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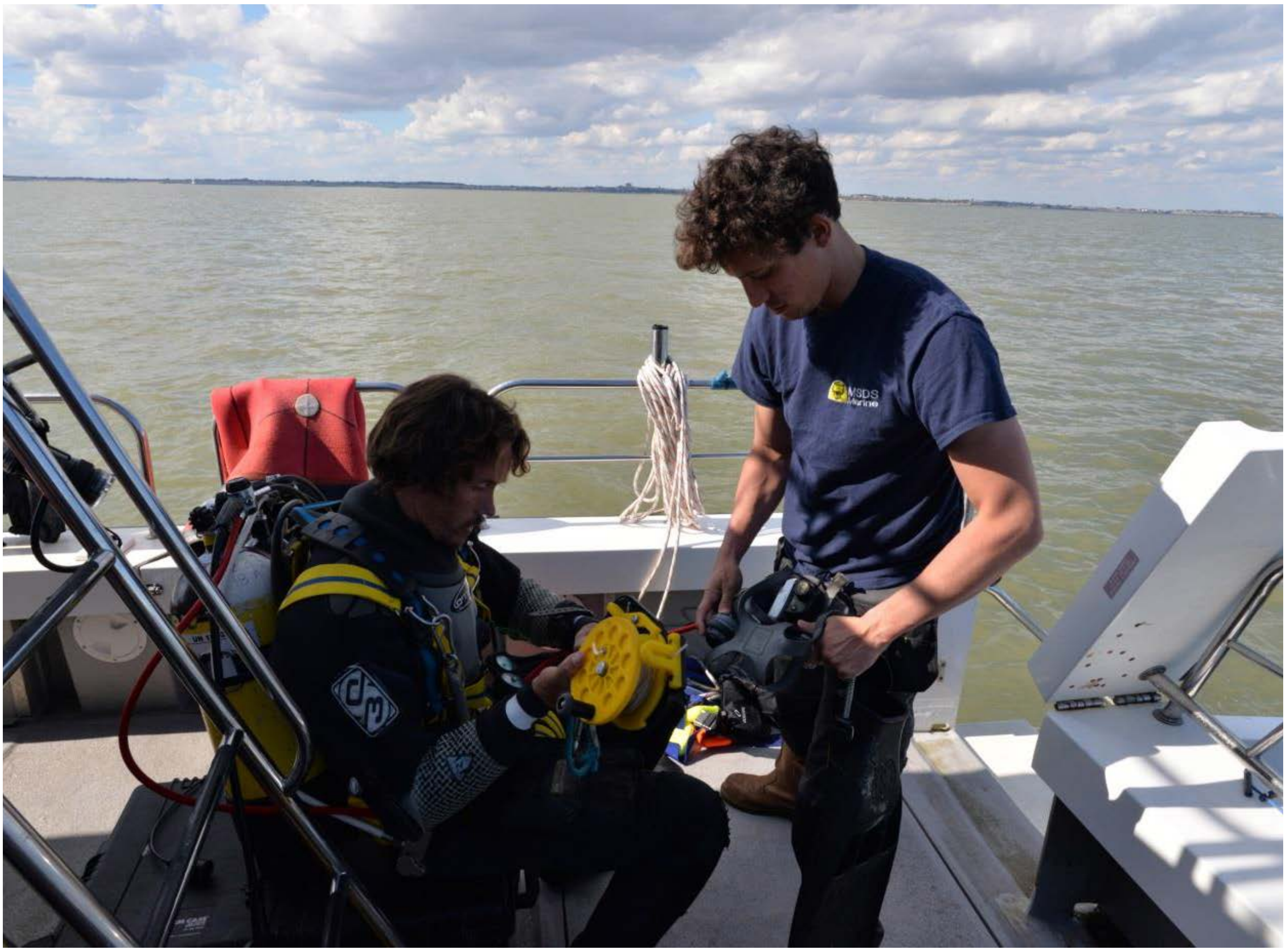
Investigating the Submerged Pleistocene Landscapes of the Wallet, off Clacton

Rachel Bynoe

Discovery, Innovation and Science in the Historic Environment



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1 EXECUTIVE SUMMARY

Recent Historic England (HE) projects identified the need for a greater appreciation of the Pleistocene submerged landscapes around the coast of England (Westley *et al.* 2013; Sturt *et al.* 2015). This type of research is essential in order to move towards a coherent understanding of the relationship between the currently terrestrial fragments of Palaeolithic landscapes and those that have been obscured by Holocene sea-level rise. Three key areas of necessary research have been highlighted: large scale offshore characterisation projects, research on Pleistocene deposits at a smaller, targeted level, and establishing best practice in the investigation of these deposits (Sturt *et al.* 2015). This project used information derived from trawled animal bones to target specific, high potential areas of seabed for investigation. As such it addressed the latter two areas of identified gaps in research and aimed to provide a new method for the identification and investigation of fragmentary Pleistocene submerged deposits.

As a preliminary stage in the testing of this type of research, this project aimed to demonstrate the value of derived animal bones for providing targeted locations of submerged Pleistocene deposits. This was a three phase process: the first of which involved establishing the zone of archaeological interest as shown by the trawler-derived faunal material, which was then refined using swath data acquired previous to this project. The second phase required the collection of further geophysical data, immediately prior to the dives. This included side scan sonar and sub-bottom data in order to further direct the dive sites and to assess any changes since the original swath survey. Finally, diver groundtruthing was carried out to search for faunal material and to recover short cores for analysis of seabed sediments. This was crucial in order to gain a better understanding of the context and taphonomic history of the specimens and of the now-submerged landscapes in this part of the southern North Sea. Furthermore, as originally identified through discussions with the local trawling community, this project aimed to develop and extend these relationships.

Five days of diving were planned, with two being blown out. During this time, nine dives were made on six dive sites. The visibility, however, was very poor and although thorough circular searches were carried out by finger-tip search (Section 4.2.2), no bones were encountered. Despite this, 13 sediment samples, including four short cores, were retrieved for analysis (Section 5.2) and to aid interpretation of the geophysics that was also acquired (Section 5.3). Contacts have also been made with local trawlers who have a history of recovering fauna from the seabed in this area, as well as locals who have been collecting lithics and fauna from the local beaches (Section 5.4). Whilst the primary aim of recovering specimens from the seabed was not achieved, the aims of engaging with communities and gaining a greater understanding of the deposits in this area were. It has also raised important questions about how we move forward with this type of research, which will be addressed in section 6.

