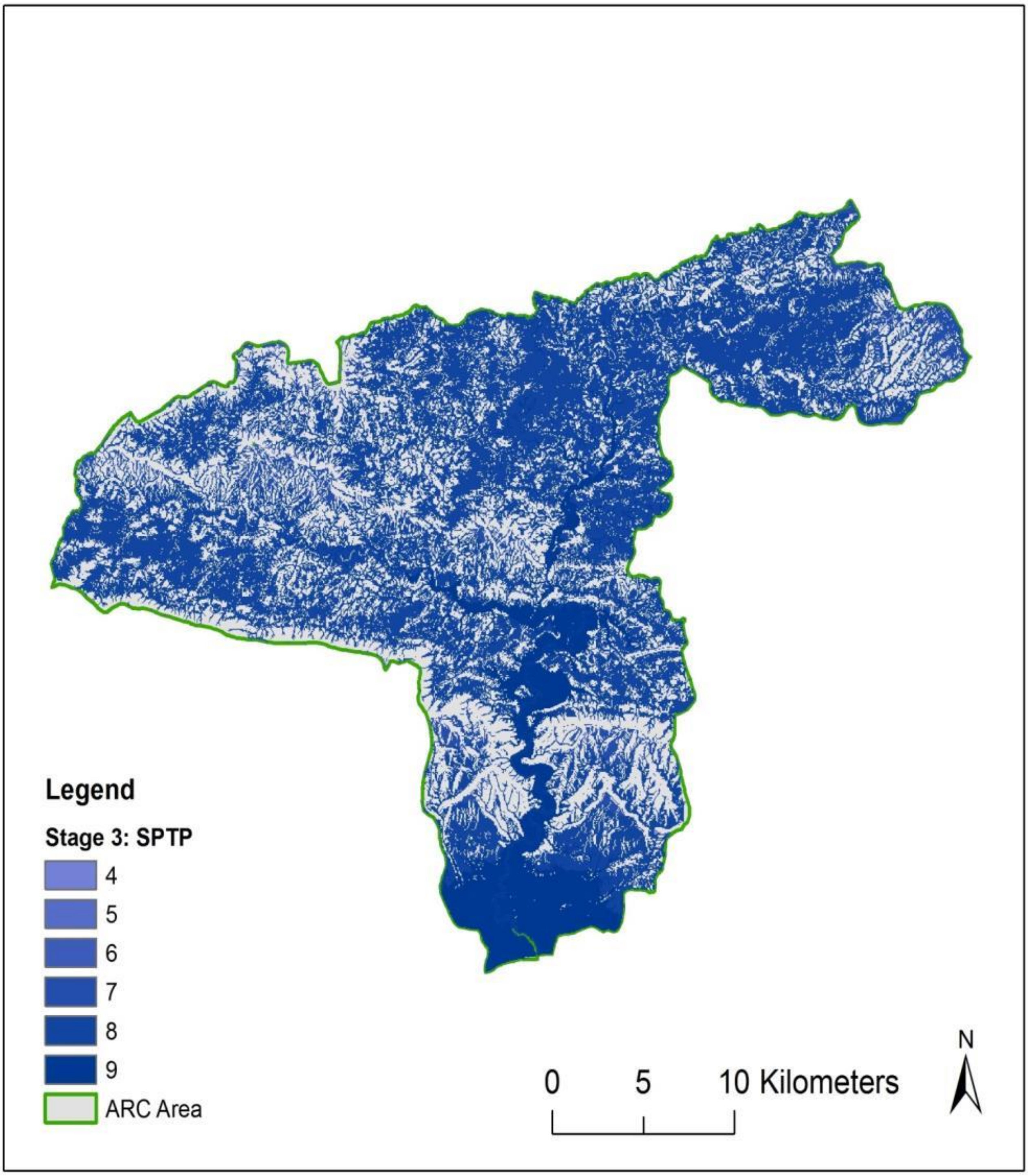
Purple Moor Grass and Rush Pasture outputs from Stage 3



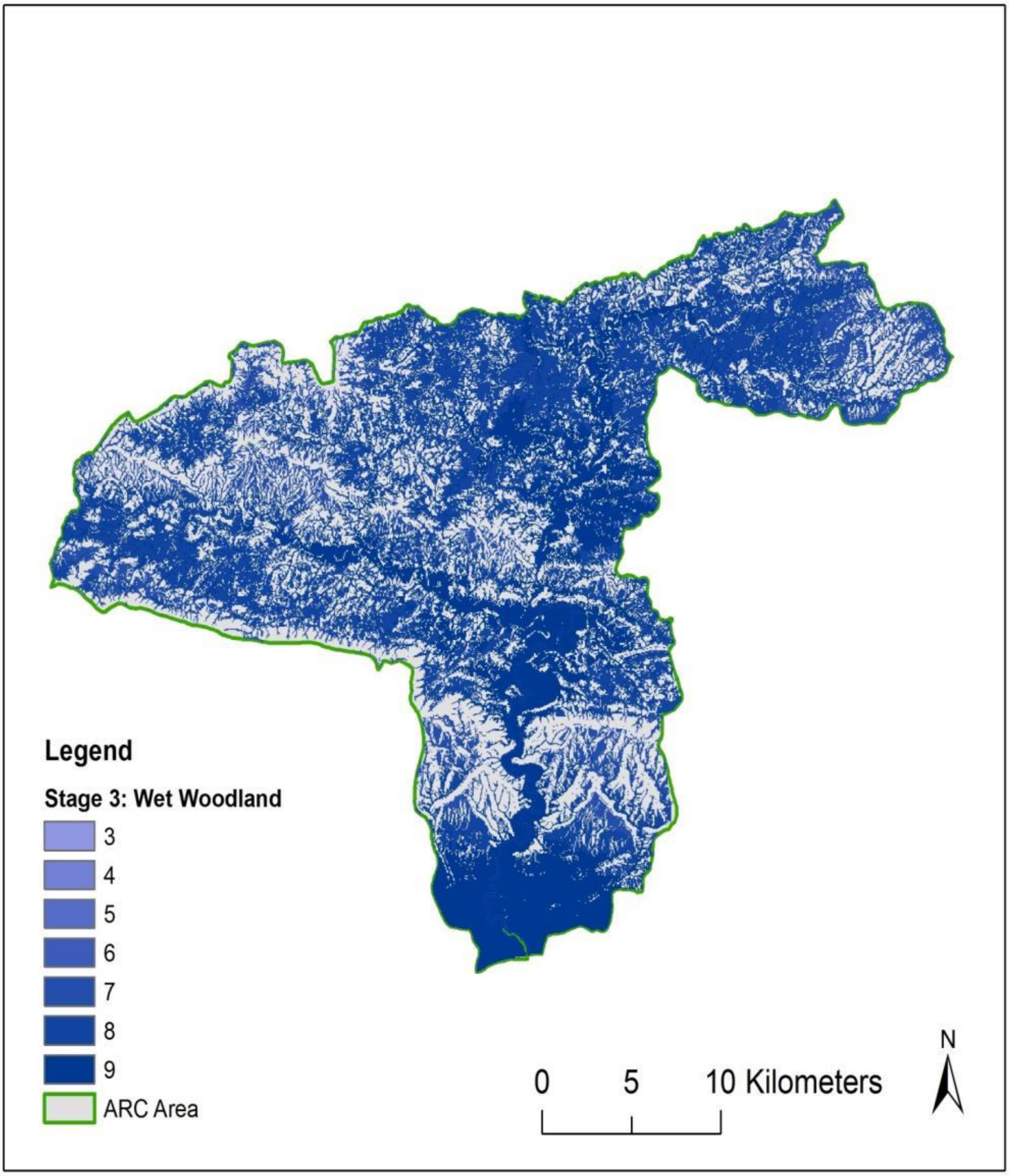
Reedbed outputs from Stage 3.



Saltmarsh outputs from Stage 3.



Species Poor Tussocky Pasture outputs from Stage 3.



Wet woodland outputs from Stage 3.

Appendix 2: Data-sets Used

Parameter	Layer Name	Supplier	New or updated layer since last model?
Stage 1 – Identification of proxies that will limit the creation of wetland habitats			
Project Area (ARC)	ARC Project area / Arun Outer	SxBRC	N
Urban land use	OS Open data local	OS	Y - 2016
Transport Networks	OS Open data local	OS	Y - 2016
Historic Landfill Sites	Historic Landfill Sites	EA Geostore	Y - 2016
OS Open Roads	Motorway junction / Road / Road node	OS	Y
Artificial Geology	DiGMapGB 625k	Natural England	Y - 2016
Stage 1 - Exclusions for floodplain woodland only			
Areas where not to plant trees / allow wet wood	Floodplain woodland model buffer data	SFI / SxBRC	Y - 2015
Land use and limiting factors Areas where not to plant trees	Flood Embankments_Defences	EA	Y – 2016. buffered to 8m as an exclusion zone for tree planting
Areas already wooded	National Forestry Inventory	FC / Open data	Y Updated
Stage 1 - Exclusions for saltmarsh only			
Inferred Saltmarsh Communities	Saltmarsh Habitat Potential Sussex Upper saltmarsh, enteromorpha etc	SxBRC	Y. 2015 All land outside this layer excluded + 5m altitude.
Non saltmarsh coastal communities	EA BRANCH (SESRCMP) Coastal sand dunes SS1 Intertidal boulder communities LR4 Littoral built structures LR5 Littoral rock pool communities LS64	Environment Agency	
Stage 2 – Identification of areas that are suitable for the creation of wetland habitats			
Landlevels = <15°	OS Terrain 50	Natural England	Y - 2016
Rivers, Tributaries and Drainage channels	Digital Rivers Network	Environment Agency	Y
Flood Zones (Floods less but to higher levels)	Flood Zone 2	EA Geostore	
Flood Zones (floods more frequently)	Flood Zone 3	EA Geostore	
Areas which would have flooded in past (and may be able to in future)	Historic flood zone	EA	Y - 2016
Springs & Issues (with 10m buffer)	Merged map springs 2011	Internal	N
Hydrogeology	Permeability of groundwater rocks	BGS 625k	2016
Open Water / Standing water	OS	OS	Y - 2013
Groundwater flood zones	Areas susceptible to groundwater flooding	EA Geostore	Y – 2016
Lake or waterbody	Nat Map Vector Soils	NE	Y - 2016
Stage 3 – Parameters used to identify areas of each wetland habitat type			
Slope & Altitude	OS Terrain 50	OS EA	Y
Aspect	OS Terrain 50	OS EA	Y
Salinity / Estuarine	DRN	EA	Y
Salinity / Tidal & Estuarine	Flood Zone 2	Environment Agency	Y

			Newly downloaded 2016
Floodzone	Flood Zone 3	Environment Agency	Y Newly downloaded 2016
Surface Water Accumulation and Flow Direction	Compound Topographic Index of Wetness	Internal	Y Newly created 2016
Closeness to River Corridor	Digital Rivers Network	Environment Agency	Y
Running Water	Digital Rivers Network	Environment Agency	Y
Water Flow	Digital Rivers Network	Environment Agency	Y
Ditch Drainage	Digital Rivers Network	Environment Agency	Y
Geology (Bedrock)	DiGiMap 625k Bedrock	BGS	Y
Geology (Superficial)	DigiMap 625k Superficial	BGS	Y
Low Grade Agricultural Land	Agricultural Land Classification map London and the South East (ALC007)	Natural England	Y - 2015
National Soils Data	NSRI NatMap Soilscapes	NE	Y - 2016
Organic land	ESS Merged Sussex – Organic ELS& HLS	NE	Y - 2016. Used for fen models
Inferred Saltmarsh Communities	Saltmarsh Habitat Potential Sussex Upper saltmarsh, enteromorpha etc	SxBRC	Y - 2016. Predictive not definitive
Existing Habitat	Ancient Woodland SxBRC Fen SxBRC Reedbed SxBRC Wet Heath Existing MG5 (Arun NVC)	NE SxBRC SxBRC SxBRC SxBRC	Y Updated since 2011
Stage 5 – Parameters used to prioritise the creation of different wetland habitat types			
River Catchment Flood Risk (Target areas for habitat Creation or re-wetting) P6 & P2 areas = high potential P1 = medium potential P3,4,5 = low potential	Catchment Flood Management Plan	EA Geostore	Y – 2016 update
Invasive Alien Species Used only American mink, f pennywort, f water lily, hybrid knotweed, indian balsam, himalayan balsam, Japanese Knotweed, Knotweed, New zealand pigmyweed, Water fern (azolla), giant hogweed, parrotsfeather records	SxBRC Records	SxBRC	Y – 2016.
Invasive alien species - Skunk cabbage	SxBRC records	SxBRC	Y - 2016. Doesn't appear in SxBRC invasive species register.
Within / Near Designated Sites	South Downs National Park Boundary	NE	N
	Areas of Oustanding Natural Beauty (AONB)		N
	SSSI Units, Boundaries and conditions	SxBRC /NE	Y - 2016. Unfavourable recovering weighted higher
	SSSI Impact zones	NE	Y - 2016
	SNCI boundaries	SxBRC / WSCC	Y
	BOA's	SxBRC / NE	N

	RAMSAR boundaries	Natural England	?
	SAC boundaries	Natural England	?
	SPA boundaries	Natural England	?
	Local Nature Reserve Boundaries	SxBRC / NE	?
	Country Park Boundaries	SxBRC / NE	?
	Source Protection Zones	EA	Y - 2016
	Nitrate Vulnerable Zones	EA	Y - 2016
	Sensitive Area Maps – River eutrophic SA's	EA	Y - 2016
	WFD Groundwater bodies cycle 2 draft	EA	Y - 2016
	WFD lake water bodies cycle 2 draft	EA	Y - 2016
	WFD river water bodies cycle 2 draft	EA	Y - 2016
	WFD transitional water bodies cycle 2 draft	EA	Y - 2016 Used for saltmarsh to show heavily modified /defended section of lower Arun currently preventing saltmarsh establishment
	WFD awb_canals_frbmp (artificial water body)	EA	Y - 2016.
	Important areas for birds	RSPB	Y - 2016
	Important areas for ponds	Wetlands / NE	Y - 2016
	Regionally Important Geological Sites (RIGS)	Booth Museum	Y - 2016
Within / Near Archaeological Sites	Scheduled Ancient Monuments	English Heritage	Y
Agricultural Land Class	Agricultural Land Classification map London and the South East (ALC007)	NE	Y - 2015.
Countryside Stewardship Schemes	ESS Merged Sussex	Natural England	Y
Proximity to BAP Habitat	Priority Habitat Inventory SE England		Replaces BRC BAP habitats layer but needs to be cross referenced with layers below.
Proximity to existing habitat of value	Sussex Chalk Streams	SxBRC	Y
Proximity to existing habitat of value	Greensand streams near springs	Sussex Wetlands	Y
Proximity to existing habitat	PMG & Rush records last 15 years	SxBRC	Y
Proximity to existing habitats – Purple Moor grass	NE lowland dry acid grassland	Natural England	?
Proximity to existing habitat	Internal, SCHIP & EA SESRCMP	SxBRC / Partnership / EA	Y / Y / 2008 data
Proximity to habitats of value	Ghyll Woodland	SxBRC	Y
Proximity to habitats of value	Ancient woodland	NE	Y
Proximity to habitats of value	National Forest Inventory	FC	Y Use only assumed woodland / woodland, not non woodland
Proximity to existing habitats	Arun NVC Main – Woodland codes	SWT	Y Proximity to all W codes, and to wet woodland (W1, W4, W5, W6 & W7) codes
Sussex Reedbeds	Sussex Reedbeds Combined	SxBRC	Y - Updated

Proximity to existing reedbed	Arun NVC main – reedbed codes	SWT	Y Proximity to codes S4, S24, S25, S26, W2, W5a & OV26a codes
Sussex Fens	Sussex Fens Combined	SxBRC	Y
Proximity to existing fen	Arun NVC Main – fen codes	SWT	New layer Proximity to codes S25, S26, S27, S28, M27, OV24, OV26, M22, M23, M26, S3, S7, S11, M4, M5, M27
Proximity to existing habitats – flow fed Base rich Fen meadow	Arun NVC main – base rich fen	SWT	Y M22 codes only
Proximity to existing habitats – flow fed Base rich Fen meadow	SWT NVC – base rich fen	SxBRC	Y M22 codes
Proximity to existing species rich meadow	Arun NVC main – species rich meadow	SWT	Y MG5 & MG6 codes
Proximity to existing species rich meadow	SWT NVC (Amberley, Waltham, Ebernoe etc) - Species rich meadow	SxBRC	Y MG5 & MG6 codes
Proximity to existing meadow habitat	Sussex lowland wet meadows	Natural England	
Proximity to existing rush pasture	Arun NVC main – rush pasture	SWT	Y MG10 & MG23 codes
Proximity to existing rush pasture	SWT NVCs – rush pasture	SxBRC	Y MG10 & MG23 codes
Proximity to existing species poor grasslands	Arun NVC main - sptg	SWT	Y MG11a & MG13 codes
Proximity to existing species poor grasslands	SWT NVC's - sptg	SxBRC	Y MG11a & MG13 codes
Wet heath	ARC Wet Heaths 2012	SxBRC	Y
Proximity to existing heathy habitats	SxBRC Combined Sussex heath and acid grassland	SxBRC	Y Proximity to water / wet soils.
Proximity to existing coastal and floodplain Grazing marsh	NE coastal and floodplain grazing marsh	Natural England	?
Proximity to existing ponds	Sussex pond inventory Sussex dew ponds ARC Rother ponds urban Open water locations Arun NVC main	SxBRC SxBRC SWT SxBRC SWT	Y Layers merged where possible All A codes
Proximity to existing habitat Proximity to existing saltmarsh Proximity to existing saltmarsh Potential for saltmarsh	EA BRANCH (SESRCMP) Brackish standing water AS6 Coastal Saltmarsh LS3 Mudflats LS4	Environment Agency	?Y
Stage 6 - Climate change parameters			
Sussex climate change predictions	SX NBCCVM PMG	Natural England	New HPM layer 2016, though NE layers created earlier

APPENDIX 3: Habitat Specific Parameters

The tables below present the parameters and weightings for each of the habitat models. Due to the details of the soils and current land use parameters these are presented separately at the end of this section. Weightings of 9 are high, and weightings of 0 or 1 are low.

