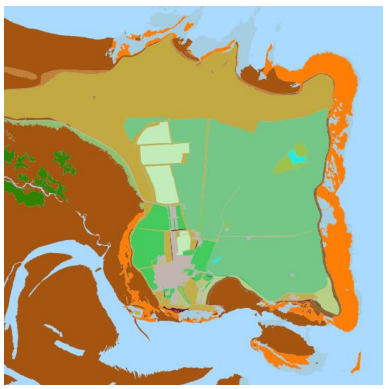
Northeast Coastal Monitoring Programme: Cell 1 Terrestrial Ecological Mapping 2017



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1 Introduction

1.1 Project background

This report was commissioned by Scarborough Borough Council, on behalf of the North-east Regional Coastal Monitoring Programme. Through conducting a range of surveys including aerial, bathymetric, wave and tidal surveys, and ecological mapping, the programme aims to promote and implement a repeatable, standard, and cost-effective method of monitoring the coastal environment.

The overall objectives of the programme are to provide data that meet the operational monitoring requirements of shoreline management plans, coastal strategies and individual schemes, between the limits of the Flamborough Head, Yorkshire to Cockburnspath, Scottish Borders. This report focusses on the ecological mapping component of the programme. It is intended that this in turn will inform action plans and strategies for coastal management in the future.

The requirement for coastal and terrestrial habitat mapping is primarily based upon the needs of the main Regional Coastal Monitoring Programme partners, including the Local Authorities and the Environment Agency. These operating authorities have a statutory obligation to conserve and enhance biodiversity under the Natural Environment and Rural Communities (NERC) Act 2006, as well as contribute to the reporting and monitoring requirements for, Natura 2000 sites (designated by the EU Habitats and EU Birds Directives), Sites of Special Scientific Interest (designated under the Wildlife and Countryside Act 1981, and Countryside and Rights of Way Act 2000), and for reporting to the Convention on Biological Diversity and its associated Aichi Targets.

National Indicator 197 (NI197) measures the performance of Local Authorities in protecting and improving local biodiversity via the proportion of Local Sites where positive conservation management has been or is being implemented. The habitat extent data reported because of the mapping work will help satisfy the NI197 target by demonstrating whether the area has maintained or increased in area.

The coastal and terrestrial mapping is to support wider strategic planning and nature recovery programmes and projects. Local Nature Partnerships (LNPs) launched, by the Natural Environment White Paper in 2011 and supported by the UK National Ecosystem Assessment (UKNEA), will be able to use the mapping data to help strategically inform sustainable land use and management policies, green economic growth and enhance quality of life and local health and wellbeing.

Spatial ecological mapping data is used to assess the impacts on European designated sites of Shoreline Management Plans (SMP), Flood and Coastal Defence Strategy Studies and Flood and Coastal Defence schemes. If any such scheme exerts a significant effect on a Europa Natura 2000 site, a Habitats Regulations Assessment (HRA) will then need to be undertaken by a competent authority. Habitat extent data and changes over time are crucial for undertaking a thorough HRA.

The principal objectives are to provide priority habitat extent data for:

- Identification and quantification of regional coastal change
- Providing contextual information to support HRA for Shoreline Management Plans, Flood and Coastal Defence Strategies and Flood and Coastal Defence Schemes
- Assessing losses and gains for the Environment Agency's Regional Habitat Creation Programme
- Identification and strategic consideration of coastal flood and erosion risks

- Assisting development of nature conservation programmes and projects

The mapping project consisted of four main tasks:

- Task 1: Map the extent of all coastal and terrestrial Priority Habitats within the study region, using 2017 aerial photography
- Task 2: Analyse the extent of habitat change between the 2017 habitat data, and the previous 2012/13 habitat data
- Task 3: Map the extent of all coastal and terrestrial Priority Habitats within the study region, using 1940's aerial photography
- Task 4: Analyse the extent of habitat change between the 1940's habitat data, and the 2017 habitat data

1.2 Study area

Habitat mapping was carried out for the north-east England and south-east Scotland coast extending from Flamborough, Yorkshire to Cockburnspath, Scottish Borders, including any major estuaries; a total area of 28,946.90.

The ecological mapping requirement for the ANE01 region is divided into three sub-regions with areas ranging from ~5,900 ha to ~13,200 ha as described in Table 1.1 and displayed in Figure 1.1.

Table 1.1: Sub-regions of the North-east Coastal Monitoring Programme and their areas

Sub-region	Area (ha)
ANE01-01	5,880.33
ANE01-02	9,885.38
ANE01-03	13,185.17

1.3 Habitats included in the study

The study made use of the Integrated Habitat System (IHS). Habitats used in the study are listed in

Table 1.2, Table 1.3 and Table 1.4. The list contains priority habitats (excluding hedgerows) plus supporting and additional habitats. The selection of additional habitats was guided by analysis of existing habitat data for the region, and visual analysis of the aerial photography to determine habitats present.

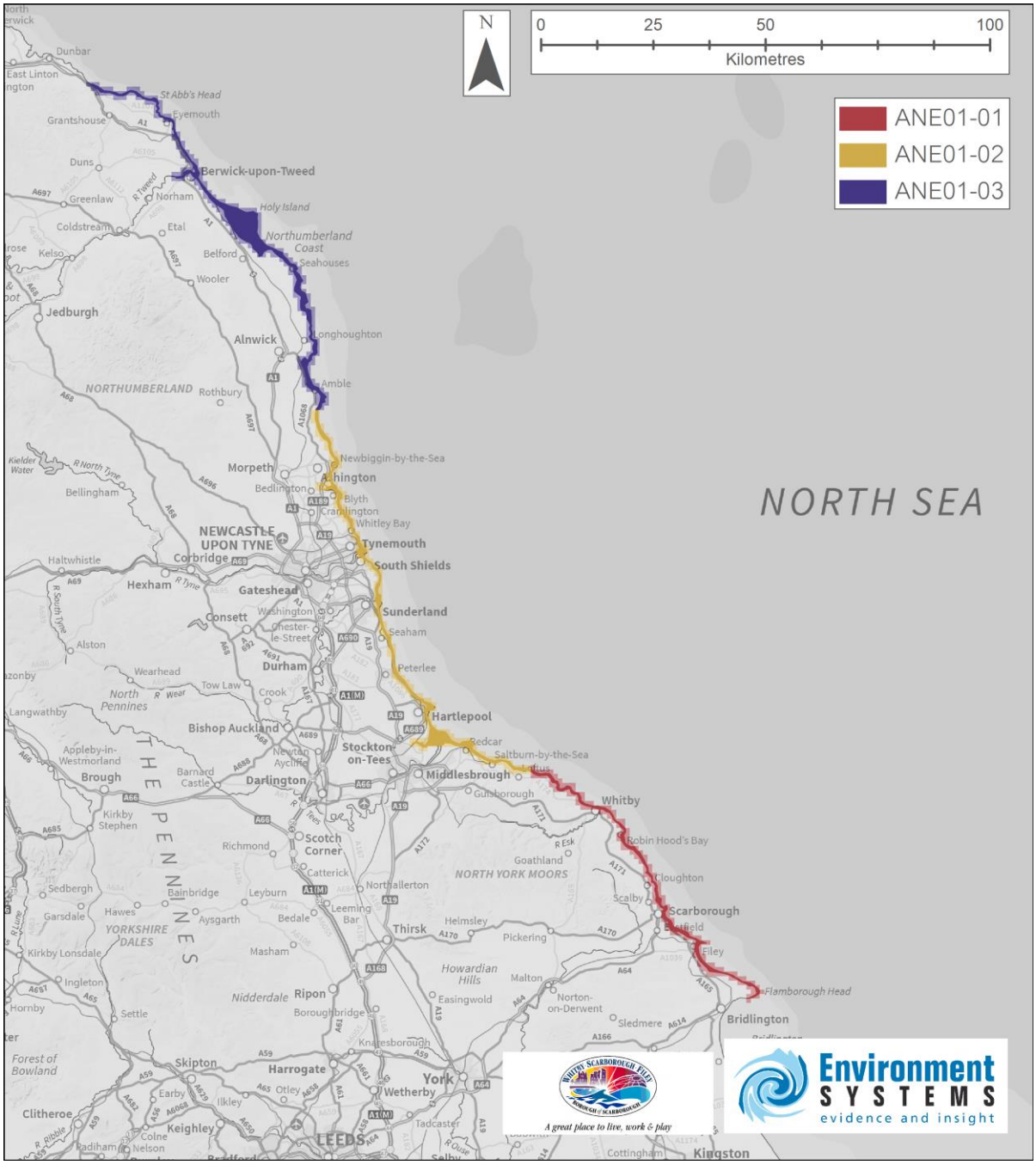

Figure 1.1: ANE01 coastal habitat mapping area Flamborough, Yorkshire to Cockburnspath, Scottish Borders divided into sub-regions

Table 1.2: IHS priority, supporting and additional habitats selected for classification

Broad priority habitat	Priority habitat	Supporting habitat
Broadleaved, mixed and yew woodland	WB31 Upland oakland WB32 Upland mixed ashwood WB331 Lowland beech and yew woodland WB34 Wet woodland WB35 Upland birch woodland WB36 Lowland mixed deciduous woodland FT1 Traditional orchard	WB3 Broadleaved woodland WB3Z Other broadleaved woodland

Broad priority habitat	Priority habitat	Supporting habitat
Coniferous woodland	WC1 Native pine woodland	
Acid grassland	GA1 Lowlands dry acid grassland	
Calcareous grassland	GC1 Lowland calcareous grassland GC2 Upland calcareous grassland	
Neutral grassland	GN1 Lowland meadow GN2 Upland hay meadow GN4 Grazing marsh pasture	GN3 Coarse neutral grassland GNZ Other neutral grassland
Bog	EO1 Blanket bog [Blanket bog] EO2 Lowland raised bog	
Fen, marsh and swamp	EM11 Reedbed EM31 Fen [lowland] EM32 Fen [upland] EM4 Purple moor grass and rush pasture	AS0 Standing open water and canal
Standing open water and canal	AS11 Natural dystrophic lakes and pond AS21 Oligotrophic lake AS31 Mesotrophic lake AS4 Eutrophic standing water AS7 Aquifer fed naturally fluctuating water bodie AP1 Pond	
River and stream	AR0 River and stream	
Arable and horticulture	CR61 Arable field margin	
Supralittoral rock	SR1 Maritime cliff and slope	
Supralittoral sediment	SS1 Coastal sand dune SS2 Machair SS31 Coastal vegetated shingle	SS19 Unvegetated sand and dunes above the high tide mark SS1Z Other sand dune SS3Z Unvegetated shingle above the high tide mark
Littoral rock	LR1 Intertidal chalk LR3 Sabellaria alveolata reef LR4 Intertidal underboulder communitie	LRZ Other littoral rock
Littoral sediment	LS2 Seagrass bed - Zostera noltii adjacent to saltmarsh LS3 Coastal saltmarsh LS4 Intertidal mudflat LS5 Sheltered muddy gravel	LS6 Intertidal shingle LSZ Other littoral sediment
Sublittoral sediment	LS7 Blue Mussel Beds on sediment IR7 Horse mussel bed IS2 Subtidal sand and gravel [inshore] IS3 Seagrass bed - Zoostera marina & Z. angustifolia located on mid to lower foreshore and sub littoral zone IS4 Maerl bed IS5 Saline Lagoons with restricted sea connection AS61 Saline Lagoons with no sea connection IS6 Serpulid reef	
Sublittoral rock	CS1 Cold-water coral reef (Lophelia pertusa reef)	

Broad priority habitat	Priority habitat	Supporting habitat
	IR2 Sabellaria spinulosa reef IR5 Tide-swept channel IR6 Subtidal chalk	
Inland rock	PI1 Calaminarian grasslands of the Violetalia Calaminariae	
Built-up area and garden		UR0 Built-up area and garden
Scrub		SC0 Scrub
Arable		CR0 Arable and horticulture
Improved grassland		GI0 Improved grassland
Dwarf shrub heath		HE0 Dwarf shrub heath

Table 1.3: Additional IHS habitats identified for classification

Broad additional habitat	IHS code
River and stream	AR5 Estuarine saline water and sea ARZ Other river and stream
Standing open water	AS6 Brackish standing water with no sea connection AS62 Brackish AS63 Very brackish
Bracken	BR0 Bracken BRZ Other continuous bracken
Arable	CR3 Non-cereal crop including woody crop CR5 Whole field fallow CR6 Arable headland or cultivated strip
Fen, marsh and swamp	EM1 Swamp EM13 Bolboscheoenus maritimus dominant community EM18 Tussocky swamp vegetation EM1Z Other swamp vegetation EM2 Marginal and inundation vegetation EM21 Marginal vegetation EM22 Inundation vegetation EM3 Fen
	FT0 Orchard
Calcareous grassland	GC0 Calcareous grassland
Maritime grassland	GM1 Festuca rubra maritime grassland GMZ Other maritime grassland
Neutral grassland	GN0 Neutral grassland GN5 Inundation grassland GN6 Sea wall grassland
Heathland	HE1 European dry heath HE2 Wet heath
Inshore rock	IRZ Other sublittoral rocks
Inshore sediment	IS0 Inshore sublittoral sediment
Boundary and linear features	LF11 Hedges/line of trees LF12 Line of trees LF2 Other boundary and linear feature LF24 Dry ditch
Littoral rock	LR42 Intertidal communities on natural boulder formation with algal cover LR5 Littoral built structure

Broad additional habitat	IHS code
	LR6 Littoral rock pool community LR7 Littoral rock exposure
Littoral sediment	LS0 Littoral sediment
Unknown terrestrial vegetation	OV3 Undetermined young woodland
Inland rock	RE0 Inland rock RE1 Natural rock exposure feature RE2 Natural rock exposure and waste
Supralittoral rock	SR0 Supralittoral rock SR2 Maritime cliff and slope
Supralittoral sediment	SS12 Shifting dune along the shoreline SS3 Shingle above high tide mark SS4 Strandline vegetation SSZ Other supralittoral sediment
Broadleaved woodland	WB1 Mixed woodland WB2 Scrub woodland
Conifer woodland	WCZ Other coniferous woodland

Table 1.4: IHS habitat complex codes used in the mapping.

Habitat complex	Habitat complex code
Coastal and floodplain grazing marsh	CF1 Coastal and floodplain grazing marsh
Maritime cliff and slopes	MC1 Maritime cliff and slopes
Lowland heathland	HL1 Lowland heathland
Upland heathland	HU1 Upland heathland
Tidal	TD1 Tidal

2 Method

2.1 Data and data processing

A suite of aerial photography (AP) was made available to the project to facilitate habitat mapping by aerial photograph interpretation (API). The AP imagery consisted of red/green/blue (RGB) and near infra-red (NIR) photography captured in 2017, supplied in Enhanced Compression Wavelet (ECW) format at 0.1 m pixel size, and delivered as individual 10*10 km tiles, following the Ordnance Survey (OS) reference grids. Figure 2.1 illustrates the range of capture dates for each of the region.

