Saltmarsh Accretion Monitoring Network Installation Report

Interim report

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1. Introduction

1.1 UK Saltmarsh extent and loss

Saltmarsh habitats make up approximately 36,000 ha of English coastline (Environment Agency, 2022a), 7000 ha of the Welsh coastline, and 6000 ha of Scottish coastline (Phelan et al., 2011), collectively an area roughly the size of West Yorkshire. Since the mid 1800s, approximately 85% of UK saltmarsh has been lost (Green et al., 2021), largely due to land reclamation. In recent years there has been an increase in saltmarsh cover due to large managed realignment projects, yet still there is significant degradation of marshes due to sea level rise across the UK, with significant losses due to erosion in the Thames and Essex coast and net loss in South Wessex (Environment Agency, 2022b).

1.2 Sea level rise and saltmarshes

The ICCP project a global relative sea level rise (rSLR) of up to 1m by 2100 under SSP8.5 high emissions and temperature rise scenario (IPCC, 2023), with large regional variability. In the UK, under the high emissions scenario there is an 80% probability of nationwide marsh retreat by 2100 with areas of southern and eastern England reaching this probability by 2040 (Horton et al., 2018a).

Several factors operating at regional and global scales may influence the efficacy of tidal marsh vertical adjustment to sea-level rise, and their ability to perform flood abatement services into the future. In the UK sea level rise is regionally variable due to geological uplift and subsidence (Figure 1). Regional variability in tidal range from <2m to 15m in the Bristol Channel can also influence susceptibility to drowning under a given rate of rSLR. Other factors that influence the ability of saltmarsh to keep pace with rSLR include tidal hydrodynamics, sediment delivery through river discharges, plant productivity and composition, salinity and soil organic carbon accumulation and decomposition. UK saltmarshes are minerogenic systems which are strongly reliant on sediment supply to maintain marsh extent. Over the last 150 years there has been marsh expansion in the north and severe erosion in the south due to a gradient towards high wave fetch length and sediment transport in the North, supplying marsh expansion in these lower rSLR regions (Ladd et al., 2019). Furthermore, long-term sediment elevation data has informed that in the southeast there is a likelihood of marsh drowning under rapid sea level rise (3.6-7.6 mm y^{-1}) due to shallow subsidence (Saintilan et al., 2022).

Management of saltmarshes has the potential to provide key flood abatement and coastal protection services as sea levels rise and storms intensify over the next century. The estimated value of flood mitigation by saltmarshes in 2019 was £62 million in England and £9 million in Wales, with 93,000 urban properties protected (Watson & McGirr, 2022). Given the value of saltmarsh in protecting national assets

it is important to understand how they respond to change for mitigation and management. Currently in the UK there is good evidence of historic and current changes in lateral extent, but less nationwide data of marsh elevation changes which are key to predicting resilience and vulnerability to rising sea levels and climate change and informing how we prioritise management of these precious ecosystems and natural flood defences.

Only by sampling across hydro-geomorphic settings and biogeographic gradients can the significance of these factors be clarified, and the consistency of feedbacks between rSLR and position in the tidal frame be determined. And thereafter, a marshes future function in flood abatement.

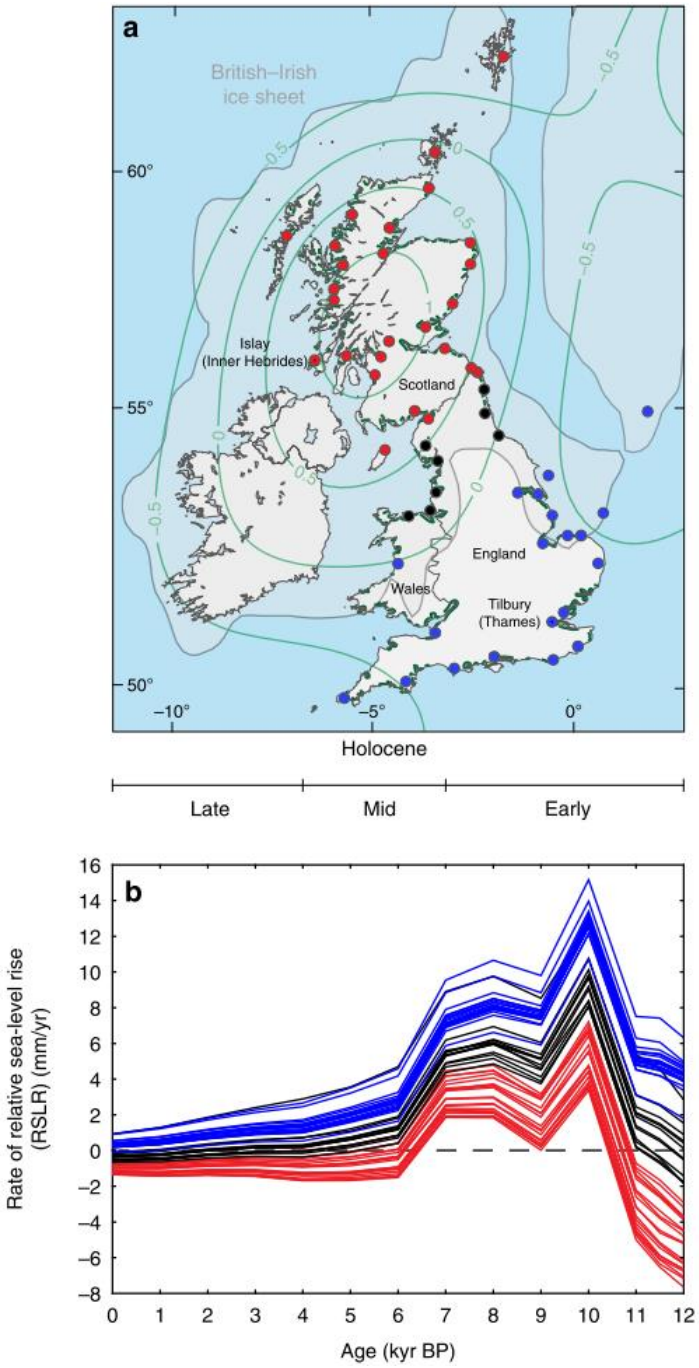


Figure 1: Variation in UK Sea level rise (RSLR) in the Holocene, (Horton et al., 2018b)**.**
A) Approximate spatial extent (light blue) of the British–Irish ice sheet (BIIS) at the last glacial maximum. Contours represent the predicted present-day rate of land-level change, where relative uplift is positive, subsidence is negative (mm/yr). Current tidal marshes are shown in green.

B) Holocene rates of RSLR for 54 locations. The red dots and lines are sites located close to the center of the BIIS; black are sites at the margin of the BIIS; and blue are sites distal to the BIIS.

1.3 Globally standardised sediment elevation monitoring

Accurate measures of tidal marsh vertical adjustment in relation to sea level require a fixed benchmark against which elevation gain or loss can be measured. To this end, the Surface Elevation Table - Marker Horizon (SET-MH) method has been developed as a global standard for monitoring tidal marsh responses to sea-level rise (Cahoon et al., 2002; Lynch et al., 2015). A benchmark rod is driven into the marsh to form a stable benchmark against which elevation change can be measured. Vertical accretion is also measured at most sites above an artificial soil horizon (e.g. typically white feldspar or sand) introduced at the time of the first reading against the benchmark.

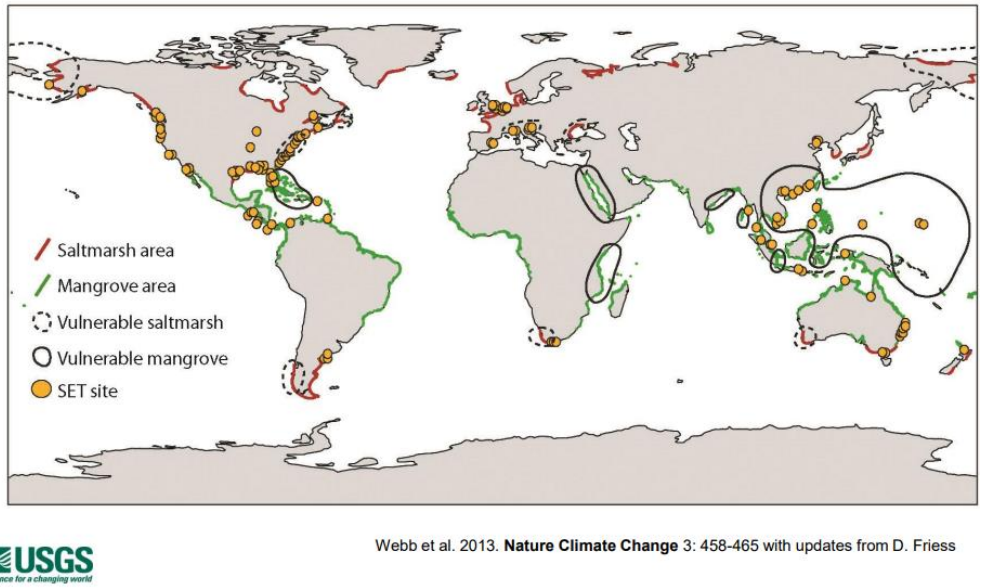


Figure 2: Global distribution of SET-MH sites (credit: N. Cormier, USGS)

Data from SET-MH stations around the globe (Figure 2) have informed models of marsh resilience to RSLR, global projections of tidal marsh and mangrove change in the coming century, and the influence of vertical accretion on carbon sequestration (Saintilan et al., 2022).