Coastal and Floodplain Grazing Marsh – Stage 3

Parameter	Criteria	Dataset
Slope	Value Weight <1 9 <2 8 <3 7 <4 6 <5 5 <10 2 <15 1 <20 1 >20 1	OS terrain 50
Altitude	Value Weight <0 9 0-5 9 5-10 9 10-25 8 25-50 6 50-75 Exclude 75-100 Exclude *100-200* Exclude >200 Exclude	
Salinity	Value Weight Fluvial 9 F/T 6 Tidal 1	Flood Zone 2 (Tidal, tidal/fluvial areas)
Flood zone 3 Flood Zone 2	Within Weight 9 Within Weight 5	Highest frequency, low depth flood risk areas Low frequency, high depth flood risk areas
Groundwater Storage / Flood Areas	YES	Areas Susceptible to groundwater flooding (EA)
Areas accumulating water	Within High Weight 9 Within Moderate Weight 5	Compound topographic index of wetness (CTI)
Closeness to River Corridor	<100m - No Preference	Digital Rivers Network

Open Water / Standing Water	No	OS & merged Sx Pond inventory, SxBRC open water locations, Dew pond locations, ARC Rother ponds urban, & Arun NVC main A codes
Running Water	No	Digital Rivers Network
Springs & Issues	Yes - Within 20m	SxBRC
Ditch Drainage	Yes	Digital Rivers Network
Soil Type	Weighted (See table below)	NSRI NatMap Soilscapes (NE) BGS Geology (Bedrock) Digimap 625k BGS Geology (Superficial) Digimap 625k
Suitability for Agricultural Cultivation ALC 1 ALC 2 ALC 3a ALC 3b ALC 4 ALC 5 Non Agricultural Urban All other categories	Weighted Value 1 1 3 4 6 9 7 Exclude Exclude	Agricultural Land Classification Map ALC007 (NE)
Likelihood of past function as C&FGM	Within (Exclude areas already counted in Flood zone 2 & 3)	Historic floodzone
Existing Habitat	No	Ancient Woodland (NE) SxBRC Fen SxBRC Reedbed SxBRC Wet heath

Coastal and Floodplain Grazing Marsh – Stage 5

Parameter	Criteria	Dataset
River catchment flood risk (target areas for re-wetting / habitat creation) P6 & P2 areas P1 areas P3,4 &5 areas	Weighted High Medium Low	Catchment Flood Management Plan (EA)
Size of potential habitat >50Ha >5-50Ha <5Ha	Weighted High Mod Low	From model output
Proximity to existing CFPGM Adjacent <250m >250m	Weighted High Mod Low	NE Coastal and floodplain grazing marsh
Proximity to other BAP habitat Adjacent to <250m >250m	Weighted High Mod Low	Priority Habitat Inventory SE England & SxBRC layers Proximity to Sussex chalk streams Proximity to Greensand streams near springs Proximity to existing heath & wet heath Proximity to existing fen Proximity to existing reedbed Proximity to ancient woodland
Presence of Invasive Species • Floating Pennywort • Giant Hogweed • Australian Swamp Stonecrop / New Zealand pigmyweed • Japanese Knotweed • Himalayan balsam • Water fern • Parrotsfeather • Skunk cabbage Absent Present **(within 50m)**	Weighted High Low	SxBRC Records
Within Designated Sites South Downs National Park RAMSAR/SAC/SPA SSSI AONB BOA SNCI LNR Country Park Source Protection Zone Nitrate Vulnerable Zone River Eutrophic Sensitive Areas WFD Groundwater bodies WFD Lake waterbodies	Weighted High High High High Mod Mod Low Low Mod Mod Mod Low Low	Designated sites, Archaeological, Important Bird Area, Important Areas for Ponds & WFD layers

WFD River waterbodies WFD Transitional waterbodies WFD awb_canals_frbmp IBA IAP RIGS	Mod High EXCLUDE High High EXCLUDE	
SSSI Units, Boundaries, Conditions Favourable Unfavourable recovering Unfavourable no change Unfavourable declining Destroyed Part destroyed	Weighted High Med Low Low EXCLUDE EXCLUDE	
Adjacent to designated sites South Downs National Park RAMSAR/SAC/SPA SSSI SSSI Impact zone AONB BOA SNCI LNR Country Park Source Protection Zone Nitrate Vulnerable Zone River Eutrophic Sensitive Areas WFD Groundwater bodies WFD Lake waterbodies WFD River waterbodies WFD Transitional waterbodies WFD awb_canals_frbmp IBA IAP RIGS	Weighted High High High High Mod Mod Low Low Low Mod Mod Mod Low Low Mod Mod Low High High Mod	
Archaeological Sites with 10m buffer	Exclude	Scheduled Ancient Monuments
Countryside Stewardship Scheme Yes currently in Organic HLS Yes currently in HLS Yes currently in Organic ELS Yes currently in ELS No not currently in	Weighted High Mod Mod Low Low	 ESS merged Sussex

Lowland Fen – Stage 3

Parameter	Criteria		Dataset
	Base Poor	Base Rich	
Slope	Value Weight <1 9 <2 9 <3 9 <4 9 <5 8 <10 6 <15 3 <20 2 >20 1		OS terrain 50
Altitude	Value Weight <0 9 0-5 9 5-10 9 10-25 8 25-50 7 50-75 6 75-100 5 *100-200* 4 >200 3		
Salinity	Value Weight Fluvial 9 F/T 3 Tidal Exclude		Flood Zone 2 (Tidal, tidal/fluvial areas)
Flood zone 3 Flood Zone 2	Within Weight 4 Within Weight 7		Highest frequency, low depth flood risk areas Low frequency, high depth flood risk areas
Groundwater Storage / Flood Areas	YES		Areas susceptible to groundwater flooding (EA)
Areas accumulating water	Within High Weight 9 Within Moderate Weight 5		Compound topographic index of wetness (CTI)
Closeness to River Corri RIVERYTPE 1	Value Weight Intersect 2 Adjacent 4 <100m 4 >100m 6		

RIVERTYPE 2 & 3	<150m >200m 8 Value Weight Intersect 9 Adjacent 9 <100m 6 >100m <150m 2 >200m 1		Digital Rivers Network
Standing Water	Yes (*for fringe vegetation)*		OS & Sx Pond inventory, SxBRC open water locations, & Arun NVC main A codes
Running Water	No		Digital Rivers Network
Springs (within 50m)	Yes	Yes	SxBRC
Soil Type	Weighted, see tables below	Weighted, see tables below	NSRI NatMap Soilscapes (NE)
Geology	1. Sandstone 2. Calcareous	1. Chalk 2. Limestone	BGS Geology (Bedrock) Digimap 625k BGS Geology (Superficial) Digimap 625k
Current Land Use ALC 1 & 2	No		Agricultural Land Class (ALC007, NE)
Existing Habitat Ancient woodland Saltmarsh	No No		Ancient woodland (NE) EA Branch (SESRCMP) code LS3
Model Validation Current Fen	N/A		SxBRC Fen Combined

Lowland Fen – Stage 5

Parameter	Criteria		Dataset
	Base Poor	**Base Rich**	
River catchment flood risk (target area re-wetting / habitat creation) P6 & P2 areas P1 areas P3,4 &5 areas	Weighted High Medium Low		Catchment Flood Management Plan (EA)
Size of potential habitat >20Ha 10-20Ha <10Ha	Weighted High Mod Low		From model output
Proximity to existing fen Adjacent <500m >500m Proximity to Arun NVC codes S25, S26, S27, S28, M27, OV24, OV26, M22, M23, M26, S3, S7, S11, M4, M5, M27	Weighted High Mod Low High		SxBRC Fens Combined & Arun NVC
Closeness to other BAP habitat Adjacent <250m >250m	Weighted High Mod Low		Priority Habitat Inventory SE England & SxBRC habitat layers Proximity to existing species rich meadow (NE & NVC) Proximity to existing wet heath Proximity to existing reedbed
Presence of chalk river/stream Borders/intercepts within 10m		High	SxBRC Chalk streams layer
Presence of greensand spring / Stream Borders/intercepts within 10m	High		SxBRC Greensand streams near springs layer
Presence of Invasive Species Floating Pennywort Giant Hogweed Australian Swamp Stonecrop / New	Weighted		SxBRC Records

Zealand pigmyweed Himalayan balsam Water fern Parrotsfeather Skunk cabbage Absent Present	High Low	
Within Designated Sites South Downs National Park RAMSAR/SAC/SPA SSSI AONB BOA SNCI LNR Country Park Source Protection Zone Nitrate Vulnerable Zone River Eutrophic Sensitive Areas WFD Groundwater bodies good status WFD Groundwater bodies poor status WFD Lake waterbodies good status WFD River waterbodies poor status WFD Transitional waterbodies WFD awb_canals_frbmp IBA IAP RIGS	Weighted High High High High Mod Mod Low Low High Mod Low Mod Low Mod Low Low Low High High EXCLUDE	Designated sites, Archaeological, Important Bird Area, Important Areas for Ponds & WFD layers
SSSI Units, Boundaries, Conditions Favourable Unfavourable recovering Unfavourable no change Unfavourable declining Destroyed Part destroyed	Weighted High Med Low Low EXCLUDE Low	

 Adjacent to designated sites South Downs National Park RAMSAR/SAC/SPA SSSI SSSI Impact zone AONB BOA SNCI LNR Country Park Source Protection Zone Nitrate Vulnerable Zone River Eutrophic Sensitive Areas WFD Groundwater bodies good status WFD Groundwater bodies poor status WFD Lake waterbodies good status WFD River waterbodies poor status WFD River waterbodies WFD Transitional waterbodies WFD awb_canals_frbmp IBA IAP RIGS	Weighted High High High High High Mod Mod Low Low High Mod Low Mod Low Mod Low Low Mod Mod High High EXCLUDE	
Archaeological Sites with 10m buffer	Exclude	Scheduled Ancient Monuments
Current Land Use Organic ELS & HLS Non Organic Improved Grassland Arable Field Margins	Weighted High Low Low No	ESS Merged
River at high risk of pollution High and moderate risk Low and no risk	Weighted 1 9	Water Framework Directive – Risk of diffuse pollution categories

Lowland Wet Meadow – Stage 3

Parameter	Criteria	Dataset
Slope	Value Weight <1 9 <2 9 <3 9 <4 9 <5 8 <10 6 <15 4 <20 2 >20 1	OS terrain 50
Altitude	Value Weight <0 9 0-5 9 5-10 9 10-25 8 25-50 7 50-75 6 75-100 5 *100-200* 4 >200 3	
Salinity	Value Weight Fluvial 9 F/T 2 Tidal Exclude	Flood Zone 2 (Omitting tidal, tidal/fluvial areas)
Flood zone	Within	Flood Zone 3 – highest flood risk areas
Groundwater Storage Areas / Flood zones	Yes	Areas Susceptible to groundwater flooding (EA)
Areas accumulating water	Within High Weight 9 Within Moderate Weight 5	Compound topographic index of wetness (CTI)
Closeness to River Corridor	<100m - No Preference	Digital Rivers Network
Standing Water	No	Merged Sx Pond inventory, Sx Dew ponds ARC Rother urban ponds, Open water locations & Arun NVC main (All A codes)
Running Water	No	Digital Rivers Network
Springs	Yes – within 50m	SxBRC
Ditch Drainage	No	Digital Rivers Network
Soil Type	Weighted	NRSI NatMap Soilscapes
Suitability for Agricultural	Weighted	Agricultural Land Classification map (ALC007)

Cultivation ALC 1 ALC 2 ALC 3a ALC 3b ALC 4 ALC 5 Non Agricultural Urban All other categories	Value Exclude Exclude 2 2 5 9 7 Exclude Exclude	
Existing habitats Ancient woodland Reedbed (S4 only)	 Exclude Exclude	SxBRC layers

Lowland Wet Meadow – Stage 5

Parameter	Criteria	Dataset
River catchment flood risk (target areas for re-wetting / habitat creation) P6 & P2 areas P1 areas P3,4 &5 areas	Weighted High Medium Medium	Catchment Flood Management Plan (EA)
Size of potential habitat >20Ha >10-20Ha <10Ha	Weighted High Mod Low	From model output
Proximity to existing Lowland wet meadow Adjacent <500m >500m	Weighted High Mod Low	Sussex lowland meadows (NE)
Proximity to existing Lowland wet meadow Adjacent <500m >500m	Weighted High Mod Low	Arun NVC main – MG5 & MG6 codes
Proximity to existing Lowland wet meadow Adjacent <500m >500m	Weighted High Mod Low	SWT NVC (Amberley, Waltham, Ebernoe) MG5 & MG6 codes
Closeness to other BAP habitat Adjacent <250m >250m	Weighted High Mod Low	Priority Habitat Inventory SE England & SxBRC layers Proximity to Sussex chalk streams Proximity to Greensand streams near springs Proximity to existing heath & wet heath Proximity to existing fen Proximity to existing reedbed Proximity to ancient woodland Proximity to existing lowland acid dry grassland (NE inventory)
Presence of Invasive Species • Giant Hogweed • Japanese Knotweed • Himalayan balsam Absent Present	Weighted High Low	SxBRC Records
Within Designated Sites South Downs National Park RAMSAR/SAC/SPA SSSI	Weighted High High High	

AONB BOA SNCI LNR Country Park Source Protection Zone Nitrate Vulnerable Zone River Eutrophic Sensitive Areas WFD Lake waterbodies WFD River waterbodies WFD Transitional waterbodies WFD awb_canals_frbmp IBA IAP RIGS	High Mod High Mod Low Mod Mod Low EXCLUDE EXCLUDE EXCLUDE EXCLUDE High Mod EXCLUDE	Designated sites, Archaeological, Important Bird Area, Important Areas for Ponds & WFD layers
SSSI Units, Boundaries, Conditions Favourable Unfavourable recovering Unfavourable no change Unfavourable declining Destroyed Part destroyed	Weighted High High Mod Low EXCLUDE EXCLUDE	
Adjacent to designated sites South Downs National Park RAMSAR/SAC/SPA SSSI SSSI Impact zone AONB BOA SNCI LNR Country Park Source Protection Zone Nitrate Vulnerable Zone River Eutrophic Sensitive Areas WFD River waterbodies WFD Transitional waterbodies WFD awb_canals_frbmp IBA IAP RIGS	Weighted High High High High High Mod High Mod Low Mod Mod Low EXCLUDE EXCLUDE EXCLUDE Mod Mod EXCLUDE	
Archaeological Sites with 10m buffer	Exclude	Scheduled Ancient Monuments
Current land use (agricultural) Organic ELS & HLS Non Organic ELS / HLS Improved Grassland Arable Field Margins	Weighted High Mod Low Low	ESS Merged Sussex
River at high risk of pollution High and moderate risk Low and no risk	Weighted – within zone 3 flood zone 1 9	Water Framework Directive – Risk of diffuse pollution categories

Purple Moor-Grass and Rush Pasture - Stage 3

Parameter	Criteria	Dataset
Slope	Value Weight <1 9 <2 9 <3 9 <4 9 <5 9 5-10 9 10-15 6 15-20 2 >20 1	OS terrain 50
Altitude	Value Weight <0 9 0-5 9 5-10 9 10-25 8 25-50 7 50-75 6 75-100 5 *100-200* 4 >200 3	
Salinity	Value Weight Fluvial 9 F/T 3 Tidal 1	Flood Zone 2 (Omitting tidal, tidal/fluvial areas)
Flood zone Within Within	Weight High Mod	 Flood Zone 3 Flood zone 2
Groundwater Storage / Flood Areas	Yes	Areas susceptible to Groundwater flooding (EA)
Areas accumulating water	Within	Compound topographic index of wetness (CTI)
Closeness to River Corridor	<100m - No Preference	Digital Rivers Network
Standing Water	No	Merged Sx Pond inventory, Sx Dew ponds, Open water locations & Arun NVC main (All A codes)
Running Water	No	Digital Rivers Network
Springs (within 20m)	Yes	SxBRC
Ditch Drainage	No	Digital Rivers Network
Soil Type	Weighted	NSRI Natmap soils (NE)
Suitability for Agricultural Cultivation	Weighted Value	

ALC 1 ALC 2 ALC 3a ALC 3b ALC 4 ALC 5 Non Agricultural Urban All other categories	EXCLUDE EXCLUDE 5 5 8 9 7 EXCLUDE EXCLUDE	Agricultural Land Classification Map ALC007 (NE)
Historic Flood Zone Within	Weighted High	EA Historic flood zone
Existing Habitat	EXCLUDE	Ancient Woodland (NE SxBRC reedbed (S4 code only) Lowland Meadow (NE & NVC MG5 & MG6 Arun & SxBRC)