2 PROJECT BACKGROUND

In recent years there has been a resurgence of interest in the submerged archaeological record around the coast of England (Coles 1998; Gaffney *et al*. 2007; 2009; Bailey and Flemming 2008; Dix and Sturt 2011; Momber *et al*. 2011; Tizzard *et al*. 2014; Bicket and Tizzard 2015). The vast majority of this work, however, has dealt with the more recent Mesolithic (or, at least, the post Last Glacial Maximum [LGM, c.19 kya]) record, or has focused on largely geophysics-based deposit models (Gaffney *et al*. 2007; 2009; Dix and Sturt 2011). As such, although recent coastal discoveries in East Anglia have demonstrated early hominin occupation possibly as far back as c.1 million years (Parfitt *et al*. 2010), our appreciation of the wider context of these finds is hampered by our lack of understanding of the now-submerged landscapes they relate to.

Whilst this lacuna is likely due to the assumption that pre-LGM landscapes will have been eroded beyond use or greatly reworked, recent research—both commercially derived (e.g. Regional Environmental Characterisation reports) as well as research based—has demonstrated the inaccuracy in this assumption showing a range of Pleistocene-age deposits, landscape features and archaeology to occur on the seabed (Hublin *et al*. 2009; Dix and Sturt 2011; Tizzard *et al*. 2014; Bicket and Tizzard 2015). What is now key to unlocking the clear potential that these submerged landscapes hold is increasing the frequency of ground truthing; to-date, archaeological discoveries from the offshore zone have been entirely serendipitous (e.g. Area 240, Zeeland Ridges Neanderthal). In order to move beyond this reactive style of archaeology, methodologies need to be developed that tackle these areas in a more focused and reasoned way.

The call for these new methodologies was explicitly identified by HE project 6918 (Sturt *et al*. 2015). Firstly, this project stated a requirement for more large-scale projects to characterise these offshore areas, and secondly, and most relevant to this project, is the real need for more research at a smaller, targeted level. This is most pertinent with regards to Pleistocene deposits given their lack of obvious markers, such as Holocene submerged forests, and consequent rarity. Establishing best practice in the investigation of these deposits was identified as the third issue, with an intrinsic difficulty being the lack of identified archaeologically rich deposits with which to work.

Previous work by the project manager laid the groundwork for the development of approaches through the location, collation and analysis of a prolific collection of faunal specimens from the southern North Sea (Bynoe 2014; Bynoe *et al*. 2016). These finds were largely recovered through the development of the trawling industry in the 19th and 20th centuries, so historical approaches were developed in order to glean the greatest amount of information possible relating to the provenance and initial collection of these specimens. Combining this positional information with an understanding of faunal taxonomic evolution throughout the Pleistocene allowed significant chrono-spatial patterns to emerge, providing a fresh understanding of the integrity of the extant deposits and unprecedented opportunities for locating them on the seabed. Not only do these faunal remains work as a marker of preserved

Pleistocene deposits within which we can begin to search for archaeological traces, but also as an ecological indicator for these landscapes.

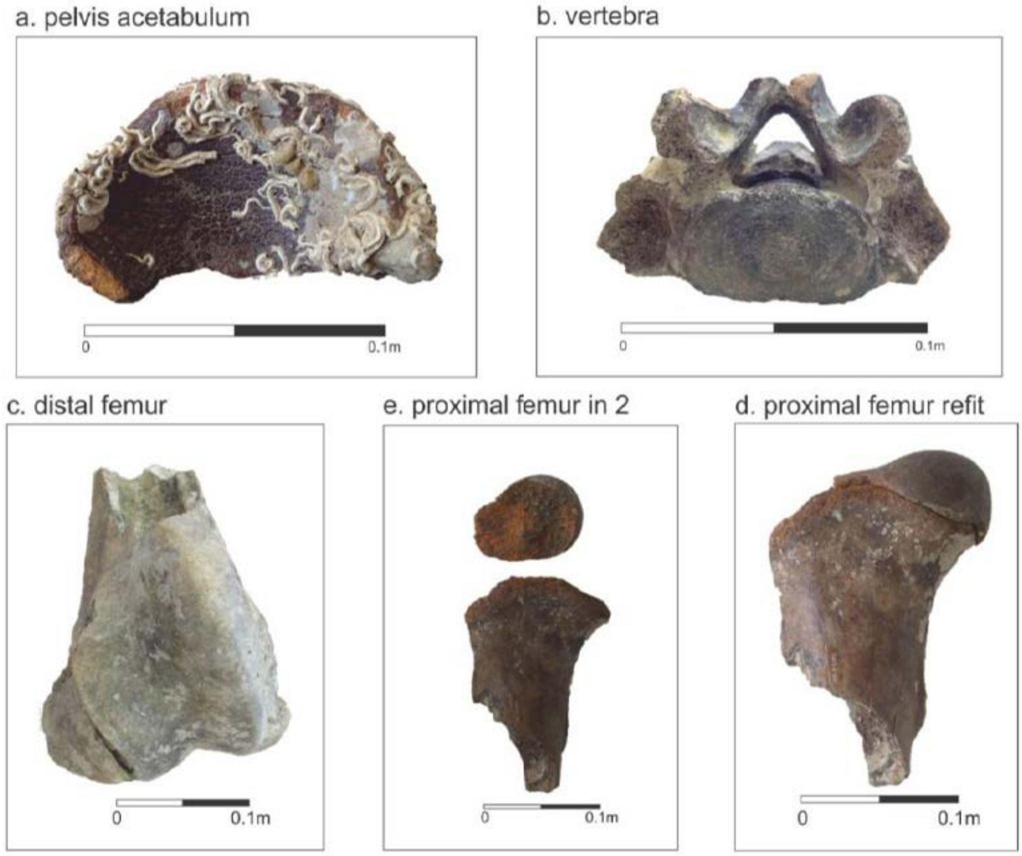

Fig.1: Series of bones from the Wallet Collection, showing a range of conditions, colours and marine growth

2.1 Study Area

One promising location was identified through the analysis of a recent faunal collection from off the coast of Clacton-on-Sea (Figure 1, 2 and Appendix A of PD 7204 [Bynoe 2016]) held by Colchester Museums Service.

