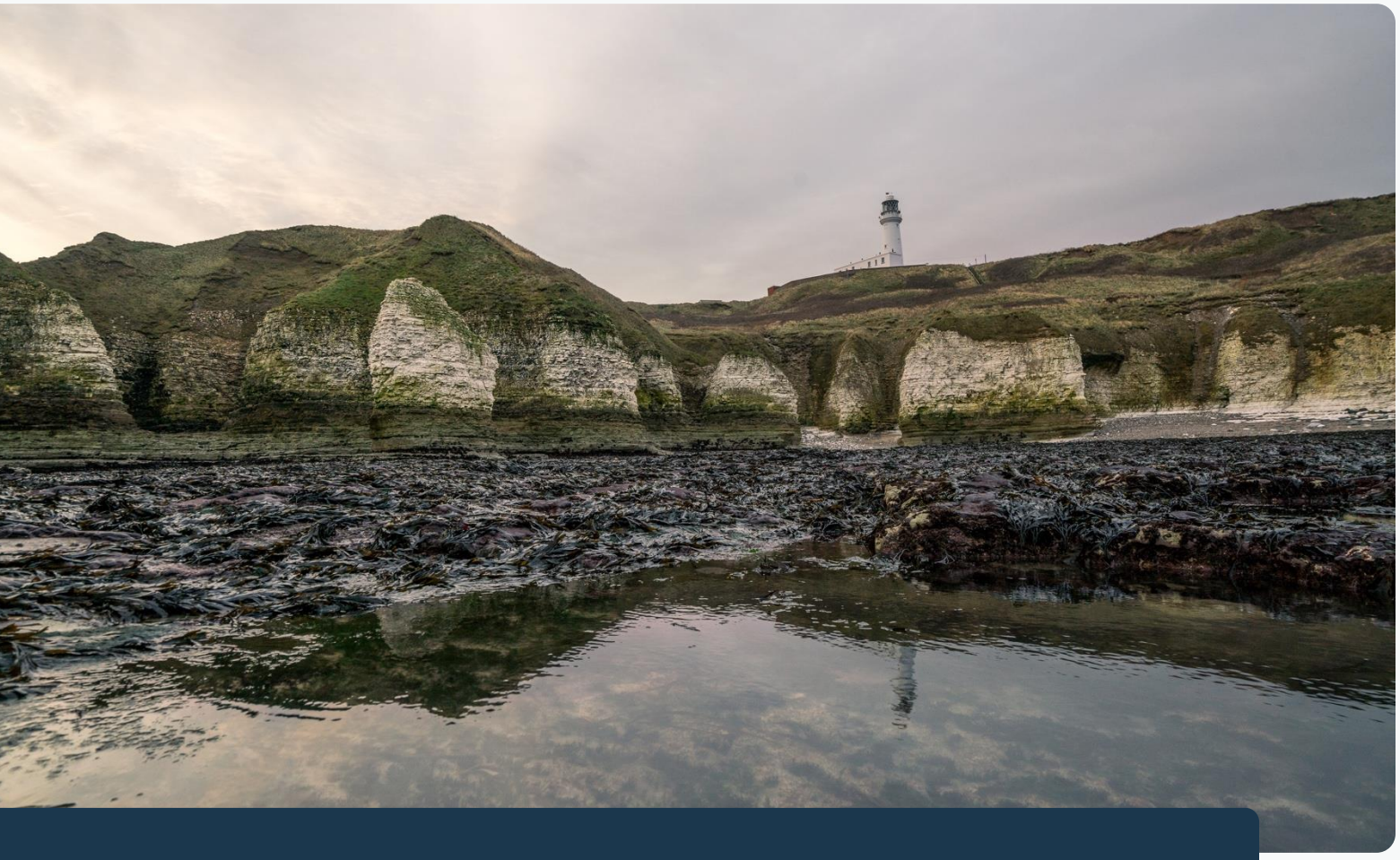

Habitat Connectivity along the Yorkshire Coast

Prepared for
National Trails UK

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NATIONAL TRAILS.UK

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Executive Summary

The Yorkshire coastline supports a diverse range of species within its vital habitats. However, coastal erosion, habitat fragmentation, and other environmental pressures threaten connectivity, restrict species' movement, and complicate future range shifts driven by climate change. These disruptions pose a significant challenge to biodiversity resilience and the ability of species to relocate in response to habitat loss.

Coastal Wildbelt, a project hosted by National Trails UK, seeks to address these critical threats while engaging the public in conservation solutions. The **Condatis model** was used to assess potential 'bottlenecks' in movement corridors to identify habitat connectivity vulnerabilities and explore improvement opportunities. This analysis was based on representative habitats and species outlined in the draft Marine Local Nature Recovery Strategy for Yorkshire (2025). The key habitat scenarios assessed include:

- Wader habitat
- Designated Seabird Breeding Cliffs
- Soft sediment habitat
- Rivers and coastal streams

Key Findings

- Wader habitat exhibited the highest number and widest distribution of severe bottlenecks. Many of these areas present opportunities for habitat expansion, particularly by creating new habitats within predicted future flood extents and enhancing foraging and breeding areas in grassland and arable land.
- Designated cliff habitats for seabirds showed weaker bottlenecks, primarily north of the main nesting sites at Bempton. These areas align with other significant nesting sites and coastal built-up areas, suggesting opportunities for broader designation and strategies to reduce recreational disturbance.
- Soft sediment habitats displayed a severe bottleneck between Bridlington and Filey bays. These areas overlap with zones of predicted coastal erosion, highlighting the need for managed retreat space and measures to mitigate limiting pressures such as recreational activities and hard coastal barriers.
- Rivers and Coastal Stream bottlenecks were primarily clustered around The Gypsey Race, a key chalk stream. This area has already been identified as a priority waterbody for enhancement, presenting a strong opportunity to improve habitat connectivity. Targeted restoration efforts here and across the wider water network could further strengthen ecological corridors, supporting species migration and movement.

Conclusion

This analysis highlights priority areas where habitat connectivity is most vulnerable to current and future pressures. It also identifies key opportunities for Coastal Wildbelt to enhance ecological corridors through habitat expansion, protection, and sustainable land-use management. These findings can guide targeted conservation actions and inform strategies to strengthen biodiversity resilience along the Yorkshire coast.

Acknowledgements

This project has been supported by the North York Moors National Park and the Yorkshire Marine Nature Partnership. These partners have contributed essential knowledge and ideas that have helped shape this project.

Project Partners

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We are the Protected Landscapes Partnership

National Landscapes Association | National Parks England | National Trails UK | Natural England

Introduction

The Yorkshire Coastline

Stretching approximately 145km from the Tees Estuary in the north to the Humber Estuary in the south, the Yorkshire Coastline is one of the UK's most ecologically significant stretches of coastline. It features a diverse shoreline of rugged cliffs, sandy beaches, rocky shores, wetlands and estuarine mudflats, creating important habitats for a wide array of species and wildlife and provides vital connectivity to different areas to find food, shelter, and breeding sites.

The Yorkshire coast is dominated by towering limestone and sandstone cliffs such as those at Flamborough Head and Bempton Cliffs, which provide significant nesting sites for seabirds like auks, gannets, fulmars and kittiwakes. Areas like the coastal wetlands and salt marshes, which lie at the mouth of the estuaries, form a critical interface between the land and sea, supporting and connecting aquatic and terrestrial species and habitats. The mudflats and estuaries of the Humber and Tees are important for migratory birds, providing feeding and breeding grounds for species such as redshank, curlew, and oystercatcher. Like Scarborough and Filey, Yorkshire’s sandy beaches and rocky shores offer vital intertidal zones where marine life thrives.

However, despite its many connected ecosystems, the Yorkshire coastline faces many threats to habitat connectivity. Urban development, intensive agricultural practice, sea level rise, and coastal erosion have fragmented habitats, reducing corridors for species movement. Coastal erosion brings seaward change to coastal habitats, which will intensify with climate change. As climate ranges shift northwards, species will rely on accessible connective pathways of suitable habitat. These habitats' connectivity, health and functionality will be crucial to landscape and species resilience.

Coastal Wildbelt - Background

Coastal Wildbelt is a national initiative advocating for people and nature along England's dynamic coastline. We exist to unlock the potential of the King Charles III England Coast Path, which, when complete, will be the longest managed coastal path in the world at 2,700 miles, and its coastal margin; ensuring they are valued, protected, and accessible for all.

Established under the Marine and Coastal Access Act 2009, the coastal margin is a stretch of land, normally between the King Charles III England Coast Path and the sea at low tide, that typically includes beaches, cliffs, dunes, and other coastal habitats. Much of this 240,000ha designation is open access, allowing people to explore and enjoy it, though some areas are restricted for safety, land management or conservation reasons.

This unique space plays a vital role in both public access and nature conservation, supporting wildlife, coastal protection, and climate resilience while offering opportunities for recreation and connection with the natural environment. Enhancing the coastal margin for people, wildlife, and climate change resilience is a core mission of the project. Enabling habitats to become more connected is a key component of this.

Aims and Objectives

This study aims to identify possible bottlenecks for key coastal habitats along the Yorkshire coastline to inform how Coastal Wildbelt and other projects could support actions to alleviate located bottlenecks.

The key objectives are:

- Map the extent of key coastal habitats under pressure from current and future connectivity issues.
- Model the possible bottlenecks in connectivity for representative species that move across these habitats, either up the coast (South to North) or inland (East to West).
- Identify the bottlenecks in the context of other datasets to inform opportunities that could alleviate these bottlenecks in connectivity.
- Provide conclusions and recommendations for the application and further use of this analysis.

The Condatis Modelling Tool

Condatis is a habitat connectivity tool created by the University of Liverpool to explore where the strains in species mobility exist (bottlenecks) for habitat types across a landscape, for defined dispersal distances, reproduction rates, and dispersal directions. The tool has been used to support several projects, including PlantLifes B-Lines (Rothwell, Lantham and Hodgson, 2014), Connectivity of Woodland Protected Areas in Wales (Rothwell, Latham and Hodgson, 2014), an assessment of using bottlenecks for nature recovery projects (Gutierrez-Arellano *et al.*, 2024) and as an indicator for habitat connectivity for the Outcome Indicator Framework for the 25-Year Environment Plan (Mancini, Hodgson and Isaac, 2022). This study will use Condatis to identify possible bottlenecks in important coastal habitats along the Yorkshire coast and locate areas of opportunity to support enhanced habitat connectivity. The Methods chapter provides further information on the modelling approach, methodology, and detailed 'explainer'. More information about the Condatis tool can be found here: condatis.org.uk.

Methods

Study Area

This analysis covers the Yorkshire coastline between Staithes in the North and Spurn in the South. The National Coastal Erosion Risk Mapping (2024) dataset was used to map future coastline extent to assign the inwards terrestrial limit. The maximum predicted extent (95th quartile) of the 2105 prediction was used to capture the maximum extent. Buffers of 1km, 5km, 10km and 20km were applied to net around bordering habitats to consider connectivity constraints. Figure 1 shows a map of the study area and buffers.

Habitat modelled scenarios

This analysis has explored four habitat scenarios to investigate the connectivity pressures along the Yorkshire coastline. The scenarios have been informed by the pressures and priority species outlined in the draft Marine Local Nature Recovery Strategy for Yorkshire, produced by the Yorkshire Marine Partnership (2025). This section outlines the four scenarios for this analysis and the approaches taken to investigate habitat connectivity bottlenecks.

Connectivity for Waders

Wading birds, including curlew, lapwing, and redshank, rely on the expansive low-tide mudflats along the Yorkshire coast. Inland, the saltmarsh, grazing marsh, blanket bog, and areas of grasslands are important roosting, foraging and nesting sites for these birds. The low tide range for feeding and roosting is threatened by habitat loss due to sea level rise, with limited retreat space inland. Available grasslands and arable land used by waders year-round are under pressure from development and intensive farming.

