The extent and zonation of saltmarsh in England: 2016-2019

An update to the national saltmarsh inventory

August 2022

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Executive summary

In 2011, the Environment Agency published the first saltmarsh national inventory mapped from aerial imagery captured between 2006 and 2009. Since then, approximately 95% of saltmarsh in England has been remapped using imagery captured predominantly between 2016 and 2019. This report examines the overall picture of change in marsh extent between these time periods, providing detail of zonation and several in-depth case studies from different regions around the country.

Historically, significant saltmarsh loss occurred due to land reclamation for agriculture and coastal development. These wide scale losses have now halted, and large areas of saltmarsh now lie within a network of protected sites. However it remains vital to closely monitor this sensitive and unique habitat to ensure further degradation and loss does not occur. In natural capital terms, it is recognised that saltmarsh provides a range of important ecosystem services including biodiversity enhancement, carbon sequestration and wellbeing enhancement through recreational activities. The ability of saltmarsh to absorb tidal and wave energy has resulted in numerous habitat restoration and creation schemes for protecting against future flooding and coastal erosion.

The latest mapped saltmarsh extent in England, primarily mapped between 2016-19, is 35,504.85 ha. This is an overall increase of 2342.75 ha (7%) when compared with the first version of the inventory (2006-09).

A total of 869.64 ha (37%) can be attributed to gains in managed/unmanaged realignment and regulated tidal exchange sites. The majority of these gains (600.41 ha) can be attributed to the development of new marsh in Steart Marshes (Parrett estuary), Alkborough Flats (Humber estuary), Medmerry (south coast) and Hesketh Out Marsh (Ribble estuary) managed realignment sites.

The largest areas of expansion (positive net change) outside of the realignment and tidal exchange sites were recorded in the Humber (26.2%) and Thames (8.3%). The region with the greatest net loss was South Wessex (-2.5%).

The temporal changes discussed here represent an analysis of the data and not an assessment of why or reasons for change. Further, this report does not assess the quality or condition of saltmarsh and is limited to analysing saltmarsh extent and zonation only.

The inventory provides evidence and insight into changing habitat extent at national, regional, and local scales. It is an intention of the inventory that national scale trends do not misrepresent or mask local trends. Furthermore, gains within one waterbody or region should not be seen as compensation for losses in another waterbody or region.

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1. Introduction

Saltmarsh represents an important intertidal habitat found across the world, predominantly in middle to high latitudes. Over recent centuries, a significant area of saltmarsh habitat has been lost from England's coastal regions (ReMeMaRe, 2021). Previously seen as being of low value, it is now known that saltmarshes provide numerous ecosystem services and functions and are extremely important from a natural capital perspective. They provide significant benefits towards flood protection, carbon sequestration and storage, water quality and biodiversity (including importance to fisheries) (Möller and others, 2021). This is particularly true in terms of their importance towards flood and coastal erosion risk management (FCERM) where these habitats are known to help protect against flooding, reducing wave and tidal energy if present in appropriate quantity and form (Möller and others, 1999, Möller and others, 2003; Vuik and others, 2019). These benefits are why saltmarsh habitat is identified as an important contributor to the nature based solutions aspects of the National Flood and Coastal Erosion Risk Management (FCERM) Strategy for England (Environment Agency, 2020). It is therefore imperative for both planning and works related to flood and coastal risk management that we have an accurate inventory of saltmarsh extent.

Historically, land claim has been a major factor in the decline of England's saltmarsh habitat. However, over the last few decades this type of pressure has been almost eliminated due to increased environmental protection and conservation measures. Other impacts that have had detrimental effects on saltmarsh include dredging activity, cabling activities, inappropriate grazing practices, historical landfill activity embanking and other such engineering work (Doody 2008; Davidson and others, 2017). More recent pressures on saltmarsh are likely to be derived from other factors such as climate change, sea level rise and coastal squeeze. Coastal squeeze is thought to be a potentially significant problem for saltmarshes backed by sea defences with or without development behind, where they are unable to transgress in response to sea level rise. This has been the subject of a recent review by the Environment Agency (Pontee and others, 2021). Changes in sediment supply in this context is also important as this will impact the ability of marsh to keep pace with sea level rise (Pontee and others, 2021).

In the last few decades there has been a push to prevent loss and degradation of saltmarsh which has led to a number of national and international conservation objectives. For the Environment Agency, these responsibilities include the Water Environment (England and Wales) Regulations (WER) (2017)[1], monitoring and

[1] formerly the Water Framework Directive (WFD).

reporting requirements which link to UK Marine Strategy[2] assessments and in addition, support Natural England's responsibilities associated with protected sites such as Marine Conservation Zones (MCZs), Special Areas of Conservation (SACs), Ramsar sites, Special Protection Areas (SPAs), and Sites of Special Scientific Interest (SSSIs).

The 2021 Environment Act empowered the UK Government to publish the nation's first statutory environmental improvement plan, the '25 Year Environment Plan'. Strategies to support the delivery of the 25 Year Plan targets relating directly to saltmarsh include the:

- FCERM Strategy for England that includes the Regional Habitat Compensation and Restoration Programmes (HCRPs) and nature based solutions for protecting against flooding and coastal erosion.
- Nature Recovery Network[3] and Local Nature Recovery Strategies that will utilise spatial mapping and planning tools to identify existing and potential habitat for enhancing biodiversity
- Biodiversity 2020 Strategy[4] and subsequent G7 Nature Compact 2021 agreement to halt and reverse biodiversity loss by 2030.

In addition to the Strategies listed above, the 25 Year Plan introduces a mandatory minimum 10% Biodiversity Net Gain (BNG) principle for development, including housing and infrastructure (including Nationally Significant Infrastructure Projects). A biodiversity metric[5] has been developed to enable planners and developers to assess an area's value to wildlife.

1.1. Report scope

This report provides an update to the 2011 Environment Agency report entitled: 'The extent of saltmarsh in England and Wales: 2006–2009' (Phelan and others, 2011),

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[2] Available online at: Introduction to UK Marine Strategy (cefas.co.uk) [Accessed 25/04/2022].

[3] Available online: Nature Recovery Network - GOV.UK (www.gov.uk) [Accessed 25/04/2022].

[4] Available online at: https://www.gov.uk/government/publications/biodiversity-2020-a-strategy-for-england-s-wildlife-and-ecosystem-services [Accessed 20/01/20202].

[5] Available online: Biodiversity metric: calculate the biodiversity net gain of a project or development - GOV.UK (www.gov.uk) [Accessed 25/04/2022].

and presents a temporal comparison to the original saltmarsh extent dataset (Environment Agency baseline). Since the baseline dataset was created, almost 100% of saltmarsh has been remapped with later aerial imagery, allowing accurate comparison on a national scale. During this exercise, the baseline dataset was reassessed to eliminate discrepancies between assessors and/or assessment procedures providing a more accurate view of real change. In addition to providing an update of the Environment Agency national inventory that includes current extent, change from the original dataset and zonation, this report also contains details of saltmarsh within sites[6] created or restored through managed/unmanaged realignment (MR/unMR) and regulated tidal exchange (RTE).

While the 2011 report focussed on both England and Wales, this report focusses on **England only** and does not include details of saltmarsh in Wales. The temporal changes discussed here represent an analysis of the data and not an assessment of why or reasons for change. Further, this report does not assess the quality or condition of saltmarsh and is limited to analysing saltmarsh extent and zonation only.

1.2. Saltmarsh in England

Prior to the recording a national inventory of saltmarsh in 2011, the only other national extent survey was undertaken by Fiona Burd in 1989 on behalf of the Nature Conservancy Council (NCC) (Burd 1989). This survey was generally understood to have underestimated the extent of saltmarsh due to the constraints of the methodology at the time.

There have also been a number of local and regional examples of saltmarsh extent investigations. These have tended to indicate that areas in the South and South East of England have undergone a trend of saltmarsh loss (Burd 1992, Pye and French 1993a, Baily and others, 2002, Cooper and Cooper 2000, Cooper and others, 2001) whereas those in the North West are traditionally thought to be accreting (Hill 1987, Burd 1989, Pye and French 1993a, Huckle and others, 2004). These trends have also been confirmed in a study by Ladd and others, (2019) for a number of marshes within each location. Ladd and others (2019) examined lateral expansion of saltmarsh using OS maps between 1967 and 2016, however it should be noted that this dataset only goes up to 2001 for the South and South East regions.

While these patterns indicate a picture of erosion and accretion in different parts of the country, the widely accepted trend is that England is losing saltmarsh, however not all regions have been considered or accounted for on a national scale. Further,

[6] Please note that the list of coastal realignment and tidal exchange sites is not exhaustive.

there are initiatives to restore saltmarsh through managed realignment and other techniques which aim to mitigate and offset saltmarsh loss. Accurate information on the location, extent and zonation of existing marshes is imperative to be able to aid in restoration practices.

Environment Agency Regional Habitat Compensation and Restoration Programme (HCRP) leads have been assigned throughout England to develop and deliver schemes to meet the requirements detailed in the Habitats Regulations Assessments (HRAs) of Shoreline Management Plans (SMPs) and aligned to the FCERM strategy. These programmes work collaboratively and strategically to monitor long-term habitat change at regional level and mitigate against loss through habitat compensation (see Hardiman, 2018).

Another cross-Defra restoration initiative called ReMeMaRe[7] aims to reverse the decline of estuarine and coastal habitats by **Re**storing [seagrass] **Me**adows, [salt] **Ma**rsh and [oyster] **Re**ef. ReMeMaRe have produced a set of handbooks[8] providing guidance for restoration approaches such as managed realignment.

2. Methodology

Saltmarsh extent and zonation mapping was completed following standard guidelines and methodology used in Hambidge and Phelan (2014). A combination of true-colour and near-infrared aerial photography with 20 cm resolution was used for assessment of extent and zonation classification. All imagery came from the Regional Coastal Monitoring Programmes[9].

For the extent and analysis of change, the country was split into broad regions of the UK (boundaries set as Environment Agency administrative regions) and within HCRP administrative regions which break down into more strategic units (Figure 1).

[7] Available online at: Restoring Meadow, Marsh and Reef (ReMeMaRe) | Estuarine & Coastal Sciences Association (ecsa.international) [Accessed 20/01/2011].

[8] Available online at: Tools and guidance | Estuarine & Coastal Sciences Association (ecsa.international) [Accessed 20/01/2011].

[9] Available online at: National Coastal Monitoring - Welcome [Accessed 01/04/2022]

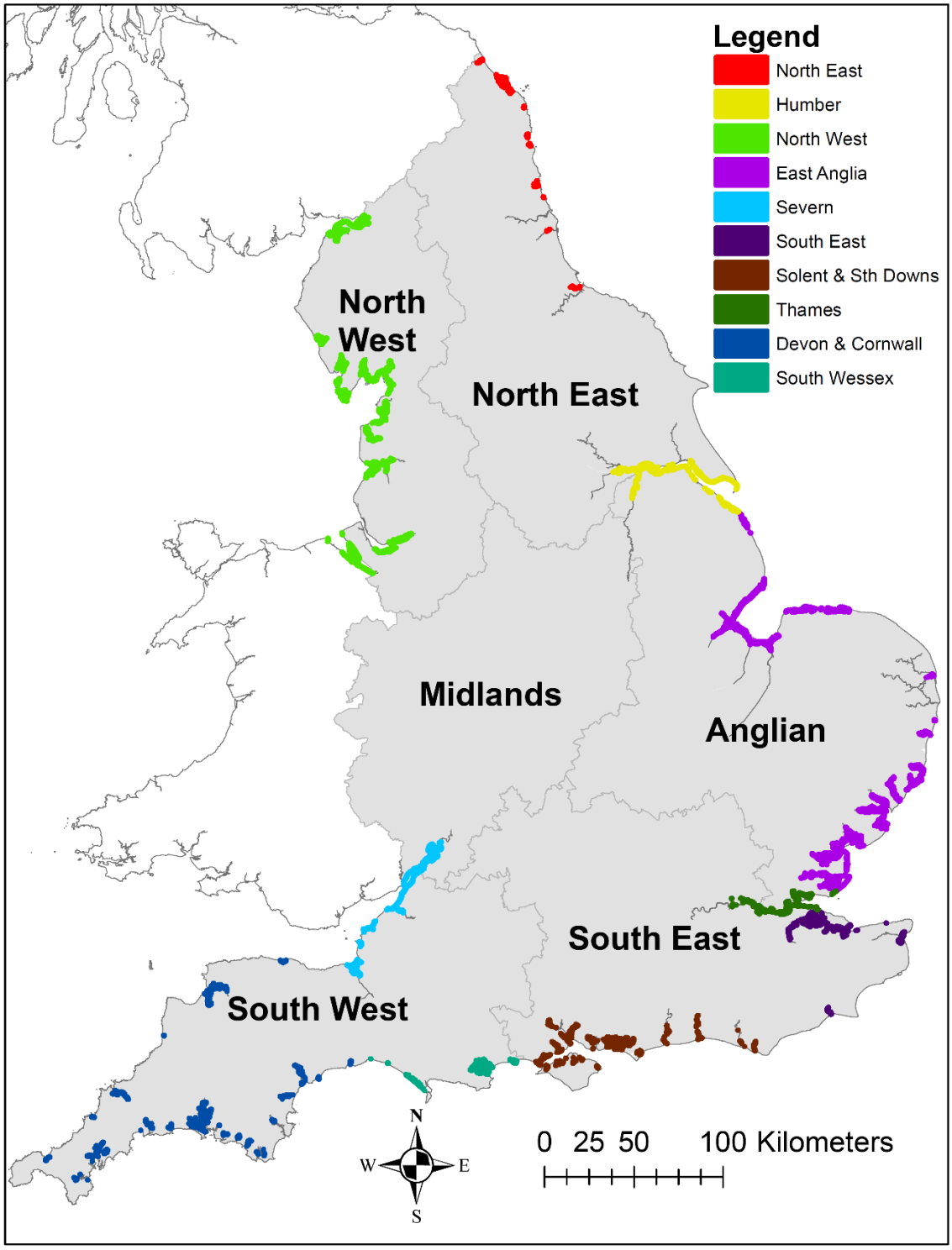

Figure 1: HCRP regions (overlaying Environment Agency regions in England) used as units for analysis and reporting. Saltmarsh extent in England. © Environment Agency, 2022.

2.1. Saltmarsh extent

Aerial images (4-band colour) at a resolution of 20 cm used to produce the first version (Environment Agency baseline) of the national saltmarsh inventory were mostly captured between 2006–2009, and are detailed in the previous report (Phelan and others, 2011). Approximately 99.5% of saltmarsh in England has been remapped since the baseline. The majority of waterbodies were remapped using imagery taken between 2016 and 2019, although 10 waterbodies used imagery taken between 2011 and 2015. One waterbody (Wear; 2.43 ha of saltmarsh) has had no remapping done. Where ecological monitoring ground-truth data was available from Environment Agency WER water bodies, Natural England protected areas, FCERM project sites and from the Regional Coastal Monitoring Programmes, this was used to validate the mapped outputs.

It is important to note that analysis of the two datasets was not done independently, the baseline dataset has been re-edited to ensure consistent approaches to mapping. This focused on the identification of extent change on the frontal edge of the saltmarsh, rather than identifying discrepancies with the terrestrial edge which has been identified by the extent of the Highest Astronomical Tide. When making an assessment of change, this minimised artefacts brought about due to interpreter bias. This means that baseline extent values reported here will differ from those reported in the previous saltmarsh inventory (Phelan and others, 2011).

2.2. Saltmarsh zonation

Whilst 86% of saltmarsh in England was mapped to zonation level, much of the zonation mapping was done prior to the latest round of extent mapping. As a result, many areas of accretion were left ‘unclassified’. Other areas of saltmarsh that were never mapped to zonation level were also labelled as ‘unclassified’.

Where classification was possible, communities were classed as ‘unvegetated’ habitat, ‘pioneer’, ‘low-mid’, ‘upper, ‘reedbed’ and ‘*Spartina’* which can be quantified against the National Vegetation Classification (NVC) definitions (Appendix 1). Less than 1% of saltmarsh (213.19 ha) has been given a classification of ‘unvegetated’. This classification is given for the following scenarios:

- these areas fall over salt pans and creeks (or similar areas) that are not picked up in the extent mapping. Large fragmented saltmarshes tend to have greater areas classified as ‘unvegetated’;
- images (or years of capture) used to classify extent and zonation are different resulting in changes in vegetated cover;
- discrepancies between extent and zonation recorders.

2.3. Saltmarsh change

To compare between two time periods, extent shapefiles (GIS layers) were created for each time period. These layers were combined using a Union analysis within ArcGIS where the resulting polygons could be attributed as areas of loss, gains, no change, and not remapped.

It is likely that areas of high creek density or highly fragmented habitat will be less accurately mapped than more dense marsh. A GIS layer was therefore created to analyse ‘gross’ and ‘marginal’ change. This was accomplished by creating an additional change layer that heavily generalised the creek networks and the areas of fragmented habitat. It did this by firstly creating extent layers utilising a 20 m creek width delineation instead of 2 m. To do this, on both the baseline and latest dataset, a 10 m outward buffer, followed by a dissolve and 10-metre inward (negative) buffer was used. This created datasets that filled in small creeks and fragmented habitat.