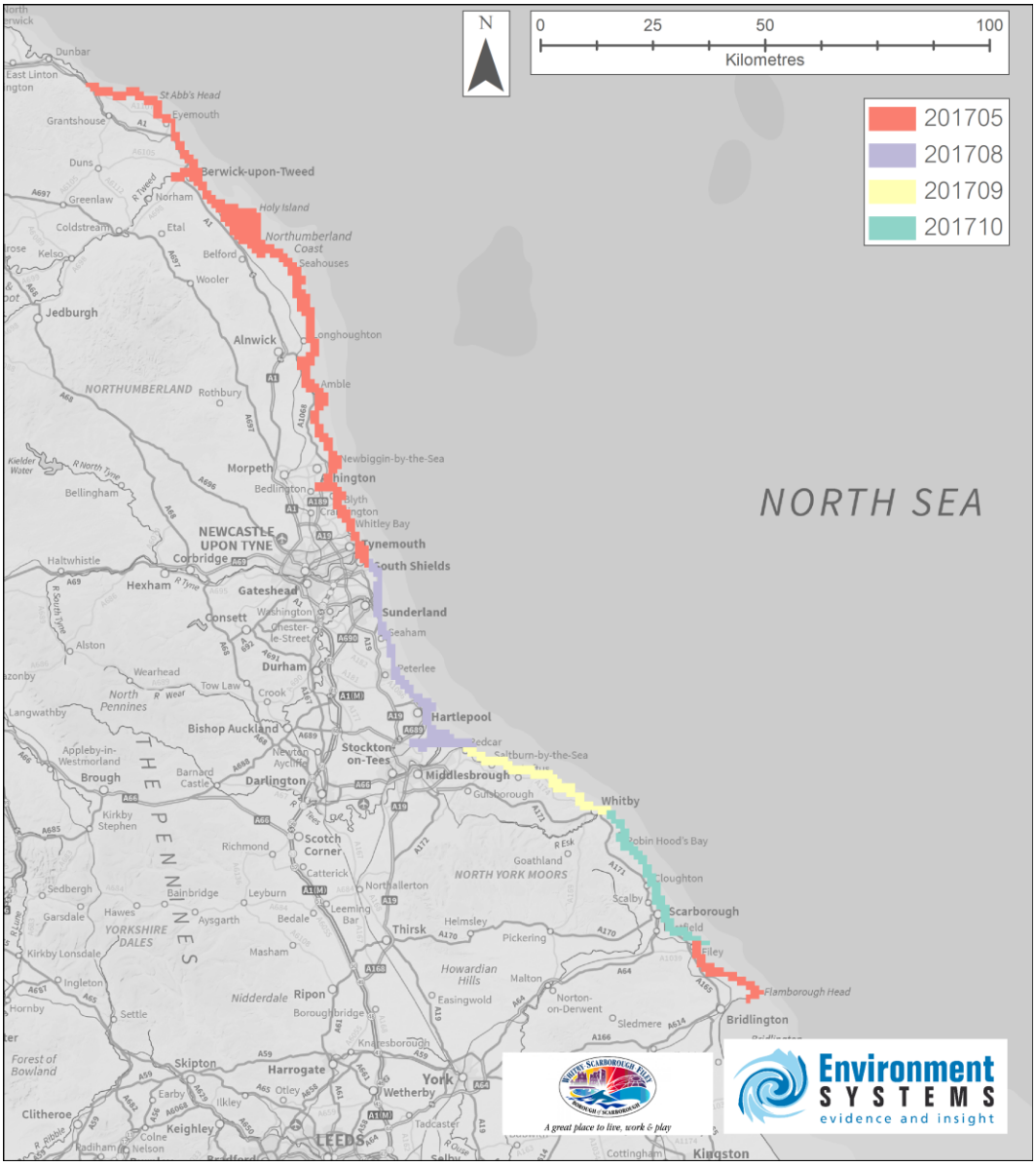

Figure 2.1: Dates (in YYYMM) of aerial photography capture within ANE01

Each ECW RGB and NIR tile were converted from their original data format to GeoTiff, an Open Geospatial Consortium (OGC) recognised data format. The two datasets for each corresponding datetime (i.e. the RGB and CIR datasets for the same capture date) were combined into a single four-band dataset (i.e., blue, green, red and near infra-red), for ease of analysis and interpretation. For image segmentation purposes, the four-band dataset was resampled to 0.5 m spatial resolution to reduce the required computational power and processing speed, but maintain the required precision. For API purposes, the 10*10km were not resampled but were instead mosaicked into a single, all-encompassing dataset, for ease of interpretation.

2.2 Image segmentation

Polygons for the 2017 and 1940's habitat map were produced by automated image segmentation. The AP, OS OpenData and manually digitised urban areas were imported into Trimble eCognition software, and processed via a multi-resolution segmentation algorithm. The segmentation process analyses each pixel location for each specified data layer, and groups pixels of similar characteristics together to form 'objects', following spatial changes in land cover type.

The segmentation process follows user-defined parameters relating to the scale and compactness of the objects to be produced, and any weightings to be applied to specific image bands. Trial segmentations were produced in order to determine appropriate segmentation parameters; chosen to produce sub-minimum mapping unit (MMU) scale objects, which would be aggregated during the manual API procedure. Areas of open water and urban were delineated either manually or through the ancillary OS attribution.

In order to maintain compatibility with the existing habitat mapping attributes for the analysis of change detection, the segmentation routine incorporated the previous habitat IHS codes. Image objects were exported to polygon shapefile format for each image-processing tile. Tiles were then merged together to provide a single polygon shapefile layer per OS 10 km grid. A subset example of an output segmentation is shown in Figure 2.2.

Figure 2.2: Example subset of a merged image segmentation output from OS tile NZ52

2.3 Aerial photographic interpretation

IHS habitat attribution was carried out through manual API within QGIS software. An overview of the 1940's and 2017 habitat mapping process is shown in Figure 2.3.

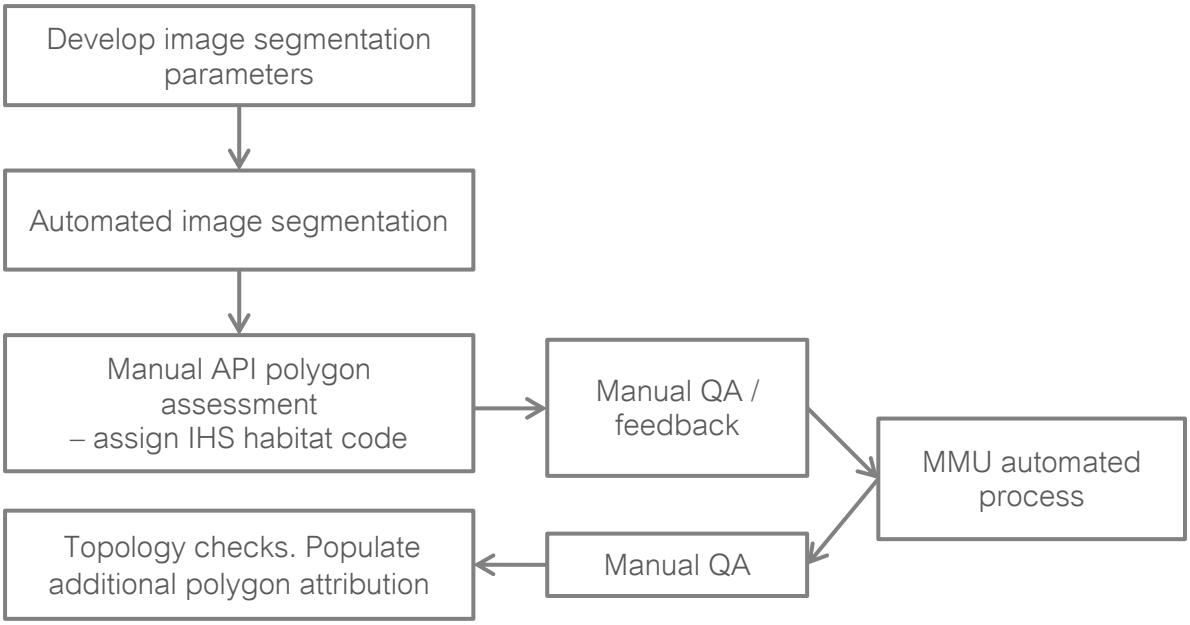

Figure 2.3: Overview of 2017 habitat mapping methodology

For the 2017 mapping, habitat object polygons for individual OS 10 km grids were processed and supplied to the ecological analysists for manual editing and interpretation. The entire range of IHS habitat codes were made available via a dropdown menu developed in-house, which were used to attribute individual or multiple selected polygons. The ecologists were able to cut and re-shape polygons by manual editing, if required. A variety of data sources to inform the habitat attribution decisions including;

- 2017 aerial ortho-photography, including infra-red imagery
- Ground survey data
- Google Earth
- Google Street View
- Environment Agency saltmarsh dataset
- 2012/13 habitat map
- OS OpenData™ high tide limit polyline.

2.4 Quality assurance

Quality assurance (QA) comprised a manual assessment of polygon attribution using the same reference material available during the API phase. The accuracy of polygon shape and transitions between habitats was also checked at this stage.

The proportion of area deemed for QA was set at 10% of the area of interest. This was achieved by splitting each region to be mapped into 1 km grids using OS OpenData, and through QGIS applying a random 10% selection based on grid size. Minor, manual adjustments were made to ensure the selected 1 km grids were not wholly located within an open water environment or comprised of mostly singular habitats (e.g., a tile that consist entirely of GN4 Grazing marsh pasture).

2.5 Feedback and map revision

Completed 10 km OS grids were submitted to Scarborough Borough Council and Royal Haskoning DHV for review, allowing a correctional period to incorporate feedback into the final dataset, before the minimum mapping unit (MMU) was applied, described below.

2.6 Minimum mapping unit

The MMU describes the minimum size for features to be included into their respective habitats. Four minimum polygon size thresholds were used, depending on whether habitats are most commonly found in small or larger patches. The automated image segmentation method of analysis facilitates the identification of many small, discrete habitat types. For this reason, following discussion with stakeholders, the initial project MMU thresholds were revised and reduced for many of the priority and supporting habitats. Consideration was given to the scale of mapping used within previous Regional Coastal Monitoring Programmes. Appendix A – Polygon area thresholds used to define habitat MMU lists the MMU thresholds used for each habitat type.

The MMU process was carried out such that polygons falling below the minimum area thresholds were merged into the neighbouring polygons with which it shared the longest common boundary. The MMU process was carried out using Feature Manipulation Engine (FME) software. The MMU output was quality assured using FME, in a process which manages the geometric translation of spatial datasets between digital formats.

2.7 Internal consistency checks

Before and after the MMU stage, the entire dataset was automatically and manually checked for inconsistencies, then cleaned for final delivery.

Data geometries were repaired and snapped within a tolerance of 0.01 m, correcting for errors such as self-intersections. The data were dissolved into 'flat' files that were analysed for gaps and checked for overlaps, which were removed by overlaying data on top of itself.

At this point, the MMU process was run to remove and reclassify any small features which do not qualify for mapping. The established MMUs ensured that no polygons below these size thresholds were included in the final dataset. The data were visually checked for errors at this stage.

A final cleaning process was applied on the final dataset, to ensure that there were no overlaps, and that the polygon vertices remained snapped.

3 Ground Field Surveys

A series of ground surveys were conducted for validation of the habitat attribution assigned by API. This section provides details on the methods used to undertake these field surveys.

Candidate areas for ground survey were chosen through a random selection process of the 2017 IHS habitat dataset. The 2017 IHS classification was divided into 1 km OS grids, with entire grids of habitat data selected at random using the QGIS Research Tools functionality, so that the number of OS grids selected was proportional to the size of the sub-region. These OS grid squares of habitat data were used as candidate areas for field survey, subject to accessibility.

The ground survey was conducted in June 2019. A total of eight sites were surveyed with a total of 20 habitat polygons at each site.

3.1 Survey planning

Datasets for the survey were provided in a single shapefile format for field surveyors to review. The survey datasets were provided as 2017 attributed polygons split into randomly selected 1 km squares.

The datasets were reviewed by the survey manager and the field surveyors using aerial photography and OS data. The original grid squares were ranked by priority for field visits resulting in a subset of data for field survey. Various factors were considered when making the pre-selection of the field survey subset including:

- Geographic representation of habitats.
- Diversity of habitats.
- Habitat distribution across the project area.
- Noteworthy or unusual land features.
- Accessibility.

3.2 Access and health & safety

Access onto survey areas was appraised by the survey manager and field surveyor by investigating public rights of way (PROW) and identifying areas with restricted access (such as Ministry of Defence land and private land), all survey areas were designed to use PROW.

Risk assessments were developed for each survey series and the surveyor was required to use a SPOT Gen3 device and phone in at pre-arranged times whilst undertaking field visits. The SPOT Gen 3 device includes automatic tracking of the surveyor's movement and transmits the GPS location of the surveyor every five minutes for up to 24 hours. A survey itinerary was developed for the surveyor and any changes to the itinerary were notified to the project manager.

3.3 Surveyor experience

The surveys were conducted by Laura Cottrell MSc MCIEEM who has over ten years' experience in ecological survey including IHS, National Vegetation Classification and Phase 1 habitat survey.

The field surveyor is an experienced botanist and was able to identify the habitat types within the period of survey using flowering and vegetative characteristics of key plant species and other habitat features (such as the presence of limestone outcrops).

3.4 Survey schedule

The surveys were conducted between the 10th and 14th of June 2019. The weather during the surveys was overcast with rain showers and not considered a constraint to the survey effort and subsequent result.

3.5 Initial assessment

Each site was initially walked over to assess the coverage of vegetation and different habitat types. Access to difficult to reach areas was also assessed. Habitats in areas of the sites that were visually obscured and not accessible were not surveyed. Some polygons were identified using binoculars where habitats were homogenous or simple to identify (such as mud and sand flats).

3.6 Habitat classification

IHS codes had already been assigned to the majority of the polygons within each survey location, originating from the habitat attribution assigned by the Aerial Photography Interpretation (API).

Habitat classification was undertaken by identifying changes in vegetation communities or repeating patterns of homogenous areas in the walk-over surveys. Once variations in the

community structures became apparent then the habitats were identified. Habitats within the survey polygons were classified within the IHS classification system.

Where possible, habitats were defined to IHS level 2 (e.g., LS41: Mudflats and sandflats not covered by sea water at low tide). Matrix codes were not used in the assessments because mosaics were identified in a different manner (see below).

Once the habitats were assigned IHS codes these codes were compared with the existing codes assigned to each polygon. A justification was provided where there were discrepancies between the new and existing codes. Any codes which remained the same were not commented on.

3.7 Habitat mosaics

Habitat types can occur in mosaic formations and repeating patterns. Such linked habitat types can occur across large areas, showing little variation.

Repeating patterns of habitat types within polygons were assessed in the field and then the area of the mosaic noted. An estimate of the cover of each component of the mosaic was then recorded as a percentage. Up to three habitat types could be included within each mosaic.

3.8 Global Positioning System (GPS)

Site walks were recorded using handheld GPS units set to automatic tracking, which records the surveyor's location every 10—15 seconds. GPS units were set to Longitude/Latitude using the WGS84 projection.

Field data was collected using a customized mobile application developed using the Fulcrum platform and then deployed using iOS smartphones. At each field data point, the GPS location, date and time were automatically recorded. The user then recorded information on the IHS category and percentage of habitat cover in each polygon.

Many GPS units identify their precision up to 3 m away from the original point. In practice, such precision is not reliable and 5—10 m precision should be considered a more cautious estimate. It is also important to remember that the layout of the surroundings (e.g. dense tree cover) and the triangulation of satellites at the time of survey can also affect the accuracy of target notes and tracks.

3.9 Survey locations

Figure 3.1 illustrates the location of survey effort within each project region. Details of habitats found at each location can be found in Appendix B – Ground survey results (summary).