Purple Moor-Grass and Rush Pasture - Stage 5

Parameter	Criteria	Dataset
River catchment flood risk (target areas for re-wetting / habitat creation) P6 & P2 areas P1 areas P3,4 &5 areas	Weighted High Medium Medium	Catchment Flood Management Plan (EA)
Size of potential habitat >20Ha >10-20Ha <10Ha	Weighted High Mod Low	From model output
Proximity to existing PMGRP Adjacent <500m >500m	Weighted High Mod Low	Priority habitat inventory of SE England
Proximity to existing PMGRP Adjacent <500m >500m	Weighted High Mod Low	Arun NVC Rush pasture codes MG10 & MG23
Proximity to existing PMGRP Adjacent <500m >500m	Weighted High Mod Low	SWT NVC's Rush pasture codes MG10 & MG23
Proximity to other BAP habitat Adjacent <250m >250m	Weighted High Mod Low	Priority Habitat Inventory SE England & SxBRC layers Proximity to Sussex chalk streams (within 20m) Proximity to Greensand streams near springs (within 20m) Proximity to existing heath & wet heath Proximity to existing fen Proximity to existing reedbed Proximity to ancient woodland
Clusters of existing rush & PMG records	Weighted High	SxBRC PMG & Rush records last 15 years, Within 20m
Presence of Invasive Species • Floating Pennywort • Giant Hogweed • Australian Swamp Stonecrop / New Zealand pigmyweed • Japanese Knotweed • Himalayan balsam • Water fern • Parrotsfeather • Skunk cabbage Absent Present (within 50m)	Weighted High Mod	SxBRC Records
Within Designated Sites South Downs National Park	Weighted High	Designated sites, Archaeological,

RAMSAR/SAC/SPA SSSI AONB BOA SNCI LNR Country Park Source Protection Zone Nitrate Vulnerable Zone River Eutrophic Sensitive Areas WFD Lake waterbodies WFD River waterbodies WFD Transitional waterbodies WFD awb_canals_frbmp IBA IAP RIGS	High High High Mod Mod Low Low Mod Mod Mod EXCLUDE EXCLUDE EXCLUDE EXCLUDE High Mod EXCLUDE	Important Bird Area, Important Areas for Ponds & WFD layers
<u>SSSI Units, Boundaries, Conditions</u> Favourable Unfavourable recovering Unfavourable no change Unfavourable declining Destroyed Part destroyed	<u>Weighted</u> High High Mod Low EXCLUDE Low	
<u>Adjacent to designated sites</u> South Downs National Park RAMSAR/SAC/SPA SSSI SSSI Impact zone AONB BOA SNCI LNR Country Park Source Protection Zone Nitrate Vulnerable Zone River Eutrophic Sensitive Areas WFD River waterbodies WFD Transitional waterbodies WFD awb_canals_frbmp IBA IAP RIGS	<u>Weighted</u> High High High High High Mod Mod Low Low Mod Mod Low EXCLUDE EXCLUDE EXCLUDE High Mod EXCLUDE	
<u>Archaeological Sites</u> with 10m buffer	Exclude	Scheduled Ancient Monuments
<u>Current land use (agricultural)</u> Organic ELS & HLS Non Organic ELS / HLS Improved Grassland Arable Field Margins	<u>Weighted</u> High Mod Low Low	ESS Merged Sussex

Reedbed – Stage 3

Parameter	Criteria	Dataset
Slope	Value Weight <1 9 <2 8 <3 8 <4 7 <5 6 <10 4 <15 2 <20 1 >20 1	OS terrain 50
Altitude	Value Weight <0 9 0-5 9 5-10 9 10-25 9 25-50 8 50-75 6 75-100 5 *100-200* 4 >200 1	
Salinity	Value Weight Fluvial 9 F/T 6 Tidal 4	Flood Zone 2 (Tidal, tidal/fluvial areas)
Flood zone	Within Within	Flood Zone 3 Flood zone 3
Groundwater Flood Storage Areas	Within	EA
Areas accumulating water	Within	Compound topographic index of wetness (CTI)
Closeness to River Corridor Directly connected Within 100m	<u>Weighted</u> 9 5	Digital Rivers Network
Standing Water	Yes	Sx Pond inventory SxBRC open water locations Dew pond locations ARC Rother ponds urban Arun NVC main A codes
Running Water	Yes	Digital Rivers Network
Ditch Drainage	Yes	Digital Rivers Network

Water Flow	Low	Water Framework Directive
Soil Type	Weighted	NSRI Natmap Soilscapes (NE)
Current Land Use Low value agricultural land Medium value agricultural land High Grade agricultural land	<u>Weighted</u> High Mod Low	 Agricultural Land Classification (Grades 4 & 5) Agricultural Land Classification (Grades 3, 3a & 3b) Agricultural Land Classification (Grades 1 & 2)
Historic Flood Zone Within	<u>Weighted</u> High	 EA Historic flood zone
Existing Habitat	EXCLUDE	Ancient Woodland (NE Habitat inventory) Lowland Meadow (NE data, and NVC MG5 & MG6 Arun & SxBRC NVC's) SxBRC Wet Heath & Heathland
<u>Model Validation</u> Current Reedbed	 N/A	 Sussex Reedbed Combined

Reedbed – Stage 5

Parameter	Criteria	Dataset
River catchment flood risk (target areas for re-wetting / habitat creation) P6 & P2 areas P1 areas P3,4 &5 areas	Weighted High Medium Medium	Catchment Flood Management Plan (EA)
Size of potential habitat >20Ha 10-20Ha <10Ha	Weighted High Mod Low	From model output
Proximity to existing reedbed Adjacent <500m >500m	Weighted High Mod Low	SxBRC Reedbed Combined
Proximity to existing reedbed Adjacent <500m >500m	Weighted High Mod Low	Arun NVC codes (main) S4, S24, S25, S26, W2, W5a & OV26a codes
Proximity to existing reedbed Adjacent <500m >500m	Weighted High Mod Low	SWT NVC codes (main) S4, S24, S25, S26, W2, W5a & OV26a codes
Closeness to other BAP habitat Adjacent <250m >250m	Weighted High Mod Low	Priority Habitat Inventory SE England & SxBRC layers Proximity to Sussex chalk streams (within 20m) Proximity to existing heath & wet heath Proximity to existing fen Proximity to existing lowland meadow Proximity to ancient woodland
Presence of Invasive Species • Floating Pennywort • Giant Hogweed • Australian Swamp Stonecrop / New Zealand pigmyweed • Japanese Knotweed • Himalayan balsam • Water fern • Parrotsfeather • Skunk cabbage Absent Present (within 50m)	Weighted High Low	SxBRC Records
Within Designated Sites South Downs National Park RAMSAR/SAC/SPA SSSI AONB BOA SNCI	Weighted High High High High Mod High	

LNR Country Park Source Protection Zone Nitrate Vulnerable Zone River Eutrophic Sensitive Areas WFD Lake waterbodies WFD River waterbodies WFD Transitional waterbodies WFD awb_canals_frbmp IBA IAP RIGS	Low Low High High High Mod Mod Low Mod High High EXCLUDE	
SSSI Units, Boundaries, Conditions Favourable Unfavourable recovering Unfavourable no change Unfavourable declining Destroyed Part destroyed	Weighted High High High Low EXCLUDE Low	Designated sites, Archaeological, Important Bird Area, Important Areas for Ponds & WFD layers
Adjacent to designated sites South Downs National Park RAMSAR/SAC/SPA SSSI SSSI Impact zone AONB BOA SNCI LNR Country Park Source Protection Zone Nitrate Vulnerable Zone River Eutrophic Sensitive Areas WFD River waterbodies WFD Transitional waterbodies WFD awb_canals_frbmp IBA IAP RIGS	Weighted High High High High High Mod Mod Low Low Mod Mod Mod Low Low Low High Mod EXCLUDE	
Archaeological Sites with 10m buffer	Exclude	Scheduled Ancient Monuments
Current land use (agricultural) Organic ELS & HLS Non Organic ELS / HLS Improved Grassland Arable Field Margins	Weighted High Mod Mod Low	ESS Merged Sussex
River at high risk of pollution High and moderate risk Low and no risk	Weighted 7 3	Water Framework Directive – Risk of diffuse pollution categories

Saltmarsh – Stage 3

Parameter	Criteria	Dataset
Slope	Value Weight <1 9 <2 9 <3 8 <4 7 <5 6 <10 3 <15 1 <20 1 >20 1	OS Terrain 50
Salinity	Value Weight Fluvial 4 F/T 6 Tidal 9	Flood Zone 2 (Tidal, tidal/fluvial areas)
Flood zone (Tidal)	Within	Flood Zone 3 – highest flood risk areas (Tidal)
Closeness to River Corridor	Value Weight Intersect 6 Adjacent 9 <100m 6 >100m 1	Digital Rivers Network
Soil Type	Weighted	NSRI NatMap Soilscapes (NE)
Current Land Use ALC 1 All other land classes	Weighted Low Moderate	Agricultural Land Class ALC007 (NE)
Existing Habitat	EXCLUDE	Ancient Woodland (NE Habitat inventory) Lowland Meadow (NE data, and NVC MG5 & MG6 Arun & SxBRC NVC's) SxBRC, Arun & SWT NVC fens
Model Validation Current Saltmarsh		

PLEASE NOTE that the location of sea defences is an important consideration when creating saltmarsh. The turbidity of wave action is reduced by coastal defences and therefore can indicate suitable areas where wave action is low enough to allow sediments to be laid down and saltmarsh to establish.

Saltmarsh – Stage 5

Parameter	Criteria	Dataset
River catchment flood risk (target areas for re-wetting / habitat creation) P6 (UNIQUEID 92 only, FID 31) & P5 area (UNIQUEID 104 & FID 41 only) P4 areas P1, P2 & P3 areas	Weighted High Mod Low	Catchment Flood Management Plan (EA)
Size of potential habitat >50Ha >5-50Ha <5Ha	Weighted High Mod Low	From model output
Proximity to existing Saltmarsh Adjacent <5km 5>10km	Weighted High Mod Low	Proximity to LS3 EA SESRCMP 2008
Closeness to other BAP habitat Adjacent <250m >250m	Weighted High Mod Low	Mudflat EA SESRCMP LS4 Brackish standing water EA SESRCMP Proximity to Sussex chalk streams (within 50m) Proximity to existing fen (SxBRC + Arun & SWT NVC fen codes) Proximity to existing lowland meadow (NE, and Arun & SWT NVC MG5 & MG6) Proximity to PMG (Arun NVC & SWT NVC codes MG10 & MG23) Proximity to ancient woodland (NE) Proximity to reedbed (Reedbed combined + Arun & SWT NVC S4)
Presence of Invasive Species Spartina angelica Crassula Helmsii Giant Hogweed Japanese Knotweed Absent Present	 High Low	SxBRC Records
Within Designated Sites South Downs National Park RAMSAR/SAC/SPA SSSI AONB BOA SNCI LNR Country Park Source Protection Zone Nitrate Vulnerable Zone River Eutrophic Sensitive Areas WFD Lake waterbodies WFD River waterbodies WFD Transitional waterbodies WFD awb_canals_frbmp IBA	Weighted High High High N/A Mod Mod Low Low High High High EXCLUDE Mod High EXCLUDE High	Designated sites, Archaeological, Important Bird Area, Important Areas for Ponds & WFD layers

IAP RIGS	Mod EXCLUDE	
SSSI Units, Boundaries, Conditions Favourable Unfavourable recovering Unfavourable no change Unfavourable declining Destroyed Part destroyed	Weighted High High Mod Mod EXCLUDE Low	
Adjacent to designated sites South Downs National Park RAMSAR/SAC/SPA SSSI SSSI Impact zone AONB BOA SNCI LNR Country Park Source Protection Zone Nitrate Vulnerable Zone River Eutrophic Sensitive Areas WFD River waterbodies WFD Transitional waterbodies WFD awb_canals_frbmp IBA IAP RIGS	Weighted High High High High N/A Mod Mod Low Low High High High Mod High EXCLUDE High Mod EXCLUDE	
Archaeological Sites with 10m buffer	Exclude	Scheduled Ancient Monuments
Current land use (agricultural) Organic ELS & HLS Non Organic ELS / HLS Improved Grassland Arable Field Margins	Weighted Mod Mod High Low	ESS Merged Sussex

PLEASE NOTE that the Shoreline Management Plan, developed by the Environment Agency would be useful as an additional parameter to use for the saltmarsh prioritisation phase. This would detail whether it is viable to remove/relocate sea defences to extend saltmarsh habitat.

Species Poor Tussocky Pasture – Stage 3

<table>
<tr><th>Parameter</th><th>Criteria</th><th>Dataset</th></tr>
<tr><td>Slope</td><td>Value Weight
<1 9
<2 9
<3 9
<4 9
<5 9
5-10 9
10-15 6
15-20 2
>20 1</td><td rowspan="2">OS terrain 50</td></tr>
<tr><td>Altitude</td><td>Value Weight
<0 9
0-5 9
5-10 9
10-25 8
25-50 7
50-75 6
75-100 6
100-200 5
>200 2</td></tr>
<tr><td>Salinity</td><td>Value Weight
Fluvial 9
F/T 5
Tidal 1</td><td>Flood Zone 2 (Omitting tidal, tidal/fluvial areas)</td></tr>
<tr><td>Flood zone</td><td>Within
Within</td><td>Flood Zone 3
Flood Zone 2</td></tr>
<tr><td>Groundwater Flood Zones</td><td>Within</td><td>EA</td></tr>
<tr><td>Areas accumulating water</td><td>Within</td><td>Compound topographic index of wetness (CTI)</td></tr>
<tr><td>Closeness to River Corridor</td><td>No Preference</td><td>Digital Rivers Network</td></tr>
<tr><td>Standing Water</td><td>Yes (Upper reach)</td><td>Sx Pond inventory
SxBRC open water locations
Arun NVC main A codes</td></tr>
<tr><td>Running Water</td><td>No</td><td>Digital Rivers Network</td></tr>
<tr><td>Springs – within 50m</td><td>Yes</td><td>SWT Springs combined</td></tr>
<tr><td>Ditch Drainage</td><td>No</td><td>Digital Rivers Network</td></tr>
<tr><td>Soil Type</td><td>Weighted</td><td>NSRI Natmap Soilscapes</td></tr>
<tr><td><u>Current Land Use</u>
Low Grade Agricultural Land
Medium Grade Agricultural Land
High Grade Agricultural Land</td><td><u>Weighted</u>
High
Mod
Low</td><td>
Agricultural Land Classification (Grades 4 & 5)
Agricultural Land Classification (Grades 3, 3a, 3b)
Agricultural Land Classification (Grades 1 & 2)</td></tr>
</table>

Existing Habitat	EXCLUDE	Ancient woodland (NE) Existing fen (SxBRC & Arun & SWT NVC) Existing reedbed (SxBRC & Arun & SWT NVC) Existing MG5 & MG6 grassland (NE lowland meadow habitat inventory and Arun & SWT NVC)

Species Poor Tussocky Pasture – Stage 5

Parameter	Criteria	Dataset
River catchment flood risk (target areas for re-wetting / habitat creation) P6 & P2 areas P1 P2, P3 & P5 areas	Weighted High Mod Low	Catchment Flood Management Plan (EA)
Size of potential habitat >20Ha >10-20Ha <10Ha	Weighted High Mod Low	From model output
Proximity to existing SPTP Adjacent <500m >500m	Weighted High Mod Low	Arun & SWT NVC codes MG11a & MG13
Closeness to other BAP habitat Adjacent <250m >250m	Weighted High Mod Low	Proximity to Sussex chalk streams (within 50m) Proximity to existing fen (SxBRC + Arun & SWT NVC fen codes) Proximity to existing lowland meadow (NE, and Arun & SWT NVC MG5 & MG6) Proximity to PMG (Arun NVC & SWT NVC codes MG10 & MG23) Proximity to ancient woodland (NE) Proximity to reedbed (Reedbed combined + Arun & SWT NVC S4)
Presence of Invasive Species • Floating Pennywort • Giant Hogweed • Australian Swamp Stonecrop / New Zealand pigmyweed • Japanese Knotweed • Himalayan balsam • Water fern • Parrotsfeather • Skunk cabbage Absent Present (within 50m)	Weighted High Low	SxBRC Records
Within Designated Sites South Downs National Park RAMSAR/SAC/SPA SSSI AONB BOA SNCI LNR Country Park Source Protection Zone Nitrate Vulnerable Zone River Eutrophic Sensitive Areas WFD Lake waterbodies	Weighted High High High High Mod High Low Low Low High Low EXCLUDE	Designated sites, Archaeological, Important Bird Area, Important Areas for Ponds & WFD layers

WFD River waterbodies WFD Transitional waterbodies WFD awb_canals_frbmp IBA IAP RIGS	EXCLUDE EXCLUDE EXCLUDE High Mod EXCLUDE	
SSSI Units, Boundaries, Conditions Favourable Unfavourable recovering Unfavourable no change Unfavourable declining Destroyed Part destroyed	Weighted High High Mod Low EXCLUDE Low	
Adjacent to designated sites South Downs National Park RAMSAR/SAC/SPA SSSI SSSI Impact zone AONB BOA SNCI LNR Country Park Source Protection Zone Nitrate Vulnerable Zone River Eutrophic Sensitive Areas WFD River waterbodies WFD Transitional waterbodies WFD awb_canals_frbmp IBA IAP RIGS	Weighted High High High High High Mod Mod Low Low Mod Mod Mod N/A N/A N/A High Mod EXCLUDE	
Archaeological Sites with 10m buffer	Exclude	Scheduled Ancient Monuments
Current land use (agricultural) Organic ELS & HLS Non Organic ELS / HLS Improved Grassland Arable Field Margins	Weighted High Mod Low Low	ESS Merged Sussex

Wet Woodland – Stage 3

Parameter	Criteria	Dataset
Slope	Value Weight <1 9 <2 9 <3 9 <4 9 <5 9 5-10 9 10-15 6 15-20 2 >20 1	OS Terrain 50
Altitude	Value Weight <0 9 0-5 9 5-10 9 10-25 9 25-50 8 50-75 7 75-100 5 *100-200 3* >200 1	
Salinity	Value Weight Fluvial 9 F/T 6 Tidal 1	Flood Zone 2 (Omitting tidal, tidal/fluvial areas)
Flood zone	Within Within	Flood Zone 3 Flood Zone 2
Groundwater flood zones	Within	EA
Areas accumulating water	Within	Compound topographic index of wetness (CTI)
Closeness to River Corridor	Value Weight Intersect 6 Adjacent 9 <100m 6 >100m >150m 2 >150m 1	Digital Rivers Network
Standing Water	Yes	Sx Pond inventory SxBRC open water locations ARC Rother ponds urban Arun NVC main A codes
Running Water	Yes	Digital Rivers Network
Water Flow	LOW/MOD	Water Framework Directive