This collection is dominated by later Pleistocene species (n=75%), probably Late MIS 7 or MIS 3 due to the dominance of woolly mammoth and woolly rhino (Currant and Jacobi 2001), with minor components of interglacial species, such as straight-tusked elephant and narrow-nosed rhinoceros. Discussions with the trawler-man responsible for this collection led to the identification and subsequent swath bathymetry survey (2014) of a discrete area (1 x 3 km) of seabed within an area known as the Wallet (Figure 2). On the basis of bathymetry alone the area was further subdivided into a zone of irregular terrain *c.* 1 x 1 km to the west of the survey block [centred on 381155, 5739450: WGS84 UTM Zone 31N] whilst to the east the seabed is dominated by bedforms of coarse grained (probably sands and gravel) deposits suggesting either active or historic seabed mobility (Figure 3). The westerly block coincides with the faunal hotspot identified by the local fishermen and so may represent in situ Late Pleistocene deposits resting on exposed Tertiary bedrock. To the west any material has probably been re-worked if only locally. If this interpretation is correct its significance is twofold:

1. It would be the first identification of a pre-LGM deposits outcropping offshore identified primarily from an analysis of the derived fauna.

2. As such, it would provide the best candidate in UK waters for the recovery of in situ Pleistocene material and thus could act as an exemplar for a methodological approach that could be adopted in other offshore areas.

The project therefore proposed that diver based groundtruthing of these Wallet exposures was the logical next stage. Whilst coring could ultimately provide key information about the deposits (date; palaeoenvironmental data), it was first essential to verify that any seabed or near surface exposures are the actual source of material being trawled and ideally identify material in situ. Applying an approach of diver surveys, followed by coring if appropriate, would provide a proof of concept, demonstrating the potential of this method for targeting fossiliferous Pleistocene deposits.

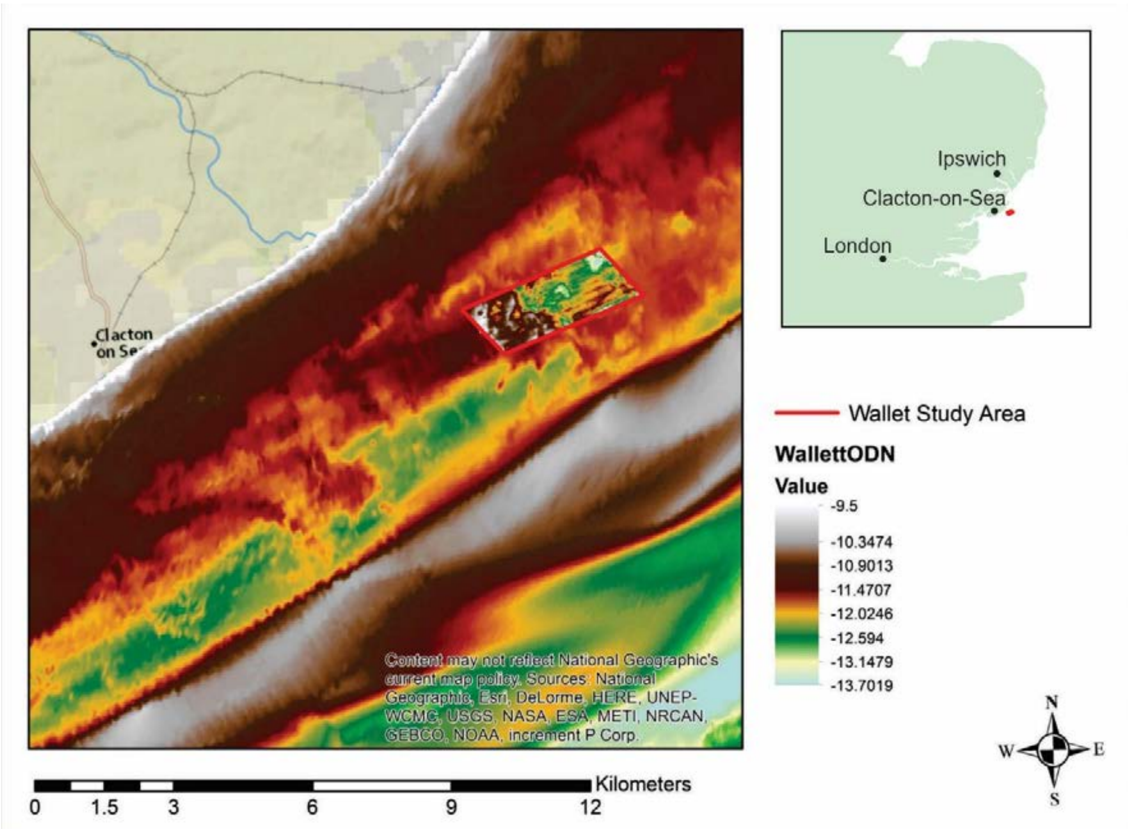

Fig. 2: Study area within the Wallet, showing the higher resolution data acquired (Main data source: UKHO bathymetry)

In addition, although trawling or using benthic grabs may recover specimens (e.g. hand axes in Area 240; Tizzard *et al*. 2014), this removes the finds from their context. Consequently, material recovered by trawls or grabs cannot be established as primary context (or not), or provide any information about the taphonomy of the finds–it simply replicates the methodology (trawls) from which the original finds were recovered. The absence of any primary context is the main contributing reason that so many of these finds have been left gathering dust in museum collections for hundreds of years. To prove that there is greater value to these specimens opens up a large, and ever increasing, source for further, affordable research into the submerged deposits in the North Sea.

