Mersea Harbour Protection Trust

Mersea Harbour and Tollesbury Wick climate change adaptation recharge project

Year 1 (2022/23) monitoring report to the Marine Management Organisation

Licence no:L/2018/00131/1 **February 2023**

Front cover: View west across the Mersea Harbour completed recharge sites: Cobmarsh Island in the foreground, Packing Marsh Island immediately north-west, and Old Hall and Tollesbury Wick in the background.to the south-west (Jim Pullen).

THE MERSEA HARBOUR PROTECTION TRUST

Charitable Incorporated Organisation Reg Number 1159088

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The Mersea Harbour Protection Trust would like to extend our thanks to our partners in this project for their generous funding and support**:** Harwich Haven Authority, the Environment Agency and the RSPB.

Mersea Recharge Project

This is a partnership between the Mersea Harbour Protection Trust, Harwich Haven Authority, the Environment Agency and the Royal Society for the Protection of Birds. The Mersea Harbour Protection Trust is supported by Essex County Council Community Initiatives Fund, Essex Community Foundation and other national and local bodies including: West Mersea Town Council, Maldon Council, Tollesbury Parish Council, Royal Yachting Association, and contributions from local people.

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In memory of Allan Bird who instigated the construction of the new protecting beaches. Without his knowledge, enthusiasm and dedication this project would never have happened and Mersea Harbour would not have been saved for future generations.

Contents

1. Introduction

Sand and gravel dredgings obtained from the Harwich Approaches were delivered to the licensed sites in the Mersea Quarters between 5 November 2021 and 15 January 2022. The first loads were placed to Packing Marsh Island, with subsequent deliveries to Tollesbury Wick and Cobmarsh Island, completing at Old Hall. The volumes deposited at each site are shown in Table 1, below, and the locations of the receptor sites are shown in Figure 1.

Table 1. Volumes of sands and gravels placed to each site (based on hopper cubic metres).

Deposit site	Hopper m^3	Material density	Wet tonnes
Packing Marsh Island	5,659	1.6 (T/m3)	9,054
Cobmarsh Island	47,716	1.6 (T/m3)	76,346
Tollesbury Wick	5,555	1.6 (T/m3)	8,888
Old Hall	40,014	1.6 (T/m3)	64,022
Total	**98,944 m^3**	-	**158,310 T**

Information supplied by Harwich Haven Authority from vessel log.

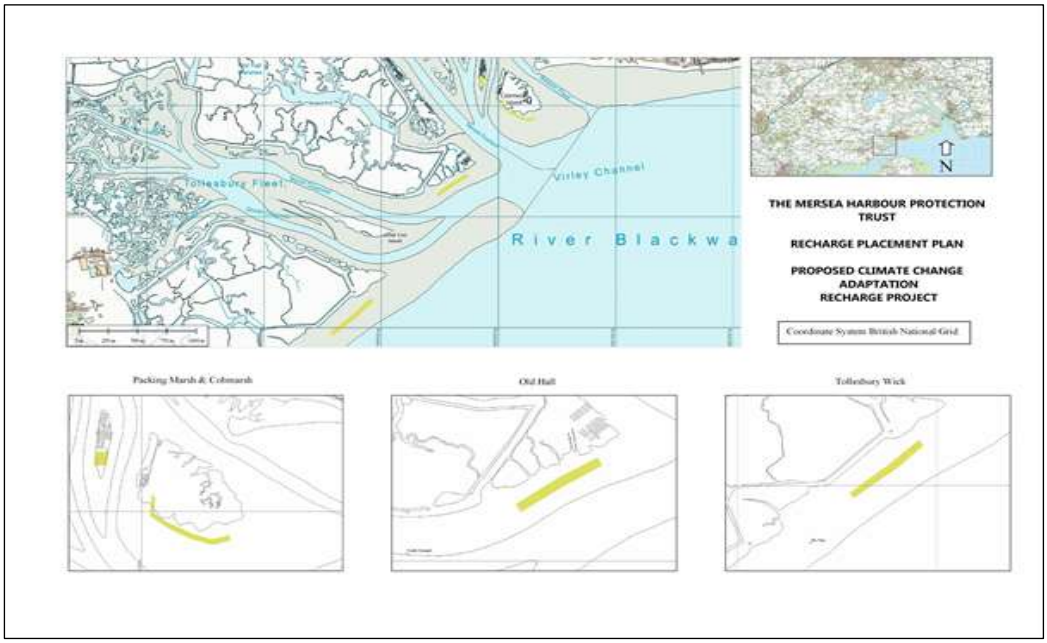

Figure 1. Proposed recharge placement locations [Jim Pullen, 2014. (c) Crown Copyright OS open data 50k vector mapping 2015 - OS 50k Great Britain 2013].

The monitoring requirements of the licence are to undertake the following:

- Turbidity: to monitor silts in suspension in the water column during discharge of dredgings to address the potential to smother oyster beds – to address concerns raised by the local oyster fishery.
- Surface elevation: to monitor changes in surface elevation above Ordnance Datum Newlyn (ODN), and spatial redistribution of the recharge.
- Fixed-point photography: to monitor changes at ground level.
- Bathymetry survey: to monitor any variations in sea bed levels with reference to spatial redistribution of material.
- Siltation: measuring silt build-up leeward of the recharge at Cobmarsh Island, Old Hall and Tollesbury Wick.
- Retaining fences: to monitor the effectiveness of the fencing in constraining recharge.
- Bird surveys pre and post placement: nesting and roosting survey on original and current recharge; bird feeding survey on foreshore at Cobmarsh Island and Old Hall.

2. Turbidity monitoring during discharge of dredgings

Monitoring	Purpose	Location	Pre-placement survey	Post-placement monitoring
Turbidity as a surrogate for considering potential for sedimentation on oyster beds.	To assess any increase in turbidity, from an established baseline and the potential for silts to settle on private oyster beds and the free grounds during discharge of early loads.	Private oyster beds in the harbour creeks and the grounds south of West Mersea.	Water sampling will be undertaken at fixed locations within 2 hours of the start of the ebb tide to obtain a baseline.	Sampling during the early discharge of material to compare with baseline, along with monitoring, by oyster fishery representatives of oyster beds for silt settlement. Any significant increase above baseline levels may require a change to the discharge regime. Recording of discussions with oyster fishery representatives and any mitigation.

2.1 Method

A Secchi disc was used to measure water clarity as a surrogate to assess the potential for sediments, arising from the recharge placement, to smother the oyster beds in the adjacent creeks and on the free ground: an increase in silt settlement could negatively impact filter-feeding and respiration of oysters. In order to minimise the risk of sediments in suspension settling on the oyster beds, the MHPT, in consultation with the oyster fishing community, had requested that the dredging company did not begin discharging cargoes until the start of the ebb tide.

Sampling was carried out at four sites: Tollesbury North Channel, off Old Hall Point; Salcott Channel; Thorn Fleet/Little Ditch; and the Besom fleet, off Kings Hard (refer to chart, Figure 2). Readings were taken during recharge deposition of the early loads to Packing Marsh Island, Cobmarsh Island and Old Hall, and compared with three baseline readings collected monthly between May and July 2021.

The Secchi disc, attached to a line with measured intervals, was lowered into the water column from a boat. At the point at which it disappeared from sight, the depth was recorded. It was then slowly lifted until it came into view and a second depth reading was taken. The two depth measurements were averaged to obtain a final reading. At each sampling location the following were also recorded: date, time, tide heights, wind strength and direction, air pressure at mean sea level, weather and sea conditions. The results were compared with the baseline data to consider whether sediment concentrations were within acceptable limits to avoid a detrimental impact on the oyster beds.

After each sampling exercise, the results were processed within 24 hours and distributed to the oyster industry representatives.

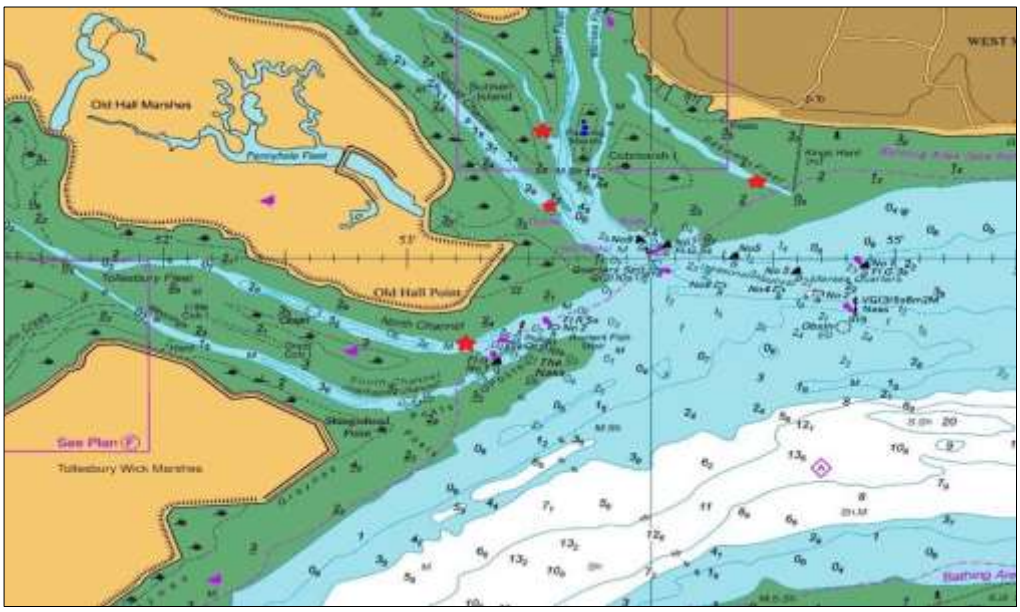

Figure 2. Location of turbidity sampling sites. (© Crown copyright 2022 UK Hydrographic Office.)

2.2 Results

Table 2, below, shows the comparison between readings taken earlier in the year and those taken during the placement of dredgings. For full results for each site refer to the tables in the individual site sections below.

Table 2. Water clarity results comparing depth readings (m) taken during discharges to Packing Marsh Island, Cobmarsh Island and Old Hall, with baseline readings (May to July 2021). (Sampling technique uses a Secchi disk: the greater the depth, the clearer the water**.)**

Site	May 21 (SE)	June 21 (SW)	July 21 (NE)	5 Nov 21 (SW) Packing Marsh	17 Nov 21 (W) Cobmarsh	4 Jan 22 (NNE) Old Hall
Tollesbury North, off Old Hall Point	0.735	2.075	1.315	0.835	1.075	0.595
Salcott Channel	0.69	2.07	0.995	0.79	1.06	0.67
Thorn Fleet/Little Ditch	0.805	1.725	1.015	0.74 (0.40 – Thorn Fleet; 0.74 Little Ditch 0.05 - directly in plume)	0.69*	0.69
Besom, off King's Hard	0.91	1.765	1.215	0.79 (0.45 - Mersea Fleet)	1.075	0.67

Note: the readings highlighted in red were additional readings taken because the dredger had begun discharging to Packing Marsh Island at 11.20am, 47 minutes before high tide @ 12.07pm**.**
***oyster dredging was taking place upstream of the recording location.

2.2.1 Packing Marsh Island

Turbidity testing was carried out at the locations indicated above (Figure 2) as the first load was discharged on 5 November 2021. The wind was from a south-westerly direction, force 1 to 2 (5 to 9 mph) and the sea state was '1' (ie wave height 0 to 0.1 m). High tide at West Mersea was at 12:07pm at a height of 5.61m above Chart Datum (CD).

Due to concerns that the dredger might be in danger of grounding at this location, the ship's master made the decision to begin discharging before high tide. Both the MHPT and the oyster fishery representatives were advised of this beforehand. This prompted additional water clarity readings to be taken at four sites – Thorn Fleet, Little Ditch, Mersea Fleet, and

directly in the discharge plume, as indicated in Table 3 and the location chart below (Figure 3). With sediment moving north-westward (Figure 4) it is not surprising that the 'sediment in suspension' readings were quite high in Thorn Fleet/Little Ditch and the Mersea Fleet, compared with the baseline readings. A reading of 0.05m was obtained directly in the sediment plume (Table 3; also refer to Table 2).

Table 3. Packing Marsh Island: water clarity readings collected at sites in the Mersea Quarters during discharging of 1st load on 5 November 2021. (Sampling technique uses a Secchi disk: the greater the depth, the clearer the water.)

Location	Conditions		Reading 1 (m)	Reading 2 (m)	Average (m)
Tollesbury North off Old Hall Point **51° 45.786'N** **0° 53.431'E**	Date and time: 05-11-2021 12:27pm	High tide height: 5.61 above chart datur	0.85	0.82	0.835
	Wind strength & direction: Force 1-2 South West	Air pressure msl: 1020.7			
	Weather and sea conditions: sunny, 11°C; wave height: 0.25m				
Salcott Channel **51° 46.038'N** **0°.53.722'E**	Date and time: 05-11-2021 12:37pm	High tide height: 5.61 above chart datum	0.80	0.78	0.79
	Wind strength & direction: Force 1-2 South West	Air pressure msl: 1020.7			
	Weather and sea conditions: sunny, 11°C; wave height: 0.20m				
ThornFleet/Little Ditch **51° 46.369'N** **0° 53.587'E**	Date and time: 05-11-2021 12:41pm	High tide height: 5.61 above chart datur	0.75	0.73	0.74 (0.40, Thorn Fleet; 0.74 Little Ditch; 0.05, directly in plume)
	Wind strength & direction: Force 1-2 South West	Air pressure msl: 1020.7			
	Weather and sea conditions: sunny, 11°C; wave height: 0.20m				
Besom, off Kings Hard **51°.46.215'N** **0°.54.530'E**	Date and time: 05-11-2021 12:50pm	High tide height: 5.61 above chart datum	0.80	0.78	0.79 (0.45 – Mersea Fleet)
	Wind strength & direction: Force 1-2 South West	Air pressure msl: 1020.7			
	Weather and sea conditions: sunny, 11°C wave height: 0.1m				

Note: The extra readings, highlighted in red, were taken because the dredger had begun discharging at 11.20am, 47 minutes before high tide @ 12.07pm, for reasons of maritime safety.

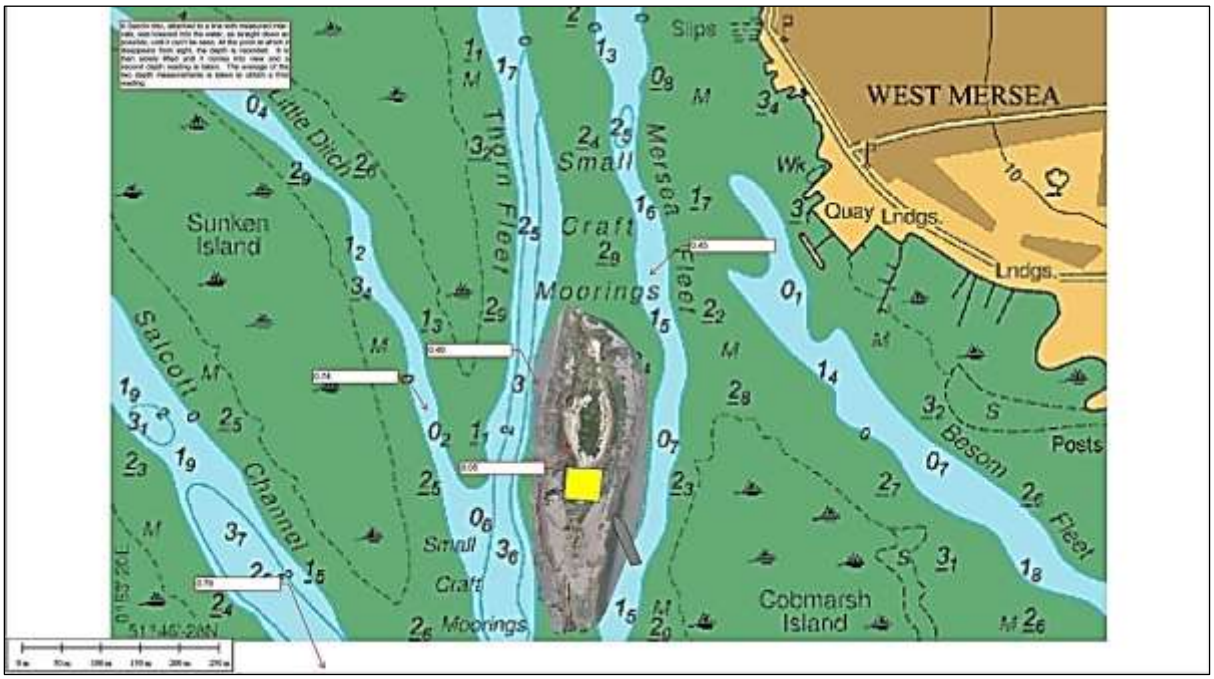

Figure 3. Location of additional turbidity readings taken during the first placement to Packing Marsh Island on 5 November 2021. (© Crown copyright 2022 UK Hydrographic Office.)

Figure 4. Sediment plume in Thorn Fleet drifting north-westward during rainbow delivery as dredger discharges 47 minutes before the ebb.

2.2.2 Cobmarsh Island

The second cycle of turbidity testing was carried out on 17 November 2021 at the locations indicated above (Figure 2). Figure 5 shows the sediment plume being carried east on the ebb toward the estuary mouth, on day seven of the delivery schedule to Cobmarsh Island. A westerly wind of force 1 to 3 prevailed. The water turbidity reading was the highest in Thorn Fleet/Little Ditch and was obtained while oyster dredging was taking place upriver of this location; this is likely to have influenced the result. Readings at the other three locations were not significantly different from those obtained earlier in the year (see Table 4, below, and refer to Table 2, above).

Figure 5. Cobmarsh Island: sediment plume deriving from pipeline delivery[1] from the trailing suction hopper dredger, Sospan Dau.

[1] For operational reasons, Harwich Haven Authority undertook floating pipeline delivery of dredgings at Cobmarsh Island and Old Hall. This allows material to be placed with greater precision and enables the dredger to stand off in deeper water reducing the risk of running aground while discharging on a falling tide. This was a departure from the delivery method stated in MHPT's marine licence. This issue was raised by the MHPT and Harwich Haven Authority at the licence inspection meeting with the MMO on 16 December 2021. The MMO inspector confirmed that the licence report would state that the placement method was not fully compliant with the MHPT's licence, but that no further action would be taken, or required.

Table 4. Cobmarsh Island: water clarity readings obtained from sites in the Mersea Quarters on 17 November 2021, during delivery of 11th load @ day 7, by floating pipeline. (Sampling technique uses a Secchi disk: the greater the depth, the clearer the water.)

Location	Conditions		Reading 1 (m)	Reading 2 (m)	Average (m)
Tollesbury North off Old Hall Point **51° 45.786'N** **0° 53.431'E**	Date and time: 17-11-2021 11:05 am	High tide height: 4.81 above chart datum	1.10	1.05	1.075
	Wind strength & direction: Force 1-3 West	Air pressure msl: 1015.7			
	Weather and sea conditions: sunny, 11°C; wave height: 0.30m				
Salcott Channel **51° 46.038'N** **0°.53.722'E**	Date and time: 17-11-2021 11:21 am	High tide height: 4.81 above chart datum	1.10	1.02	1.06
	Wind strength & direction: Force 1-3 West	Air pressure msl: 1015.7			
	Weather and sea conditions: sunny, 11°C wave height: 0.15m				
ThornFleet/Little Ditch **51° 46.369'N** **0° 53.587'E**	Date and time: 17-11-2021 11:34am	High tide height: 4.81 above chart datum	0.70	0.68	0.69
	Wind strength & direction: Force 1-3 West	Air pressure msl: 1015.7			
	Weather and sea conditions: sunny, 11°C wave height: 0.15m				
	Note: Oyster dredging operations taking place upstream of collection location.				
Besom, off Kings Hard **51°.46.215'N** **0°.54.530'E**	Date and time: 17-11-2021 11:56 am	High tide height: 4.81 above chart datum	1.10	1.05	1.075
	Wind strength & direction: Force 1-2 West	Air pressure msl: 1015.7			
	Weather and sea conditions: sunny, 11°C wave height: 0.13m				

2.2.3 Old Hall

The third cycle of turbidity testing during placement was carried out on 4 January 2022 (refer to Figure 2 for locations). The recordings were taken on day nine of the Old Hall delivery schedule with the dredger positioned 100m to the south, placing material via pipeline. The wind was NNE, coming off the land, reaching speeds of up to 20mph. Turbidity was found to be quite high at all locations, compared to the baseline readings (refer to Table 5, below, and Table 2, above). The results were considered to have been influenced by the very high tides and prolonged easterlies leading up to the survey date. Nevertheless, it was evident that sediment was being carried on the ebb, away from the oyster layings. This is demonstrated in Figure 6, which, although obtained the day before the sampling was undertaken, the same conditions prevailed.

Figure 6. Discharging by pipeline at the start of the ebb at Old Hall on 3 January 2022 @ 12:54 pm (the day before readings were collected).

Table 5. Old Hall: water clarity readings obtained from sites in the Mersea Quarters on 4 January 2022 during delivery of 16th load @ day 9. (Sampling technique uses a Secchi disk: the greater the depth the clearer the water.)					
Location	**Conditions**		**Reading 1 (m)**	**Reading 2 (m)**	**Average (m)**
Tollesbury North off Old Hall Point **51° 45.786'N** **0° 53.431'E**	Date and time: 04-01-2022 13:14	High tide height: 5.56 above chart datum	0.60	0.59	0.595
	Wind strength & direction: Force 3-5 NNE	Air pressure msl: 994.6			
	Weather and sea conditions: overcast/rain, 3°C; wave height: 0.25m				
Salcott Channel **51° 46.038'N** **0°.53.722'E**	Date and time: 04-01-2022 13:24	High tide height: 5.56 above chart datum	0.68	0.66	0.67
	Wind strength & direction: Force 3-5 NNE	Air pressure msl: 994.6			
	Weather and sea conditions: overcast/rain, 3°C; wave height: 0.15m				
ThornFleet/Little Ditch **51° 46.369'N** **0° 53.587'E**	Date and time: 04-01-2022 13:35	High tide height: 5.56 above chart datum	0.70	0.68	0.69
	Wind strength & direction: Force 3-5 NNE	Air pressure msl: 994.6			
	Weather and sea conditions: overcast/rain, 3°C; wave height: 0.15m				
Besom, off Kings Hard **51°.46.215'N** **0°.54.530'E**	Date and time: 04-01-2022 13:47	High tide height: 5.56 above chart datum	0.68	0.66	0.67
	Wind strength & direction: Force 3-5 NNE	Air pressure msl: 994.6			
	Weather and sea conditions: overcast/rain, 3°C; wave height: 0.20m				

2.3 Discussion

The amount of suspended sediment in the water column depends on wind strength/direction and duration, time of year, and size of tides. Discharging material on the ebb allowed any fine sediments disturbed by the recharge operation to be carried away by the falling tide towards the main channel of the Blackwater estuary and not into the creeks. Though some concern was expressed by the oyster fishery representatives during the discharge of the early loads to Packing Marsh - ahead of the start of the ebb - with only six loads being deposited here, the settlement of suspended sediment was not found to present a risk to the oyster beds. Prevailing winds and exceptionally high tides leading up to the sampling date at Old Hall are likely to have accounted for turbidity readings higher than the baseline figures. This did not present an increased risk of smothering the oyster layings during delivery as the ebb tide carried the sediments away from the creeks.

Harwich Haven reported that the loads contained a very limited amount of fine material: the sediment profile of the first load was described as a clean, gravel and sand mix, with very little silt or mud present. Later loads become sandier but continued to be suitable for recharge.

3. Surface elevation

Monitoring	Purpose	Location	Pre-placement survey	Post-placement monitoring
Surface elevation	Digital surface modelling to monitor any changes in surface elevation above ODN level and any spatial redistribution of material. To be accompanied by fixed-point photography to monitor changes at ground level.	All recharge sites	Pre commencement	Immediately post placement then at annual intervals for 5 years.

3.1 Method

High accuracy photogrammetry UA (unmanned aircraft) survey was used to collect data to show the distribution and height above Ordnance Datum Newlyn (AODN) of material placed.

A Trimble explorer high accuracy (Centimetre Edition) GPS (global positioning system) was deployed to collect and mark ground control points (GCP). Each GCP was marked with a bold marker which can be easily identified from a UA camera operating at a height of 75m above ground level (AGL). The aim is to collect points to an accuracy of 10mm horizontally and 10mm vertically by post-processing collected GPS data.

Prior to the site visit, a pre-programmed flight path was prepared to calculate the number of photographs which would be required to cover the whole site, with the necessary overlap of photos to achieve the desired accuracy. The survey grid was flown and photos collected on board the UA. A quality check was carried out to ensure the mission had been successful in the field. All the necessary permissions to fly in the desired area are obtained and checked with the Civil Aviation Authority (CAA).

The photos were subsequently loaded into the photogrammetry software and the GCPs were loaded and matched. A GeoTiff image to a resolution of 2cm to 3cm per pixel was produced by the software along with a very high resolution 3D point cloud model similar to LiDAR data.

3.2 Results

The output from the photogrammetry survey is included in the individual site sections below. It shows how the sand and gravel recharge has responded since deposition. Table 6 records the time period between recharge delivery and the dates the data was collected. Each site section also contains a link to time-lapse footage showing the movement of material since placement.

The images demonstrate that there has been some landward migration of material and also some lateral movement. Storm driven transport of sands and gravels, eastward, has resulted in the formation of a lagoon (0.2ha x 0.25m deep) between the recharge and the saltmarsh edge at the eastern end of Cobmarsh Island.

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Table 6. Time intervals between delivery completion and dates images obtained.						
Site	**Pre recharge date image obtained**	**Date recharge delivery completed**	**Date 1st image obtained post-delivery (Post 1)**	**Time period between 1st image and delivery completion**	**Date 2nd image obtained post-delivery (Post 2)**	**Time period between 2nd image and delivery completion**
Packing Marsh Island	10 Sept 2021	8 Nov 2021	9 Nov 2021	1 day	13 Sept 2022	52 weeks, 2 days
Cobmarsh Island	13 Sept 2021	27 Dec 2021	10 Jan 2022	2 weeks	15 Sept 2022	37 weeks, 3 days
Old Hall	9 Sept 2021	15 Jan 2022	21 Jan 22	6 days	28 Sept 2022	36 weeks, 4 days
Tollesbury Wick	8 Sept 21	12 Nov 2021	23 Nov 2021	1 week, 4 days	3 Oct 2022	46 weeks, 3 days

The physical dimensions of the material, obtained from the second data collection exercise, are shown in Table 7. A beach slope is developing at all locations in response to wind, wave and tidal action. The steepest slope, of 7.4 degrees (averaging 6.8 degrees), has formed at Packing Marsh Island, and this is the highest site at 3m to 3.5m AOD. Old Hall and Tollesbury Wick have the shallowest gradients (average of 5.2 and 5.68 degrees respectively), with Old Hall recording the lowest elevation with maximum heights of between 1.5m and 2m AOD. Cobmarsh Island and Tollesbury Wick recharge both show a maximum height range of 2m to 2.5m AOD. Based on tide height readings at West Mersea, taken in June and July (during the peak of the bird nesting season), the frequency of high tide coverage was highest at Old Hall (upwards of 60 per cent) while Packing Marsh remaining uncovered during this period. This was reflected in the results obtained from the nesting survey with Packing Marsh Island being the only site to support nesting over the 2022 season (see Section 7). The intertidal area covered by the recharge is 5.6 hectares representing 0.18 per cent of the total intertidal area of the Blackwater estuary.