The UK has data on marsh elevation change in East Anglia, from SETs set up in the Wash, North Norfolk and Essex. This has contributed towards an in-depth

understanding of the local systems (Cahoon et al., 2000; Spencer et al., 2020) and a growing understanding of the global effects and challenges of sea level rise on marsh systems (Figure 3) (Saintilan et al., 2022).

The Saltmarsh Accretion Monitoring Network will measure change across Great Britain from the north of Scotland down to the south coast of England, reflecting the different sea level states and contributing to a global network of SET data. Data produced by this project will be publicly available via the Environmental Information Data Centre | EIDC (EIDC) and fed into a global dataset used to report on changes in tidal marsh elevation from four continents (Guntenspergen, 2023). This will allow scientists of the world to continue building understanding in these processes in a rapidly changing world, which can inform decisions on how best to protect the global coastlines and their inhabitants.

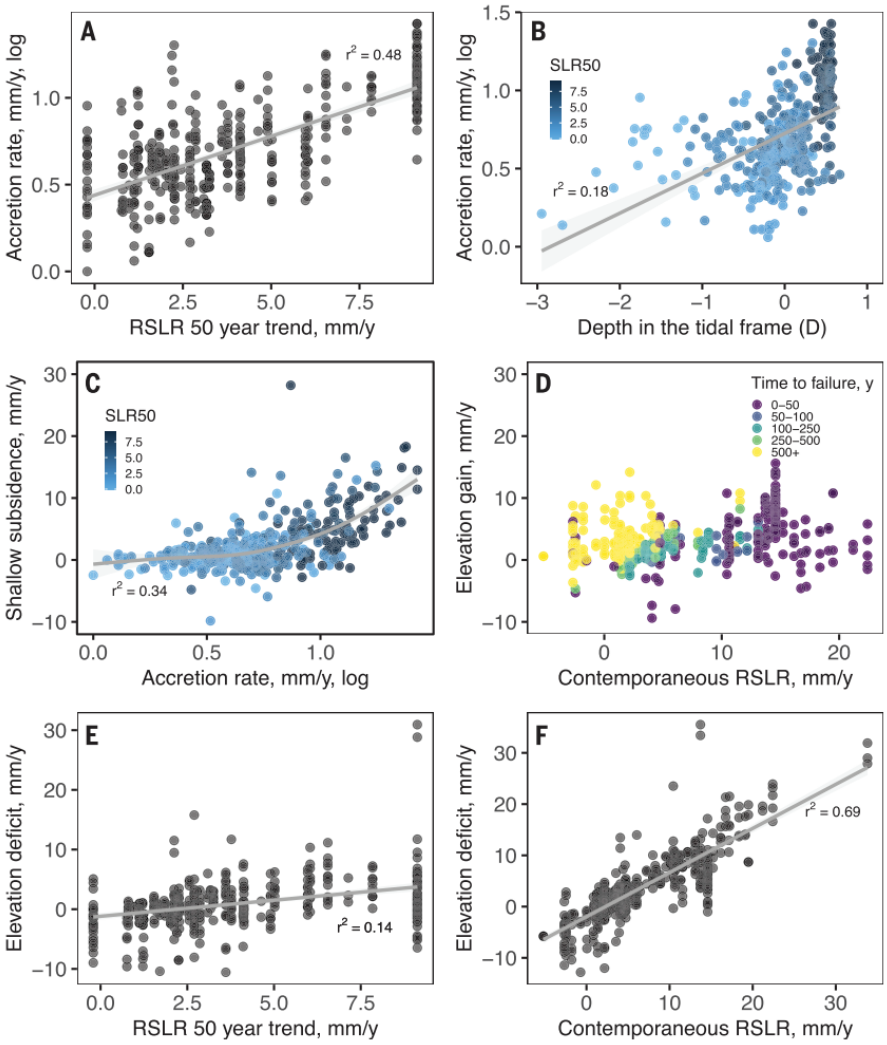


Figure 3: The increasing vulnerability of tidal marshes to RSLR after (Saintilan et al., 2022)**.**
(A and B) Accretion increases in parity with the 50-year RSLR trend (A) and with marshes lower in the tidal frame (B).
(C and D) However, the rate of shallow marsh subsidence increases with the rate of vertical accretion, with an upward inflexion as RSLR increases between 5 and 10 mm year–1 (C), suppressing elevation adjustment to RSLR (D).
(E and F) As a result, the deficit between elevation gain and RSLR increases with the 50-year RSLR trend (E) and the contemporaneous RSLR trend, the period over which individual SET-MH stations were measured (F). In (B) and (C), points are colored for the 50-year RSLR trend in mm year–1, and in (D) for estimated time to failure (years) under the elevation deficit against the 50-year RSLR trend.

2. Sites selected

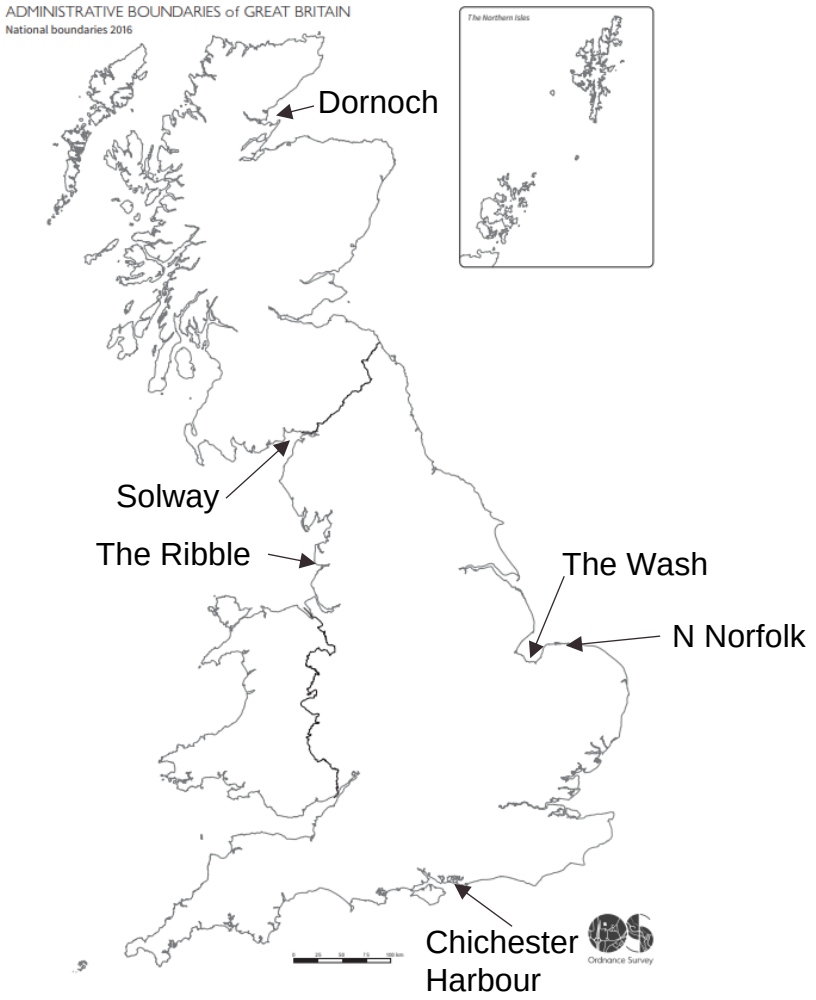


Figure 1. Estuaries within the Sediment Erosion Table network.

Six estuaries were selected across Britain representing a sea level rise gradient from low in the north, to high in the south. SETs were installed at three saltmarshes within each estuary, except the Dornoch Firth where there only one marsh was suitable. And within each marsh three SETs were installed.

2.1 Dornoch

2.1.1 Dornoch Point

Dornoch Point marsh is owned by the Highland Council with minimal management and no grazing. There are a number of footpaths across the marsh and along the beach front and dunes to the East which are frequented by walkers. The marsh has few, shallow channels and sparse beds of *Zostera noltii* just beyond the marsh edge.

Three locations were selected approximately 200m apart using a LiDAR map to inform or areas approximately the same elevation. The marsh vegetation is growing directly onto sandy sediment, there was some seaweed wrack deposition on the low marsh and large amounts of the mid-marsh are covered 15cm thick mat of *Puccinellia maritima*. The difficulty in actually reaching the sediment to measure elevation resulted in choosing areas which were dominated by *Triglochin maritima* and *Plantago maritima*.

Table 1: Summary of baseline data for three SETs at Dornoch point. Baseline elevation is 0, but an average for each SET base is included from 72 measurements. National Vegetative Community (NVC) has been characterised from observation.

SET	Depth (m)	Average elevation (mm)	NVC Community	Sediment type	Site notes
1	8	322.97	SM13d	Sandy-loam 15cm, Sand	Mat of roots and rhizomes and root bowls.
2	5	353.42	SM13d	Sandy-loam 15cm, Sand	
3	5	333.49	SM13d	Sandy-loam 15cm, Sand	

Image 1: Aerial photo of Dornoch Point marsh with SET locations indicated by pins and access across the marsh and beach outlined in green.