It is important to understand where connectivity bottlenecks exist for these species, to interpret where additional retreat space and supplementary sites might be necessary to ensure their resilience and continued presence, and to create areas of functionally linked land vital for our internationally designated sites to thrive.

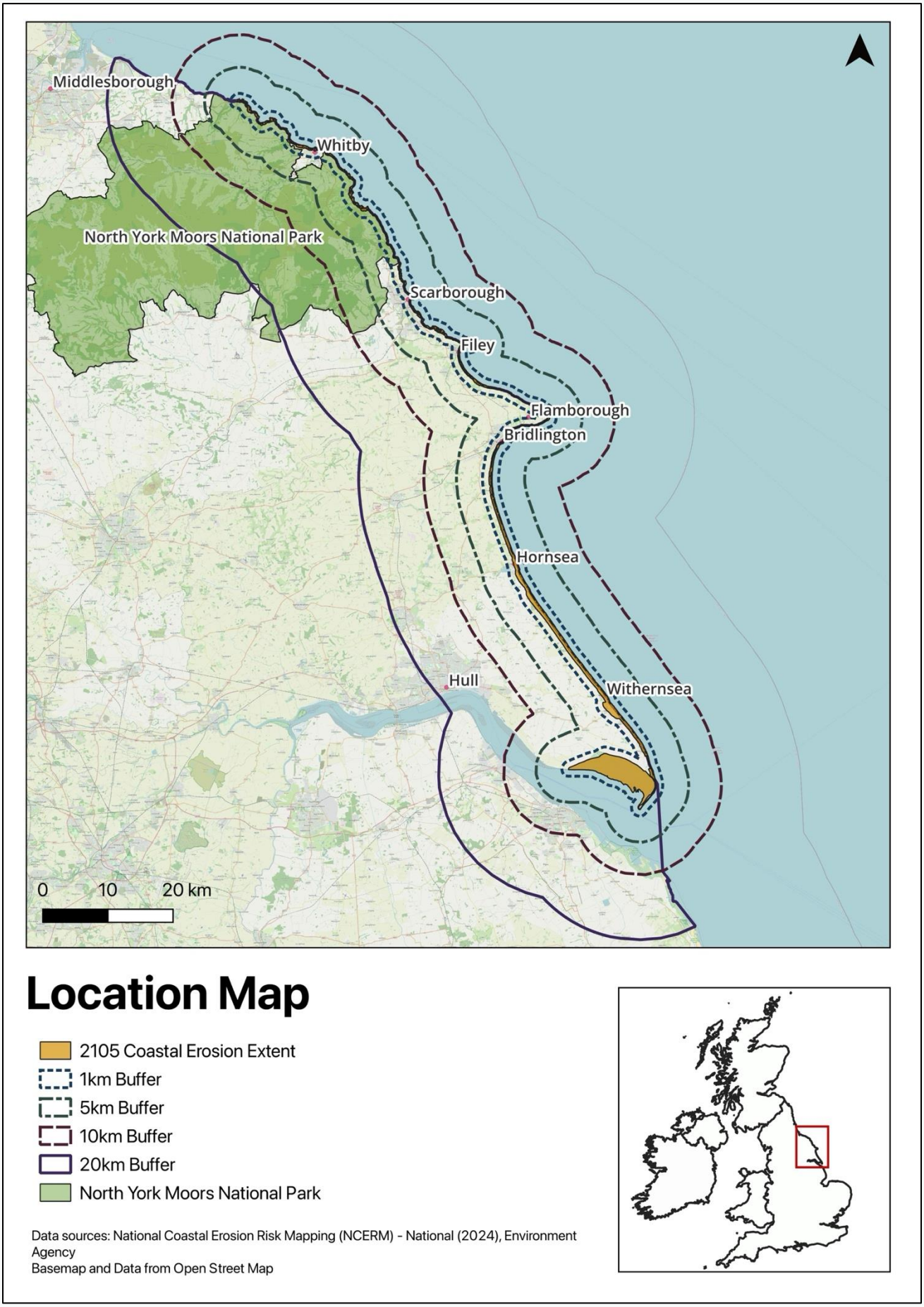

Figure 1: Map of the study area and the 1km, 5km, 10km and 20km buffers applied to the 2105 coastal erosion extent to inform the analysis. The 2105 coastal erosion extent uses the 95th quartile of the 2024 National Coastal Erosion Risk Mapping dataset. Major towns and National Park labelled.

Designated Seabird Breeding Cliffs

The Yorkshire cliffs are globally important for seabirds, holding the largest mainland seabird colony in the UK. Bempton cliffs attract around half a million birds yearly between March and August to breed on the chalk cliffs. Coastal erosion will result in geomorphological changes to these crucial cliff habitats. This could create new suitable habitats or undermine the utility of current habitats. Only a small percentage of the Maritime Cliff and Slope habitats along the Yorkshire coast (between study area limits) are protected under statutory designation. This could mean that current and future suitable cliff habitats may not be safeguarded, compromising their future use due to pressure exposure (e.g., recreational disturbance). Understanding where there are bottlenecks between the designated cliff habitats can help identify important connections that could inform future areas for protection and designation.

Soft Sediments

Soft sediment coastal habitats such as sandy bays and sand dunes are important along the Yorkshire coastline. These habitats support species like the east coast native sea buckthorn and important breeding populations of little tern. Sea level rise is causing coastal squeeze, reducing their future habitat range. Dunes are particularly vulnerable, with a mature dune system taking 50-100 years to establish and requiring decades to transition between habitat stages naturally. On the other hand, sandy beaches rely on replenishment from soft-sediment cliffs, which in turn rely on the space for the cliffs to erode and retreat, compensating for a loss in beach area resulting from a rising sea level. Making space and safeguarding what space remains for these habitats is essential for their existence.

Understanding this in the context of future erosion rates and what this range backs onto can inform where the space and connectivity may be threatened. This is also important for the King Charles III England Coast Path, which follows much of this dynamic coastline.

The coast path can be a useful tool to help provide the essential space for natural processes to continue unimpeded.

Rivers and Coastal Streams

Waterways are intrinsically connected habitats. Rivers connect to one another through webs of streams and wetlands, allowing movement through a landscape via water highways. These water highways are essential for important fish species such as salmon, trout, and eels. Crucially, these waterways connect the terrestrial to the marine, feeding into the sea via estuaries and coastal streams, providing migratory roots and breeding grounds.

Over-abstraction, over-engineering, and disconnection from the floodplain have fragmented river networks, undermining their ecological function. Understanding where this fragmentation has happened and identifying resulting bottlenecks in species movement can help map out where re-wetting and river restoration are most needed. Ensuring species can move across a landscape via the waterways and make sea-to-river migrations is essential to their survival and establishment.

Model Setup

Habitat Maps

Bespoke habitat maps were produced for each scenario tested. Table 1 lists data sources and habitat types for each scenario.

Habitat datasets were merged and dissolved to intersect with a 100mx100m grid covering the study area to produce a raster. Habitat coverage for each raster cell ranged between 0-1, with 0 denoting 0% habitat coverage and 1 being 100% coverage.

Dispersal Distance

A literature review was conducted to assess appropriate dispersal distances for the species and habitat scenarios assessed. Table 1 outlines the dispersal distances used for each scenario and the referenced sources that informed the distances used.

Dispersal Direction

Different dispersal distances were tested where relevant to the habitat type. A south-north dispersal direction was used to simulate range shifts with climate change, a west-east direction to simulate migration from land to sea, and an east-west direction to simulate movement from coast to inland.

Reproductive Rate

The model used a reproductive rate of 1000 as a generic rate used in similar analyses (Travers, 2022; Gutierrez-Arellano et al., 2024).

Bottlenecks

The rasterised habitat map and species behaviour metrics (reproductive rate, dispersal distance and direction) were then inputted into the Condatis Model. 100 Bottlenecks were computed for each run. Once the model runs were completed for each scenario, the bottlenecks were classified into 'scores' using methods applied by Gutierrez-Arellano *et al.* (2024). From the scores, the bottlenecks were then classified into 'Severe', 'Major' and 'Minor':

Severe Bottlenecks: Scores >50
Major Bottlenecks: Scores >5 - =<50
Minor Bottlenecks: Scores >1 - <5

Severe bottlenecks were then buffered using half the length of the bottleneck polyline to create 'Severe Bottleneck Zones' polygons. Figure 2 explains how a bottleneck is calculated from the Condatis Model.

Condatis Bottlenecks: Explainer

Condatis highlights pathways that allow species to disperse and reproduce across a landscape. The model assigns flow to each habitat cell, which gives an indicative number of individuals moving through that cell who will colonise the defined target. A higher flow of a habitat cell means it is important for connectivity between source and target. High-flow areas are conservation priorities, representing an important route for species mobility through a landscape.

The strength/power of the links between habitats depends on the time the population takes to move across – the model also represents this as 'resistance'. If there is high resistance in one of these links but it forms a route to the best available habitat, this produces a Bottleneck. These are locations within the landscape that, if the habitat were created/restored along or around this bottleneck location, would support a significantly higher flow of species movement across the landscape habitat network.

From the Bottleneck scores, the most severe resistance locations can be identified and produced into a severe bottleneck zone. This zone maps out an effective area for habitat creation/restoration in a location that would significantly increase the efficiency of species movement across the landscape in the defined direction by adding a suitable pathway.

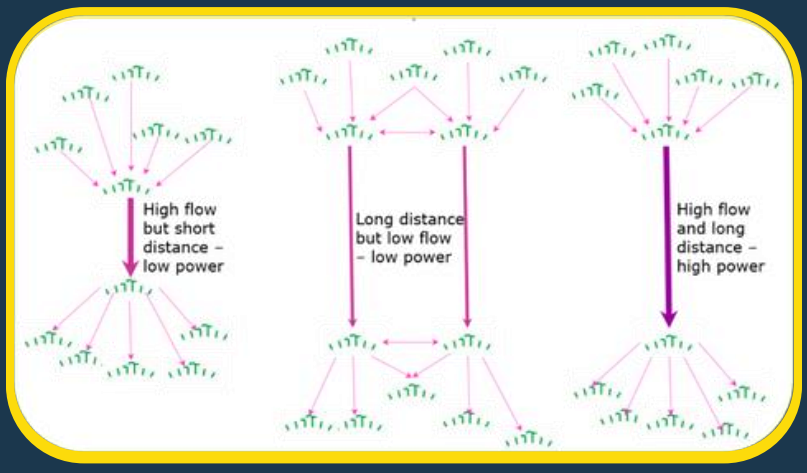

Figure 2: Adapted from How Condatis Works webpage. The diagram shows how high-power links occur when there is limited choice in habitat connections across large areas of the landscape that form an essential route for species.

Table 1: Table of habitat datasets used to create habitat rasters for model input and species behaviour metrics tested for each model run. The scale refers to the buffer size used, outlined in Figure 1.