Table 7. Physical dimensions of recharge based on 2nd data collection results ('Post 2').					
Site	**Max (& average) degree of slope seaward face**	**Intertidal area covered by new recharge (ha)**	**Height range of highest areas of recharge above ODN (m)**	**Height range of highest areas of recharge above CD (m) and approx frequency of tide coverage (%) June – July 2022**	
Packing Marsh Island	7.4 (6.83)	0.4 (deposited onto former recharge and eroded marsh)	3 – 3.5	5.61 - 6.11 (0%)	
Cobmarsh Island	6.75 (5.74)	2.5	2 – 2.5	4.61 (60%) - 5.11 (20%)	
Old Hall	6.1 (5.2)	1.9	1.5 - 2	4.11 (95%) – 4.61 (60%)	
Tollesbury Wick	6.2 (5.68)	0.8	2 – 2.5	4.61 (60%) – 5.11 (20%)	
Total intertidal covered by recharge (ha), and % intertidal of Blackwater estuary (3086 ha)	-	5.6 ha; 0.18 per cent of total Blackwater estuary intertidal	-	-	-

By comparing data collected in 2014 - the research stage of the MHPT project – with the output from the September 2021 pre-recharge survey, it has now been possible to accurately assess saltmarsh edge erosion at Cobmarsh Island and Old Hall over this seven-year period. The saltmarsh edge is delineated along the 2.3m AOD contour. This establishes a baseline for monitoring the effect of the recharge intervention in future. At Cobmarsh Island the maximum edge erosion is 11.3m but generally ranges between 3m to 5m. Using the lower measurements, this gives an annual rate of loss of between 0.43m and 0.71m. At Old Hall the maximum loss is between 8m and 9m, in places, but mostly between 2m to 3m: an annual rate of loss of 0.29m to 0.43m. The change in marsh edge position between 2014 and 2021 is outlined on the images included in the relevant site sections below.

3.2.1 Packing Marsh Island

Packing Marsh Island was the first site to receive material from the Harwich Approaches dredge, commencing on 5 November 2021: six loads of sands and gravels were delivered by rainbow discharge from the dredger, Sospan Dau, to the south of the island. A total volume of 5659m³ was deposited over 6 days completing on 8 November 2021 (Table 8).

Table 8. Packing Marsh Island: deliveries and volumes.

Date delivery commenced	Date delivery completed	Number of loads	Total volume placed (m³)
5 Nov 2021	8 Nov 2021	6 (over 6 days)	5,659

The images presented below (Figures 7i to 7vi) show the realignment of material over the time intervals indicated in Table 9. The link immediately below shows the movement of material between these dates. Just over one year since deposition, the foreshore at Packing Marsh Island is 1m to 1.5m higher than the pre-placement baseline (see Figures 7v & 7vi). The area of foreshore covered by the recharge on 13 September 2022 – when the second post-placement image was obtained – was approximately 0.4ha.

https://youtu.be/mG-jLaVmu28

Table 9. Packing Marsh Island: time intervals between delivery completion and dates images obtained.

Pre recharge date image obtained	Date recharge delivery completed	Date 1st image obtained post-delivery (Post 1)	Time period between 1st image and delivery completion	Date 2nd image obtained post-delivery (Post 2)	Time period between 2nd image and delivery completion
10 Sept 2021	8 Nov 2021	9 Nov 2021	1 day	13 Sept 2022	52 weeks, 2 days

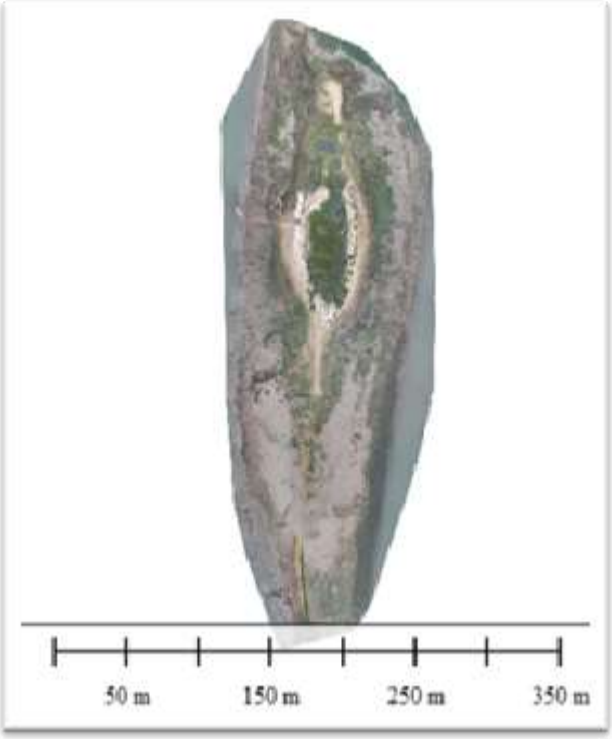


Figure 7i. Packing Marsh Island before placement of recharge (image obtained 10 Sept 2021).

Figure 7ii. Post 1: 1 day after deposition.

Figure 7iii. Post 2: 1 year after deposition.

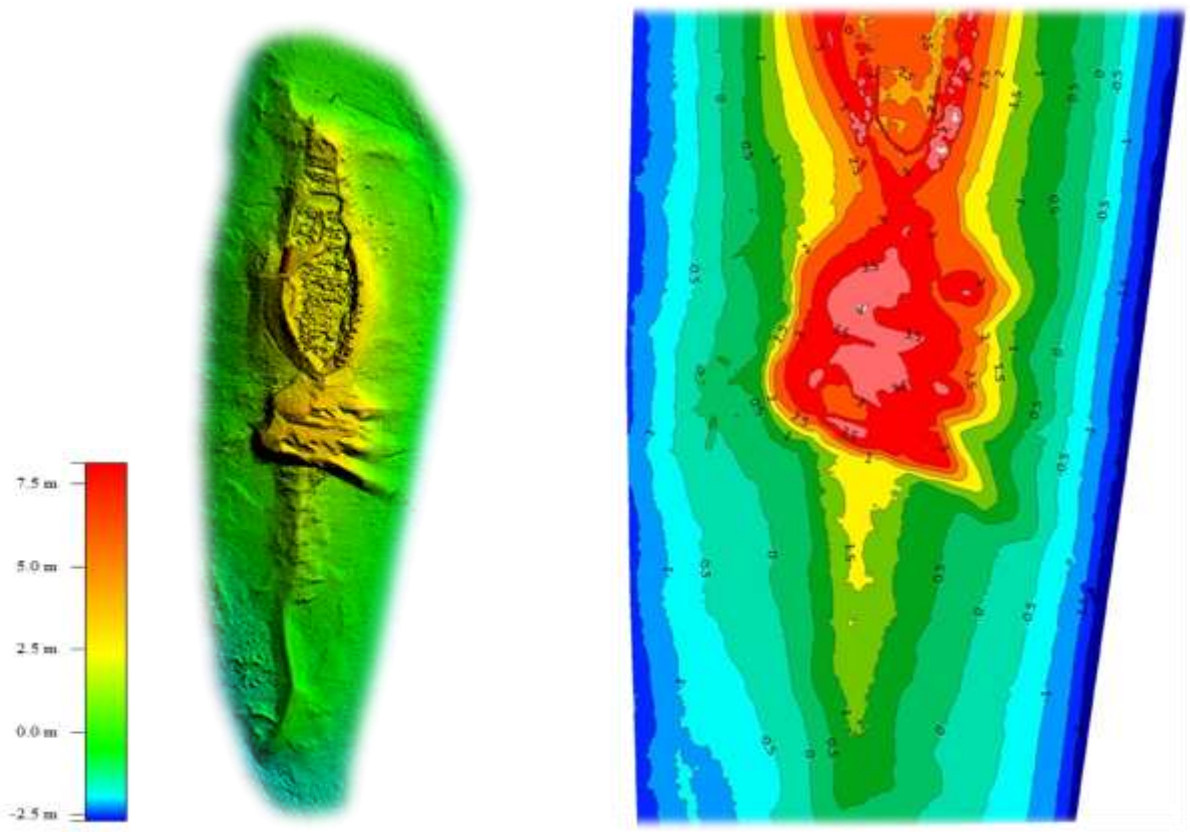


Figure 7iv. Post 1: 1 day after deposition.

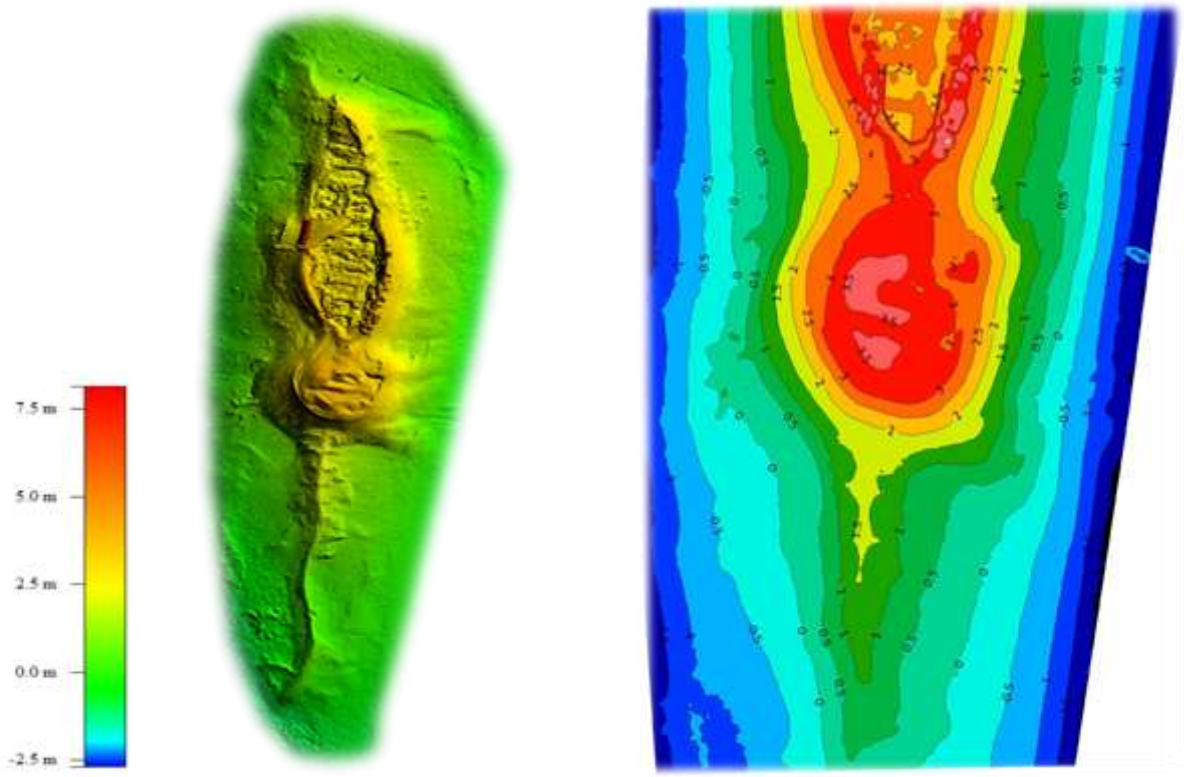


Figure 7v. Post 2: 1 year after deposition.

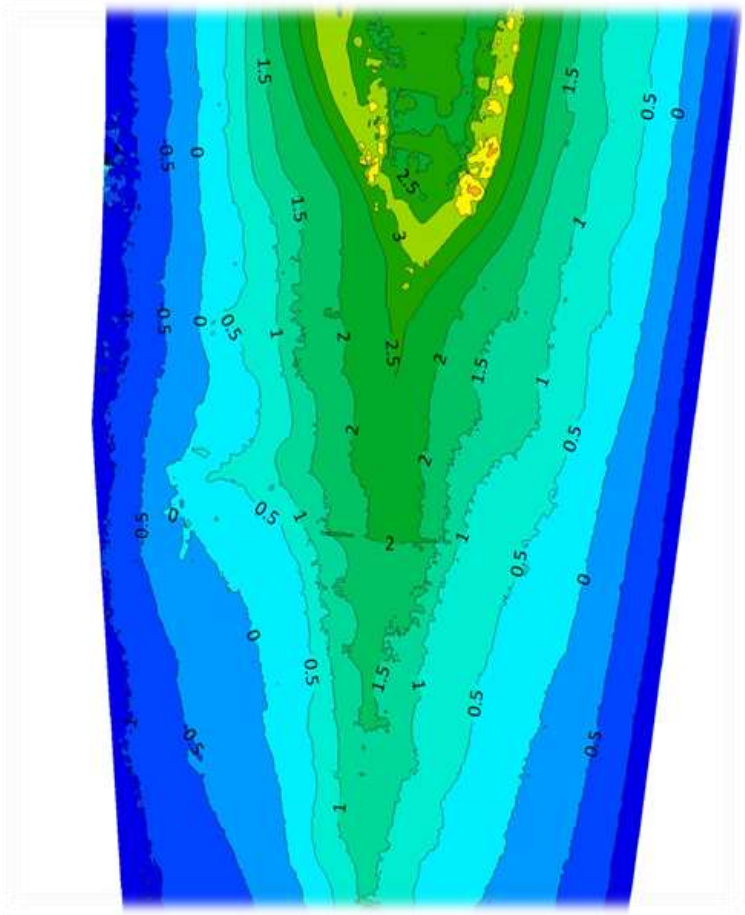


Figure 7vi. Pre recharge (image obtained 10 September 2022).

3.2.2 Cobmarsh Island

In total, 49 loads (47,716m³) were deposited to the south of Cobmarsh Island. All 34 cargoes were pumped ashore from a floating pipeline - the first 12 cargoes were delivered by the dredger, Sospan Dau, over a period of seven days, between 11 and 17 November 2021 (Figure 8.) Subsequently, 22 loads were discharged by the dredger, Scald, between 5 and 27 December 2021 (Table 10).

Table 10. Cobmarsh Island: deliveries and volumes.

Date delivery commenced	Date delivery completed	Number of loads	Total volume placed (m³)
11 Nov 2021	27 Dec 2021	49 (over 29 days)	47,716

Figure 8. Cobmarsh Island after delivery of the 6th hopper load. The pipeline remains in place at low tide to be reconnected to the dredger when it returns on the next tide; a further 31 loads were delivered. Line of retention fencing on the west side of the recharge (see Section 6). View north: Mersea Island in the background and Mersea Fleet to the west.

The images presented below (Figures 9i to 9viii) show the alignment of material over the time intervals specified in Table 11. The link below shows the movement of material between these dates. Nine months since deposition, the recharge has raised the height of the foreshore by up to 2.5m to 3m AOD (see Figures 9vii & 9viii). The area of foreshore covered by the recharge on 15 September 2022 – when the second post-placement image was obtained – was approximately 2.5ha.

It has now been possible to accurately determine recent marsh edge erosion along the southern perimeter of Cobmarsh Island (Figure 10). Over the seven years between 2014 and September 2021 (two months before recharge delivery commenced) there was a width loss of between 3m and 5m (0.43m – 0.71m annually), but this extends to 11m in places (1.6m per year). Erosion has not been observed along this margin since the recharge was placed.

https://youtu.be/73_hyLoU2XE

Table 11. Cobmarsh Island: time intervals between delivery completion and dates images obtained.

Pre recharge date image obtained	Date recharge delivery completed	Date 1st image obtained post-delivery (Post 1)	Time period between 1st image and delivery completion	Date 2nd image obtained post-delivery (Post 2)	Time period between 2nd image and delivery completion
13 Sept 2021	27 Dec 2021	10 Jan 2022	2 weeks	15 Sept 2022	37 weeks, 3 days

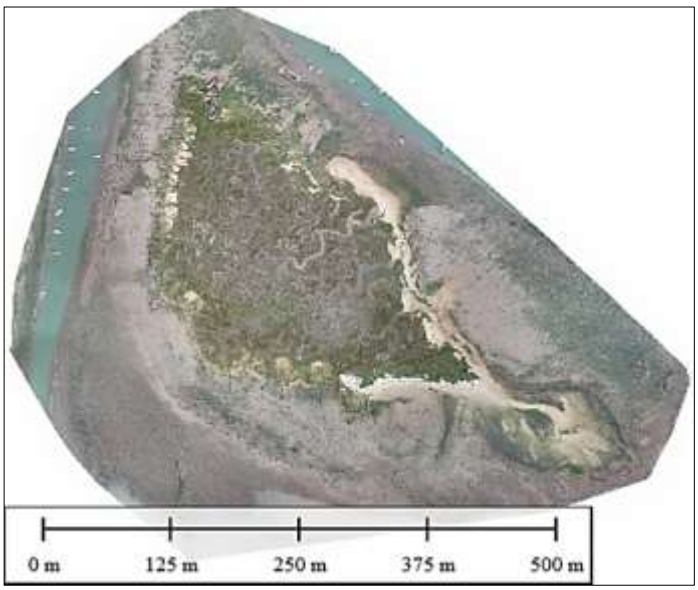


Figure 9i. Cobmarsh Island prior to 2021 recharge placement. Image obtained 13 September 2021.

Figure 9ii. Post 1: 2 weeks after deposition.

Figure 9iii. Post 2: 9 months after deposition.

Westerly winds are driving the new recharge east towards the old recharge - the latter having been conveyed westward since deposition at the point in 1998. A small channel has formed between the two transporting sea water into the lagoon at high tide and partially draining it on the ebb. (Lagoon images obtained 18 January 2023 right; ground image below - 10 January 2023.)

Figure 9iv. Lagoon.

Figure 9v. View SW – new recharge advancing towards the old recharge.

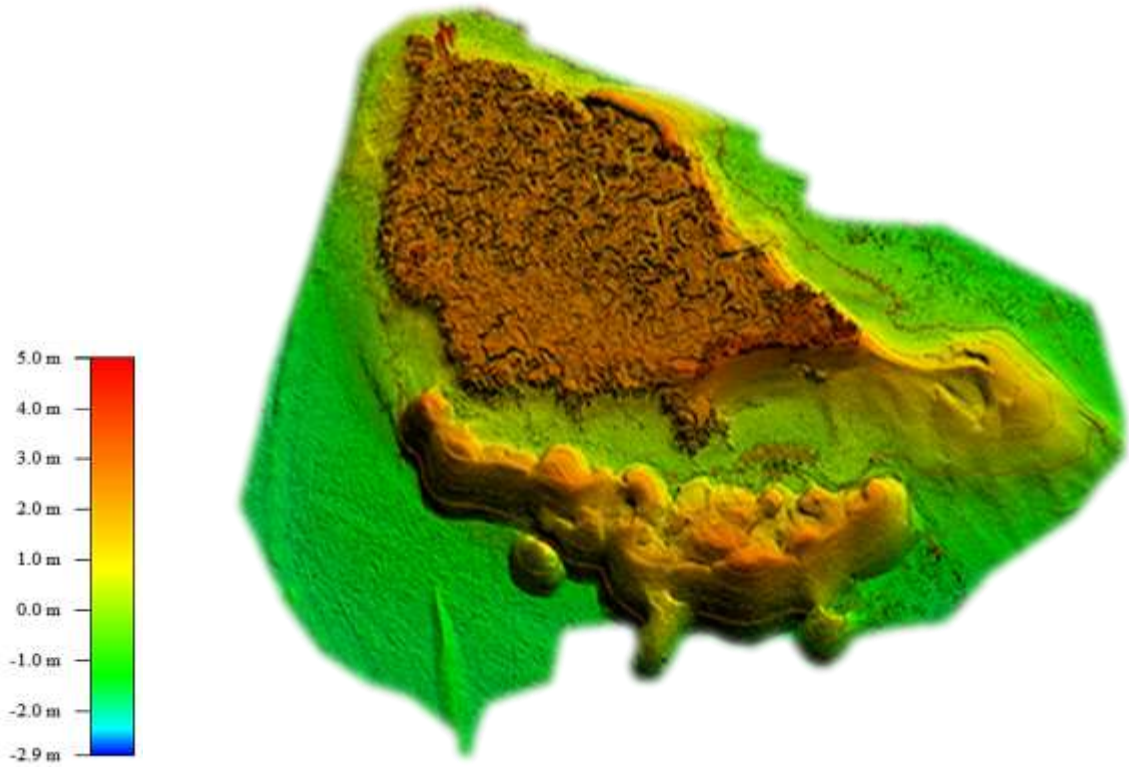
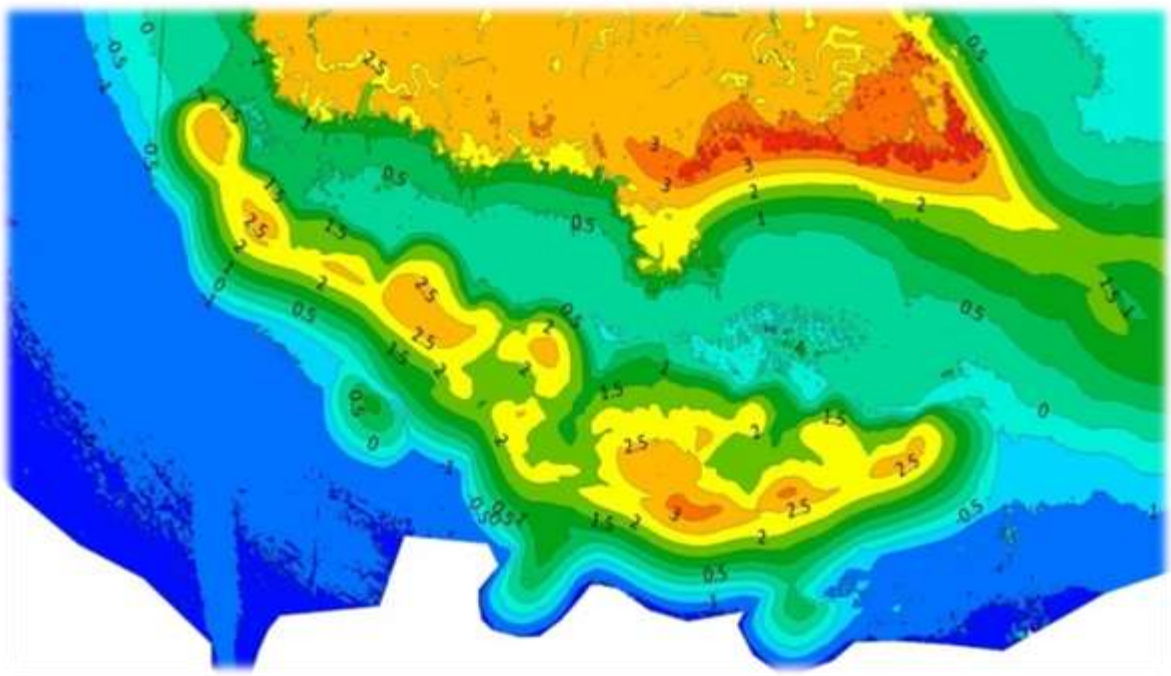
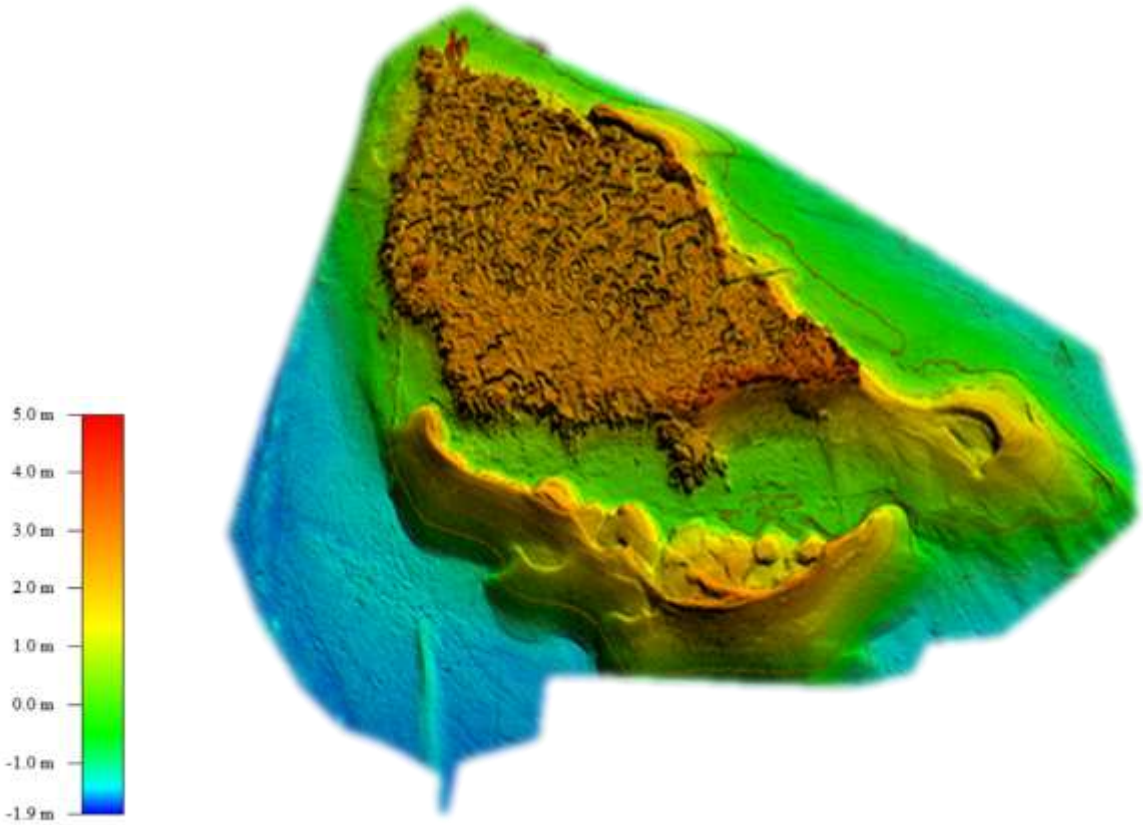
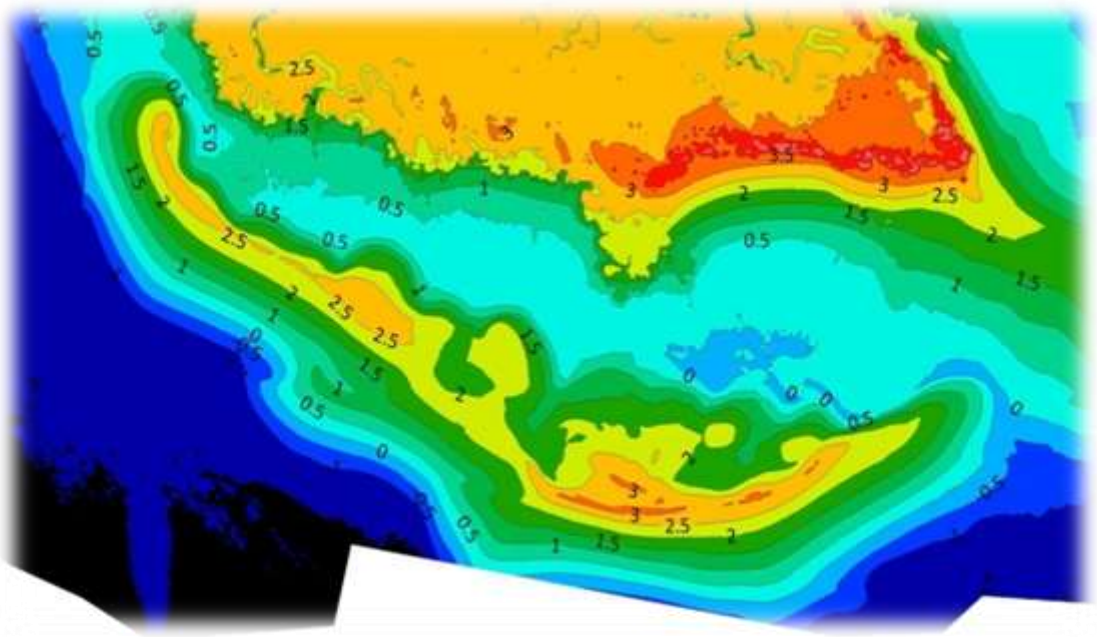


Figure 9vi. Post 1: 2 weeks after deposition (above and below).