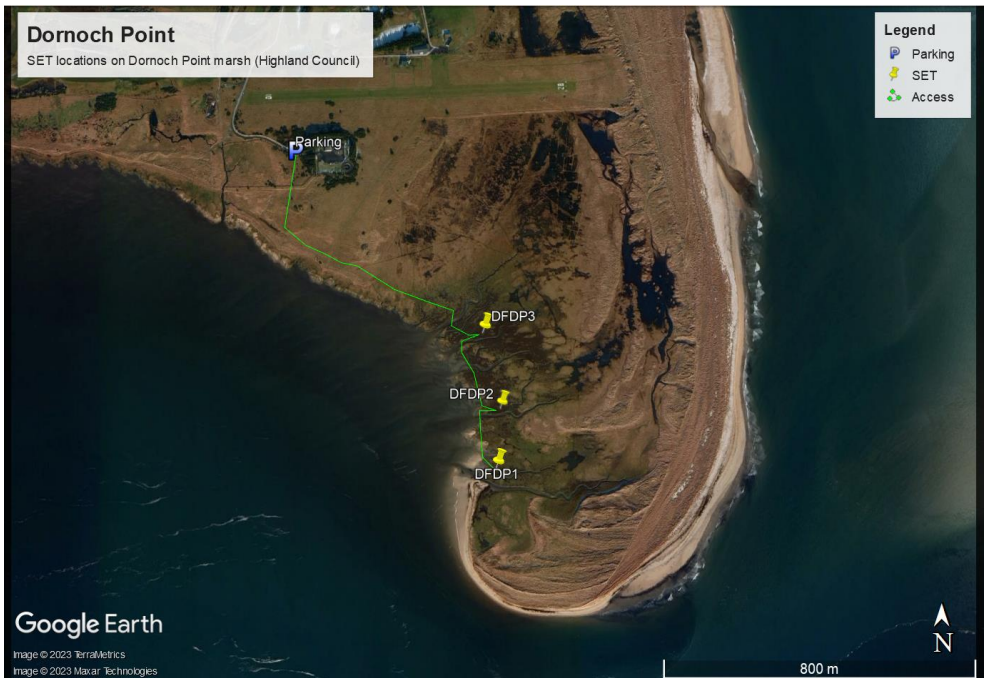


Image 2: View of the marsh edge facing North West from SET DFDP1. The channels are shallow, with little evidence of erosion, the marsh edge descends directly onto to the beach

2.2 Solway Firth

2.2.1 Crook of Baldoon

The Crook of Baldoon marsh is owned and managed by the RSPB. A public footpath runs along some of the high marsh edge with occasional footfall on the marsh, though it is more popular for birdwatchers than walkers due to supporting a variety of nesting and overwintering birds. During the installation period, lapwing, meadow pipit and skylarks were nesting so great care was taken in visually surveying routes and avoiding key areas as advised by the warden.

Three locations were selected more than 200m apart due to recommendation of sections less visited by cattle and areas which did not currently contain lapwing nests. Plant communities selected were *Puccinellia maritima* dominated, with some patches of *Triglochin maritima* and *Armeria maritima*.

Table 2: Summary of baseline data for three SETs at the Crook of Baldoon. Baseline elevation is 0, but an average for each SET base is included from 72 measurements. National Vegetative Community (NVC) has been characterised from observation.

SET	Depth (m)	Average elevation (mm)	NVC Community	Sediment type	Site notes
1	8	339.31	SM13d	Sandy-loam	Edge of high-mid marsh, small band before a Spartina frequent lower community.
2	10	348.83	SM13d	Sandy-loam	
3	4.2	332.43	SM13d	Sandy-loam, shallow bedrock	

Image 3: Aerial photo of Crook of Baldoon marsh with SET locations indicated by pins and access outlined in red via 4x4, in blue via ATV and in green by foot across the marsh.

Image 4: Taking measurements at SET SWCB1 facing North East.

2.2.2 Caerlaverock

Caerlaverock marsh is owned and managed by the Wildfowl and Wetlands Trust, where a birdwatching centre is located and frequented by members of the public. A building is situated on the seawall, providing a viewing point for visitors who do not have access to the marsh. The marsh is periodically grazed by a small number of sheep.

Three locations were selected approximately 200m apart using a LiDAR map to inform of areas approximately the same elevation. Vegetation was sparse on the sandy sediment and the marsh very dry due to the strong winds experiences along this shore. Plant communities selected were *Puccinellia maritima* dominated, with some patches of *Triglochin maritima*, *Aster tripolium* and *Armeria maritima*.

Table 3: Summary of baseline data for three SETs at the Caerlaverock. Baseline elevation is 0, but an average for each SET base is included from 72 measurements. National Vegetative Community (NVC) has been characterised from observation.

SET	Depth (m)	Average elevation (mm)	NVC Community	Sediment type	Site notes
1	5.6	331.38	SM13a	Sandy-silt	Bare ground in places, sandy sediment all the way down.
2	5	360.64	SM13a	Sandy-silt	
3	5	348.64	SM13a	Sandy-silt, shallow bedrock	

Image 5 Aerial photo of Caerlaverock marsh with SET locations indicated by pins and access outlined in red via a track and in green across the marsh.

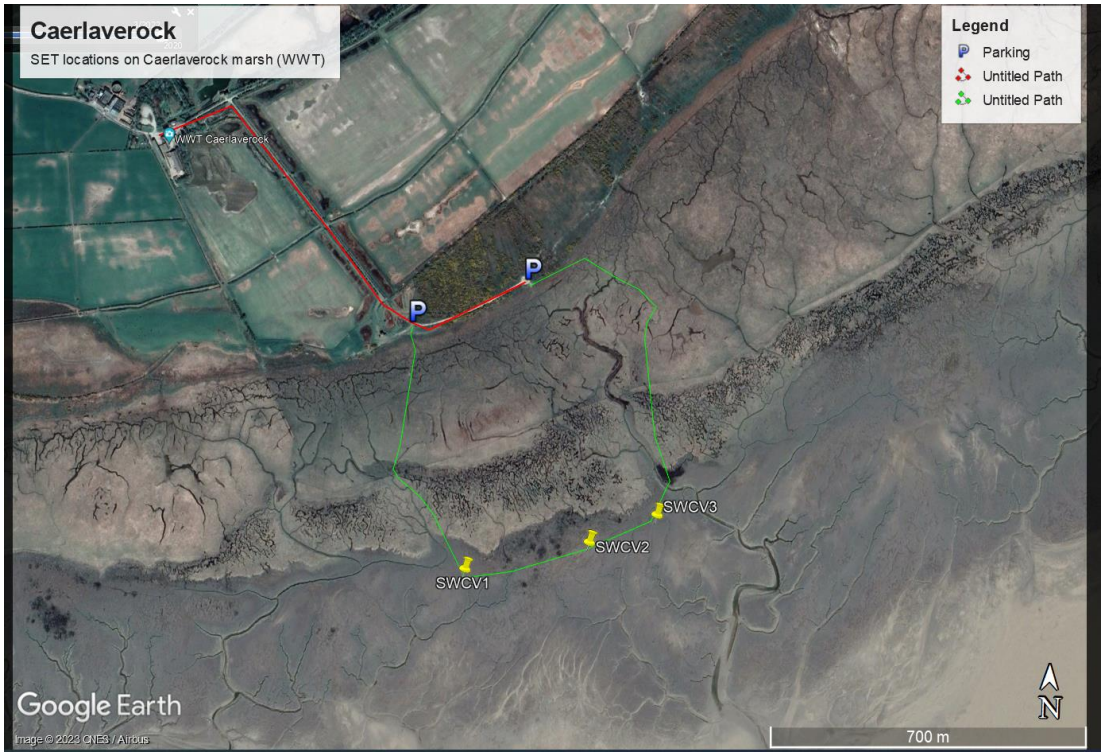


Image 6: Taking measurements at SET SWCV2 facing East.