Soil Type	Weighted	NSRI Natmap Soilscapes
Current Land Use Low Grade Agricultural Land Medium Grade Agricultural Land High Grade Agricultural Land	Weighted High Mod Low	 Agricultural Land Classification (Grades 4 & 5) Agricultural Land Classification (Grades 3, 3a, 3b) Agricultural Land Classification (Grades 1 & 2)
Existing Habitat	EXCLUDE	Ancient woodland (NE) Existing fen (SxBRC & Arun & SWT NVC) Existing reedbed (SxBRC & Arun & SWT NVC) Existing MG5 & MG6 grassland (NE lowland meadow habitat inventory and Arun & SWT NVC)

Wet Woodland – Stage 5

Parameter	Criteria	Dataset
River catchment flood risk (target areas for re-wetting / habitat creation) P6 & P2 areas P1 P2, P3 & P5 areas	Weighted High Mod Low	Catchment Flood Management Plan (EA)
Size of potential habitat >50Ha >5Ha <1Ha	Weighted 9 5 1	From model output
Proximity to existing woodland type Adjacent to floodplain woodland (Floodplain woodland layer, Arun & SWT NVC) Adjacent to Ghyll woodland Adjacent to Ancient Woodland Adjacent to other woodland types <250m from floodplain woodland (Floodplain woodland layer, Arun & SWT NVC) <250m from Ghyll woodland <250m from Ancient woodland <250m from other woodland types	Weighted 9 9 9 7 5 5 5 5	SxBRC / SWT floodplain woodland layer National Forest Inventory (Assumed, Broadleaf, Coppice, Coppice with standards, Low density, Mixed, Young trees) SxBRC Ghyll Woodland inventory Ancient woodland inventory (NE) Arun NVC Main woodland codes W1, W4, W5, W6 & W7
Closeness to other BAP habitat Adjacent <500m >500m	Weighted 9 5 1	Proximity to existing fen (SxBRC + Arun & SWT NVC fen codes) Proximity to existing lowland meadow (NE, and Arun & SWT NVC MG5 & MG6) Proximity to PMG (Arun NVC & SWT NVC codes MG10 & MG23) Proximity to heath & wet heath Proximity to reedbed (Reedbed combined + Arun & SWT NVC S4)
Presence of chalk river/stream Borders/intercepts Does not border/intercept	 9 1	Chalk stream surveys
Presence of greensand river/stream Borders/intercepts Does not border/intercept	 9 1	SxBRC Greensand stream layer
Presence of Invasive Species • Giant Hogweed • Australian Swamp Stonecrop / New Zealand pigmyweed • Japanese Knotweed • Himalayan balsam • Parrotsfeather • Skunk cabbage Absent Present (within 50m)	Weighted High Low	SxBRC Records
Within Designated Sites	Weighted	Designated sites,

South Downs National Park RAMSAR/SAC/SPA SSSI AONB BOA SNCI LNR Country Park Source Protection Zone Nitrate Vulnerable Zone River Eutrophic Sensitive Areas WFD Lake waterbodies WFD River waterbodies WFD Transitional waterbodies WFD awb_canals_frbmp IBA IAP RIGS	High High High High Mod Mod Low Low High High High Low Low Low EXCLUDE Mod Mod EXCLUDE	Archaeological, Important Bird Area, Important Areas for Ponds & WFD layers
<u>SSSI Units, Boundaries, Conditions</u> Favourable Unfavourable recovering Unfavourable no change Unfavourable declining Destroyed Part destroyed	<u>Weighted</u> High High Mod Low EXCLUDE Low	
<u>Adjacent to designated sites</u> South Downs National Park RAMSAR/SAC/SPA SSSI SSSI Impact zone AONB BOA SNCI LNR Country Park Source Protection Zone Nitrate Vulnerable Zone River Eutrophic Sensitive Areas WFD River waterbodies WFD Transitional waterbodies WFD awb_canals_frbmp IBA IAP RIGS	<u>Weighted</u> High High High High High Mod Mod Low Low Mod Mod Mod Mod Low N/A Mod Mod EXCLUDE	
<u>Archaeological Sites</u> with 10m buffer	Exclude	Scheduled Ancient Monuments
<u>Current land use (agricultural)</u> Organic ELS & HLS Non Organic ELS / HLS Improved Grassland Arable Field Margins	<u>Weighted</u> Mod Mod High Low	ESS Merged Sussex
<u>River at high risk of pollution</u> High and moderate risk Low and no risk	<u>Weighted</u> 9 1	Water Framework Directive – Risk of diffuse pollution categories

Soils weightings for NSRI soils data

Geology	SIMPLEDESC	DOM_SOILS	RB	BR FEN	BP FEN	WW	SPTP	PMGRP	LM	CFPGM	SM
Aeolian silty drift	Deep silty	Deep, stoneless, well drained, affected by groundwater, over gravels locally	5	1	1	5	5	5	5	5	1
Aeolian silty drift	Seasonally wet deep loam	Deep, stoneless, silty, variably affected by groundwater	9	5	2	9	5	5	9	9	5
Chalk	Shallow silty over chalk	Shallow, well drained, calc soils over chalk. Often on steep land.	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex
Chalk	Clayey over chalk	Well drained calc clayey and fine silty soil over clay / chalk	1	1	1	1	Ex	Ex	1	Ex	Ex
Chalk and clay-with-flints	Shallow silty over chalk	Shallow, well drained, silty soils over chalk	1	1	1	1	Ex	Ex	1	Ex	Ex
Chalky drift and chalk	Silty over chalk	Well drained, calc, fine silty soils over chalk	Ex	1	1	1	Ex	Ex	1	Ex	Ex
Cretaceous and Jurassic loam and sand	Loam over sandstone	Well drained coarse loamy and sandy soils over sands and sandstones	Ex	1	2	1	1	1	2	1	Ex
Cretaceous and Jurassic siltstone and sandstone	Silty over sandstone	Silty soils over siltstone with slowly permeable subsoils and slight seasonal waterlogging	2	2	1	4	5	5	5	4	Ex
Cretaceous and Tertiary sand	Sandy over sandstone	Well drained soils, over soft rock, mainly on heaths and often acid	Ex	1	4	2	2	2	1	Ex	Ex
Cretaceous loam	Loam over sandstone	Well drained coarse and fine loamy soils over interbedded sands and sandstones	Ex	1	3	1	2	2	2	1	Ex
Cretaceous sandstone	Loam over sandstone	Fine loamy soils over sandstone with slowly permeable sub soils and slight seasonal waterlogging	2	3	6	5	5	5	6	2	Ex
Drift over Cretaceous clay and sandstone	Seasonally wet loam to clayey over shale	Slowly permeable seasonally waterlogged fine loamy over clayey, fine silty over clayey and clayey soils locally reddish	3	5	3	9	5	3	5	9	4
Drift over Cretaceous clay or mudstone	Seasonally wet loam to clayey over shale	Slowly permeable seasonally waterlogged fine silty over clayey, fine loamy over clayey and clayey soils	3	4	3	9	4	2	5	9	5
Drift over Jurassic and Cretaceous clay or mudstone	Seasonally wet silty to clayey over shale	Slowly permeable seasonally waterlogged fine loamy over clayey, fine silty over clayey and clayey soils	2	4	2	8	5	3	4	9	5
Drift over tertiary clay	Seasonally wet loam to clayey over shale	Slowly permeable seasonally waterlogged fine loamy over clayey and fine silty over clayey soils assoc with similar clayey soils	3	5	3	9	4	2	5	9	5
Dune Sand & marine shingle		Mainly deep, well drained calc and non calc sandy soils	1	Ex	Ex	Ex	Ex	Ex	Ex	Ex	4
Fen peat	Peat	Deep peat soils	9	7	9	5	1	1	5	6	Ex
Flinty silty drift	Deep silty to clay	Well drained fine silty and fine silty over clayey soils	1	Ex	Ex	2	2	1	2	2	Ex
Jurassic and Cretaceous	Seasonally wet deep clay	Slowly permeable seasonally waterlogged clayey	3	2	1	5	3	3	3	5	1

clay		soils with similar fine loamy over clayey soils									
Jurassic and Cretaceous siltstone and sandstone	Silty over sandstone	Deep well drained silty soils some over soft rock	Ex	1	2	2	1	1	2	Ex	Ex
Marine alluvium	Seasonally wet deep clay	Deep stoneless calcareous clayey and fine silty soils	9	2	1	5	4	3	5	9	9
Marine and river terrace gravel	Deep loam over gravel	Well drained fine loamy soils often over gravel assoc with .	6	2	1	3	4	1	7	5	2
Mesozoic and Tertiary sand and loam	Loam over sandstone	Deep well drained often stoneless coarse loamy and sandy soils	Ex	1	3	1	2	2	2	Ex	Ex
Mesozoic and Tertiary sands	Deep sandy	Deep well drained sandy and coarse loamy soils	Ex	1	3	1	2	2	2	Ex	Ex
Lake or water body			4	4	4	4	1	Ex	Ex	Ex	Ex
Sea			Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	1
Plateau drift and clay-with-flints	Deep silty to clay	Well drained fine silty over clayey, clayey and fine silty soils	1	1	1	2	1	1	2	1	Ex
River alluvium	Seasonally wet deep clay	Stoneless, clayey, fine silty and fine loamy soils affected by groundwater	9	3	1	5	4	5	4	9	9
River terrace drift	Seasonally wet deep loam	Deep fine loamy and fine loamy over sandy soils variably affected by groundwater	9	4	6	5	8	9	7	9	8
River terrace drift	Deep loam	Deep permeable mainly fine loamy soils variably affected by groundwater	9	3	2	5	6	5	7	9	9

Weighting between soils for waterlogging

Geology	SIMPLEDESC	DOM_SOILS	Weighting / Waterlogging
Aeolian silty drift	Deep silty	Deep, stoneless, well drained, affected by groundwater, over gravels locally	3
Aeolian silty drift	Seasonally wet deep loam	Deep, stoneless, silty, variably affected by groundwater	4
Chalk	Shallow silty over chalk	Shallow, well drained, calc soils over chalk. Often on steep land.	Ex
Chalk	Clayey over chalk	Well drained calc clayey and fine silty soil over clay / chalk	1
Chalk and clay-with-flints	Shallow silty over chalk	Shallow, well drained, silty soils over chalk	1
Chalky drift and chalk	Silty over chalk	Well drained, calc, fine silty soils over chalk	1
Cretaceous and Jurassic loam and sand	Loam over sandstone	Well drained coarse loamy and sandy soils over sands and sandstones	2
Cretaceous and Jurassic siltstone and sandstone	Silty over sandstone	Silty soils over siltstone with slowly permeable subsoils and slight seasonal waterlogging	4
Cretaceous and Tertiary sand	Sandy over sandstone	Well drained soils, over soft rock, mainly on heaths and often acid	1
Cretaceous loam	Loam over sandstone	Well drained coarse and fine loamy soils over interbedded sands and sandstones	1
Cretaceous sandstone	Loam over sandstone	Fine loamy soils over sandstone with slowly permeable sub soils and slight seasonal waterlogging	4
Drift over Cretaceous clay and sandstone	Seasonally wet loam to clayey over shale	Slowly permeable seasonally waterlogged fine loamy over clayey, fine silty over clayey and clayey soils locally reddish	5
Drift over Cretaceous clay or mudstone	Seasonally wet loam to clayey over shale	Slowly permeable seasonally waterlogged fine silty over clayey, fine loamy over clayey and clayey soils	5
Drift over Jurassic and Cretaceous clay or mudstone	Seasonally wet silty to clayey over shale	Slowly permeable seasonally waterlogged fine loamy over clayey, fine silty over clayey and clayey soils	5
Drift over tertiary clay	Seasonally wet loam to clayey over shale	Slowly permeable seasonally waterlogged fine loamy over clayey and fine silty over clayey soils assoc with similar clayey soils	5
Dune Sand & marine shingle		Mainly deep, well drained calc and non calc sandy soils	1
Fen peat	Peat	Deep peat soils	9
Flinty silty drift	Deep silty to clay	Well drained fine silty and fine silty over clayey soils	2
Jurassic and Cretaceous clay	Seasonally wet deep clay	Slowly permeable seasonally waterlogged clayey soils with similar fine loamy over clayey soils	7
Jurassic and Cretaceous siltstone and sandstone	Silty over sandstone	Deep well drained silty soils some over soft rock	1
Marine alluvium	Seasonally wet deep clay	Deep stoneless calcareous clayey and fine silty soils	6
Marine and river terrace gravel	Deep loam over gravel	Well drained fine loamy soils often over gravel assoc with ..	3
Mesozoic and Tertiary sand and loam	Loam over sandstone	Deep well drained often stoneless coarse loamy and sandy soils	2
Mesozoic and Tertiary sands	Deep sandy	Deep well drained sandy and coarse loamy soils	2
Sea			Ex
Plateau drift and clay-with-flints	Deep silty to clay	Well drained fine silty over clayey, clayey and fine silty soils	3
River alluvium	Seasonally wet deep clay	Stoneless, clayey, fine silty and fine loamy soils affected by groundwater	7
River terrace drift	Seasonally wet deep loam	Deep fine loamy and fine loamy over sandy soils variably affected by groundwater	7
River terrace drift	Deep loam	Deep permeable mainly fine loamy soils variably affected by groundwater	7

Appendix 4: Weighting between parameters

Coastal Flood Plain Grazing Marsh

Stage 3

Variable	Variable weighting	Group	Group Weighting	Overall Weighting
Slope	0.5	Topography	0.25	0.125
Altitude	0.5			0.125
Within flood zone 3	0.175			0.025
Within flood zone 2	0.1			0.0125
Groundwater flood areas	0.1			0.0125
Proximity to river	0.1			0.03125
Compound topographic index of wetness	0.1			0.025
Salinity	0.1			0.04375
Presence of springs	0.075	Hydrology/wetness	0.25	0.04375
Presence of ditch drainage	0.125			0.0125
Presence of running water	0.05			0.0125
Presence of standing water	0.075			0.03125
Soil type	1	Soils and geology	0.2	0.2
Suitability for agricultural cultivation	0.25			0.1
Likelihood of past function as C&FGM	0.25	Habitat	0.3	0.1
Existing Habitat	0.5			0.1
TOTAL			**1**	**1**

Stage 5

Variable	Variable weighting	Group	Group Weighting	Overall Weighting
Size of potential habitat	0.3			0.05
Proximity to same habitat	0.2	*Connectivity*	0.2	0.08
Proximity to other BAP habitat	0.5			0.07
River catchment flood risk	0.15			0.04375
Agri environment scheme (ESS)	0.2		0.25	0.04375
Within designated site	0.2	*Selection / optimisation*		0.0875
SSSI Condition	0.15			0.0375
Proximity to designated site	0.3			0.0375
Archaeology (SAMS)	0.6		0.1	0.06
Presence of invasive species	0.4	*Restrictions*		0.04
Stage 3 score	1	*Stage 3 influence*	0.45	0.45
TOTAL			**1**	**1**

Lowland Fen (Base Poor)

Stage 3				
Variable	**Variable weighting**	**Group**	**Group Weighting**	**Overall Weighting**
Slope	0.6	Topography		0.09
Altitude	0.4		0.175	0.085
Flood zone 3	0.04			0.015
Flood zone 2	0.06			0.015
Groundwater flood areas	0.125	Hydrology/wetness		0.06
Proximity to river	0.025			0.0075
Areas with impeded drainage	0.15			0.06
CTI of wetness	0.075			0.0225
Water flow	0.1		0.4	0.03
Salinity	0.1			0.06
Presence of ditch drainage	0.05			0.015
Presence of springs	0.125			0.06
Presence of standing water	0.1			0.04
Presence of running water	0.05			0.015
Soil type	0.6	Soils and geology	0.25	0.15
Geology	0.4			0.1
Suitability for agricultural cultivation	0.3	Habitat	0.175	0.075
Existing habitat	0.7			0.1
TOTAL			**1**	**1**

Stage 5

Variable	**Variable weighting**	**Group**	**Group Weighting**	**Overall Weighting**
Size of potential habitat	0.2			0.05
Proximity to same habitat type	0.5	*Connectivity*	0.25	0.125
Proximity to other BAP habitat	0.3			0.075
River catchment flood risk	0.1			0.04
Agri environment scheme	0.1			0.04
Presence of greensand streams	0.2			0.06
Within designated site	0.25	*Selection / optimisation*	0.25	0.06
SSSI condition	0.2			0.025
Proximity to designated site	0.15			0.025
Archaeology (SAMS)	0.25			0.0225
Presence of invasive spp	0.25	*Restrictions*	0.2	0.0525
Risk of pollution	0.5			0.125
Stage 3 score	1	*Stage 3 influence*	0.3	0.3
TOTAL			**1**	**1**

Lowland Fen (Base Rich)

Stage 3

Variable	Variable weighting	Group	Group Weighting	Overall Weighting
Slope	0.6	Topography		0.12
Altitude	0.4		0.2	0.08
Flood zone 3	0.05			0.015
Flood zone 2	0.1			0.025
Groundwater flood areas	0.15			0.065
Proximity to river	0.025			0.005
CTI of wetness	0.15	Hydrology/wetness		0.065
Water flow	0.1			0.0275
Salinity	0.075			0.025
Presence of ditch drainage	0.05		0.35	0.02
Presence of springs and groundwater	0.15			0.05
Presence of standing water	0.075			0.0375
Presence of running water	0.075			0.015
Soil type	0.4	Soils and geology	0.25	0.11
Geology	0.6			0.14
Suitability for agricultural cultivation	0.3	Habitat	0.2	0.05
Existing habitat	0.7			0.15
TOTAL			**1**	**1**