Modelled Scenario	Habitat Dataset	Dispersal	Direction	Scale
Wading Birds	Blanket bog, Coastal and floodplain grazing marsh, Coastal saltmarsh, Good quality semi-improved grassland, Grass moorland, Lowland calcareous grassland, Lowland dry acid grassland, Lowland fens, Lowland heathland, Lowland meadows, Mudflats, Ponds, Purple moor grass and rush pastures, Reedbeds, Saline lagoons, Upland flushes fens and swamps (PHI, 2024)	3km (Rogers, 2003) *High-Tide Roost Choice for Coastal Waders*	S-N W-E E-W	10km 5km 1km
Designated Seabird Breeding Cliffs	Maritime cliff and slope (PHI, 2024) that intersected protected sites (SSSI, SPA, SAC, LNR) *Full Maritime Cliff and Slope PHI also assessed*	10km 5km (Fayet et al., 2021; Patterson *et al.*, 2022; Langstone and Boggio, 2011) *Foraging distances for Puffins, Gannets and by seabird colony size*	S-N	1km
Coastal Rivers and Estuaries	Rivers (OS Open Rivers) +50m buffer Estuaries	5km (Walker, Godard and Davidson, 2014) *Home-range for Eels*	S-N E-W	10km 20km
Soft Sediments	Coastal Sand Dunes (Living England 2023; PHI, 2024) Bare Sand (Living England 2023)	1km *Generalised short dispersal species* (Travers, 2022)	S-N	1km

Model and input limitations

While this study offers valuable insights, several limitations should be considered when interpreting the results. The Condatis model was based on several assumptions with in-built bias in species behaviour and bottleneck calculation, as Travers et al. (2022) outlined. Habitat data (Priority Habitat Inventory (PHI), 2024) input to Condatis relied on publicly available sources. As a result, the coverage is not completely accurate due to infrequent updates, lack of ground truth, and assumptions in data collection methods. Information on the methodology informing the PHI is outlined in the PHI User Guide (2022). Furthermore, the PHI is not a complete coverage of all suitable habitats within the scenarios tested, due to the specifications of the dataset. As a result, the habitat inputs may not be a complete picture of all suitable habitats for the relevant scenarios.

Raster resolution for this analysis (100m by 100m grids) also reduced the detail and complete coverage. This resolution was taken to adequately capture habitat coverage without compromising the model's resolution limits.

Habitat needs and behaviours for the species assessed and discussed in this study are limited to existing published data and reports. Hence, there is likely record and focus bias on the generalisations given to species.

The coastal erosion and flood prediction datasets used in the analysis were produced by national models, which may vary in predictions relative to other model outputs. The datasets used are national best estimates used by regulators, e.g., the Environment Agency.

Connectivity Enhancement Opportunities

To further investigate areas identified by the severe bottleneck zones as opportunities to support connectivity, other datasets were assessed to inform the potential and broader context of these locations. Table 2 outlines the datasets used and their descriptions for each scenario.

Table 2: Table to show datasets used and accompanying link. Dataset attribution statements are outlined in the data sources table in the References chapter.

Habitat	Dataset Used
Connectivity for Waders	National Coastal Erosion Risk Mapping (NCERM) 2024 Habitat Networks (England) 2019 Risk of Flooding from Rivers and Sea 2024 Crop Map of England (CROME) 2023 North York Moors National Park Wader Survey Data (2021 and 2024)
Designated Seabird Breeding Cliffs	National Coastal Erosion Risk Mapping (NCERM) 2024 Seabird Nesting Counts (British Isles) 2019 National Trails 2024 King Charles III England Coast Path Route 2024 OS Open Built Up Areas 2024
Soft Sediments	King Charles III England Coast Path Route 2024 National Coastal Erosion Risk Mapping (NCERM) 2024 Habitat Networks (England) 2019
Coastal Rivers and Coastal Streams	Risk of Flooding from Rivers and Sea 2024 Priority Habitats Inventory (England) 2024 River Obstacles 2021 Habitat Networks (England) 2019

Results

Overall

This analysis has identified several bottlenecks along the Yorkshire coastline, ranging in strength, for all of the habitats assessed. Wader habitats had the strongest and most widespread bottleneck areas compared to other habitats. Seabird habitats (designated cliffs) had the lowest habitat coverage and the weakest bottlenecks.

Wader Habitat

Figure 3 shows five areas of major and severe bottleneck zones. Severe bottleneck zones were produced at all 1km, 5km, and 10km study area scales of analysis. At the 1km study area scale of analysis, the severe bottleneck zones are clustered north of the coastline. For the larger study area scales of analysis (5km and 10km), bottlenecks are clustered around the centre and south of the coastline. A severe bottleneck zone is identified further inland for the 10 km study area.

Designated Seabird Breeding Cliffs

For the designated cliff habitat, the model only derived minor bottlenecks that punctuated the northern section of the study area coastline, where cliff habitats had greater coverage, as highlighted in Figure 4. Bottleneck strength (minor) was the same across 5km and 10km dispersal distances. Bottlenecks for the two tested distances clustered around Filey, with 5km dispersal distance outputs extending further north to Scarborough and Whitby.

Soft Sediment Habitat

Figure 5 shows one severe bottleneck zone between Bridlington and Filey Bay. The bottlenecks cross over the hard chalk cliffs around Flamborough to connect the two soft sand bays. Both Severe and Major bottlenecks are clustered in the same location.

Rivers and Coastal Stream Habitats

River and coastal stream bottlenecks were severe across the 10km and 20km study areas assessed. All bottlenecks are clustered at a single location, notably with a gap from the Gypsey Race chalk stream to the broader river network, as a result of the geological isolation of this watercourse from the wider catchments. An east-west and south-north direction of movement was tested, both producing the same bottleneck locations.

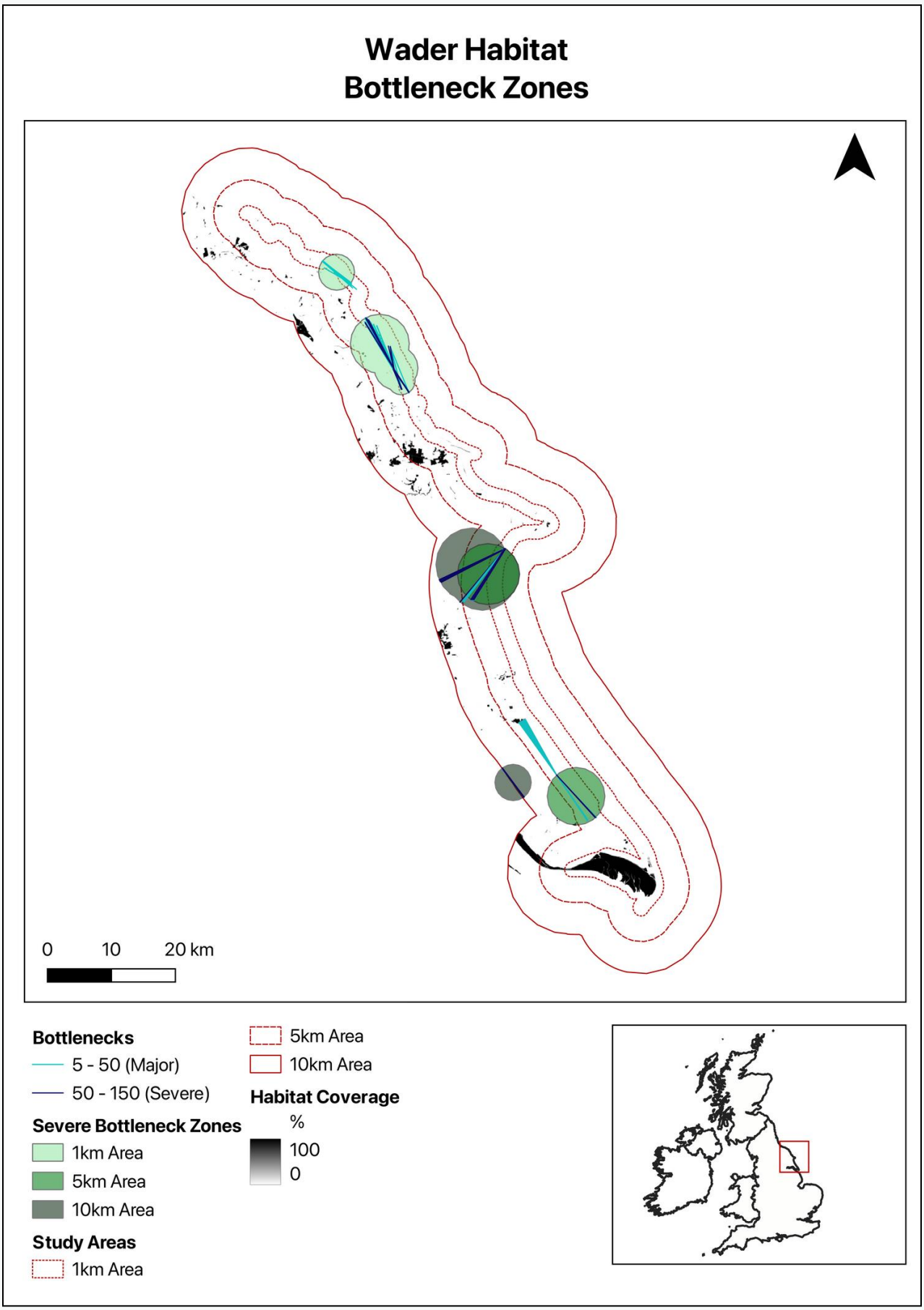

Figure 3: Major and Severe bottlenecks for Wader habitats at 1km, 5km, and 10km scales of analysis. Severe bottlenecks also shown as polygon 'zones', coloured by scale of analysis. Habitat % coverage shown by black to white shading.

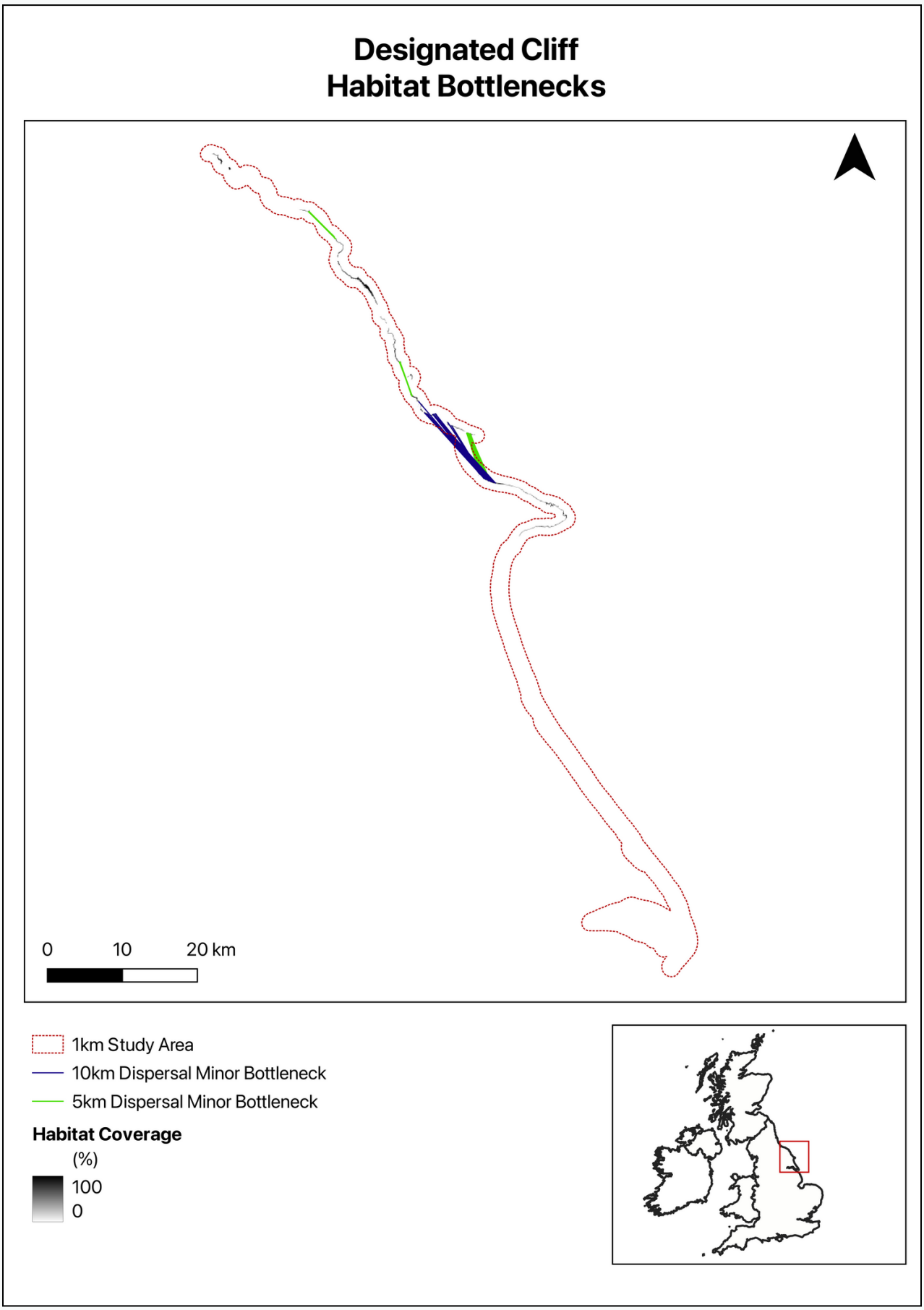

Figure 4: Minor bottlenecks for Designated Cliff habitats at a 1km scale of analysis, for 5km (Green) and 10km (Blue) dispersal. Habitat % coverage shown by black to white shading.