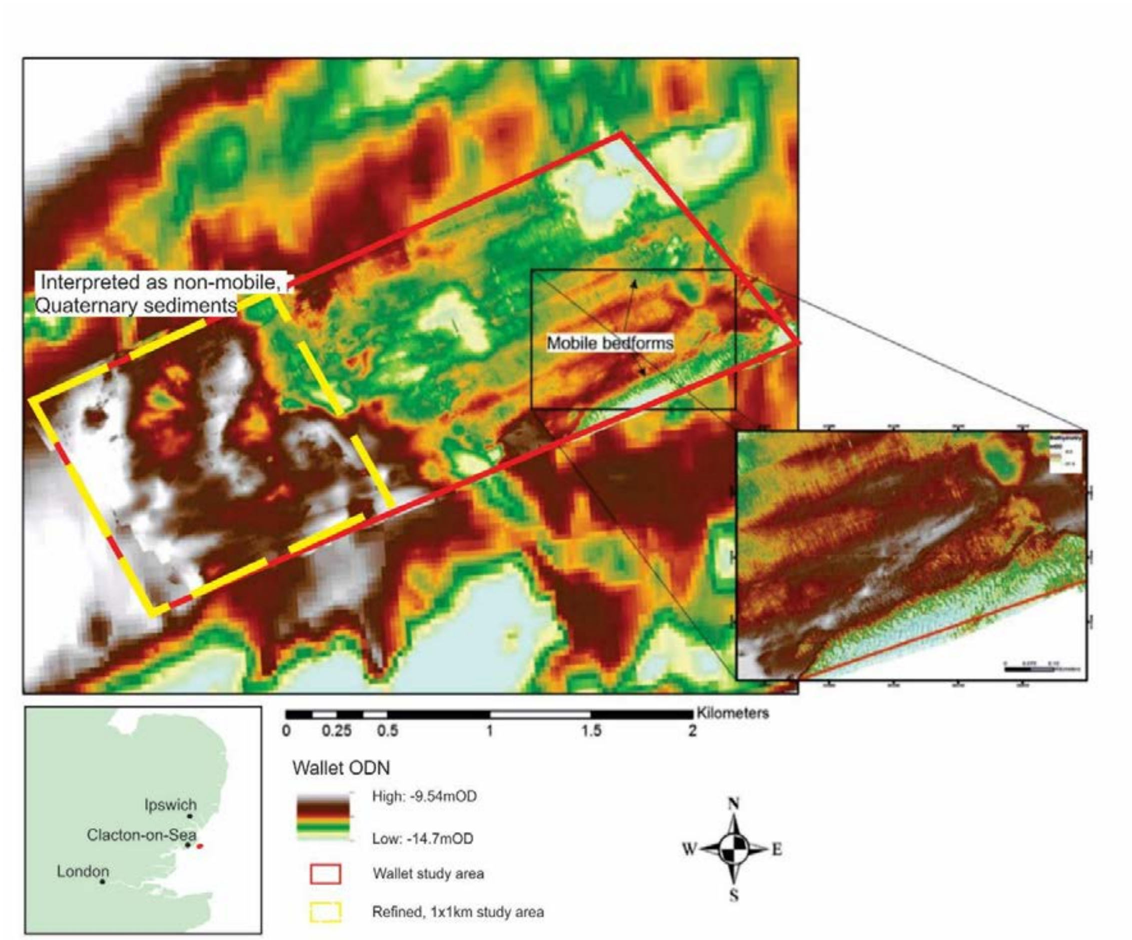

Fig. 3: The Quaternary sediments forming the approximately 1km x 1km study area to the south-west of the Wallet study area. Data acquired by the EA on behalf of UoS (2014)

2.2 Geological Background

The Tendring Peninsula and surrounding coastal areas of South-East Essex are dominated by various spreads of low-lying fluvial terrace gravels cut into the underlying Tertiary deposits (London Clay or Harwich Formation), relating to river systems which both pre and post-date the Anglian Glaciation (Bridgland *et al*.

1999; Roe *et al*. 2009; Roe and Preece 2011; Roe *et al*. 2011). The northern extent of the area, near Little Oakley, contains deposits which document the position of the Thames whilst it was depositing its pre-Anglian Kesgrave Sands and Gravels: sites such as Little Oakley (Preece *et al*. 1990), Wivenhoe and Ardleigh (Bridgland 1988; Rose *et al*. 1999; Rose *et al*. 2010). Despite their extensive nature, these sands and gravels are surprisingly lacking in archaeology, with only a few potential find spots (Hosfield 2011 [as well as the Happisburgh 3, which has been assigned as part of a converged Thames/Bytham system flowing out of north Norfolk in the Early Pleistocene (Parfitt *et al*. 2010)]).

During the Anglian stage, glacial ice diverted the Thames south to its current course (Bridgland 1988; 1994). The deposits to the south of the Tendring Peninsula are representative of these late Middle Pleistocene fluvial landscapes, differentiated from the earlier Medway gravels by their distinctively post-Anglian clast composition (Bridgland 1988). Several sites of archaeological importance have been discovered associated with these myriad channel systems and a complex set of biostratigraphic and amionostratigraphic criteria, as well as river terrace positions, have been used to assign them to specific interglacial periods (Bridgland 1994; Roe *et al*. 2009; Roe and Preece 2011).

The internationally important site of Clacton, type-site of the Clactonian industry, is part of this fluvial sequence and, forming part of the first interglacial, post-diversion drainage route taken by the Thames river system, has been unequivocally dated to the first post-Anglian interglacial: the Hoxnian (MIS 11) (Bridgland 1988; Bridgland *et al*. 1999). The channel-fill sequence that encompasses these richly fossiliferous deposits is the downstream equivalent of the Swanscombe sequence in aminostratigraphy and terrace stratigraphy (McNabb 2007). The amount of evidence from these sites (in addition to archaeological sites in other locations such as Hoxne, and purely environmental sites such as Marks Tey) provides a rich database of information for at least part of the Hoxnian interglacial, meaning that an array of marker species are known: *Dama dama clactoniana*, *Ursus spelaeus*, *Talpa minor* (small mole), *Trogontherium cuvieri* (giant beaver), *Oryctolagus cuniculus* (rabbit) and *Microtus subterraneus* (European pine vole) make up a distinctly Hoxnian indicator group (Schreve 2001).