A Union analysis on these buffered datasets was then used to assign changes in saltmarsh (gain, loss, no change, not remapped). Where changes were consistent between the two change layers (2 m and 20 m creek widths), these are referred to as ‘gross’ change. Where there were disagreements between the two layers, it was referred to as ‘marginal’ change. These areas of ‘marginal’ change relate to creek and fragmented habitat on the saltmarsh margins and are less accurately interpreted compared with the ‘gross’ changes.

2.4. Limitations

It is likely that seasonal differences played some effect on results, particularly when images were not captured during a similar part of the season. While efforts were made to capture imagery within the summer months, as outlined above, there has been some cases where images were needed to be used outside of this period, or at different times within the season resulting in differences due to varying levels of senescence towards the end of the season or poor visibility of new growth (e.g. ‘pioneer’ and ‘low’ marsh species) at the beginning of the season.

Other factors such as differing weather, variation in image quality and type will have an impact on how the imagery is interpreted. The presence of opportunistic macroalgae can make it difficult to delineate saltmarsh from non-saltmarsh. Older imagery is often of poorer quality than the newer imagery therefore could impact interpretation. In addition ‘pioneer’ marsh and fragmented areas are difficult to consistently delineate, particularly where they coincide with areas of macroalgae either overtopping the saltmarsh or where it is located directly adjacent to saltmarsh plants.

3 Results

3.1 Change in extent

3.1.1 National

The baseline and latest extents of saltmarsh in England are summarised in Table 1. The latest mapped extent in England is 35504.85 ha. This is an overall increase of 2342.75 ha (7%) compared with the baseline (2006–2009) figures; 869.64 ha of this increase can be attributed to gains in managed/unmanaged realignment and regulated tidal exchange sites (Section 3.2).

The largest areas of expansion (positive net change) outside of the realignment and tidal exchange sites were recorded in the Humber (26.2%) and Thames (8.3%) HCRP regions. The region with the greatest net loss was South Wessex (-2.5%).

The net change is made up of discrete areas of loss and gains. Table 2 outlines the specific areas of gain, loss and no change compared with the baseline within each HCRP. In total, 1502.87 ha of saltmarsh was lost since the baseline was recorded, whereas 3794.21 ha of saltmarsh was gained resulting in a net positive change.

3.1.2 Anglian Environment Agency Region

The Humber HCRP region saw the largest net increase in saltmarsh (630 ha), which is explored in the Humber case study (section 4.3).

The East Anglian HCRP shows a net gain in extent (621 ha). The greatest gains were found in the Wash (391 ha) and in many of the middle and upper reaches of East Anglia's estuaries. Creation of saltmarsh through realignment and RTE sites contributed to 88 ha of marsh extent gain, primarily at sites on the North Norfolk coast and within Suffolk and Essex estuaries. In contrast, considerable marsh erosion was found along the outer Thames and Essex coast (see section 4.1).

3.1.3 North East Environment Agency Region

In the North East, the most significant change in extent can be attributed to the creation of marsh at the Greatham MR site, in the Tees (42.7 ha). Without the intervention of the MR site, saltmarsh extent would have seen a very marginal decrease over recent time.

3.1.4 North West Environment Agency Region

In the North West, large areas of expansion can be attributed to the Hesketh Outer Marsh MR sites (264 ha). The amount of saltmarsh created within these sites equated to approximately 40% of the net gain in the North West region (see section

4.4). Not all waterbodies in the North West experienced significant gains. The Solway data indicated a minimal net loss (22 ha) had occurred over the recent 9-year period (2009 to 2018).

3.1.5 South East Environment Agency Region

Solent & South Downs HCRP region had a net gain of 18.6 ha of saltmarsh overall (1.4% change) including the realignment and RTE sites (Table 2). However, this value does not show the scale of local changes within this region. There was 184.46 ha of new growth (gains) compared with 217.29 ha of lost saltmarsh within this region. The breach at the Medmerry managed realignment site has resulted in a gain of 51 ha for this region. If gains (and losses) within Medmerry and other realignment sites are excluded, this region had a net loss of 34.75 ha (-2.6%). Most of the losses were observed within the Solent waterbodies (See section 4.2).

3.1.6 South West Environment Agency Region

South Wessex HCRP region, lost 16 ha of saltmarsh which represented 2.5% of the total saltmarsh habitat in this region. This loss can be attributed to a net loss (18 ha) observed in Poole Harbour between 2008 and 2014. Significant patches of saltmarsh loss were observed within Holes Bay on the seaward edge currently occupied by Pioneer and *Spartina* zones.

The area of the Severn HCRP region located within the South West Environment Agency Region saw a substantial gain of 220 ha. Over 200 ha of the marsh gained in this region was created within the Steart MR and Otterhampton RTE sites located in the Parrett estuary.

3.1.7 Midlands Environment Agency Region

An increase in saltmarsh (23.93 ha) was observed within the area of the Severn HCRP region that overlaps the Midlands Environment Agency Region (from above Sharpness). The gains (20.41 ha) in this area can be attributed to widespread, patchy change outside of realignment sites (see Appendix 1).

Table 1: Aerial extent of saltmarsh within Habitat Compensation and Restoration Programme (HCRP) regions in England, comparing baseline and latest extents. Numbers in brackets indicate net change (ha and percentage) when managed realignment sites are excluded. © Environment Agency, 2022.

EA Region	HCRP Region	Baseline Extent (ha)	Latest Extent (ha)	Net change (ha)	Net change (%)
Anglian	East Anglia	12732.65	13353.83	621.18 (533.18)	4.88% (4.23%)
	Humber	1744.48	2375.09	630.61 (451.87)	36.15% (26.22%)
North East	North East	430.88	463.78	32.89 (-8.96)	7.63% (-2.21%)
North West	North West	12318.05	12943.50	625.45 (361.27)	5.08% (2.93%)
South East	Solent & South Downs	1346.36	1364.92	18.56 (-34.75)	1.38% (-2.60%)
	South East	1425.83	1502.17	76.34 (76.34)	5.35% (5.35%)
	Thames	551.85	606.62	54.77 (46.00)	9.92% (8.34%)
South West	Devon & Cornwall	935.84	990.84	55.00 (27.94)	5.88% (3.33%)
	South Wessex	647.79	631.79	-16.00 (-16.00)	-2.47% (-2.47%)
	Severn*	282.15	502.13	219.98 (15.77)	77.96% (5.66%)
Midlands	Severn*	746.21	770.17	23.96 (20.44)	3.21% (2.83%)
England Total		**33162.10**	**35504.85**	**2342.75 (1473.10)**	**7.06% (4.48%)**

*The Severn HCRP is split across the Midlands and South West Environment Agency region

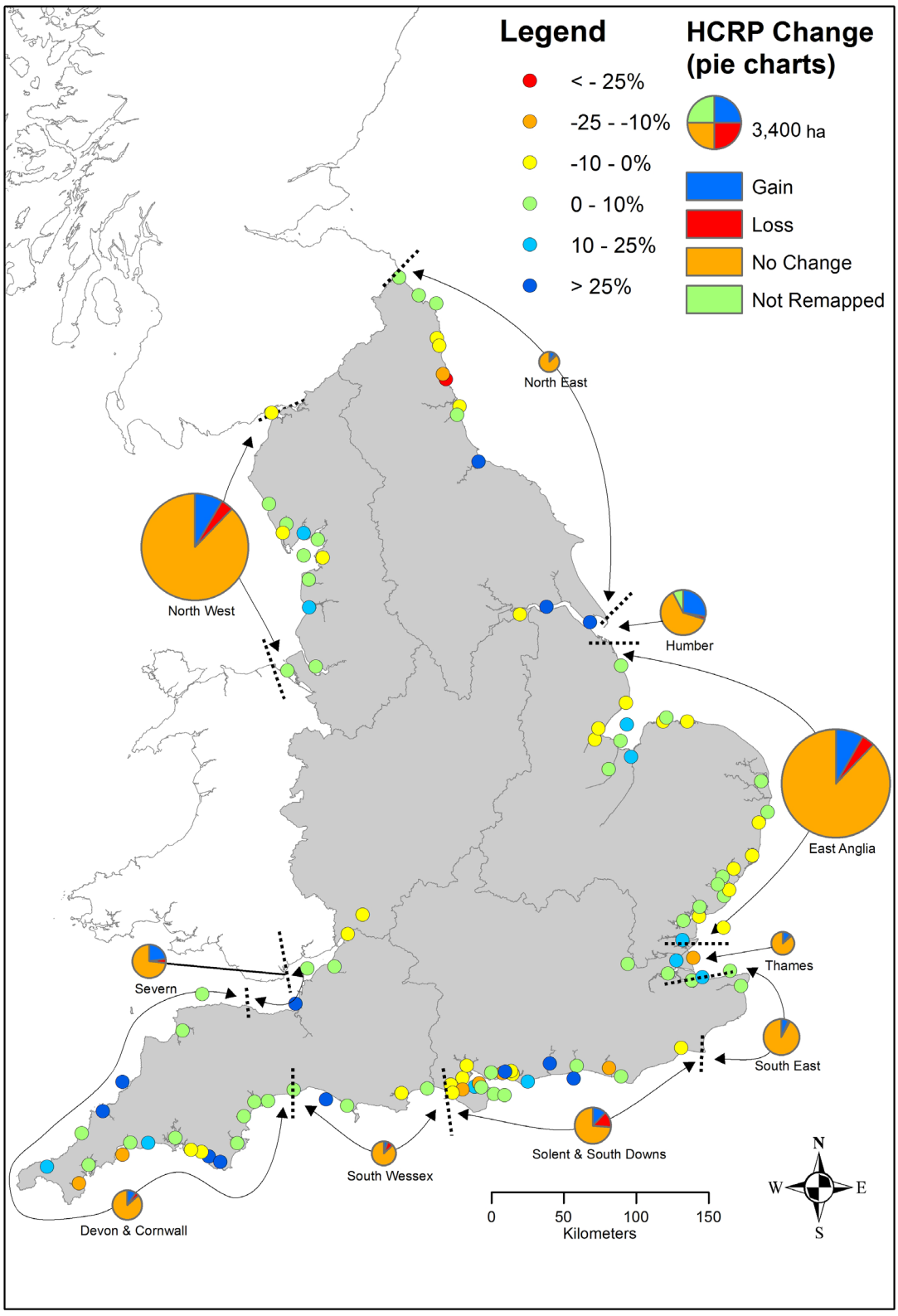

Figure 2: Saltmarsh gains and losses in English Habitat Compensation and Restoration Programme (HCRP) regions. Size of pie charts reflect the extent of saltmarsh in each region. Saltmarsh (outlined in black) and change analysis relate to England only. © Environment Agency, 2022.

Table 2: Localised changes in saltmarsh extent (gains, losses, net change) within Habitat Compensation and Restoration Programme (HCRP) regions in England relative to baseline extent. Numbers in brackets represent area and percentages that have not been remapped. © Environment Agency, 2022.

Environment Agency Region	HCRP region	Baseline Extent (ha)	Net change (ha)	Net change (%)	Gain (ha)	Gain (%)	Loss (ha)	Loss (%)	No Change (ha)	No Change (%)
Anglian	East Anglia	12732.65	621.18	4.88%	1149.64	9.03%	528.46	4.15%	12204.05 (0.14)	95.85% (0.00%)
	Humber	1744.48	630.61	36.15%	676.42	38.77%	45.80	2.63%	1520.28 (178.39)	87.15% (10.23%)
North East	North East	430.88	32.89	7.63%	47.42	11.01%	14.53	3.37%	413.92 (2.43)	96.06% (0.56%)
North West	North West	12318.05	625.45	5.08%	1134.69	9.21%	509.24	4.13%	11808.82 (0.00)	95.87% (0.00%)
South East	Solent & South Downs	1346.36	18.56	1.38%	184.46	13.70%	217.29	16.14%	1124.10 (4.97)	83.49% (0.37%)
	South East	1425.83	76.34	5.35%	98.74	6.93%	22.40	1.57%	1403.43 (0.00)	98.43% (0.00%)
	Thames	551.85	54.77	9.92%	70.12	12.71%	15.36	2.78%	536.50 (0.00)	97.22% (0.00%)
South West	Devon & Cornwall	935.84	55.00	5.88%	97.82	10.45%	42.82	4.58%	891.98 (1.04)	95.31% (0.11%)
	South Wessex	647.79	-16.00	-2.47%	36.90	5.70%	52.89	8.17%	594.90 (0.00)	91.83% (0.00%)
	Severn*	282.15	219.98	77.96%	242.03	85.78%	22.05	7.82%	260.10 (0.00)	92.18% (0.00%)
Midlands	Severn*	746.21	23.96	3.21%	55.98	7.50%	32.03	4.29%	714.19 (0.00)	95.71% (0.00%)
England Total		**33162.10**	**2291.35**	**6.91%**	**3794.21**	**11.44%**	**1502.87**	**4.53%**	**31472.26 (186.98)**	**94.90% (0.56%)**

*The Severn HCRP is split across the Midlands and South West Environment Agency region

3.2 Restored/created sites

At a national scale, there were gains of 869.64 ha of saltmarsh within restored/created sites (through managed/unmanaged realignment and regulated tidal exchange) (Table 3). A total of 507.18 ha is attributed to sites that have been created since the first version of the Environment Agency inventory (baseline) was produced (Figure 3). While there are gains at the regional level (Table 3), there have been some losses seen within some sites, particularly in the North East and Solent regions (net change is less than the amount that has grown in newly created sites). However, as restoration is a process that can see changes in communities and bed forms over time until a more stable state has been reached, this should not be a cause for concern without further examination of the data.

Table 3: Aerial extent of saltmarsh within Habitat Compensation and Restoration Programme (HCRP) regions in England attributed to restoration sites, comparing baseline and latest extent records. New sites are those created since the baseline. © Environment Agency, 2022.

Environment Agency Region	HCRP	Baseline (ha)	Latest (ha)	New sites (ha)	Net change (ha)	Net change (%)
Anglian	East Anglia	125.79	213.78	38.90	88.00	69.96%
	Humber	21.34	200.09	0.00	178.75	837.53%
North East	North East	25.13	66.98	49.94	41.85	166.51%
North West	North West	0.00	264.18	132.18	264.18	-
South East	Solent & South Downs	8.16	61.47	55.70	53.31	653.01%
	South East	0.00	0.00	0.00	0.00	-
	Thames	0.40	9.16	8.72	8.76	2199.74%
South West	Devon & Cornwall	96.91	123.97	15.41	27.06	27.93%
	South Wessex	0.00	0.00	0.00	0.00	-
	Severn*	3.57	207.78	204.11	204.21	5722.50%
Midlands	Severn*	22.93	26.45	2.22	3.52	15.35%
England Total		**304.23**	**1173.87**	**507.18**	**869.64**	**285.85%**

*The Severn HCRP is split across the Midlands and South West Environment Agency region

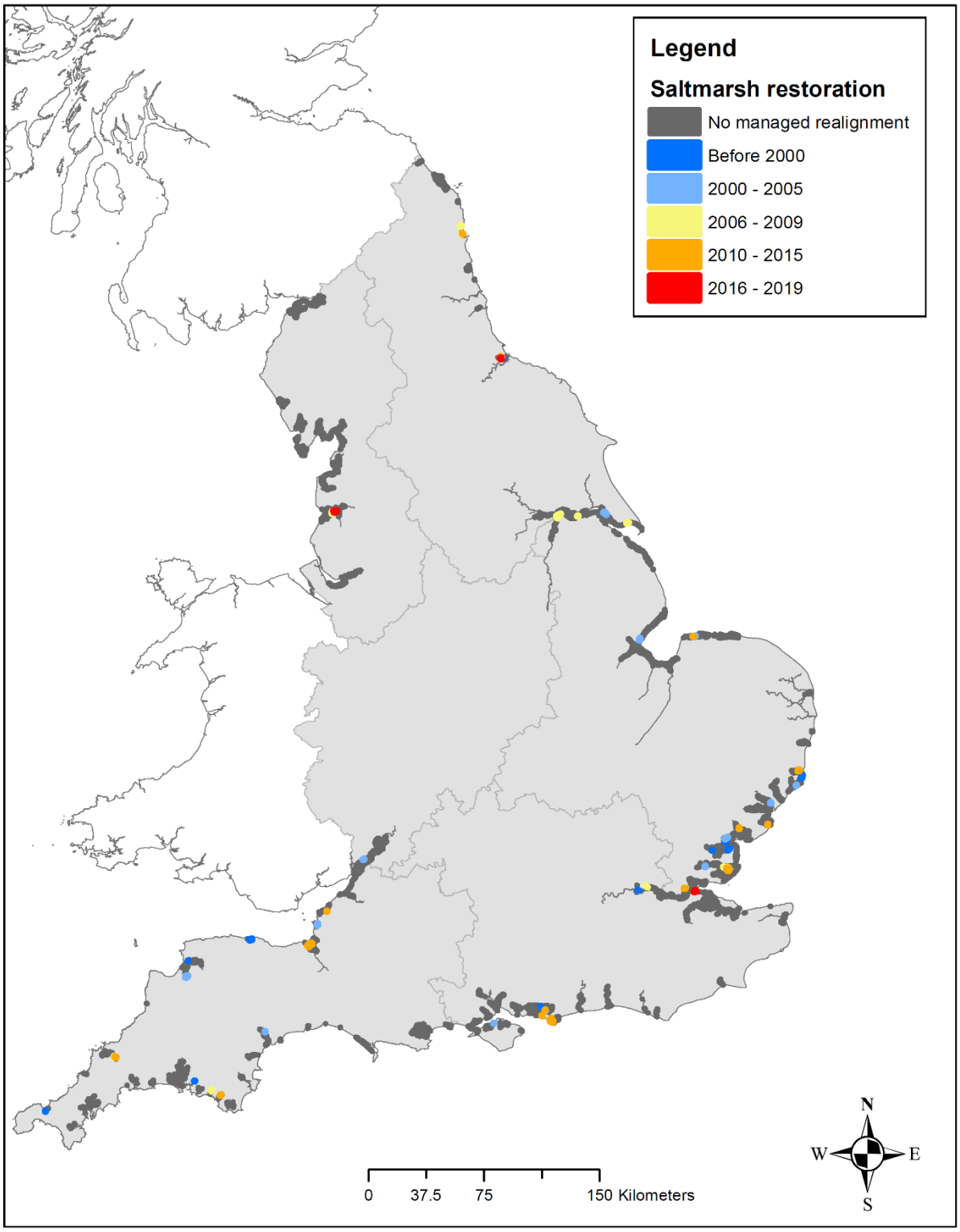

Figure 3: Location of saltmarsh restoration sites (managed/unmanaged realignment and regulated tidal exchange) compared with saltmarsh (dark grey outline) in England. Colour represents year of restoration. Restoration sites as listed in the ABPmer OMreg database (ABPmer, 2021). © Environment Agency, 2022.