Stage 5

Variable	Variable weighting	Group	Group Weighting	Overall Weighting
Size of potential habitat	0.2			0.05
Proximity to same habitat type	0.5	*Connectivity*	0.25	0.125
Proximity to other BAP habitat	0.3			0.075
River catchment flood risk	0.15			0.0225
Agri environment scheme	0.2			0.01
Presence of chalk streams	0.2			0.025
Within designated site	0.2		0.15	0.025
SSSI condition	0.15	*Selection / optimisation*		0.0525
Proximity to designated site	0.1			0.015
Archaeology (SAMS)	0.25			0.0625
Presence of invasive species	0.25	*Restrictions*	0.25	0.0625
Risk of pollution	0.5			0.125
Stage 3 score	1	*Stage 3 influence*	0.35	0.35
TOTAL			**1**	**1**

Lowland wet meadow

Stage 3

Variable	Variable weighting	Group	Group Weighting	Overall Weighting
Slope	0.6	*Topography*	0.25	0.15
Altitude	0.4			0.1
Within flood zone 3	0.05			0.02
Within flood zone 2	0.1			0.025
Groundwater flood areas	0.1			0.03
Proximity to river	0.2			0.03
CTI of wetness	0.2	*Hydrology/wetness*	0.25	0.03
Salinity	0.05			0.03
Presence of springs	0.1			0.025
Presence of ditch drainage	0.05			0.02
Presence of standing water	0.075			0.02
Presence of running water	0.075			0.02
Soil type	1	*Soils and geology*	0.3	0.3
Suitability for agricultural cultivation	0.4	*Habitat*	0.2	0.1
Existing habitats	0.6			0.1
TOTAL			**1**	**1**

Stage 5

Variable	Variable weighting	Group	Group Weighting	Overall Weighting
River catchment flood risk	0.1			0.05
Size of potential habitat	0.3			0.09
Proximity to same habitat type	0.4	*Connectivity*	0.3	0.1
Proximity to other BAP habitat	0.2			0.06
Agri environment scheme	0.4			0.075
Within designated site	0.3	*Selection / optimisation*	0.2	0.055
SSSI condition	0.1			0.025
Proximity to designated site	0.2			0.045
Archaeology (SAMS)	0.25	*Restrictions*	0.2	0.05
Presence of invasive spp	0.25			0.05
Risk of pollution	0.5			0.1
Stage 3 score	1	*Stage 3 influence*	0.3	0.3
TOTAL			**1**	**1**

Purple Moor Grass and Rush Pasture

Stage 3

Variable	**Variable weighting**	**Group**	**Group Weighting**	**Overall Weighting**
Slope	0.5	*Topography*	0.2	0.1
Altitude	0.5			0.1
Within flood zone 3	0.125			0.03
Within flood zone 2	0.1			0.0225
Groundwater flood area	0.075			0.0125
Proximity to river	0.075			0.0325
CTI of wetness	0.125	*Hydrology/wetness*		0.0475
Salinity	0.125		0.3	0.0375
Presence of ditch drainage	0.075			0.015
Presence of springs	0.125			0.0375
Presence of standing water	0.125			0.0375
Presence of running water	0.05			0.0275
Soil type	1	*Soils and geology*	0.3	0.3
Suitability for agricultural cultivation	0.4			
Existing habitat	0.4	*Habitat*	0.2	0.2
Historic flood zone	0.2			
TOTAL			**1**	**1**

Stage 5

Variable	**Variable weighting**	**Group**	**Group Weighting**	**Overall Weighting**
River catchment flood risk	0.1			0.025
Size of potential habitat	0.2			0.05
Proximity to same habitat type	0.3	*Connectivity*	0.25	0.075
Proximity to other BAP habitat	0.1			0.025
Proximity to rush & PMG records	0.3			0.075
Agri environment scheme	0.3			0.09
Within designated site	0.4		0.275	0.0825
SSSI condition	0.1	*Selection / optimisation*		0.03
Proximity to designated site	0.2			0.0725
Archaeology (SAMS)	0.6	*Restrictions*	0.1	0.04
Presence of invasive spp	0.4			0.06
Stage 3 score	1	*Stage 3 influence*	0.375	0.375
TOTAL			**1**	**1**

Reedbeds

Stage 3

Variable	**Variable weighting**	**Group**	**Group Weighting**	**Overall Weighting**
Slope	0.6	*Topography*	0.3	0.17
Altitude	0.4			0.13
Within flood zone 3	0.125			0.0325
Within flood zone 2	0.075			0.0125
Groundwater flood area	0.175			0.035
Proximity to river	0.05			0.02
CTI of wetness	0.175	*Hydrology/wetness*	0.25	0.035
Water flow (speed of)	0.1			0.02
Presence of ditch drainage	0.05			0.01
Presence of Chalk streams	0.075			0.0125
Presence of G'sand streams	0.075			0.0125
Presence of standing water	0.025			0.025
Presence of running water	0.075			0.035
Soil type	1	*Soils and geology*	0.3	0.3
Suitability for agricultural cultivation	0.4	*Habitat*	0.15	0.06 0.07
Existing habitat	0.5			
Historic flood zone	0.1			0.02
TOTAL			1	1

Stage 5

Variable	**Variable weighting**	**Group**	**Group Weighting**	**Overall Weighting**
River catchment flood risk	0.2			0.05
Size of potential habitat	0.25			0.075
Proximity to same habitat	0.35	*Connectivity*	0.25	0.075
Proximity to other BAP habitat	0.2			0.05
Agri environment scheme	0.3			0.06
Within designated site	0.3	*Selection / optimisation*	0.2	0.08
SSSI Condition	0.2			0.03
Proximity to designated site	0.2			0.03
Archaeology (SAMS)	0.4	*Restrictions*		0.06
Presence of invasive species	0.5		0.15	0.075
Risk of pollution	0.1			0.015
Stage 3 score	1	*Stage 3 influence*	0.4	0.4
TOTAL			**1**	**1**

Saltmarsh

Stage 3

Variable	Variable weighting	Group	Group Weighting	Overall Weighting
Slope	0.5	*Topography*	0.25	0.125
Altitude	0.5			0.125
Within flood zone3 (**tidal**)	0.3			0.1
Proximity to river	0.3	*Hydrology/wetness*	0.25	0.05
Salinity	0.4			0.1
Soil type	1	*Soils and geology*	0.25	0.25
Suitability for agricultural cultivation	0.4	*Habitat*	0.25	0.125
Existing habitat	0.6			0.125
TOTAL			**1**	**1**

Stage 5

Variable	Variable weighting	Group	Group Weighting	Overall Weighting
River catchment flood risk	0.2			0.04
Size of potential habitat	0.3			0.06
Proximity to same habitat type	0.3	*Connectivity*	0.2	0.06
Proximity to other BAP habitat	0.2			0.04
Agri environment scheme	0.2			0.06
Within designated site	0.5	*Selection / optimisation*		0.1
SSSI condition	0.1		0.25	0.05
Proximity to designated site	0.2			0.04
Archaeology (SAMS)	0.8	*Restrictions*	0.25	0.2
Presence of invasive species	0.2			0.05
Stage 3 score	1	*Stage 3 influence*	0.3	0.3
TOTAL			**1**	**1**

Species Poor Tussocky Pasture

Stage 3

Variable	**Variable weighting**	**Group**	**Group Weighting**	**Overall Weighting**
Slope	0.4	*Topography*	0.25	0.1
Altitude	0.6			0.15
Within flood zone 3	0.15	*Hydrology/wetness*	0.25	0.0275
Within flood zone 2	0.1			0.02
Groundwater flood zone	0.15			0.0275
Proximity to river	0.1			0.025
CTI of wetness	0.15			0.04
Presence of springs	0.1			0.0375
Presence of ditch drainage	0.05			0.0175
Presence of standing water	0.15			0.03
Presence of running water	0.05			0.025
Soil type	1	*Soils and geology*	0.25	0.25
Suitability for agricultural cultivation	0.6	*Habitat*	0.25	0.15
Existing habitat	0.4			0.1
TOTAL			**1**	**1**

Stage 5

Variable	**Variable weighting**	**Group**	**Group Weighting**	**Overall Weighting**
River catchment flood risk	0.1	*Connectivity*	0.2	0.04
Size of potential habitat	0.35			0.06
Proximity to same habitat type	0.1			0.0675
Proximity to other BAP habitat	0.45			0.0325
Agri environment scheme	0.4	*Selection / optimisation*	0.3	0.1
Within designated site	0.3			0.075
SSSI Condition	0.1			0.05
Proximity to designated site	0.2			0.075
Archaeology (SAMS)	0.4	*Restrictions*	0.125	0.05
Presence of invasive species	0.6			0.075
Stage 3 score	1	*Stage 3 influence*	0.375	0.375
TOTAL			**1**	**1**

Wet Woodland

Stage 3

Variable	Variable weighting	Group	Group Weighting	Overall Weighting
Slope	0.5	*Topography*	0.1	0.05
Altitude	0.5			0.05
Within flood zone 3	0.125	*Hydrology/wetness*	0.4	0.05
Within flood zone 2	0.1			0.04
Groundwater flood zone	0.2			0.07
Proximity to river	0.05			0.03
CTI of wetness	0.225			0.07
Salinity	0.075			0.04
Water flow (speed of)	0.05			0.03
Presence of standing water	0.1			0.04
Presence of running water	0.075			0.03
Soil type	0.25	*Soils and geology*	0.3	0.07
Hydrology of soil type	0.35			0.09
Bedrock type	0.1			0.04
Areas with impeded drainage	0.3			0.1
Suitability for agricultural cultivation	0.7	*Habitat*	0.2	0.125
Existing habitat	0.3			0.075
TOTAL			**1**	**1**

Stage 5

Variable	Variable weighting	Group	Group Weighting	Overall Weighting
River catchment flood risk	0.2	*Connectivity*	0.2	0.05
Size of potential habitat	0.4			0.0725
Proximity to same habitat type	0.2			0.025
Proximity to other BAP habitat	0.2			0.0525
Agri environment scheme	0.15	*Selection / optimisation*	0.3	0.05
Presence of chalk streams	0.15			0.0275
Presence of greensand streams	0.15			0.0275
Within designated site	0.25			0.125
SSSI condition	0.1			0.05
Proximity to designated site	0.2			0.02
Archaeology (SAMS)	0.5	*Restrictions*	0.2	0.0875
Presence of invasive species	0.35			0.0675
Risk of pollution	0.15			0.045
Stage 3 score	1	Stage 3 influence	0.3	0.3
TOTAL			**1**	**1**

Appendix 5

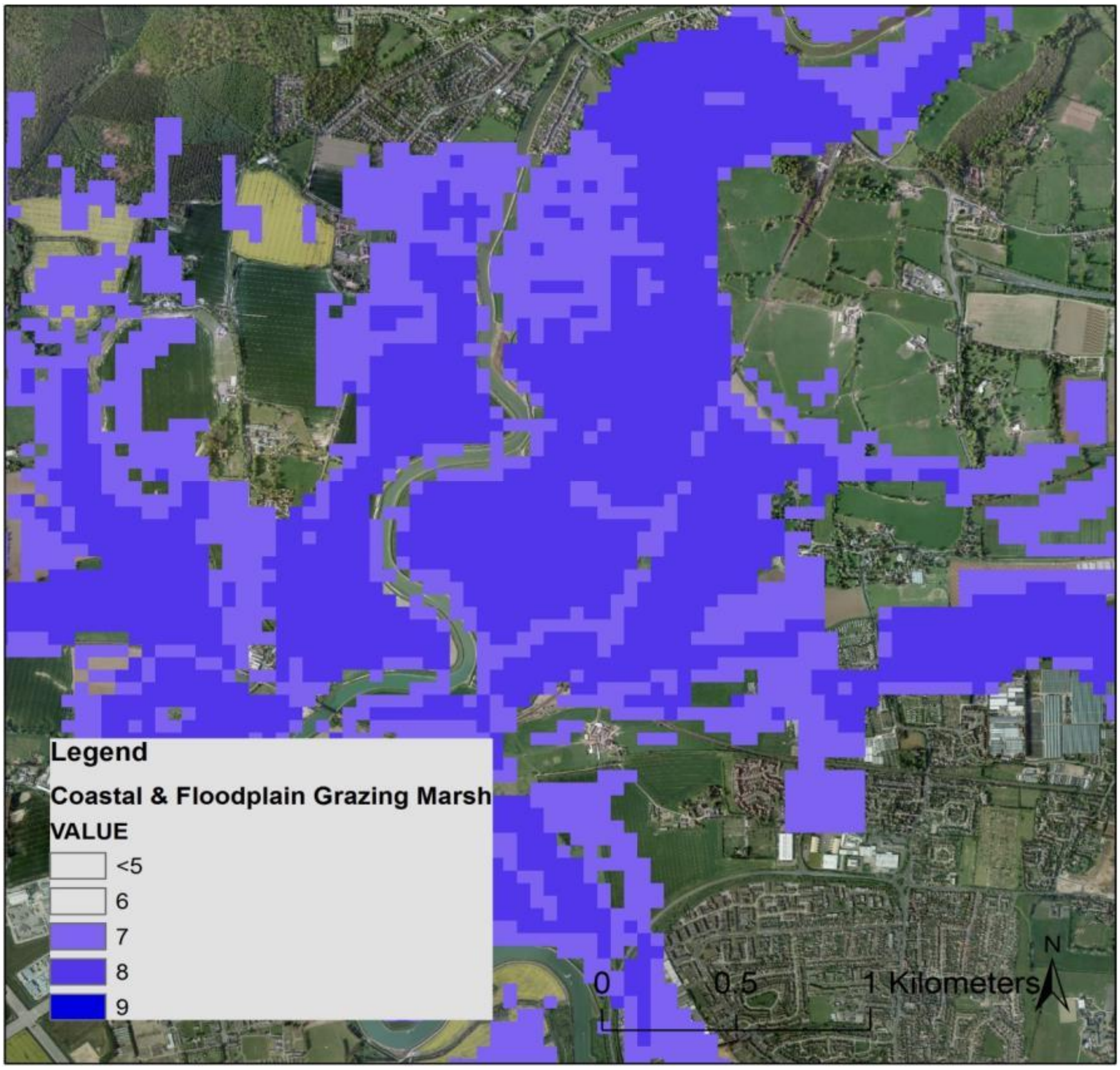


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Figure 3.13. Zooming in to the location with the most potential to restore a large area of coastal flood plain grazing marsh on landbetween Lyminster and Tortington

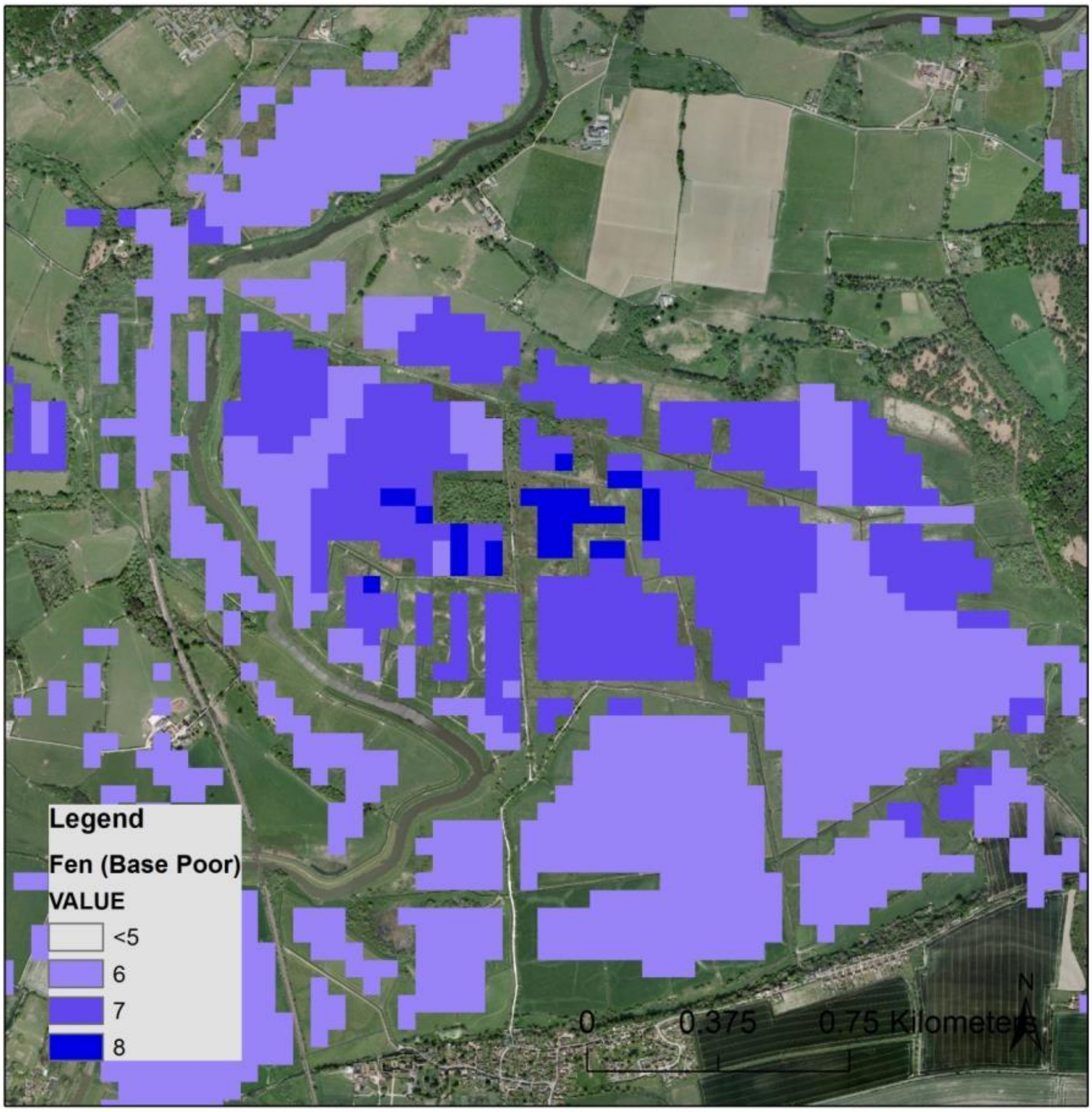


Figure 3.14. **Zooming in to the location with the most potential to restore a large area of fen (base poor). Unsurprisingly on Amberley Wildbrooks.**