There exist two further interglacial channel deposits in the vicinity which have been extensively studied: Cudmore Grove and the East Mersea Restaurant Site. Contained within estuarine silts and clays in a steepwalled channel-like depression in the London Clay, the Cudmore Grove Channel site has produced several flint flakes (Roe and Preece 2011). Accumulating throughout much of an interglacial sequence, this channel sequence was deposited in a dynamic and varied coastal environment (ibid.). Distinguished biostratigraphically from the Hoxnian through the early interglacial presence of the bivalve *Corbicula fluminalis* (which occurs later in all Hoxnian assemblages [Meijer and Preece 2000]), this early presence links this site to others which are thought to be attributed to a post- Holstenain stage, MIS 9 (Barling and Hackney Downs [Bridgland *et al*. 2001; Green *et al*. 2006]). Furthermore, the presence of the bear *Ursus arctos* as opposed to the Hoxnian type *Ursus spelaeus*, and recent convincing AAR evidence, place Cudmore Grove within MIS 9 (Roe and Preece 2011).

The East Mersea Restaurant Site is located just 2km along the foreshore from Cudmore Grove and, characterised by a non-marine mollusc assemblage and indicative vertebrates including *Hippopotamus*, can be reliably placed within the Last Interglacial (MIS 5e [Roe and Preece 2011]).

Along with Holocene channels, there are therefore four post-Anglian interglacials represented in the vicinity of the Tendring Peninsula as well as that of the pre-diversion Thames represented at Little Oakley, tentatively assigned to approximately MIS 15 (Preece *et al*. 1990; Preece and Parfitt 2000; 2012).

The offshore zone has had limited investigation and consequently the picture is generally highly speculative, but several studies have demonstrated the existence of the continuation of these deposits on and under the seabed (eg. Dix and Sturt 2011; DONG Energy 2011). The identification of a pre-Anglian fluvial system in the north of the Outer Thames Estuary (Dix and Sturt 2011) is likely to be linked to the pre-diversion Thames deposits flowing across the Tendring Peninsula (Preece *et al*. 1990; ibid.) and, although initially incised in the early Middle Pleistocene, has yielded deposits from a range of Early to Late Pleistocene and Holocene dates (Dix and Sturt 2011), indicating cyclical re-activation of this system. The potential therefore exists for a range of Pleistocene–Holocene deposits on the seabed in this area.

The continuation of the Clacton Channel has been inferred offshore by Bridgland and D'Olier (1995). More recently, geophysical and geotechnical work in the area, carried out as part of the Gunfleet Sands Windfarm project, has picked up a Pleistocene palaeochannel system immediately offshore Clacton (DONG Energy 2011). The same work has also identified Holocene Channels cut into these Pleistocene deposits. Although in approximately the same location as the proposed Clacton Channel continuation, evidence from the offshore channel deposits appears to correlate with either the Cudmore Grove channel system (MIS 9) or, potentially, the following interglacial: MIS 7 (Figure 4; Dong Energy 2011, 154). Seismic interpretation, groundtruthed using vibracore data, further indicates the presence of spreads of Pleistocene deposits of varying thickness throughout the cable route and main body of the Gunfleet Sands windfarm (Section 6.1, Figure 14). These are consistently overlain by Holocene deposits and cut through underlying London Clay/Harwich Formation (DONG Energy 2006).

In terms of a Late Pleistocene signal Bridgland and D'Olier (1995) have presented offshore maps of Late Pleistocene deposits of the Thames–Medway system. However, due to a relative dearth of deposits, much information about the evolution and direction of these systems is unknown (ibid.). It is thought that during the Late Pleistocene this area would have been dry land at the head of these Thames–Medway systems (Bridgland 1995). There is therefore potential for Late Pleistocene terrestrial deposits in the vicinity, although these have yet to be conclusively identified.

In summary, deposits from a range of ages exist in this offshore area documenting the evolution of a dynamic sea/landscape throughout the Pleistocene and into the early Holocene. Whilst these are generally poorly constrained—chronologically as well as spatially—their presence within geophysical and geotechnical data provides useful indications of potential for work in this area.