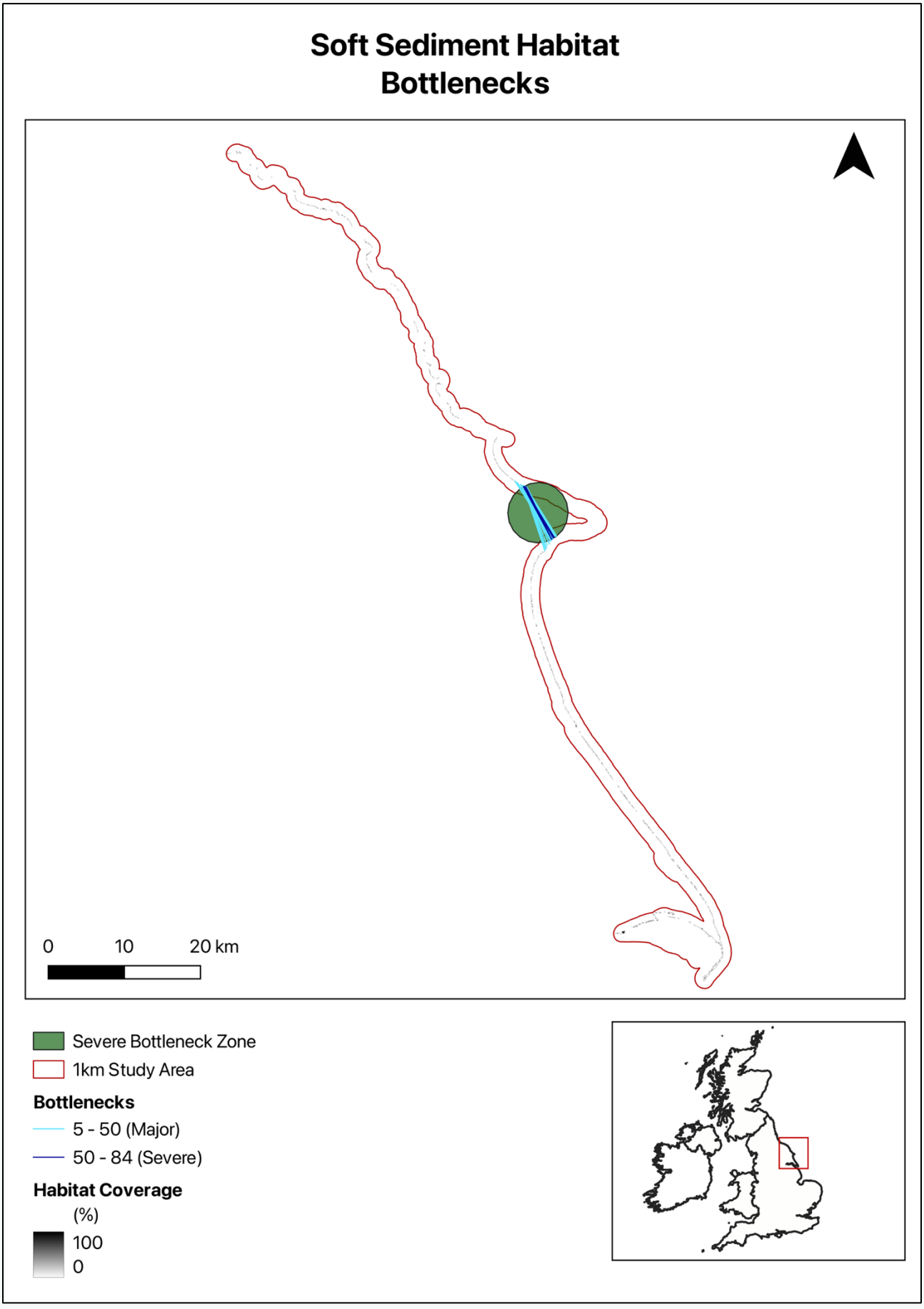

Figure 5: Major and Severe bottlenecks for Soft Sediment habitats at a 1km scale of analysis. Severe bottlenecks also shown as polygon 'zones', coloured green. Habitat % coverage shown by black to white shading.

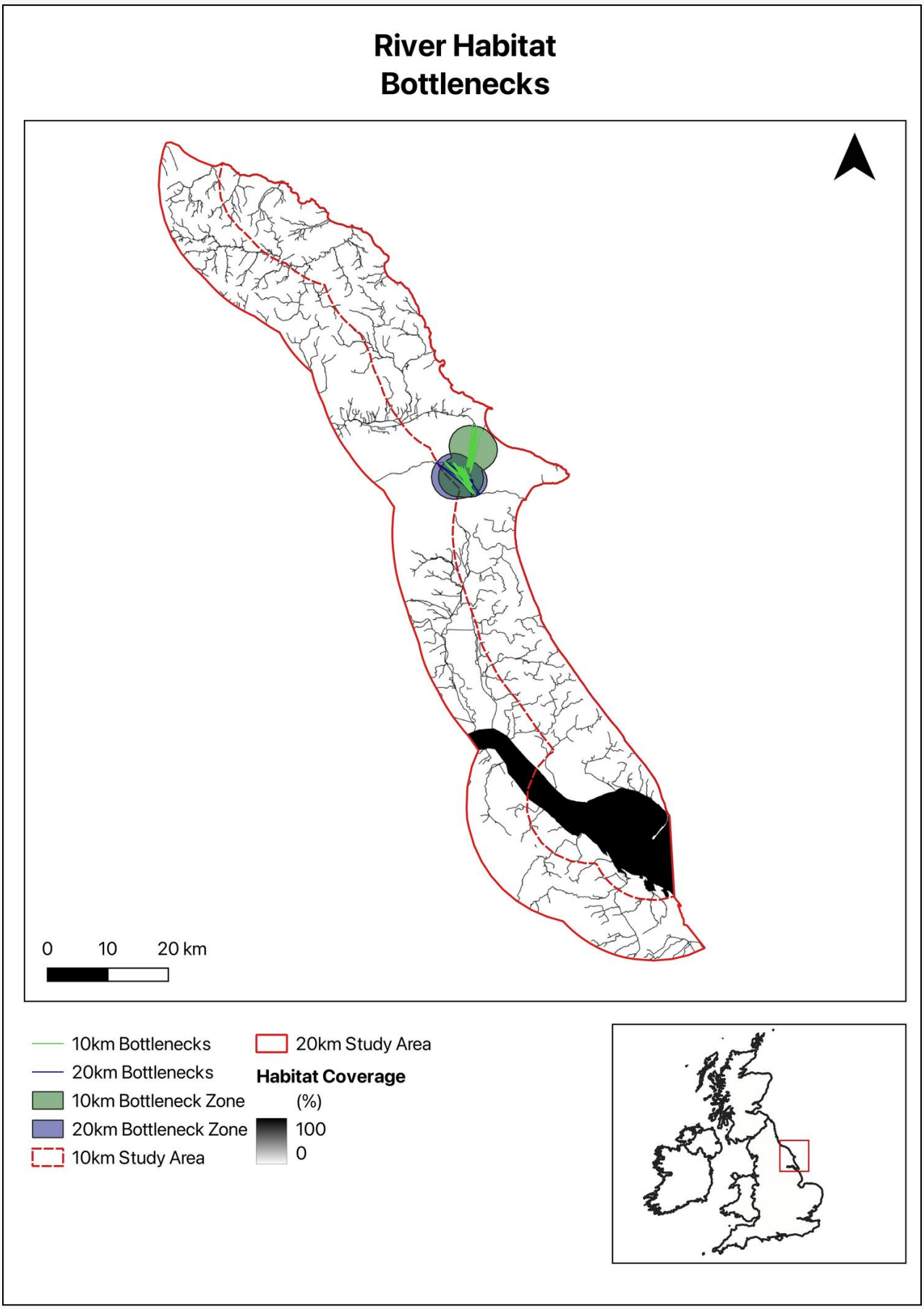

Figure 6: Bottlenecks and bottleneck zones for River and coastal stream habitats at a 10km (Green) and 20km (Blue) scale of analysis. Habitat % coverage shown by black to white shading.

Opportunities for Coastal Wildbelt to remove bottlenecks in connectivity

Waders

The spread of bottleneck zones for wader habitats presents opportunities to enhance their connectivity. The northern bottleneck zones intersect opportunity areas to expand and enhance key wader habitats (blanket bog, upland fens, flushes and swamps, and lowland fen), as shown in Figure 7. By expanding and enhancing these habitats, the wader wetland refuge and feeding range could be improved, benefiting from additional functionally linked land extending to the coast between internationally designated sites. Figure 9 shows that these northern bottlenecks are currently in grassland land cover areas, which is important for the wader populations in and around the North York Moors National Park. Therefore, with landowner engagement, appropriate land management could promote the expansion and establishment of suitable habitats, alleviating connectivity pressures in this location. This is especially important for waders and other birds that could/do use arable land and grassland as breeding and foraging habitat. Appropriate land management could support the needs of these species and expand their range of safe and functional habitats, delivered through landscape-scale partnership and collaborative working.

Figure 8 also provides an opportunity for supporting wader habitat expansion, as shown by bottleneck zones overlaying areas at risk of flooding. In these locations, allowing the floodplain to get wetter and reconnect across its extent will enhance and expand the wetland wader habitats, and provide Natural Flood Management (NFM) for the surrounding areas. The feeding range will expand for these species, as will the refuge space, protecting populations against predatory pressures.