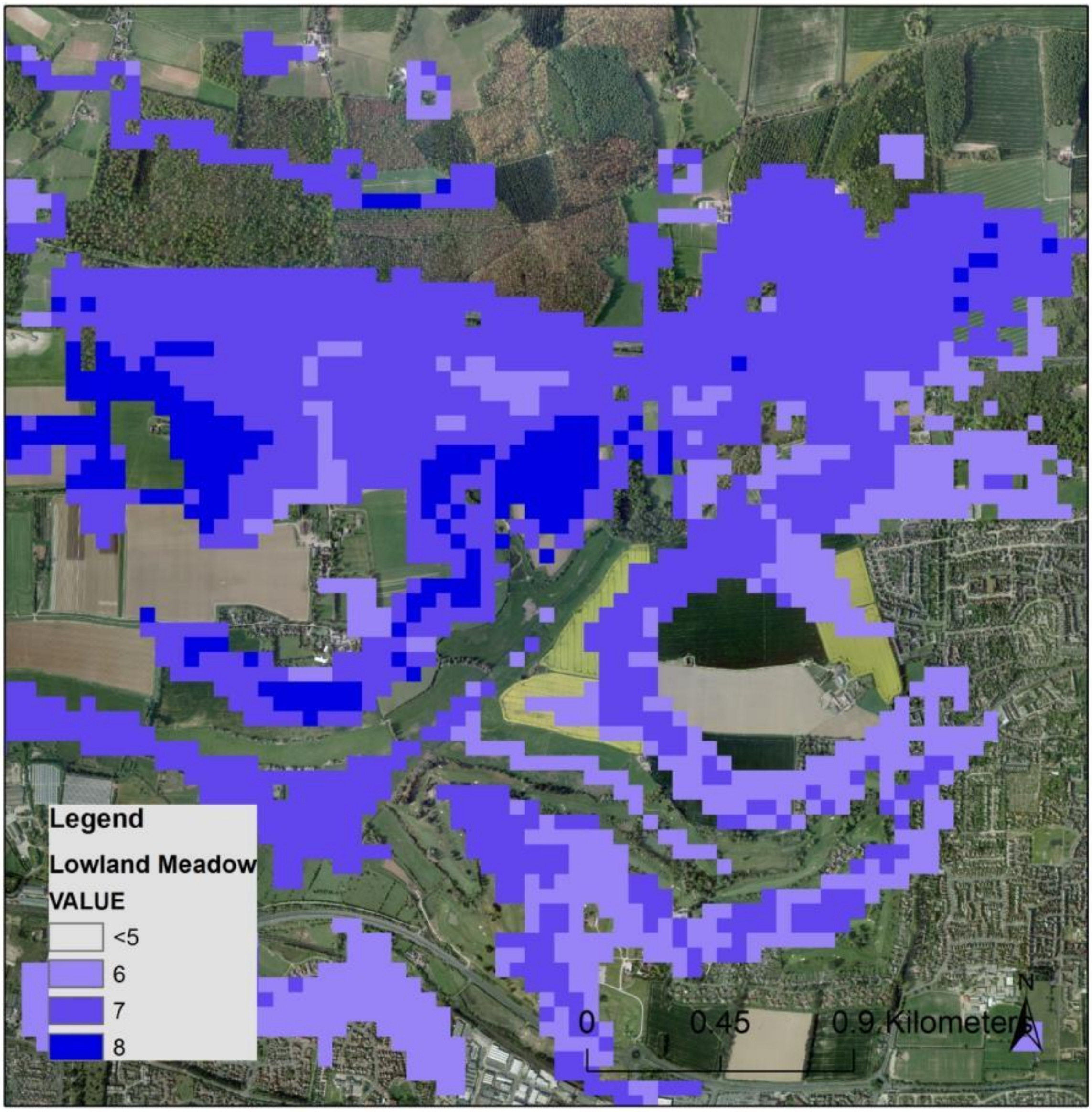


Figure 3.15. **Zooming in to the location with the most potential to restore a large area of lowland wet meadow on the Black ditch, north of Rustington**

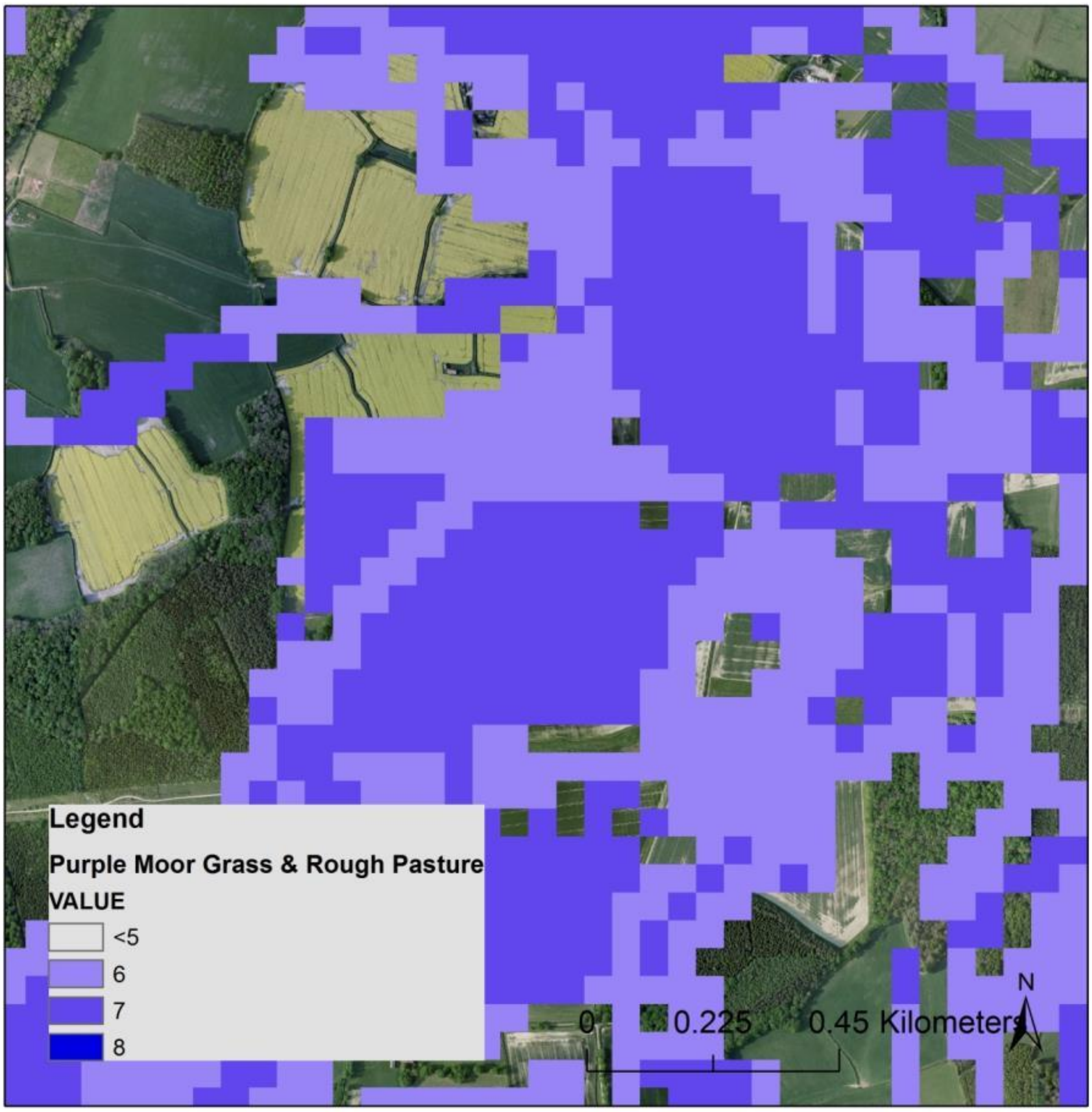


Figure 3.16. Zooming in to the location with the most potential to restore a large area of purple moor grass and rush pasture South East of Balls Cross

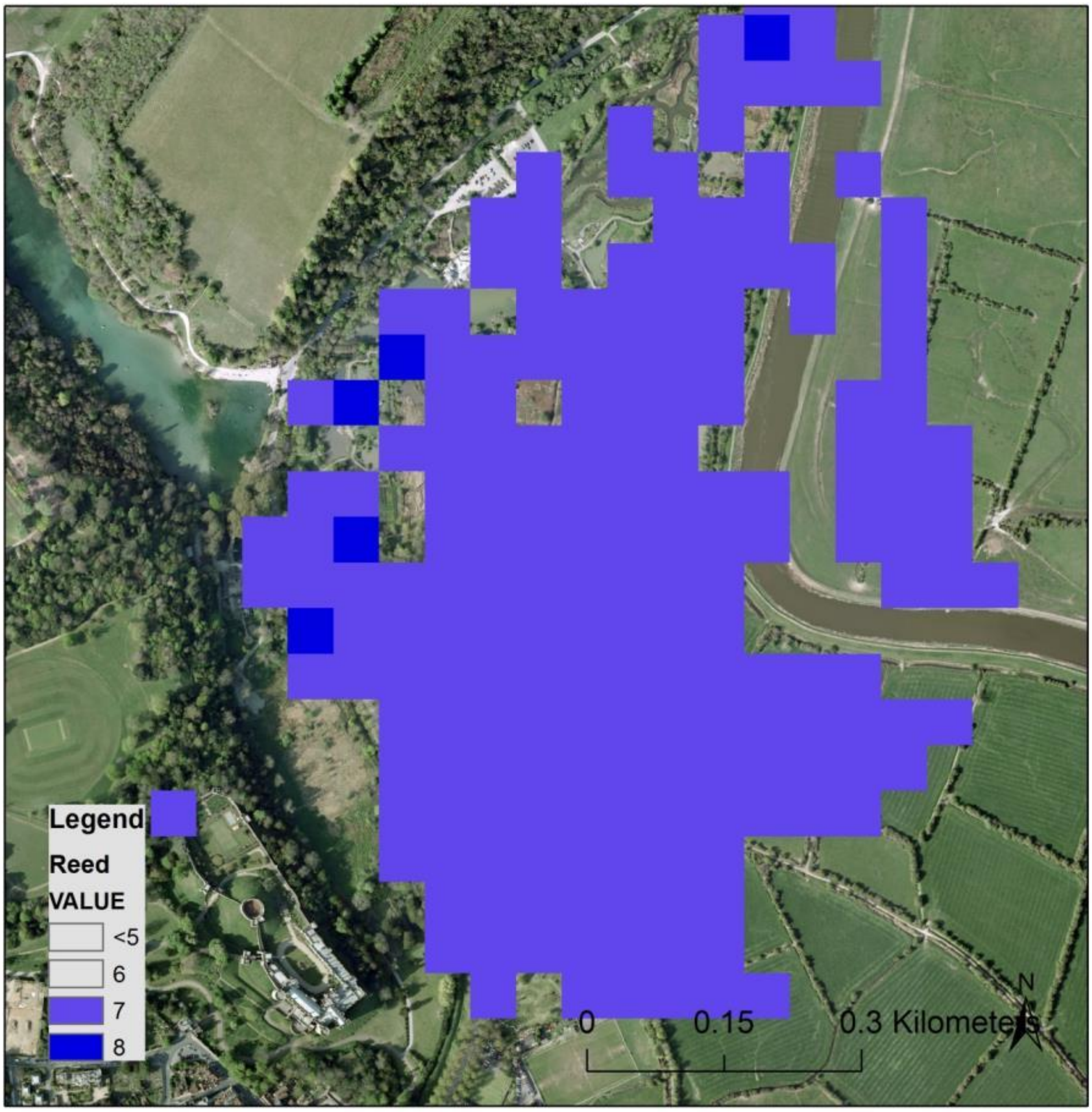


Figure 3.17. Zooming in to the location with the most potential to restore a large area of reedbed both in, and South of, the Arundel Wildfowl and Wetland Trust

Figure 3.18. Zooming in to the location with the most potential to restore a large area of saltmarsh, between Tortington and Lyminster

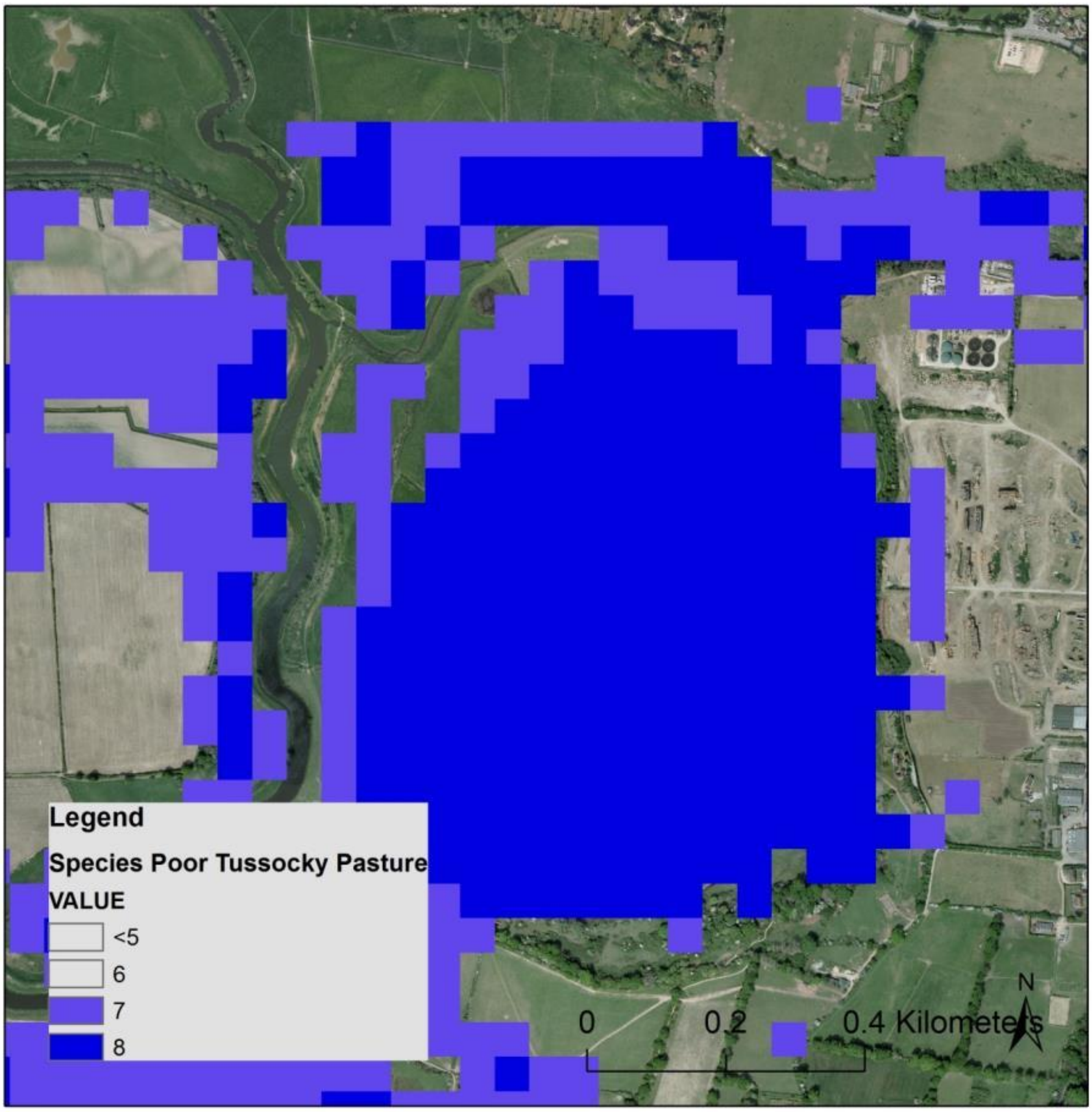


Figure 3.19. Zooming in to the location with the most potential to restore a large area of species poor tussocky pasture around Pulborough Brooks