3.3 Saltmarsh zonation

Zonation has been mapped in 75 out of the 111 waterbodies that contain saltmarsh in England (Appendix 3). Zonation appears to differ throughout the country and HCRP regions (Table 4; Figure 4). The majority of saltmarsh in England is within the 'low-mid' zone. This is unsurprising as this zone is made up of a number of species that encompass a wide variety of habitats (typically from lower marsh to upper marsh). Due to mapping constraints, some communities that would typically be related to the upper shore are included in this zone (See Appendix 1). Saltmarshes in East Anglia, Thames and North West HCRP regions are predominantly comprised of this zone, with each of these regions displaying similar zonation patterns (Figure 5).

The 'upper' zone is the second largest zone in England, the Severn HCRP has the largest proportion of 'upper' saltmarsh compared with other regions. Devon and Cornwall waterbodies also have large areas of 'upper' saltmarsh. '*Spartina'* makes up less than 10% of England's saltmarsh, the largest areas of this zone are found in the Anglian and Solent & South Downs regions. In the Anglian region this zone makes up less than 10% of the total marsh area and is typically very much a component of the marsh rather than a dominant constituent of the sward. In contrast, almost 50% of saltmarsh in the Solent & South Downs region is made up of '*Spartina'* (see Solent case study). Other regions where *Spartina* is most prevalent (by percentage area) are in the North East and Severn HCRPs.

'Pioneer' and 'reedbed' zones each make up less than 5% of England's total saltmarsh habitat. The 'pioneer' zone in England was found in low abundance in almost all waterbodies that were categorised, however due to the mapping protocols used there is potential for 'pioneer' marsh to be underestimated due to its low density and fragmented nature. Some waterbodies had relatively large proportions of 'reedbed'. Approximately 40% of 'reedbed' found in England's saltmarshes are located in the Humber where this zone makes up a large proportion of the saltmarsh. Only South Wessex has a larger proportion of 'reedbed', although it should be noted that the only waterbody in this region that was classified was Poole Harbour.

Table 4: Extent of each zone in saltmarshes in England's Environment Agency regions and Habitat Compensation and Restoration Programme (HCRP) regions. (% of total below). © Environment Agency, 2022.

Environment Agency Region	HCRP region	Pioneer (ha)	Mid-Low (ha)	Upper (ha)	Reedbed (ha)	*Spartina* (ha)	Unclassified (ha)	Un-vegetated (ha)
Anglian	East Anglia	895.23	8553.62	2068.29	106.92	996.60	641.48	91.69
	Humber	81.99	679.62	547.70	358.61	300.25	404.08	6.37
North East	North East	31.14	153.15	81.28	3.30	84.01	99.20	8.41
North West	North West	439.20	7526.45	3243.58	27.22	301.67	1368.73	36.66
South East	Solent & South Downs	19.95	384.03	148.36	72.96	632.34	98.81	9.34
	South East	0.00	0.00	0.00	0.00	0.00	1502.17	0.00
	Thames	17.07	312.89	192.69	8.08	71.40	2.27	2.22
South West	Devon & Cornwall	24.52	248.36	315.31	107.39	55.21	222.78	17.28
	South Wessex	5.17	197.32	163.77	135.90	23.46	99.06	8.39
	Severn*	11.36	96.97	173.90	32.30	135.52	24.12	27.95
Midlands	Severn*	8.42	190.99	404.40	35.31	119.23	6.95	4.87
England Total		**1534.05**	**18343.40**	**7339.26**	**888.01**	**2719.69**	**4469.66**	**213.19**

*The Severn HCRP is split across the Midlands and South West Environment Agency region.

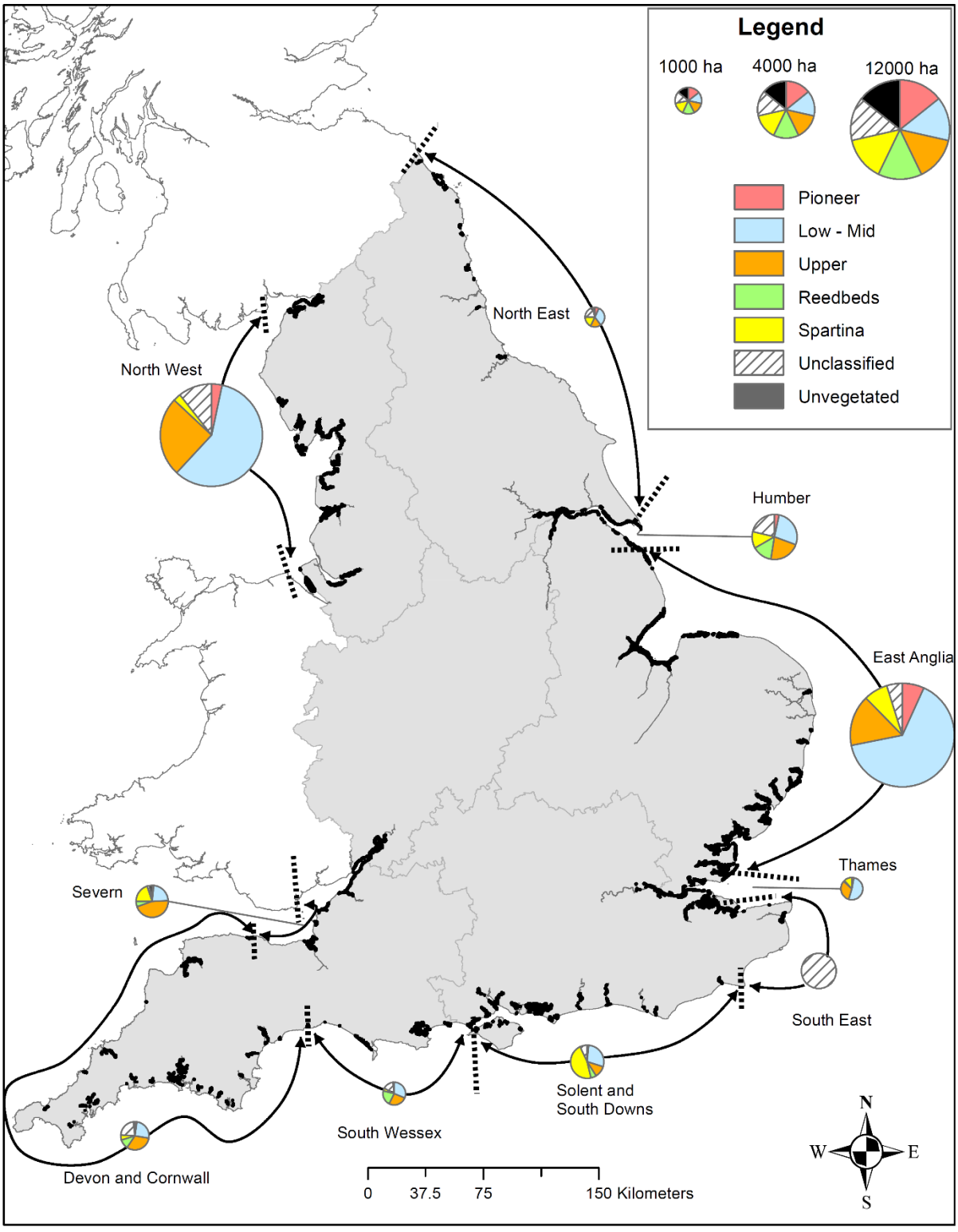

Figure 4: Saltmarsh zonation in English Habitat Compensation and Restoration Programme (HCRP) regions. Size of pie charts reflect the extent of saltmarsh in each region. Saltmarsh (outlined in black) and zonation analysis relate to England only. © Environment Agency, 2022.

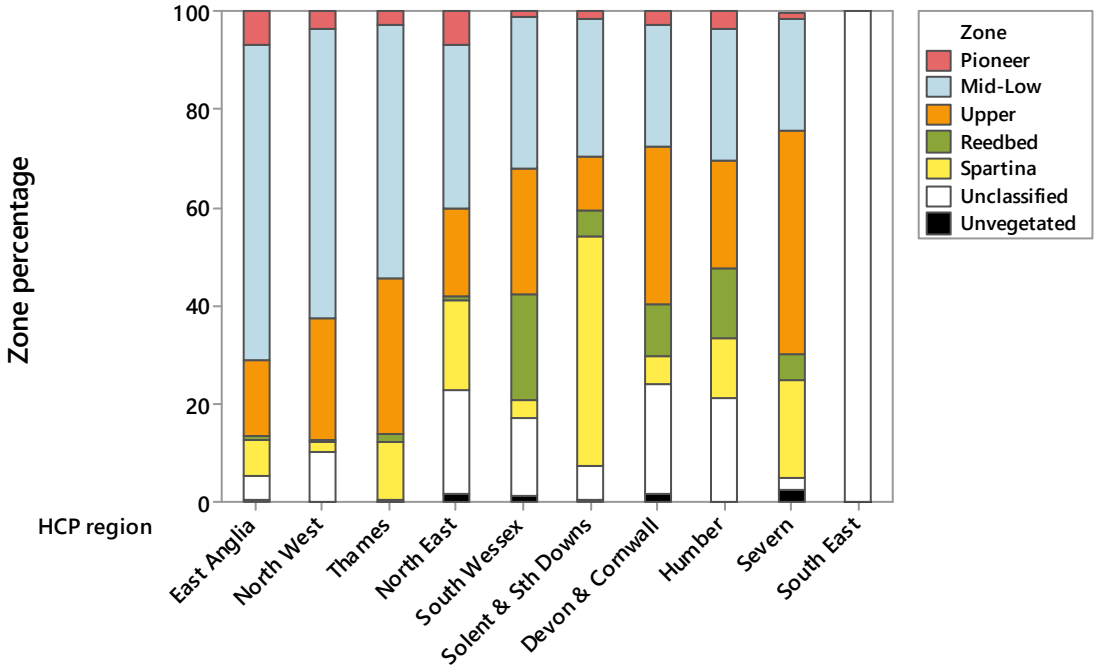

Figure 5: Stacked bar chart showing the percentage of each saltmarsh zone within each Habitat Compensation and Restoration Programme (HCRP) region. Regions organised by the percentage area of the Low-Mid region. © Environment Agency, 2022.

3.4 Long term change

These results mark the first time national surveys for England's saltmarsh can be analysed for change in extent. The only previous comprehensive study of England's saltmarsh was the NCC survey of saltmarsh in Great Britain in 1989 (Burd, 1989). While this assessment was generally considered to be an underestimation due to methodological differences and other limitations, a direct analysis of change between the 1989 dataset and the latest Environment Agency datasets is not feasible without further examination. The results shown below (Table 5) are therefore for comparison only and should not be construed as evidence of long term change.

Table 5: Comparison to Burd 1989; these results should not be interpreted as evidence of change due to differing approaches and methodologies. © Environment Agency, 2022.

	Burd (ha) 1973 –1988	Environment Agency Baseline (ha) 2006–2009	Environment Agency Latest extent (ha) 2016 –2019
England Total	32500.13	33162.1	35504.85

4 Case studies

4.1 Essex Estuaries – East England

Over 80% of the saltmarsh in each of the Essex waterbodies examined here (Blackwater, Blackwater Outer, Colne, Crouch, Essex, and Thames Coastal North) is classified as Low-Mid zone. There are also small amounts of 'upper' zone saltmarsh and some '*Spartina'*. A small area (53 ha) of these waterbodies are classed as 'unvegetated' in the saltmarsh zonation classifications, this is likely largely due to the high creek densities and fragmented saltmarsh habitat in this region.

The total extent of saltmarsh has increased in this region, however there were some losses, both at a waterbody level (Blackwater Outer, Essex and Thames Coastal North) and more locally (Table 6). The saltmarsh in many of the waterbodies in this region have dense creek networks or are highly fragmented. A large proportion of gains and losses observed in these waterbodies are related to 'marginal' changes which have a lower accuracy than the 'gross' changes. Furthermore, this region has been shown to have high densities of opportunistic macroalgae which can further impact the confidence of mapping as signals from macroalgae can be confused with saltmarsh. For future mapping, site visits for the collection of ground-truth information will be particularly important in this region.

Table 6: Saltmarsh accretion (gain) and erosion (loss) observed in Essex waterbodies between the baseline and latest extent records. © Environment Agency, 2022.

Waterbody	Change Period	Baseline extent (ha)	Net Change (ha)	Gain (Gross) (ha)	Gain (Marginal) (ha)	Loss (Gross) (ha)	Loss (Marginal) (ha)
Blackwater	2008 to 2016	622.03	54.95	31.53	48.12	10.54	14.16
Blackwater Outer	2007 to 2016	321.99	-9.25	2.76	1.52	7.80	5.72
Colne	2008 to 2016	561.12	23.14	9.94	25.77	8.03	4.54
Crouch	2007 to 2016	702.66	76.59	70.28	34.08	10.15	17.62
Essex	2007 to 2016	390.81	-24.04	1.24	2.95	19.85	8.38
Thames Coastal North	2007 to 2016	8.28	-1.04	0.01	0.01	0.81	0.24

Both the Blackwater and Crouch waterbodies displayed large net gains in saltmarsh. If managed realignment sites are excluded from the assessment both waterbodies still display a net gain of saltmarsh (31.5 ha and 25.3 ha respectively). Within the

Blackwater for example, the managed realignment site Tollesbury has seen accretion of saltmarsh, most of this new accreted marsh is made up of primarily '*Spartina'* and 'pioneer' species. Outside of the managed realignment site, while the saltmarsh mapping is indicating large areas of accretion along the creeks in this area, there is also some evidence of erosion (Figure 7).

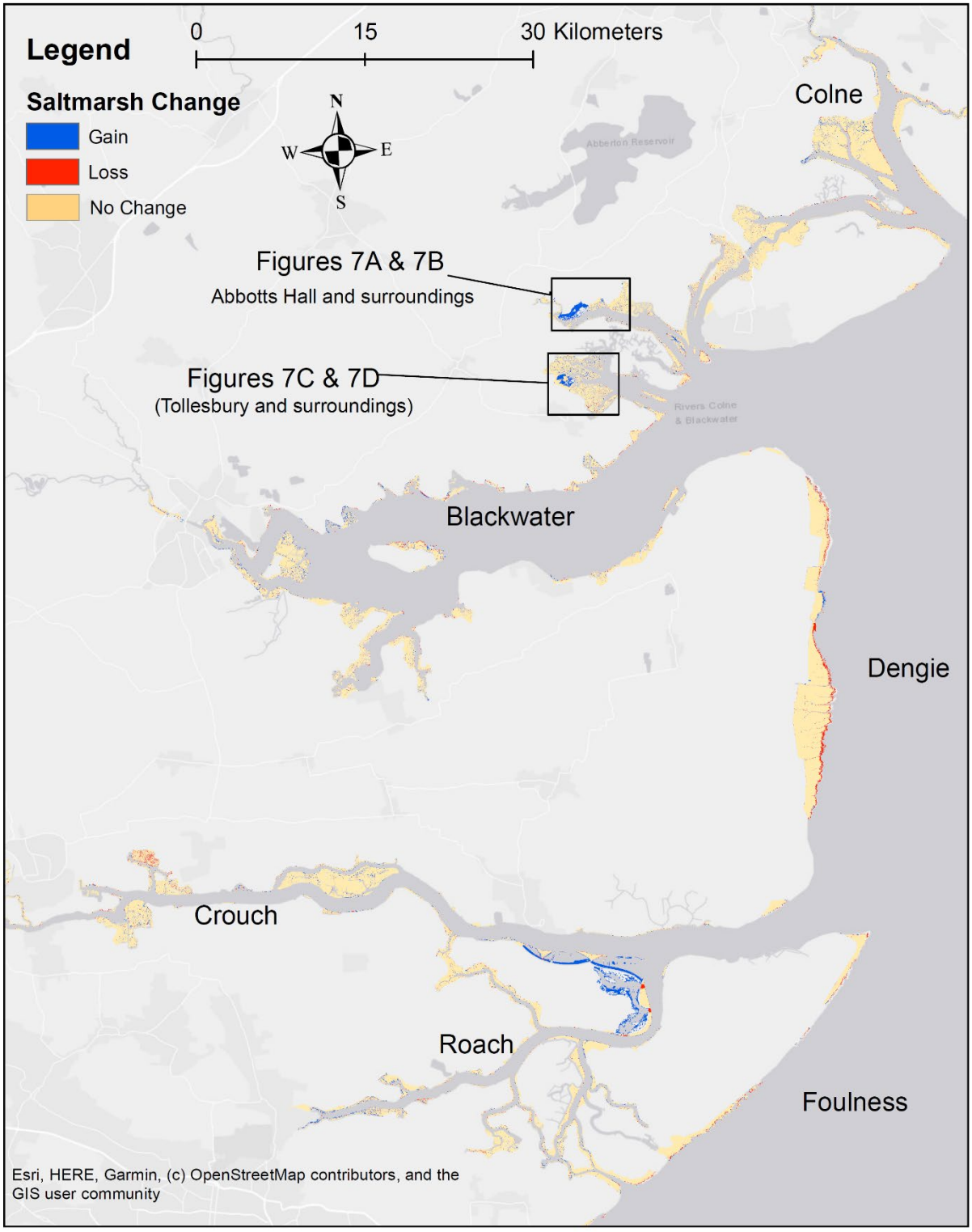

Figure 6: Assessment of change between baseline and latest saltmarsh extent mapping exercise in Essex. Labels highlight regions for comparison in Figure 7. © Environment Agency, 2022.