2.2.3 Campfield marsh

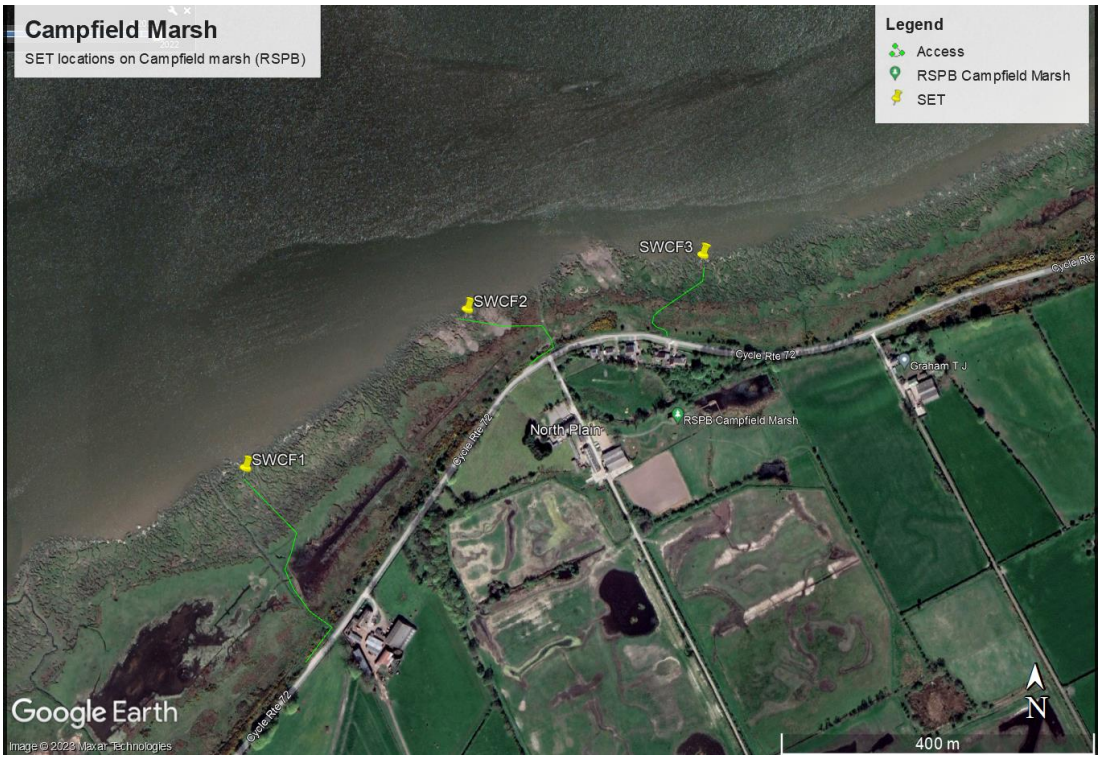
Campfield marsh is owned and managed by the RSPB. It is a narrow marsh in contrast to the wide marsh at Caerlaverock and is subject to rapidly changing channels and fast currents which causes phases of erosion and deposition along the marsh edge. The marsh is periodically grazed by a small number of cattle therefore locations were partly informed by the guidance of the warden.

Three locations were selected using a LiDAR map to inform of areas approximately the same elevation, these were more than 200m apart to capture the variability in accretion and erosion particular to this location. Plant communities selected were *Puccinellia maritima* dominated, with some patches of *Armeria maritima* and *Triglochin maritima*.

Table 4: Summary of baseline data for three SETs at Campfield marsh. Baseline elevation is 0, but an average for each SET base is included from 72 measurements. National Vegetative Community (NVC) has been characterised from observation.

SET	Depth (m)	Average elevation (mm)	NVC Community	Sediment type	Site notes
1	6	328.40	SM13d	Sandy-silt	Very eroded, few suitable spots, SWCF1 slightly higher community
2	6	328.24	SM13d	Sandy-silt	
3	6	323.79	SM13d	Sandy-silt, shallow bedrock	

Image 7: Aerial photo of Campfield Marsh with SET locations indicated by pins and access across the marsh outlined in green.


Campfield Marsh
SET locations on Campfield marsh (RSPB)
Legend
Access
RSPB Campfield Marsh
SET
SWCF3
SWCF2
SWCF1
Cycle Rte 72
Graham T J
RSPB Campfield Marsh
North Plain
Google Earth
Image © 2022 Maxar Technologies
400 m
N

2.3 The Ribble

2.3.1 Banks Marsh

Banks marsh is managed by the RSPB and owned by Natural England. A footpath runs along the seawall which is used by some members of the public. The marsh is periodically grazed by cattle which cover the whole extent of the Ribble marsh, whilst the bank side section where RBBS1 and the GHG chamber collars are located are seldom grazed. Volunteer groups periodically help manage and survey bird and plant communities, particularly within Hesketh out marsh Managed realignment site on the opposite side of the seawall.

Three locations were selected at least 200m apart using a LiDAR map to inform of areas approximately the same elevation. Plant communities selected were *Puccinellia maritima* dominated with some *Atriplex portulacoides* and *Atriplex prostrata*.

One SET (RBBS1) was installed near the greenhouse gas chamber collars and location of the upcoming flux tower. RBBS2 and RBBS3 are located in areas which are grazed, though care was taken to select areas which are less visited by cattle yet still within reasonable access for transporting heavy equipment onto the marsh for installation.

Table 5: Summary of baseline data for three SETs at Banks marsh. Baseline elevation is 0, but an average for each SET base is included from 72 measurements. National Vegetative Community (NVC) has been characterised from observation.

SET	Depth (m)	Average elevation (mm)	NVC Community	Sediment type	Site notes
1	5.7	313.58	SM13a	Clayey	
2	5.9	310.47	SM13a	Clayey	Drier sediment, potentially slightly higher elevation
3	6	380.88	SM13a	Clayey	Many pools and small creeks, frequented by cattle

Image 8: Aerial photo of Banks marsh with SET locations indicated by pins and access along sea wall and across the marsh outlined in green.

2.3.2 Marshside

Marshside marsh is managed by the RSPB, though the road which crosses the marsh is owned by the council with access granted to pedestrians and fisherman such as cockle-pickers who still harvest from the low tide mark. The marsh is un-grazed and is an important nesting site for many birds including redshank and skylarks during the installation period. Great care was taken during installation to check for nests and asses the safest routes to the locations.

Three locations were selected approximately 200m apart using a LiDAR map to inform or areas approximately the same elevation. Plant communities selected were *Atriplex portulacoides* and *Puccinellia maritima* dominated, with some patches of and *Atriplex prostrata* and *Spartina*.

Table 6: Summary of baseline data for three SETs at Marshside. Baseline elevation is 0, but an average for each SET base is included from 72 measurements. National Vegetative Community (NVC) has been characterised from observation.

SET	Depth (m)	Average elevation (mm)	NVC Community	Sediment type	Site notes
1	4	365.84	SM13a	Clayey 1.5m, gravel, clay	Gravelly substrate at 1-2m then mud again as visible in creeks.
2	4.6	367.45	SM13a	Clayey 1.5m, gravel, clay	
3	4.7	334.28	SM13a	Clayey	

Image 9: Aerial photo of Marshside with SET locations indicated by pins and access via a track and across the marsh outlined in green.

2.3.3 Warton Marsh

Warton marsh is owned by wildfowlers, who allow periodic grazing of a small number of cattle across the whole marsh. The wildfowlers have been recognised for their careful management of the marsh which has greatly increased bird biodiversity, establishing it as an important nesting and overwintering site.

Three locations were selected approximately 200m apart using a LiDAR map to inform or areas approximately the same elevation. Plant communities selected were *Puccinellia maritima* dominated, with some patches of and *Atriplex prostrata, Atriplex portulacoides* and *Spartina*.

Table 7: Summary of baseline data for three SETs at Warton Marsh. Baseline elevation is 0, but an average for each SET base is included from 72 measurements. National Vegetative Community (NVC) has been characterised from observation.

SET	Depth (m)	Average elevation (mm)	NVC Community	Sediment type	Site notes
1	5	340.72	SM13a	Clayey	Cattle grazing. Standing pools nearby
2	5	341.03	SM13a	Clayey	Cattle grazing. Standing pools nearby
3	5	384.11	SM13a	Clayey	Cattle grazing. Standing pools nearby

Image 10: Aerial photo of Warton Marsh with SET locations indicated by pins and access via a track and across the marsh outlined in green.

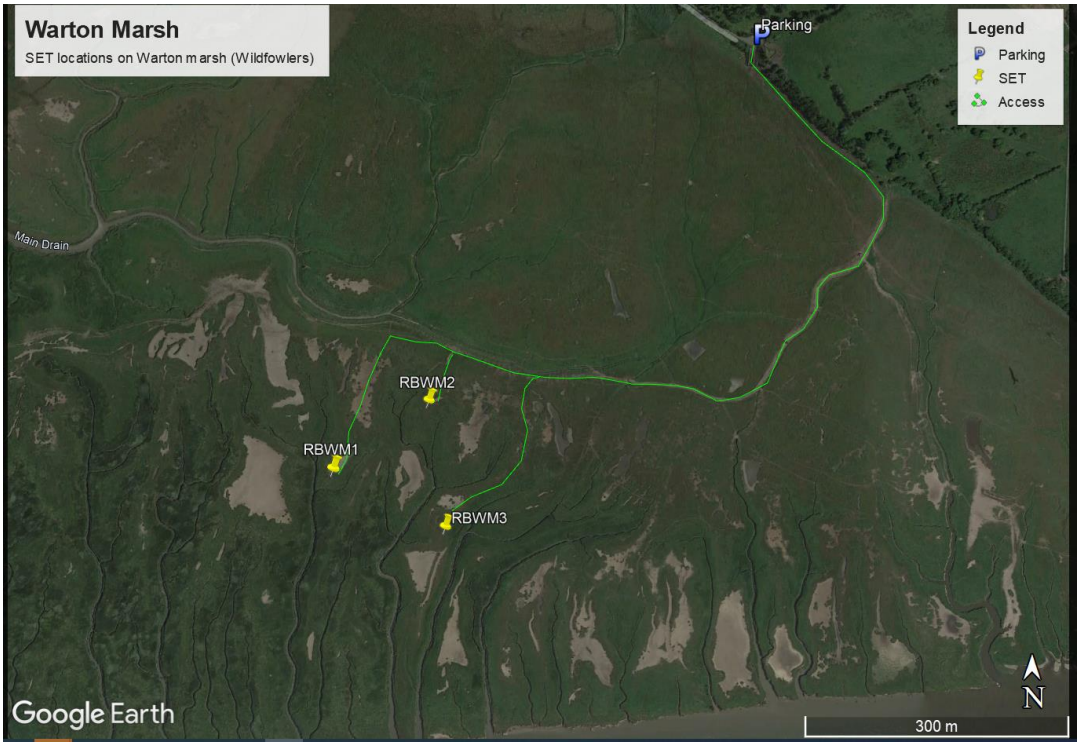
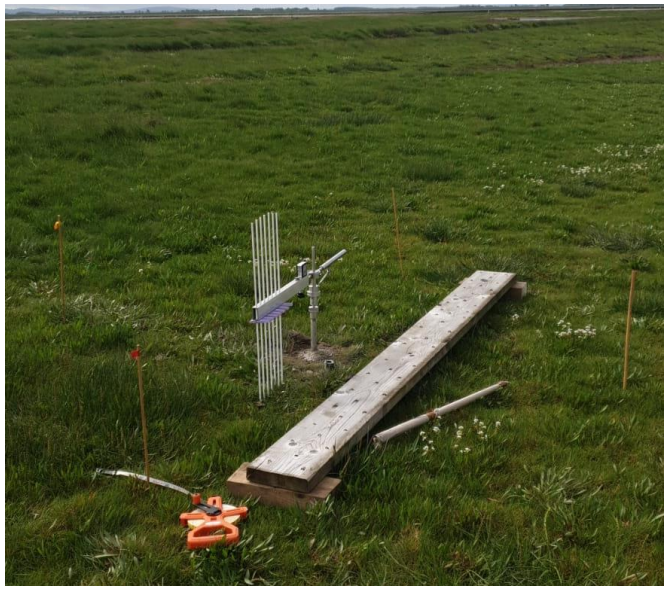