. **Figure 9vii.** Post 2: 9 months after deposition (above and below).



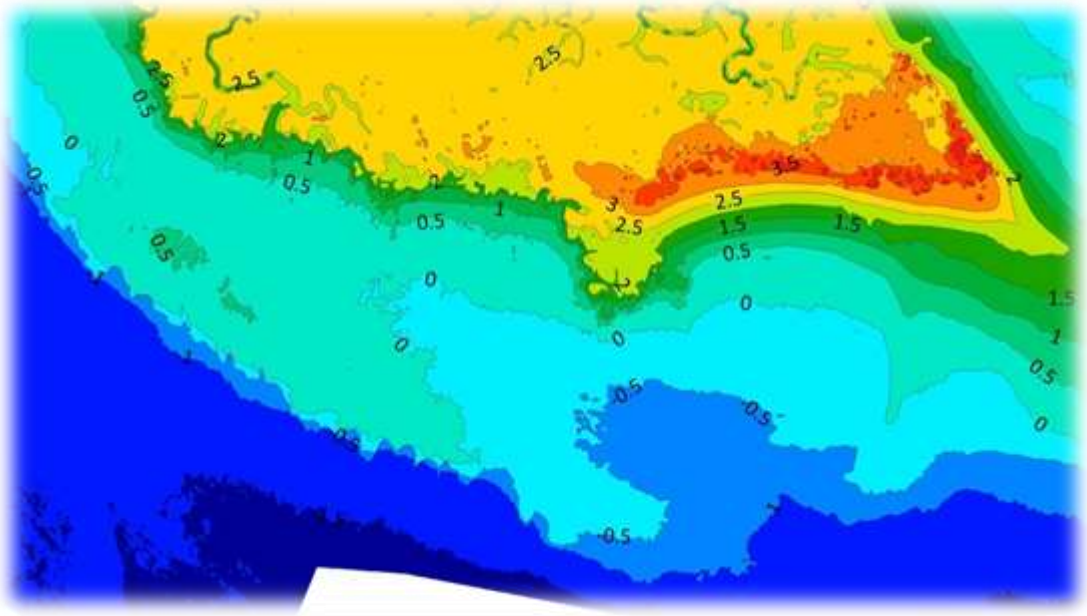


Figure 9viii. Cobmarsh Island prior to 2021 recharge placement (image obtained 13 September 2021).

Figure 10. Edge erosion of saltmarsh, southern margin of Cobmarsh Island, between 2014 (green line) and 13 September 2021, two months before recharge delivery, (blue line). The width of loss during this seven-year period generally ranged between 3m and 5m (0.43m – 0.71m annual rate of loss), with a maximum edge loss of 11m (1.58 annually).

3.2.3 Old Hall

Thirty-five cargoes were discharged south-west of Old Hall Point over 19 days, between 27 December 2021 and 15 January 2022, delivered by floating pipeline from the dredger Scald. The volume deposited was 40,014m³ (Table 12).

Table 12. Old Hall: deliveries and volumes.

Date delivery commenced	Date delivery completed	Number of loads	Total volume placed (m³)
27 Dec 2021	15 Jan 2022	35 (over 19 days)	40,014

The images presented below (Figures 11i to 11vi) show the alignment of material over the time intervals specified in Table 13. The link below shows the movement of material between these dates. Nine months since deposition, the recharge has raised the foreshore by up to 3.5m above AOD (Figures 11v & 11vi). The area of foreshore covered by the recharge on 28 September 2022 – when the second post-placement image was obtained – was approximately 1.9ha.

It has now been possible to accurately determine recent marsh edge erosion along the south-eastern margin of Old Hall (Figure 12). Over the seven years, between 2014 and September 2021 (three months before recharge delivery commenced), width loss was between 2m and 3m (0.28m – 0.43m annually), but losses of up to 9m are indicated in places (1.28 per year).

https://youtu.be/vKdV_3AAIFQ

Table 13. Old Hall: time intervals between delivery completion and dates images obtained.

Pre recharge date image obtained	Date recharge delivery completed	Date 1st image obtained post-delivery (Post 1)	Time period between 1st image and delivery completion	Date 2nd image obtained post-delivery (Post 2)	Time period between 2nd image and delivery completion
9 Sept 2021	15 Jan 2022	21 Jan 22	6 days	28 Sept 2022	36 weeks, 4 days

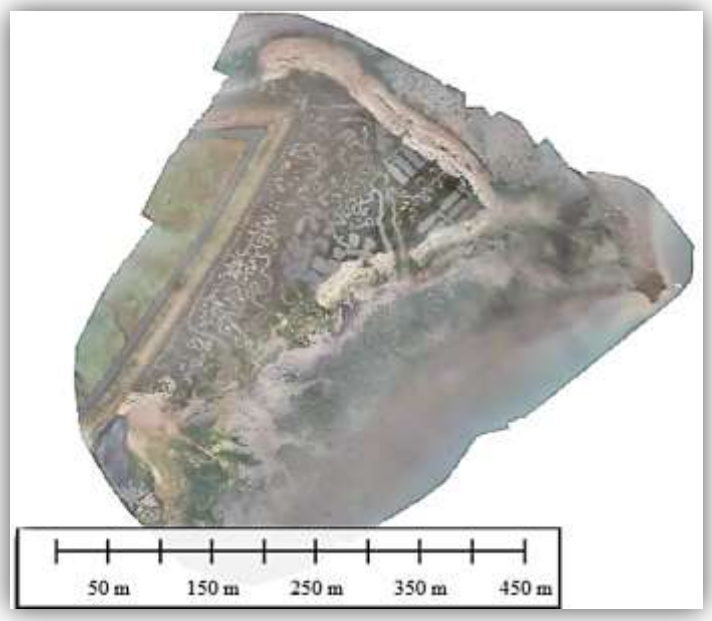


Figure 11i. Old Hall prior to 2021 recharge placement (image obtained 9 September 2021).

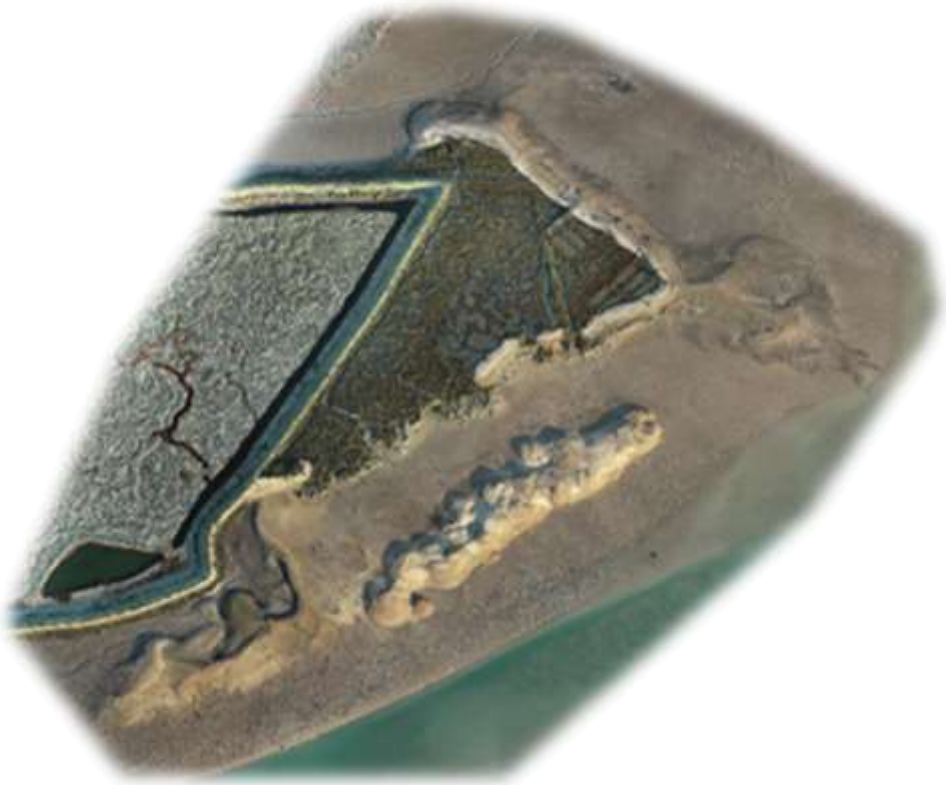


Figure 11ii. Post 1: 6 days after deposition.

Figure 11iii. Post 2: 9 months after deposition.

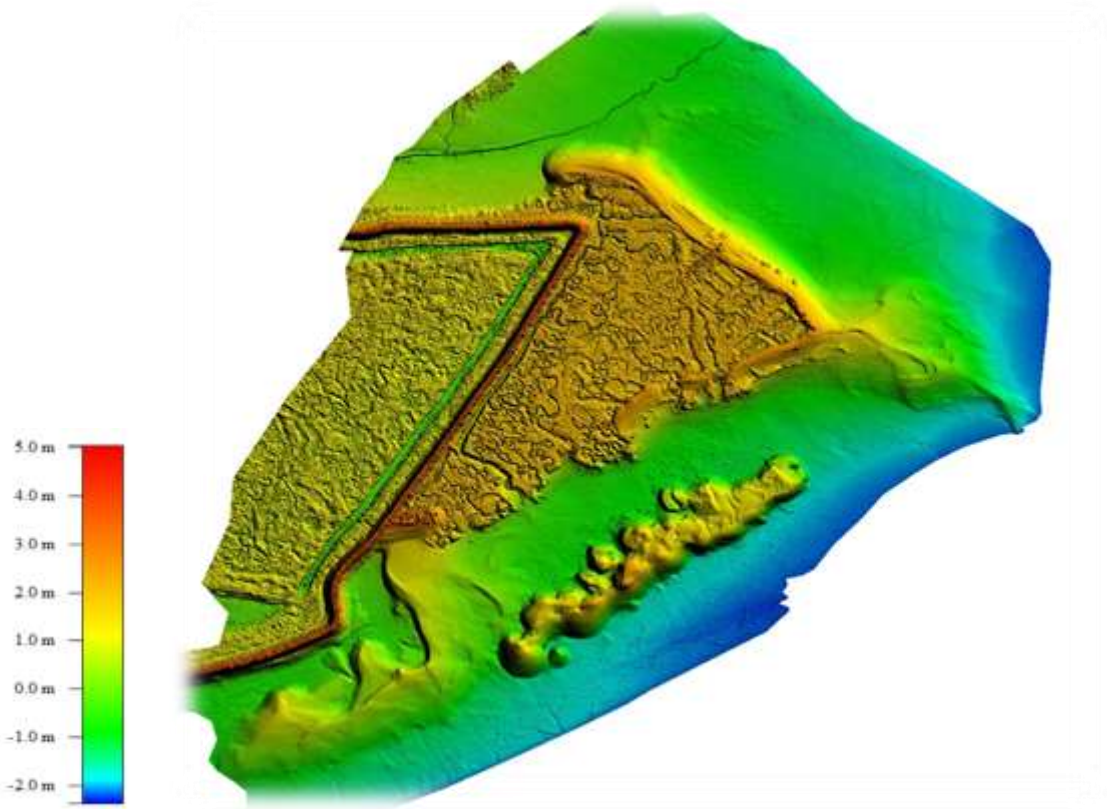
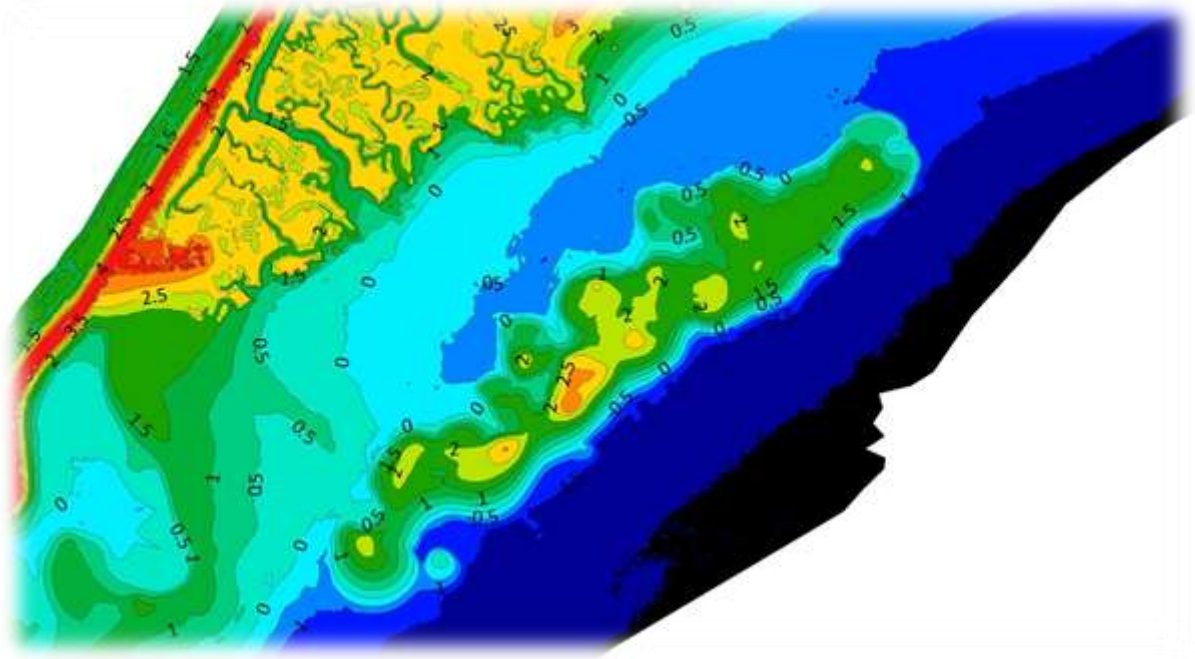


Figure 11iv. Post 1: 6 days after deposition (above and below).



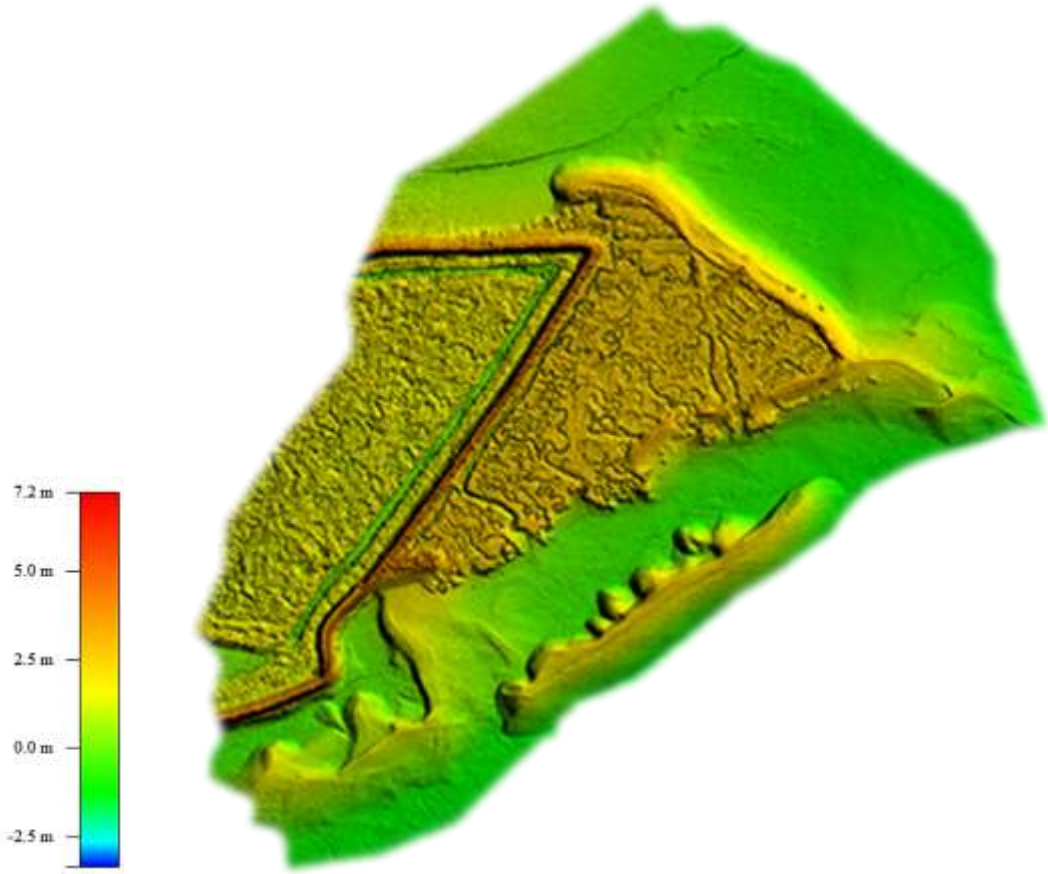
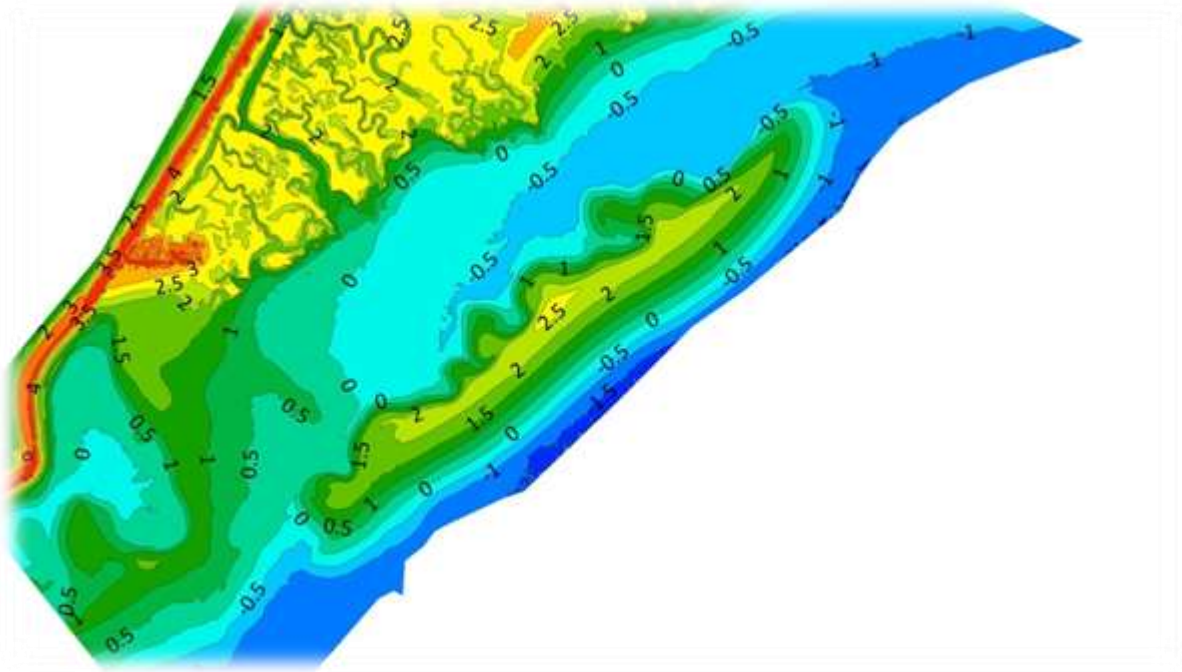


Figure 11v. Post 2: 9 months after deposition (above and below).



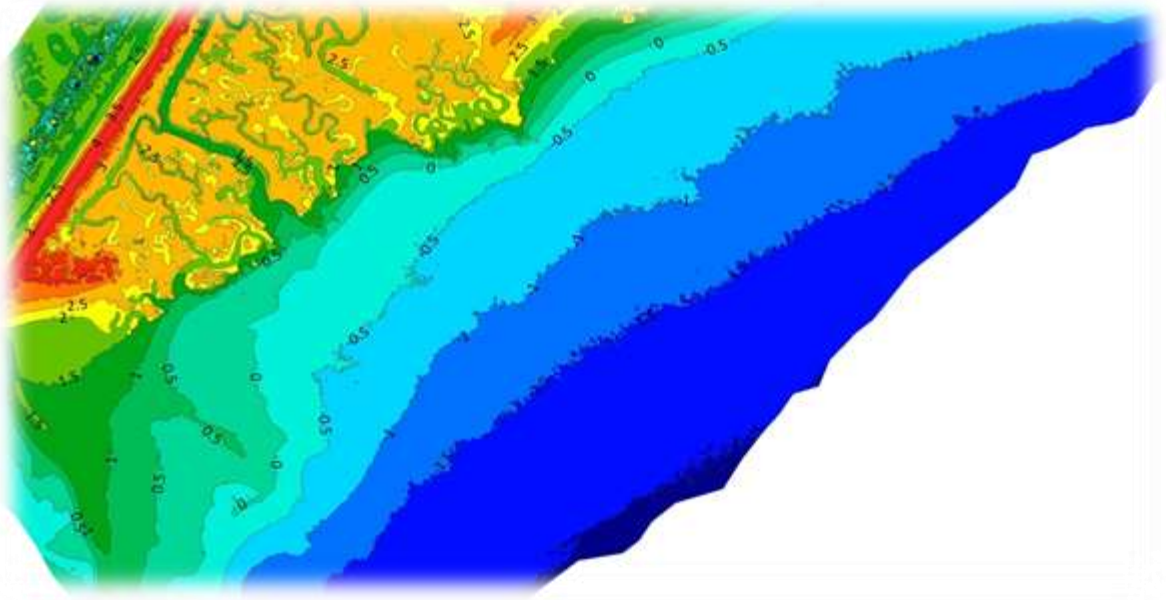


Figure 11vi. Old Hall prior to 2021 recharge placement (image obtained 9 September 2021).

Figure 12. Edge erosion of saltmarsh, south-eastern margin of Old Hall between 2014 (green line) and 13 September 2021, two months before recharge delivery began (blue line). The width of loss during this seven year period generally ranged between 2m and 3m (0.28m – 0.43m annually), with a maximum loss of 9m in places (1.28m annually).

3.2.4 Tollesbury Wick

Rainbow discharge to Tollesbury Wick commenced on 8 November 2021 and completed on 12 November 2021. Six loads, totalling 5,555m³, were delivered to the lower foreshore, extending the recharge placed in 1999, south-west of Shinglehead Point (Table 14).

Table 14. Tollesbury Wick: deliveries and volumes.

Date delivery commenced	Date delivery completed	Number of loads	Total volume placed (m³)
8 Nov 2021	12 November 2021	6 (over 7 days)	5,555

The images presented below (Figures 13i to 13vi) show the alignment of material over the time intervals specified in Table 15. The link below shows the movement of material between these dates. Relative to obtaining the second data set, the recharge has raised the foreshore by up to 2m AOD (Figures 13v & 13vi). The area of foreshore covered by the recharge at that time was approximately 0.8ha.

https://youtu.be/vDTMp3BjblI

Table 15. Tollesbury Wick: time intervals between delivery completion and dates images obtained.

Pre recharge date image obtained	Date recharge delivery completed	Date 1st image obtained post-delivery (Post 1)	Time period between 1st image and delivery completion	Date 2nd image obtained post-delivery (Post 2)	Time period between 2nd image and delivery completion
8 Sept 21	12 Nov 2021	23 Nov 2021	1 week, 4 days	3 Oct 2022	46 weeks, 3 days

Figure 13i. Tollesbury Wick prior to 2021 recharge placement (8 September 2021).

Figure 13ii. Post 1: 1 week 4 days after deposition

Figure 13iii. Post 2: 11.5 months after deposition.