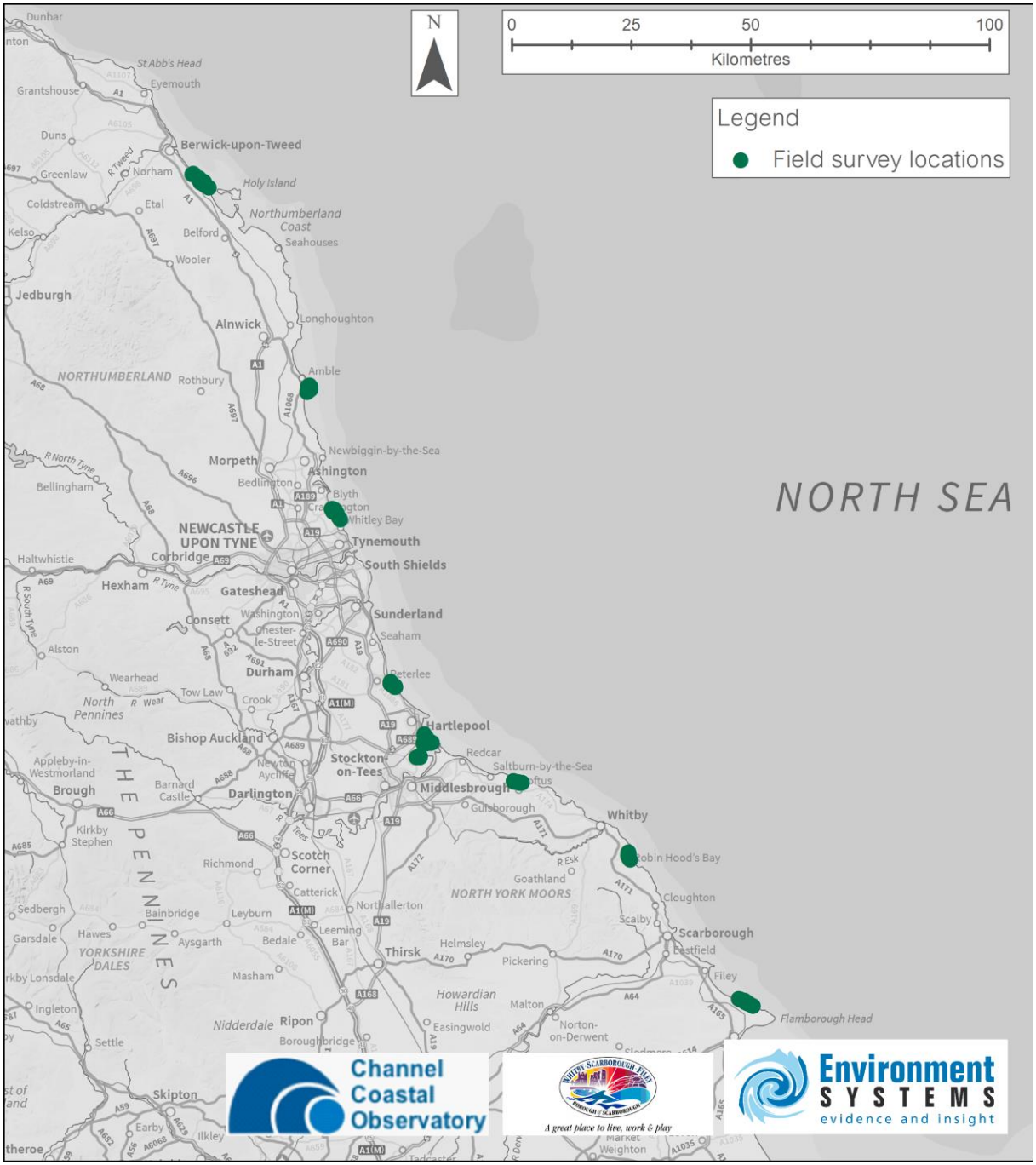

Figure 3.1: Location of ground survey areas for ANE01

4 Habitat spatial configuration

4.1 1940's habitat extent

This section graphically presents the total extent of each priority, supporting and additional habitat recorded in the region for the 1940's mapping. Figure 4.3 provides a summary of current priority habitat extents across the region of study, with Figure 4.4 and Figure 4.5 describing the extent of supporting and additional habitats, respectively.

These figures represent the habitat extents within the counties analysed for the ANE01 region. The combined totals of these counties represent the total habitat extents across the entire ANE01 region, with some exceptions described below.

For visual clarity, IHS habitats AR5 and GN0 are excluded from the figures, as the extent of these habitats far surpassed the normal distribution and impede a visual interpretation. The extents for these two IHS habitats are available in tabular form within Appendix C – 1940's IHS habitat extents

Another omission from the graphs are those habitat extents found within the ANE01 region area of interest and aerial photography, but outside the OS OpenData county boundaries. The majority of these habitats are littoral sediments and open water (e.g., LS4, LSZ and AR5). An example of this is displayed in Figure 4.1.

The final omission from the graphs are those habitat extents where no 1940's imagery is available for interpretation, or where the image quality is not high enough to be confident of its interpretation. The extent of these omissions is illustrated in Figure 4.2.

The total extents of all habitats across the region are available in tabular form in the project analysis spreadsheets.

Figure 4.1: Example of habitats occurring outside the OS OpenData county boundaries (dotted line) that are not included in the graphical representation of habitat extents