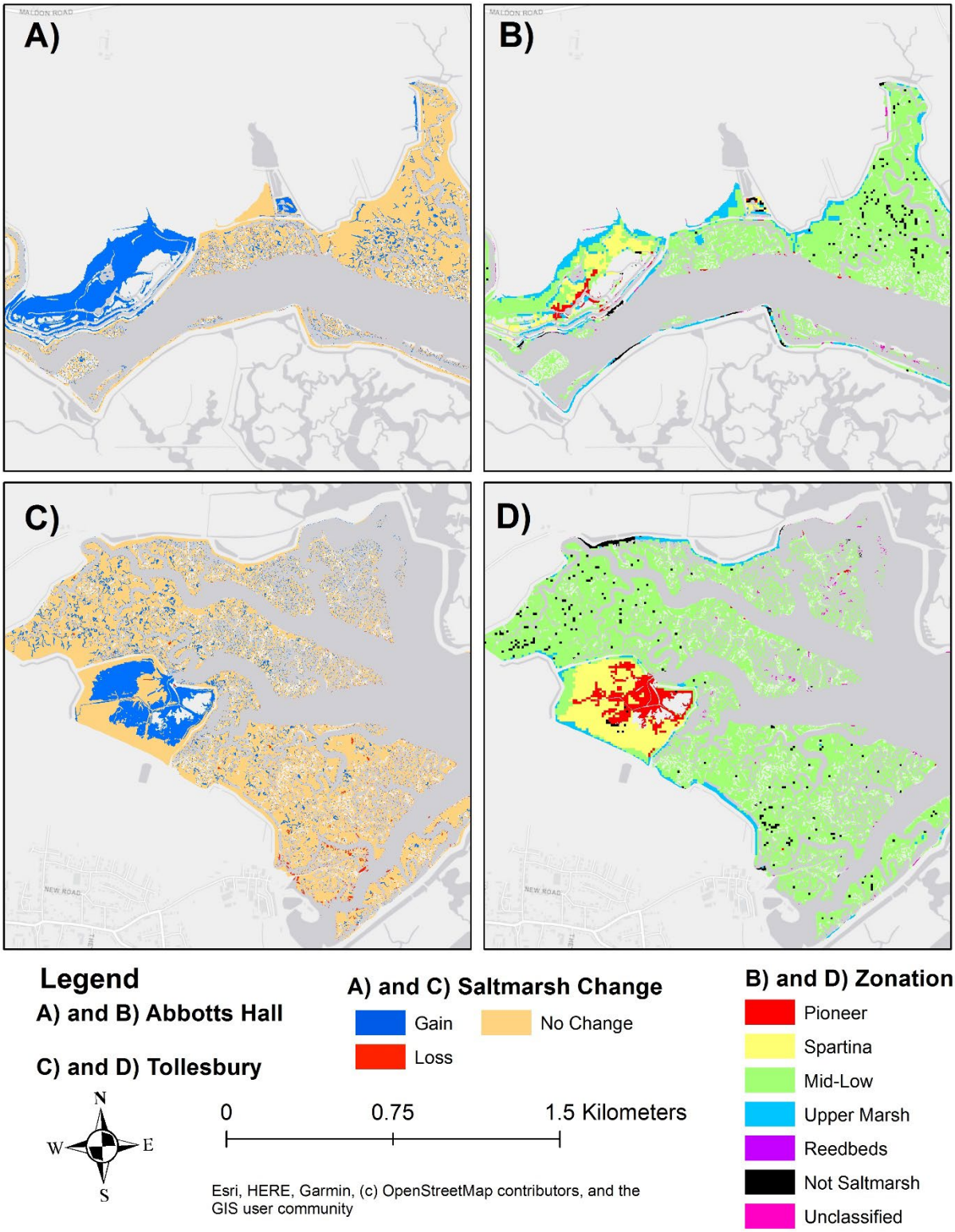

Figure 7: Close up view of changes (A and C) and zonation (B and D) within Abbotts Hall managed realignment site and adjacent saltmarsh (A and B) and within Tollesbury managed realignment site and adjacent habitat (C and D). Managed realignment sites can be viewed as the large areas of gain. © Environment Agency, 2022.

There has also been some concern around erosion in this region, particularly Tollesbury Fleet (e.g. ABPmer, 2016). In this survey, net losses (erosion) were detected only in the Blackwater Outer and Essex waterbodies. This is mostly evident in the coastal areas (Figure 7). A re-examination of some of these Essex waterbodies has indicated that opportunistic macroalgae has increased in this area between 2008 and 2016. The problems with the changing presence of macroalgae in this area were mitigated for, by incorporating LIDAR elevation data into modelling of the saltmarsh extent area. Other methodological differences between the Environment Agency surveys and the ABPmer (2016) report may also impact interpretation. For example, the methodology used in delineating saltmarsh extent in this survey infills gaps in saltmarsh that are less than 150 m^2 meaning that small patches and highly fragmented habitat are unable to be detected by these mapping procedures.

The saltmarsh in the Essex region has been well studied in the past. Cooper and others (2001) reported changes in saltmarsh extent between 1973 and 1988. Phelan and others (2011) further compared these reported extents to the data recorded between 2006 and 2009. These figures are reported in Table 7 and compared with the latest extent data. Figures taken from Cooper and others (2001) indicate a decreasing trend of saltmarsh extent between 1973 to 1998 whereas within the Environment Agency dataset between 2006–2009 and 2016, most areas show an increasing trend with the exception of Dengie saltmarsh (Figure 8). These figures include gains within managed realignment sites (e.g. Wallasea).

Note that in all cases boundary definitions will be slightly different and this may result in added comparison inaccuracies. Furthermore, the boundaries are different to the waterbodies reported in Table 5. It is also assumed that the saltmarsh aerial photography coverage reported in Cooper and others (2001) will be different to the Environment Agency data; therefore an accurate assessment of change between the two studies is not possible from these results without further in depth examination of the spatial data used.

Table 7: Saltmarsh extent (ha) reported in Essex saltmarshes reported by Cooper and others (2001) and observed in this study. © Environment Agency, 2022.

Saltmarsh	Cooper			Environment Agency	
				baseline	latest
	1973	1988	1998	2006-2009	2016
Orwell	99.50	69.50	53.70	60.07	61.03
Stour (Essex)	264.20	148.20	107.40	125.90	135.93
Hamford Water	876.10	765.40	621.10	667.31	720.27
Blackwater and Colne	1671.70	1482.90	1378.50	1353.15	1430.21
Dengie	473.80	436.50	409.70	449.10	421.67
Crouch	467.10	467.10	307.80	395.86	426.23
Thames (Lower)	443.70	-	-	423.82	475.81
Medway	843.80	-	-	783.44	808.60
Swale	377.00	-	-	485.27	529.30
Roach/Foulness	590.92*	-	218.40	444.59	484.32

*Values not reported in Cooper and others, 2001, this figure has been taken from the reported value in Burd, 1989.

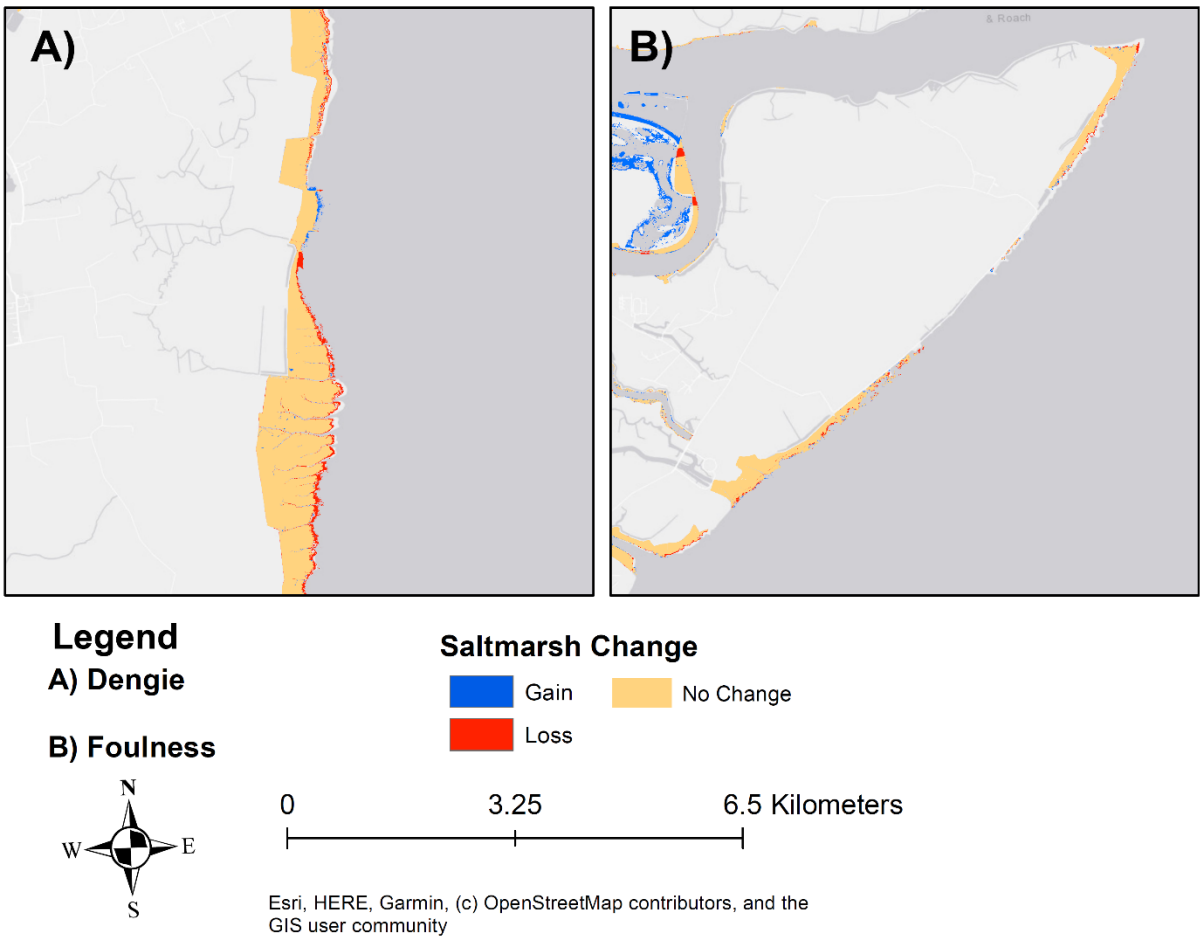

Figure 8: Close up view of Essex saltmarshes that have undergone significant loss. Losses seen are observed on the seaward edges of the marshes. © Environment Agency, 2022.

4.2 Solent – South England

Many waterbodies in the Solent are dominated by the '*Spartina'* zone (Figure 9). This makes up more than 50% of the marsh within the Pagham Harbour, Portsmouth Harbour, Chichester Harbour and Lymington waterbodies. Realignment and RTE sites make up a small proportion of the combined area of the waterbodies present within the Solent. The small gains seen in the realignment and RTE sites in Chichester Harbour, for example, did not make up for losses seen in other parts of the waterbody. Medmerry is a new MR site in this region and while gains of more than 50 ha were observed within this site, these did not make up for losses across the rest of the region.

Of the 22 saltmarsh containing waterbodies in the Solent & South Downs HCRP region, ten displayed net loss of saltmarsh, with most of these located within the Solent (Figure 9). While some of the smaller waterbodies saw small net gains (see Appendix 2), of the ten largest waterbodies in the Solent & South Downs region, only

Portsmouth Harbour and Pagham Harbour displayed net gains of saltmarsh (Table 8). Examples of major areas of losses in the Solent can be found in Figure 10. These areas mainly relate to '*Spartina'*, 'low-mid' and 'pioneer' zones with fewer losses observed in and around 'upper' marsh zones. Major losses can be attributed to both 'gross' and 'marginal' loss (Table 8).

Table 8: Saltmarsh accretion (gain) and erosion (loss) observed in the Solent waterbodies between the baseline and latest extent records. © Environment Agency, 2022.

Waterbody	Change Period	Baseline extent (ha)	Net Change (ha)	Gain Gross (ha)	Gain Marginal (ha)	Loss Gross (ha)	Loss Marginal (ha)
Beaulieu River	2008 to 2016	108.62	-1.61	10.86	7.31	6.39	13.38
Chichester Harbour	2008 to 2016	323.86	-16.70	20.38	29.88	34.31	32.65
Langstone Harbour	2008 to 2016	69.58	-7.34	1.97	4.48	9.70	4.10
Lymington	2008 to 2016	92.47	-8.12	2.66	3.79	7.37	7.20
Newtown River	2008 to 2016	78.69	-8.71	7.92	3.12	10.86	8.89
Pagham Harbour	2008 to 2013	108.15	15.74	10.25	6.99	0.58	0.92
Portsmouth Harbour	2008 to 2016	43.86	4.17	6.42	9.87	7.64	4.48
Solent	2008 to 2016	137.69	-16.22	6.59	5.10	14.79	13.12
Southampton Water	2008 to 2016	269.03	-2.08	13.29	13.19	16.29	12.27
Western Yar	2008 to 2016	45.32	-1.48	3.48	1.78	3.35	3.39

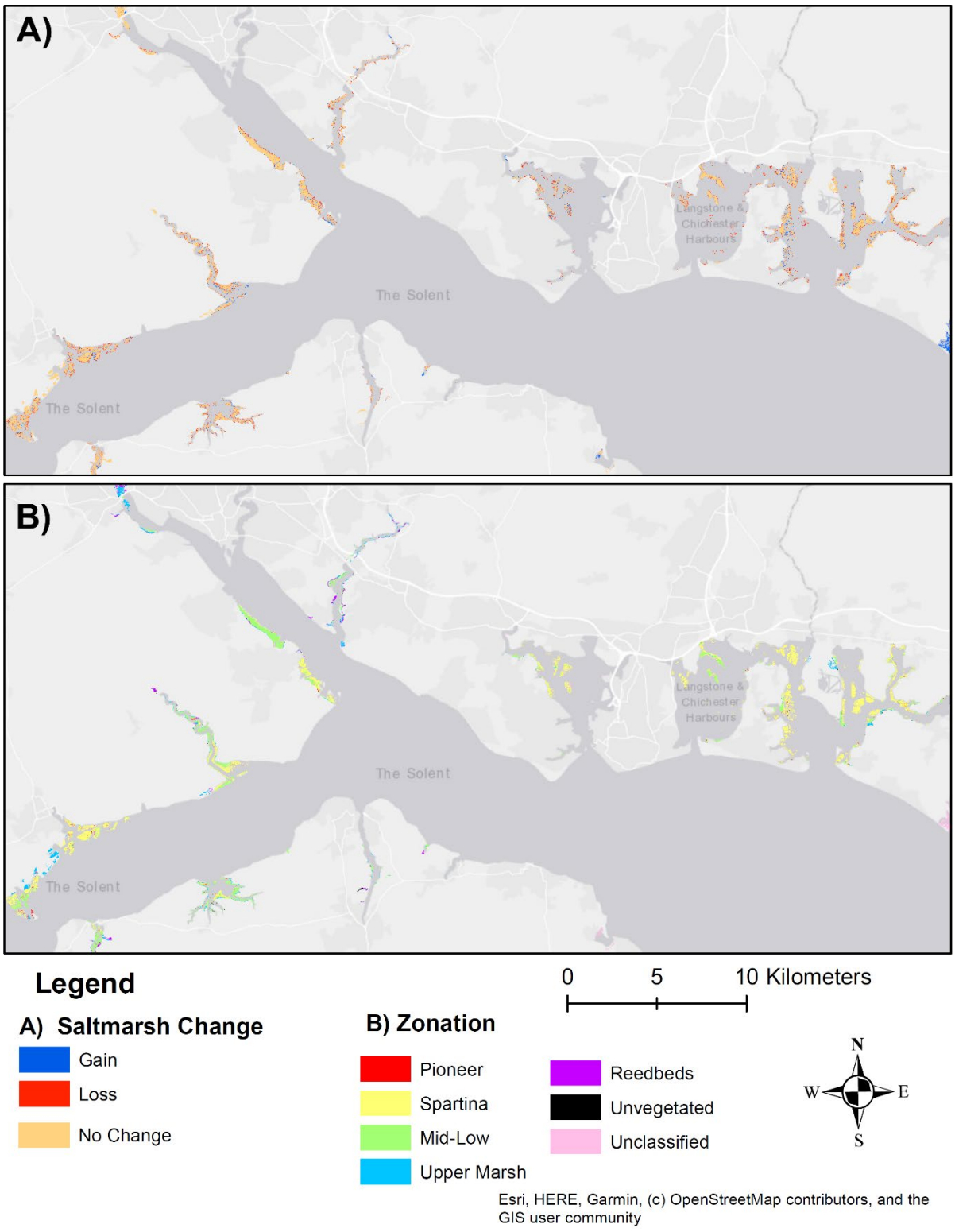

Figure 9: Assessment of change between baseline and latest Environment Agency saltmarsh mapping exercise in Solent saltmarshes. © Environment Agency, 2022.