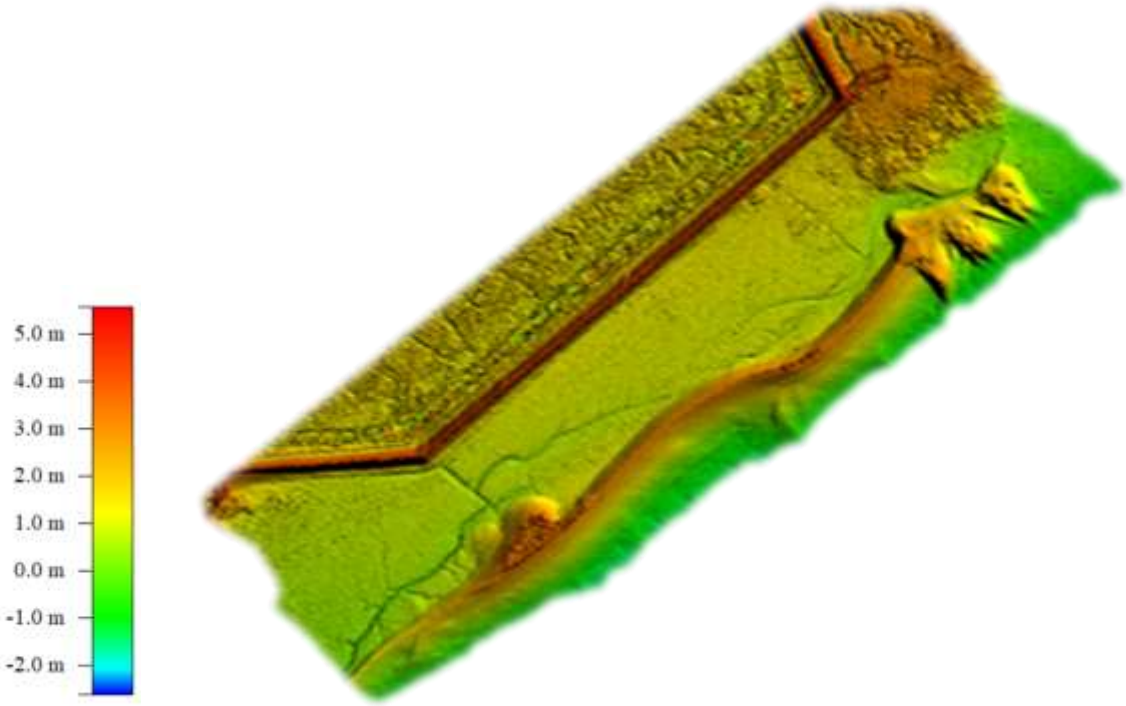
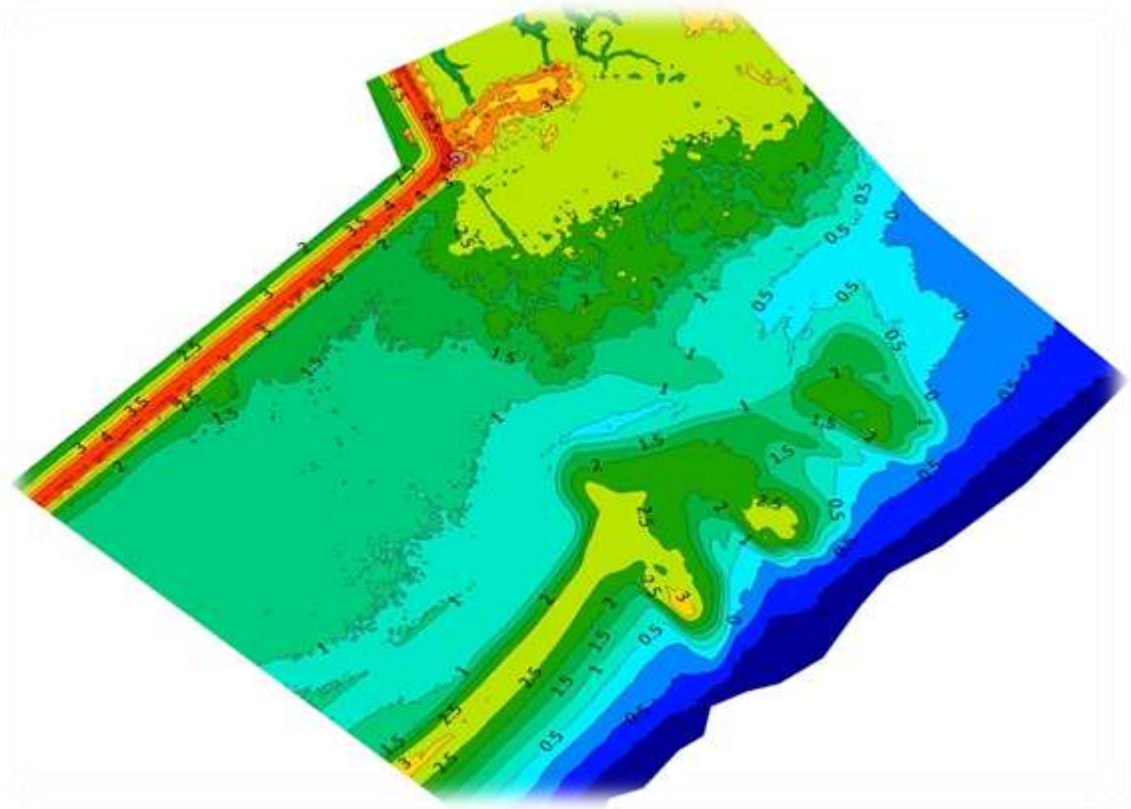


Figure 13iv. Post 1: 1 week 4 days after deposition (above and below).



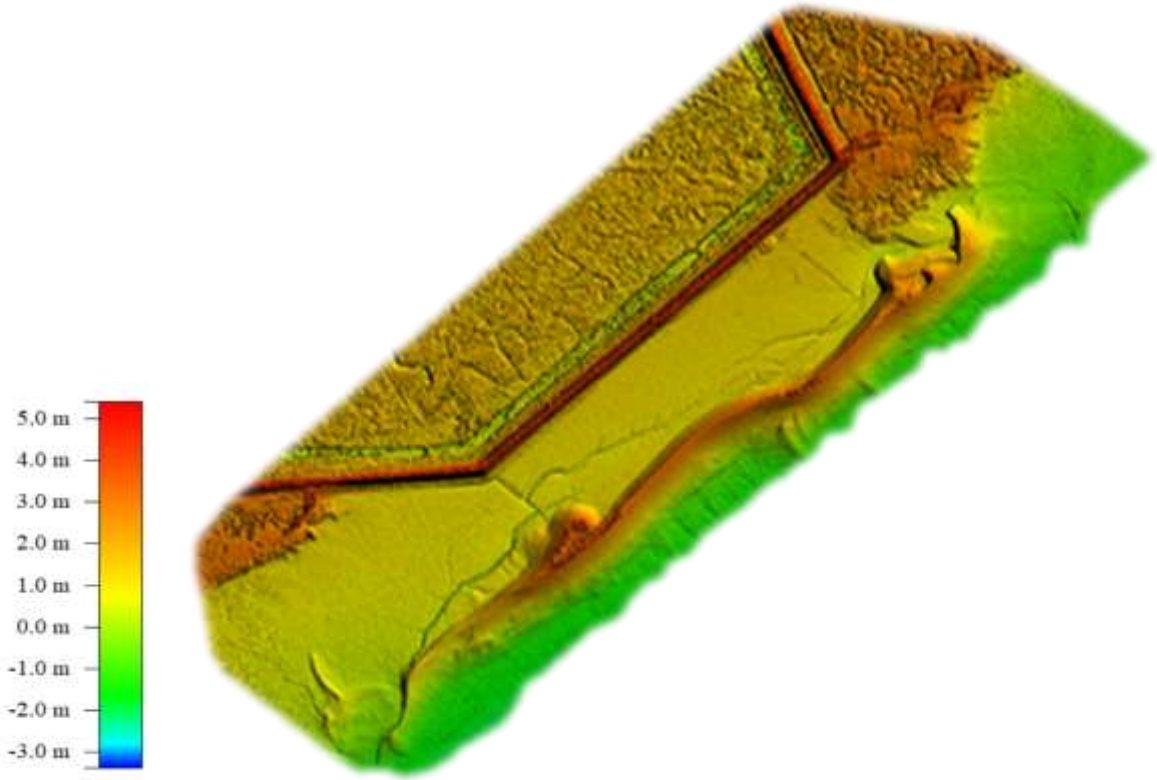
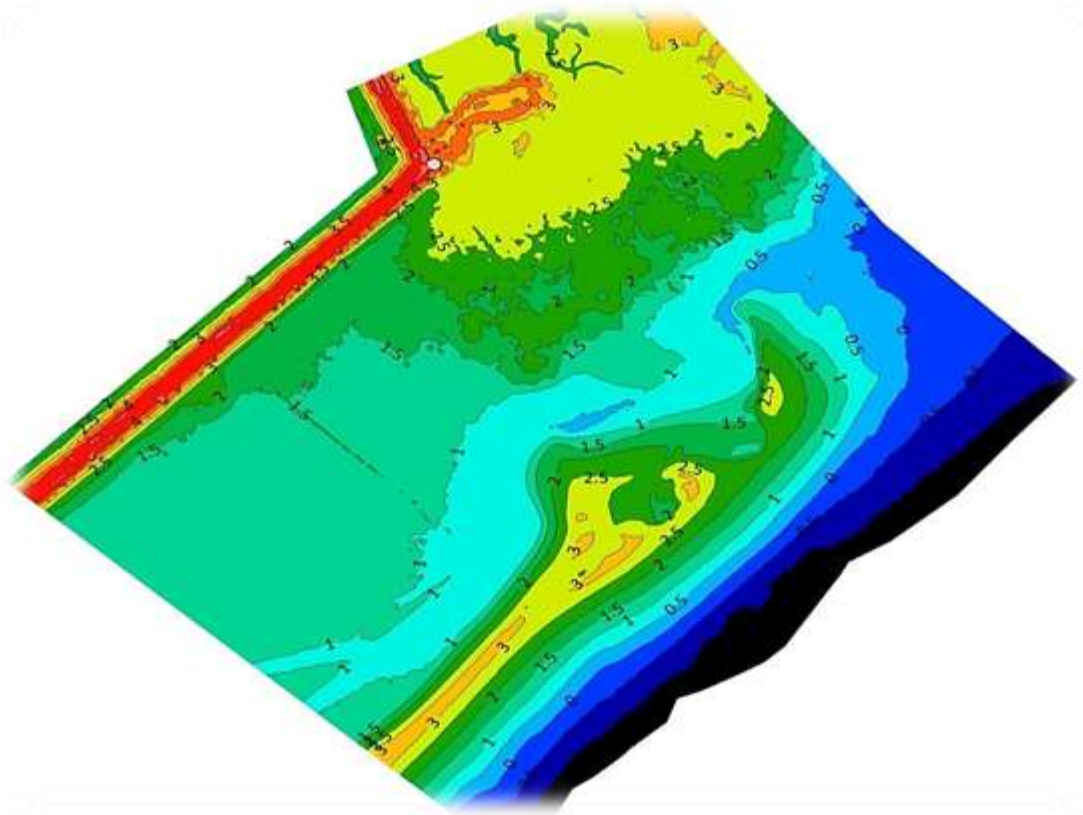


Figure 13v. Post 2: 11.5 months after deposition (above and below).



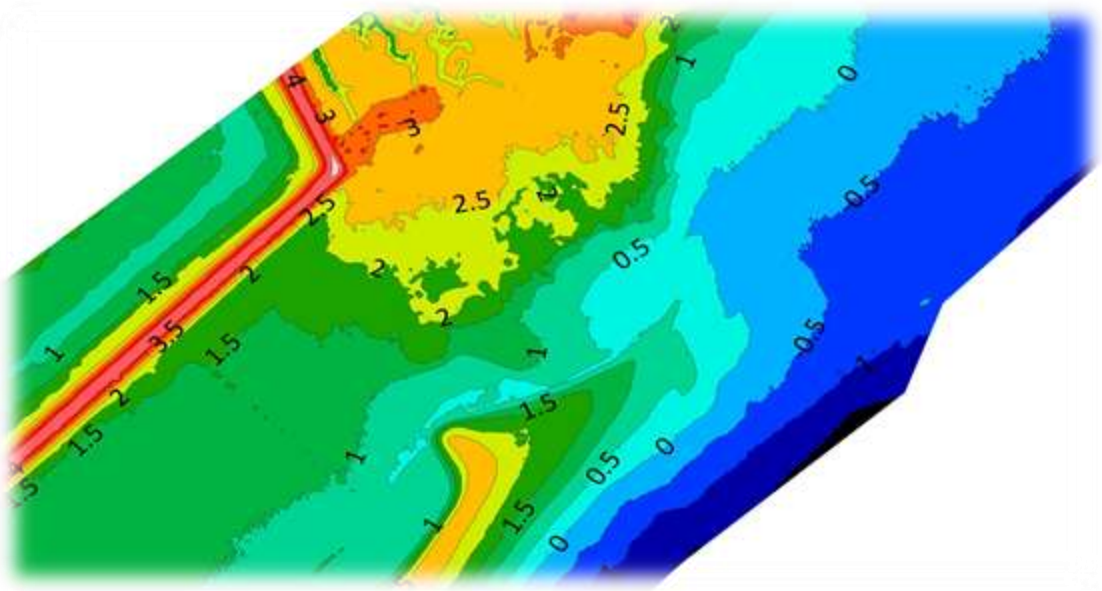


Figure 13vi. Prior to 2021 recharge placement (8 September 2021).

3.3 Fixed-point photography

Marker posts had been installed post placement at each site in order to monitor changes at ground level. Photographs were taken from these positions. Unfortunately the posts were stolen and it was decided to obtain fixed-point information from the DSM data generated from the UA survey. The images were captured at 1.5m above ground level.

3.3.1 Results

The fixed point locations, bearings and timings are shown in the Table 16. Figures 14 to 17 show the results.

Table 16. Fixed point photography: location, bearing and dates of images.

Site	Fixed point position (British Grid) & bearing	Pre recharge date image obtained	Date recharge delivery completed	Date 1st image obtained post delivery (Post 1)	Time period between 1st image and delivery completion	Date 2nd image obtained post delivery (Post 2)	Time period between 2nd image and delivery completion
Packing Marsh Island	X 599861.5 Y 212280.5 180°	10 Sept 21	8 Nov 21	9 Nov 21	1 day	13 Sept 22	52 weeks, 2 days
Cobmarsh Island	X 600149.3 Y 212006.4 160°	13 Sept 21	27 Dec 21	10 Jan 22	2 weeks	15 Sept 22	37 weeks, 3 days
Old Hall	X 599558.7 Y 211391.6 130°	9 Sept 21	15 Jan 22	21 Jan 22	6 days	28 Sept 22	36 weeks, 4 days
Tollesbury Wick	X 598801.9 Y 210279.9 170°	8 Sept 21	12 Nov 21	23 Nov 21	1 week, 4 days	3 Oct 22	46 weeks, 3 days

Figure 14. Packing Marsh Island: From left to right: pre placement, post placement 1 (1 day after delivery), post placement 2 (1 year after delivery).

Figure 15. Cobmarsh Island: from left to right: pre placement, post placement 1 (2 weeks after delivery), post placement 2 (9 months after delivery).

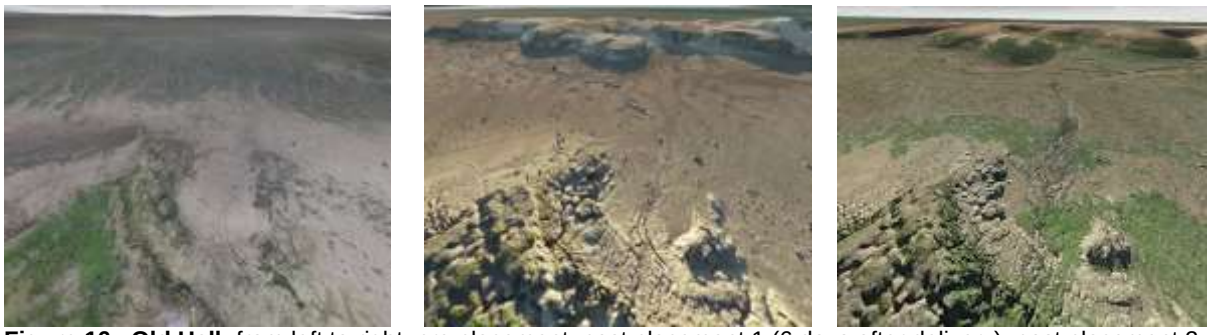


Figure 16. Old Hall: from left to right: pre placement, post placement 1 (6 days after delivery), post placement 2 (9 months after delivery).

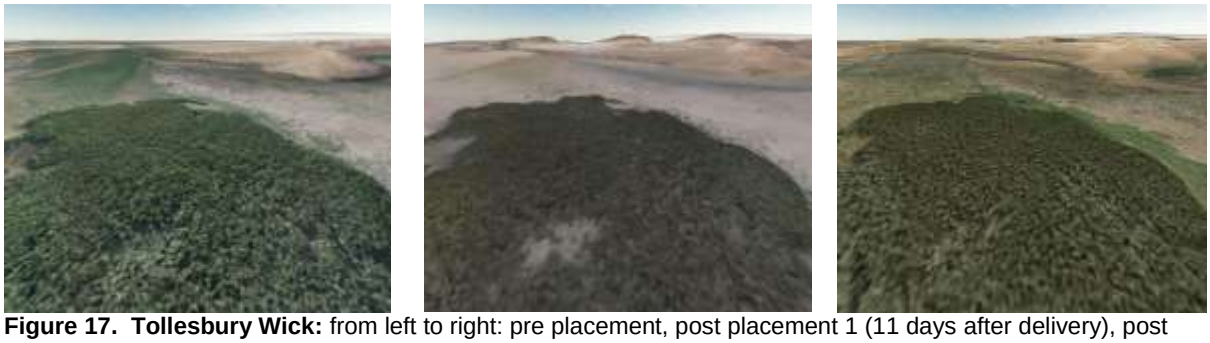


Figure 17. Tollesbury Wick: from left to right: pre placement, post placement 1 (11 days after delivery), post placement 2 (11½ months after delivery).

3.4 Discussion

The images obtained from the surface elevation data show how wind, wave, and tidal action have changed the alignment of the recharge. Between the data collection dates, it is evident that the recharge is responding to natural tidal forcing by slowly migrating landward, with some minimal migration, eastward or westward, dictated by storm wind direction. Shoreline orientation will obviously influence the degree of wind and wave exposure. At Cobmarsh Island, westerlies are driving the recharge east towards the old recharge, the latter having been conveyed westward since deposition at the point in 1998. A small channel has formed between the recent historical recharge conveying sea water into the lagoon at high tide and partially draining it on the ebb.

Seaward slope profiles suggest the recharge 'beaches' are achieving a dynamic equilibrium consistent with that of adjacent natural beaches on the south shore of Mersea Island. Slope profiles have attained maximum values of plus six degrees at all sites, with Packing Marsh recording the steepest gradient at over seven degrees. Here material was placed on top of the foreshore raised by the previous recharge while loads discharged to the other sites were located on the lower foreshore. Grain size will affect movement and changes in elevation. The material was dredged from an area in the Harwich Approaches where trial pits had indicated a high gravel to sand ratio: 3:1, 4:1 and 5:4. Harwich Haven Authority described the hopper loads as a clean, gravel and sand mix, with later loads having a higher sand content. The development of steep beach-face gradients will present the most effective barrier to combatting damaging onshore storm waves.

It is already being demonstrated that this mix of sands and gravels distributed to the Mersea Quarters is offering resistance to extreme storm events and protecting the saltmarsh edge. During regular ground-truthing visits undertaken by the MHPT project manager following onshore winter storm events - to identify any potential residual management actions and to complement the monitoring programme - it was observed that sediment had accreted in the lee of the recharge at Cobmarsh Island sufficient to support saltmarsh seed establishment at the base of the existing marsh (refer to monitoring results and discussion Section 5 – 'silt deposition'). Furthermore, there was no evidence of saltmarsh edge erosion which would normally be conspicuous following episodes of stormy weather (losses have now been assessed over the last seven years. Also, patchy vegetation on the fringes of the marsh was undergoing recovery. The recharge itself, at Packing Marsh Island, was observed to be supporting a sparse cover of pioneer vegetation the following summer.

4. Bathymetry

Monitoring	Purpose	Location	Post-placement monitoring
Bathymetry	To monitor any changes in surface elevation below ODN and any spatial redistribution of material.	All recharge sites	Immediately post placement then annually for three years.

4.1 Method

Bathymetric data was collected on board the MV Corinne (21 foot/6m survey dory). A 'lawnmower' course was steered to ensure maximum coverage of the seabed. The data was captured by a Humminbird Side Scan Sonar unit (Helix 10) using a calibrated transducer mount. These were operated in conjunction with an RTK (real time kinematics) enabled GPS (global positioning system) to ensure accurate 'Z' (vertical) data. Data was collected in chart datum and processed using a computer GIS, and subsequently adjusted to ordnance datum.

4.2 Results

The data was collected at the four sites on the dates indicated in Table 17. Figures 18 to 21, below, show water depths around the recharge relative to ODN.

Table 17. Dates bathymetric data collected.

Site	Date recharge delivery completed	Date of bathymetric survey	Time period between survey and delivery completion
Packing Marsh Island	8 Nov 21	25 May 2022	6½ months
Cobmarsh Island	27 Dec 21	24 March 2022	3 months
Old Hall	15 Jan 22	27 May 2022	4 months
Tollesbury Wick	12 Nov 21	16 June 2022	7 months

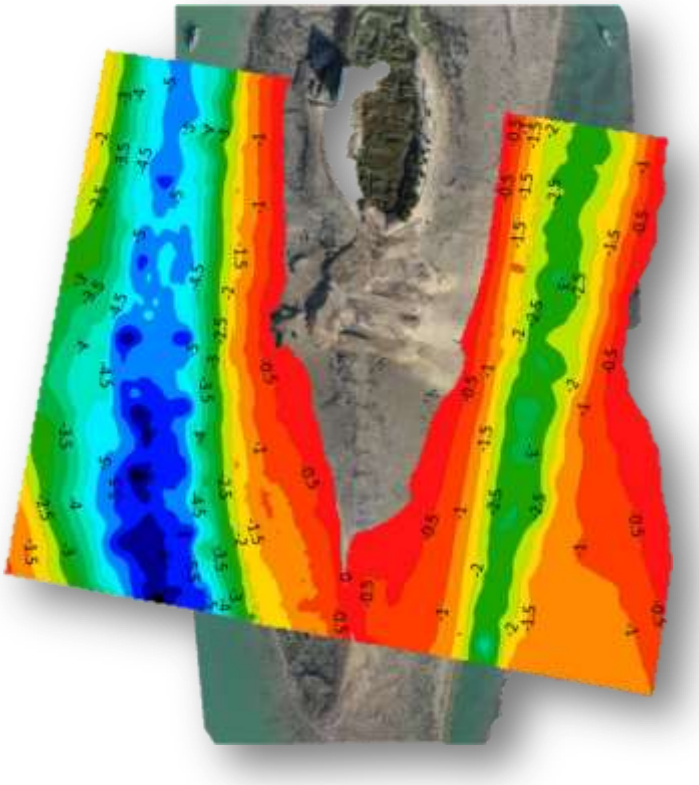


Figure 18. Packing Marsh Island.

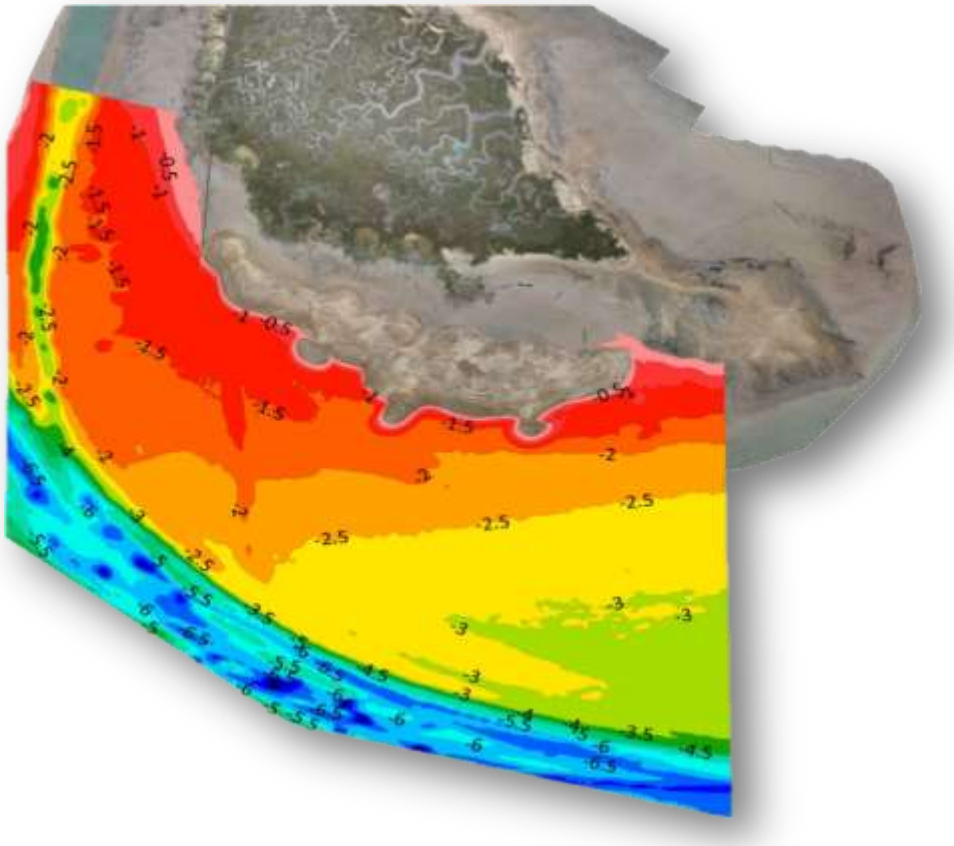


Figure 19. Cobmarsh Island.

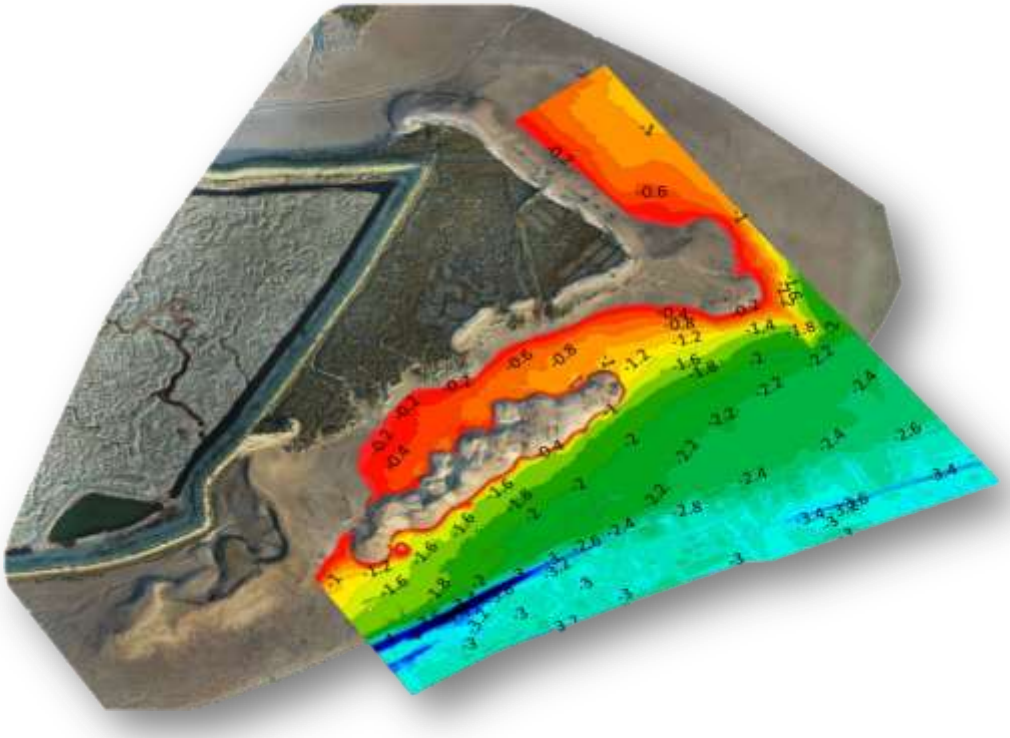


Figure 20. Old Hall.