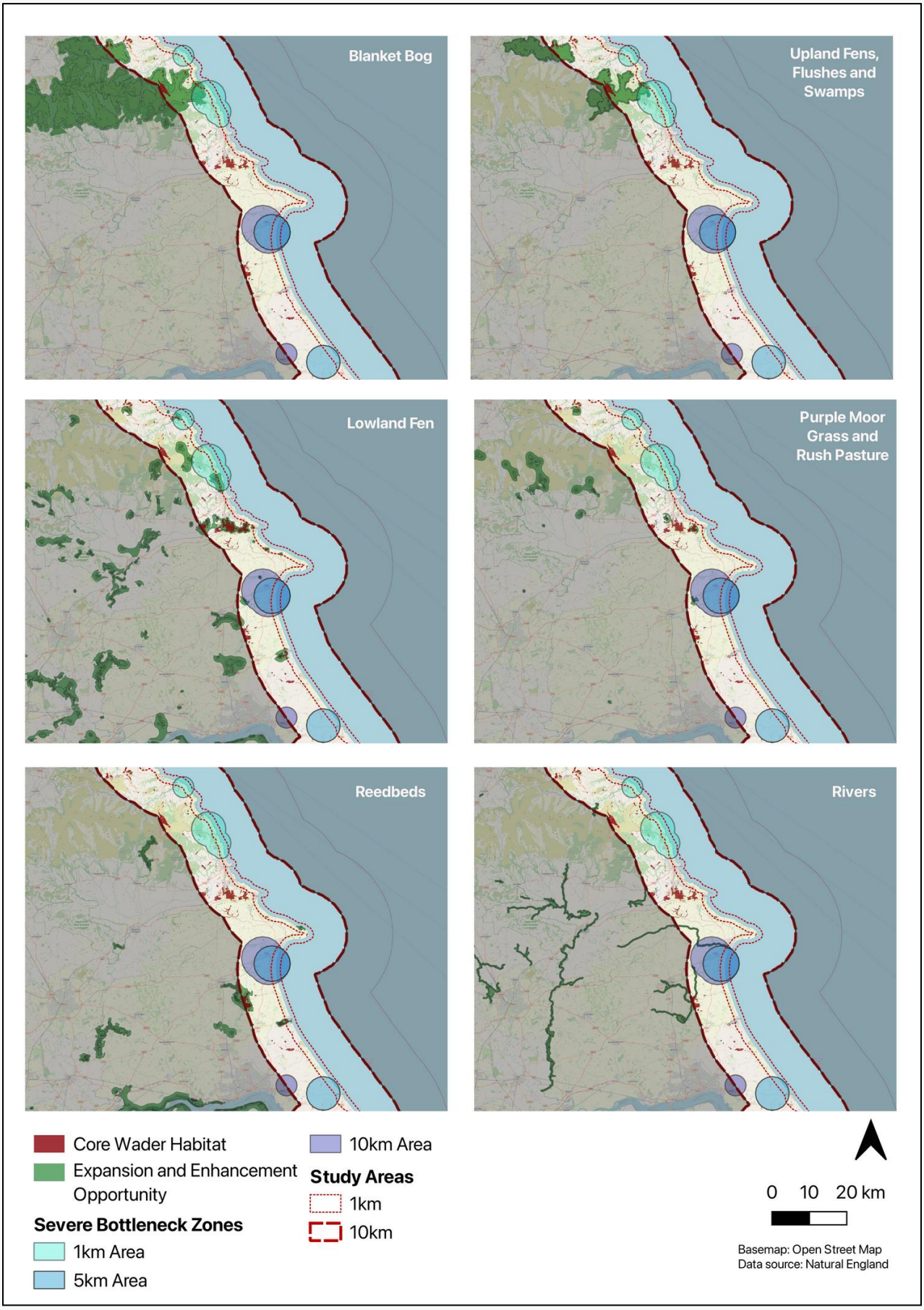

Figure 7: Severe bottleneck zones for Wader habitats at 1km, 5km, and 10km scales of analysis, shown in the context of expansion and enhancement opportunities for wader habitats (as labelled in maps) shown in green, and core wader habitat used in modelling assessment, shown in red.

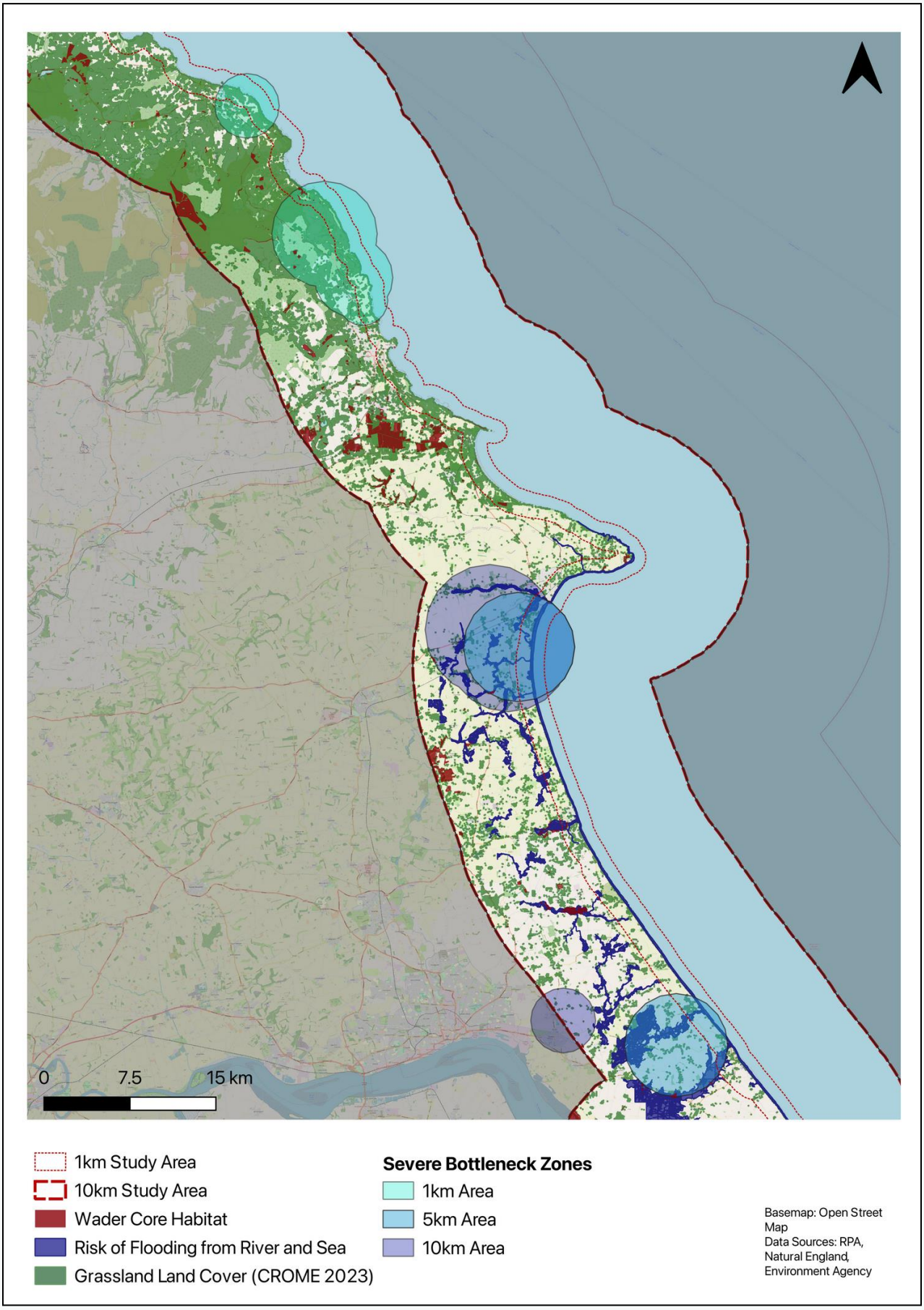

Figure 8: Severe bottleneck zones for Wader habitats at 1km, 5km, and 10km scales of analysis, shown in the context of existing Grassland Land Cover from the Crop Map of England (2022) shown in green, and predicted areas to be flooded by rivers and sea shown in blue.

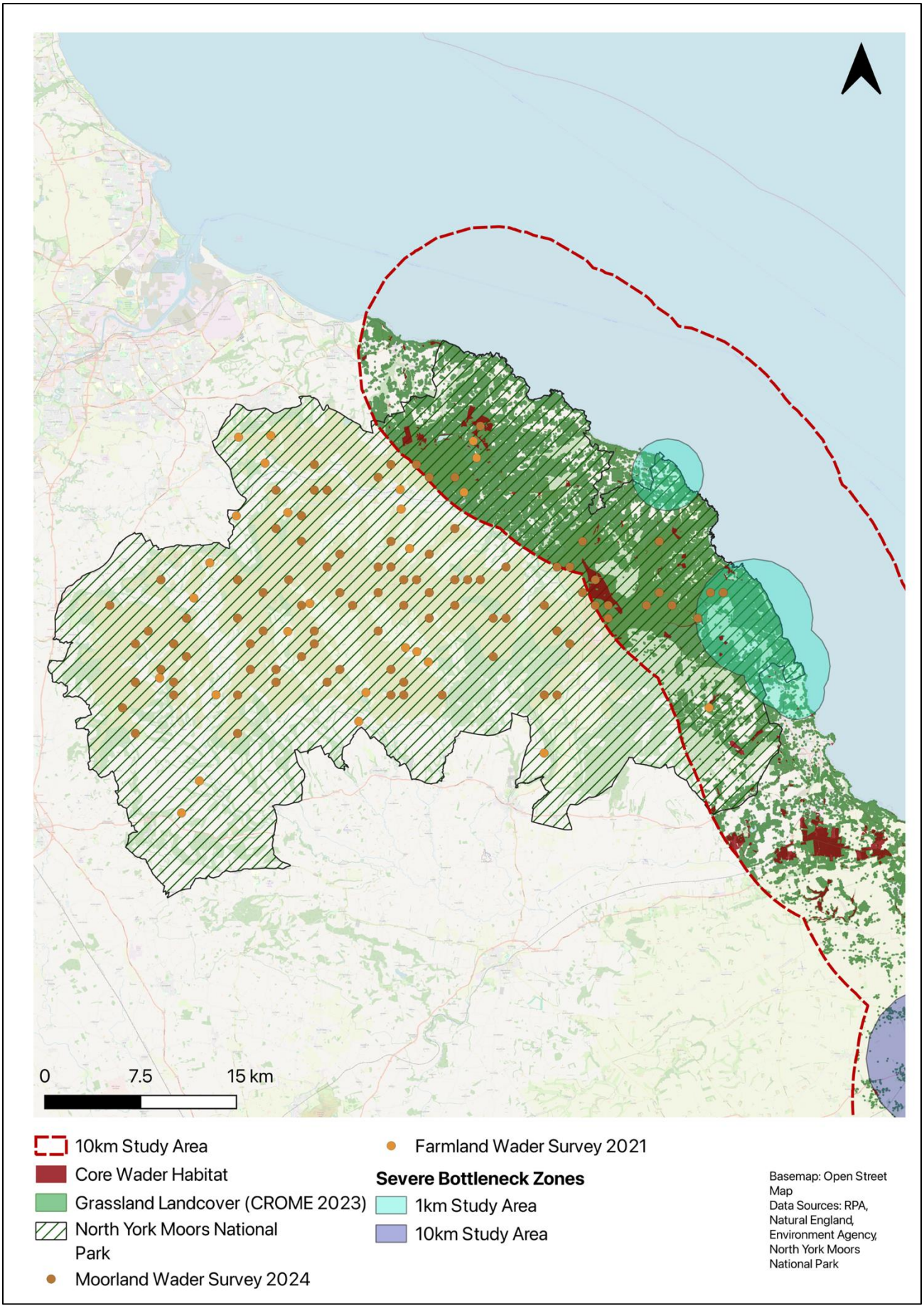

Figure 9: Severe bottleneck zones for Wader habitats at 1km and 10km scales of analysis, shown in the context of existing Grassland Land Cover from the Crop Map of England (2022) shown in green, and surveyed wader locations across the North York Moors National Park.

Designated Seabird Breeding Cliffs

While no severe or major bottlenecks for designated cliff habitats were identified, likely due to the limited habitat coverage and the greater dispersal distances of the species using them, the locations of the bottlenecks provided insight into locations that could support enhanced connectivity for seabirds. Seabirds tend to nest where they were born, so it is important that there is space for their colonies to expand (Scottish Seabird Centre, 2023). With increased cliff geomorphology change from coastal erosion and landslips, the need to relocate nesting grounds may become necessary. Although these sea bird colonies have been facing declines, should existing pressures, including foraging resources, offshore development and disease, be reduced, populations could increase, with signs of increased chick productivity for Flamborough and Filey Coast SPA showing in recent surveys (Butcher, Aitken and O'Hara, 2023). Therefore, there may be an increase in demand for nesting habitat and suitable areas for expanding populations. Where bottlenecks have been identified, these spotlight areas where expansion may currently be limited within the range of designated suitable habitat.

As shown in Figure 10 the current seabird nesting sites are the densest around Bempton Cliffs. However, bottleneck zones have been identified just north of this, along the Bay Beach and north of Filey Brigg. Nesting site density is low within this Bay, largely due to the shallow sloping sandstone cliffs, but does increase further north of the bottleneck zones. This area of the bottleneck zone could be a significant connector to the expansion and relocation of nesting seabirds. Additionally, soft sediment shallow cliffs can be suitable habitats for seabirds such as puffins and fulmars, benefiting from the vegetated shelter. Therefore, the area highlighted still provides priority connective habitats.