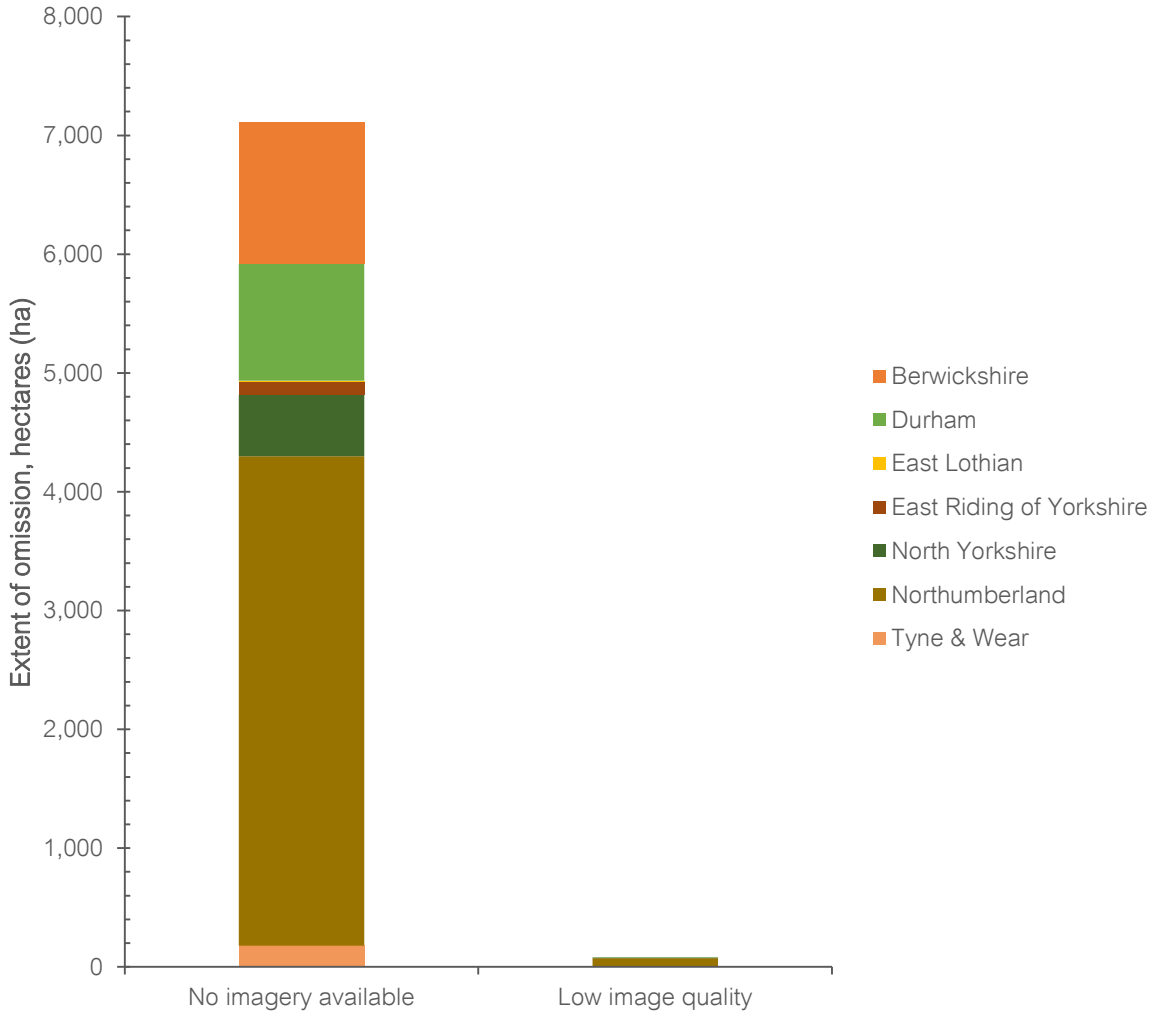

Figure 4.2: Extent of missing data, and reason in ANE01, 1940's

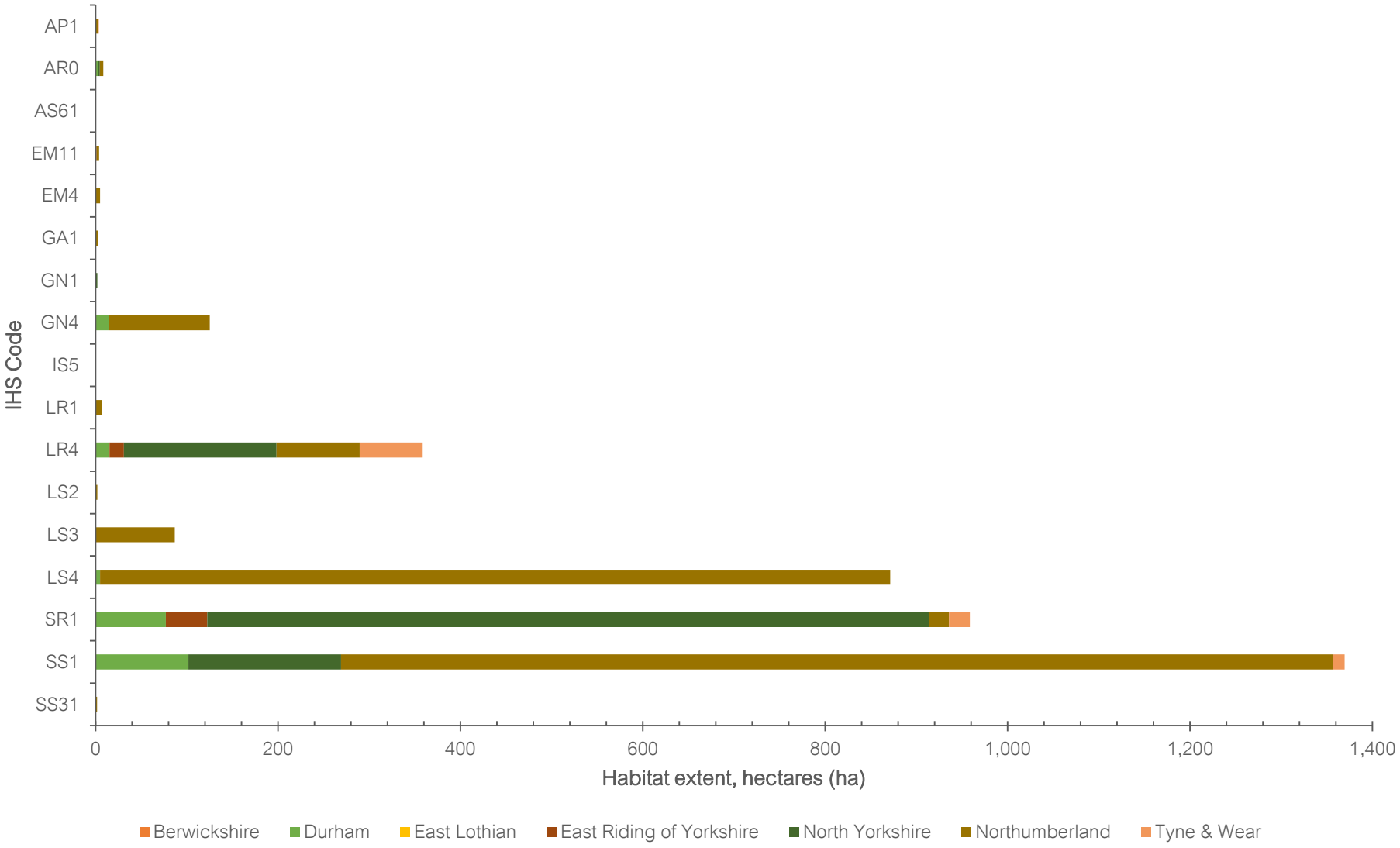

Figure 4.3: IHS priority habitat extents in ANE01, 1940's

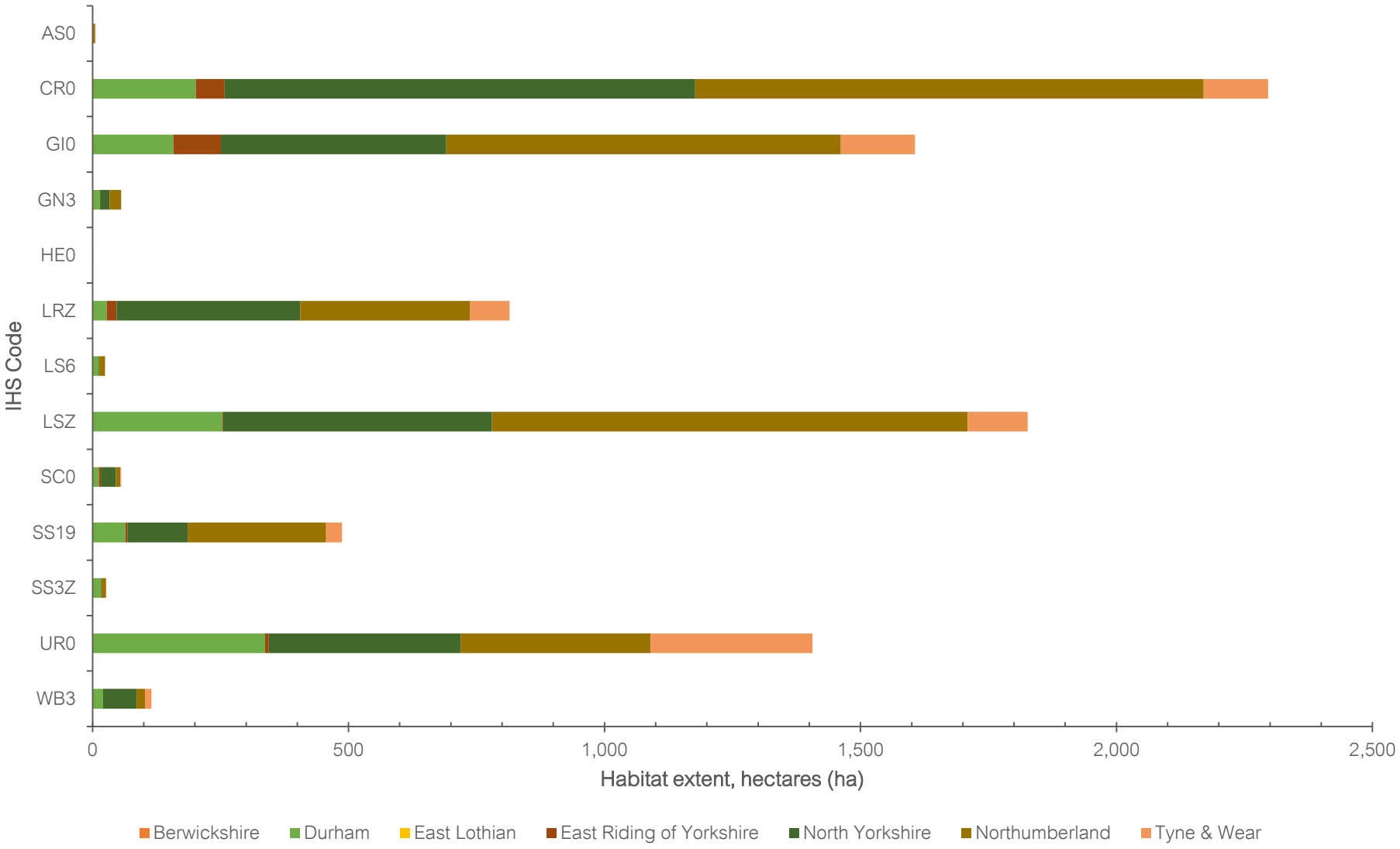

Figure 4.4: IHS supporting habitat extents in ANE01, 1940's

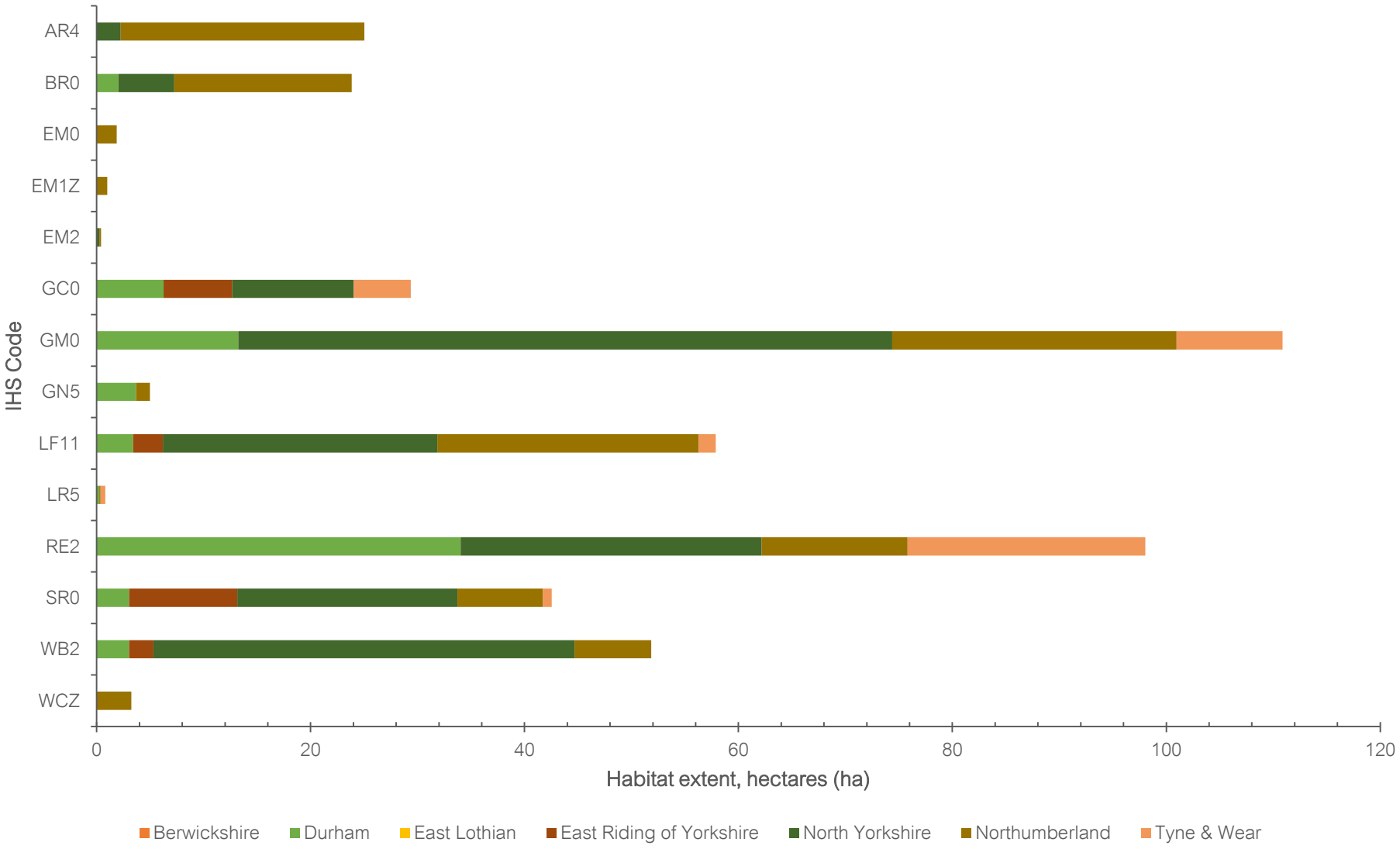

Figure 4.5: IHS additional habitat extents in ANE01, 1940's

4.2 2017 habitat extent

This section graphically presents the total extent of each priority, supporting and additional habitat recorded in the region for the 2017 mapping. Figure 4.6 provides a summary of current priority habitat extents across the entire region of study, with Figure 4.7 and Figure 4.8 describing the extent of supporting and additional habitats, respectively.

These figures represent the habitat extents within the counties analysed for the ANE01 region. The combined totals of these counties represent the total habitat extents across the entire ANE01 region, with some exceptions, described below.

For visual clarity, IHS habitats AR5 and GN0 are excluded from the figures, as the extent of these habitats far surpassed the normal distribution and impede a visual interpretation. The extents for these two IHS habitats are available in tabular form within Appendix D – 2017 IHS habitat extents.

Another omission from the graphs are those habitat extents found within the ANE01 region area of interest and aerial photography, but outside the OS OpenData county boundaries. The majority of these habitats are littoral sediments and open water (e.g., LS4, LSZ and AR5). An example of this is displayed in Figure 4.1. The total extents of all habitats across the region are available in tabular form in the project analysis spreadsheets.

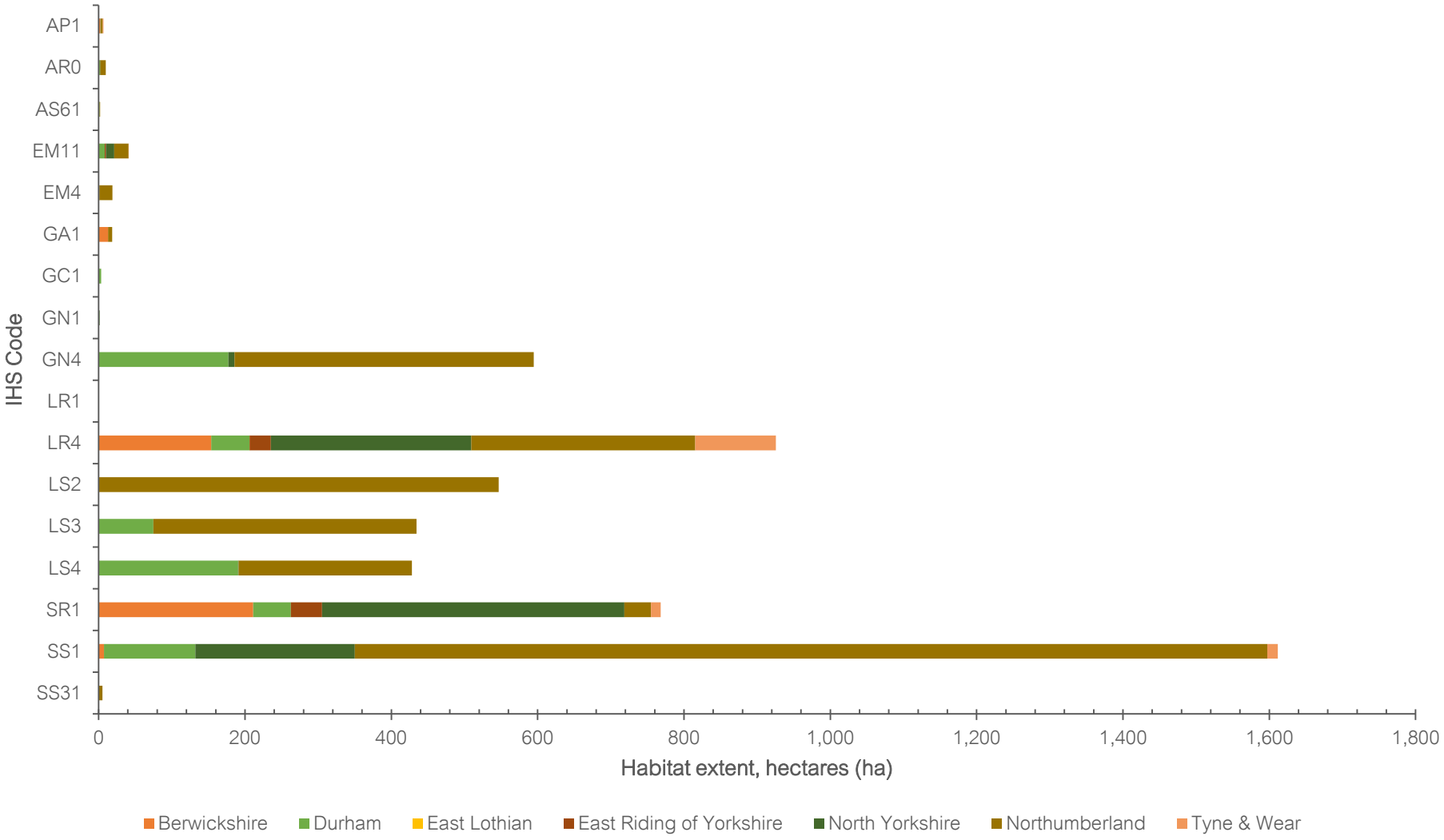

Figure 4.6: IHS priority habitat extents in ANE01, 2017

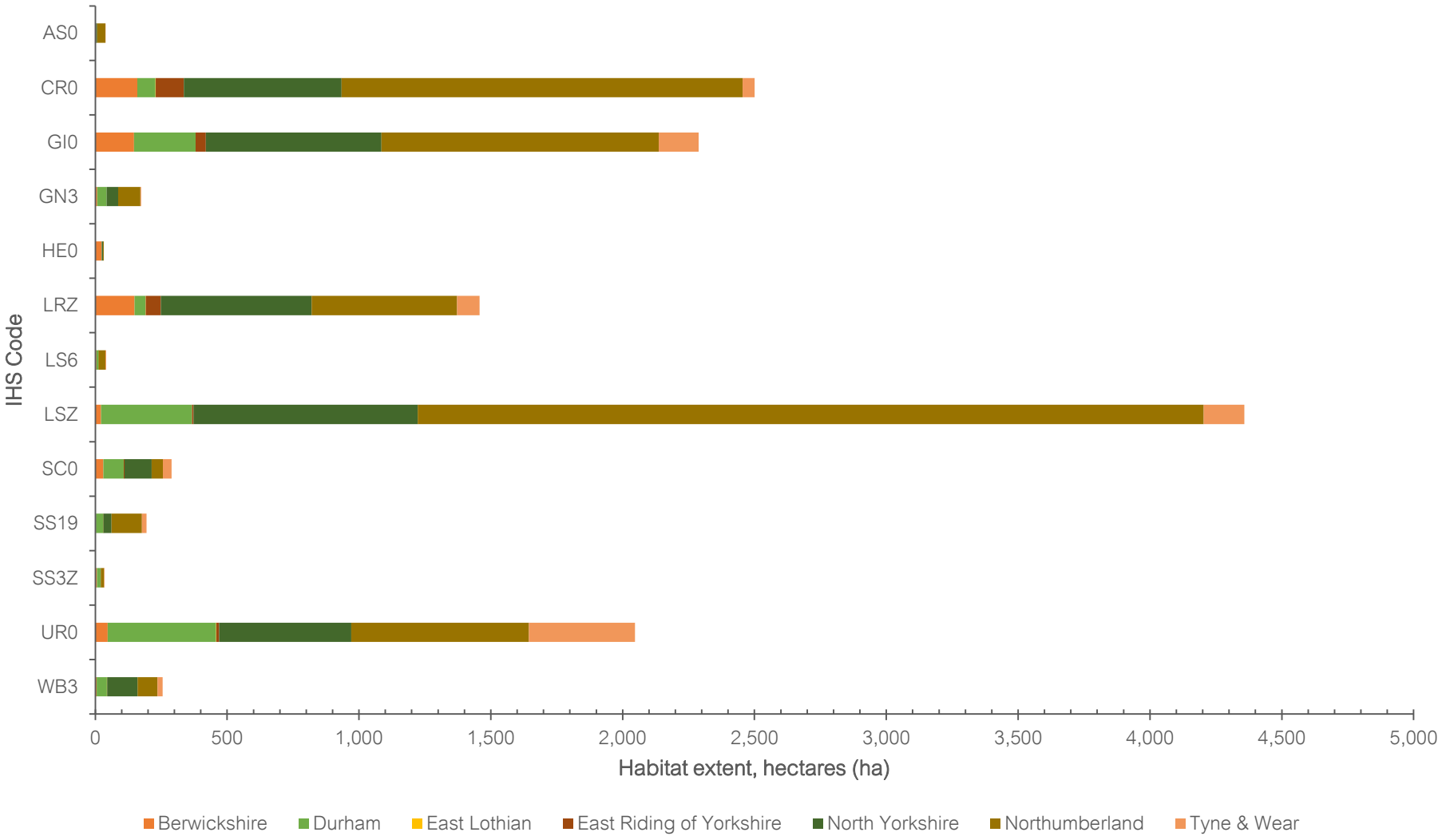

Figure 4.7: IHS supporting habitat extents in ANE01, 2017

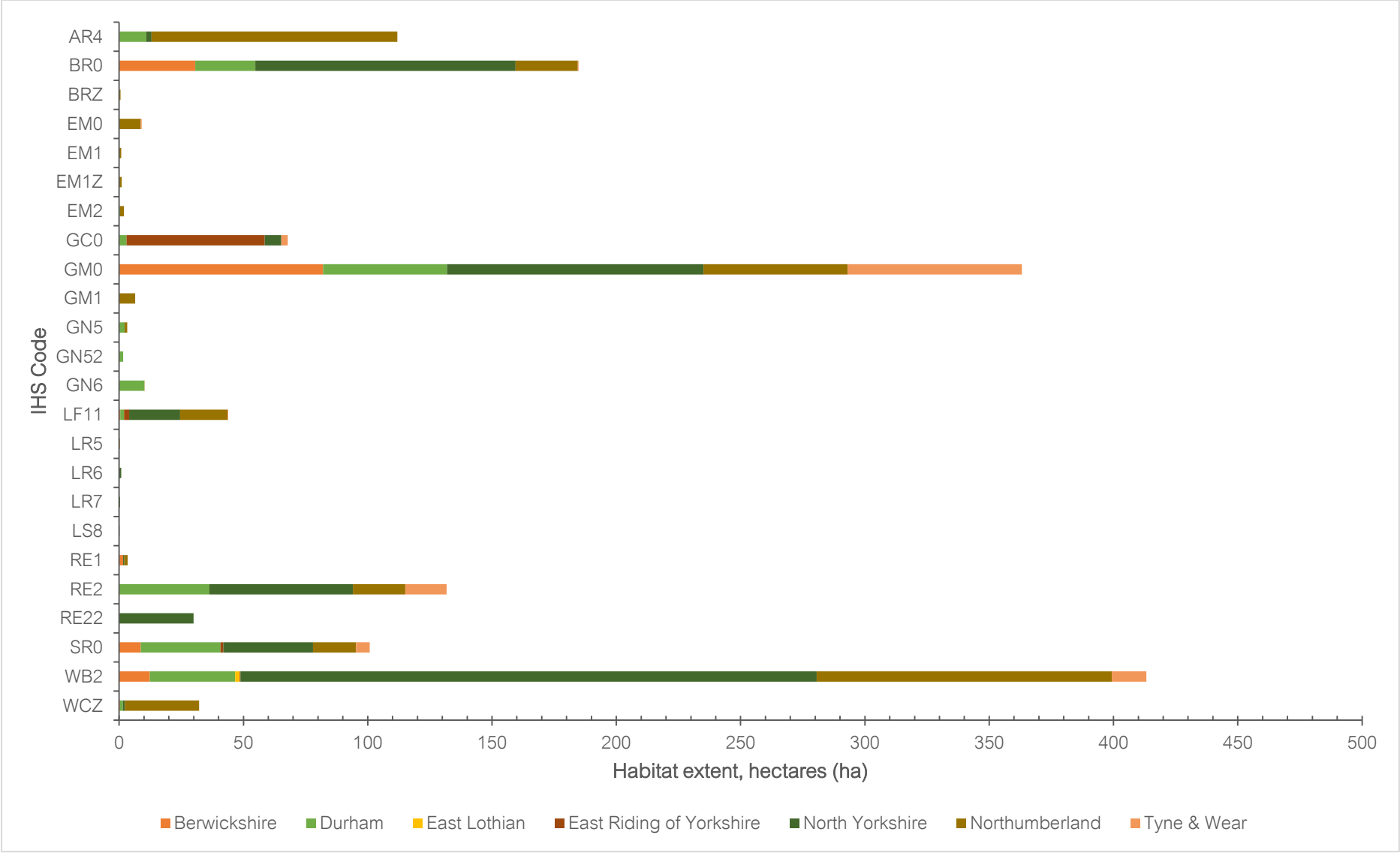

Figure 4.8: IHS additional habitat extents in ANE01, 2017

5 Habitat change

5.1 1940's—2017 habitat change

This section graphically presents the change in total extent of each priority, supporting and additional habitat recorded in the region for the 2017 mapping, compared to 1940's habitat extents. Figure 5.1 provides a summary of current priority habitat extents across the entire region of study, with Figure 5.2 and Figure 5.3 describing the change in extent of supporting and additional habitats, respectively. These figures represent the change in habitat extents within the counties of this study region. The total change observed across the entire ANE01 region has been incorporated into the same graphical outputs.

For visual clarity, IHS habitat AR5 has been omitted from the figures, as the change in extent of these habitats far surpassed the normal distribution and would impede a visual interpretation. The excessive nature of this apparent change may not represent a physical change in habitat, but rather an update in the identification of the polygons to better represent the classification. The change in extent for this habitat is available in tabular form within Appendix E – IHS habitat change 1940's—2017.

Another omission from the graphs are those habitat extents found within the ANE01 region area of interest and aerial photography, but outside the OS OpenData county boundaries. The majority of these habitats are littoral sediments and open water (e.g., LS4, LSZ and AR5).

The total habitat extent change of all habitats across the region are available in tabular form in the project analysis spreadsheets.