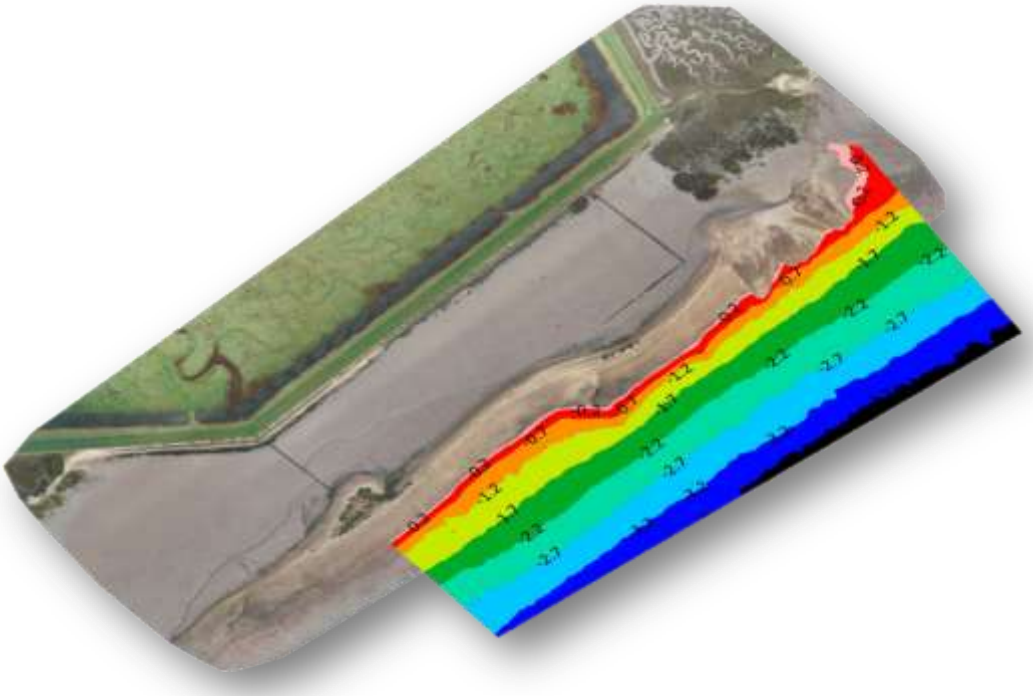


Figure 21. Tollesbury Wick.

4.3 Discussion

This is a baseline survey. Future surveys will check the movement of recharge and will consider any variations in sea bed relief.

5. Silt deposition

Monitoring	Purpose	Location	Post-placement monitoring
Silt deposition	To measure build-up of silts inside the recharge bunds.	Cobmarsh, Old Hall, and Tollesbury Wick	At 6 monthly intervals for 1 year then annually for 3 years.

5.1 Method

Following placement of the recharge at Cobmarsh Island and Old Hall, up to ten bamboo canes (900mm length and 10mm diameter) were embedded 700mm into the mudflats leaving a 200mm length of cane extending above the mud surface. Canes were placed over an area of approximately 1988m² at Cobmarsh (9 canes) and 3965m² at Old Hall (10 canes), situated landward of the central part of the recharge. On the return visit, the length between the surface of the mud and the top of the cane was measured. The timing of the first measurement was originally scheduled for six months following recharge placement. However, this coincided with the bird breeding season (July) and was not carried out at this time to avoid disturbance. When weather conditions became favourable, one set of data was collected at the beginning of 2023. No canes had been placed at Tollesbury Wick so foreshore heights were obtained from surface modelling data.

5.2 Results

5.2.1 Cobmarsh Island and Old Hall

Figure 22 shows the distribution of the canes at both sites. With the exception of one reading, at both Cobmarsh Island and Old Hall, all results were positive showing an average accretion of 10.6mm and 9.9mm respectively over the four months since the canes were placed (Table 18). Figure 23 shows readings being taken at two of the sample sites. The sediment type building up across the whole of the survey area is described as 'fine silts', and this is evident at these sample stations.

Table 18. Silt deposition results shoreward of recharge at Cobmarsh Island and Old Hall.

Cobmarsh Island				Old Hall			
Date recharge completed	**Date canes placed**		**Date of reading /time since placed**	**Date recharge completed**	**Date canes placed**		**Date of reading /time since placed**
27 Dec 2021	13 Sep 2022		10 Jan 2022 17 weeks	15 Jan 2022	15 Sept 2022		10 Jan 2022 16w 5 days
Cane number	**OSGB co-ords**		**Accretion mm**	**Cane number**	**OSGB co-ords**		**Accretion mm**
	X eastings	Y northings			X eastings	Y northings	
1	600133	211970.8	39	**1**	599642.2	211368	35
2	600132.6	211979.8	6	**2**	599634.6	211379.2	6
3	600132.6	211987.6	15	**3**	599624.1	211392.5	-23
4	600151.5	211970.2	-11	**4**	599580.9	211369.9	15
5	600171.7	211960.3	3	**5**	599585.5	211348	0
6	600187.9	211965.5	13	**6**	599588.9	211332.3	5
7	600181.7	211955.3	5	**7**	599546.2	211294.8	25
8	600182.6	211945.1	10	**8**	599532.2	211308.7	10
9	600201.1	211945.3	16	**9**	599517.6	211323.3	23
-	-	-	**-**	**10**	599527.7	211262.6	3
Average accretion (mm)	-	-	**10.6**	-	-	-	**9.9**

Figure 22. Distribution of canes located behind the central area of the recharge at Old Hall (left) and Cobmarsh (right).

Figure 23. Taking siltation readings. At Old Hall (left), brown seaweed had wrapped around the cane and had to be moved to obtain the reading. Live common periwinkle (edible periwinkle: *Littorina littorea*) were clustered beneath the seaweed. A reading of 184mm was taken at the location on the right (Cobmarsh Island) giving an accretion measure of 16mm.

5.2.2 Tollesbury Wick

In the absence of field measurements, a profile of the foreshore behind the recharge was obtained from the surface model (Figure 24). This indicates that the foreshore has increased by 119mm in places. However, field observation suggests that this is fine sand washed from the crest of the new recharge.

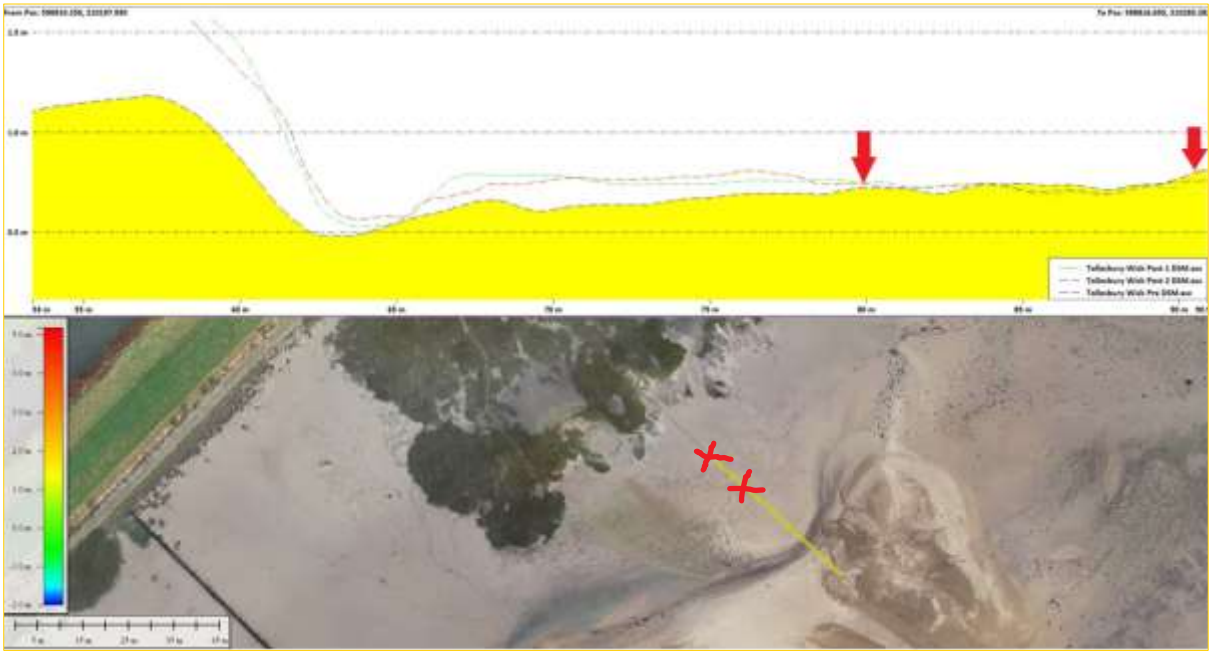


Figure 24. Tollesbury Wick: foreshore height change since placement (black dotted line pre-placement level; green dotted line post 1 data (obtained 23 Nov 2021); red dotted line post 2 data (obtained 3 Oct 2022). Placement was completed on 12 Nov 2021.

5.3 Discussion

In the lee of the recharge at Cobmarsh Island and Old Hall, silt build-up has averaged 10mm in four months. Over one year, this would equate to a 30mm increase. At Tollesbury Wick, sand washed from the recharge is likely to have accounted for the high increase in foreshore level. The shelter afforded by the recharge is already beginning to transform these formerly exposed, eroding areas, and the common periwinkle (*Littorina littorea*) is starting to colonise, with an aggregation found beneath seaweed at one of the sample sites at Old Hall (Figure 22 above). In October 2022 it was reported that *Spartina* sp (common cord-grass) was beginning to establish at the base of the eroding saltmarsh edge inside the recharge at Cobmarsh Island (pers comm Mark Dixon).

Inside the old recharge at Tollesbury Wick the silts here have built up to over one metre with the highest elevation close to the recharge bank, where silts have covered the stakes of an old polder fence, with levels tapering off towards the sea wall – indicated by the exposed stakes (reported by Jim Pullen, January 2023). Between the placement date (1999) and January 2023, this suggests an annual average accretion rate of 43mm.

Accretion rates are influenced by wind direction and atmospheric pressure: during a low pressure weather system, waves driven by easterly winds will carry high silt loads into the Mersea Quarters.

Measuring canes have now been placed at Tollesbury Wick (on 12 January 2023) in readiness to obtain results in the next monitoring cycle.

6. Retaining fences

Monitoring	Purpose	Location	Pre-placement	Post-placement monitoring
Retainment of recharge	To ensure material is retained where considered to be more vulnerable to wind and wave events.	Cobmarsh and Packing Marsh Islands	To construct fences prior to placement: work will be timed to avoid the bird breeding season and over-wintering season.	Checks to be carried out monthly for the first three months post placement. Subsequently monitoring to be carried out quarterly to check conditions and repair as required. Further fences to be constructed should monitoring demonstrate the need for this. Additional checks to be undertaken prior to predicted severe weather events and post severe events. Ongoing.

6.1 Method

Brushwood retaining fences were constructed in September 2021 prior to recharge placement at Cobmarsh and Packing Marsh islands. They consist of two rows of 100mm width non-pressure treated soft pine stakes with a 250mm channel between, infilled with hazel brushwood (Figures 25 and 26). At Cobmarsh Island the fencing was assembled in a straight line extending north-south from the westernmost point of the island (Figure 27); it is intended to check any drift of material towards the Mersea Fleet navigation channel. At Packing Marsh the fence follows the curve around the southern end of the island and the height, HAT (highest astronomical tide) + 200mm, is intended to check rollover of material onto the low saltmarsh vegetation on extreme tides.

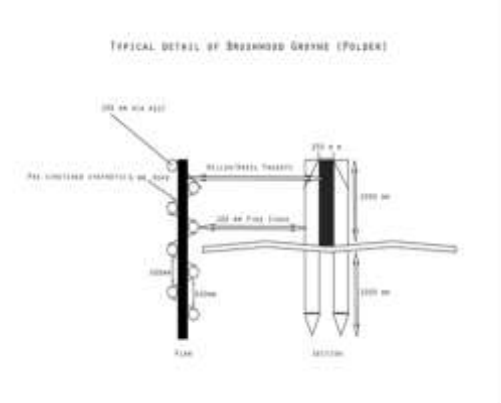


Figure 25. Retaining fence design (Jim Pullen).

Figure 26. Structure of the retaining fence, northern end of Cobmarsh Island (Mark Dixon).

Figure 27. Cobmarsh fence alignment, view east.

6.2 Results

At Packing Marsh Island the fence is stable and has yet to be tested by a surge tide (Figure 28).

Figure 28. Packing Marsh fencing is effectively restricting rollover since dredgings were fully discharged (on 8 November 2021). Image on the left (11 August 2022) and right (13 September 2022), looking north.
Note: the round shrubs (shrubby sea-blite, *Suaeda vera*) outside the fencing have established at the upper limit of tidal inundation on the former recharge placed in 1998.

At Cobmarsh Island, some material has been transported around the southern end of the fence (Figure 29).

Figure 29. View NE with Packing Marsh Island to the west and Mersea Island in the background. The Mersea Fleet cuts between the two islands. The fence runs from north to south across the western foreshore. The photo was taken on 16 January 2023, just over one year after recharge was completed, on 27 December 2021. Inset shows the movement of material around the southern end of the fence on 12 January 2023 (looking west).

6.3 Discussion

The fence at Cobmarsh acts as a beach control groyne capturing material migrating west, driven by longshore drift and easterly winds. Wave refraction, influenced by the fence and mud flat topography, has moved some of the sands and gravels around the end of the structure to the west side, while driving it northward (landward); westerly winds push it back against the fence. There is no indication of material drifting towards the Mersea Fleet: hydrodynamic processes will naturally move the material landwards, and this is already being observed (see Section 3). It has been demonstrated during winter 2022/23 that the fencing is able to withstand extreme winds.

The shingle bank, formed by the old recharge at Packing Marsh Island - outside the new fence – has had an important influence. Over the years since placement in 1998, tidal forcing has heaped the recharge around the island, protecting the lower marsh within the centre. Shrubby sea-blite (*Suaeda vera*) has subsequently established, marking the drift line, and helps to stabilise the material.

7. Bird nesting

Monitoring	Purpose	Location	Pre-placement survey	Post-placement monitoring
Bird nesting	To monitor nesting of all bird species, with particular focus on the Annex 1 species, the little tern, counting nests and young.	All recharge proposal sites (and earlier recharge bunds)	Further monitoring of current recharge sites for at least one season prior to new recharge placement.	Annually over three years with two counts each season in June and July.

7.1 Method

As the bird nesting survey was intended to be focussed on little terns, it was decided to follow the methodology developed by the Essex Little Tern Group in 2016. This involves conducting co-ordinated counts, from a boat, twice, during the summer (June and July) to establish the number of 'apparently incubating adults' (AIAs). It was considered that this technique would also be suitable for recording breeding waders, including ringed plover and oystercatcher. Table 19 outlines the methodology used for the various species.

Table 19. Survey methodology to record bird nesting.

Species	Information required	Recording results
Oystercatcher **Lapwing,** **Redshank** **Ringed Plover**	Record location, movement and behaviour using standard BTO symbols and codes to eliminate double counting. Scan ahead in case birds are disturbed.	**Oystercatcher** Record the total number of pairs, where a pair is: ➢ Total number of paired individuals divided by 2. ➢ Displaying individual. ➢ Single bird. ➢ Nest. ➢ Brood. **Lapwing** Record the peak number of birds seen. The number of breeding pairs is the maximum number of individuals between mid-April and late May divided by 2. **Redshank** Record the mean number of birds. This is also the number of breeding pairs. **Ringed plover** Record the maximum number of territorial pairs: ➢ One adult alone, 50m or more from other adults = one pair ➢ Two individual adults within 50m of other adults = one pair ➢ Two adults together = one pair ➢ Two, three or four adults = two pairs ➢ One to four adults flying into, out of or through the area, or into the site = one to two pairs ➢ Five or more adults remaining in the area, either on the ground or circling around (vocal birds only) = three+ pairs.
Little Tern, **Common Tern**	Count the number of apparently incubating adults (AIAs) regardless of presence of nest material. Record the location, movement and behaviour of all birds using standard BTO symbols and codes to eliminate double counting. Incubating birds sit in a hollow or scrape and thus will be partly hidden with the tail pointing up at a sharp angle, whereas resting birds are more visible and the tail is held at a shallower angle.	Record the maximum number of apparently incubating adults. Estimate the AIAs for unseen parts of the colonies.
Black-headed Gull **Mediterranean Gull** **Herring gull**	Count 'apparently occupied nests' (AONs)**:** well-constructed nest attended by an adult and capable of holding eggs or, if it is not possible to see the nest - eg due to vegetation - an apparently incubating adult. Beware of counting both members of a pair sitting in close proximity as two AONs. Note position of all AONs on a map to avoid counting the same nest twice when using more than one vantage point.	Record the maximum number of AONs counted on a single visit as the population estimate. If parts of the colony are hidden, estimate (minimum-maximum) the likely number of nests hidden based on the density of nests in the rest of the colony.

7.2 Results

7.2.1 Pre-placement surveys

Surveys of the historical recharge locations were carried out each year between 2018 and 2021. The results are presented In Figure 30.

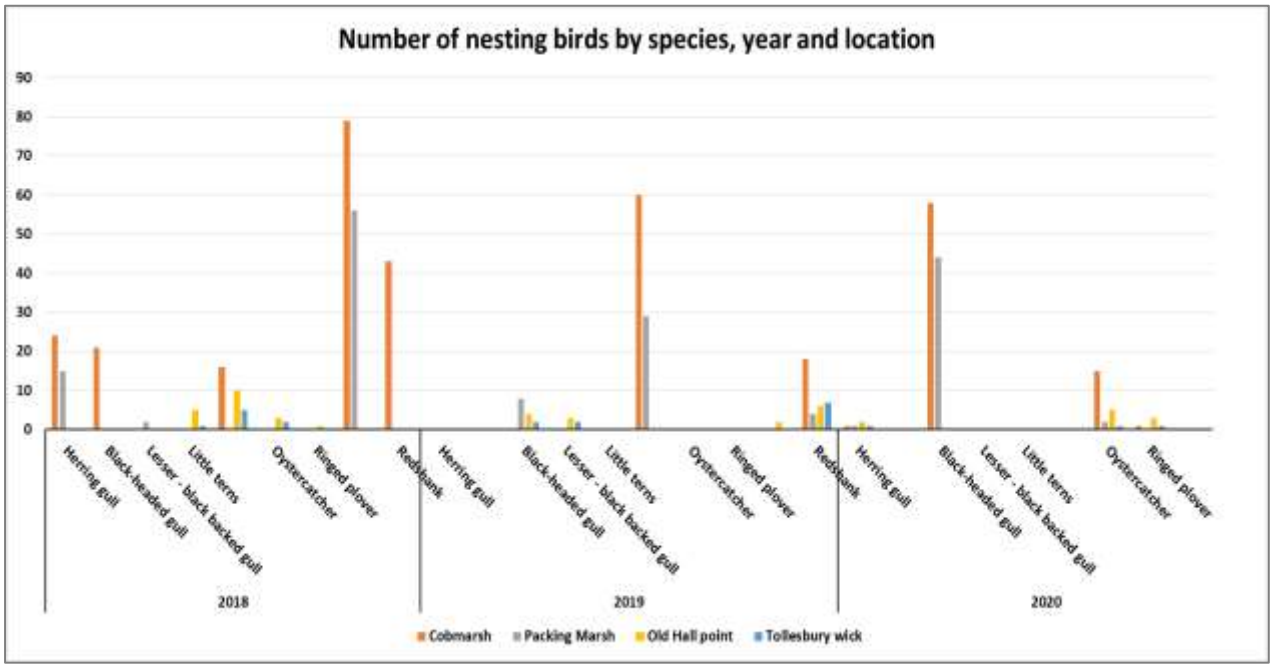


Figure 30. Number of nesting birds by species, year and location 2018 to 2021.

The most numerous breeding species was the herring gull, which showed an increase in nesting pairs from 2018 to 2021. Lesser black-backed gulls bred in 2018 but not in subsequent years. Black-headed gulls disappeared from Cobmarsh Island in 2020 and did not return.

Ringed plover numbers stayed remarkably stable across the survey years with five pairs recorded across all locations. The most frequented sites were Old Hall point and Tollesbury Wick, except in 2020 when they were noticeably dispersed across the study area.

Oystercatcher pairs fluctuated throughout the period, possibly a reflection of the complexity of monitoring these large, noisy and easily disturbed birds.

Little terns bred only twice - in 2018 and again in 2020 - and on both occasions in low numbers (five pairs in 2018 and two pairs in 2020).

The number of fledglings raised between 2018 and 2021 is summarised in Figure 31. The most successful breeding species over the study term was the herring gull, in particular on Packing Marsh (Packing Shed) Island, where young were fledged in each of the survey years: 65, in 2019: 12 in 2020; and 54 in 2021 (see note below Figure 31 below).

Ringed plover also did well, fledging young in all years except 2019. They were successful on two occasions at Old Hall point, and one fledgling was raised on Cobmarsh Island in 2020.

Little terns fledged six young in 2018, from Old Hall point and Tollesbury Wick. It is disappointing that this was not repeated between 2019 and 2021.

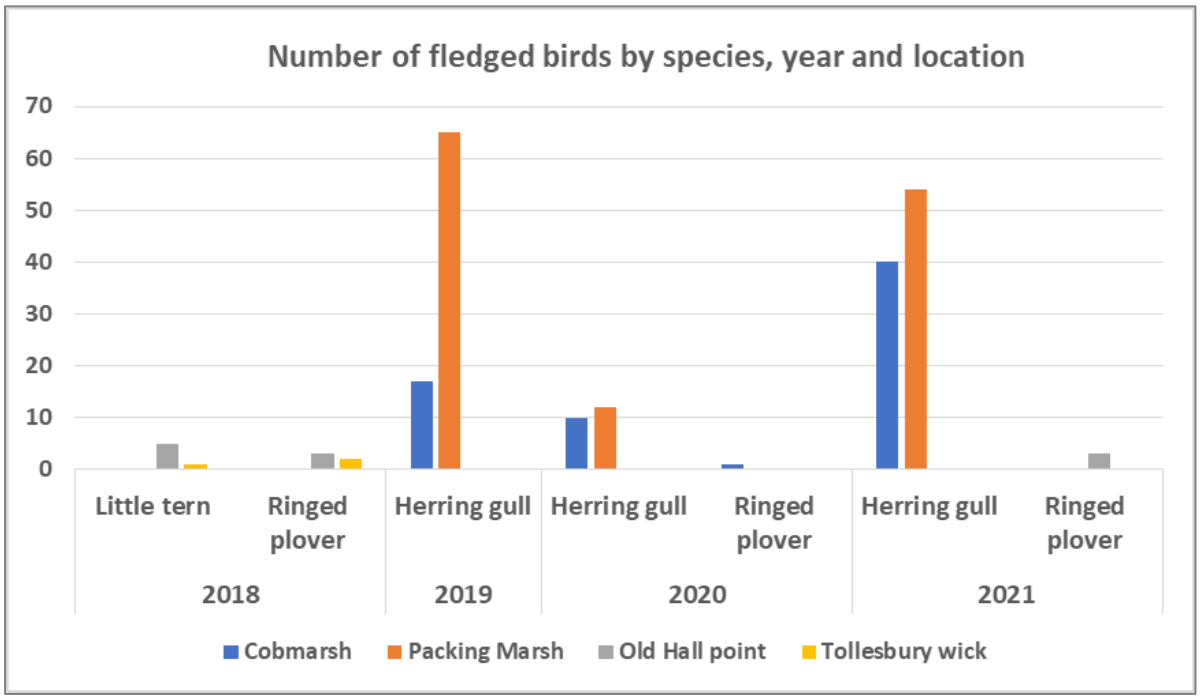


Figure 31. Number of fledged young by species and location on historical recharge, 2018 to 2021.
Note: Data on fledgling herring gulls was not collected in 2018 - it is not possible to accurately separate lesser black-backed gulls and herring gulls from a visual survey alone.

7.2.2 Post-placement survey

One reporting season has occurred since the completion of the recharge campaign on 15 January 2022. The outcome of the summer 2022 breeding survey is reported below. Figure 32 compares breeding success across the historical and new recharge sites.

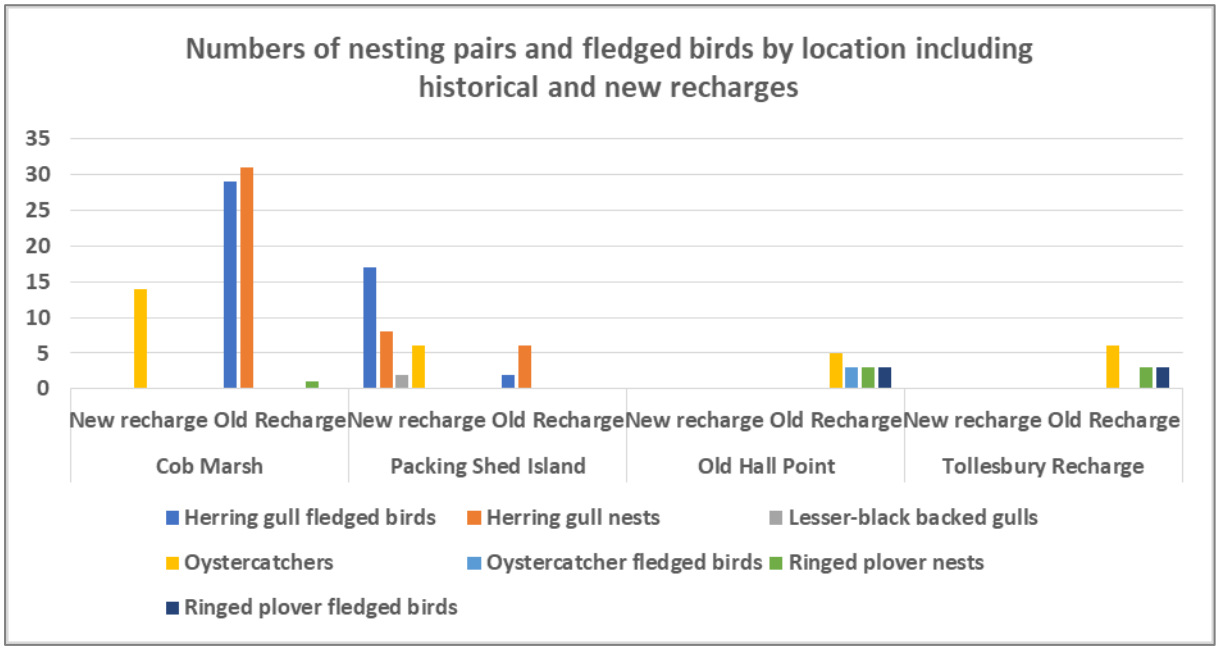


Figure 32. Number of nesting pairs and fledged young by location, comparing historical and new recharge sites, 2022.