Image 11: Example plot on Warton Marsh. Bamboo posts indicate marker horizons. The platform allows measurement of the plot without compression of the soil or plants. The SET instrument is set up in the Northern orientation.



2.4 North Norfolk

2.4.1 Brancaster

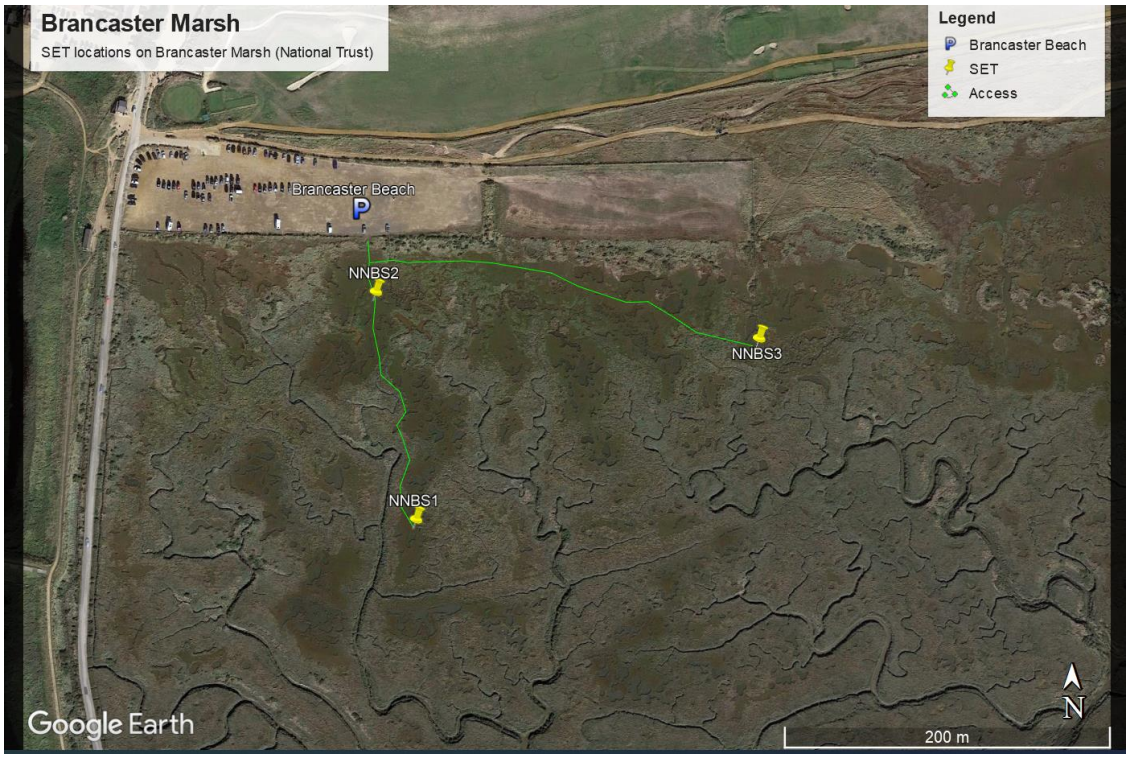
Brancaster marsh is owned by the National Trust and backs onto a beach and golf course. The marsh is somewhat overlooked as most of the visitors are accessing the beach.

Three SET locations were been informed by conversation with landowners, LiDAR and the EA saltmarsh extent maps and visual assessment of the community. The plant community was dominated by *Limoneum vulgare* with abundant patches of Salicornia and *Triglochin maritima*. *Puccinellia*, *Armeria maritima* were also frequent. The terrain was fairly flat, with some shallow standing pools and highly embanked creeks.

Table 8: Summary of baseline data for three SETs at Brancaster Beach. Baseline elevation is 0, but an average for each SET base is included from 72 measurements. National Vegetative Community (NVC) has been characterised from observation.

SET	Depth (m)	Average elevation (mm)	NVC Community	Sediment type	Site notes
1	10	354.86	SM13c	Sandy-silt	
2	8	351.78	SM13c	Sandy-silt	
3	9	337.50	SM13c	Sandy-silt	Some shallow standing pools nearby

Image 12: Aerial photo of Brancaster marsh with SET locations indicated by pins and access on foot outlined in green



2.4.2 Stiffkey

Stiffkey marsh is owned and managed by the National Trust. A footpath across the marsh to the shore is frequented by swimmers, walkers and birdwatchers however the track across Cabbage creek has now much reduced footfall due to the recent bridge collapse. Accretion has been previously monitored on this marsh using SETs by Cahoon (2000). Skylarks were nesting during installation so great care in surveying and assessing routes was taken to avoid disturbance.

Three SET locations were informed by conversation with landowners, LiDAR and the EA saltmarsh extent maps. The plant community at Stiffkey is unique to this marsh, dominated by a short sward of *Limonium vulgare* and *Puccinellia*, with abundant *Atriplex portulacoides* and *Armeria maritima*. At slightly higher elevations there is also *Artemisia* growing throughout. The creeks are deep and lined with frequent bushes of *Atriplex portulacoides*, which provide cover for ground nesting birds.

Table 9: Summary of baseline data for three SETs at Stiffkey. Baseline elevation is 0, but an average for each SET base is included from 72 measurements. National Vegetative Community (NVC) has been characterised from observation.

SET	Depth (m)	Average elevation (mm)	NVC Community	Sediment type	Site notes
1	10	328.22	SM13c	Silt-loam	Short sward community. Rich, high organic matter soil
2	7	335.36	SM13c	Silt-loam	Post driver broke, NNSK2 driven using a sledgehammer
3	6	347.47	SM13c	Silt-loam	Post driver broke, NNSK3 driven using a sledgehammer

Image 13: Aerial photo of Stiffkey marsh with SET locations indicated by yellow pins and access across the marsh outlined in green. The approximate locations of historic SETs (Cahoon, 2000) are indicated by pink pins though access to them is now difficult following the collapse of the bridge across Cabbage Creek.

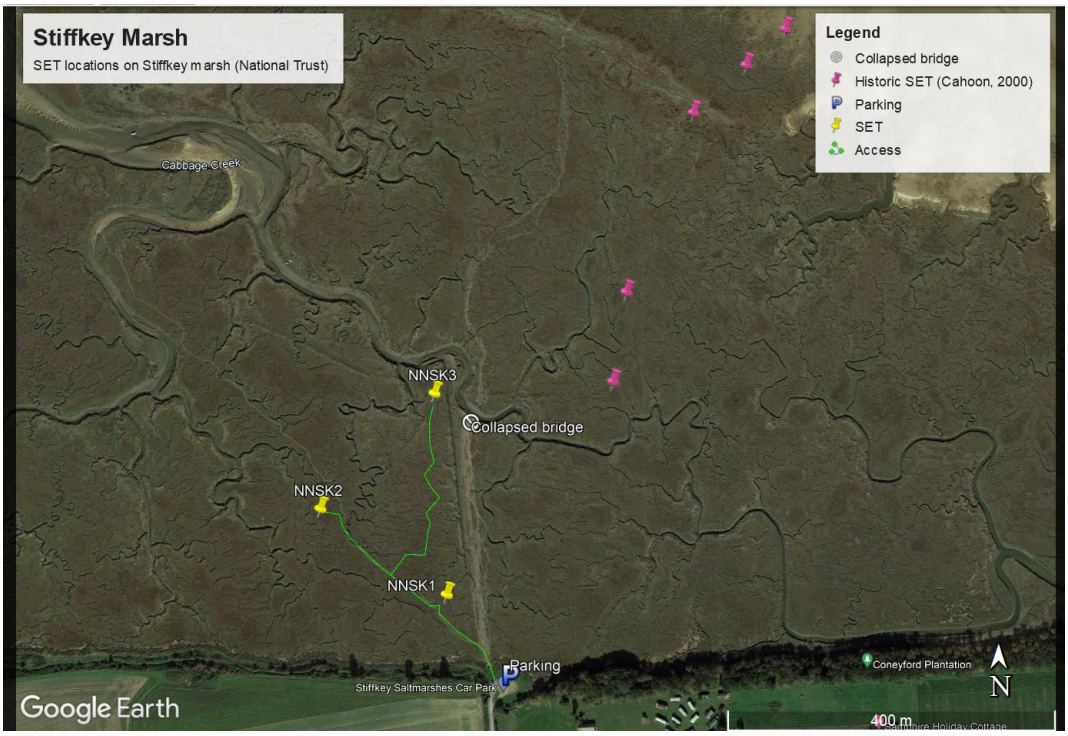


Image 14: Photo of higher elevation mid-marsh community endemic to Stiffkey but not quite captured in the SET plots.