Further up the coastline, smaller bottleneck zones are identified near Scarborough and Whitby. Within these zones, there are areas of cliff habitat that fall outside existing SSSI designations yet are still nesting sites for a number of seabirds, as shown in Figure 10. Therefore, monitoring populations outside of designated areas will be important to understand the connectivity for the seabirds nesting along this coastline.

Incidentally, these bottleneck zones are also situated near urban areas that join onto the King Charles III England Coast Path (Figure 11). In addition to this potential connectivity bottleneck, recreational disturbance may also be a pressure for future seabird colonisation. Coastal Wildbelt could help reduce recreational pressure through signage and give space to species that need to use the cliffs as the coastline geomorphology evolves, to allow access and enjoyment of the Coast Path without compromising space used by seabirds.

In alignment with the proposed Urban Gull Strategy for North Yorkshire (2024), Whitby and Scarborough are important areas to improve coexistence with gulls, which could include suitable supplementary nesting locations and taking advantage of the already suitable urban infrastructure.

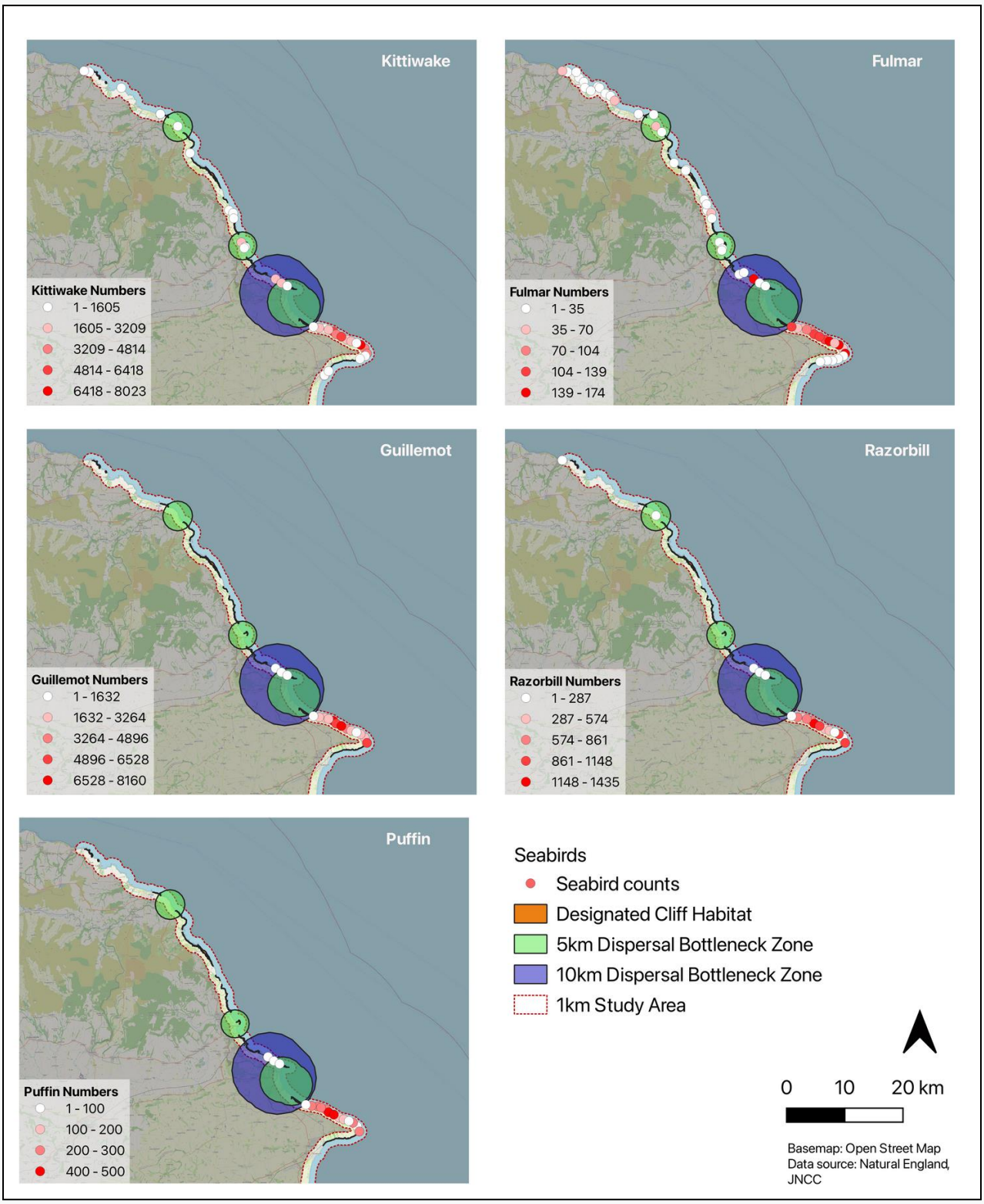

Figure 10: Minor bottlenecks zones for Designated Cliff habitats at a 1km scale of analysis, for 5km (Green) and 10km (Blue) dispersal. Designated cliff habitat shown in orange using Natural England Priority Habitat Inventory. Numbers of nesting seabirds showing in shaded red dots, using JNCC data from Seabird 2000 census (2019) of nesting seabird colonies, collected between years 1993-2003.

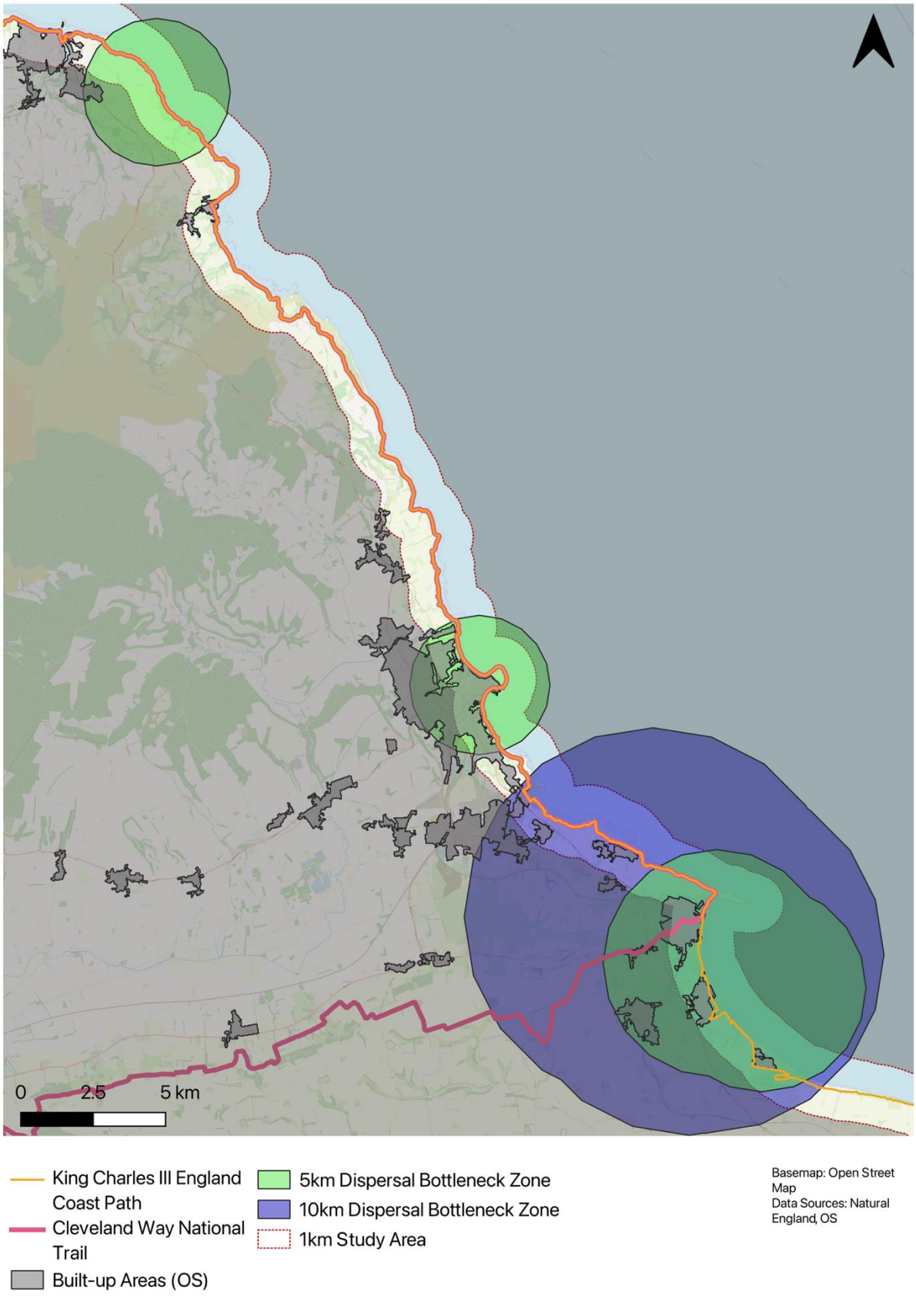

Figure 11: Minor bottleneck zones for Designated Cliff habitats at a 1km scale of analysis for 5km (Green) and 10km (Blue) dispersal. Grey polygons show built-up areas, alongside the King Charles III England Coast Path (Orange) and the Cleveland Way National Trail (Pink).

Soft Sediment

Connectivity for soft sediment habitats is important for seed dispersal and invertebrates that rely on the sandy refuge. Movement across suitable habitats will become more important with sea level rise, which will cause a 'coastal squeeze' - a contraction of the soft sediment intertidal as the high-water mark extends up the shore. This removes the area of intertidal that supports species reliant on dry and tidally submerged habitats. This is particularly an issue for coastlines with a hard backstop, e.g., a concrete seawall or rocky cliff.

The soft sediment severe and major bottleneck zones are within an area suitable for coastal habitat expansion and enhancement (Figure 12). This area can potentially support greater connectivity for existing smaller habitat patches. The bottleneck zones are also likely to experience geomorphology changes as the cliff retreats, as shown by the erosion limits in Figure 13, and due to the encouragement of this process through the shoreline management plan policy in the coastline section of the severe bottleneck as 'No Active Intervention'. Although cliff erosion can replenish soft sediment shorelines, this may not keep pace with sea level rise and erosion. As such, beach nourishment and recharge could support a healthy sediment balance and restore lost habitat, providing important bird nesting habitat and colonisable space for soft sediment specialist plants and invertebrates (Manning, Scott and Leegwater, 2021). However, this will rely on understanding of the local sediment redistribution via coastal currents to be viable.

In situations where this unimpeded retreat is not possible, intervention can be taken to provide supplementary habitat to compensate for what will be lost through coastal squeeze. Developing on the Yorkshire Concrete Coast initiative, current and future coastal infrastructure areas could be enhanced with ecologically engineered habitats, e.g., interventions like Vertipools in Whitby that provide vertical adaptive habitat and refuge for species losing their suitable range to sea level rise (Arc Consulting Isle of Wight Ltd, 2022).

The King Charles III England Coast Path, which runs along the coastline, has the potential to be a useful tool to support the enhancement and connectivity of soft sediment habitats (National Trails Nature Recovery Toolkit, 2025). Recreational pressure is a significant threat to the establishment and health of fragile soft sediment habitats like coastal sand dunes. Ensuring users of the coastal path are informed about these fragilities and encouraged away from these habitats can also alleviate this, allowing these dynamic habitats to function. Similar to initiatives elsewhere, boardwalks, signage, and alternative routes can help support enjoyment and access to the coast while protecting vulnerable species and habitats.