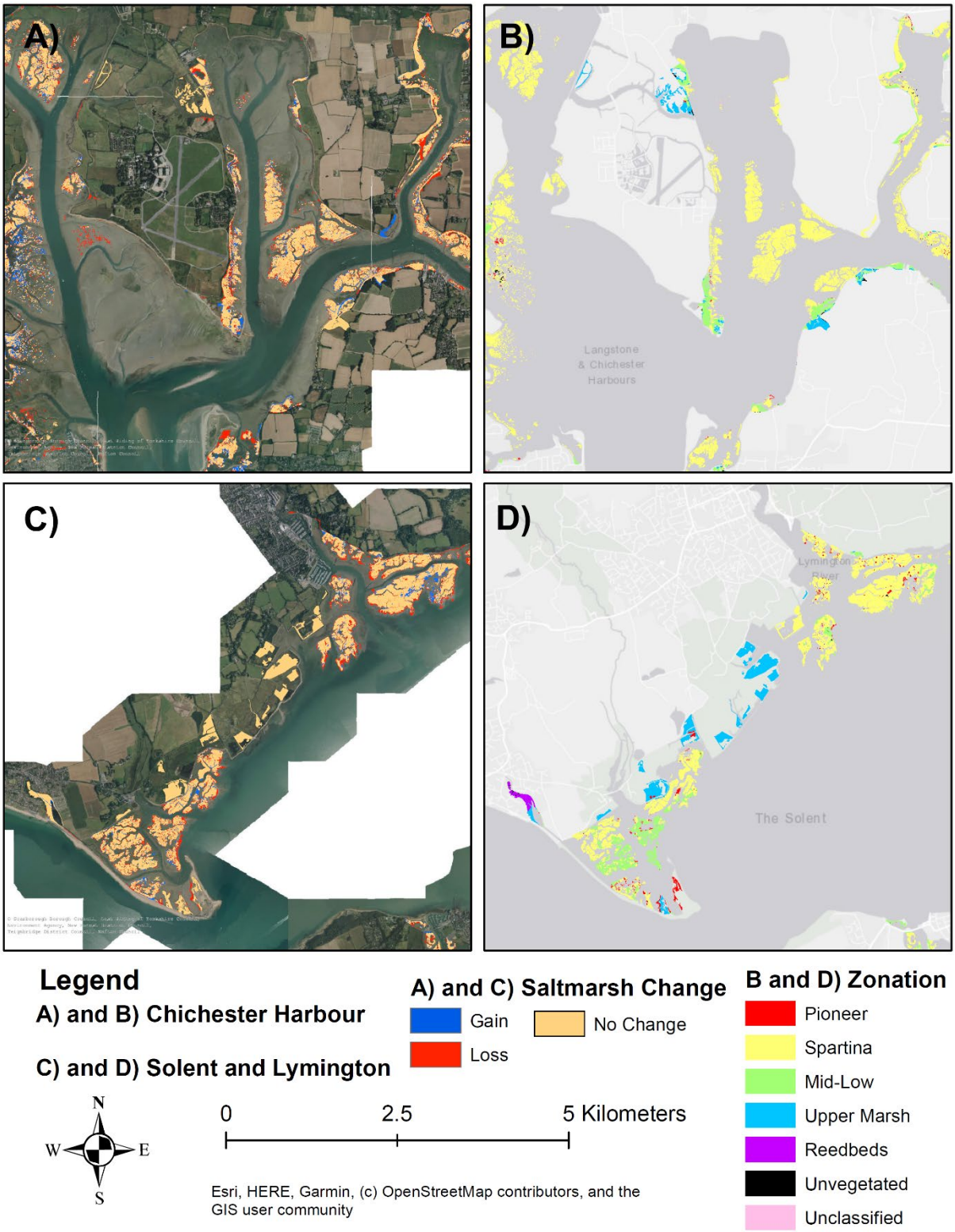

Figure 10: Close up view of changes (A and C) and zonation (B and D) within Chichester Harbour (A and B) and within Solent and Lymington waterbodies (C and D). © Environment Agency, 2022 and © South East Coastal Monitoring National Coastal Monitoring - Welcome.

4.3 Humber – North East England

The Humber HCRP region is made up of three saltmarsh containing waterbodies – Humber Lower, Upper and Middle (Figure 11). Saltmarsh is present in all three WER waterbodies within the Humber HCRP region (Figure 11). In Humber Upper, only 42% has been remapped since the first edition of the Environment Agency inventory was produced. Of the area that has been remapped, there has been very little overall change in extent (-0.1% loss). The other waterbodies have been 100% remapped. Both the Humber Upper and Middle waterbodies are made up primarily of 'reedbed' and 'upper' saltmarsh zone, whereas the Humber Lower is comprised mainly of 'low-mid' marsh (particularly around the Humber mouth) with large extents of 'upper' marsh zone and *Spartina*.

Both the Humber Lower and Middle waterbodies have seen large gains in saltmarsh, increases of 46% and 64% respectively (Table 9). The areas of growth responsible for these gains are present both inside and outside a number of managed realignment sites. In the Humber Middle waterbody large areas of growth have developed outside of the MR sites at Cherry Cobb sands ('*Spartina'*, 'pioneer' and 'unclassified'), Whitton sands and Winteringham ('mid-low', 'pioneer' and 'unclassified'). The largest managed realignment site in the Humber HCRP and Humber Middle waterbody is Alkborough Flats, with 230 ha of saltmarsh recorded at this site (Figure 12).

In the Humber Lower waterbody, there were gains of approximately 70 ha within managed realignment sites, outside of these areas there was also significant accretion of sediment (350 ha, 39% increase). Most accretion has occurred in close proximity to the Paull Holme Strays MR site which was breached in 2003 (Figure 12). Within the MR site there is approximately 52 ha of saltmarsh, which has increased from 18 ha recorded in the first inventory. '*Spartina'* dominates the new growth both within Paull Holme Strays MR site and the large areas of growth adjacent to this site, although some areas have been attributed to 'pioneer' and 'low-mid' marsh. As with all MR sites, over time it is anticipated that natural zonation succession will continue to occur.

Table 9: Saltmarsh a) accretion (gain) and erosion (loss) and b) zonation observed in Humber waterbodies between the baseline and latest extent records. © Environment Agency, 2022.

a)

Waterbody	Change Period	Extent (ha)	Net change (ha)	Gain (Gross) (ha)	Gain (Marginal) (ha)	Loss (Gross) (ha)	Loss (Marginal) (ha)
Humber Lower	2007 to 2016	909.45	419.43	421.25	24.56	20.53	5.85
Humber Middle	2007 to 2016	525.49	211.51	217.99	9.65	12.09	4.04
Humber Upper	2001 to 2012	309.53	-0.32	2.68	0.28	3.07	0.22

b)

Waterbody	Pioneer (ha)	Mid-Low (ha)	Upper (ha)	Reedbeds (ha)	Spartina (ha)	Unclassified (ha)	Unvegetated (ha)
Humber Lower	59.65	597.76	201.78	4.24	280.84	181.84	2.78
Humber Middle	21.29	62.23	218.60	220.93	16.31	195.84	1.80
Humber Upper	1.05	19.63	127.32	133.44	3.11	26.40	1.79

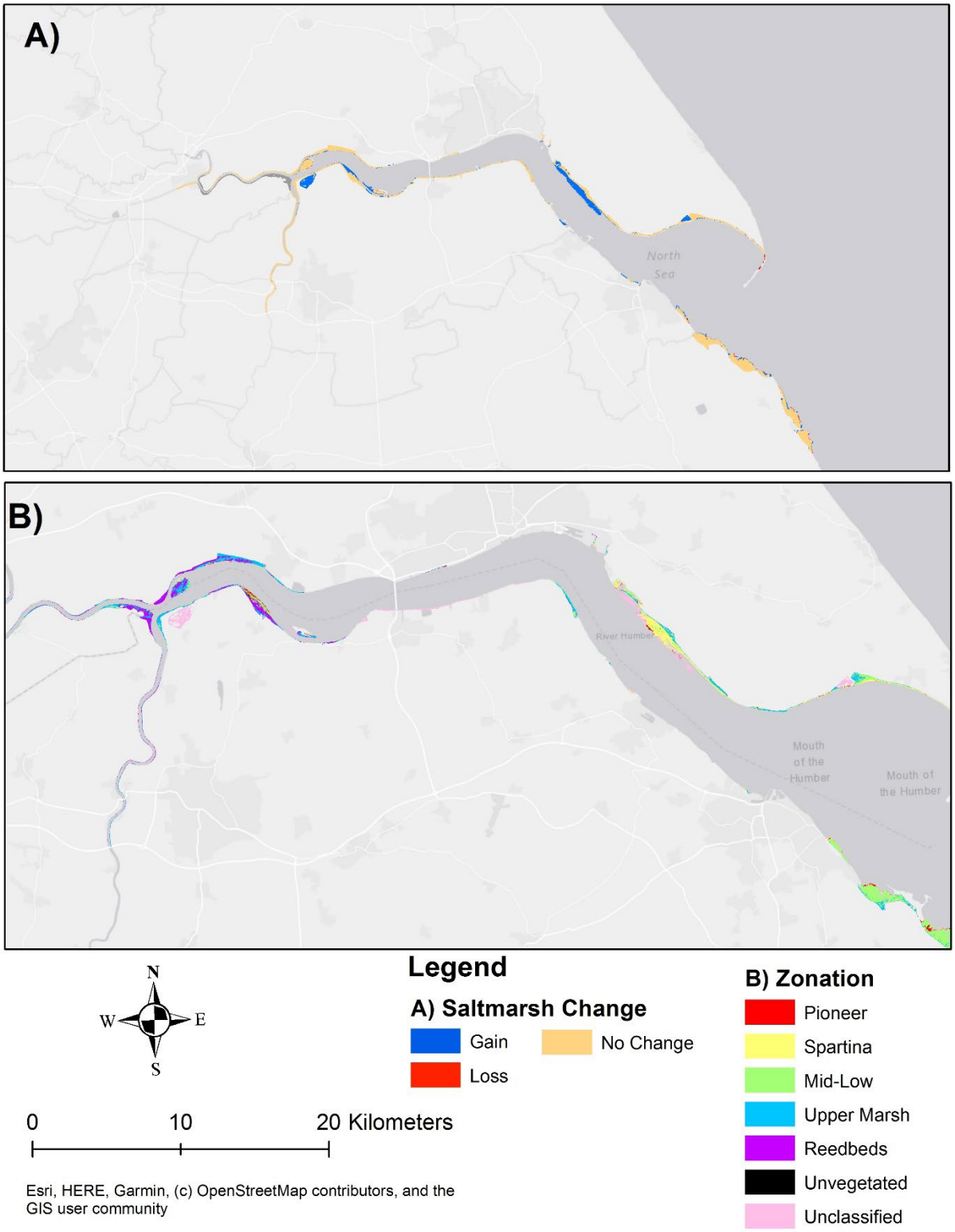

Figure 11: Assessment of change between baseline and latest Environment Agency saltmarsh mapping exercise in Humber saltmarshes. © Environment Agency, 2022.

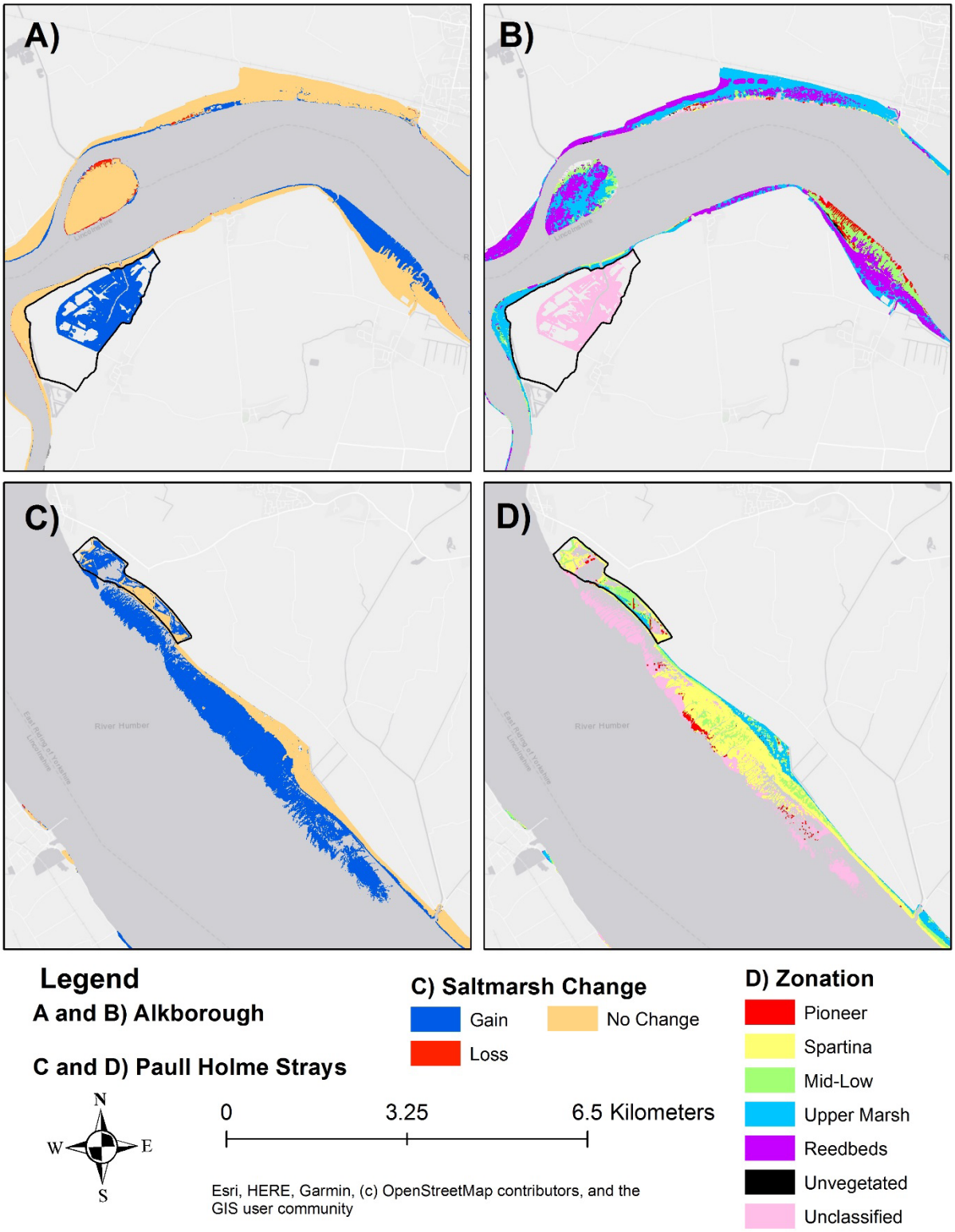

Figure 12: Close up view of changes (A and C) and zonation (B and D) within Alkborough Flats managed realignment site (outlined) and adjacent saltmarsh (A and B) and within Paull Holme Strays managed realignment site (outlined) and adjacent habitat (C and D). © Environment Agency, 2022.

4.4 Ribble – North West England

The Ribble displays similar patterns of change and zonation seen in many north-west waterbodies. Zonation mapping in the Ribble (Figure 13) indicates that this waterbody is mainly comprised of the 'low-mid' zone (70%) followed by 'upper' marsh (17%). Between 2009 (baseline record) and 2018 (latest record), the extent of saltmarsh has increased by 313 ha (Figure 13). Much of this (264 ha) can be attributed to new growth within the Hesketh Out Marshes managed realignment sites. The main areas of expansion were located on the lower marsh edges around the mouth of the estuary, these areas are located in proximity to 'pioneer' and '*Spartina'* zones, although it should be noted that many areas of expansion have not yet been classified. There was very little loss seen in this waterbody (12 ha, 0.53% of baseline extent). Areas of erosion were mostly restricted to creek edges.