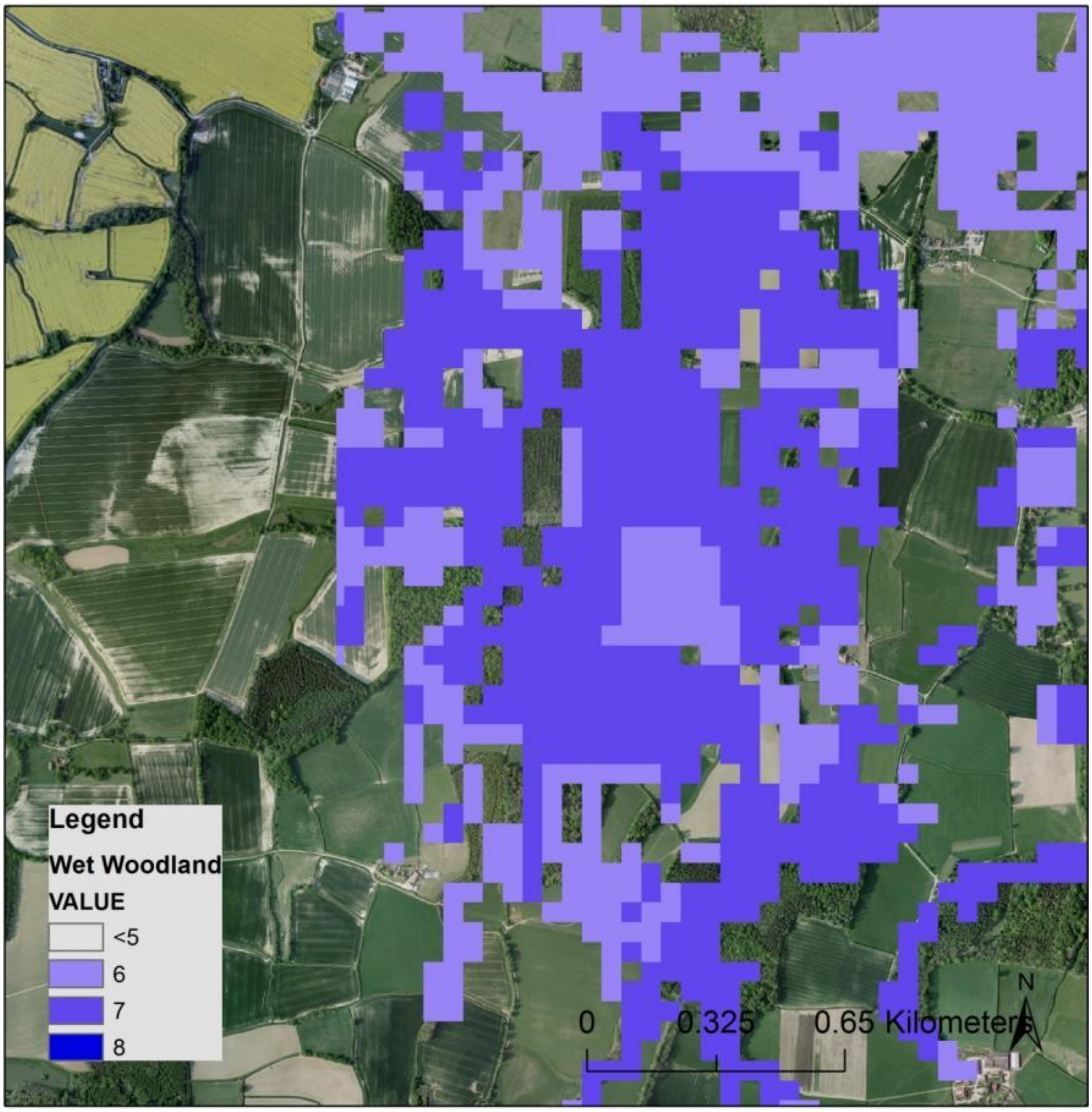


Figure 3.20. Zooming in to the location with the most potential to restore a large area of wet woodland North of Glasshouse Lane between Balls Cross and Strood Green

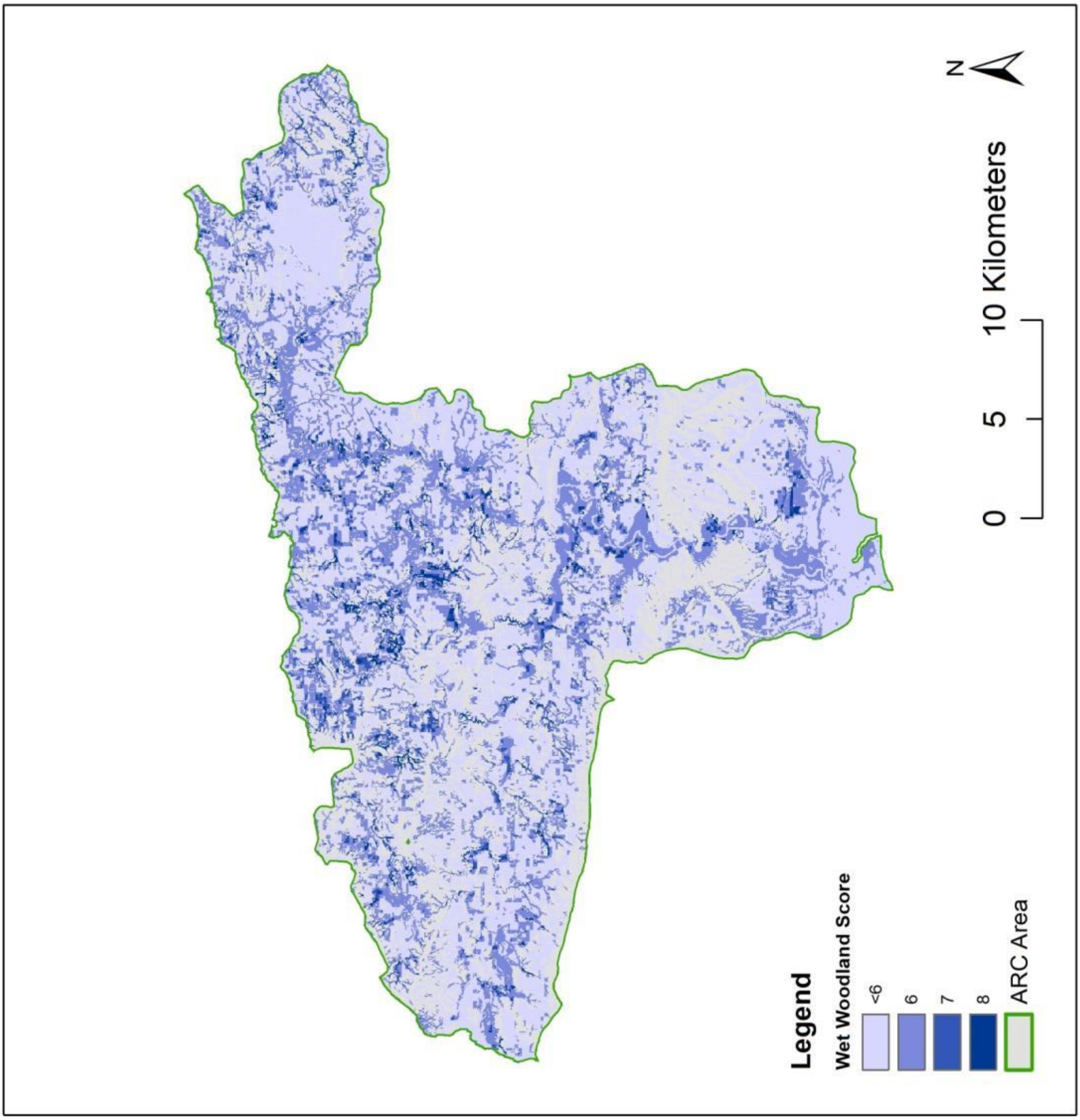
APPENDIX 6
Parameters used by Natural England in their climate change model

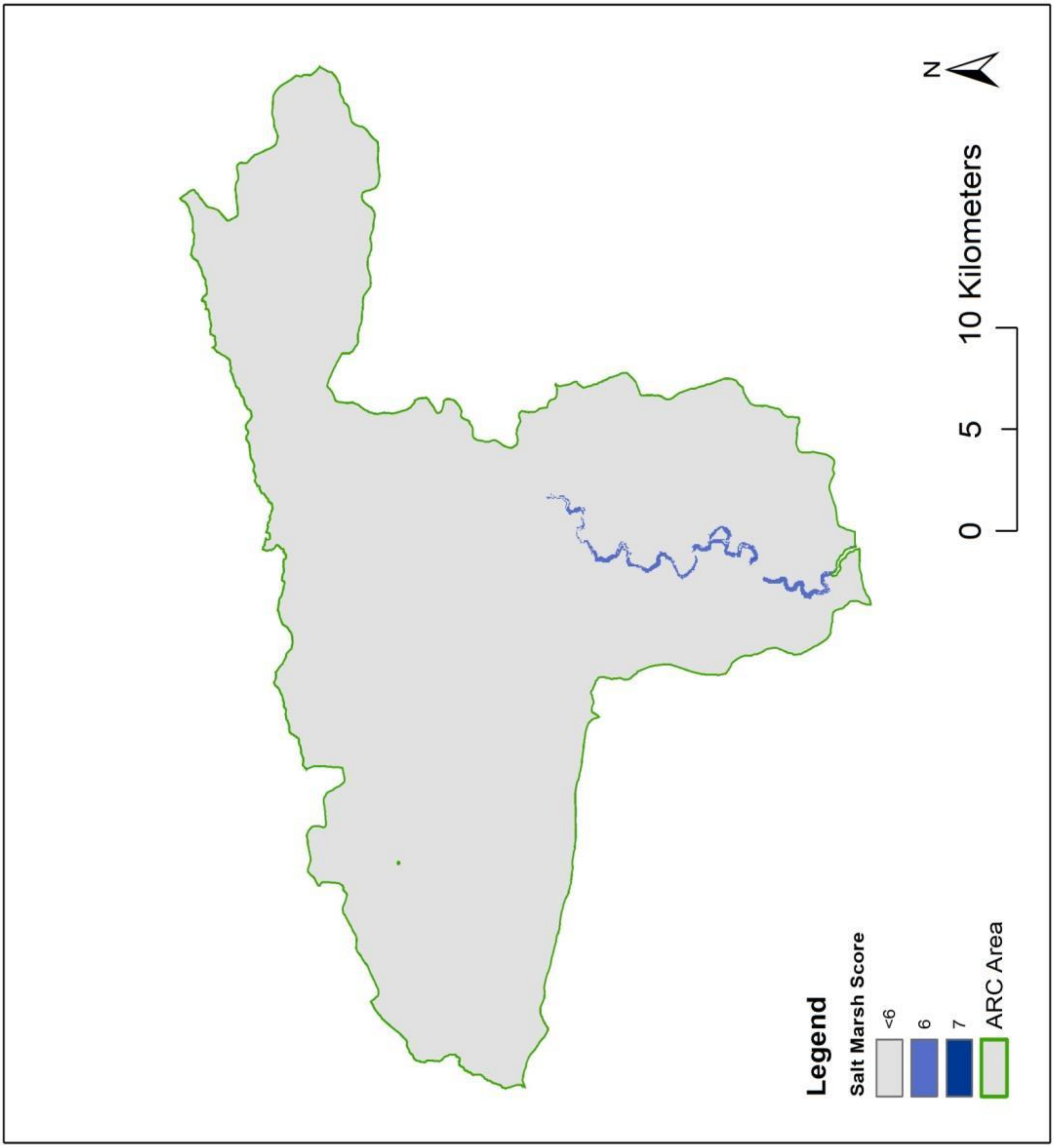
Habitat Name	Model Code	Type of ref date	Ref date	Access	Source Notes
Blanket Bog	BLB	Version	2.1	Open data	
Coastal Sand Dunes	CSD_SE	Version	1.3	Open data	South East data also integrated
Coastal Vegetated Shingle	CVS	Reference date	2008	Open data	
Mudflats	CIM	Version	1.2	Open data	
Deciduous Woodland	**DW**	**Version**	**2**	**Open data**	
Limestone Pavements	LIP	Version	1	Open data	
Lowland Calcareous Grassland	LCG	Version	2.01	Open data	South East data also integrated
Lowland Dry Acid Grassland	LAG	Version	2.01	Open data	South East data also integrated
Lowland Fens	**FEN_SE**	**Version**	**1.2**	**Open data**	**South East data also integrated**
Lowland Raised Bogs	LRB	Version	1.2	Open data	
Maritime Cliff And Slope V2 0	CCS	Version	2	Open data	
Purple Moor Grass And Rush Pasture	**PMG**	**Version**	**2.01**	**Open data**	**South East data also integrated**
Reedbeds	**RDB_SE**	**Version**	**1.2**	**Open data**	**South East data also integrated**
Saline Lagoons	CSL	Version	1.1	Open data	
Upland Calcareous Grassland	UCG	Version	2	Open data	
Upland Hay Meadows	UHM	Version	2.01	Open data	
Lowland Heathland	**LHL_SE**	**Version**	**1.2**	**Open data**	**South East data also integrated**
Upland Heathland	UHL	Version	2.1	Open data	Excluded Montane Heath polygons identified by habitat class.
Coastal Saltmarsh	**CSM**	**Dataset ref date**	**1999 – 2009**	**EA**	**Environment Agency supplied data**
Coastal Grazing Marsh	**CGM_SE**	**Version**	**1.1**	**Open data**	**Polygons with overlap with EA Tidal Flood zone 3. South East data also integrated**
Floodplain Grazing Marsh	**FGM**	**Version**	**1.1**	**Open data**	**Inverse of CGM**
Lowland Meadows	LMD	Version	2.01	Open data	Extracted by union with EA Flood zone 2. South East data also integrated
Lowland Meadows	LMW	Version	2.01	Open data	Extracted by union with Environment Agency Flood zone 2. South East data also integrated
Rivers	**RIV**	**Original supply date**	**23/05/2011**	**Open data**	**Extracted from Environment Agency Detailed River Network using lookup from JNCC**
BAP Chalk Rivers		**File date**	**15/09/2011**	**EA?**	**Used in the BAP**

Lakes	**WAT**	**Original supply date**	**23/05/2011**	**Open data**	**Environment Agency WFD Lake waterbodies with Good Ecological Status**
Montane	MTN	Version	2.1	NE	Natural England local habitat datasets for North Pennines and Lake District, plus Montane Heath habitats extracted from the Upland Heathland BAP habitat inventory by Habitat class.
SSSI	**S3I**	**Download date**	**08/09/2011**	**Open data**	
LNR	**LNR**	**Download date**	**08/09/2011**	**Open data**	
NNR	**NNR**	**Download date**	**08/09/2011**	**Open data**	
Natura 2000 sites plus Ramsar	**N2K**	**Download date**	**08/09/2011**	**Open data**	
SSSI units	**UNT**	**Download date**	**11/11/2011**	**Open data**	**Only site units in 'Favourable' or 'Unfavourable Recovering' condition were used.**
Ancient Woodland Inventory	**AWI**	**Download date**	**08/09/2011**	**Open data**	**Planted Ancient Woodland (PAWS) polygons were excluded if less than half of their area coincided with the Forestry Commission's National Forest Inventory (downloaded 21/9/11) excluding 'non-woodland' and 'low density' polygons.**
Woodland Grant Schemes	WGS	Download date	21/09/2011	Open data	WGS round 3 dataset
Agri-environment scheme beneficial options	**AGR**	**Reference date**	**22/09/2011**	**NE**	**Created from the Natural England NI197 dataset**
Water availability	CAM	Download date	13/10/2011	Open data	Environment Agency Catchment Abstraction Management Strategies – all WRMU and GWMUs with a status of 'water available' in the latest CAMS
Traditional Orchards	TOR	Download date	07/03/2011	Open data	
Water quality – terrestrial	RWQ	Reference date	06/01/2009	Open data	Environment Agency Water Framework Directive linear or lake waterbodies with an ecological status of 'Good' or 'High'
Water quality – coastal	CWQ	Reference date	06/01/2009	Open data	Environment Agency Water Framework Directive coastal or transitional waterbodies with an ecological status of 'Good' or 'High'
Land Cover Map 2007	LCM	Reference date	06/07/2011	NE	'Natural' habitats extracted from the vector version of LCM2007. The habitat classes used are listed in Appendix A
Major roads	**RD**	**Version**	**1.2 r2 2011**	**Open data**	**An extract from the Ordnance Survey OpenData Meridian 2 dataset of Motorways and dual carriageways**
Flood Zones		**Version**	**1.1.6**	**EA**	
Detailed River Network		**File date**	**01/06/2008**	**EA**	**Already had from a previous project**
WFD waterbodies		**Original supply date**	**23/05/2011**	**Open data**	
NextMap DTM		File date	01/04/2009	NE	
EA CAMS Ref boundaries		Original supply date	23/05/2011	Open data	