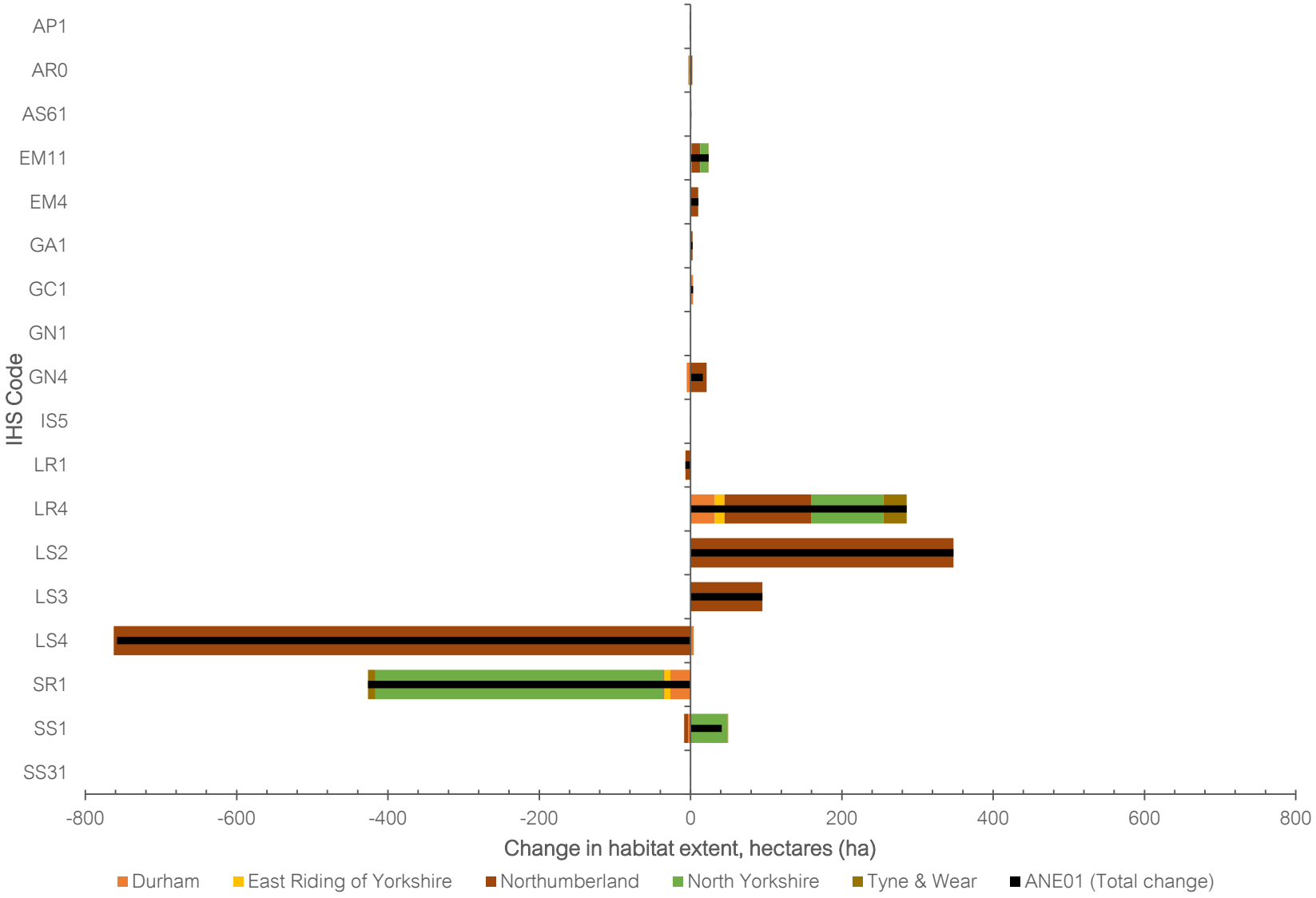

Figure 5.1: Change in IHS priority habitat extent, ANE01 region and counties, 1940's—2017

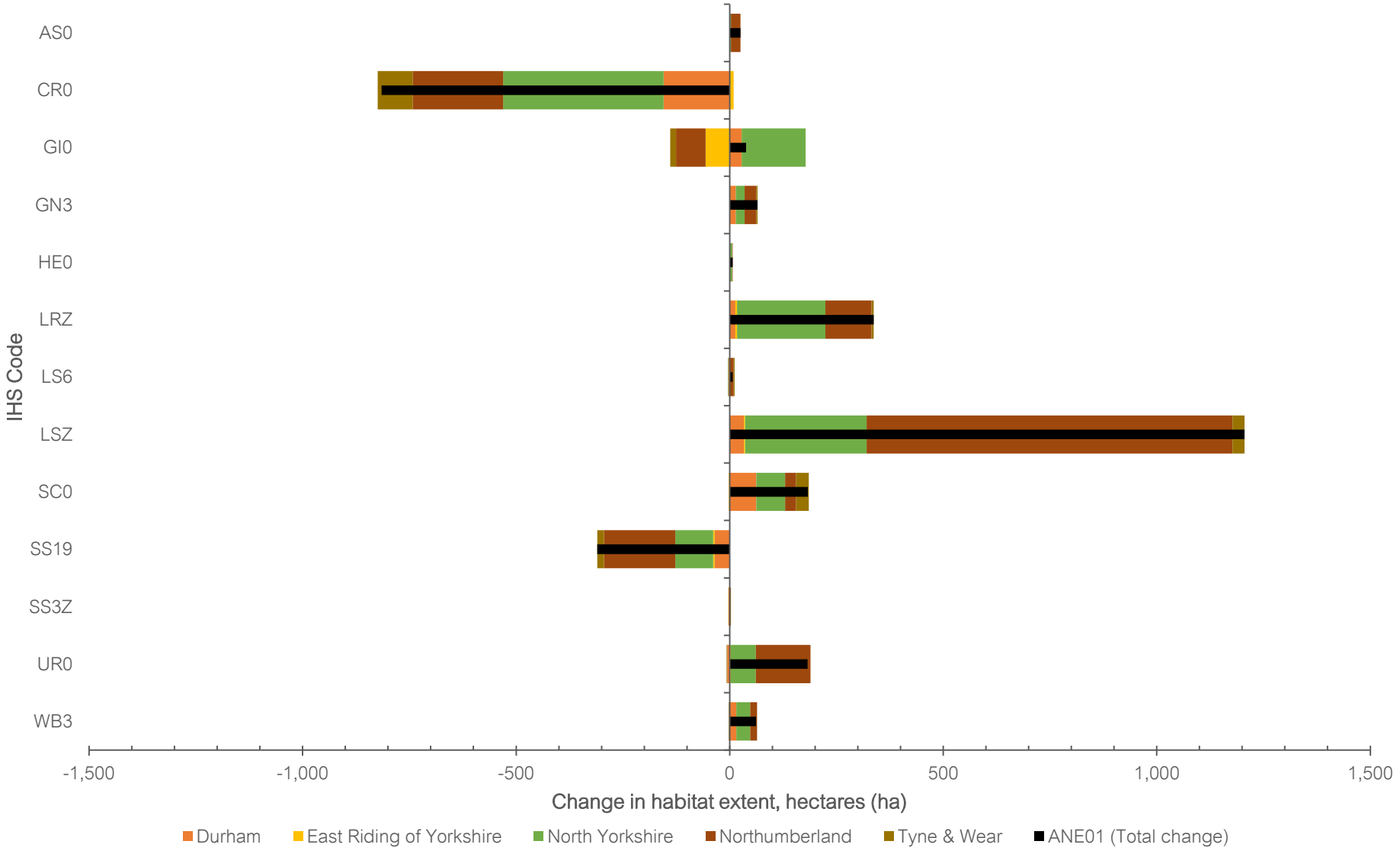

Figure 5.2: Change in IHS supporting habitat extent, ANE01 region and counties, 1940's—2017

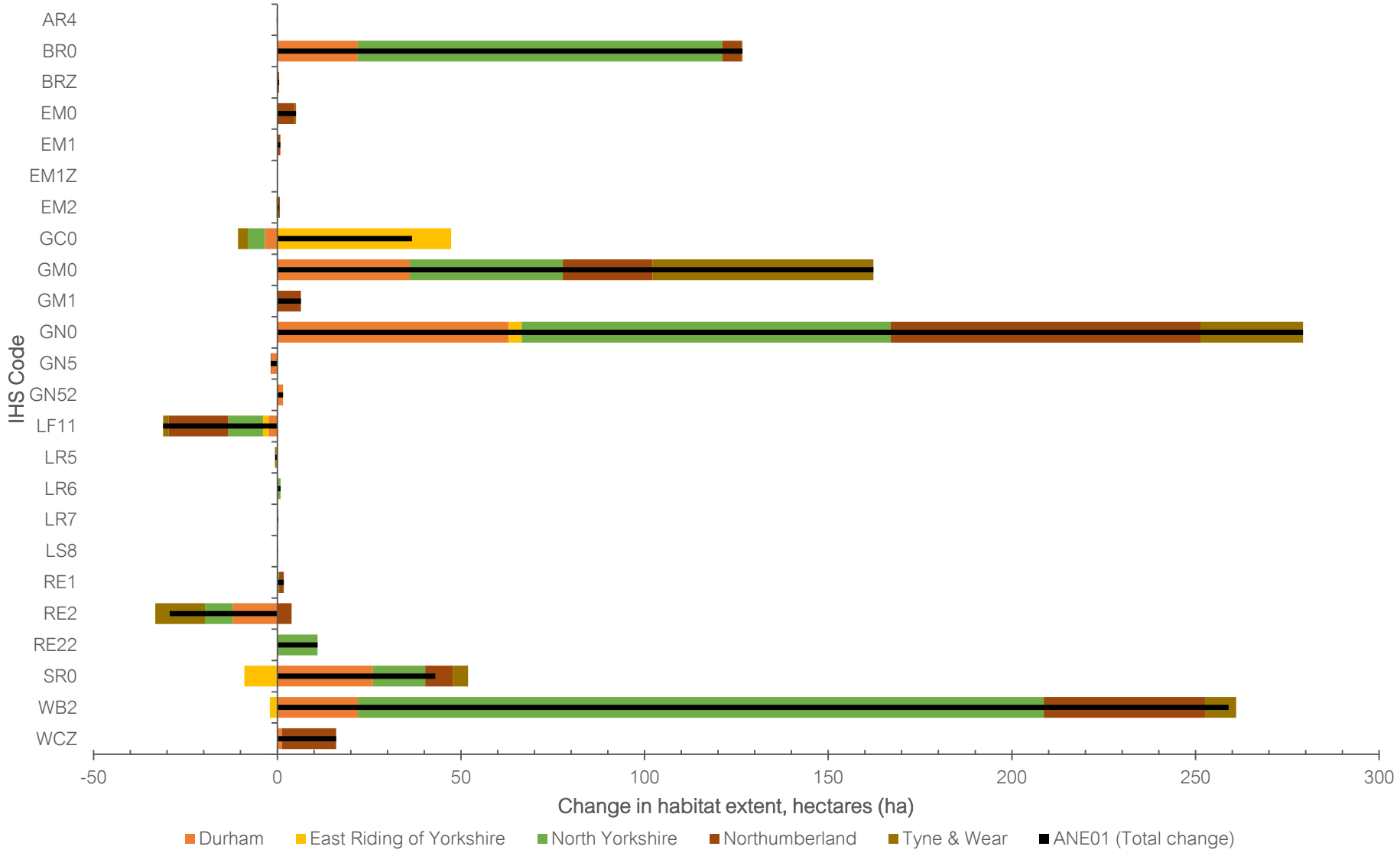

Figure 5.3: Change in IHS additional habitat extent, ANE01 region and counties, 1940's—2017

5.2 2012/13—2017 habitat change

This section graphically presents the change in total extent of each priority, supporting and additional habitat recorded in the region for the 2017 mapping, compared to 2012/13 habitat extents. Figure 5.4 provides a summary of current priority habitat extents across the entire region of study, with Figure 5.5 and Figure 5.6 describing the change in extent of supporting and additional habitats, respectively. These figures represent the change in habitat extents found within the counties of this study region. The total change observed across the entire ANE01 region has been incorporated into the same graphical outputs.

For visual clarity, IHS habitats AR0 and GN0 have been omitted from the figures, as the change in extent of these habitats far surpassed the normal distribution and would impede a visual interpretation. The excessive nature of this apparent change may not represent a physical change in habitat, but rather an update in the identification of the polygons to better represent the classification. The change in extent for these two IHS habitats are available in tabular form within Appendix F – IHS habitat change 2012/13—2017.

Another omission from the graphs are those habitat extents found within the ANE01 region area of interest and aerial photography, but outside the OS OpenData county boundaries. The majority of these habitats are littoral sediments and open water (e.g., LS4, LSZ and AR5).

The total habitat extent change of all habitats across the region are available in tabular form in the project analysis spreadsheets).

It is important to note that the differences in scale between the classifications derived from OS MasterMap boundaries for the 2012/13 mapping and the AP-derived objects for 2017, introduce considerable error when comparing the extent of habitats. As an example, an object from 2012/13 classified as GI0 Improved grassland may actually be comprised of multiple habitats that have been delineated and identified as other habitats in the 2017 mapping, such as UR0 or LF0. This improvement in scale could suggest drastic declines and/or increases in certain habitat extents within the classification, but not necessarily reflect any real-world change. A better understanding of the dynamics of the coastal environment would be achieved by utilising the smaller objects created through the 2017 mapping during sequential phases of habitat mapping and monitoring.

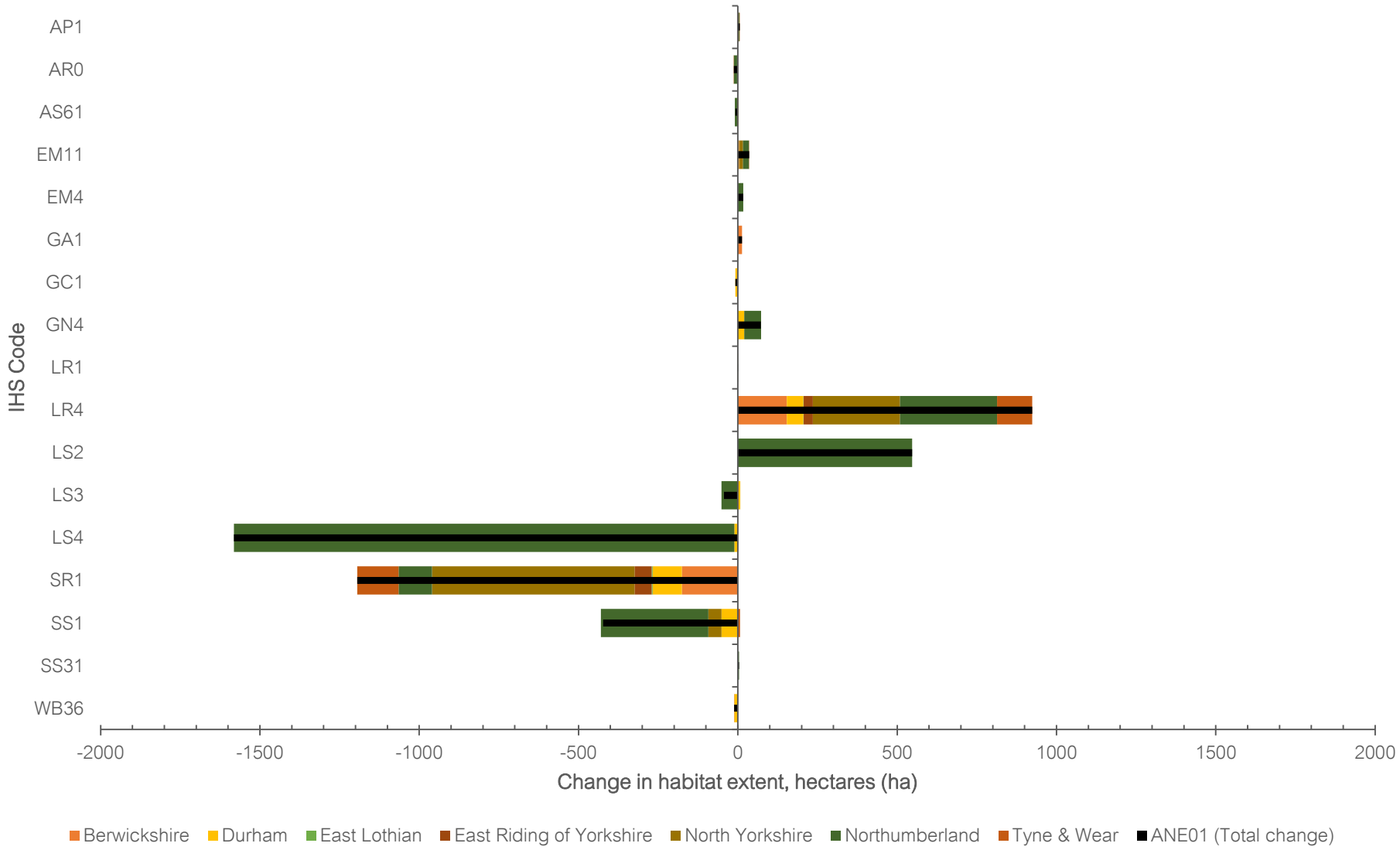

Figure 5.4: Change in IHS priority habitat extent, ANE01 region and counties, 2012/13—2017