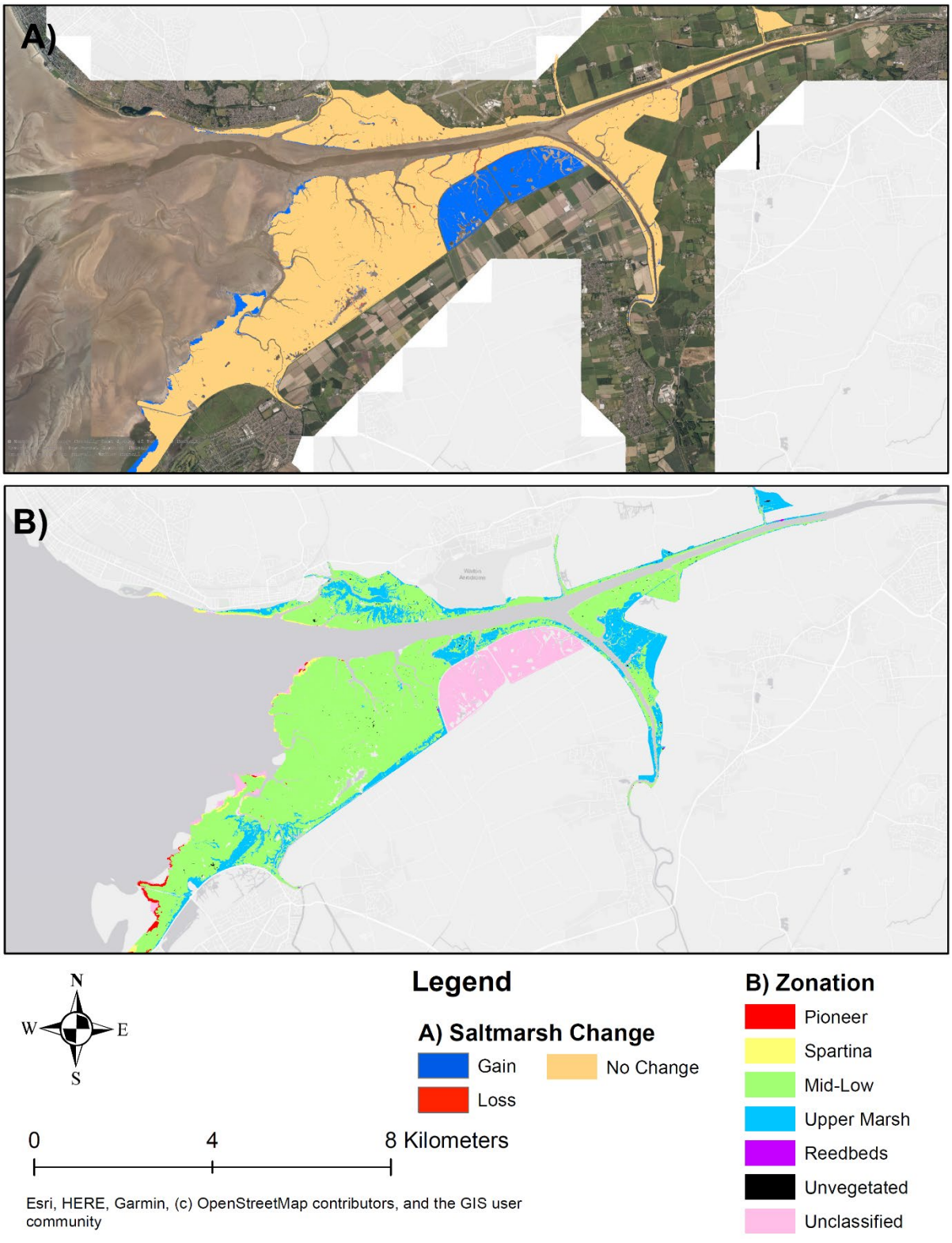

Figure 13: Assessment of change between baseline and latest Environment Agency saltmarsh mapping exercise in the Ribble. © Environment Agency, 2022 and © North West Coastal Monitoring [National Coastal Monitoring - Welcome].

5 Discussion

This saltmarsh inventory update shows a range of changes have occurred to the extent of saltmarsh habitat across England, between 2006–09 and 2016–19. The inventory provides evidence and insight into changing habitat extent at national, regional, and local scales. It is an intention of the inventory that national scale trends do not misrepresent or mask local trends. Furthermore, gains within one waterbody or region should not be seen as compensation for losses in another waterbody or region.

At a national scale, the extent of saltmarsh has increased in England, however, there are parts of the country which have seen a net loss. The overall pattern of loss and accretion seen in this study only partly agrees with past assessments of erosion and accretion. At a regional scale, the only region to undergo a net loss was on the South coast (South Wessex), however on a wider-scale there have been losses of saltmarsh in more localised settings, with losses seen in multiple waterbodies (Appendix 2).

A recent analysis of long term change between 1967 and 2016 by Ladd and others (2019) looked at a number of significant saltmarshes throughout the country. While their findings suggest accretion in the North West and erosion in the South and South East, their dates assessing change relating to the South and South East regions ended prior to the baseline surveys undertaken in this survey. Whereas we are seeing an overall increase in the South East, however saltmarsh extent is still declining outside of realignment and RTE sites in the Solent area.

While the overall extent of saltmarsh in the East Anglia HCRP region has increased, there is anecdotal evidence of localised losses (e.g. Essex and Thames Coastal North saltmarshes). Where in this analysis we see that there has been erosion along creek edges and in the highly fragmented habitat, there has also been significant gains. Two factors could be interrupting these results, firstly, opportunistic macroalgae is prevalent in the area. The signals from the macroalgal species appear similar to pioneer vegetation so it is possible that saltmarsh extent is being exaggerated. Secondly, this area is highly fragmented which means that detection is consequently less accurate. Any increase in marsh fragmentation, where erosion for example created patches less than 150 m would not be detected by the current methodology.

A significant proportion of the gains in saltmarsh was attributed to managed realignment sites. Of those that have been classified, many newer sites are being filled in with ‘pioneer’ and ‘*Spartina’* zones however a number of sites also include species from ‘low-mid’ and ‘upper’ zones. This is encouraging for the long-term gains in saltmarsh, however restoration efforts should not be relaxed due to the high number of localised losses seen elsewhere.

Given that this survey was only 10 years since the previous baseline and we have only seen 7.3% increase at a national scale (4.3% if managed realignment sites are excluded), this does not provide evidence of a trend of long term saltmarsh gains, only a snapshot from two time points. There are a number of factors that could illicit this type of response over two time points, for example, seasonal/yearly differences (e.g. warmer summer) affecting state of saltmarsh at time of image capture, presence of macroalgae affecting interpretation, or increases in fragmentation leading to overestimation of saltmarsh. True patterns of change may not be realised without further long term monitoring efforts. Reducing sustained restoration efforts now could have detrimental effects on the future state of saltmarshes when considered with predicted sea-level rise.

6 References

ABPmer, 2021. Online Marine Registry (OMReg). Available from https://www.omreg.net/ [Accessed 27/04/2022].

Burd, F., 1989. The saltmarsh survey of Great Britain: an inventory of British saltmarshes. Nature Conservatory Council, Research and Survey in Nature Conservation no. 42. Peterborough: Nature Conservancy Council.

Burd, F., 1992. Erosion and vegetation change on the saltmarshes of Essex and north Kent between 1973 and 1988. Research and Survey in Nature Conservation No. 42. Peterborough: English Nature.

Baily, B., Pearson, A., Collier, P. and Fontana, D., 2002. Mapping the intertidal vegetation of the harbours of southern England for water quality management. Journal of Coastal Conservation, 8, 77-86.

Cooper, N. and Cooper, T., 2000. Saltmarsh change within the Suffolk estuaries between 1971, 1986 and 1998. Report to the Environment Agency Anglian Region.

Cooper, N. Cooper, T. and Burd, F., 2001. 25 years of saltmarsh erosion in Essex: Implications for coastal defence and nature conservation. Journal of Coastal Conservation, 7, 31-40.

Davidson, K.E., Fowler, M.S., Skov, M.W., Doerr, S.H., Beaumont, N., and Griffen, J.N., 2017. Livestock grazing alters multiple ecosystem properties and services in salt marshes: a meta-analysis. Journal of Applied Ecology, 54, 1395–1405

Doody, P., 2008, Saltmarsh Conservation, Management and Restoration. Dordrecht and London: Springer.

Environment Agency, 2020. National Flood and Coastal Erosion Risk Management Strategy for England. Available online: Environment Agency – National Flood and Coastal Erosion Risk Management Strategy for England (publishing.service.gov.uk). [Accessed 20/01/2022].

Gregg, R., Elias, J.L., Alonso, I., Crosher, I.E., Muto, P., and Morecroft, M.D. 2021. Carbon storage and sequestration by habitat: a review of the evidence (second edition) Natural England Research Report NERR094. Natural England, York.

Hill, M.I., 1987. Vegetation change in communities of *Spartina anglica* C.E. Hubbard. In Saltmarshes of northwest England. Contract Surveys No. 9. Peterborough: Nature Conservancy Council.

Hambidge, C. Phelan, N. 2014. Saltmarsh mapping standardisation for the Water Framework Directive (NMBAQC scheme). Available online: NMBAQCS: Reports [Accessed 25/04/2022].

Hardiman , N., 2018. National Review of Statutory Habitat Compensation Associated with Flood and Coastal Risk Management Activity. Environment Agency.

Huckle, J.M., Marris, R.H. and Potter, J.A., 2004. Spatial and temporal changes in saltmarsh distribution in the Dee estuary, NW England, determined from aerial photographs. Wetlands Ecology and Management, 12(5), 483-498.

Ladd, C.J.T., Duggan-Edwards, M.F., Bouma, T.J., Pagès, J.F. and Skov, M.W., 2019. Sediment supply explains long-term and large-scale patterns in salt marsh lateral expansion and erosion. Geophysical Research Letters, 46(20), 11178–11187.

Möller, I., Spencer, T., French J.R., Leggett, D.J. AND Dixon M., 1999. Wave transformation over salt marshes: a field and numerical modelling study from north Norfolk, England. Estuarine, Coastal and Shelf Science, 49(3), 411-426.

Möller, I., Spencer, T. and French, J.R., 2003. Wave attenuation over saltmarshes: implications for flood defence management. Saltmarsh Management Handbook series. Bristol: Environment Agency.

Möller, I., Spencer, T., Best, M., Austin, W. AND Burden, A. 2021. Saltmarsh Restoration: An introduction. In: Saltmarsh Restoration Handbook: UK and Ireland (eds. R. Hudson, J. Kenworthy and M. Best), pp.1-16. Environment Agency, Bristol, UK.

Parker, R., Benson, L., Graves, C., Kröger, S., and Vieira R., 2020. Carbon stocks and accumulation analysis for Secretary of State (SoS) region, Cefas Report for Defra project ME5439, 42 pp.

Phelan, N., Shaw, A., Baylis, A. 2011. The extent of saltmarsh in England and Wales: 2006–2009. Environment Agency.

Pontee, N., Pye, K., Tempest, J., and Blot, S., 2021. What is coastal squeeze? Environment Agency.

Pye, K. and French, P.W., 1993. Erosion and Accretion Processes on British Saltmarshes. Volumes 1–5. Cambridge: Cambridge Environmental Research Consultants.

ReMeMaRe. 2021. Restoring Meadow, Marsh and Reef (ReMeMaRe). Estuarine and Coastal Sciences Association. Available online: Restoring Meadow, Marsh and Reef (ReMeMaRe) | Estuarine & Coastal Sciences Association (ecsa.international) [Accessed 20/01/2022].

Vuik, V., Borsje, B.W., Willemsen, P.W.J.M., and Jonkman, S.N., 2019. saltmarshes for flood risk reduction: Quantifying long-term effectiveness and life-cycle costs. Ocean & Coastal Management,171, 96-110

Appendix 1. Environment Agency zonation mapping compared to the National Vegetation Classification (NVC) and the Integrated Habitat System (IHS) (Phelan and others, 2011).

Environment Agency Zone	sub-zone	Principal taxon	Other characterising taxa[10]	NVC[11]	IHS[12] (approximate match)
Pioneer		*Salicornia spp.*	*Suaeda maritima ,Puccinellia maritima, Atriplex sp., Limonium sp., Tripolium pannonicum, Sarcocornia perennis*	SM7, SM8, SM9	LS311, LS312, LS313, LS31Z
Spartina		*Spartina spp.*	*Macroalgae, Puccinellia sp.*	SM4, SM5, SM6	LS321, LS32Z
Mid-Low	low	*Puccinellia sp.*	*Salicornia spp., Suaeda sp., Tripolium pannonicum, Spartina spp.*	SM10, SM11, SM12, SM13	LS331, LS332
	mid	*Atriplex sp.*	*Puccinellia sp., Juncus maritimus, Suaeda sp., Triglochin sp., Plantago sp., Glaux sp.*	SM14, SM15	LS333, LS3363

[10] Species names checked against the Botanical Society of Britain & Ireland database available online at: Taxon lists – Botanical Society of Britain & Ireland (bsbi.org) [Accessed 20/01/2022]

[11] Available online at: NVC | JNCC - Adviser to Government on Nature Conservation [Accessed 20/01/2022]

[12] Available online at: Integrated Habitat System (IHS) - Somerset Environmental Records Centre (somerc.com) [Accessed 20/01/2022]

Environment Agency Zone	sub-zone	Principal taxon	Other characterising taxa[10]	NVC[11]	IHS[12] (approximate match)
	upper	*Festuca rubra*	*Plantago sp., Triglochin sp., Juncus gerardii, Agrostis sp., Glaux sp., Armeria sp., Limonium sp., Artemisia sp., Atriplex sp., Puccinellia sp., Juncus maritimus, Suaeda vera, Frankenia sp., Spergularia sp., Salicornia spp.*	SM16, SM17, SM21, SM22, SM23	LS3361
Upper marsh		*Elymus sp.* *Agrostis sp.* without *Puccinellia sp.* *Festuca* rubra without *Puccinellia sp.* *Juncus maritimus* without *Puccinellia sp.* *Bolbo schoenus*	*Juncus geradii, Triglochin sp., Plantago sp., Oenanthe sp., Trifolium sp., Glaux sp., Blysmus sp., Inula sp., Atriplex prostrata, Atriplex sp., Suaeda vera, Elymus repens, Potentilla sp.*, very small amounts of *Puccinellia sp.*	SM18, SM19, SM20, SM24, SM25, SM26, SM27, SM28 S21	LS3362 LS37 EM13
Reedbeds		*Phragmites*	*Zostera noltii* at low levels; *Atriplex prostrata*; *Puccinellia* sp. (V) in S4dii	S4d	EM11
Unvegetated		No saltmarsh vegetation present			

Environment Agency Zone	sub-zone	Principal taxon	Other characterising taxa[10]	NVC[11]	IHS[12] (approximate match)
Unclassified		No zonation mapping has been conducted			