2.4.3 Blakeney Marsh

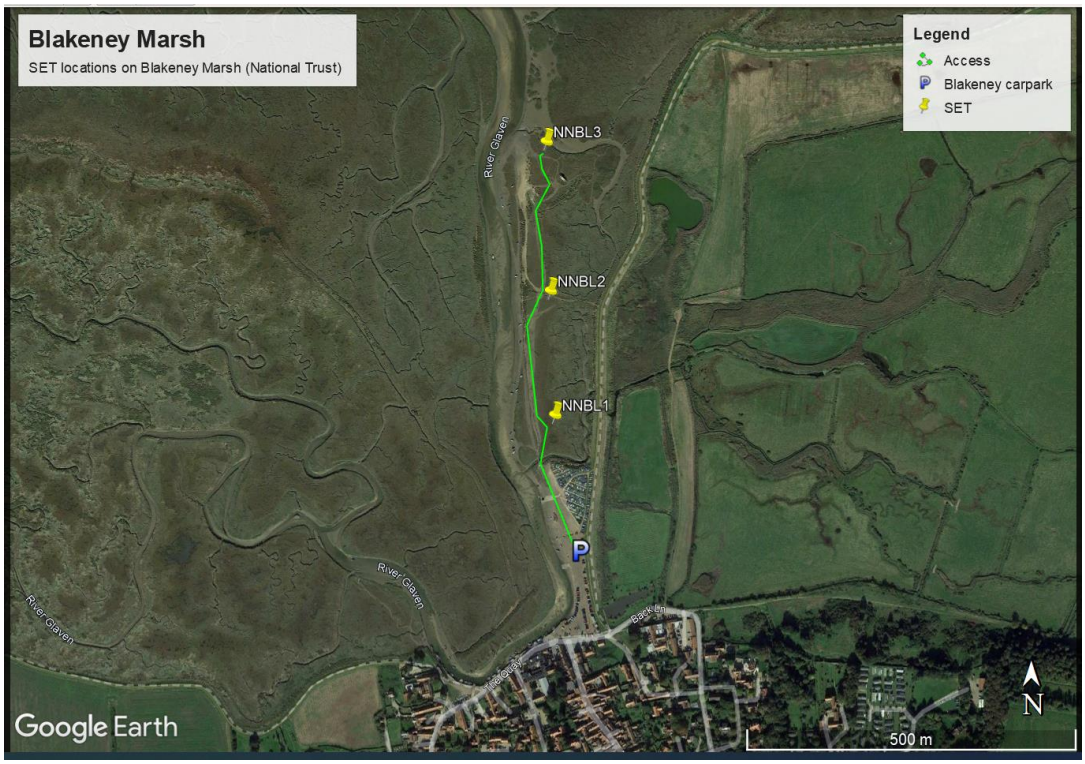
Blakeney marsh is owned by the National Trust is situated next to a creek which is frequented by small craft such as sailing boats, stand-up paddleboards and kayaks. A footpath runs along the creek edge and on the sea wall.

Three SET locations have been selected by conversation with landowners, LiDAR and the EA saltmarsh extent maps and visual assessment of the marsh. The plant community is abundant in *Limoneum vulgare*, *Salicornia* and *Puccinellia*. There are patches of *Atriplex portulacoides* and the northern extent of the marsh is abundant in *Spartina* and *Suaeda maritima*.

Table 10: Summary of baseline data for three SETs at Blakeney. Baseline elevation is 0, but an average for each SET base is included from 72 measurements. National Vegetative Community (NVC) has been characterised from observation.

SET	Depth (m)	Average elevation (mm)	NVC Community	Sediment type	Site notes
1	10	362.25	SM13c	Silt-loam	Short sward community.
2	4	361.94	SM13c	Silt-loam 10cm, sand	
3	5	321.19	SM13c	Silt-loam 10cm, sand	

Image 15: Aerial photo of Blakeney Marsh with SET locations indicated by pins and access via a path outlined in green.



2.5 The Wash

2.5.1 Bulldog Sand West

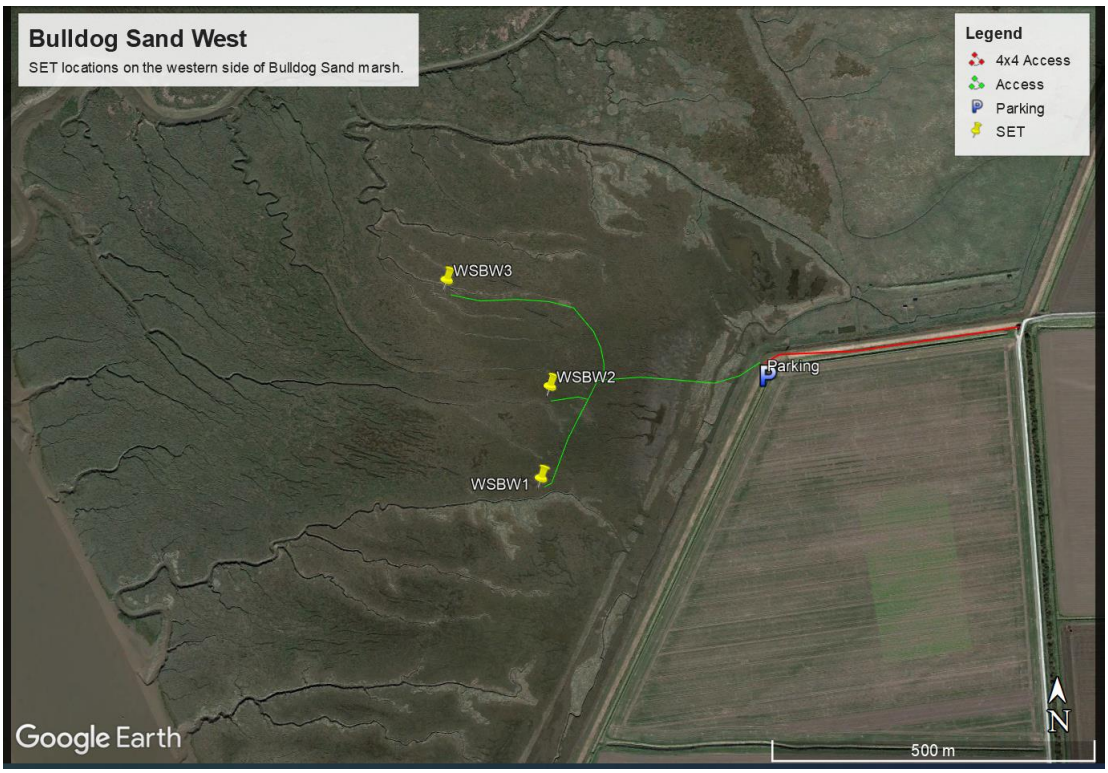
Bulldog Sand marsh is owned by a farmer and grazed periodically by a small cattle herd which roam the western section of the marsh. A series of wildfowlers huts are located north of the sea wall as the extensive marsh is an important site for breeding and overwintering birds.

Three locations were selected approximately 200m apart and care was taken to select locations less frequented by cattle. A slightly higher elevation was chosen as the extent of the marsh and the difficult terrain prohibited accessing a mid-low marsh community. Plant communities selected were long swards *Festuca rubra* dominated, with some patches of *Atriplex portulacoides*, *Spartina* and *Aster tripolium*.

Table 11: Summary of baseline data for three SETs at Bulldog sand (west). Baseline elevation is 0, but an average for each SET base is included from 72 measurements. National Vegetative Community (NVC) has been characterised from observation.

SET	Depth (m)	Average elevation (mm)	NVC Community	Sediment type	Site notes
1	5	362.99	SM13a	Silt-clay	Sea couch stands at creek edge, many Spartina stands (avoided in plots). Marsh is grazed. Long sward.
2	5	385.19	SM13a	Silt-clay	
3	5	402.03	SM13a	Silt-clay	

Image 16: Aerial photo of the western side of Bulldog Sand marsh with SET locations indicated by pins and 4x4 access along sea wall indicated in red and access across the marsh outlined in green.



2.5.2 Bulldog Sand East

Bulldog Sand marsh is owned by a farmer. A series of wildfowlers huts are located west side of the sea wall as the extensive marsh is an important site for breeding and overwintering birds.

Three locations were selected approximately 200m apart using a LiDAR map to inform or areas approximately the same elevation. Plant communities selected were long sward *Puccinellia maritima* and *Festuca rubra* dominated, with some patches of and *Atriplex prostrata, Atriplex portulacoides* and *Spartina*.