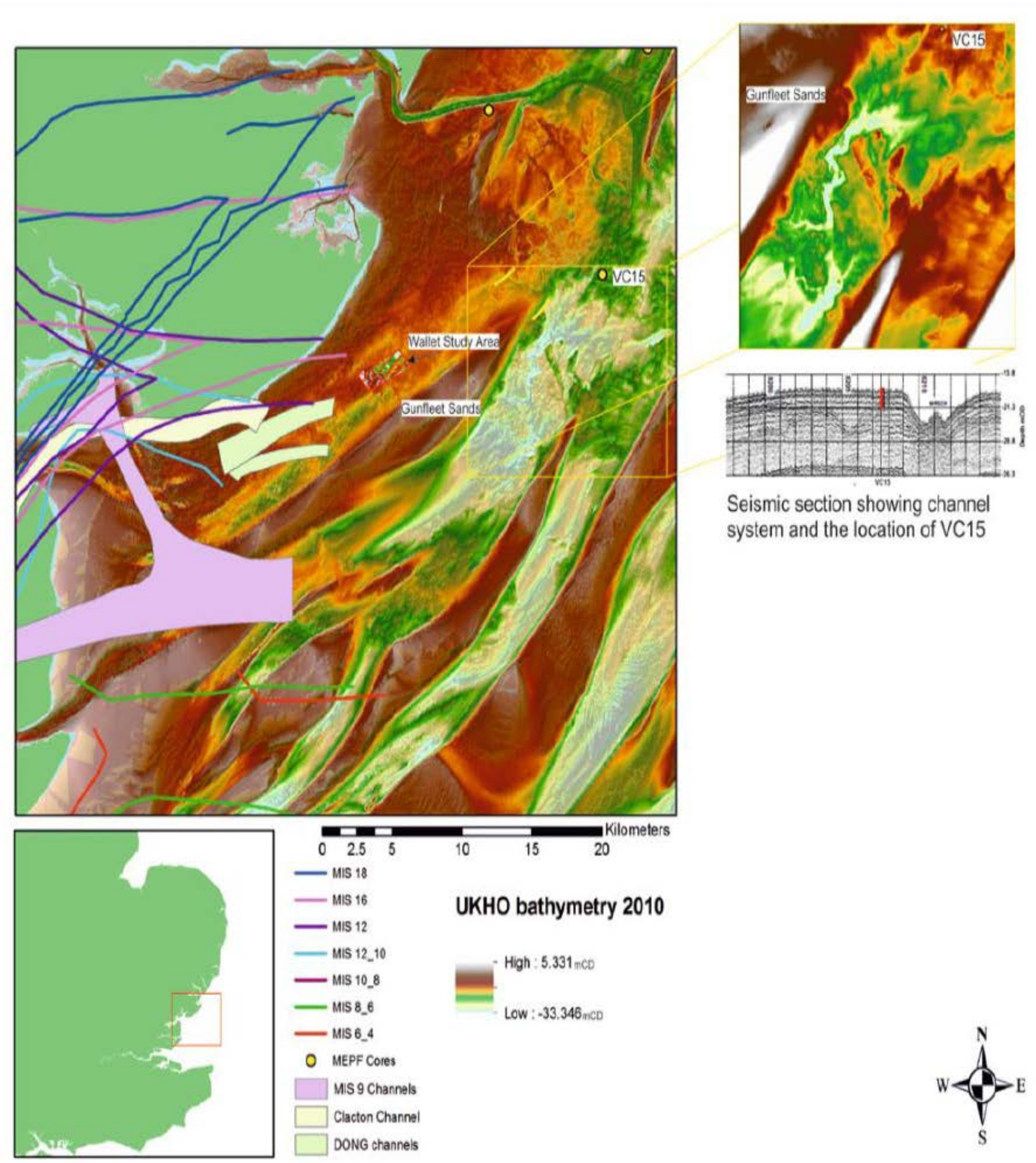

Fig. 4: Showing the location of the Wallet Study are in its broader context: the mapped onshore channels (after Bridgland et al.), offshore DONG Energy (2011) channels, the speculative extension of the (MIS 9) Cudmore Grove channel system (Roe and Preece 2011; Roe et al. 2009; 2011) and the channel system yielding an MIS 5e date from core VC15, shown in detail in the expanded box with seismic section beneath (Dix and Sturt 2011). (Data source: UKHO bathymetry)

3 RESEARCH AIMS AND OBJECTIVES

The work this project proposed aimed to ground-truth the theory that we can use derived faunal remains to pin-point Pleistocene deposits on the seabed and, as such, it had a series of potential outcomes.

3.1 Aims

A lack of understanding of the submerged resource, particularly for the Pleistocene period, is well documented (Westley *et al*. 2013). The overarching aim of this project was to begin taking practical steps towards filling this gap, using a bottom-up approach developed through the utilisation of the prolific, existing, faunal resource. Pinpointing Pleistocene deposits, particularly those that yield artefactual/fossiliferous remains, is problematic as they are typically extremely fragmentary owing to their age and location, and lack obvious markers. As such, if the use of these faunal remains could be shown to accurately determine the offshore location of these deposits then this would provide us with a relatively cheap and effective way of refining our understanding of the Pleistocene deposits of the southern North Sea and begin to produce definable areas of higher Palaeolithic archaeological potential.

This project aimed to:

1. Determine the value of derived faunal remains for providing targeted locations of Pleistocene deposits on the seabed.

2. Investigate the nature of the fossiliferous deposits within the Wallet to better understand the context and taphonomic history of the specimens and of the nowsubmerged landscapes in this part of the southern North Sea.

3. Expand on and develop the relationship with fishing communities used to identify the study area for this project.

4. Develop methods for targeting diver-based investigation of Pleistocene deposits on the seabed.

3.2 Objectives

The above aims were to be achieved through the following objectives:

- Objective 1: To use derived faunal material, first-hand local knowledge and acquired geophysical data to locate fossiliferous Quaternary deposits within the Wallet.
- Objective 2: To groundtruth and survey the extent of these fossiliferous deposits on the seabed using archaeological (diver) assessment.
- Objective 3: To recover faunal material for further species analysis and comparisons with existing datasets.
- Objective 4: To sample the sedimentary bodies associated with located find spots to infer sample taphonomy

4 METHODS

4.1 Diver Survey

4.1.1 Introduction

As discussed in Section 3 it was the explicit intention of this project to attempt to ground truth areas noted to be of high potential via diver based survey. Specifically aim 4 ('Develop methods for targeting diver-based investigations of Pleistocene deposits on the seabed') and objectives 2, 3 and 4 (to carry out diver assessment, recover faunal material and sample sedimentary bodies) related to this activity.
As noted within the business case given in the project design (Bynoe 2016, 7), commitment to this form of activity is seen as crucial in helping us to move from broad-based discussion of potential and towards targeted interventions to begin to investigate the record in more detail. However, as discussed by Sturt *et al* (2015), it was also noted to be of high risk with regard to the ability to deliver a positive result within any one project, and thus expectations had to be managed. In essence, the action of doing diver based survey helps us to evaluate the techniques available to us and to begin the process of refining methods for the future.

This section of the report provides details on the diving operations undertaken and points to the conclusions arrived at based on the experience gained. These ideas are reflected on in light of the goals of recent research agendas and the Heritage 2020 document in Section 6.

4.1.2 Geophysical Analysis and Target Identification

Prior to diving activities a side scan sonar and Chirp sub-bottom survey was carried out over the refined 1 x 1 km zone of the study area (Figure 3). This data was used to select six targets for further investigation (Figure 5). These targets were selected for their potential to allow access to exposed faces where stratigraphy might be encountered. They are also related to areas where Mr Brand, the local trawlerman responsible for the recovery of the majority of recent finds in this area, had noted an increased concentration of finds being made.

In addition, the geophysical survey provided an important additional line of safety for diving operations. It permitted an assessment of the environment at dive locations, allowing for consideration of hazards such as possibilities for entanglement. The geophysical survey revealed a remarkably consistent seafloor with no identifiable hazards.