Appendix 2. Saltmarsh extent

Region	HCRP	Waterbody	Change Period	Change Period (no. of years)	Baseline (ha)	Latest (ha)	Net change (ha)	Net change excluding MR sites (ha)	Gain (Gross) (ha)	Gain (Marginal) (ha)	Loss (Gross) (ha)	Loss (Marginal) (ha)
Anglian	East Anglia	ALDE & ORE	2006 to 2016	10	379.94	365.06	-14.88	-28.66	31.30	6.48	37.78	14.87
Anglian	East Anglia	Benacre Broad	1999 to 2019	20	20.06	21.05	0.99	0.99	1.42	0.78	1.05	0.16
Anglian	East Anglia	BLACKWATER	2008 to 2016	8	622.03	676.98	54.95	31.52	31.53	48.12	10.54	14.16
Anglian	East Anglia	Blackwater Outer	2007 to 2016	9	321.99	312.74	-9.25	-9.25	2.76	1.52	7.80	5.72
Anglian	East Anglia	BLYTH (S)	2006 to 2016	10	76.75	72.43	-4.31	-4.31	3.67	1.40	6.88	2.50
Anglian	East Anglia	BURE & WAVENEY & YARE & LOTHING	2007 to 2011	4	13.40	13.63	0.23	0.23	0.21	0.12	0.06	0.05
Anglian	East Anglia	BURN	2007 to 2016	9	808.04	794.10	-13.94	-13.94	13.83	16.89	30.26	14.40
Anglian	East Anglia	COLNE	2008 to 2016	8	561.12	584.26	23.14	22.84	9.94	25.77	8.03	4.54
Anglian	East Anglia	CROUCH	2007 to 2016	9	702.66	779.25	76.59	25.27	70.28	34.08	10.15	17.62
Anglian	East Anglia	DEBEN	2006 to 2016	10	247.06	244.12	-2.93	-2.93	6.79	10.08	11.59	8.21
Anglian	East Anglia	Essex	2007 to 2016	9	390.81	366.78	-24.04	-24.04	1.24	2.95	19.85	8.38
Anglian	East Anglia	GREAT OUSE	2008 to 2016	8	567.56	628.27	60.71	60.71	60.98	6.41	3.95	2.73
Anglian	East Anglia	Hamford Water	2008 to 2016	8	610.86	665.48	54.61	52.26	16.48	61.20	7.61	15.46
Anglian	East Anglia	Harwich Approaches	2008 to 2016	8	56.45	54.79	-1.65	-1.65	0.24	0.66	2.20	0.35
Anglian	East Anglia	Lincolnshire	2008 to 2016	8	554.49	589.24	34.74	34.74	60.70	15.33	32.84	8.45
Anglian	East Anglia	NENE	2007 to 2016	9	9.10	9.33	0.23	0.23	0.30	0.10	0.17	0.00
Anglian	East Anglia	Norfolk North	2007 to 2016	9	313.18	326.95	13.77	12.70	15.33	9.66	6.74	4.49
Anglian	East Anglia	ORWELL	2007 to 2016	9	60.07	61.03	0.96	0.65	4.20	3.35	3.90	2.69
Anglian	East Anglia	STEEPING	2008 to 2016	8	9.69	9.52	-0.17	-0.17	0.35	0.33	0.46	0.40
Anglian	East Anglia	STIFFKEY & GLAVEN	2007 to 2016	9	1286.46	1276.26	-10.20	-10.20	32.09	29.85	56.17	15.97
Anglian	East Anglia	STOUR (ESSEX)	2007 to 2016	9	125.90	135.93	10.03	10.03	6.90	9.63	3.83	2.68
Anglian	East Anglia	Thames Coastal North	2007 to 2016	9	8.28	7.24	-1.04	-1.04	0.01	0.01	0.81	0.24
Anglian	East Anglia	WASH INNER	2007 to 2016	9	3299.69	3530.42	230.72	230.72	232.01	68.46	33.14	36.60
Anglian	East Anglia	Wash Outer	2008 to 2016	8	1182.52	1343.01	160.48	165.05	172.35	12.25	9.52	14.60
Anglian	East Anglia	WELLAND	2007 to 2016	9	442.51	426.72	-15.80	-15.80	3.51	3.51	12.49	10.33
Anglian	East Anglia	WITHAM	2007 to 2011	4	62.03	59.26	-2.77	-2.77	1.97	0.29	4.39	0.65

Region	HCRP	Waterbody	Change Period	Change Period (no. of years)	Baseline (ha)	Latest (ha)	Net change (ha)	Net change excluding MR sites (ha)	Gain (Gross) (ha)	Gain (Marginal) (ha)	Loss (Gross) (ha)	Loss (Marginal) (ha)
Anglian	Humber	HUMBER LOWER	2007 to 2016	9	909.45	1328.89	419.43	349.99	421.25	24.56	20.53	5.85
Anglian	Humber	HUMBER MIDDLE	2007 to 2016	9	525.49	736.99	211.51	102.20	217.99	9.65	12.09	4.04
Anglian	Humber	HUMBER UPPER	2001 to 2012	11	309.53	309.21	-0.32	-0.32	2.68	0.28	3.07	0.22
Anglian total					**14477.13**	**15728.92**	**1251.79**	**985.05**	**1422.33**	**403.72**	**357.91**	**216.35**
Midlands	Severn	SEVERN LOWER (England)	2008 to 2019	11	314.22	342.79	28.57	21.44	22.26	11.90	3.18	2.41
Midlands	Severn	SEVERN MIDDLE (England)	2008 to 2019	11	380.55	376.88	-3.67	-0.06	9.20	9.20	18.58	3.49
Midlands	Severn	SEVERN UPPER	2009 to 2019	10	51.44	50.50	-0.94	-0.94	2.48	0.95	3.92	0.45
Midlands total					**746.21**	**770.17**	**23.96**	**20.44**	**33.93**	**22.05**	**25.68**	**6.35**
North East	North East	ALN	2008 to 2017	9	41.41	39.01	-2.40	-2.17	0.21	0.97	2.56	1.03
North East	North East	BLYTH (N)	2009 to 2017	8	11.88	5.51	-6.37	-6.37	0.19	0.18	6.54	0.21
North East	North East	COQUET	2008 to 2017	9	21.45	20.47	-0.98	-0.37	0.12	0.15	0.86	0.39
North East	North East	Farne Islands to Newton Haven	2008 to 2017	9	30.07	30.44	0.37	0.37	0.26	0.21	0.04	0.07
North East	North East	Holy Island & Budle Bay	2009 to 2012	3	246.50	246.93	0.43	0.43	1.33	0.58	1.08	0.41
North East	North East	TEES	2009 to 2019	10	46.82	88.76	41.94	-0.76	42.74	0.07	0.64	0.23
North East	North East	TWEED	2009 to 2016	7	26.13	26.19	0.06	0.06	0.27	0.08	0.22	0.07
North East	North East	Tyne and Wear	2008 to 2017	9	3.59	3.51	-0.08	-0.08	0.02	0.00	0.02	0.09
North East	North East	WANSBECK	2009 to 2017	8	0.60	0.53	-0.07	-0.07	0.02	0.01	0.08	0.01
North East	North East	WEAR	2008 to 2008	0	2.43	2.43	0.00	0.00	0.00	0.00	0.00	0.00
North East total					**430.88**	**463.78**	**32.89**	**-8.96**	**45.17**	**2.25**	**12.02**	**2.50**
North West	North West	DEE (England)	2007 to 2018	11	1819.70	1840.50	20.80	20.80	112.35	19.15	55.54	55.16
North West	North West	DUDDON	2009 to 2017	8	625.69	683.60	57.91	57.91	66.77	20.28	25.56	3.58
North West	North West	Duddon Sands	2008 to 2017	9	94.03	93.88	-0.15	-0.15	2.77	3.46	4.64	1.73
North West	North West	ESK (W)	2009 to 2017	8	215.35	233.85	18.50	18.50	20.06	7.64	8.21	0.98
North West	North West	KENT	2009 to 2012	3	1108.14	1199.98	91.83	91.83	160.13	19.05	75.95	11.39
North West	North West	LEVEN	2009 to 2012	3	372.59	460.71	88.12	88.12	76.25	20.42	6.91	1.65
North West	North West	LUNE	2008 to 2012	4	352.82	350.70	-2.13	-2.13	1.37	2.91	5.03	1.37
North West	North West	MERSEY	2009 to 2018	9	898.57	907.48	8.91	8.91	43.51	18.33	46.67	6.27
North West	North West	Morecambe Bay	2008 to 2017	9	1148.78	1186.62	37.85	37.85	42.32	34.43	13.32	25.59
North West	North West	RIBBLE	2009 to 2018	9	2405.56	2718.52	312.96	48.78	317.14	8.53	5.18	7.53
North West	North West	SOLWAY	2009 to 2018	9	2937.21	2915.05	-22.16	-22.16	101.15	17.08	123.93	16.47
North West	North West	WYRE	2009 to 2017	8	339.61	352.61	13.00	13.00	15.87	3.72	5.28	1.31
North West total					**12318.05**	**12943.50**	**625.45**	**361.27**	**959.69**	**174.99**	**376.21**	**133.02**
South East	Solent & South Downs	ADUR	2008 to 2016	8	21.28	23.15	1.88	1.88	2.01	1.34	0.84	0.63
South East	Solent & South Downs	ARUN	2008 to 2016	8	10.31	13.07	2.76	2.76	4.01	0.58	1.48	0.35
South East	Solent & South Downs	BEAULIEU RIVER	2008 to 2016	8	108.62	107.01	-1.61	-1.61	10.86	7.31	6.39	13.38
South East	Solent & South Downs	Bembridge Harbour Lagoon	2008 to 2016	8	1.79	1.96	0.17	0.17	0.28	0.01	0.08	0.03
South East	Solent & South Downs	CHICHESTER HARBOUR	2008 to 2016	8	323.86	307.16	-16.70	-18.61	20.38	29.88	34.31	32.65
South East	Solent & South Downs	CUCKMERE	2008 to 2016	8	10.72	11.57	0.85	0.85	0.92	0.59	0.40	0.26
South East	Solent & South Downs	Great Deep	2008 to 2016	8	8.95	8.59	-0.36	-0.36	0.00	0.00	0.37	0.00
South East	Solent & South Downs	Isle of Wight East	2020 to 2020	0	0.00	51.39	0.00	0.00	0.00	0.00	0.00	0.00
South East	Solent & South Downs	LANGSTONE HARBOUR	2008 to 2016	8	69.58	62.24	-7.34	-7.34	1.97	4.48	9.70	4.10
South East	Solent & South Downs	Langstone Oysterbeds	2008 to 2016	8	0.44	0.59	0.16	0.16	0.16	0.12	0.09	0.03
South East	Solent & South Downs	LYMINGTON	2008 to 2016	8	92.47	84.35	-8.12	-8.12	2.66	3.79	7.37	7.20
South East	Solent & South Downs	MEDINA	2008 to 2016	8	9.75	11.10	1.35	1.35	1.31	0.35	0.26	0.05
South East	Solent & South Downs	NEWTOWN RIVER	2008 to 2016	8	78.69	69.98	-8.71	-8.71	7.92	3.12	10.86	8.89

Region	HCRP	Waterbody	Change Period	Change Period (no. of years)	Baseline (ha)	Latest (ha)	Net change (ha)	Net change excluding MR sites (ha)	Gain (Gross) (ha)	Gain (Marginal) (ha)	Loss (Gross) (ha)	Loss (Marginal) (ha)
South East	Solent & South Downs	Old Mill Ponds	2008 to 2016	8	2.58	5.07	2.49	2.49	2.34	0.31	0.07	0.09
South East	Solent & South Downs	OUSE	2008 to 2016	8	1.84	1.64	-0.20	-0.20	0.08	0.00	0.24	0.05
South East	Solent & South Downs	PAGHAM HARBOUR	2008 to 2013	5	108.15	123.89	15.74	15.74	10.25	6.99	0.58	0.92
South East	Solent & South Downs	PORTSMOUTH HARBOUR	2008 to 2016	8	43.86	48.03	4.17	4.17	6.42	9.87	7.64	4.48
South East	Solent & South Downs	Solent	2008 to 2016	8	137.69	121.47	-16.22	-16.24	6.59	5.10	14.79	13.12
South East	Solent & South Downs	SOUTHAMPTON WATER	2008 to 2016	8	269.03	266.95	-2.08	-2.08	13.29	13.19	16.29	12.27
South East	Solent & South Downs	Sussex	2008 to 2016	8	1.10	1.50	0.41	0.41	0.62	0.03	0.18	0.07
South East	Solent & South Downs	WESTERN YAR	2008 to 2016	8	45.32	43.84	-1.48	-1.48	3.48	1.78	3.35	3.39
South East	Solent & South Downs	WOOTTON CREEK	2008 to 2016	8	0.31	0.33	0.02	0.02	0.05	0.01	0.04	0.01
South East	South East	Kent North	2008 to 2016	8	0.80	0.80	0.00	0.00	0.01	0.01	0.01	0.01
South East	South East	MEDWAY	2008 to 2016	8	783.44	808.60	25.16	25.16	19.24	13.47	5.50	2.06
South East	South East	ROTHER	2008 to 2016	8	36.24	35.37	-0.88	-0.88	0.82	0.77	2.06	0.41
South East	South East	STOUR (KENT)	2008 to 2016	8	119.21	127.08	7.87	7.87	8.80	3.59	3.82	0.70
South East	South East	SWALE	2008 to 2016	8	485.27	529.30	44.02	44.02	23.49	28.36	5.21	2.62
South East	South East	Whitstable Bay	2008 to 2016	8	0.85	1.02	0.17	0.17	0.07	0.11	0.01	0.00
South East	Thames	THAMES LOWER	2009 to 2016	7	423.82	475.81	51.99	43.30	28.84	32.66	3.85	5.66
South East	Thames	THAMES MIDDLE	2009 to 2018	9	128.03	130.81	2.78	2.70	6.57	2.05	4.11	1.73
South East total					**3324.04**	**3473.71**	**98.28**	**87.59**	**183.46**	**169.87**	**139.88**	**115.17**
South West	Devon & Cornwall	AVON	2008 to 2017	9	14.47	25.25	10.78	0.95	11.12	0.60	0.55	0.39
South West	Devon & Cornwall	AXE	2006 to 2018	12	14.09	14.33	0.24	0.24	0.33	0.29	0.23	0.15
South West	Devon & Cornwall	Bristol Channel Outer South	2006 to 2018	12	58.17	60.16	1.99	0.07	1.11	3.04	0.90	1.26
South West	Devon & Cornwall	CAMEL	2006 to 2017	11	54.47	73.47	19.00	4.70	19.26	1.98	1.40	0.85
South West	Devon & Cornwall	CARRICK ROADS INNER	2008 to 2018	10	68.11	68.64	0.53	0.53	1.45	1.51	1.60	0.83
South West	Devon & Cornwall	Cornwall North	2006 to 2017	11	0.14	0.19	0.05	0.05	0.07	0.00	0.01	0.01
South West	Devon & Cornwall	DART	2007 to 2017	10	22.72	22.74	0.02	0.02	0.87	0.11	0.51	0.45
South West	Devon & Cornwall	ERME	2008 to 2017	9	28.95	27.27	-1.67	0.64	1.20	1.16	1.70	2.33
South West	Devon & Cornwall	EXE	2007 to 2017	10	70.86	75.59	4.73	2.51	5.18	1.49	1.32	0.62
South West	Devon & Cornwall	FOWEY	2007 to 2018	11	13.63	14.05	0.41	0.41	0.62	0.14	0.19	0.16
South West	Devon & Cornwall	GANNEL	2008 to 2017	9	15.23	15.72	0.49	0.49	0.45	0.47	0.19	0.24
South West	Devon & Cornwall	HAYLE	2008 to 2018	10	13.41	16.10	2.69	2.91	3.09	0.34	0.35	0.39
South West	Devon & Cornwall	HELFORD	2008 to 2018	10	2.67	2.36	-0.31	-0.31	0.23	0.09	0.44	0.20
South West	Devon & Cornwall	KINGSBRIDGE	2008 to 2017	9	0.39	0.58	0.18	0.18	0.17	0.04	0.02	0.01
South West	Devon & Cornwall	LOOE	2007 to 2017	10	5.66	6.22	0.57	0.57	0.59	0.12	0.07	0.07
South West	Devon & Cornwall	OTTER	2006 to 2017	11	16.08	16.78	0.70	0.70	0.61	0.41	0.16	0.17
South West	Devon & Cornwall	PLYMOUTH TAMAR	2008 to 2017	9	284.62	286.06	1.44	0.90	6.76	3.79	5.64	3.46
South West	Devon & Cornwall	St Austell	2007 to 2018	11	0.10	0.08	-0.02	-0.02	0.00	0.00	0.03	0.00
South West	Devon & Cornwall	TAW / TORRIDGE	2006 to 2018	12	221.20	233.60	12.40	11.61	19.27	7.92	12.72	2.07
South West	Devon & Cornwall	TEIGN	2007 to 2017	10	27.59	28.59	1.00	1.00	1.34	0.46	0.47	0.33
South West	Devon & Cornwall	YEALM	2008 to 2017	9	3.25	3.05	-0.20	-0.20	0.08	0.06	0.29	0.05
South West	Severn	BRISTOL AVON	2008 to 2018	10	47.23	51.49	4.26	4.26	3.94	0.94	0.37	0.25
South West	Severn	PARRETT	2008 to 2018	10	234.92	450.64	215.72	11.51	227.27	9.88	18.50	2.94
South West	South Wessex	CHRISTCHURCH HARBOUR	2008 to 2016	8	65.68	66.81	1.14	1.14	0.95	0.72	0.28	0.25
South West	South Wessex	Fleet Lagoon	2006 to 2017	11	28.12	28.91	0.79	0.79	2.14	0.85	1.63	0.58
South West	South Wessex	Lyme Bay East	2006 to 2017	11	1.08	1.46	0.38	0.38	0.38	0.03	0.01	0.01
South West	South Wessex	POOLE HARBOUR	2008 to 2014	6	552.91	534.61	-18.30	-18.30	20.72	11.11	25.07	25.06

Region	HCRP	Waterbody	Change Period	Change Period (no. of years)	Baseline (ha)	Latest (ha)	Net change (ha)	Net change excluding MR sites (ha)	Gain (Gross) (ha)	Gain (Marginal) (ha)	Loss (Gross) (ha)	Loss (Marginal) (ha)
South West total					1865.78	2124.76	258.98	27.71	329.21	47.53	74.63	43.14
Grand total					33162.10	35504.85	2291.35	1473.10	2973.80	820.42	986.33	516.53