Limiting recreational pressure on soft sediment habitats can also benefit the species that rely on them. Vegetated dunes and other soft sediment habitats offer shelter and safety for a rich array of beetles, such as the nationally scarce shore ground beetle, which are easily disturbed. Likewise, wintering waders like sanderling and purple sandpipers and summer breeding birds, such as little tern, are also sensitive to recreational disturbance and rely on plentiful food and safety across the sandy and shingle habitats of the Yorkshire coast. Species living within the sediment which are important for carbon and nutrient cycling, are also important prey resources for waders. Purple sandpipers, sanderling and little terns are facing rapid decline (red and amber listed (BoCC5)), so active intervention should be taken to limit pressures as much as possible so they can use the full range of suitable habitats available to them, enabled by greater habitat connectivity, to move to nearby suitable habitats as their range is reduced over time. The Severe and Major bottlenecks for soft sediment habitats may provide a spatial priority for intervention, particularly in supporting and protecting important connective pathways.

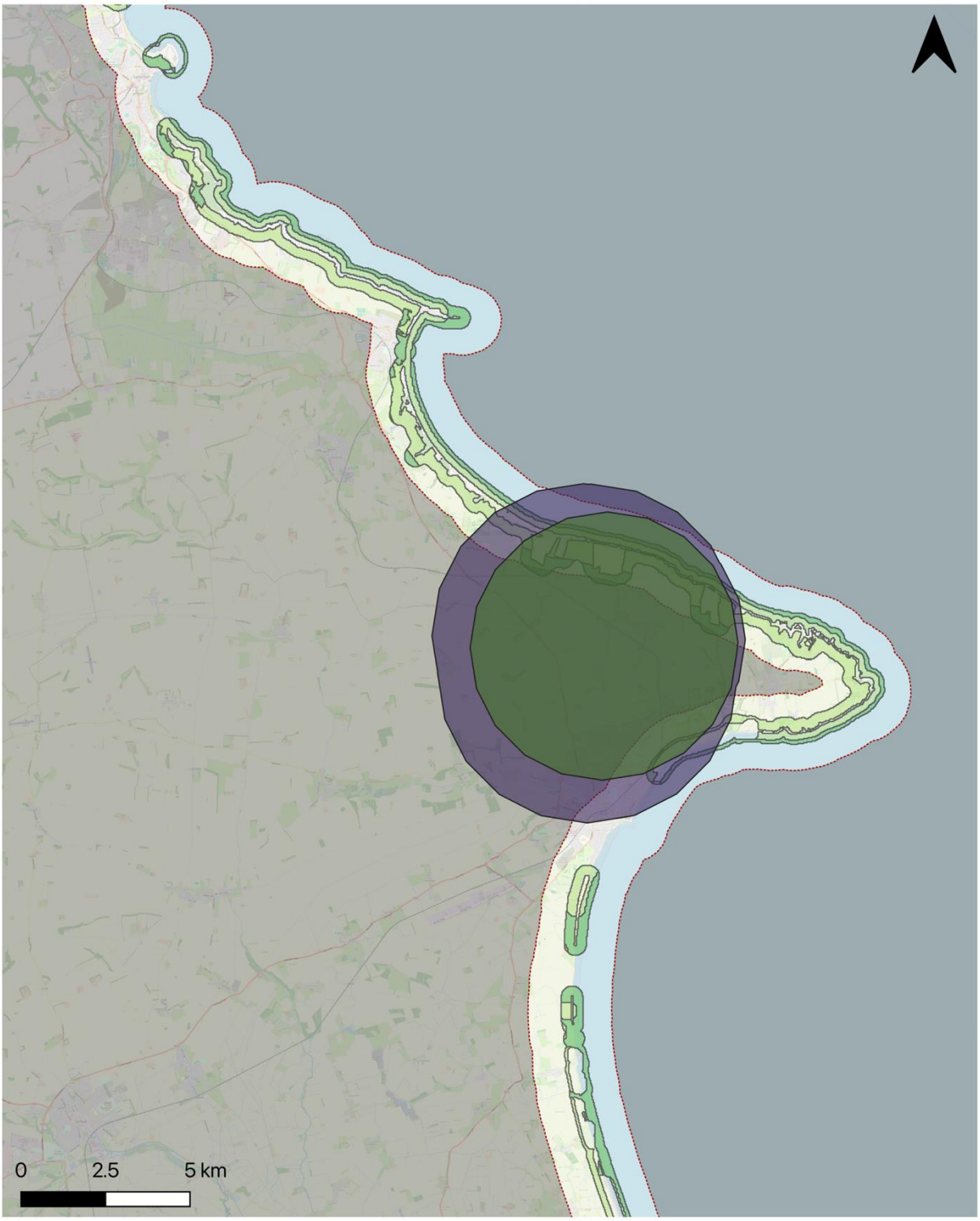

Figure 12: Severe and Major bottleneck zones for soft sediment habitats, shown alongside their coverage (red), and coastal habitat expansion and enhancement potential. The coastal habitat network includes saltmarsh, sand dunes, shingle, and maritime cliffs.

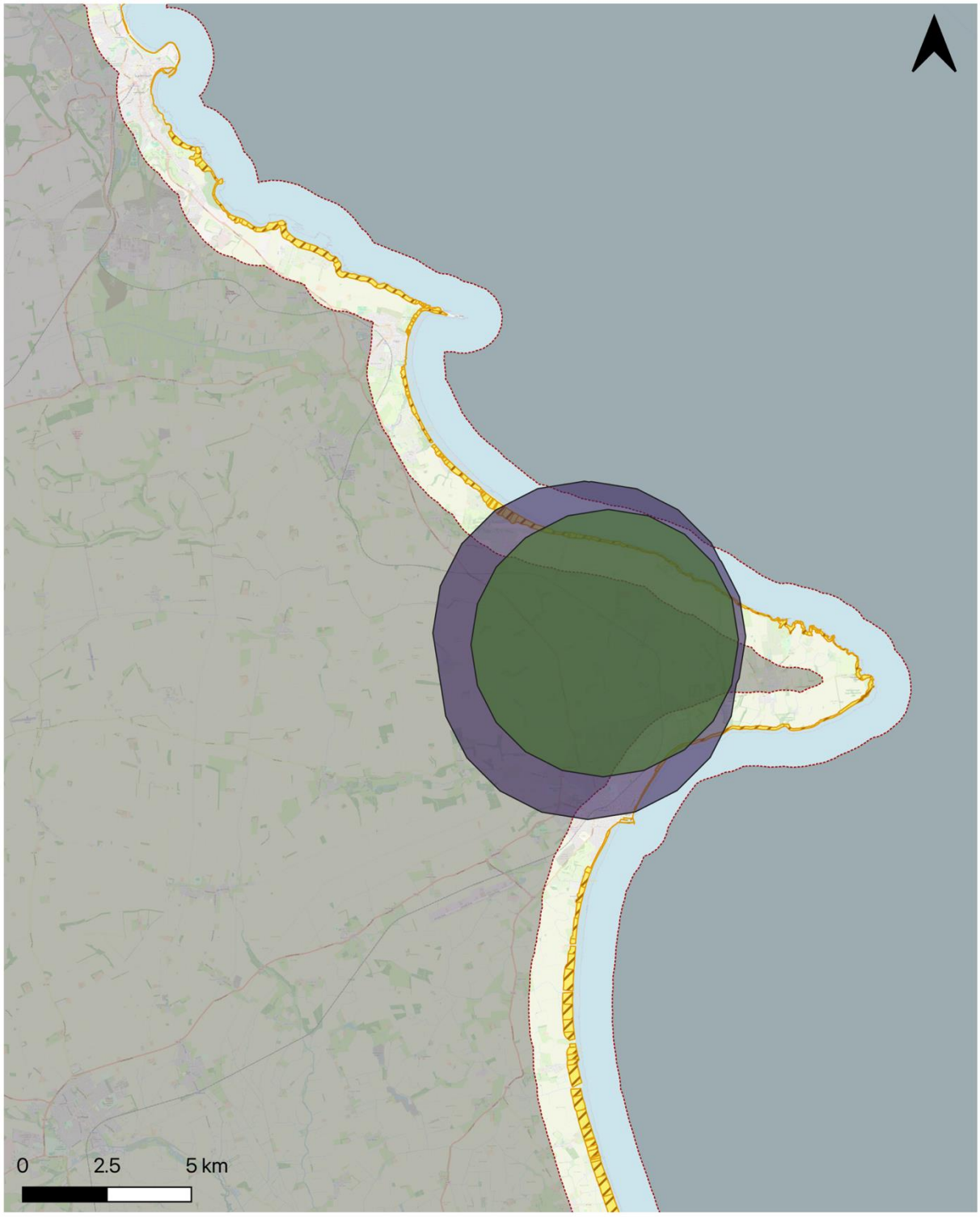

Figure 13: Soft sediment Severe and Major bottleneck zones shown alongside the habitat coverage (red) and the predicted extent of coastal erosion by 2015 (orange and red hatched).

Rivers and Coastal Streams

The severe bottleneck zones for river and coastal streams cover the Gypsey Race, a 41.5km Winterbourne stream that runs out to the North Sea, the most northern chalk stream in the UK. The ecological status of the river is 'Bad', including for fish and invertebrates, as per the latest Water Body Classification (EA, 2023). While significant work to improve the river has been done by the Hull and East Riding Catchment Partnership, as a heavily modified water body with water pollution and over-abstraction pressures, the identified bottlenecks add another pressure that can potentially exacerbate the current state.

Although geologically isolated, enhancing this chalk stream through connectivity to the wider water network across North Yorkshire, both above and below ground, can support the recovery of this globally rare habitat. As outlined in the Chalk Stream Restoration Strategy (2021), re-naturalising chalk streams and reconnecting floodplains can help improve water flow and quality. As shown in Figure 14, this is also highlighted by the habitat network expansion and enhancement area covering the full extent of the stream. Although due to landscape geomorphology, the Gypsey Race will not connect directly to the web of key nearby rivers and coastal streams, enhancing the quality and the functional connectivity of this stream to its wider catchment could help support effective movement, shelter and feeding for chalk stream species.

Figure 14 shows that this bottleneck zone sits within a landscape of connectivity opportunity. Large areas are predicted to be at risk of flooding by rivers and seas in the south of the study area, presenting an opportunity to reconnect the floodplain and allow rivers to connect naturally. By contrast, limited flooding is predicted north of the study area, but there is greater coverage of river obstacles (e.g., weirs, dams and sluices). Removing obstacles can help river flow and connectivity across its catchment. Greater access to rivers and coastal streams across their catchment and floodplain extent can help support salmon, trout, and eel movement and migration.