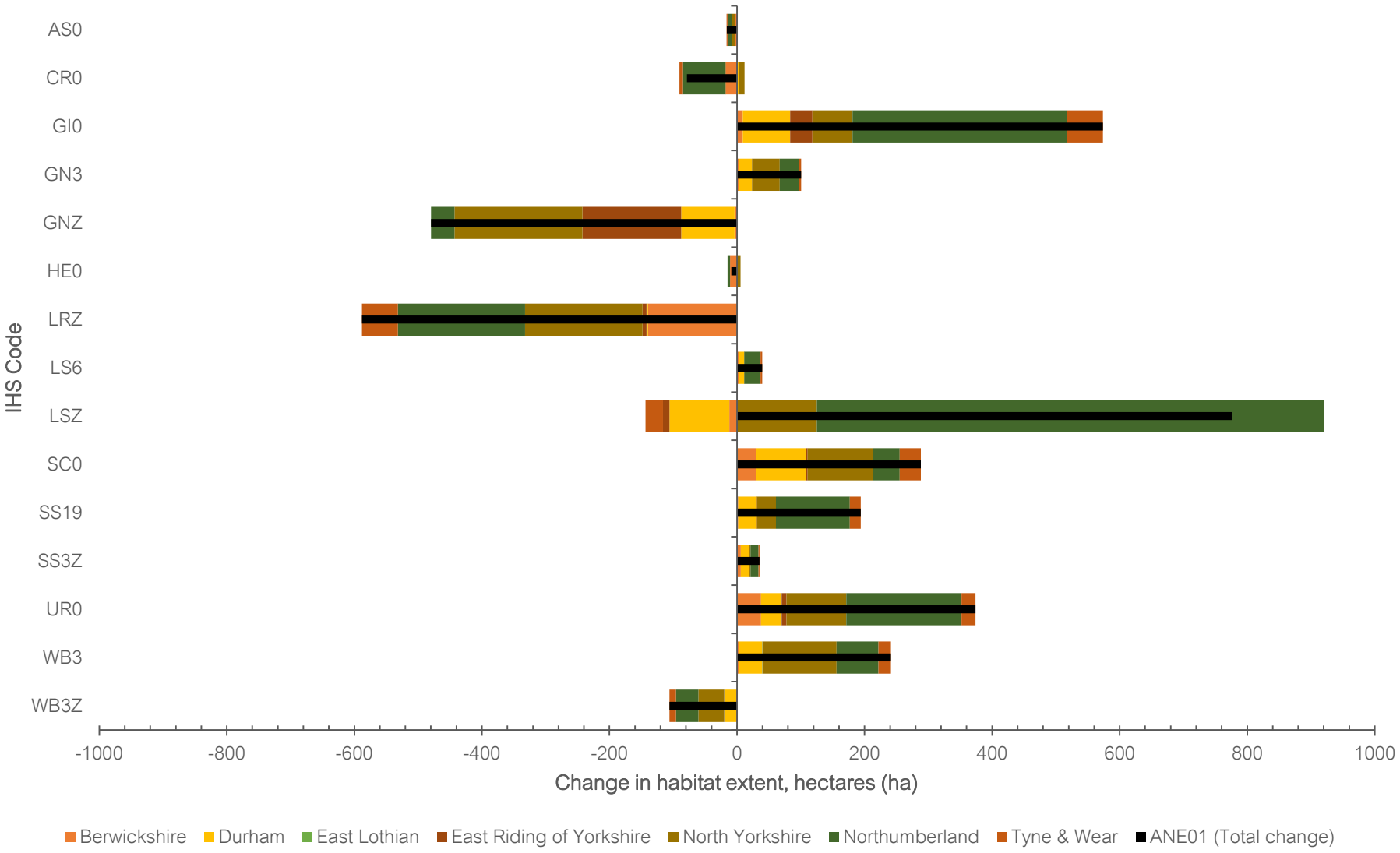

Figure 5.5: Change in IHS supporting habitat extent, ANE01 region and counties, 2012/13—2017

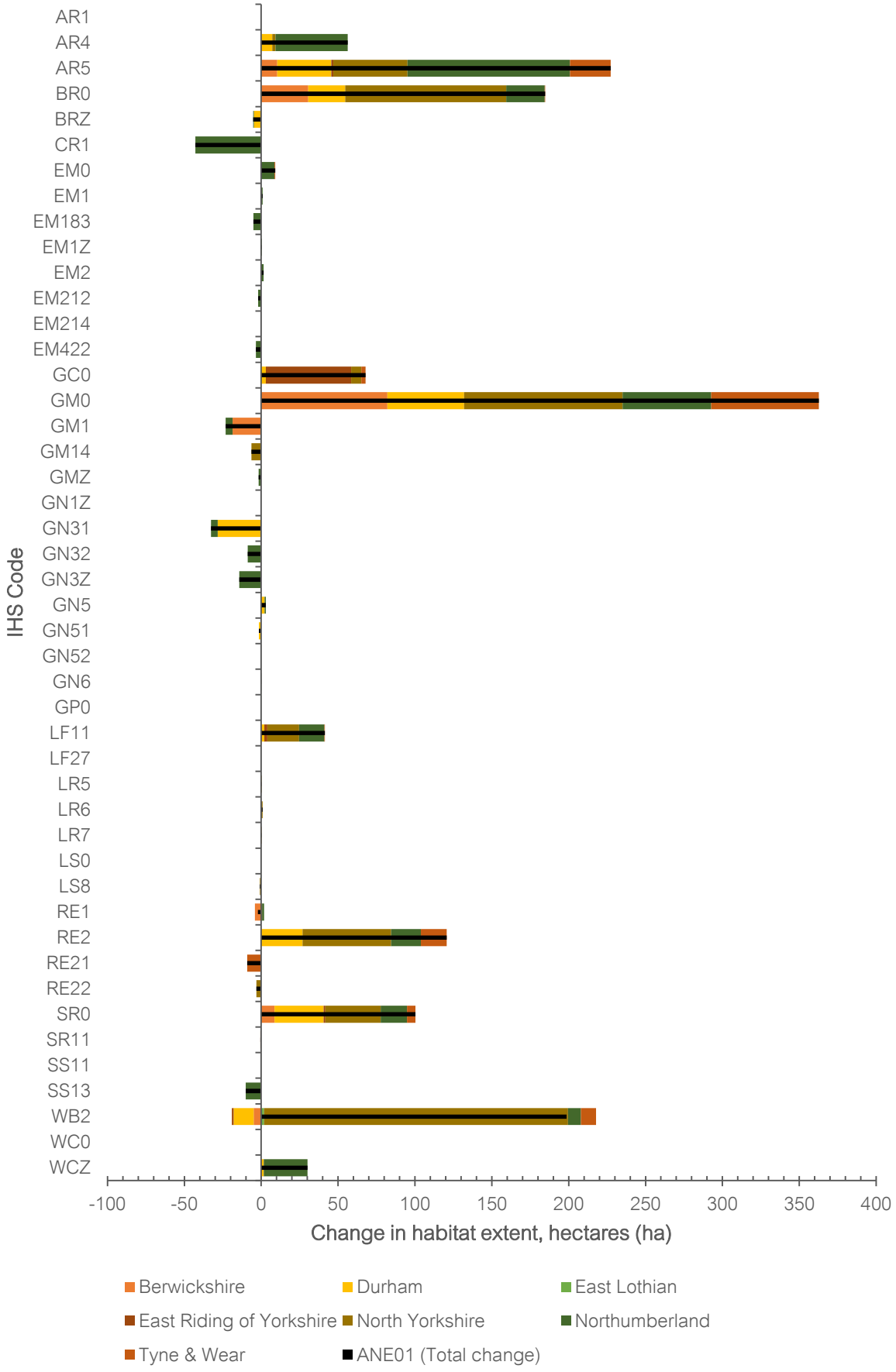

Figure 5.6: Change in IHS additional habitat extent, ANE01 region and counties, 2012/13—2017

6 Habitat analysis

6.1 Habitat precision

The advantage of the segmentation methodology applied for this region is that the objects created are more detailed, and of a smaller scale, compared to the OSMM. An object's absolute accuracy —the distance between the coordinates of a point in the dataset and the same point on the ground— is solely based on the AP's absolute accuracy, rather than inherited from the OSMM; which is dependent on the scale at which it has been mapped and is reported to be up to 0.9 m at 1:1250.

6.2 Habitat accuracy

The smaller scale objects also allow for a greater accuracy in the final dataset, compared to a reattribution of the OSMM. This is graphically illustrated in Figure 6.1. Image A represents the OSMM-derived IHS habitat mapping (the dark grey square), with a small-scale habitat feature within (the light grey rings). If the OSMM object is attributed as a singular habitat, then the smaller habitat features within will be miss-classified as the larger habitat. Image B represents the AP segmentation-derived IHS habitat mapping, where the small-scale features are clearly defined and attributed.

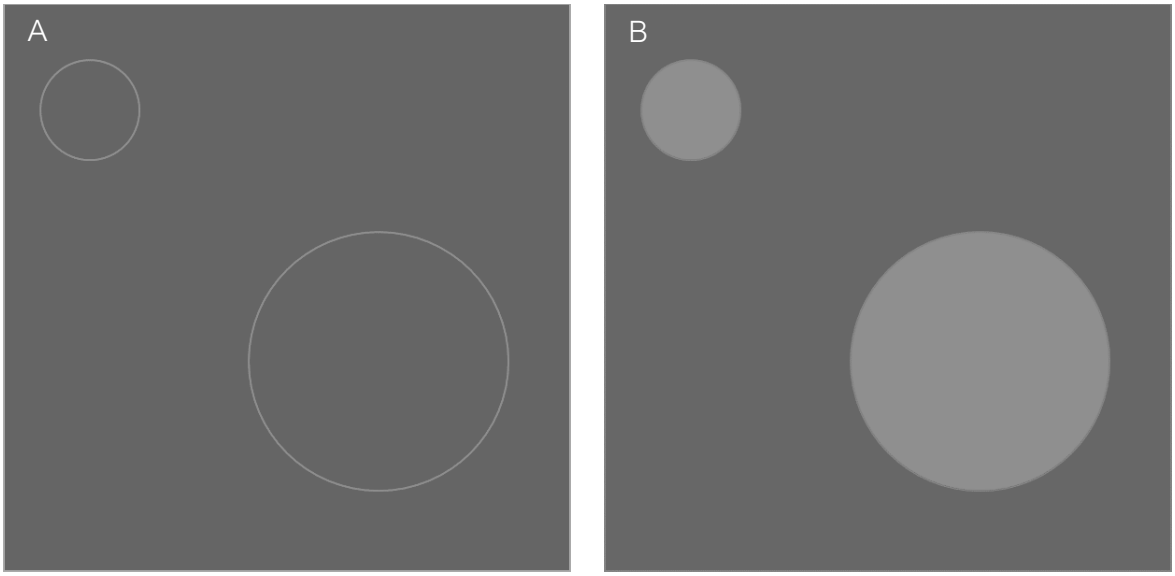

Figure 6.1: Abstraction representation of habitat accuracy with A) OS MasterMap mapping and B) AP segmentation mapping

However, sources of misclassifications in the habitat map may occur from:

- Habitat features that are different in appearance from the close-up perspective of ground survey relative to the aerial view used for API.
- Canopy cover obscuring ground-level habitats.
- IHS classification system habitat definitions overlap at Level 1 of the classification scheme. As a result, key distinguishing habitat features are present in more than one habitat class.
- Presence of heavy shadow in AP imagery.
- Long, narrow polygons bordering roads and paths.

Notable strengths of this classification process include the delineation of intertidal mudflats (LS4), coastal saltmarsh (LS3), arable and horticulture (CR0), improved grassland (GI0), grazing marsh pasture (GN4), unvegetated shingle above high tide mark (SS3Z) and brackish standing water with no sea connection (AS6).

7 Challenges and observations associated with the mapping

The mapping utilised a range of minimum mapping units, applying smaller MMUs to habitats requiring finer spatial detail such as saltmarsh and other intertidal habitats. In many cases the specified MMUs were larger than the resolution capability of the segmentation method. This meant that smaller habitat patches, identified as distinct polygons by the image segmentation method, could not be retained in the final map. This particularly applies to saltmarsh (LS3,) small reedbed (EM11), swamp (EM1), and standing water (AS0) features, but also patches of lowland calcareous grassland (GC1). Future mapping updates could consider reducing the MMU for such habitats, but such a change to map resolution would have implications for any change analysis, and could give a false impression of habitat extent increases.

Difficulties can be encountered mapping habitats where the salinity, presence of a sea connection, or nutrient content determines the habitat classification. This led to frequent use of the AS0 habitat class where the water chemistry could not be inferred, instead of derivatives such as AS3 or AS4. Ground survey and/or water quality testing are needed to confirm the chemical qualities of water features.

Intertidal and marine habitats are challenging to identify for a number of reasons, including real-world habitat change of dynamic habitats (e.g. LS4, LS6), image resolution, water clarity, sea roughness, and water depth. The API process is unable to identify examples of the habitats listed in Table 7.1. For these habitats, ground survey would be a more effective way to gain habitat extent data.

Due to the tiered IHS classification system for hard and soft features, there are two plausible codes (LR7 or LRZ) for hard intertidal rock at the level 1 classification. This reduces the consistency of classification between surveyors, and can potentially introduce error when calculating for habitat change. These habitat codes should be reviewed before the next round of habitat mapping commences to ensure a common interpretation of the habitat descriptions.

An objective of the current project was to undertake a change analysis of priority habitat extent between the previous and updated habitat mapping. The resulting comparison of habitat area should be viewed with caution as the two maps have been produced using different methodologies, and the scale of original mapping is unknown. The most noticeable differences between the two maps occur in the spatial delineation of vegetation canopy features, intertidal rocks and intertidal sediment.

The updated habitat map is more likely to over-map habitat types defined by trees and shrubs at the expense of habitats defined by low-growing species (e.g., grasses and herbs). This affects small areas at the interface between two habitat types (e.g., where an improved grassland field adjoins woodland), and occurs because the automated image segmentation procedure creates polygon boundaries that follow the canopy outline; it cannot interpolate below the surface vegetation cover.

By the same reasoning, the image segmentation procedure permits a much more detailed level of mapping of dynamic intertidal features than obtainable by digitisation, or by reference

to pre-existing data sources such as OSMM. Therefore, habitats such as LR4, LR7, LRZ, LS4 and LS6 have been mapped to a higher spatial accuracy in the updated habitat map (Figure 7.1).