Appendix 3. Saltmarsh zonation

Region	HCRP	Waterbody	Pioneer (ha)	Mid-Low (ha)	Upper Marsh (ha)	Reedbeds (ha)	*Spartina* (ha)	Unclassified (ha)	Unvegetated (ha)
Anglian	East Anglia	ALDE & ORE	3.84	194.25	78.83	47.09	24.11	13.64	3.31
Anglian	East Anglia	Benacre Broad						21.05	
Anglian	East Anglia	BLACKWATER	8.19	547.40	56.22	3.25	42.75	2.25	16.93
Anglian	East Anglia	Blackwater Outer	16.30	262.79	18.05	0.44	10.23	0.27	4.66
Anglian	East Anglia	BLYTH (S)						72.43	
Anglian	East Anglia	BURE & WAVENEY & YARE & LOTHING	0.20	9.85	3.15		0.38	0.04	0.02
Anglian	East Anglia	BURN	28.11	617.08	86.80	16.20	40.28	3.13	2.48
Anglian	East Anglia	COLNE	2.58	515.12	37.03	2.97	10.79	0.45	15.32
Anglian	East Anglia	CROUCH	1.72	665.42	47.33	1.81	19.09	28.60	15.28
Anglian	East Anglia	DEBEN						244.12	
Anglian	East Anglia	Essex	1.82	340.29	18.53		5.28	0.15	0.71
Anglian	East Anglia	GREAT OUSE	14.80	388.08	151.12		61.33	12.95	
Anglian	East Anglia	Hamford Water	37.06	555.30	29.83		38.88	1.46	2.95
Anglian	East Anglia	Harwich Approaches	0.16	49.36	5.25			0.01	0.01
Anglian	East Anglia	Lincolnshire	21.21	361.34	150.82	0.11	15.41	39.61	0.74
Anglian	East Anglia	NENE	0.01	7.65	1.54		0.08	0.01	0.03
Anglian	East Anglia	Norfolk North	43.95	213.78	25.79	30.34	6.82	5.15	1.11
Anglian	East Anglia	ORWELL	0.94	37.14	6.06	0.01	16.30	0.19	0.39
Anglian	East Anglia	STEEPING	0.02	1.93	7.35		0.17	0.04	0.01
Anglian	East Anglia	STIFFKEY & GLAVEN	43.28	954.64	134.00	3.71	126.36	10.95	3.32
Anglian	East Anglia	STOUR (ESSEX)	2.94	90.05	9.01	0.99	31.45	0.35	1.14
Anglian	East Anglia	Thames Coastal North	0.01	6.70	0.41		0.08	0.01	0.03
Anglian	East Anglia	WASH INNER	530.48	1696.37	834.37		340.09	112.61	16.48
Anglian	East Anglia	Wash Outer	133.17	807.93	134.97		197.95	67.50	1.48
Anglian	East Anglia	WELLAND	4.24	182.60	225.66		7.28	1.75	5.18
Anglian	East Anglia	WITHAM	0.20	48.55	6.15	0.02	1.48	2.75	0.11
Anglian	Humber	HUMBER LOWER	59.65	597.76	201.78	4.24	280.84	181.84	2.78
Anglian	Humber	HUMBER MIDDLE	21.29	62.23	218.60	220.93	16.31	195.84	1.80
Anglian	Humber	HUMBER UPPER	1.05	19.63	127.32	133.44	3.11	26.40	1.79
Anglian total			**977.22**	**977.22**	**977.22**	**977.22**	**977.22**	**977.22**	**977.22**
Midlands	Severn	SEVERN LOWER (England)	4.57	122.39	126.63	8.51	71.56	6.47	2.66
Midlands	Severn	SEVERN MIDDLE (England)	3.85	66.72	243.53	13.13	47.61	0.27	1.77
Midlands	Severn	SEVERN UPPER		1.89	34.24	13.68	0.06	0.21	0.43
Midlands total			**8.42**	**190.99**	**404.40**	**35.31**	**119.23**	**6.95**	**4.87**

Region	HCRP	Waterbody	Pioneer (ha)	Mid-Low (ha)	Upper Marsh (ha)	Reedbeds (ha)	*Spartina* (ha)	Unclassified (ha)	Unvegetated (ha)
North East	North East	ALN						39.01	
North East	North East	BLYTH (N)						5.51	
North East	North East	COQUET						20.47	
North East	North East	Farne Islands to Newton Haven	0.20	6.58	23.14	0.29	0.00	0.15	0.08
North East	North East	Holy Island & Budle Bay	16.63	119.44	18.52	0.28	83.61	0.60	7.85
North East	North East	TEES	14.17	24.92	15.82	2.73	0.37	26.99	0.27
North East	North East	TWEED	0.14	2.21	23.80		0.03	0.01	0.21
North East	North East	Tyne and Wear						3.51	
North East	North East	WANSBECK						0.53	
North East	North East	WEAR						2.43	
North East total			**31.14**	**153.15**	**81.28**	**3.30**	**84.01**	**99.20**	**8.41**
North West	North West	DEE (England)	44.66	1296.38	417.08	9.70	64.70	0.35	7.63
North West	North West	DUDDON	26.34	454.22	81.07		64.65	56.84	0.47
North West	North West	Duddon Sands	4.97	64.05	4.45	1.09	11.90	3.33	4.09
North West	North West	ESK (W)	13.26	89.02	125.56	4.23		1.75	0.02
North West	North West	KENT	144.11	878.18	151.40	1.68	7.14	15.99	1.46
North West	North West	LEVEN	5.78	374.20	54.07	4.81	1.82	19.68	0.36
North West	North West	LUNE		330.49	13.44	0.10	6.31	0.13	0.23
North West	North West	MERSEY						907.48	
North West	North West	Morecambe Bay	97.95	802.09	166.41	1.31	76.76	36.46	5.64
North West	North West	RIBBLE	19.66	1891.84	468.10	1.63	34.65	290.00	12.64
North West	North West	SOLWAY	78.62	1080.27	1701.54	0.33	21.21	32.34	0.74
North West	North West	WYRE	3.85	265.69	60.46	2.34	12.52	4.37	3.37
North West total			**439.20**	**7526.45**	**3243.58**	**27.22**	**301.67**	**1368.73**	**36.66**
South East	Solent & South Downs	ADUR	0.48	13.73	5.43		2.88	0.61	0.03
South East	Solent & South Downs	ARUN						13.07	
South East	Solent & South Downs	BEAULIEU RIVER	1.67	47.49	9.78	5.56	41.05	0.32	1.13
South East	Solent & South Downs	Bembridge Harbour Lagoon						1.96	
South East	Solent & South Downs	CHICHESTER HARBOUR	3.67	49.11	11.08	1.32	237.70	2.25	2.04
South East	Solent & South Downs	CUCKMERE						11.57	
South East	Solent & South Downs	Great Deep	0.14	0.61	7.64			0.02	0.18
South East	Solent & South Downs	Isle of Wight East						51.39	
South East	Solent & South Downs	LANGSTONE HARBOUR	0.53	29.32	1.18		30.83	0.37	0.02
South East	Solent & South Downs	Langstone Oysterbeds	0.16	0.30			0.13	0.01	
South East	Solent & South Downs	LYMINGTON	2.55	3.68	13.65		64.19	0.11	0.19
South East	Solent & South Downs	MEDINA	0.01	4.54	2.88	1.50	0.07	0.04	2.06
South East	Solent & South Downs	NEWTOWN RIVER	2.08	43.77	10.93	0.06	12.07	0.17	0.90

Region	HCRP	Waterbody	Pioneer (ha)	Mid-Low (ha)	Upper Marsh (ha)	Reedbeds (ha)	*Spartina* (ha)	Unclassified (ha)	Unvegetated (ha)
South East	Solent & South Downs	Old Mill Ponds						5.07	
South East	Solent & South Downs	OUSE						1.64	
South East	Solent & South Downs	PAGHAM HARBOUR	1.13	15.20	1.71	0.02	103.46	3.23	0.01
South East	Solent & South Downs	PORTSMOUTH HARBOUR	0.02	12.05	0.99		30.33	4.48	0.16
South East	Solent & South Downs	Solent	5.75	28.47	22.14	5.15	59.30	0.35	0.32
South East	Solent & South Downs	SOUTHAMPTON WATER	1.26	110.57	57.40	48.64	46.55	0.59	1.94
South East	Solent & South Downs	Sussex						1.50	
South East	Solent & South Downs	WESTERN YAR	0.51	25.01	3.42	10.71	3.79	0.03	0.37
South East	Solent & South Downs	WOOTTON CREEK		0.18	0.13			0.02	
South East	South East	Kent North						0.80	
South East	South East	MEDWAY						808.60	
South East	South East	ROTHER						35.37	
South East	South East	STOUR (KENT)						127.08	
South East	South East	SWALE						529.30	
South East	South East	Whitstable Bay						1.02	
South East	Thames	THAMES LOWER	16.64	276.78	118.87	1.70	58.93	1.26	1.63
South East	Thames	THAMES MIDDLE	0.43	36.11	73.82	6.38	12.47	1.01	0.59
South East total			**37.02**	**696.92**	**341.05**	**81.04**	**703.74**	**1603.25**	**11.56**
South West	Devon & Cornwall	AVON						25.25	
South West	Devon & Cornwall	AXE						14.33	
South West	Devon & Cornwall	Bristol Channel Outer South						60.16	
South West	Devon & Cornwall	CAMEL	1.74	31.51	16.01	0.23	7.27	16.59	0.11
South West	Devon & Cornwall	CARRICK ROADS INNER	7.78	17.94	37.76	3.22	1.03	0.91	
South West	Devon & Cornwall	Cornwall North	0.01	0.04	0.02	0.06		0.05	0.02
South West	Devon & Cornwall	DART		1.07	5.85	14.83	0.12	0.83	0.04
South West	Devon & Cornwall	ERME						27.27	
South West	Devon & Cornwall	EXE	0.20	7.66	14.39	39.56	12.59	1.11	0.09
South West	Devon & Cornwall	FOWEY						14.05	
South West	Devon & Cornwall	GANNEL	0.07	9.46	5.48	0.01	0.17	0.34	0.19
South West	Devon & Cornwall	HAYLE	0.79	11.39	1.38	0.11		2.32	0.11
South West	Devon & Cornwall	HELFORD	0.63	0.70	0.62		0.32	0.09	
South West	Devon & Cornwall	KINGSBRIDGE						0.58	
South West	Devon & Cornwall	LOOE						6.22	
South West	Devon & Cornwall	OTTER						16.78	
South West	Devon & Cornwall	PLYMOUTH TAMAR	1.86	66.40	142.81	47.78	9.30	3.83	14.08
South West	Devon & Cornwall	St Austell						0.08	
South West	Devon & Cornwall	TAW / TORRIDGE	11.44	101.09	90.24	0.51	24.42	3.33	2.57

Region	HCRP	Waterbody	Pioneer (ha)	Mid-Low (ha)	Upper Marsh (ha)	Reedbeds (ha)	*Spartina* (ha)	Unclassified (ha)	Unvegetated (ha)
South West	Devon & Cornwall	TEIGN						28.59	
South West	Devon & Cornwall	YEALM		1.09	0.74	1.07		0.08	0.07
South West	Severn	BRISTOL AVON	0.04	0.04	32.95	1.35	16.54	0.02	0.54
South West	Severn	PARRETT	11.32	96.93	140.95	30.95	118.98	24.10	27.41
South West	South Wessex	CHRISTCHURCH HARBOUR						66.81	
South West	South Wessex	Fleet Lagoon						28.91	
South West	South Wessex	Lyme Bay East						1.46	
South West	South Wessex	POOLE HARBOUR	5.17	197.32	163.77	135.90	23.46	1.88	8.39
South West total			**41.05**	**542.64**	**652.97**	**275.60**	**214.19**	**345.96**	**53.63**
Grand total			**1534.05**	**10087.39**	**5700.50**	**1399.70**	**2400.05**	**4401.32**	**1092.34**

Appendix 4. Managed/Unmanaged (MR/unMR) and Regulated Tidal Exchange (RTE) Sites

Region	HCRP	Waterbody	Aerial imagery year	Site name	Saltmarsh extent (Ha)	Type
Anglian	East Anglia	ALDE & ORE	2016	Havergate Island	1.54	MR
Anglian	East Anglia	ALDE & ORE	2016	Hazlewood Marsh	5.30	unMR
Anglian	East Anglia	ALDE & ORE	2016	Lantern Marsh	15.45	MR
Anglian	East Anglia	BLACKWATER	2016	Abbotts Hall	15.33	MR
Anglian	East Anglia	BLACKWATER	2016	Northey	1.23	MR
Anglian	East Anglia	BLACKWATER	2016	Orplands	24.49	MR
Anglian	East Anglia	BLACKWATER	2016	Tollesbury	42.92	MR
Anglian	East Anglia	COLNE	2016	Fingringhoe Wick	0.30	MR
Anglian	East Anglia	CROUCH	2016	Allfleet's Marsh (Wallasea)	25.24	MR
Anglian	East Anglia	CROUCH	2016	Brandy Hole	7.09	MR
Anglian	East Anglia	CROUCH	2019	Jubilee Marsh (Wallasea)	27.15	MR
Anglian	East Anglia	Hamford Water	2016	Devereaux Farm Marsh	2.35	MR
Anglian	Humber	HUMBER LOWER	2016	Paull Holme Strays	52.78	MR
Anglian	Humber	HUMBER LOWER	2016	Welwick	35.31	MR
Anglian	Humber	HUMBER MIDDLE	2016	Alkborough	104.03	MR
Anglian	Humber	HUMBER MIDDLE	2016	Chowder Ness	7.97	MR
Anglian	East Anglia	Norfolk North	2016	Brancaster West Marsh	5.00	MR
Anglian	East Anglia	Norfolk North	2016	Titchwell Marsh	3.80	MR
Anglian	East Anglia	ORWELL	2016	Trimley Marsh	2.15	MR
Anglian	East Anglia	Wash Outer	2016	Freiston	60.14	MR
Midlands	Severn	SEVERN LOWER	2018	Bleadon Levels	7.53	MR
Midlands	Severn	SEVERN LOWER	2018	Tutshill	2.22	MR
Midlands	Severn	SEVERN LOWER	2018	Walborough	4.27	RTE
Midlands	Severn	SEVERN MIDDLE	2019	Cone Pill	12.42	MR & RTE
North East	North East	ALN	2017	Alnmouth 1	4.38	MR
North East	North East	ALN	2017	Alnmouth 2	7.60	MR
North East	North East	COQUET	2017	Castles Dike	7.42	MR
North East	North East	COQUET	2017	Warkworth	0.30	MR
North East	North East	TEES	2019	Greatham North	16.94	MR
North East	North East	TEES	2019	Greatham South	25.58	MR

Region	HCRP	Waterbody	Aerial imagery year	Site name	Saltmarsh extent (Ha)	Type
North East	North East	TEES	2014	Seal Sands	4.76	RTE
North West	North West	RIBBLE	2018	Hesketh Out Marsh West	132.00	MR
North West	North West	RIBBLE	2018	Hesketh Outh Marsh East	132.18	MR
South East	Solent & South Downs	CHICHESTER HARBOUR	2016	Chalkdock Marsh	2.33	RTE
South East	Solent & South Downs	CHICHESTER HARBOUR	2016	Cobnor Point	1.26	MR
South East	Solent & South Downs	CHICHESTER HARBOUR	2016	West Wittering	3.05	RTE
South East	Solent & South Downs	CHICHESTER HARBOUR and Great Deep	2016	Thornham Point	3.43	MR
South East	Solent & South Downs	Isle of Wight East	2020	Medmerry	51.39	MR
South East	Solent & South Downs	Solent	2016	Thorness Bay	0.02	MR
South East	Thames	THAMES LOWER	2018	Salt Fleet Flats Reserve	8.65	MR
South East	Thames	THAMES MIDDLE	2013	Barking Creek (A13)	0.04	MR
South East	Thames	THAMES MIDDLE	2013	Barking Creek (Barking Barrier)	0.21	MR
South East	Thames	THAMES MIDDLE	2013	Millenium Terraces	0.20	MR
South East	Thames	THAMES MIDDLE and LOWER	2016	Stanford Wharf	0.07	MR
South West	Devon & Cornwall	AVON	2017	South Efford Marsh	9.82	RTE
South West	Devon & Cornwall	Bristol Channel Outer South	2018	Porlock	57.31	unMR
South West	Devon & Cornwall	CAMEL	2017	Clapper Marsches	5.59	RTE
South West	Devon & Cornwall	CAMEL	2017	Treraven Meadows	8.71	RTE
South West	Devon & Cornwall	ERME	2017	Great Orcheton Fields	15.77	unMR
South West	Devon & Cornwall	EXE	2017	Goosemoor	4.14	RTE
South West	Devon & Cornwall	HAYLE	2018	Ryan's Field	3.67	RTE
South West	Devon & Cornwall	PLYMOUTH TAMAR	2017	Saltram	3.53	RTE
South West	Devon & Cornwall	TAW / TORRIDGE	2018	Annery Kiln	3.15	MR
South West	Devon & Cornwall	TAW / TORRIDGE	2018	Horsey Island	0.02	RTE & unMR
South West	Devon & Cornwall	TAW / TORRIDGE	2018	Pillmouth	10.81	MR
South West	Devon & Cornwall	TAW / TORRIDGE	2018	Watertown Farm	1.44	MR
South West	Severn	PARRETT	2020	Otterhampton Marsh	23.30	RTE
South West	Severn	PARRETT	2018	Pawlett Hams	3.67	MR
South West	Severn	PARRETT	2018	Steart Marsh	180.81	MR

*details taken from the OMReg database (ABPmer, 2021).

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