4.2 Offshore Fieldwork

4.2.1 Geophysical Survey

Over a two day period, the 24/08/16 and the 25/08/16, a total of 23 line kilometres of side scan sonar data and 10 line kilometres of Chirp data were collected over the refined zone of interest (based on the distribution of extant faunal remains retrieved

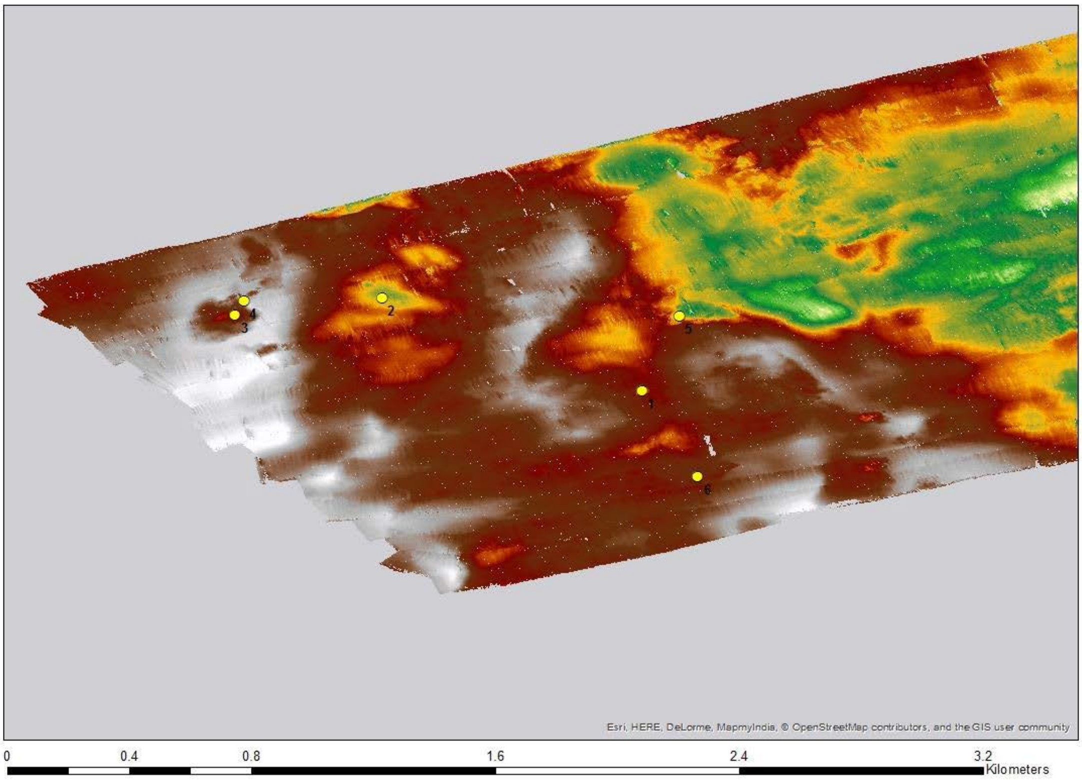

Fig. 5: Dive sites resulting from geophysical survey

through dredging and the analysis of swath bathymetry data previously acquired). A dual frequency (110 kHz and 410 kHz) GeoAcoustics side scan sonar system was used with a total swath width of 200 m. The Kongsberg GeoChirp was deployed on a surface towed catamaran with a single channel streamer. A 16 ms, 1.5–11 kHz, waveform, triggered at 8 Hz and with a recording window of 122 ms. Navigation was provided by a DGPS max system mounted on the stern of the vessel and with a static layback applied to both the side scan and Chirp data. This provided a navigational accuracy of ±2m.

The side scan sonar data was processed in CODA Survey Engine v. 4.4.3. and a mosaic (bin size 10 cm) and associated geotiff were generated at the end of the survey day to provide control for the diving activities (Figure 6). The Chirp data was processed in SEISUNIX (enabling correlation; application of bandpass filters and gain control) and then imported in to Petrel 2014 where it was integrated with a sub-sampled (5m bin) swath bathymetry data which was acquired in October 2013. The Chirp data was depth converted using a two layer velocity model (1480 ms-1 for the water column and 1650 ms-1 for the sub-surface). The Chirp data was then dc shifted to fit with the swath bathymetry which was referenced to Ordnance Datum Newlyn.

All of the original seismic files (*.cod for the side scan sonar data and *.sgy for the Chirp data) have been archived on the CMA, backed-up, disk space.

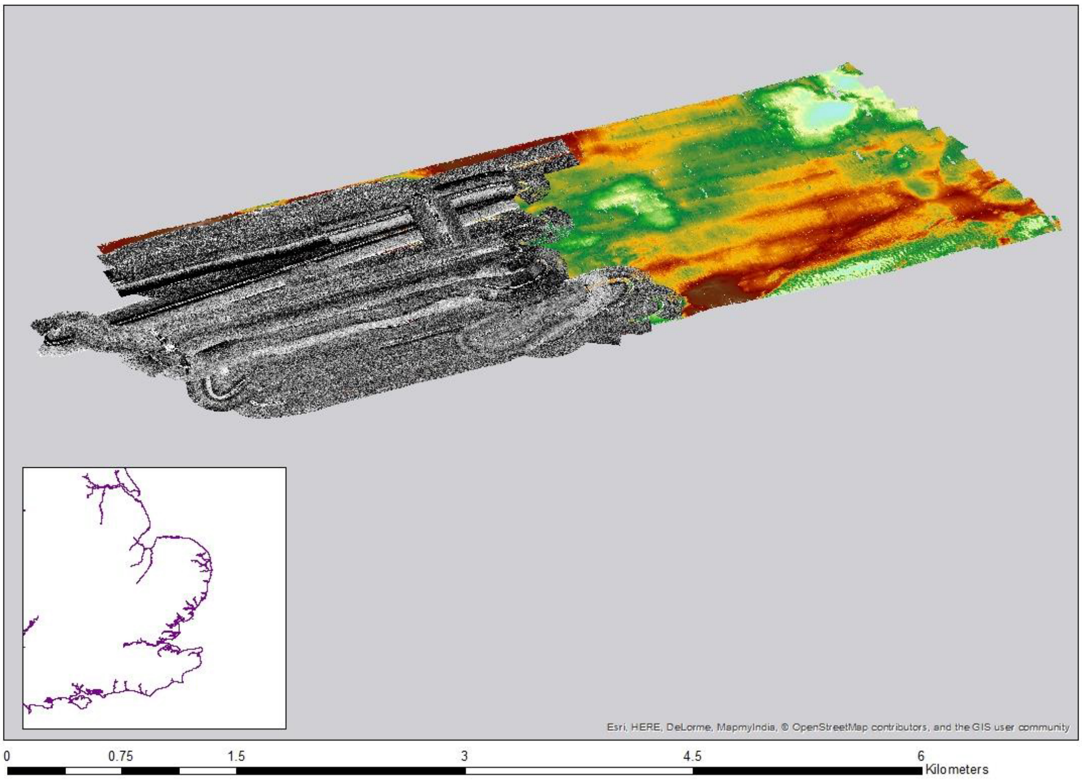

Fig. 6: Side scan sonar survey of the competent deposits within the survey area

Fig. 7: Divers getting ready on-board Vanishing Point 2

4.2.2 Diving Activities

The University of Southampton acted as diving contractor for this project, with F. Sturt appointed as diving officer. All work was carried out in accordance with the Health and Safety Executive (HSE) Diving at Work (1997) regulations, and the Scientific and Archaeological Diving approved code of practice (ACOP).