Significant breeding successes occurred on the new recharge at Packing Marsh Island, which supported three species: oystercatchers (six pairs), herring gulls (17 birds fledged, compared with 2 fledged on the old recharge); and lesser black-backed gulls making a return to the estuary to breed. A further surprising development was the appearance of 14 pairs of

oystercatchers on the new recharge at Cobmarsh Island. However, given that the highest areas of the new recharge were covered by between 20 to 60 per cent of high tides during the season (see Section 3) these pairs may only have been loafing here or were a loose flock passing through and using the recharge to rest on. Alternatively, and perhaps more likely, they may have been involved in courtship behaviour but nesting elsewhere on the estuary. Due to the prescribed survey methodology for counting nesting birds, birds engaging in other activities will, on occasion, inevitably be included.

The new recharge at Old Hall and Tollesbury Wick did not support nesting. These sites were frequently covered by high tides (see Section 3) and this may have influenced the outcome here.

It is notable that the number of ringed plover breeding pairs rose from five to seven, accounted for by an increase from one to two pairs on the old recharge at Tollesbury Wick.

7.3 Discussion

There were no records of little terns on the new recharge in this first nesting season following the recharge placement. Nevertheless, little tern are known to respond well to early successional and newly created habitat. The original recharge in the Mersea Quarters is probably one of the best examples of this behaviour (MHPT, 2016). Following the recharge placement in 1998, breeding little terns were recorded at Old Hall point in 2002 for the first time since 1993. They subsequently bred in most years until 2010, when numbers declined markedly, but returned in 2017 when 10 pairs bred. The outcome at the Tollesbury Wick recharge was even more impressive, with colonisation in 2001 and a peak count in 2005 when 30 young were fledged from 30 nests. Subsequently, numbers began to dwindle and did not return to these peaks. As habitats mature, they can become less attractive to nesting little terns. This may either be due to vegetation development or aggressive dominant species moving in - for example, large gulls, black-headed gulls, or common tern: common tern colonised the Tollesbury Wick historical recharge the year after little tern numbers peaked in 2005 (MHPT, 2016). Alternatively, an increase in predation may influence nesting behaviour as the various predators become aware of the new colony.

In more recent times little terns have continued to be infrequent breeders in the estuary, breeding only twice over the past four years. The last breeding attempt occurred in 2020, when two pairs nested at Old Hall point. The last successful breeding record was in 2018 when five pairs fledged five young from Old Hall point and Tollesbury Wick. Although little terns were present in 2019, with four individuals observed around Old Hall point, they did not settle. This was assumed to be due to the weather and/or intangibles like food availability. In 2021, six pairs of little terns nested at Colne Point, at the mouth of the adjacent Colne Estuary. It is possible that these birds had formerly nested in the Blackwater.

With the end of lockdown, in 2020, the impact of increased recreational disturbance was noticeable: ringed plover nests were spread out across the survey locations; it marked the end of black-headed gulls nesting on Cobmarsh Island; and herring gull success was much reduced. Several disturbance events were recorded in the little tern breeding colony, but it is impossible to know if this contributed to breeding failure, with mammalian predation also being a strong possibility.

It is notoriously difficult to influence little tern nesting success as there are many variables acting upon this, including: high tide events (the colony of ten pairs at Old Hall in 2017 was lost entirely in one high tide); food availability (largely unknown in the Blackwater estuary), and, as indicated above, disturbance incidents can have significant consequences. However, human disturbance is a factor we can seek to address. The RSPB has developed a communications strategy with the Essex Wildlife Trust to raise public awareness of nesting birds in the Blackwater, disseminating information through leaflet distribution and signage.

This was scaled up in the run-up to the 2022 nesting season and supplemented with educational talks given by the RSPB and MHPT at sailing clubs in the area. This led to a request from Mersea Island Watersports for an instructive loop video that could be viewed by customers hiring out kayak and paddle board equipment. The video was funded jointly by the RSPB[2] and MHPT.

Possibly resulting from the above campaigning efforts, anecdotal evidence suggests that the new recharge has reduced recreational pressure across all the recharge locations. The sites which had been roped-off and signed during the 2022 nesting season - ie the historical recharge at Old Hall point, Tollesbury Wick and Cobmarsh Island, and the new recharge at Packing Marsh Island - recorded less disturbance incidents than in previous years. The new recharge at Cobmarsh Island had unrestricted access and became a draw for recreational activities, especially during the summer holidays. With good planning and continued dialogue between all those invested in the management of the estuary, it is hoped that the range of interests and activities can continue to be accommodated. It is suggested that the locations of restricted recharge sites be reviewed by the RSPB and MHPT, in liaison with user groups, in the period leading up to the nesting season each year. Should there be any indication of prospective nesting by little terns (or indeed other species) outside of agreed delimited areas, best efforts will be made to ensure their protection.

The new recharge at Tollesbury Wick and Old Hall point was of insufficient height above the higher tides to support successful nesting in 2022. Changes in the recharge profiles are being monitored by MHPT and heights may change.

Packing Marsh Island was the most successful post recharge site for nesting birds. It supported three breeding species, with good numbers of large gull chicks fledged. Although 14 pairs of oystercatchers were recorded on the new recharge at Cobmarsh Island, as discussed above, these birds are most likely to have been breeding pairs nesting elsewhere in the estuary. It was encouraging to see an increase in nesting ringed plovers, from a very stable five to seven pairs, post recharge.

Though the saltmarsh of Cobmarsh Island is outside the scope of this study, Mersea oyster fisherman (Allan Bird) reported that he had noticed gulls nesting closer to the salting edge – 1m from the edge as opposed to around 5m pre recharge - speculating that this is a result of the marsh being more sheltered from storm waves.

However, the overall number of large gulls dropped between the 2021 and 2022 surveys. In 2021, across Cobmarsh and Packing Marsh Islands, 102 AONs (apparently occupied nests) of large gulls were counted, compared with 45 across all the survey sites (including the new recharge) in 2022. This seemed unaccountable given that anecdotal evidence suggested a reduction in the number of disturbance events, particularly on the historical recharge at Packing Marsh, roped off for the first time. Although avian flu (highly pathogenic avian influenza) was never confirmed in the local area, there were significant outbreaks in south Essex among black-headed gulls, and at the RSPB's Old Hall Marshes reserve. Several large gulls were found dead throughout the summer in the Mersea Quarters area, including 'a few dead gulls' reported on Packing Marsh by the MHPT project manager, Mark Dixon. It therefore seems likely that HPAI has had an impact on the colonies at Cobmarsh and Packing Marsh Islands.

Although it is disappointing that no little terns nested in the first-year post recharge, there was a noticeable lag effect following the original recharge placement in the late 1990s before they began to colonise. On that basis, it may be reasonable to expect that, as tide and wave action shape the recharge at Old Hall, it may become suitable to support breeding little terns in the future.

[2] Funded through 'Life on the Edge': a four-year LIFE* Nature project led by the RSPB with the National Trust (European Union LIFE programme).

8. Bird feeding

Monitoring	Purpose	Location	Pre-placement survey	Post-placement monitoring
Bird feeding – overwinter	To monitor bird usage of intertidal flats.	Cobmarsh Island and Old Hall foreshore inside recharge bunds.	Over at least two seasons prior to placement, recording on two separate occasions between October and March.	Over three seasons.

8.1 Method

There is no fixed methodology for surveying feeding birds overwintering on an estuary. A technique used in the past involves a survey, every hour, over the six-hour tidal window. This was not considered a suitable method at the current locations due to limiting geographical factors. It was therefore decided to count 1.5 hours either side of low water from a vantage point at the east end of Old Hall Marshes. This would allow both Old Hall and Cobmarsh Island to be surveyed, minimise disturbance, and avoiding double counting.

The total number of birds seen and the totals by species were recorded over the period 2018 and 2021. Surveyors covered the areas, as described, recording what they observed following the British Trust for Ornithology's 'look-see' low tide count methodology for the Wetland Bird Surveys (WeBS). Feeding patterns and changes in bird assemblage over time were also noted to establish the relative importance of feeding locations and site fealty.

No surveys were carried out in the winter of 2021/22; these would have coincided with the recharge operation and it was considered that no meaningful results would be obtained if birds were disturbed during the delivery of dredgings.

8.2 Results

Survey dates varied from year to year depending on the tide but, generally, a count was carried out before the end of the year and then within the first three months of the following year. This was to ensure a sufficient gap between counts to get as true a representation of wintering use as possible.

The table in Appendix 1 breaks down the results from each of the 12 counts conducted between 2018 and 2021 and Figure 33 shows the number of occurrences of each species recorded between this period.

Black-headed gulls, brent geese, curlew, herring gull, and oystercatcher were recorded in each of the 12 surveys. The next most commonly recorded birds were turnstone, wigeon and redshank.

In total 32 species of birds were noted: 15 waders, three duck, two geese, five gulls; with the rest made up of shelduck, cormorants etc. The results are consistent with these areas being used predominantly for wader feeding during low tide, when the maximum amount of soft mud is exposed. Surprisingly, few duck species were recorded, however, this is probably due to the fact that ducks largely feed on saltmarsh, grassland, or anywhere there is a seed-rich food source. The ducks recorded were generally found either resting or loafing on the harder, abraded clay.

Brent geese mostly used the areas for feeding along the shoreline or for roosting and feeding within the saltmarsh.

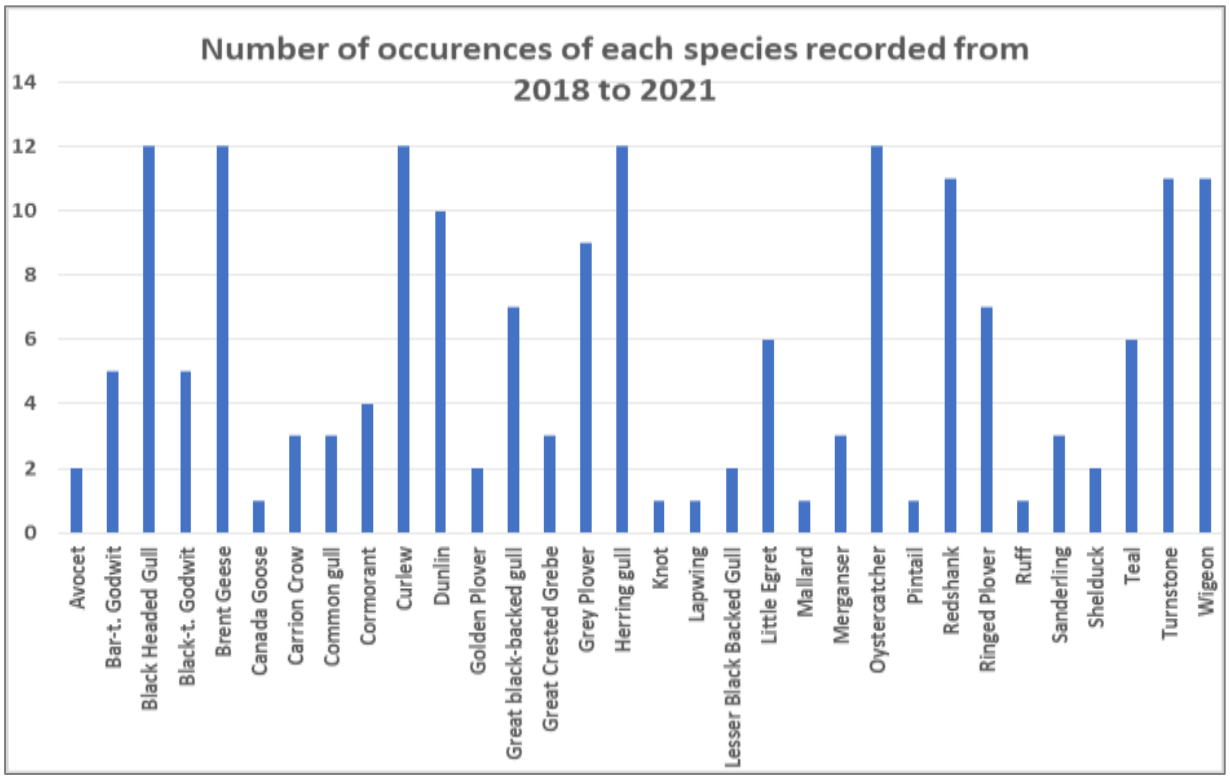


Figure 33. Number of occurrences of each feeding species recorded from 2018 to 2021.

Figure 34 averages the numbers of individual species across the 12 counts collected over the three-hour survey period, based on peak counts.

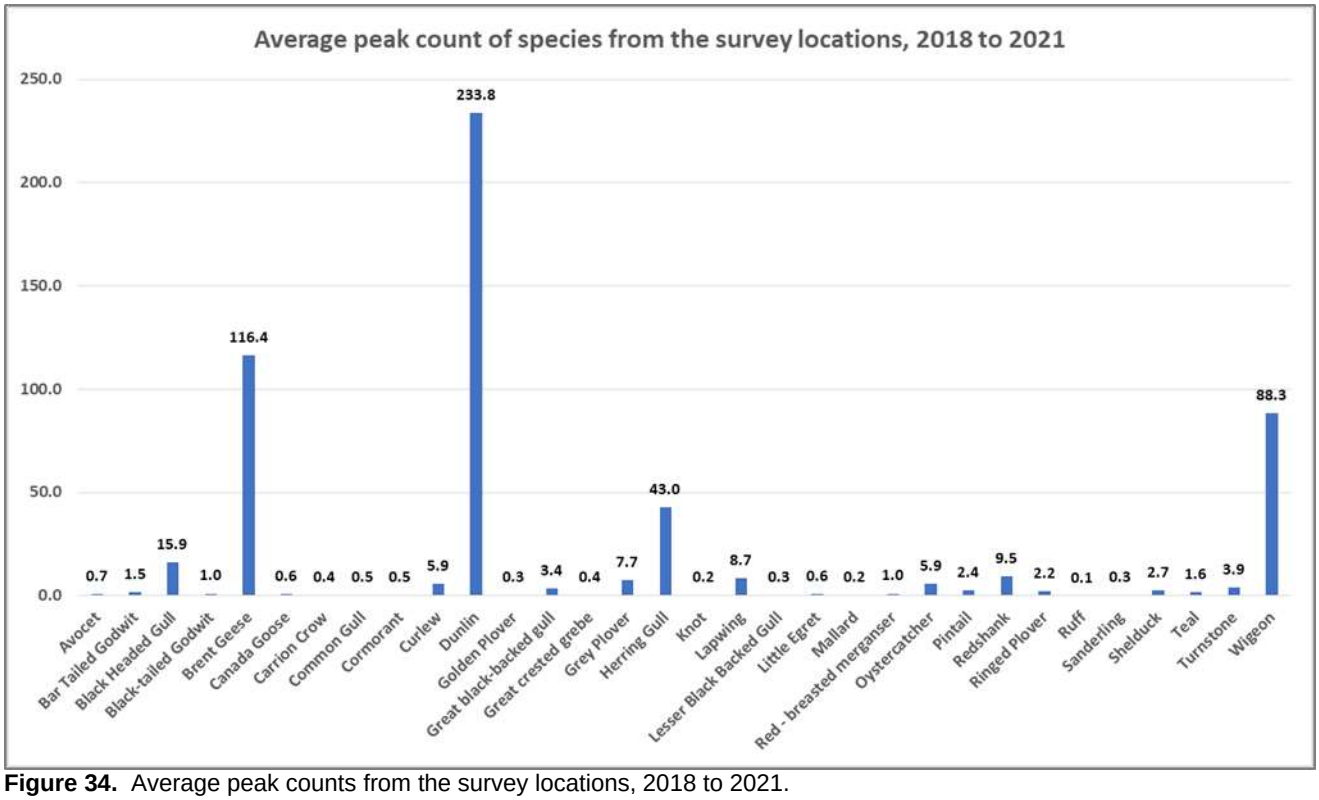


Figure 34. Average peak counts from the survey locations, 2018 to 2021.
Note: The graph takes the peak count recorded from the 3-hour survey of each species, adds them together and then divides by five, to give an idea of usage by individual species. It shows that despite some species being recorded in every count, some of the numbers are very modest.

The dominant species recorded was dunlin, and the second highest in number was brent geese, followed by wigeon. The predominance of dunlin is to be expected as this is a classic species of the shoreline, feeding on newly exposed mud. Generally, dunlin numbers peaked at the lowest tide. Once the tide turned, they moved on to new areas.

The remaining waders were found in small numbers across all counts, normally in single figures. The number of knot is relatively surprising: in most winters they can be present in high numbers in the estuary, but this was not observed in any significance during the counts.

Herring gulls are well represented, and numbers tended to be bolstered by roosting/loafing gulls in the Cobmarsh Island count area, rather than at Old Hall point. Wigeon were mostly either resting or loafing on the harder clays.

Appendices 2 and 3 detail the association between feeding birds and tide times at Cobmarsh Island and Old Hall for some of the species. As indicated, the counts were dominated by large numbers of dunlin and there appears to be a correlation between tide height and bird numbers, with birds moving away as the tide rises.

8.3 Discussion

In total, 32 different species were recorded (this total includes red–breasted merganser which would not have been feeding on the mudflat but on the sea adjacent to the study area). Generally, the species recording the highest counts were dunlin, brent geese and wigeon, although all three species were observed to have slightly different interactions with the habitats within the study area. The majority of species were waders but they were frequently found in modest numbers across all the counts and across all the survey areas, averaging single figures; even the dunlin numbers were moderate compared to the total numbers of this species using the estuary in the winter months.

Generally, waders use the area to feed on the freshly exposed mud at low tide, being pushed up as the tide rises. This association can be seen quite clearly in the graphs in Appendices 2 and 3 and is mostly accounted for by the behaviour of the dunlin flocks. Wigeon (the most commonly observed duck) was generally not feeding but resting on the hard clay. Their numbers generally remained consistent throughout the counts. Brent geese behaviour varied from bathing in the shallow water, to feeding along the water's edge, to loafing and roosting further up the shore.

As mentioned above, gulls where well represented, most notably herring gulls. However, these were generally found only at Cobmarsh Island, mostly loafing on the shingle bank formed by the earlier recharge, or on top of the saltmarsh. Black-headed gulls tended to be more actively feeding in the softer muds.

That the birds use these areas for feeding is not surprising. From the survey observations, more species of waders - and in higher numbers - were found at Old Hall point, but this may be partially accounted for by the ease of observation and the potential to miss smaller waders. However, Old Hall point is, generally, exposed to much less disturbance than Cobmarsh Island, the latter being located directly in the mouth of the estuary with more marine traffic using this area.

To put the figures into context, the most recent, 2017/18 Wetland Bird Survey (WeBS) low tide count (Frost et al., 2021) recorded a total of 54 species across the entire estuary. Although more than half of this species total was present in the study areas, there were a large number of species that did not use either of the survey locations.

The total numbers of individual bird species using the estuary during low tide, produced surprising results. The species recorded in the highest numbers in the current study was dunlin, with an average peak count across all the survey years of 233; this represents one per cent of the monthly average of 21,566 dunlin obtained from the WeBS low tide counts across the whole estuary. Knots are the second highest recorded species on the WeBS low

tide counts, with a monthly average population of 18,690. However, knots were rarely encountered feeding in the study area during the surveys. Also of note was the number and frequency of brent geese recorded (it was present across all 12 surveys) with an average peak count of 116. This represents two per cent of the monthly average population of 5,477 obtained from the WeBS low tide counts.

The recharge has covered approximately 5.16 ha of the intertidal representing 0.18 percent of the total for the Blackwater estuary. As such, there is no reason to conclude that the intertidal feeding area overall will have been significantly impacted due to the recharge placement. There is evidence of siltation over the eroded mud flats behind the recharge bunds at Cobmarsh Island and Old Hall (Section 5) and birds may have begun to utilise these areas. A small lagoon has developed behind the eastern end of the recharge at Cobmarsh Island and this new habitat is being exploited by mallard, wigeon, and teal. A redshank has also been seen in this area (pers comm, Mark Dixon).

9. Bird roosting

Monitoring	Purpose	Location	Pre-placement survey	Post-placement monitoring
Bird roosting	To monitor bird usage of new recharge.	All recharge proposal sites (and earlier recharge sites).	Earlier recharge sites.	Annually over three years – two counts between October and March.

9.1 Method

The BTO's WeBS methodology was followed to establish bird roosting ie the 'look-see' method, where observers familiar with the species survey the specified area. In order to determine the total numbers of birds and total number of species using the historical recharge sites, surveys were conducted from a boat covering all areas in one visit, starting one hour before high tide. By undertaking the counts on the same day, and by using the boat, the risk of double counting is reduced.

The timing of the survey varied from year to year, according to the tides, but generally there was one count before the end of the year and a second count before March the following year.

Five surveys were carried out across three years. The count in late winter 2020 was cancelled due to the restrictions imposed during the Covid pandemic. Also, no surveys were carried out in 2021/22 to avoid coinciding with the recharge campaign; it was considered that any disturbance arising from this activity could influence the results.

9.2 Results

The count data obtained from the historical recharge locations between 2018 and 2021 are presented in the table in Appendix 4. Figure 35 shows the average of all bird species recorded across all of the sites: the counts were added, and then divided by the number of counts carried out, to give an idea of usage for the individual species.

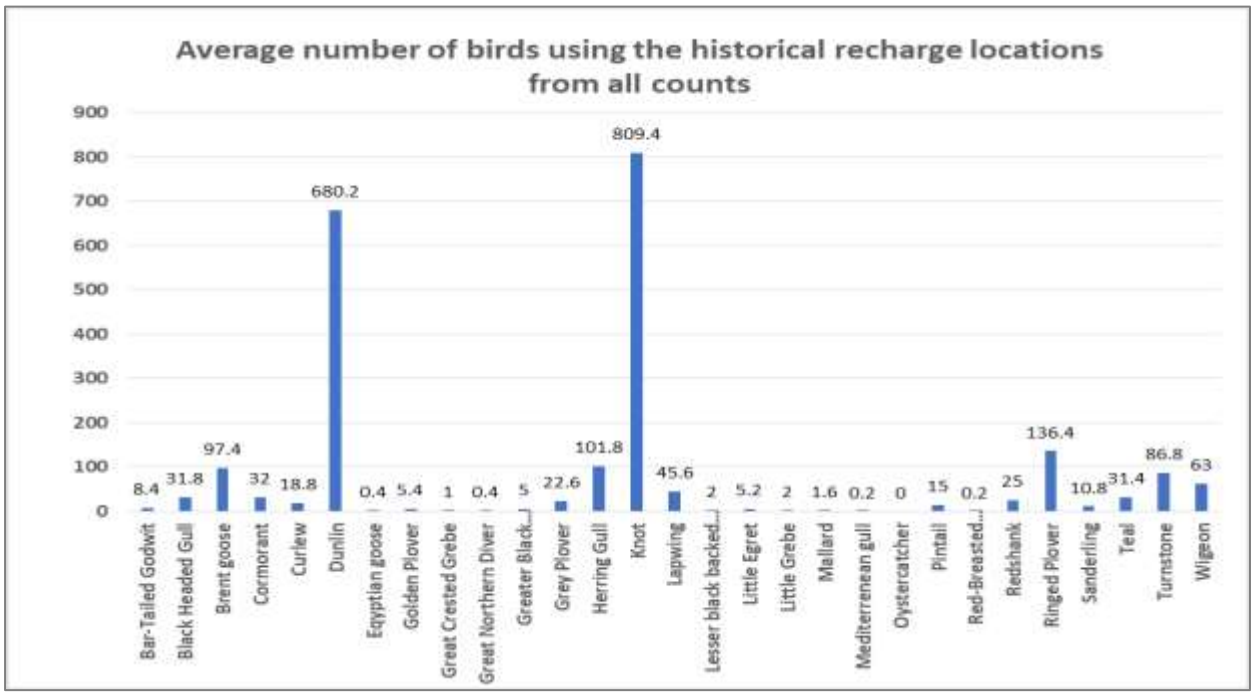


Figure 35. Average numbers of birds using the historical recharge locations, derived from all counts 2018 to 2020.

Thirty species were recorded across all the counts and it is clear that the recharge areas are important roosting sites, in particular, for supporting knot and dunlin, followed by ringed plover. The remaining waders and ducks were found in relatively modest numbers. Generally, more birds were recorded on the historical recharge areas at high tide than low tide, and this possibly reflects the limited habitat available for supporting wintering birds at high tide.

With the exception of February 2021, the Tollesbury Wick recharge supported the highest numbers of birds (Figure 36). It is a recognised location for roosting birds, in particular knot and dunlin.

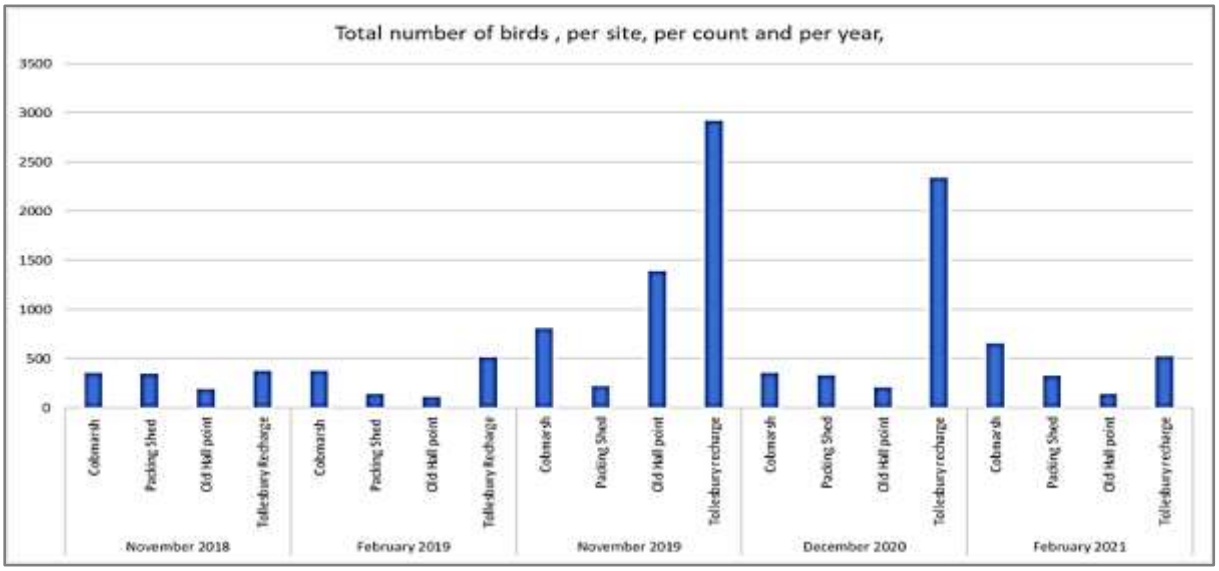


Figure 36. Total number of birds, per site, per count and per year on historical recharge sites, 2018 to 2021.