Table 12: Summary of baseline data for three SETs at Bulldog sand (east). Baseline elevation is 0, but an average for each SET base is included from 72 measurements. National Vegetative Community (NVC) has been characterised from observation.

SET	Depth (m)	Average elevation (mm)	NVC Community	Sediment type	Site notes
1	7	373.39	SM13a	Silt-clay	Dry surface of soil. Scrapes are dry at this time of the year.
2	6	392.13	SM13a	Silt-clay	
3	6	386.65	SM13a	Silt-clay	

Image 17: Aerial photo of the western side of Bulldog Sand marsh with SET locations indicated by pins and 4x4 access along sea wall indicated in red and access across the marsh outlined in green.

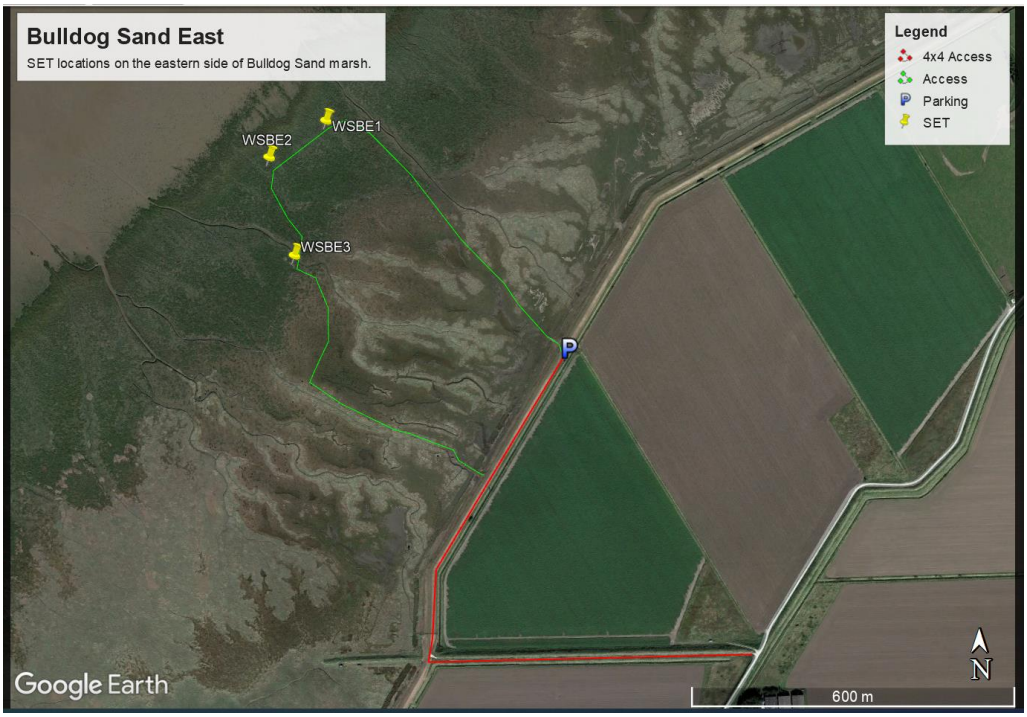


Image 18: Photo of example plot on Bulldog sand marsh (Eastern side). Measurements are being taken from WSBE3. Fluorescent flags are used to stake out the locations before transporting equipment, but here at the last site of the day, they are used to indicate marker horizon locations.

2.5.3 Wolferton marsh

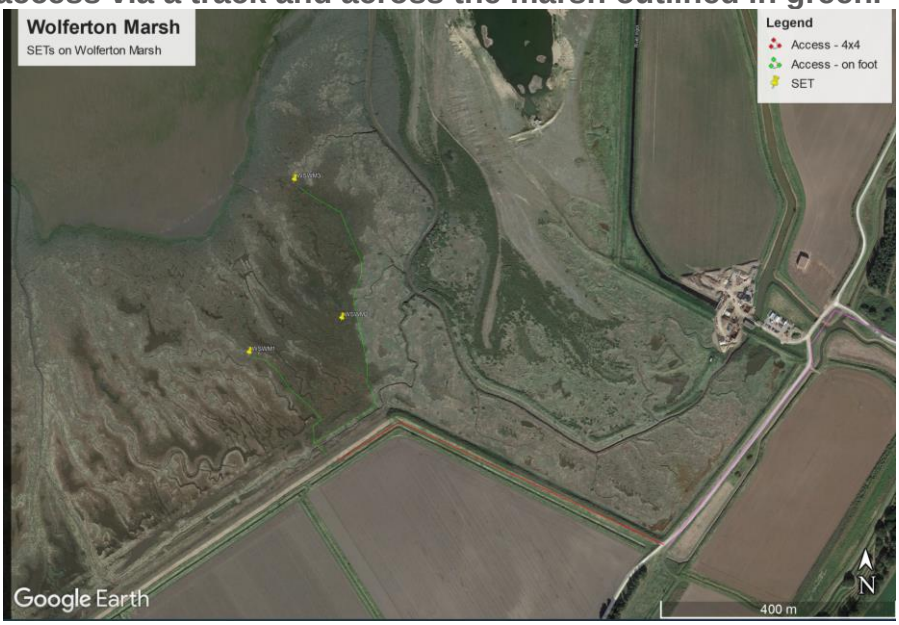
Wolferton marsh is owned by Sandringham Estate and managed by the RSPB. Approximate SET locations have been informed by LiDAR and the EA saltmarsh extent maps.

Three locations were selected approximately 200m apart, though SM13/SM14 communities were targeted, the mid-marsh was characterised by dominant *Festuca rubra*, with *Halimionie portulacoides, Suaeda maritima* and *Aster* growing in abundance. Plots were chosen to avoid dense areas of *Salicornia* and *Spartina*, though *Spartina* was abundant across the marsh.

Table 13: Summary of baseline data for three SETs at Wolferton marsh. Baseline elevation is 0, but an average for each SET base is included from 72 measurements. National Vegetative Community (NVC) has been characterised from observation.

SET	Depth (m)	Average elevation (mm)	NVC Community	Sediment type	Site notes
1	9	348.63	SM13a	Silt-clay	Wet ground, many large full pools, evidence of light cattle grazing
2	9	361.04	SM13a	Silt-clay	Very wet soil. A lot of Spartina surrounding, large shallow pools. Maybe elevation is a bit too low
3	9	354.79	SM16a/SM14c	Silt-clay	Drier than other sites but still wet. Spartina and sea couch stands nearby. Some pools

Image 19: Aerial photo of Wolferton Marsh with SET locations indicated by pins and access via a track and across the marsh outlined in green.



2.6 Chichester Harbour

2.6.1 West Itchenor

West Itchenor marsh is owned by the Chichester Harbour Conservancy. It is an un-grazed marsh with a footpath running alongside it. There is some small vessel traffic along this stretch of the harbour as it is a popular area for mooring yachts. Three locations were selected approximately 50m apart due to the marsh being small. Plant communities selected were *Atriplex portulacoides* dominated, with frequent *Puccinellia,* and occasional patches of *Spartina*.

Table 14: Summary of baseline data for three SETs at West Itchenor. Baseline elevation is 0, but an average for each SET base is included from 72 measurements. National Vegetative Community (NVC) has been characterised from observation.

SET	Depth (m)	Average elevation (mm)	NVC Community	Sediment type	Site notes
1	7.2	301.57	SM14c	Clayey	
2	6.9	333.92	SM14c	Clayey	
3	7.3	343.03	SM14c	Clayey	

Image 20: Aerial photo of West Itchenor marsh with SET locations indicated by pins and access across the marsh outlined in green.

2.6.2 Pilsey

Pilsey marsh is owned by the Ministry of Defence and managed by the RSPB. Three locations were selected approximately 150m apart using a LiDAR map to inform or areas approximately the same elevation. Plant communities selected were dominated by *Atriplex portulacoides* and *Puccinellia maritima* with some patches of and *Limonium vulgare*, *Sarcocornia perennis* and *Spartina*.

Table 15: Summary of baseline data for three SETs at Pilsey. Baseline elevation is 0, but an average for each SET base is included from 72 measurements. National Vegetative Community (NVC) has been characterised from observation.

SET	Depth (m)	Average elevation (mm)	NVC Community	Sediment type	Site notes
1	7.2	325.85	SM13c	Silt-loam, sand below	
2	6.6	308.94	SM13c	Silt-loam, sand below	
3	5.2	289.24	SM13c	Sandy-loam	

Image 21: Aerial photo of Pilsey marsh on Thorney Island with SET locations indicated by pins and access via a track and across the marsh outlined in green.

Image 22: Measurements on Pilsey saltmarsh SET CHGP2.

2.6.3 Gutner Point

Gutner Point marsh is owned by Hampshire County Council. It is periodically grazed with a few cattle and has very little footfall due to the lack of nearby footpaths and extensive private properties. The marsh has a classic transition of oak woodland to marsh with signs of erosion at the edge, and deposition onto an extensive intertidal mudflat. The mudflat is populated with *Spartina*. An unusual inhabitant of the higher marsh were saltmarsh ants.

Three locations were selected approximately 130m apart using a LiDAR map, the EA map of saltmarsh extent and discussion with the site warden. Plant communities selected were short sward *Puccinellia maritima* dominated, with abundant *Atriplex portulacoides* and *Limonium vulgare*.

Table 16: Summary of baseline data for three SETs at Gutner Point. Baseline elevation is 0, but an average for each SET base is included from 72 measurements. National Vegetative Community (NVC) has been characterised from observation.