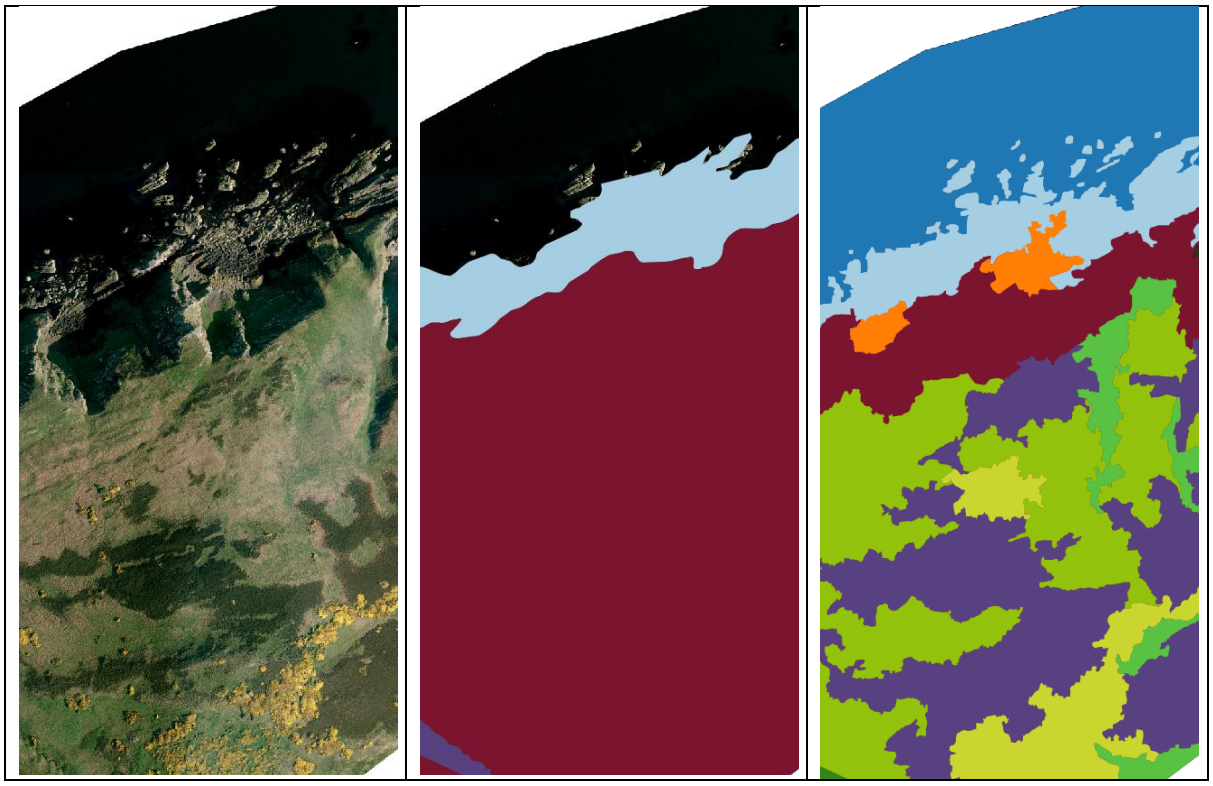

Figure 7.1: Example of differences between the Ordnance Survey MasterMap boundaries (centre) and the AP segmentation boundaries (right)

Table 7.1: Intertidal and subtidal habitats that could not be identified by API

IHS code	Description
CS1	Cold-water coral reefs (*Lophelia pertusa* reefs)
IR2	Sabellaria spinulosa reefs
IR5	Tide-swept channels
IR6	Subtidal chalk
IR7	Horse mussel beds
IS4	Maerl beds
IS6	Serpulid reefs
LR3	Sabellaria alveolata reefs
LS7	Blue Mussel Beds on sediment

It is clear that the image segmentation technique adopted by this project is able to discriminate very small habitat features, provided that they are not obscured by vegetation canopy or shadow. Future mapping projects should therefore review the scale of mapping required for each habitat type, and consider applying a smaller range between minimum and maximum MMU value. For maximum map detail achievable by the image segmentation method, this could be achieved by reducing the maximum MMU (1,000 m^2 in this project).

Other challenges and observations include:

- Detection of heathland by API depends on several factors and is not straightforward, most notably being able to distinguish heath shrub from low scrub or where heathland is present under tree canopies.

- The difficulty of mapping habitats where the salinity determines the habitat classification.
- Mapping a dynamic transient habitat that may have changed between timing of photography and survey.

Appendix A – Polygon area thresholds used to define habitat MMU

IHS Code	Description	MMU (m^2)
AP1	Pond	
AS1	Dystrophic standing water	
LR4	Intertidal underboulder communities	
LF11	Hedgerows	
LF12	Line of trees	
LF2	Other boundaries and linear features	
LR4	Intertidal underboulder communities	
LR42	Intertidal communities on natural boulder formations with algal cover	
LR5	Littoral built structures	
LR7	Littoral rock exposures	
LRZ	Other littoral rock	
LS3	Coastal saltmarsh	10
LS4	Intertidal mudflats	
LS5	Sheltered muddy gravels	
LS6	Intertidal shingle	
LSZ	Other littoral sediment	
PC0	Post-industrial sites	
PC2	Post-industrial sites of low nature conservation value	
SM1	Saltmarsh rills	
SS4	Strandline vegetation	
UR0	Built-up areas and gardens	
TC1	Tidal creeks	
TD1	Tidal	
AW1	Ancient woodland site	
MC1	Maritime cliff and slopes	50
SR0	Supralittoral rock	
WB32	Upland mixed ashwoods	
EM0	Fen, marsh and swamp	
EM3	Fens	
EM31	Fens [lowland]	
LF24	Dry ditch	100
OV0	Unknown terrestrial vegetation	
OV3	Undetermined young woodland	
SS12	Shifting dunes along the shoreline	
AR0	Rivers and streams	
AR5	Estuarine saline water and sea	
ARZ	Other rivers and streams	
AS0	Standing open water and canals	
AS3	Mesotrophic standing waters	
AS6	Brackish standing water with no sea connection	500
AS62	Brackish	
AS63	Very brackish	
EM32	Fens [upland]	
EM4	Purple moor grass and rush pastures	
HE0	Dwarf shrub heath	
HE1	European dry heaths	

HE2	Wet heaths	
HL1	Lowland heathland	
HU1	Upland heathland	
LR6	Littoral rock pool communities	
SS0	Supralittoral sediment	
SS1	Coastal sand dunes	
SS19	Unvegetated sand and dunes above the high tide mark	
SS1Z	Other sand dunes	
SS3	Shingle above high tide mark	
SS31	Coastal vegetated shingle	
SS3Z	Unvegetated shingle above the high tide mark	
SSZ	Other supralittoral sediment	
AS11	Natural dystrophic lakes and ponds	
AS21	Oligotrophic lakes	
AS31	Mesotrophic lakes	
AS4	Eutrophic standing waters	
AS61	Saline lagoons with no sea connection	
AS7	Aquifer fed naturally fluctuating water bodies	
BR0	Bracken	
CF1	Coastal and floodplain grazing marsh	
CR0	Arable and horticulture	
CR3	Non-cereal crops including woody crops	
CR5	Whole field fallow	
CR6	Arable headland or uncultivated strip	
CR61	Arable field margins	
CS1	Cold-water coral reefs (Lophelia pertusa reefs)	
EM1	Swamp	
EM11	Reedbeds	
EM13	Bolboscheoenus maritimus dominant community	
EM18	Tussocky swamp vegetation	
EM1Z	Other swamp vegetation	1,000
EM2	Marginal and inundation vegetation	
EM21	Marginal vegetation	
EM22	Inundation vegetation	
EO1	Blanket bog [Blanket bogs]	
EO2	Lowland raised bog	
FT0	Orchard	
FT1	Traditional orchard	
GA1	Lowland dry acid grassland	
GC0	Calcareous grassland	
GC1	Lowland calcareous grassland	
GC2	Upland calcareous grassland	
GI0	Improved grassland	
GM1	Festuca rubra maritime grassland	
GMZ	Other maritime grasslands	
GN0	Neutral grassland	
GN1	Lowland meadows	
GN2	Upland hay meadows	
GN3	Coarse neutral grassland	
GN4	Grazing marsh pasture	

GN5	Inundation grassland
GN6	Sea wall grassland
GNZ	Other neutral grassland
IR1	Reefs
IR2	Sabellaria spinulosa reefs
IR5	Tide-swept channels
IR6	Subtidal chalk
IR7	Horse mussel beds
IS2	Subtidal sands and gravels [inshore]
IS3	Seagrass beds - Zostera marina & Z. angustifolia located on mid to lower foreshore and sub littoral zone
IS4	Maerl beds
IS5	Saline lagoons with restricted sea connection
IS6	Serpulid reefs
LR0	Littoral rock
LR1	Intertidal chalk
LR3	Sabellaria alveolata reefs
LS0	Littoral sediment
LS2	Seagrass beds - Zostera noltii adjacent to saltmarsh
LS7	Blue mussel beds on sediment
PI1	Calaminarian grasslands of the Violetalia Calaminariae
RE0	Inland rock
RE1	Natural rock exposure features
RE2	Artificial rock exposures and waste
SC0	Scrub
SR1	Maritime cliff and slopes
SR2	Boulders and rock above the high tide mark
SRZ	Other supralittoral rock
SS2	Machair
WB1	Mixed woodland
WB2	Scrub woodland
WB3	Broadleaved woodland
WB31	Upland oak woodland
WB331	Lowland beech and yew woodlands
WB34	Wet woodland
WB35	Upland birch woodland
WB36	Lowland mixed deciduous woodland
WB3Z	Other broadleaved woodland
WC1	Native pine woodlands
WCZ	Other coniferous woodland
WF2	Plantation

Appendix B – Ground survey results (summary)

Durham

IHS code	Frequency
AS61 Saline Lagoons with no sea connection	2
BR0 Bracken	2
BR0MC1 Bracken in the maritime environment	1
EM11 Reedbeds	3
EM13 Bolboscheoenus maritimus dominant community	1
GI0 Improved grassland	1
GM0 Maritime grassland	1
GN0 Neutral grassland	3
GN3 Coarse neutral grassland	1
GN4 Grazing marsh pasture	1
GN5 Inundation grassland	3
LF11 Hedgerows	1
LR4 Intertidal underboulder communities	2
LS3 Coastal saltmarsh	1
LS6 Intertidal shingle	1
LSZ Other littoral sediment	3
RE2 Artificial rock exposures and waste	1
SC0 Scrub	1
SC0MC1 Scrub in the maritime environment	2
SR0 Suppralittoral rock	1
SR1 Maritime cliff and slopes	2
SR2 Boulders and rock above the high tide mark	5
SS1 Coastal sand dunes	1
SS19 Unvegetated sand and dunes above the high tide mark	2
SS3Z Unvegetated shingle above high tide mark	1
WB2 Scrub woodland	3
WB3 Broadleaved woodland	1

East Riding of Yorkshire

IHS code	Frequency
CR0 Arable and horticulture	2
GC0 Calcareous grassland	3
GN0 Neutral grassland	8
LR4 Intertidal underboulder communities	3
LRZ Other littoral rock	1
SR1 Maritime cliff and slopes	2
CR0 Arable and horticulture	2
GC0 Calcareous grassland	3
GN0 Neutral grassland	8
LR4 Intertidal underboulder communities	3
LRZ Other littoral rock	1
SR1 Maritime cliff and slopes	2

North Yorkshire

IHS code	Frequency
BR0MC1 Bracken in the maritime environment	2
CR0 Arable and horticulture	1
GI0 Improved grassland	3
GM0 Maritime grassland	2
GN0 Neutral grassland	5
GN3 Coarse neutral grassland	1
LF11 Hedgerows	1
LR4 Intertidal underboulder communities	3
LRZ Other littoral rock	1
LSZ Other littoral sediment	3
SC0MC1 Scrub in the maritime environment	1
SR0 Supralittoral rock	1
SR1 Maritime cliff and slopes	4
SR2 Boulders and rock above the high tide mark	2
SS3Z Unvegetated shingle above high tide mark	1
WB2MC1 Scrub woodland in the maritime environment	7
WB3 Broadleaved woodland	2

Northumberland

IHS code	Frequency
AP1 Pond	1
AR4 Tidal rivers upstream of estuary	1
CR0 Arable and horticulture	2
EM11 Reedbeds	2
EM13 Bolboscheoenus maritimus dominant community	1
GI0 Improved grassland	1
GM0 Maritime grassland	1
GM1 Festuca rubra maritime grassland	1
GN0 Neutral grassland	8
GN3 Coarse neutral grassland	2
GN4 Grazing marsh pasture	1
GN5 Inundation grassland	1
LR4 Intertidal underboulder communities	5
LRZ Other littoral rock	3
LS3 Coastal saltmarsh	2
LS6 Intertidal shingle	1
LSZ Other littoral sediment	6
SC0MC1 Scrub in the maritime environment	1
SR0 Supralittoral rock	1
SR1 Maritime cliff and slopes	1
SR2 Boulders and rock above the high tide mark	3
SS1 Coastal sand dunes	4
SS19 Unvegetated sand and dunes above the high tide mark	2
UR0 Built-up areas and gardens	1
WB2 Scrub woodland	1
WB3 Broadleaved woodland	2

IHS code	Frequency
WCZ Other coniferous woodland	1

Tyne & Wear

IHS code	Frequency
AP1 Pond	1
EM11 Reedbeds	1
GN0 Neutral grassland	1
SC0 Scrub	1

Appendix C – 1940's IHS habitat extents

Table C.1: Total extent of IHS priority habitats mapped for the ANE01 region and each constituent county, 1940's

IHS code	1940's habitat extent, hectares (ha)							
	Berwickshire	Durham	East Lothian	East Riding of Yorkshire	North Yorkshire	Northumberland	Tyne & Wear	ANE01 (Total)
AP1		0.02		0.11	0.24	2.22	0.85	3.45
AR0		2.80			1.72	3.83		8.36
AS61		0.13						0.13
EM11				0.91		2.87		3.78
EM4					0.17	4.56		4.74
GA1						2.88		2.88
GN1					1.80			1.80
GN4		14.74				110.25		125.00
IS5		0.47						0.47
LR1						7.42		7.42
LR4		15.06		15.79	167.36	91.32	69.02	358.55
LS2						1.82		1.82
LS3						86.89		86.89
LS4		4.87				866.24		871.11
SR1		76.87		45.45	791.67	21.81	22.75	958.55
SS1		101.81			167.17	1,087.44	12.99	1,369.40
SS31						1.56		1.56

Table C.2: Total extent of IHS supporting habitats mapped for the ANE01 region and each constituent county, 1940's

IHS code	1940's habitat extent, hectares (ha)							
	Berwickshire	Durham	East Lothian	East Riding of Yorkshire	North Yorkshire	Northumberland	Tyne & Wear	ANE01 (Total)
AS0		0.25			1.09	3.82	0.91	6.07
CR0		201.71		56.14	919.22	993.39	125.91	2,296.36
GI0		158.23		92.48	440.26	770.49	145.22	1,606.68
GN3		14.53			18.73	22.82		56.08
HE0						0.99		0.99
LRZ		27.72		19.51	358.65	331.05	77.35	814.29
LS6		11.98			1.43	10.78	0.46	24.65
LSZ		253.59		1.34	525.34	928.82	117.66	1,826.75
SC0		12.29		3.64	29.98	8.73	1.06	55.69
SS19		64.23		3.60	118.20	270.29	30.99	487.31
SS3Z		16.34		0.51	0.74	8.68	0.37	26.64
UR0		336.85		7.70	374.27	370.92	316.56	1,406.30
WB3		20.72			65.31	16.39	12.42	114.83

Table C.3: Total extent of IHS additional habitats mapped for the ANE01 region and each constituent county, 1940's

IHS code	1940's habitat extent, hectares (ha)							
	Berwickshire	Durham	East Lothian	East Riding of Yorkshire	North Yorkshire	Northumberland	Tyne & Wear	ANE01 (Total)
AR4					2.24	22.80		25.04
AR5		224.66		1.05	656.78	899.96	108.30	1,890.75
BR0		2.03			5.22	16.59		23.85
EM0						1.88		1.88
EM1Z						0.98		0.98
EM2					0.24	0.18		0.42
GC0		6.26		6.44	11.33		5.33	29.36
GM0		13.23			61.14	26.60	9.90	110.88
GN0		49.19		89.65	102.91	118.90	34.30	394.94
GN5		3.67				1.31		4.98
LF11		3.40		2.79	25.66	24.42	1.61	57.89
LR5		0.26				0.10	0.45	0.81
RE2		34.03			28.15	13.64	22.21	98.03
SR0		3.04		10.11	20.59	7.98	0.83	42.54
WB2		3.03		2.27	39.37	7.17		51.84
WCZ						3.24		3.24

Appendix D – 2017 IHS habitat extents

Table D.1: Total extent of IHS priority habitats mapped for the ANE01 region and each constituent county, 2017

IHS code	2017 habitat extent, hectares (ha)							
	Berwickshire	Durham	East Lothian	East Riding of Yorkshire	North Yorkshire	Northumberland	Tyne & Wear	ANE01 (Total)
AP1	2.42	0.22		0.15	0.45	2.21	1.12	6.57
AR0	0.05	1.71	0.02		0.69	7.17		9.64
AS61		1.38				0.59		1.97
EM11	0.61	7.84		1.62	11.09	19.67	0.37	41.21
EM4	0.64				0.31	17.86		18.81
GA1	13.03					5.63		18.66
GC1		3.43						3.43
GN1					1.40			1.40
GN4		177.38			8.35	408.81		594.54
LR1						0.82		0.82
LR4	153.91	52.48	0.10	28.77	273.89	306.36	110.26	925.77
LS2						546.84		546.84
LS3		74.98				359.62		434.59
LS4		190.70			0.43	236.99		428.13
SR1	211.31	51.40	0.00	42.69	412.97	36.64	13.12	768.14
SS1	7.13	125.05			217.80	1,247.32	14.23	1,611.53
SS31						5.36		5.36