In all but one survey, Cobmarsh Island supported the greatest species diversity and, generally, supports a more diverse assemblage of habitats than the other sites. In November 2019, all sites recorded 17 different species (Figure 37). The Tollesbury Wick recharge generally has the lowest species diversity but holds the highest number of birds.

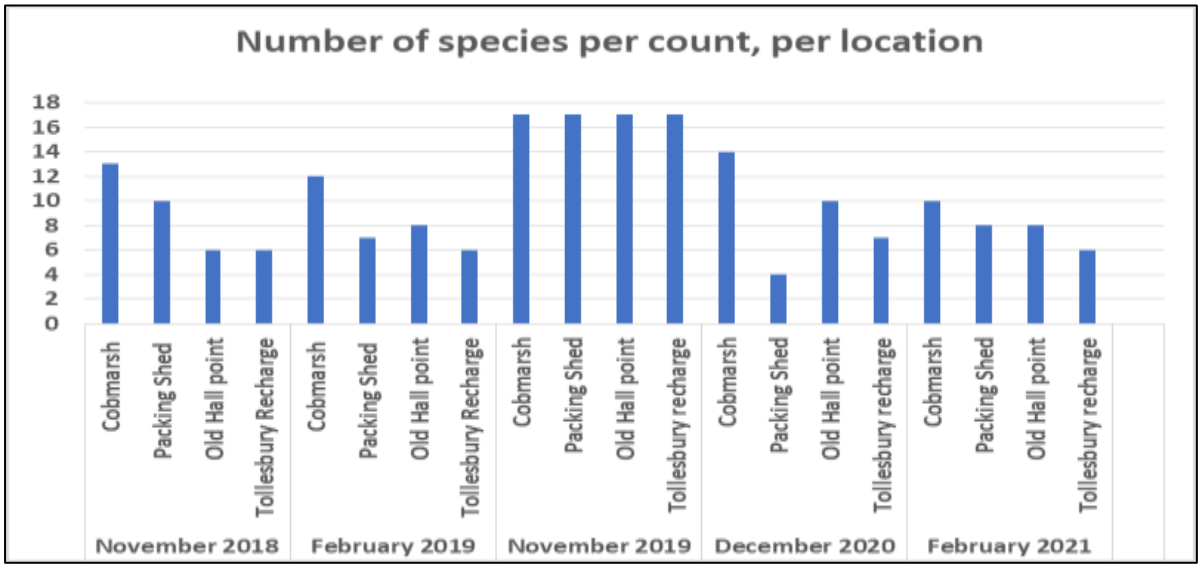


Figure 37. Number of species per count at each location between November 2018 and February 2021.

9.3 Discussion

Although the roosting surveys recorded fewer species than the low tide counts, ie 30 compared to 32, the low tide/feeding counts included some species that were observed adjacent to the survey areas - great northern diver, little grebe etc – which were not using the survey area to feed. The number of birds on the roost counts was much higher than on the low tide counts, in particular knot and dunlin were found in high numbers, notably on the Tollesbury Wick recharge.

Generally, Cobmarsh Island held the greatest species diversity and this is probably due to the size of the area; it also has the greatest variety of habitats, including high saltmarsh and shingle, in contrast to the other sites which are mostly restricted to sand and shingle. However, in terms of numbers of birds, the results at Cobmarsh were generally low, especially when compared to some of the counts obtained from the Tollesbury Wick. This is probably a reflection of the lack of disturbance at Tollesbury, which is some distance from boat traffic and far enough away from the walkers on the seawall.

Of the 30 species recorded, 12 were waders - which is more than any other taxa, for example gull and duck - showing the relative importance of the recharge roosts and associated mudflats to these species. Ducks, geese and gulls generally have more options for feeding and roosting, including on the adjacent wet grassland and brackish ditches of the RSPB's Old Hall Marshes and the Essex Wildlife Trust's Tollesbury Wick Marshes. Knot, dunlin and grey plover clearly show a much stronger preference for the intertidal areas.

The Blackwater estuary is nationally important for a wide range of wintering wildfowl and waders including dunlin, knot, brent geese, and grey plover, among others. The latest moving five-year average for the estuary, over the period 2015/16 to 2019/20 (Frost et al, 2021) indicates that the most populous species is knot (19,145), followed by dunlin (16,106). The peak count of knot recorded during the present study was 2,300 (in November 2019 at Tollesbury Wick), representing 12 percent of all knot using the estuary during the 2019/20 winter season. Although only one count was undertaken in this period, anecdotally this is not an unusual number at Tollesbury Wick over winter. The highest dunlin number across all survey sites was 1459, recorded in November 2019, representing nine per cent of all the dunlin using the estuary in winter 2019/20. These figures are indicative of the relative value of the historical recharge locations to the wintering assemblage of wading birds.

Overall, the Blackwater estuary lacks high tide roosting sites, with a few well-known locations dominating the counts, including the Tollesbury Wick recharge, which, as demonstrated, can hold a high percentage of the knot population. Dunlin are more widely spread around the recharge locations but rely on these sites almost as much. Roosting sites, as well as being restricted in number, are not always available, depending on the height of the tide, and may be subjected to human disturbance - a situation that may be worsen as sea level rise reduces the viability of roost sites. The new recharge will, hopefully, have increased the area of suitable roosting habitat within the estuary. It will be interesting to see if this is borne out when the first survey is undertaken on the new recharge over the 2023/24 wintering period.

10. References

Mersea Harbour Protection Trust (2016). Environmental Statement to support a licence application to the MMO: Mersea Harbour and Tollesbury Wick Climate change adaptation recharge project. Author: Carol Reid.

Frost, T M, Calbrade, N A, Birtles, G A, Hall, C, Robinson, A E, Wotton, S R, Balmer, D E and Austin, G E (2021).
Waterbirds in the UK 2019/20: The Wetland Bird Survey. BTO/RSPB/JNCC. Thetford.

11. Appendices

Appendix 1. Results from 12 low tide counts conducted between 2018 and 2021.

Cobmarsh												
November 2018												
	10:00	10:15	10:30	10:45	11:00	11:15	11:30	11:45	12:00	12:15	12:30	12:45
Bar tailed godwit												
Black tailed godwit												
Black-headed gull		1		1		1	1	3	2	2	2	2
Brent Goose	38	23	41	46	33	30	17	23	9	6	2	2
Carrion crow										1	2	
Common gull						1						
Cormorant											1	1
Curlew	5	3	4	3	8	6	2	5	4	2	3	5
Dunlin	2	14	23	30	21	16	1	15	11	12	77	51
Golden Plover												
Great black-backed gull	1					1	8	9	6	8	6	
Grey Plover	11	1		1	1	1		1				1
Herring gull	5	7	7	6	9	7	16	20	12	14	14	5
Lapwing								85	93	48	102	13
Little Egret										2		
Oystercatcher	1	1	1	2	1		1	1		1	1	
Redshank	3	7	7	10	10	6	12	4	13	14	10	
Ringed Plover		2	8	3	3	3	2	1			1	
Sanderling	1		1	1								
Teal												
Turnstone	2	4	2	2	1							
Wigeon	8	9	9			1			2	3	7	8
Total:	77	72	103	105	87	73	60	167	152	113	228	88
Old Hall Point												
November 2018												
	10:00	10:15	10:30	10:45	11:00	11:15	11:30	11:45	12:00	12:15	12:30	12:45
Bar tailed godwit	1	1		1								
Black tailed godwit	2	5	4	2	2	3	1				1	
Black-headed gull	2	1	1	2	2	2	1	1	1	1	1	1
Brent Goose	144	132	132	142	150	167	20	14	13	14	26	16
Common gull												
Cormorant												
Curlew	3	3	4	6	2	3	6	2	3	3	4	3
Dunlin	85	169	175	181	516	552	750	220	200	120	170	26
Golden Plover							2				1	1
Great black-backed gull		1	1	1								
Great Crested Grebe		2		2								
Grey Plover	20	19	19	18	18	21	10	8	8	12	8	10
Herring gull								1	1			
Little Egret		1	1	1	1	1	1					
Mallard												
Oystercatcher	1	1	1	1	1	2	2				1	2
Redshank	2	2	3	3	2	3	4	3	6	8	3	4
Ringed Plover												
Sanderling												
Teal	1										3	
Turnstone	1	2	1	4	4	3						
Wigeon	166	166	159	137			216	257	242	258	233	278
Total	428	505	501	501	698	757	1013	506	474	416	451	341
Old Hall Point												
Feburary 2019												
	10:00	10:15	10:30	10:45	11:00	11:15	11:30	11:45	12:00	12:15	12:30	12:45
Bar tailed godwit	1	1		1								
Black tailed godwit	2	5	4	2	2	3	1				1	
Black-headed gull	2	1	1	2	2	2	1	1	1	1	1	1
Brent Goose	144	132	132	142	150	167	20	14	13	14	26	16
Common gull												
Cormorant												
Curlew	3	3	4	6	2	3	6	2	3	3	4	3
Dunlin	85	169	175	181	516	552	750	220	200	120	170	26
Golden Plover							2				1	1
Great black-backed gull		1	1	1								
Great Crested Grebe		2		2								
Grey Plover	20	19	19	18	18	21	10	8	8	12	8	10
Herring gull								1	1			
Little Egret		1	1	1	1	1	1					
Mallard			2									
Oystercatcher	1	1	1	1	1	2	2				1	2
Redshank	2	2	3	3	2	3	4	3	6	8	3	4
Ringed Plover												
Sanderling												
Teal	1										3	
Turnstone	1	2	1	4	4	3						
Wigeon	166	166	156	137	147	126	216	257	242	516	233	278
Total	428	505	500	501	845	883	1013	506	474	674	451	341

Cobmarsh												
Feburary 2019												
	10:00	**10:15**	**10:30**	**10:45**	**11:00**	**11:15**	**11:30**	**11:45**	**12:00**	**12:15**	**12:30**	**12:45**
Bar tailed godwit												
Black tailed godwit												
Black-headed gull	120	72	35	24	24	25	19	20	20	19		23
Brent Goose	213	204	169	197	267	172	157	177	160	200	335	160
Carrion crow							1					
Common gull												
Cormorant				1					1			
Curlew	5	7	2	1	3	4	10	4	4	6	4	1
Dunlin		20	10	120	86	86			8		30	20
Golden Plover												
Great black-backed gull												
Grey Plover												
Herring gull	225	295	101	82	92	57	44	41	39	40		39
Lapwing												
Little Egret												
Oystercatcher	4	7	8	4	11	14	3	1	4	4	7	7
Redshank	9	12	18	14	12	12						
Ringed Plover			14									1
Ruff		1										
Sanderling												
Teal				2								
Turnstone		1										
Wigeon									2			
Total	**576**	**619**	**357**	**445**	**495**	**370**	**234**	**243**	**238**	**269**	**376**	**251**
Old Hall Point												
December 2019												
	10:30	**10.45**	**11:00**	**11:15**	**11:30**	**11.45**	**12:00**	**12:15**	**12:30**	**12:45**	**13:00**	**13:15**
Avocet		4	2									
Bar Tailed Godwit	7	8	4	5	6	5						
Black Headed Gull			1	1	2							
Black-tailed Godwit								1	1	1		1
Brent Geese	8		2	2					6	6		
Curlew	5	5	6	6	8	5	3	3		4	3	4
Dunlin	86	148	137	137	169	220	31	129	63	84	39	34
Grey Plover	3	6	2	4	5	5	1	9	7	2	4	4
Herring Gull	1	1	2	2	2	2			1		1	1
Little Egret								1				
Oystercatcher	4	2	3	3	2	4	2	3	1	1		
Red breasted merganser									1	3		4
Redshank	10	6	6	7	9	12	8	5	3	2	2	
Ringed Plover		1	1			1		1				
Sanderling			1					1	1			
Shelduck	16	16	1	1	10	8	8	3	9	9	9	7
Teal								3	4	3	3	4
Turnstone	9	2	4	5	5	2	6	3	2	4	2	1
Wigeon		5			34	33	22	5	41	44	46	67
Total:	**124**	**181**	**166**	**167**	**203**	**254**	**45**	**152**	**83**	**103**	**49**	**48**
Cobmarsh												
December 2019												
	10:30	**10.45**	**11:00**	**11:15**	**11:30**	**11.45**	**12:00**	**12:15**	**12:30**	**12:45**	**13:00**	**13:15**
Black Headed Gull	3	4	1	1	1	1	2	1	2	2	1	2
Brent Geese	63	99	49	63	71	59	39	24	17	13	7	
Cormorant			2	2			2	2	1	1	1	1
Curlew			1	2	1	1	2	5	2	1	1	3
Dunlin	19		21	47	32	65	155	152	116	96	14	44
Great Blacked back gull		5	12	3	2	1						1
Grey Plover					2	8	3	2	1		1	3
Herring Gull	10	12	13	23	30	30	26	17	23	12	16	25
Lesser Black Backed Gull					2							
Oystercatcher				2		1	2	3	4	4	1	3
Redshank	1		1	3		2		4	12	1	2	5
Turnstone								1	2	5	1	
Wigeon				3	26	27	23	22	26	21	25	25
Total:	**95**	**120**	**99**	**143**	**141**	**166**	**231**	**206**	**166**	**129**	**42**	**82**

Old Hall Point												
March 2020												
	11:15	11:30	11:45	12:00	12:15	12:30	12:45	13:00	13:15	13:30	13:45	14:00
Black Headed Gull	4	21	7	6	30	30	11	10	9	3	4	
Brent Geese	2	4						2				
Carrion crow								2				2
Curlew	2	2	2	2		1	2	2	3	2	2	2
Dunlin	1	40	9	22			0	59	14	9	4	0
Great Blacked back gull			1	1								
Grey Plover					1			1	1			
Herring Gull	2	2	1	3	7		1	1				
Knot		2	1									
Little Egret												1
Oystercatcher	4	4		3	2	2	0	5	5	4	1	1
Redshank	2		1	2	2							2
Ringed Plover	0									1		
Teal												
Turnstone	1	2	3	1	3							2
Wigeon							35	34	20	25	21	11
Total:	18	77	25	40	45	33	14	116	52	44	32	21
Cobmarsh												
March 2020												
	11:15	11:30	11:45	12:00	12:15	12:30	12:45	13:00	13:15	13:30	13:45	14:00
Black Headed Gull						1		1	1	1		
Brent Geese	2											
Common Gull						1						
Curlew	3	3	5	4	6	2	2	3	0	2		
Dunlin												
Great Blacked back gull				1	1	2	2	5	4		4	
Grey Plover												
Herring Gull	5	3	9	8	8	11	39	48	47	47	47	47
Oystercatcher		1		2	3	4	3		3		2	0
Pintail	18	16	19	20	24	19	24	24	24	29	29	25
Redshank	1	1									2	
Ringed Plover								1				
Teal	1		3	3	3	3						
Turnstone												
Wigeon	7	17	16	16	16	17	14	19	0	0	12	13
Total:	37	41	52	54	61	60	84	101	79	79	96	85
Old Hall Point												
December 2020												
	10:30	10.45	11:00	11:15	11:30	11.45	12:00	12:15	12:30	12:45	13:00	13:15
Avocet		4	2									
Bar Tailed Godwit	7	8	4	5	6	5						
Black Headed Gull			1	1	2							
Black-tailed Godwit								1	1	1		1
Brent Geese	8		2	2					6	6		
Curlew	5	5	6	6	8	5	3	3		4	3	4
Dunlin	86	148	137	137	169	220	31	129	63	84	39	34
Grey Plover	3	6	2	4	5	5	1	9	7	2	4	4
Herring Gull	1	1	2	2	2	2			1		1	1
Little Egret								1				
Oystercatcher	4	2	3	3	2	4	2	3	1	1		
Red breasted merganser									1	3		4
Redshank	10	6	6	7	9	12	8	5	3	2	2	
Ringed Plover		1	1			1		1				
Sanderling			1					1	1			
Shelduck	16	16	1	1	10	8	8	3	9	9	9	7
Teal								3	4	3	3	4
Turnstone	9	2	4	5	5	2	6	3	2	4	2	1
Wigeon		5			34	33	22	5	41	44	46	67
Total:	124	181	166	167	203	254	45	152	83	103	49	48

Cobmarsh												
December 2020												
	10:30	10.45	11:00	11:15	11:30	11.45	12:00	12:15	12:30	12:45	13:00	13:15
Black Headed Gull	3	4	1	1	1	1	2	1	2	2	1	2
Brent Geese	63	99	49	63	71	59	39	24	17	13	7	
Cormorant			2	2			2	2	1	1	1	1
Curlew			1	2	1	1	2	5	2	1	1	3
Dunlin	19		21	47	32	65	155	152	116	96	14	44
Great Blacked back gull		5	12	3	2	1						1
Grey Plover					2	8	3	2	1		1	3
Herring Gull	10	12	13	23	30	30	26	17	23	12	16	25
Lesser Black Backed Gull					2							
Oystercatcher				2		1	2	3	4	4	1	3
Redshank	1		1	3		2		4	12	1	2	5
Turnstone								1	2	5	1	
Wigeon				3	26	27	23	22	26	21	25	25
Total:	95	120	99	143	141	166	231	206	166	129	42	82
Old Hall point												
March 2021												
	09:05	09:20	09:35	09:50	10:05	10:20	10:35	10:50	11:05	11:20	11:35	11:50
Bar Tailed Godwit												
Black Headed Gull	16	12	16	14	6	10	4	2	6	1		
Brent Geese	341	341	344	344	328	328	341	344	367	360	360	129
Canada Goose	7											
Common Gull							1	1	1	1	1	1
Curlew	5		4	4	4	5	6	3	3	4	4	4
Dunlin	16	300	73	27	51	61	101	6	10	13		
Great Crested Grebe	1	1			1							
Grey Plover	2	1	3	4	3	4	2	1	4	1	1	4
Herring Gull	3	4	4	5	4	3		3	7	6	3	
Little Egret												
Oystercatcher	2		2	4	3	2		1	2	2	3	2
Red breasted merganser		1	2		4	1						
Redshank	3	4	5	14	8	8	2	2	2	5	1	1
Ringed Plover							1	1	2	2		
Turnstone			2	2	2	3						
Wigeon	12			8								
Total:	393	660	448	402	404	414	455	361	400	388	372	140
Cobmarsh												
March 2021												
	09:05	09:20	09:35	09:50	10:05	10:20	10:35	10:50	11:05	11:20	11:35	11:50
Black Headed Gull		1	1	3	5	1	2	1	5	1	1	2
Brent Geese	34	46	81	95	61	60	89	52	60	67	64	75
Curlew		1				1	1	1	2	2	1	4
Dunlin												
Grey Plover												
Herring Gull	33	35	27	35	30	30	36	41	44	50	73	68
Oystercatcher	1	1	2	4	2	2	1	2	7	11	8	22
Total:	68	84	111	137	98	94	129	97	118	131	147	171

Appendix 2. Low tide/feeding counts: changes in species number and composition over time - Cobmarsh Island and Old Hall, 2018/19

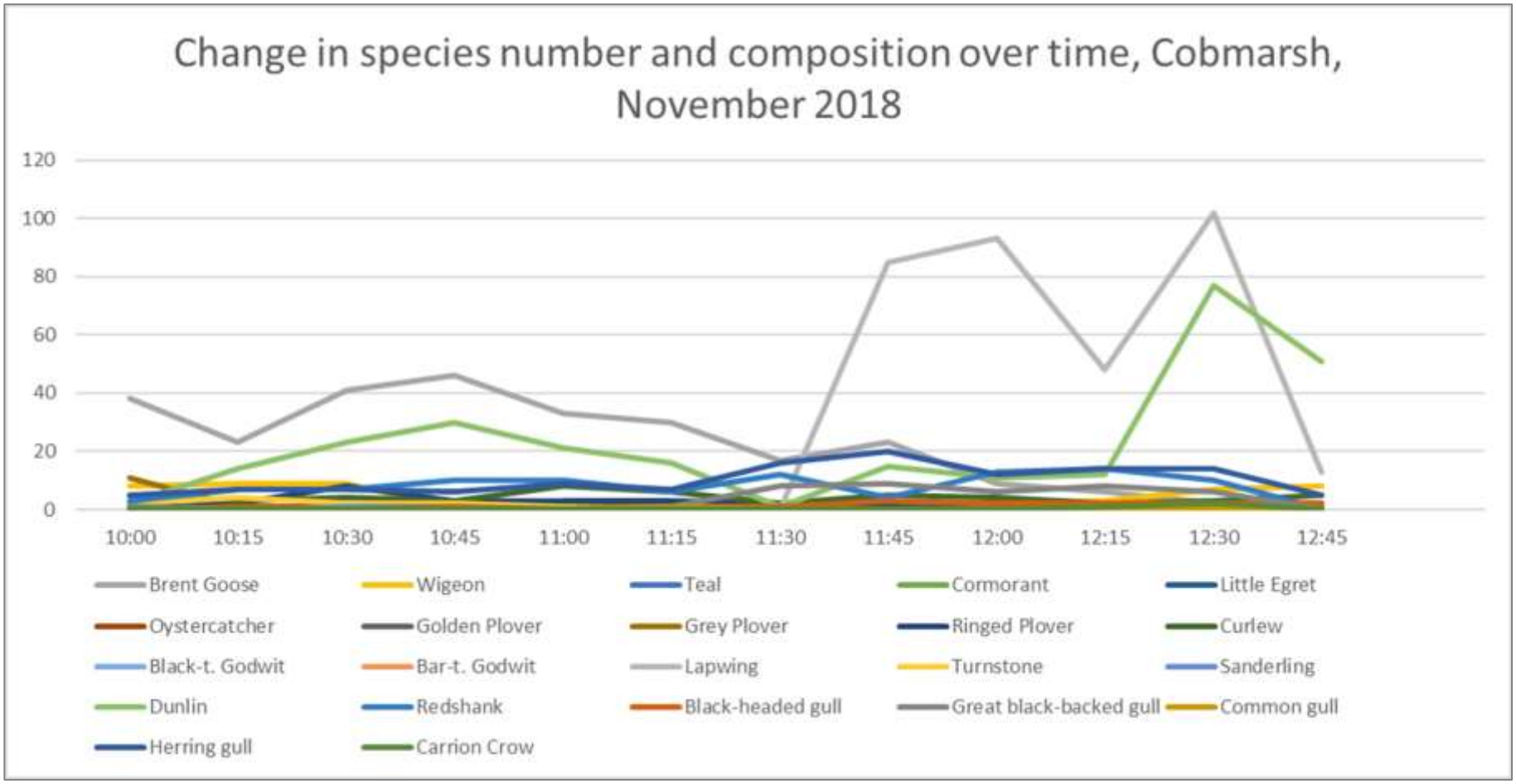


Figure i. Changes in feeding birds species composition over time, Cobmarsh Island, November 2018.

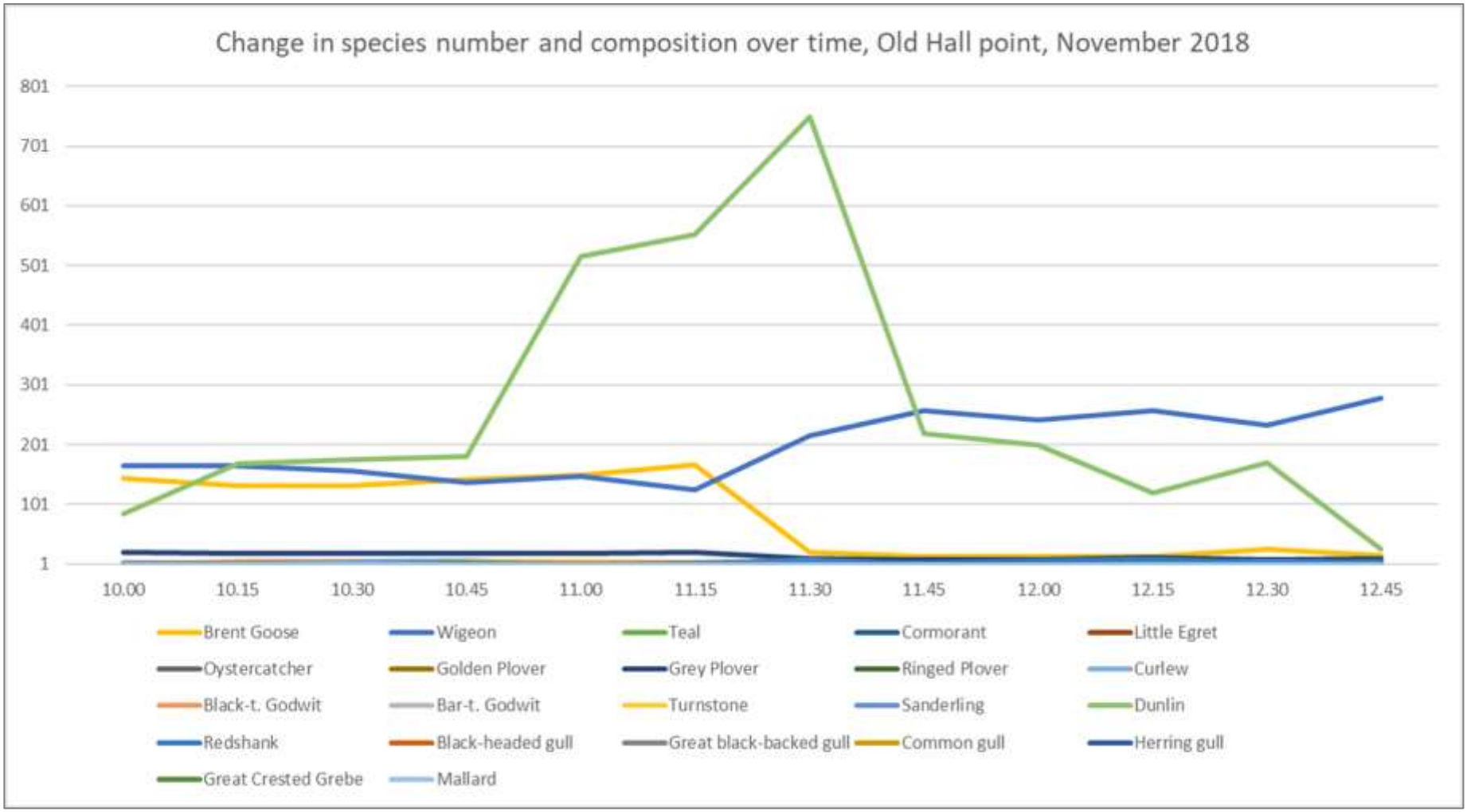


Figure ii. Changes in feeding birds species composition over time, Old Hall point, November 2018.