SET	Depth (m)	Average elevation (mm)	NVC Community	Sediment type	Site notes
1	2.4	376.06	SM13c	Silt-loam 30cm, gravel below	A few standing pools nearby
2	3	375.35	SM13c	Silt-loam 30cm, gravel below	
3	4	361.92	SM13c	Silt-loam 30cm, gravel below	

Image 23: Aerial photo of Gutner Point Marsh with SET locations indicated by pins, permitted 4x4 access across a field indicated in red, and access across the marsh outlined in green.

Image 24: Example plot CHGP1 on Gutner Point marsh. Marker horizons are just visible.

3. The Process of Installation

3.1 SET design and construction

SET bases are installed using the standard procedure as set out by Lynch et al. (2015). All SET parts were designed and built by Lincoln Jigs, as recommended by Dr. Mark Schuerch from the University of Lincoln who recently carried out similar work using their design. The original design was adjusted with drawings made and procured by the project, after use in the field, further adjustments to improve accuracy have been made to the measuring devices by UKCEH workshop.

3.2 SET installation

SET bases were installed using the standard procedure as set out by Lynch et al. (2015).

- After identifying a suitable location, a 15cm diameter x 30cm deep hole was dug into which a 15cm x 50cm soil pipe was inserted.
- A modular 14mm stainless steel mounting post was driven into the sediment using a post-driver, threading in 1m lengths one at a time until bedrock was hit or the substrate was extremely difficult to get through.
- Any protruding length of post was cut off to ground level using an angle grinder. The receiver post was then attached to the post below ground level, with approximately 10cm protruding. The post was then set in place using postcrete.
- Location, post depth and plant community were recorded.

Soil pipe inserted into the ground at Marshside from a scaffolding plank to reduce damage to plants from footfall (Top Left). Two people operating the post-driver to insert mounting posts on Marshside marsh (Top Right). Setting up to angle-grinding the protruding post (Bottom Left). Receiver post fastened in place (Bottom Right)

Setting the SET in with postcrete (Left). Installed SET base (Right).

3.3 Marker horizon set up

Marker horizons were installed using the standard procedure as set out Lynch et al. (2015).

- Four positions were identified 1.5m N, E, S and W of the SET. These marked the middle of the external edge of a 50 x 50 cm quadrat.
- Potassium feldspar clay was added to each quadrat and carefully massaged through the vegetation to ensure a consistent layer on the sediment beneath. This was watered down using a pressurised spray bottle to remove clay from the vegetation and to partially set it to prevent it blowing away.

3.4 Baseline measurement

Measurements were taken and data organised as set out by Lynch et al. (2015), with a few important **adjustments**.

- Measurements were taken at 8 orientations **instead of 4** to inform on the error of measurements and provide a suitable baseline. This will aid a more accurate measurement of elevation prior to adjustments being made to the instrument.
- Elevation was measured on 9 pins slotted into the device arm, which was levelled using a digital level. The arm was then lifted and rotated to the next position, levelled and pins measured.

Taking measurements on the Crook of Baldoon marsh. Feldspar clay patches are visible in the foreground.

4. Monitoring and reporting

4.1 Sediment Elevation measurement

Initial measurements will be taken during autumn/winter 2023 coinciding with a handover for monitoring with partner organisations. Sites will be visited once every 6 months, with coordinated measurements taken in Spring and Autumn 2024. The monitoring will include:

- **dGPS survey of each SET-MH plot**
  This will be carried out using a roving dGPS to record precise elevation and location prior to unified April measurements.
- **Sediment elevation measurements**
  These will be taken at 8 orientations for the first 3 measurements (T0 Summer 2023, Autumn/winter 2023, Spring 2024). Following measurements may only include 4 orientations.
- **Marker horizon depth**
  This will be assessed by taking small cut plugs from each MH plot annually in Spring.
- **Plant community assessment**
  This will be recorded to capture any community changes over the duration of the monitoring period, (for example, sediment accumulation may lead to higher elevation and a shift towards mid-high marsh communities).
- **Bulk density**
  This will be calculated from 2 sediment cores from each SET-MH plot, taken in Spring 2024 only.
- **Total Suspended Matter**
  Data from GlobColour http://hermes.acri.fr/) will aid data analysis.

4.2 Reporting and outputs

UKCEH commits to producing the following outputs from this project:

- **Data** will be collated by UKCEH and published via Environmental Information Data Centre (EIDC), a data repository which is part of the Natural Environment Research Council's (NERC) Environmental Data Service and managed by UKCEH.
- **A final report** for funders will be completed following Autumn measurements in 2024.
- **A newsletter** of findings and thanks will be produced for each of the landowners who participated in this project.

5. References and Appendices

5.1 References:

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5.2 Appendices

5.2.1 Appendix 1: NVC Saltmarsh community floristic tables included in the study

Full floristic tables and a handbook of further information can be found at NVC Users' Handbook | JNCC Resource Hub

Table 17: NVC plant communities included in this study

Code	Community name	Community or sub-community name
SM13a	Puccinellia maritima saltmarsh community	Puccinellia maritima sub-community
SM13c	Puccinellia maritima saltmarsh community	Limonium vulgare-Armeria maritima sub-community
SM13d	Puccinellia maritima saltmarsh community	Plantago maritima-Armeria maritima sub-community
SM14a	Atriplex portulacoides salt-marsh community	Atriplex portulacoides sub-community
SM14c	Atriplex portulacoides salt-marsh community	Puccinellia maritima sub-community
SM16a	Festuca rubra salt-marsh community	Puccinellia maritima sub-community

5.2.2 Appendix 2: Locations of all SET bases

Table 18: Location of all SET bases installed in this study

Code	Estuary	Marsh	Lat	Long
RBMS1	Ribble	Marsh Side	53.67658	-2.99331
RBMS2	Ribble	Marsh Side	53.67854	-2.99116
RBMS3	Ribble	Marsh Side	53.67867	-2.9868
RBBS1	Ribble	Bank Side	53.71576	-2.89871
RBBS2	Ribble	Bank Side	53.71317	-2.90564
RBBS3	Ribble	Bank Side	53.71013	-2.90543
RBWM1	Ribble	Warton Marsh	53.73502	-2.91238
RBWM2	Ribble	Warton Marsh	53.73573	-2.91073
RBWM3	Ribble	Warton Marsh	53.73444	-2.91043

SWCF1	Solway	Campfield Marsh	54.9412	-3.26068
SWCF2	Solway	Campfield Marsh	54.94306	-3.2562
SWCF3	Solway	Campfield Marsh	54.94372	-3.25135
SWCB1	Solway	Crook of Baldoon	54.86381	-4.42259
SWCB2	Solway	Crook of Baldoon	54.8594	-4.42166
SWCB3	Solway	Crook of Baldoon	54.83309	-4.41441
SWCV1	Solway	Caerlaverock	54.96766	-3.4733
SWCV2	Solway	Caerlaverock	54.96827	-3.46904
SWCV3	Solway	Caerlaverock	54.96885	-3.46674
DFDP1	Dornoch Firth	Dornoch Point	57.86037	-4.01992
DFDP2	Dornoch Firth	Dornoch Point	57.86175	-4.01975
DFDP3	Dornoch Firth	Dornoch Point	57.86349	-4.0205
WSBW1	Wash	Bulldog Sand West	52.80519	0.370768
WSBW2	Wash	Bulldog Sand West	52.80646	0.370986
WSBW3	Wash	Bulldog Sand West	52.80794	0.368633
WSBE1	Wash	Bulldog Sand East	52.8252	0.386598
WSBE2	Wash	Bulldog Sand East	52.82459	0.385036
WSBE3	Wash	Bulldog Sand East	52.82296	0.385733
WSWM1	Wash	Wolferton	52.84386	0.440694
WSWM2	Wash	Wolferton	52.84438	0.443025
WSWM3	Wash	Wolferton	52.84649	0.441831
NNSK1	North Norfolk	Stiffkey	52.95759	0.922725
NNSK2	North Norfolk	Stiffkey	52.95853	0.920405
NNSK3	North Norfolk	Stiffkey	52.9598	0.922487
NNBB1	North Norfolk	Brancaster Beach	52.97165	0.639058
NNBB2	North Norfolk	Brancaster Beach	52.97291	0.638681
NNBB3	North Norfolk	Brancaster Beach	52.97265	0.642208

NNBN1	North Norfolk	Blakeney	52.95899	1.017174
NNBN2	North Norfolk	Blakeney	52.96068	1.017074
NNBN3	North Norfolk	Blakeney	52.96271	1.016982
CHGP1	Chichester Harbour	Gutner Point	50.8083	-0.95742
CHGP2	Chichester Harbour	Gutner Point	50.80928	-0.957
CHGP3	Chichester Harbour	Gutner Point	50.81037	-0.95603
CHWI1	Chichester Harbour	West Itchenor	50.80788	-0.87105
CHWI2	Chichester Harbour	West Itchenor	50.80804	-0.87053
CHWI3	Chichester Harbour	West Itchenor	50.80801	-0.86993
CHPS1	Chichester Harbour	Pilsey	50.80418	-0.9098
CHPS2	Chichester Harbour	Pilsey	50.80303	-0.91031
CHPS3	Chichester Harbour	Pilsey	50.80177	-0.91026

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