Table D.2: Total extent of IHS supporting habitats mapped for the ANE01 region and each constituent county, 2017

IHS code	2017 habitat extent, hectares (ha)							
	Berwickshire	Durham	East Lothian	East Riding of Yorkshire	North Yorkshire	Northumberland	Tyne & Wear	ANE01 (Total)
AS0		2.97		0.05	3.95	30.99	0.74	38.69
CR0	159.01	68.68	1.08	106.62	598.29	1,521.54	45.57	2,500.79
GI0	146.75	233.65		38.66	666.10	1,052.10	151.20	2,288.46
GN3	6.80	36.09			43.32	84.43	2.91	173.55
HE0	24.07	0.15			5.58	2.89		32.69
LRZ	148.31	41.85	1.27	56.80	572.35	551.83	84.53	1,456.95
LS6	3.97	8.59	0.03		0.22	25.28	2.76	40.85
LSZ	21.88	344.50		6.67	849.95	2,980.63	154.64	4,358.28
SC0	30.32	77.20	0.44	2.94	102.87	42.66	32.99	289.42
SS19	1.99	29.22		0.32	29.46	115.72	17.31	194.01
SS3Z	6.06	13.43			1.53	12.76	1.60	35.37
UR0	46.89	410.91	0.91	10.49	501.78	673.13	402.92	2,047.03
WB3	5.56	38.86	0.23		116.07	75.22	19.37	255.30

Table D.3: Total extent of IHS additional habitats mapped for the ANE01 region and each constituent county, 2017

IHS code	2017 habitat extent, hectares (ha)							
	Berwickshire	Durham	East Lothian	East Riding of Yorkshire	North Yorkshire	Northumberland	Tyne & Wear	ANE01 (Total)
AR4	0.12	10.77			2.16	98.84		111.90
AR5	12.86	308.36	0.23	1.31	197.37	248.26	62.58	830.97
BR0	30.60	24.22			104.64	25.05	0.26	184.78
BRZ						0.52		0.52
EM0						8.64	0.41	9.05
EM1						0.86		0.86
EM1Z						0.99		0.99
EM2		0.40				1.50		1.90
GC0		2.92		55.63	6.63		2.68	67.86
GM0	82.03	49.89			103.16	57.94	70.08	363.11
GM1						6.44		6.44
GN0	54.09	158.08	0.64	112.75	246.00	339.56	68.00	979.12
GN5		2.20				1.03		3.23
GN52		1.58						1.58
GN6		10.07				0.10		10.17
LF11	0.41	1.59	0.02	1.97	20.56	19.01	0.28	43.85
LR5		0.01			0.08	0.12	0.08	0.29
LR6					0.88			0.88
LR7				0.00	0.32			0.32
LS8					0.14			0.14
RE1	1.58				0.51	1.39		3.47
RE2		36.36			57.68	21.06	16.64	131.73
RE22					29.94			29.94
SR0	8.62	32.11		1.16	36.10	17.29	5.47	100.75
WB2	12.31	34.31	1.90	0.24	231.86	118.70	13.94	413.27
WCZ	0.33	1.20			0.73	29.93		32.19

Appendix E – IHS habitat change 1940's—2017

Table E.1: Change in extent of IHS priority habitats mapped for the ANE01 region and each constituent county, 1940's—2017

IHS code	Change in habitat extent 1940's—2017, hectares (ha)							
	Berwickshire	Durham	East Lothian	East Riding of Yorkshire	North Yorkshire	Northumberland	Tyne & Wear	ANE01 (Total)
AP1		0.16			0.14	-1.02	0.18	-0.54
AR0		-2.14			-1.03	2.37		-0.81
AS61		0.46				0.59		1.05
EM11		0.76		0.71	10.82	11.27	0.37	23.93
EM4					0.14	10.22		10.36
GA1						2.76		2.76
GC1		3.43						3.43
GN1					-0.41			-0.41
GN4		-4.95				21.29		16.34
IS5		-0.47						-0.47
LR1						-6.77		-6.77
LR4		32.02		12.90	94.97	114.97	30.69	285.55
LS2						347.69		347.69
LS3						95.14		95.14
LS4		4.20			0.14	-762.39		-758.05
SR1		-26.59		-8.12	-380.44	-1.31	-10.08	-426.54
SS1		-3.35			48.89	-5.10	0.66	41.10
SS31						-0.22		-0.22
AP1		0.16			0.14	-1.02	0.18	-0.54
AR0		-2.14			-1.03	2.37		-0.81
AS61		0.46				0.59		1.05
EM11		0.76		0.71	10.82	11.27	0.37	23.93
EM4					0.14	10.22		10.36
GA1						2.76		2.76
GC1		3.43						3.43

Table E.2: Change in extent of IHS supporting habitats mapped for the ANE01 region and each constituent county, 1940's—2017

IHS code	Change in habitat extent 1940's—2017, hectares (ha)							
	Berwickshire	Durham	East Lothian	East Riding of Yorkshire	North Yorkshire	Northumberland	Tyne & Wear	ANE01 (Total)
AS0		0.94			1.81	22.60	-0.17	25.19
CR0		-154.92		9.28	-375.40	-211.49	-82.36	-814.89
GI0		28.09		-56.64	149.85	-68.82	-13.86	38.62
GN3		14.55			20.23	27.55	2.74	65.07
HE0		0.15			5.58	1.45		7.18
LRZ		13.49		3.78	206.82	107.84	5.02	336.94
LS6		-3.41			-1.22	9.46	2.28	7.12
LSZ		33.18		3.05	284.33	856.78	27.97	1205.31
SC0		62.33		-1.90	67.42	25.98	29.31	183.15
SS19		-35.25		-3.27	-88.89	-166.39	-16.40	-310.20
SS3Z		-2.96		-0.51	0.78	1.67	0.78	-0.23
UR0		-5.32		2.24	59.10	127.97	-1.89	182.10
WB3		15.81			32.08	15.97	-1.99	61.87

Table E.3: Change in extent of IHS additional habitats mapped for the ANE01 region and each constituent county, 1940's—2017

Habitat	Change in habitat extent 1940's—2017, hectares (ha)							
	Berwickshire	Durham	East Lothian	East Riding of Yorkshire	North Yorkshire	Northumberland	Tyne & Wear	ANE01 (Total)
AR4					-0.08	-0.11		-0.19
AR5		-122.50		0.03	-569.06	-762.61	-56.54	-1510.68
BR0		21.92			99.20	5.26	0.26	126.64
BRZ						0.52		0.52
EM0						4.68	0.41	5.09
EM1						0.86		0.86
EM1Z						0.01		0.01
EM2					-0.24	0.70		0.46
GC0		-3.34		47.37	-4.69		-2.66	36.68
GM0		36.06			41.67	24.45	60.12	162.30
GM1						6.44		6.44
GN0		63.01		3.55	100.42	84.34	27.97	279.28
GN5		-1.47				-0.28		-1.75
GN52		1.58						1.58
LF11		-2.40		-1.50	-9.45	-16.29	-1.45	-31.09
LR5		-0.25			0.08		-0.37	-0.55
LR6					0.88			0.88
LR7					0.32			0.32
LS8					0.14			0.14
RE1					0.51	1.24		1.75
RE2		-12.13			-7.55	3.93	-13.54	-29.28
RE22					10.96			10.96
SR0		26.04		-8.95	14.28	7.55	4.09	43.01
WB2		21.98		-2.03	186.69	43.96	8.41	259.01
WCZ		1.20			0.01	14.83		16.04

Appendix F – IHS habitat change 2012/13—2017

Table F.1: Change in extent of IHS priority habitats mapped for the ANE01 region and each constituent county, 2012/13—2017

IHS code	Change in habitat extent 2012/13—2017, hectares (ha)							
	Berwickshire	Durham	East Lothian	East Riding of Yorkshire	North Yorkshire	Northumberland	Tyne & Wear	ANE01 (Total)
AP1	2.42	0.22		0.15	0.45	1.79	1.12	6.15
AR0	-0.76	0.42	-0.09		-1.95	-10.08	-0.05	-12.51
AS3						-0.84		-0.84
AS61		1.38				-9.45		-8.08
CR61	-0.08							-0.08
EM11	0.44	3.04		1.62	11.09	18.90	0.37	35.47
EM31						-2.99		-2.99
EM4	0.64				0.31	15.65		16.60
GA1	13.03					-0.31		12.71
GC1		-7.95						-7.95
GN1					-0.99			-0.99
GN4		20.05			-1.07	53.01		71.99
LR1						0.82		0.82
LR4	153.91	52.23	0.10	28.77	273.89	304.39	110.26	923.55
LS2						546.84		546.84
LS3		7.63				-51.21		-43.58
LS4	-0.10	-10.61			0.43	-1571.17		-1581.44
SR1	-175.46	-92.33	-2.45	-54.15	-635.29	-104.92	-129.71	-1194.30
SS1	-0.18	-51.03			-41.10	-337.40	7.13	-422.59
SS31						3.99		3.99
WB34						-4.86		-4.86
WB36		-10.77					-1.25	-12.02

Table F.2: Change in extent of IHS supporting habitats mapped for the ANE01 region and each constituent county, 2012/13—2017

IHS code	Change in habitat extent 2012/13—2017, hectares (ha)							
	Berwickshire	Durham	East Lothian	East Riding of Yorkshire	North Yorkshire	Northumberland	Tyne & Wear	ANE01 (Total)
AS0	-2.93	0.44		-0.08	-5.20	-6.67	-1.62	-16.07
CR0	-18.05	3.53	-0.01	-0.31	8.27	-66.58	-5.43	-78.59
GI0	8.94	74.47		34.94	62.86	336.35	56.20	573.76
GN3	2.40	21.21			43.32	30.58	2.91	100.42
GNZ	-4.04	-83.47		-154.72	-200.83	-36.72		-479.78
HE0	-10.70	0.15			5.58	-4.05		-9.03
LRZ	-139.44	-2.17	-0.32	-6.14	-184.36	-199.47	-56.14	-588.04
LS6	2.77	8.59			0.22	25.28	2.76	39.63
LSZ	-12.06	-93.69		-10.16	125.19	794.99	-27.72	776.55
SC0	30.32	77.20	0.44	2.94	102.87	41.35	32.99	288.11
SS19	1.99	29.22		0.32	29.46	115.72	17.31	194.01
SS3Z	6.06	13.43			1.53	12.76	1.60	35.37
UR0	37.63	31.58	0.90	7.40	93.85	180.83	21.58	373.77
WB3	2.53	37.11	0.23		116.07	65.90	19.37	241.21
WB3Z	-1.12	-18.41	-0.19	-0.40	-40.27	-35.32	-10.13	-105.83

Table F.3: Change in extent of IHS additional habitats mapped for the ANE01 region and each constituent county, 2012/13—2017

Habitat	Change in habitat extent 2012/13—2017, hectares (ha)							
	Berwickshire	Durham	East Lothian	East Riding of Yorkshire	North Yorkshire	Northumberland	Tyne & Wear	ANE01 (Total)
AR1					-0.07			-0.07
AR4	0.12	7.00			2.16	46.92		56.21
AR5	10.39	34.97	0.23	1.31	48.25	105.66	26.48	227.28
BR0	30.60	24.10			104.64	25.05	0.26	184.66
BRZ		-4.71				-0.45		-5.17
CR1					-0.10	-42.78		-42.88
EM0						8.64	0.41	9.05
EM1						0.86		0.86
EM183						-5.07		-5.07
EM1Z						0.37		0.37
EM2						1.50		1.50
EM212						-2.08		-2.08
EM214						-0.42		-0.42
EM422						-3.50		-3.50
GC0		2.92		55.63	6.63		2.68	67.86
GM0	82.03	49.89			103.16	57.58	70.08	362.75
GM1	-18.70					-4.42		-23.12
GM14					-6.31			-6.31
GMZ						-1.63		-1.63
GN0	54.09	148.93	0.64	112.75	246.00	309.67	68.00	940.07
GN1Z	-0.36							-0.36
GN31		-28.30				-4.34		-32.64
GN32						-8.74		-8.74
GN3Z						-14.24		-14.24
GN5		2.20				0.75		2.95
GN51		-1.45						-1.45
GN52		-0.24						-0.24
GN6						0.10		0.10

Habitat	Change in habitat extent 2012/13—2017, hectares (ha)							
	Berwickshire	Durham	East Lothian	East Riding of Yorkshire	North Yorkshire	Northumberland	Tyne & Wear	ANE01 (Total)
GP0						-0.06		-0.06
LF11	0.41	1.59	0.02	1.97	20.56	16.51	0.28	41.35
LF27					-0.19			-0.19
LR5		0.01			0.08	0.12	0.08	0.29
LR6					0.88			0.88
LR7	-0.03				0.32			0.29
LS0						-0.05		-0.05
LS8					-0.85			-0.85
RE1	-4.12				0.51	1.39		-2.22
RE2		26.89			57.68	19.35	16.64	120.56
RE21							-9.15	-9.15
RE22					-3.15			-3.15
SR0	8.62	31.91		1.16	36.10	17.10	5.47	100.35
SR11					-0.13		-0.35	-0.49
SS11						-0.06		-0.06
SS13						-1		-1
WB2	-4.91	-13.03	1.90	-1.23	197.71	8.33	9.88	198.65
WC0	-0.32							-0.32
WCZ	0.33	1.20			0.23	28.37		30.14

Appendix G – Data attribution

Attribute Name	Description
FID	Unique, non-static polygon number. Virtual attribute generated by ArcMap; only visible when viewing file in ESRI software (i.e. not visible in MapInfo)
Shape	GIS file type (polygon)
OBJECT_ID	Unique polygon number assigned to polygons prior to dataset splitting. Where a polygon was split to create a data subset (e.g. split by OS tile), polygons on both side of the split boundary will have the same OBJECT_ID
OS_GRID	OS grid reference taken from polygon centroid (centroid of polygon prior to splitting e.g. by OS tile)
MASTERMAP_	Original OS MasterMap TOID unique ID
OSM_	Original OpenStreetMap TOID unique ID
CMP_FRAGID	A number unique for each fragment of an original OS MasterMap TOID, set to zero if the polygon has not been split.
SEA_LIMIT	Denoting data derived from aerial photography
HAB_CD_08	IHS habitat code from 2008 mapping
HABITAT_CD	IHS habitat code from updated mapping
MATRIX1_CD	Column to provide optional IHS habitat matrix codes
MATRIX2_CD	Column to provide optional IHS habitat matrix codes
MATRIX3_CD	Column to provide optional IHS habitat matrix codes
FORMATION_	Column to provide optional IHS habitat details
MANAGEMENT	Column to provide optional code for management and use of habitat
COMPLEX_CD	IHS habitat complexes. (e.g. CF1)
SUMMARY	Concatenation of HABITAT_CD, MATRIX1_CD, MATRIX2_CD, MATRIX3_CD, FORMATION_, MANAGEMENT and COMPLEX_CD
PROCESS	Code denoting the source of the data: O (Ordnance Survey); A (aerial photography); F (field survey); R (habitat records); FCIR (False Colour Infra-red)
MODIFIED_D	Date file modified
MODIFIED_U	User who modified file
KEYWORDS	Column to provide optional additional description to describe management or features (e.g. caravan, watersports, flood embankments)
COMMENT	This column provides a comment relating to the polygon including where a change was made to the data but can also contain additional information. The code GS followed by a date denotes that a ground survey has taken place and when it took place
GRNDSURVEY	Date of the ground survey (YYYY-MM-DD)
SHAPE_LENG	Perimeter of original polygon (m)
SHAPE_AREA	Area of original polygon (m2)
SOURCE	Joined from supplied lookup table lookup.mdb. “PHT” = Priority Habitat, “AN1” = Annex I, “TT” = Tidal Thames, “IC” = Inverse Category, “PH1” = Phase 1, “BHT” = Biodiversity Broad Habitat Type, “SC” = SERC categories, “NEHMP” = Northeast Habitat Monitoring Programme
NVC_CODE	Corresponding NVC codes
EUNIS_CODE	Corresponding EUNIS code
CORINE_BIO	Corresponding Corine biotype code