APPENDIX 7

Stage 6 Maps




Legend
Salt Marsh Score
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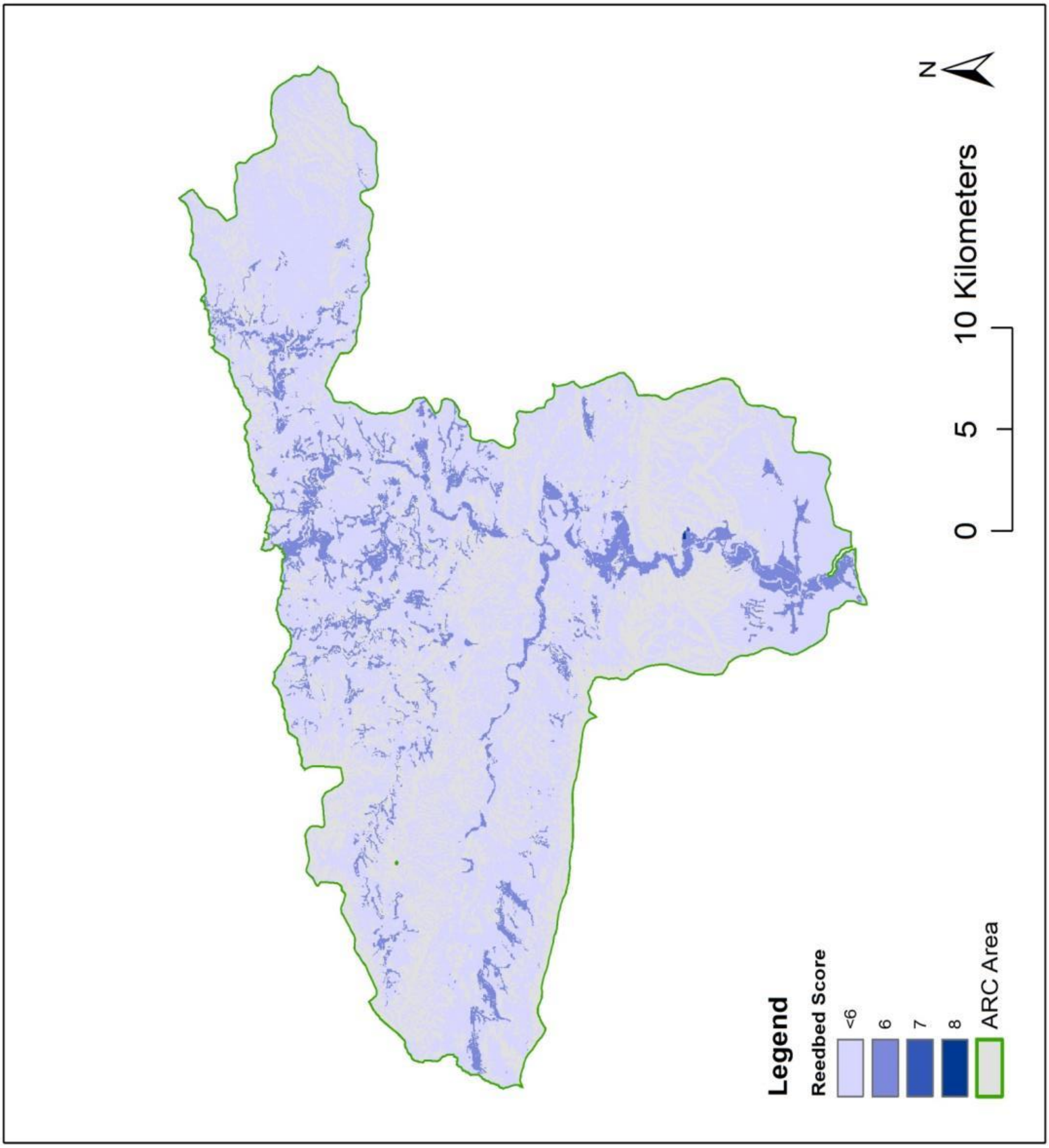
6
7
ARC Area
0
5
10 Kilometers
N


N
0
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10 Kilometers
Legend
Reedbed Score
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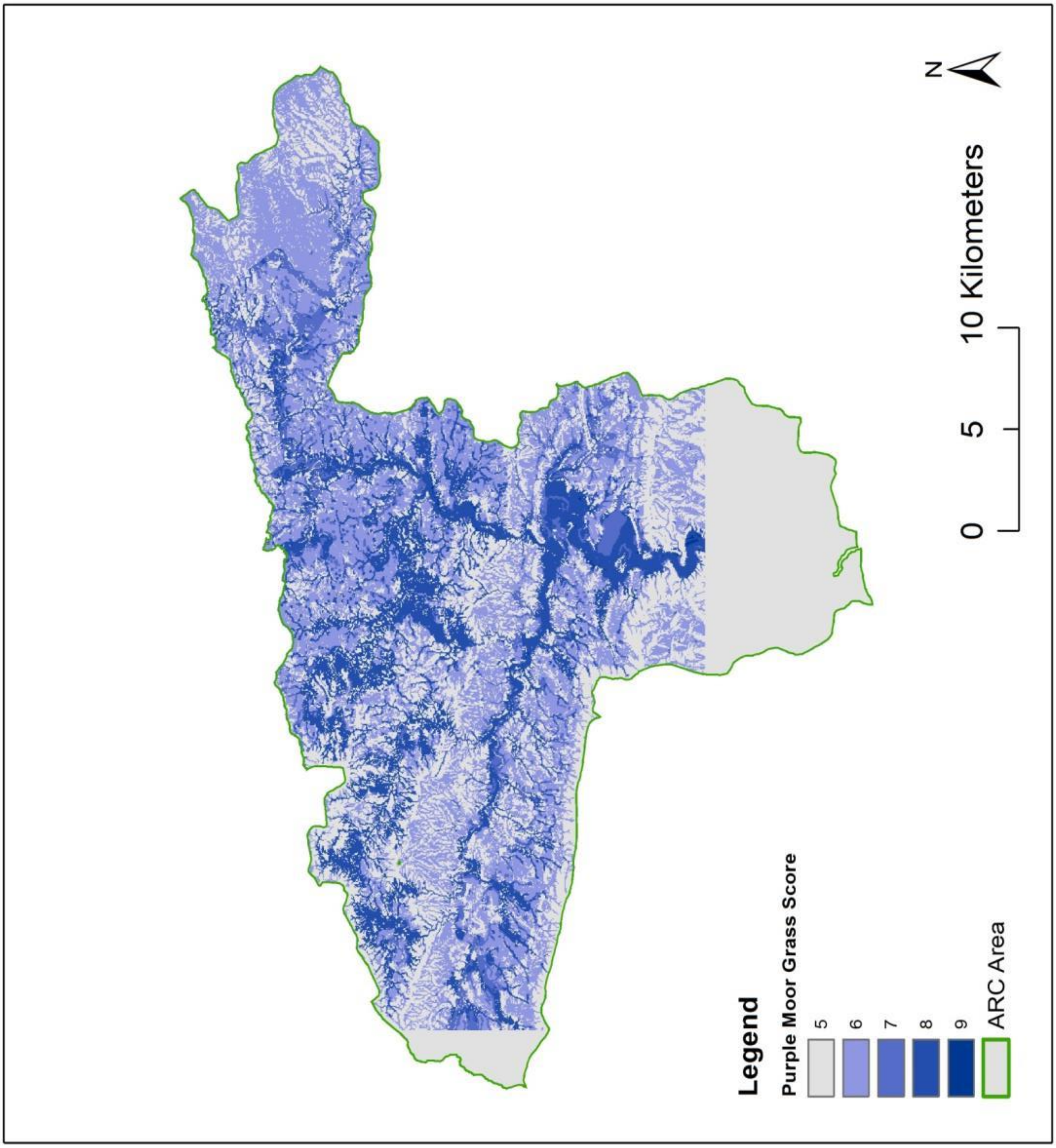
8
ARC Area


Legend
Purple Moor Grass Score
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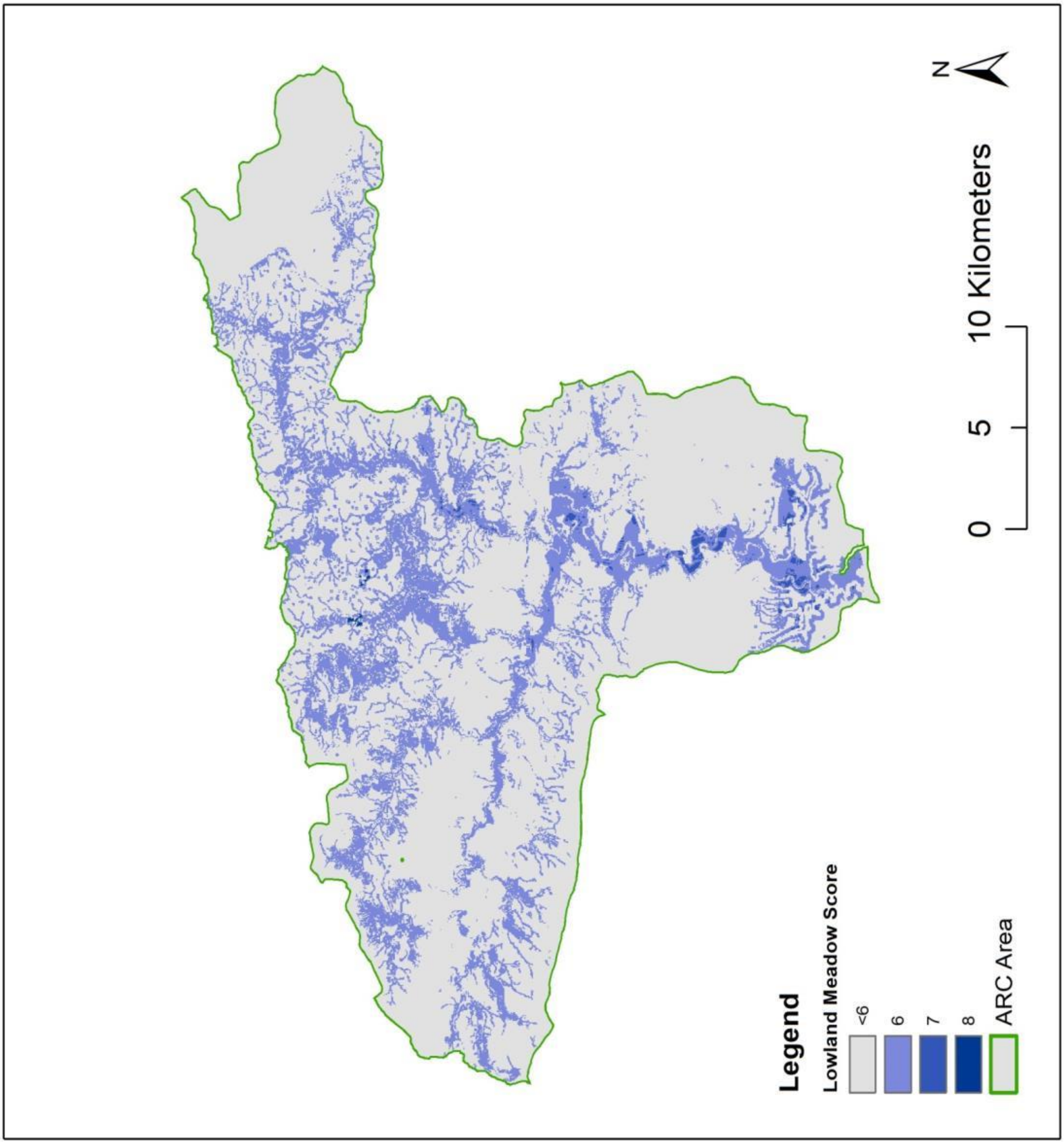
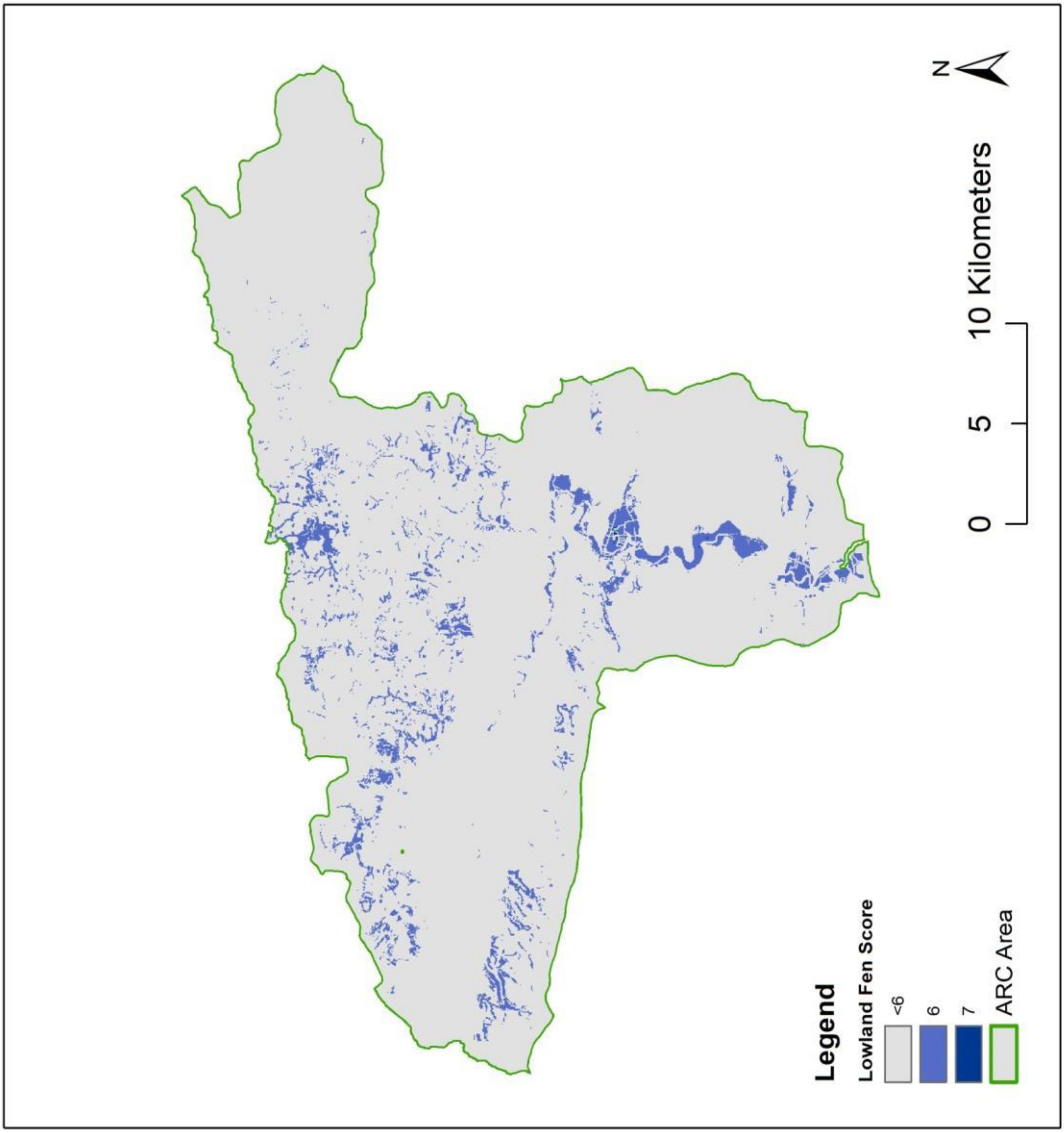
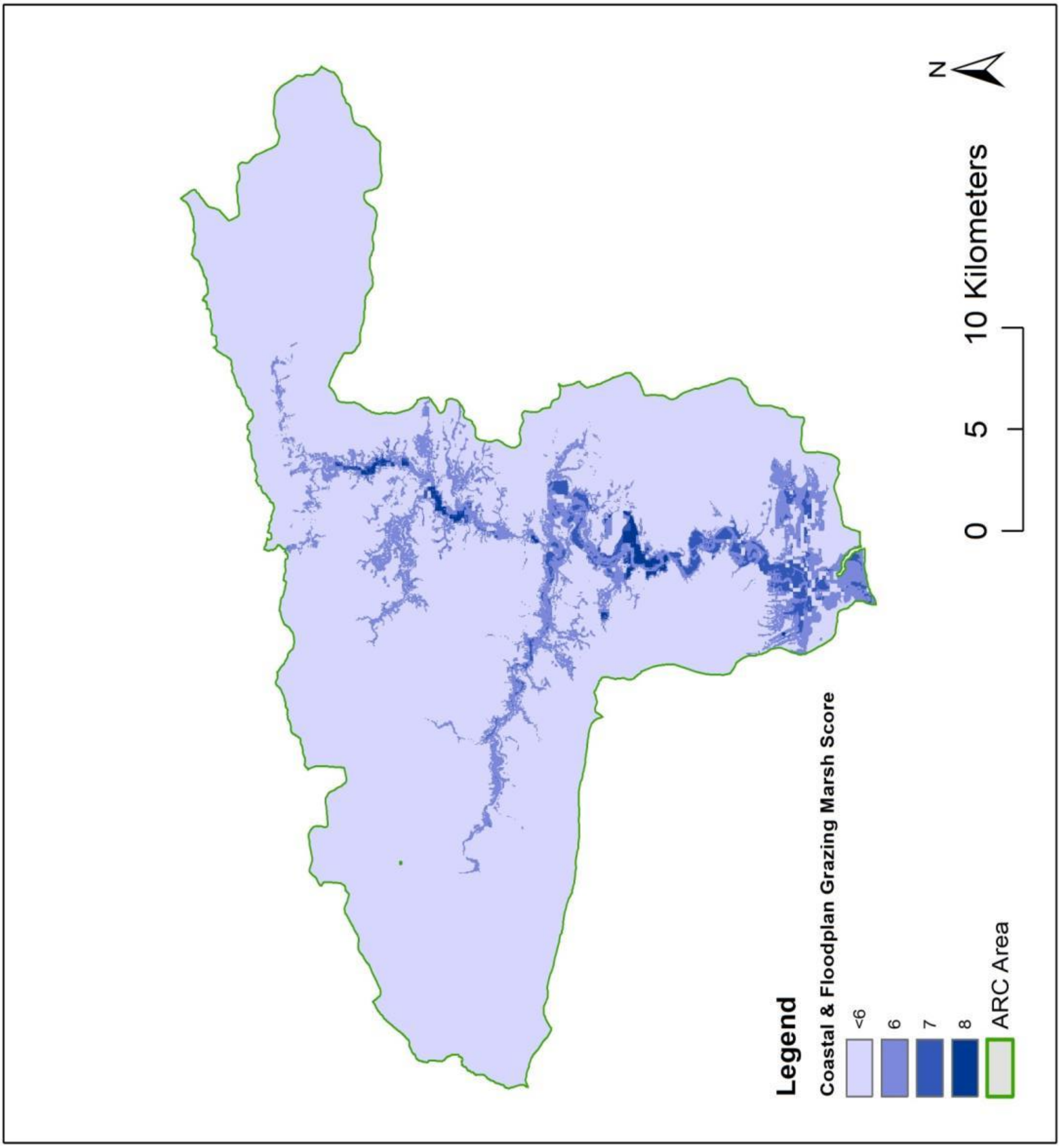
6
7
8
9
ARC Area
0
5
10 Kilometers
N


Legend
Lowland Meadow Score
<6
6
7
8
ARC Area
0 5 10 Kilometers
N


Legend
Lowland Fen Score
<6
6
7
ARC Area
0
5
10 Kilometers
N


Legend
Coastal & Floodplain Grazing Marsh Score
<6
6
7
8
ARC Area
0
5
10 Kilometers
N