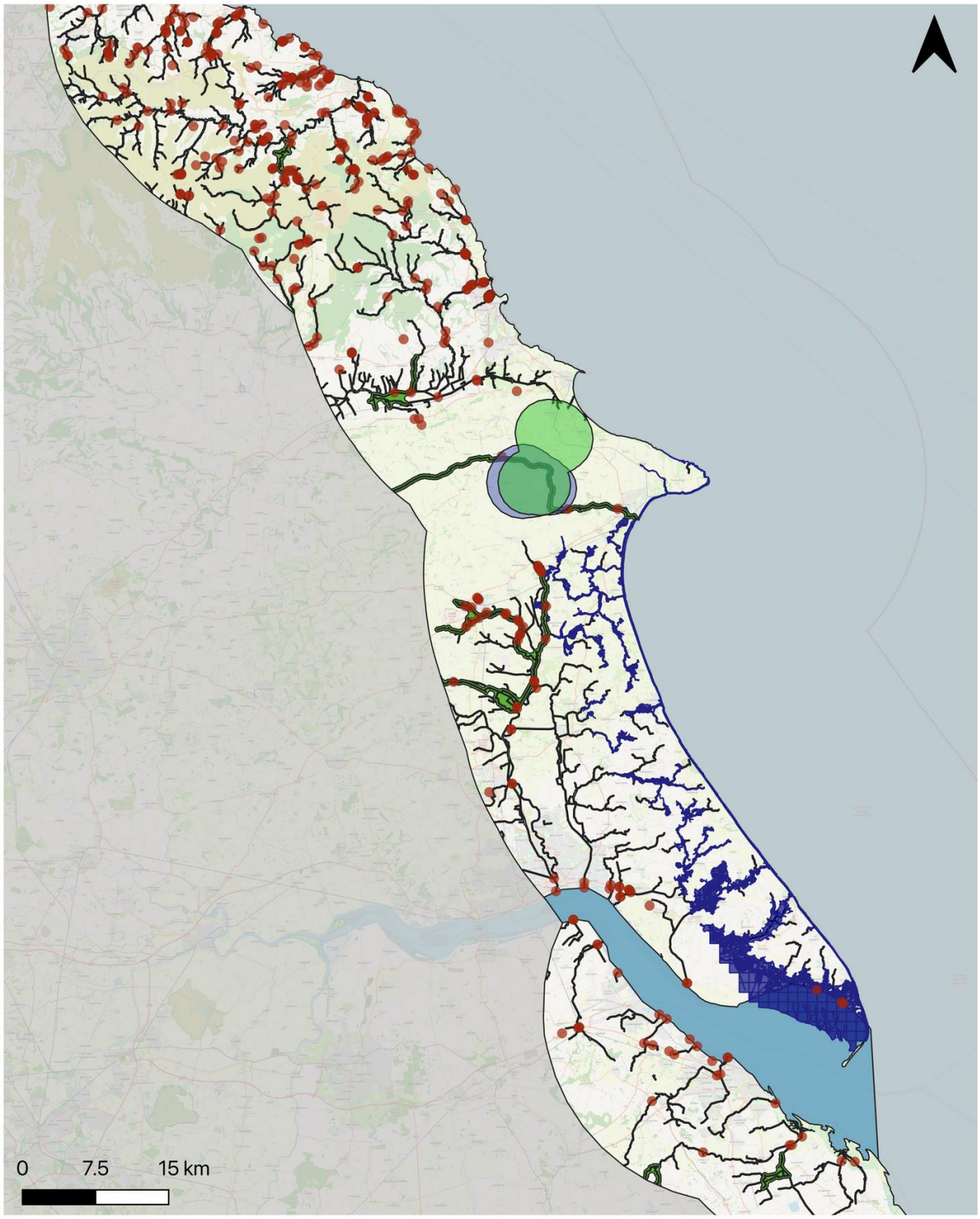

Figure 14: Severe bottleneck zones for rivers and coastal streams at 10km and 20km scales. Shown with the river network enhancement zone (green), risk of flooding for rivers and sea (dark blue), river obstacles (red points) and the initial core river and coastal stream habitat (light blue).

Conclusions and Recommendations

Summary

Overall, this analysis has identified several important bottlenecks in habitat connectivity across four main habitat types used to represent the landscape and species of the Yorkshire Coastline: Wetlands, Designated Coastal Cliffs, Coastal Soft Sediment habitats, and Rivers and Coastal Streams. The bottlenecks identified have highlighted areas across the habitat coverage at different spatial scales from the coastline, where connectivity for representative species is most strained.

Wetland habitats had the strongest and most widespread severe bottleneck zones of all habitats assessed. Within these bottlenecks are opportunities for enhancing and expanding wetlands, creating corridors and stepping stones for species and creating more areas of functionally linked land to Yorkshire's Internationally Designated Sites. Severe bottleneck zones for soft sediment habitats and river and coastal stream habitats, on the other hand, were restricted to one location. Similar to wetland habitats, the identified bottleneck zone was an area suitable for habitat expansion and enhancement, containing opportunities to support greater connectivity for these habitats. The bottleneck for soft sediments also intersected the King Charles III England Coast Path, which provides the opportunity to control and potentially alleviate a recreational disturbance pressure on species movement. The opportunity to reduce impacts through recreational pressure was also highlighted for the designated coastal cliff habitat bottlenecks. Although the bottlenecks for this habitat were relatively weak, and suitable habitat has geological and geomorphological limitations, the locations provide insight into where bottlenecks in nesting sites may occur along the coastline.

Overall, the bottleneck outputs, notably for wetland habitats, have provided indicative locations of possible strain on habitat connectivity along the North Yorkshire coastline and where action could be most effective to help alleviate this.

Recommendations

To develop this analysis and support enhancing connectivity for these habitats, the following recommendations are provided:

- Overlay bottleneck outputs with other datasets to identify more levers and opportunities to alleviate connectivity pressures and support bigger and better habitat networks. Including species distribution data to understand where populations are most affected by bottlenecks.
- Conduct baseline surveys and assess other habitat data to re-run additional analysis on more accurate data, and ground-truth the results to assess the potential for habitat creation and enhancement development.
- Work with landowners to encourage appropriate land management, which can help provide additional connective routes for species and provide ground-truthed data. Condatis modelling could be undertaken at the farm-cluster scale.
- Enhancing adjoining habitats of the King Charles III England Coast Path and the Cleveland Way National Trail will increase the availability of habitats for species to use and move through, and directly contribute to Coastal Wildbelt and its broader target ambitions.
- Use the bottleneck locations to help inform intentional public engagement and recreational management, identifying examples of balanced recreational access and management for vulnerable species, particularly in busy coastal areas. This will ensure that important habitat connectors for species are exposed to limited recreational pressure and that areas with less connectivity strain can provide access and nature engagement for the public.

References

Reference List

Arc Consulting Isle of Wight Ltd (2022) *An assessment of opportunities for the ecological enhancement of coastal infrastructure in North and East Yorkshire*. Yorkshire Marine Nature Partnership. Available at: https://yorkshiremarinenaturepartnership.org.uk/wp-content/uploads/2022/05/22-04-21-Yorkshire_Ecological_Enhancement_Opportunities_FINAL.pdf (Accessed: 26 March 2025).

Catchment Based Approach (2022) *Chalk Stream Restoration Strategy 2021 and Implementation Plan 2022.* Available at: https://catchmentbasedapproach.org/wp-content/uploads/2022/11/CaBA-CSRG-IMP-PLAN-FINAL-25.11.22.-V2.pdf (Accessed 21 March 2025).

Davison-Smith, H. (2024) *Nature Recovery in Yorkshire's Coastal & Marine Environments: An outline strategy*. Yorkshire Marine Nature Partnership. *Unpublished draft document.*

Environment Agency (2023) *Gypsey Race from Source to North Sea*. Available at: https://environment.data.gov.uk/catchment-planning/WaterBody/GB104026072790 (Accessed: 26 March 2025).

Fayet, A.L., Clucas, G.V., Anker-Nilssen, T., Syposz, M., and Hansen, E.S. (2021) 'Local prey shortages drive foraging costs and breeding success in a declining seabird, the Atlantic puffin', Journal of Animal Ecology, 90(5), pp. 1152–1164. DOI:10.1111/1365-2656.13442.

Gutierrez-Arellano, C., Crick, H.Q.P., Cowling, D., Drake, L., Hawkins, V., Newland, L., Taylor, S., Travers, T.J.P. & Hodgson, J.A., 2024. *Informing nature recovery in England by analysing "bottlenecks" in broad habitats.* Natural England Commissioned Report [NECR499]. York: Natural England.

Langston, R.H.W & Boggio, S. (2018). North Sea Gannet Tracking Year 1 Report. Offshore Energy Strategic Environmental Assessment 2. Available at: https://assets.publishing.service.gov.uk/media/5a7b4a6be5274a319e77e4d9/OESEA2_North_Sea_Gannet_Tracking_Year1_Report.pdf

Mancini, F., Hodgson, J.A. & Isaac, N.J.B., 2022. *Co-designing an Indicator of Habitat Connectivity for England.* Frontiers in Ecology and Evolution, 10, 892987. DOI: 10.3389/fevo.2022.892987.

Manning, W.D., Scott, C.R and Leegwater. E. (eds) (2021). *Restoring Estuarine and Coastal Habitats with Dredged Sediment: A Handbook. Environment Agency, Bristol, UK.*

National Trails (2025) *National Trails Nature Recovery Toolkit v1*. Available at: https://www.canva.com/design/DAGecLSjBho/_n4SdJUzd5YLYUWJ2podgA/view?utm_content=DAGecLSjBho&utm_campaign=designshare&utm_medium=link2&utm_source=uniquelinks&utlId=h14b571ca40#1 (Accessed: 26 March 2025).

Natural England, 2022. *User Guide for Natural England's Priority Habitat Inventory v3.0.* [pdf] Available at: https://environment.data.gov.uk/api/file/download?fileDataSetId=d30e3fa2-5ca6-4851-b19d-1429ad9d84e0&fileName=User%20Guide%20for%20Natural%20England%27s%20Priority%20Habitat%20Inventory%20v3.0%20Nov2022.pdf[Accessed 23 March 2025]

North Yorkshire Council, 2024. *Gull Strategy*. [pdf] Available at: https://edemocracy.northyorks.gov.uk/documents/s40902/Gull+Strategy.pdf [Accessed 26 March 2025].

Patterson, A., Gilchrist, H.G., Benjaminsen, S., Bolton, M., Bonnet-Lebrun, A.S., Davoren, G.K., Descamps, S., Erikstad, K.E., Frederiksen, M., Gaston, A.J., Gulka, J., Hentati-Sundberg, J., Huffeldt, N.P., Johansen, K.L., Labansen, A.L., Linnebjerg, J.F., Love, O.P., Mallory, M.L., Merkel, F.R., Montevecchi, W.A., Mosbech, A., Olsson, O., Owen, E., Ratcliffe, N., Regular, P.M., Reiertsen, T.K., Ropert-Coudert, Y., Strøm, H., Thórarinsson, T.L. and Elliott, K.H., 2022. Foraging range scales with colony size in high-latitude seabirds. Current Biology, 32(17), pp.3800-3807.e3. DOI:10.1016/j.cub.2022.06.084.

Robins, J., Evans, P. & Hodgson, J.A., 2014. *Condatis Case study – Buglife B-lines. Online report*. Available at: www.condatis.org.uk.

Rogers, D.I. (2003) High-tide roost choice by coastal waders. Wader Study Group Bulletin, 100, pp. 73–79. Available at: https://www.researchgate.net/publication/284902988_High-tide_roost_choice_by_coastal_waders (Accessed: 26 March 2025)

Rothwell, J., Latham, J. & Hodgson, J.A., 2014. *Condatis Case study – Woodland Protected Areas in Wales. Online report*. Available at: www.condatis.org.uk.

Scottish Seabird Centre (2023) *Returning seabirds*. Available at: https://www.seabird.org/blog/returning-seabirds(Accessed: 26 March 2025)

Travers, T., 2022. *Planning Ecological Networks to Enable Long-distance Connectivity*. University of Liverpool.

Walker, A.M., Godard, M.J. and Davison, P., 2014. The home range and behaviour of yellow-stage European eel Anguilla anguilla in an estuarine environment. Aquatic Conservation: Marine and Freshwater Ecosystems, 24(2), pp.155–165. DOI:10.1002/aqc.2380.

Data Sources

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Additional resources:

Creating rasters: QGIS Raster Creation page

Condatis help: Condatis Training Resources

Methodology paper to use Condatis for Nature Recovery Projects: Informing nature recovery in England by analysing "bottlenecks" in broad habitats (Natural England, 2024)

Example of Condatis used at the Farm Cluster scale: Condatis Connectivity analysis for the Chilterns National Landscape

Habitat Connectivity along the Yorkshire Coast

This report was produced for National Trails UK by Nature Data Solutions.

National Trails UK is dedicated to preserving and promoting the stunning National Trail network across the UK, believing that everyone should have access to these landscapes.

Nature Data Solutions specialises in geospatial intelligence for nature recovery.

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