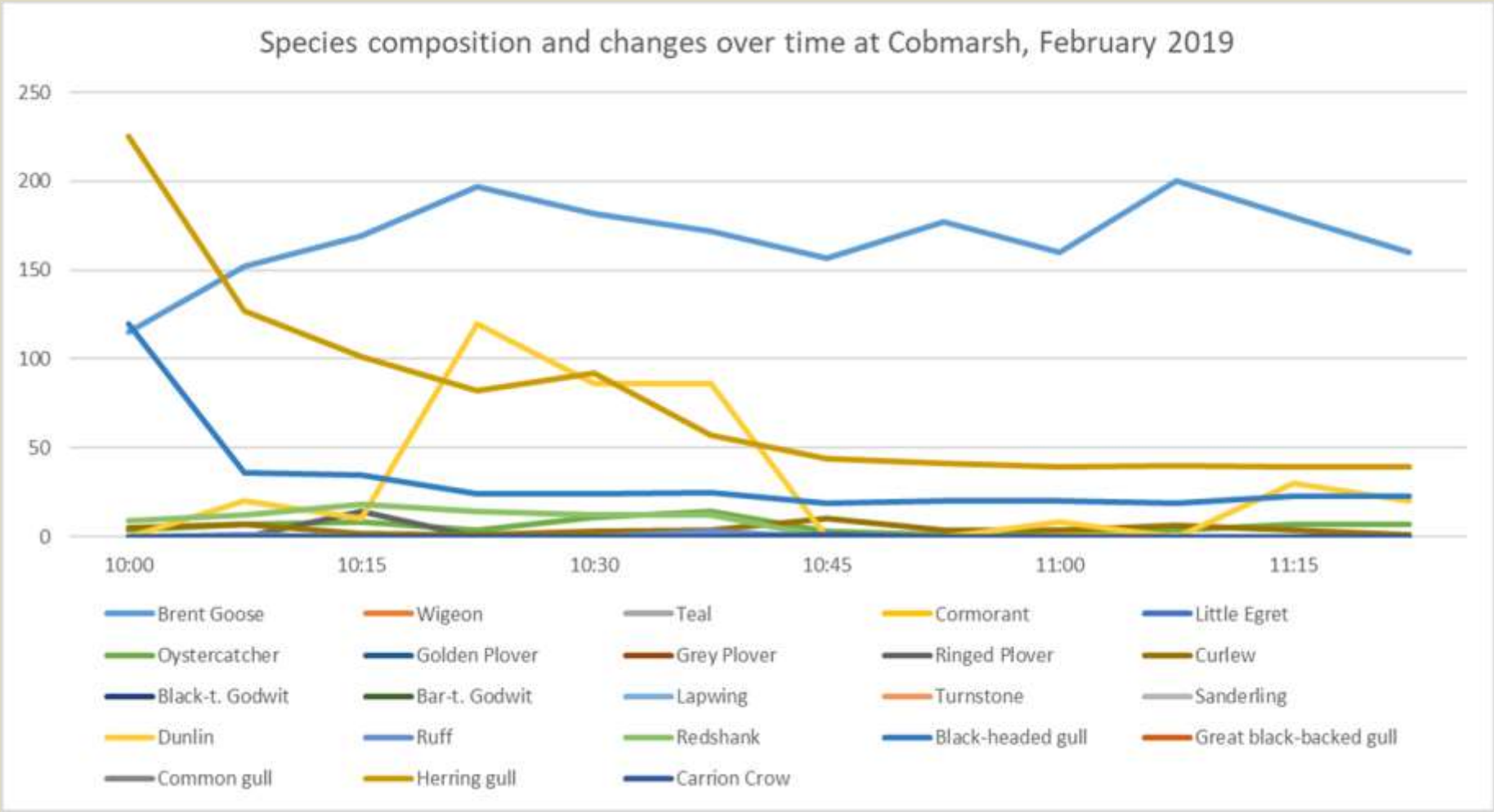


Figure iii. Changes in feeding birds species composition over time, Cobmarsh Island, February 2019.

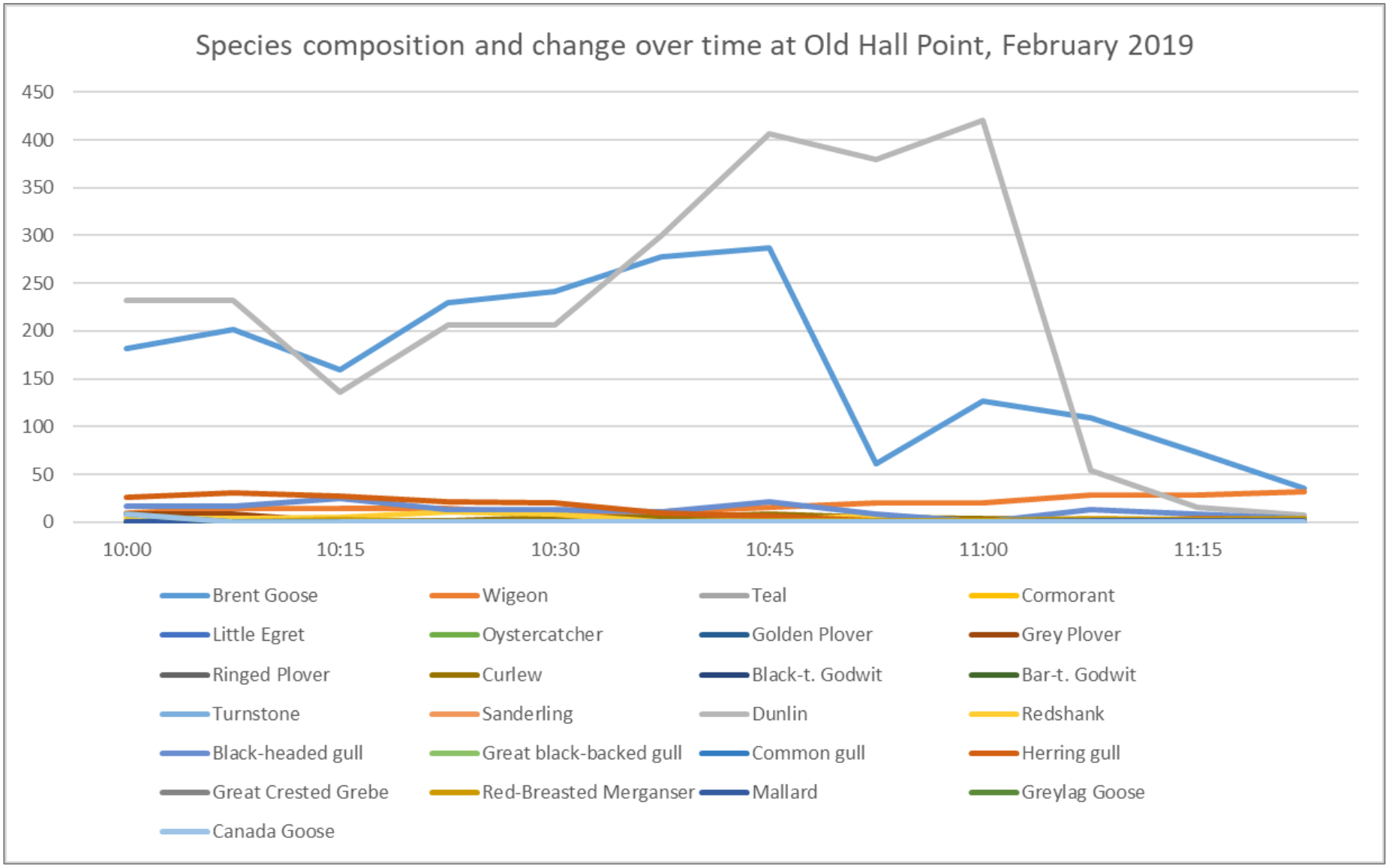


Figure iv. Changes in feeding birds species composition over time, Old Hall point, Feburary 2019.

Appendix 3. Low tide/feeding counts: total bird numbers against tide times and heights, Cobmarsh and Old Hall combined 2019/21

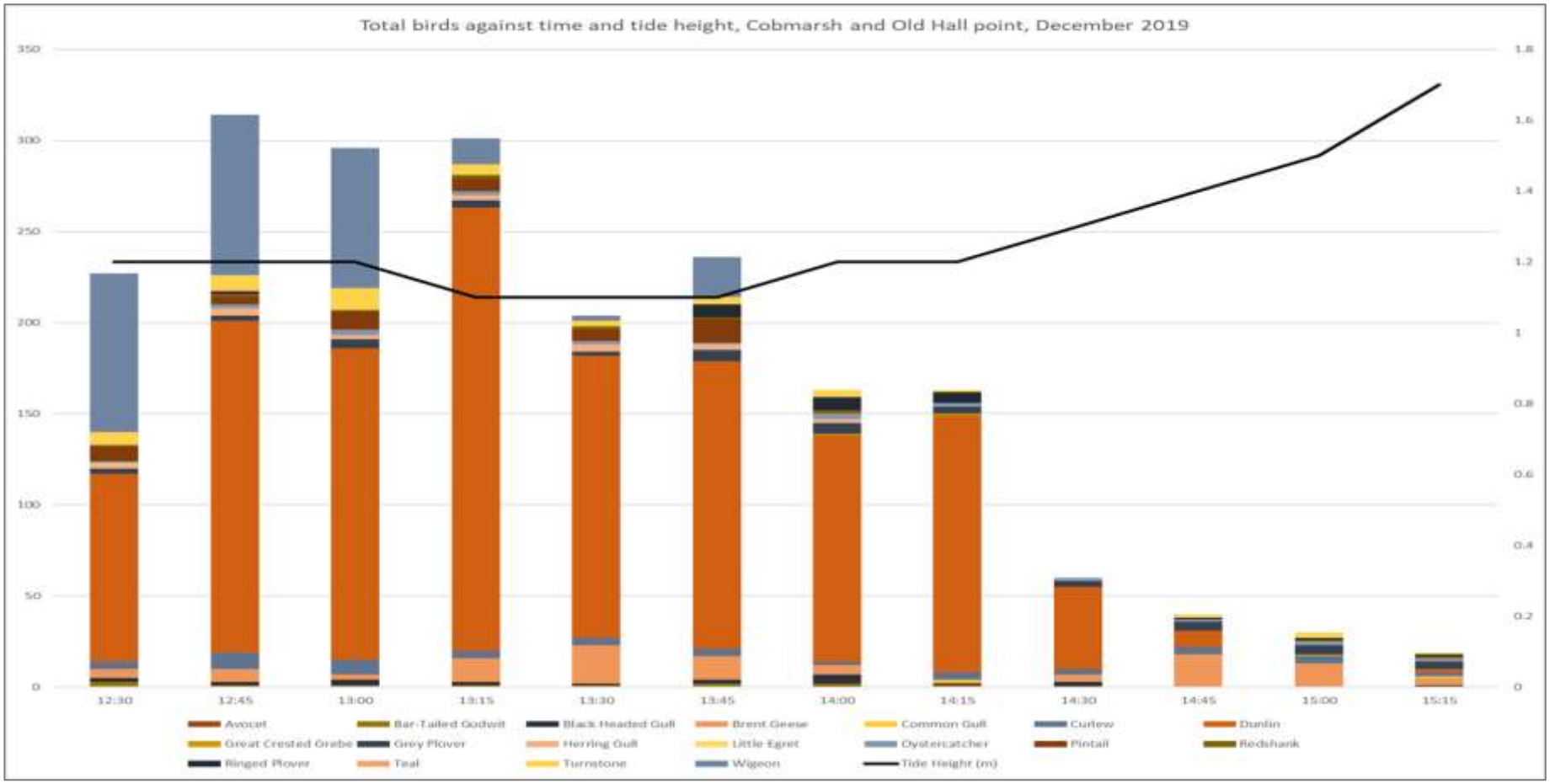


Figure v. Total feeding birds against time and tide height (m), Cobmarsh and Old Hall point, December 2019 (left axis - bird numbers; right axis – tide heights. Brown line indicates tide heights).

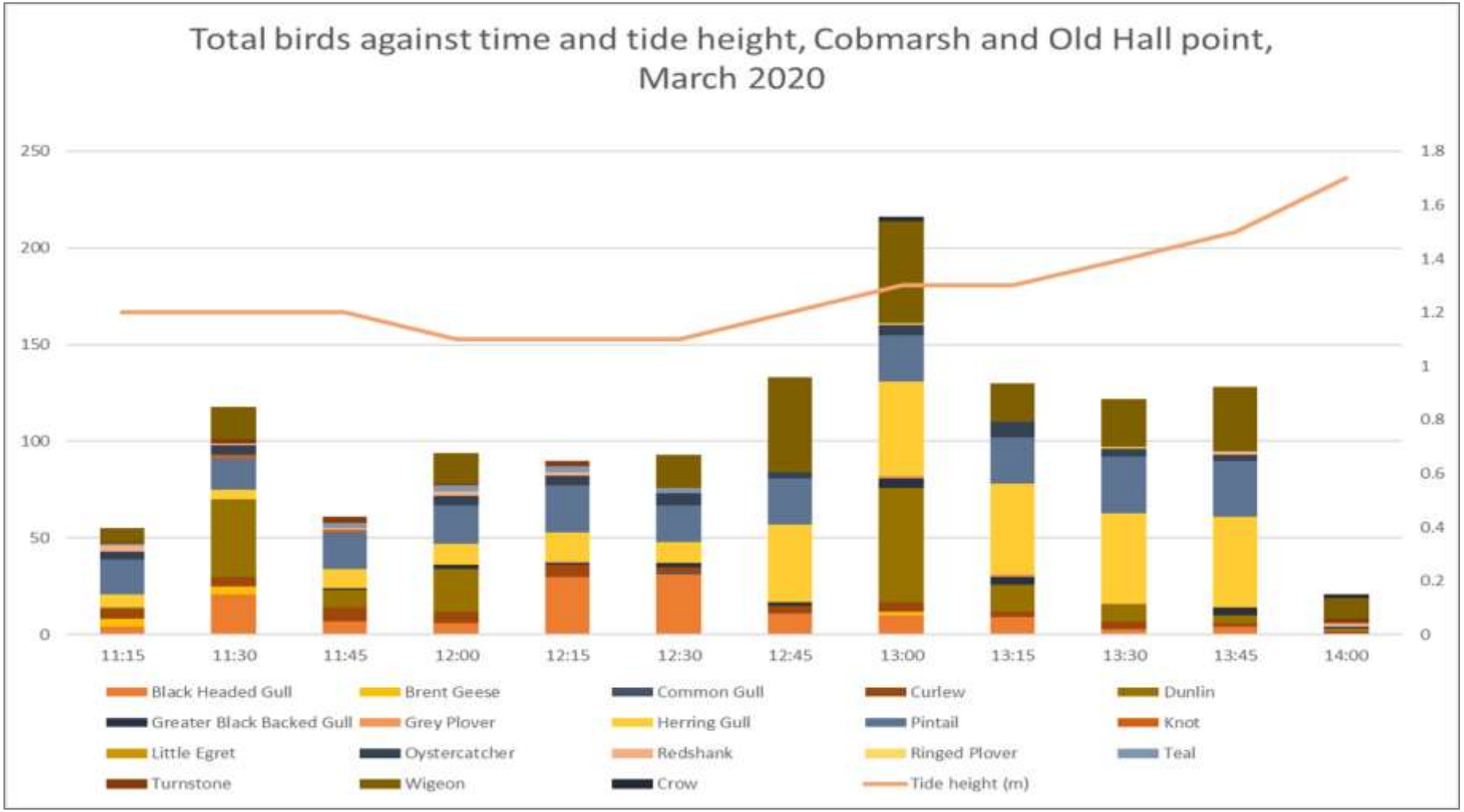


Figure vi. Total feeding birds against time and tide heights (m) Cobmarsh and Old Hall point, March 2020 (left axis - bird numbers; right axis – tide heights. Orange line indicates tide heights).

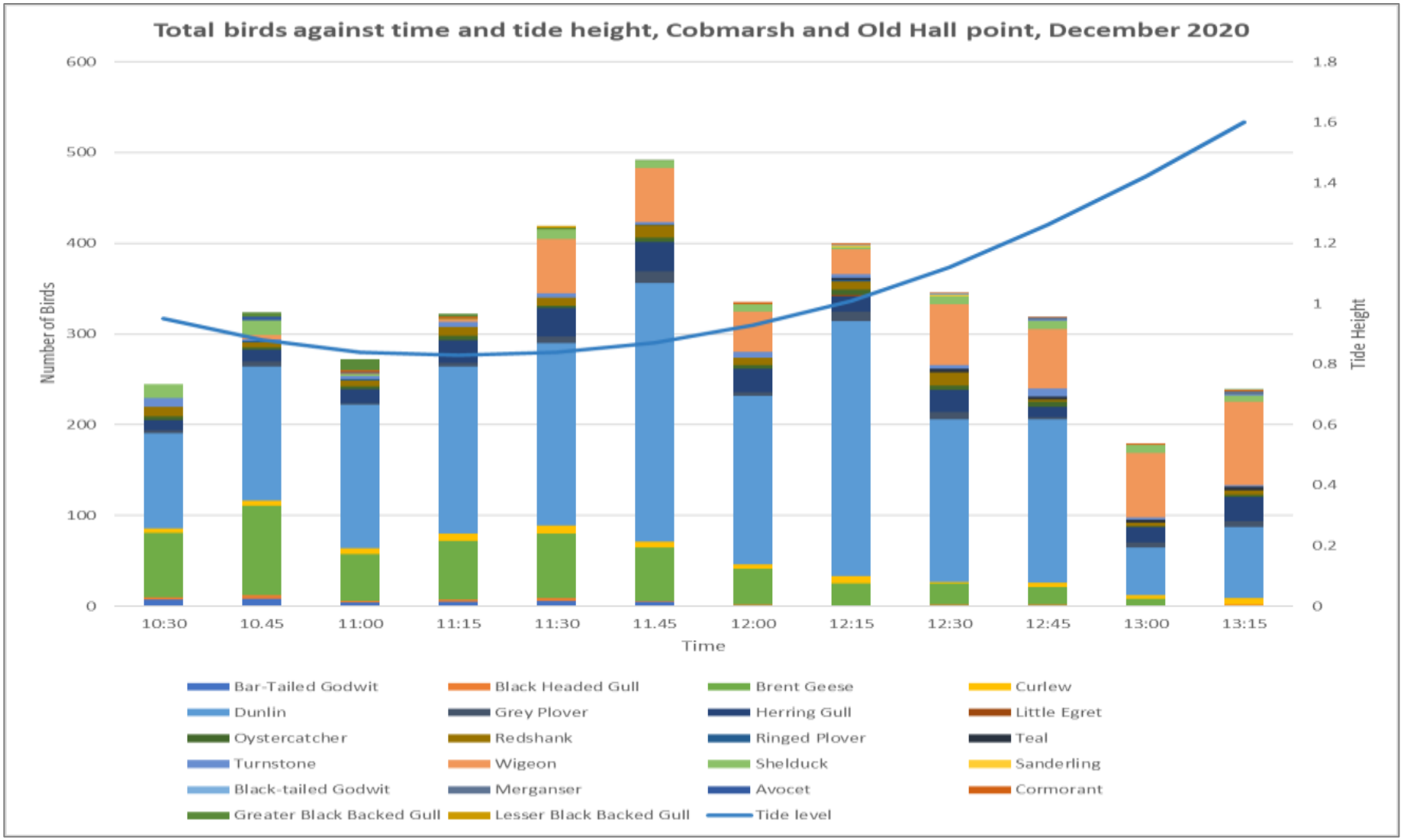


Figure vii. Total feeding birds against time and tide heights (m), Cobmarsh Island and Old Hall point, December 2020 (blue line indicates tide level).

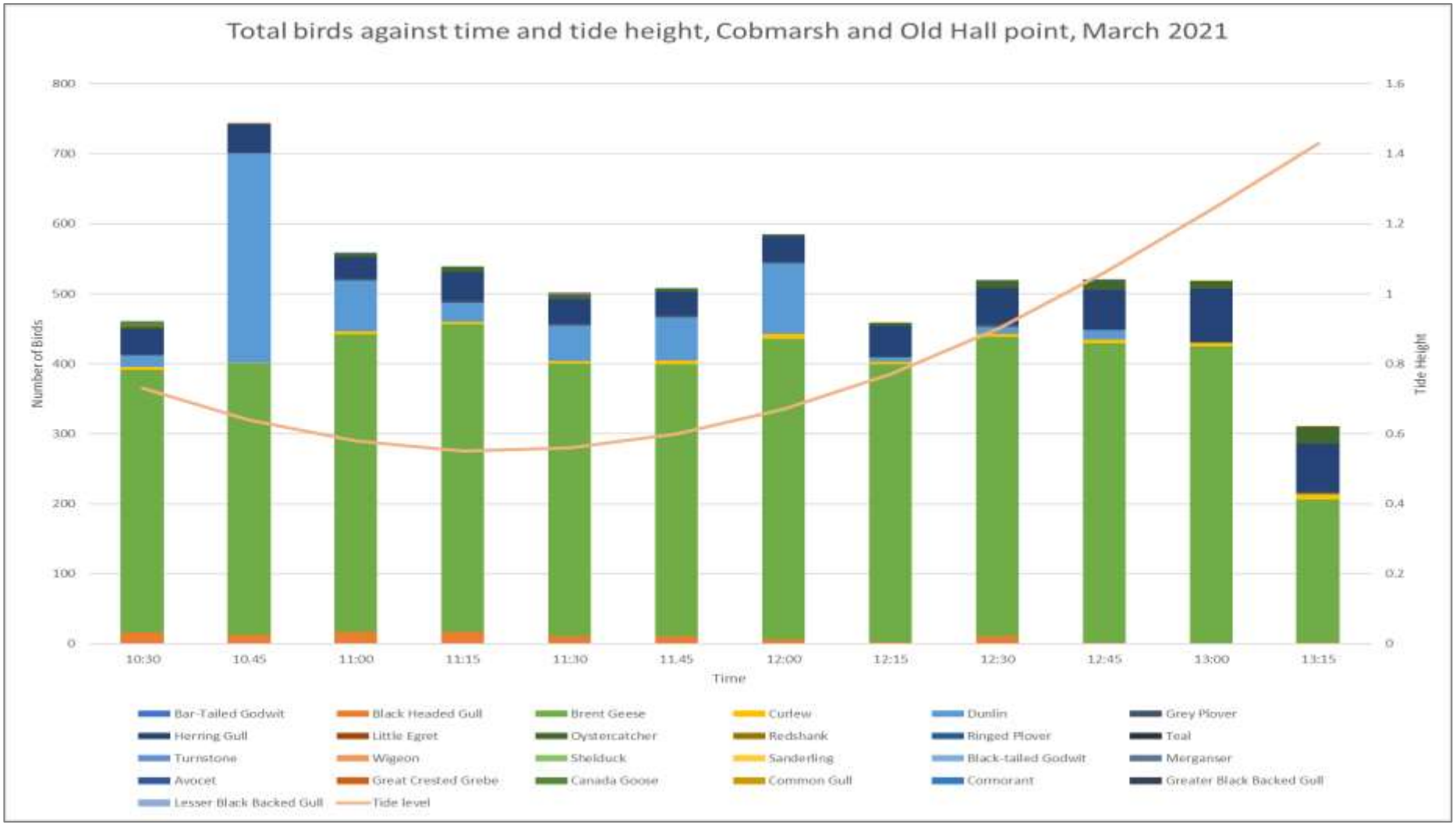


Figure viii. Total feeding birds against time and tide heights (m): Cobmarsh Island and Old Hall point, March 2021 (orange line indicates tide level).

Appendix 4. Roosting bird surveys of historical recharge sites 2018 to 2021

November 2018				
Species	Cobmarsh	Packing Shed	Old Hall	Tollesbury
Brent goose	79	42		
Cormorant				48
Curlew	9	35	3	
Dunlin	70	10		35
Great BB Gull	9			
Grey Plover	2			
Herring Gull	13	30	3	1
Lapwing	6	147		
Little Egret	6	1	3	
Mallard	1			
Oystercatcher	138	3		220
Redshank	13	6	2	
Ringed Plover		31		26
Sanderling	9			
Teal			29	
Turnstone	3	41		45
Wigeon			151	

February 2019				
Species	Cobmarsh	Packing Shed	Old Hall	Tollesbury
Black Headed Gull	1			
Brent goose	97		16	
Cormorant	1			5
Curlew			1	
Dunlin	33	39	57	380
Great BB Gull	1	1		
Grey Plover			1	1
Herring Gull	40	43		
Lapwing				
Little Egret	1			
Little Grebe		8		
Mallard			7	1
Oystercatcher	96	10	6	61
Pintail	12			
RB Merganser	1			
Redshank	2	1	1	
Ringed Plover	5	22	1	25
Sanderling	16		8	4
Shelduck				16
Teal			8	
Turnstone	30	19	1	23
Wigeon	39		3	

November 2019				
Species	Cobmarsh	Packing Shed	Old Hall	Tollesbury
Bar-Tailed Godwit	24	1	9	8
Black Headed Gull			1	
Brent Geese	54		70	12
Cormorant				101
Curlew	31	6		1
Dunlin	469	60	790	140
Golden Plover	0	27		
GC Grebe	2		1	2
GN Diver	2			
Greater BB Gull	10			1
Grey Plover	1	12	81	
Herring Gull	13	1	8	13
Knot				2300
Lapwing	4	58		
Little Egret	8		2	1
Little Grebe		1		
Mallard			2	6
Oystercatcher	2		72	185
Pintail	40			
Redshank	44	21	23	
Ringed Plover	9	7	220	99
Sanderling				7
Teal	29		45	
Turnstone	45	27		32
Wigeon	21		66	12

December 2020				
Species	Cobmarsh	Packing Shed	Old Hall	Tollesbury
Black-headed Gull	1			
Brent Goose	36		5	
Cormorant	2			2
Curlew	3		4	1
Dunlin	89	114	136	736
Great BB Gull			1	
Grey Plover	2	2	10	1
Herring Gull	4		1	
Knot				1425
Lapwing		1		12
Little Egret	3		1	
Little Grebe	1			
Oystercatcher	157	6	4	155
Pintail	23			
Redshank	11		1	
Ringed Plover	2			
Teal	15		13	
Turnstone	6	42	9	8
Wigeon	2		21	

February 2021				
Species	Cobmarsh	Packing Shed	Old Hall	Tollesbury
Black Headed Gull	23	122	11	
Brent Geese	45		31	
Cormorant				1
Dunlin	189		54	
Eqypt goose		2		
Greater BB Gull	1	1		
Grey Plover				
Herring Gull	216	122	1	
Knot				322
Lesser BB gull		10		
Med gull	1			
Oystercatcher	87	13	18	12
Ringed Plover	37	40	6	152
Sanderling	3			7
Teal			18	
Turnstone	53	14	4	32