Diving operations were carried out between the 25th and 29th August from *Vanishing Point 2, a 51x17ft catamaran* out of Bradwell Marina, skippered by Terry and Nicola Batt (Figure 7).

At the start of each day a dive briefing was held to discuss the day's aims and all equipment was checked. Diving was conducted using open circuit SCUBA and a full face mask with through water two-way communications. Each diver had a main tank (12l/15l) with a 3l pony cylinder as back-up. The dive team consisted of:

Rachel Bynoe
Bob Mackintosh
Rodrigo Ortiz
Dan Pascoe
Felix Pedrotti
Fraser Sturt
Michael Walsh

Over the course of the five diving days, two of the days were blown out. One of these (27th) was called off immediately. The 28th, however, was marginal, so the entire day was spent over site continually assessing conditions. Unfortunately the conditions on both the 27th and 28th did not allow for divers to enter the water. Over the remaining days, diving took place during slack water, allowing for diving to occur at six locations over the course of nine dives (Figure 5). The boat was steered onto target locations identified using a GIS of the geophysical data through the use of a DGPS, and a shot line dropped when over the appropriate coordinate (Figure 8). At each site, sediment samples were collected comprising both grab samples and short cores (discussed in more detail in Section 5.2).

Conditions on site were challenging due to zero visibility at depths greater than 8m. This meant that survey for faunal material was dependent on a finger-tip search. This resulted in an amended dive plan, with teams carrying out a circular search with a diameter of 10m from a known (GPS recorded point) with 100% coverage. Grab samples were taken when change in sediment types were noted, and short cores taken at the bottom of the shot line using a length of tubing 0.4m x 0.05m. Communications with the dive teams was used to draw a sediment map and to determine when to take samples.

Whilst there was no visibility on the seabed it needs to be stressed that the methods employed by the dive team meant that this work was extremely safe: the entire area had been surveyed using multibeam, side scan sonar and seismics, no seabed hazards were identified; diving only took place during slack water; all divers were

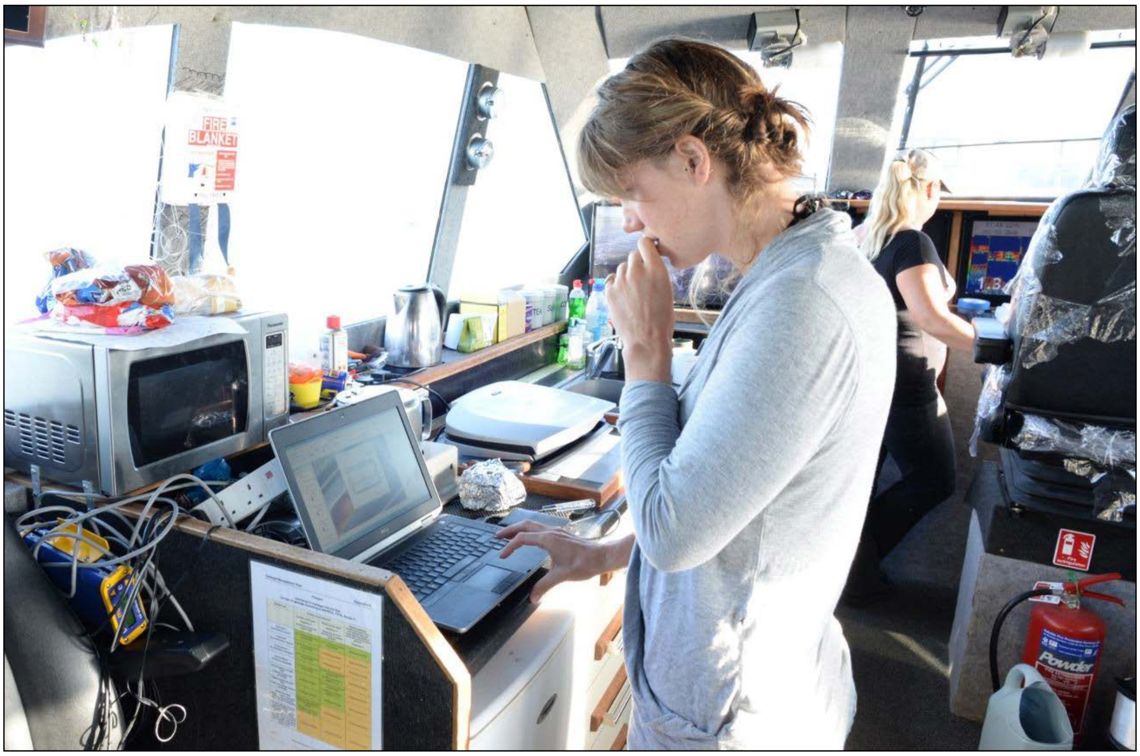

Fig. 8: On-board GIS connected to DGPS and the survey data

qualified to at least HSE Scuba or equivalent and well acquainted with poor visibility conditions; a maximum of two divers were in the water at any time (with one standby on the boat) both of whom were attached to the shot line which was in turn connected to a surface buoy, thereby ensuring a direct line to the surface at all times; all diving took place using both a main air supply and a backup 'pony' air cylinder, with an easily accessible switching block facilitating the swift move to the backup air source should it be required, and all divers were in constant twoway communication with the surface.

Despite the conditions being safe, there is little doubt that surveying in zero visibility is a marginal activity and reduces the chances of success. However, the teams were able to carry out work, meet aim 4 of the project and deliver on objectives 2 and 4. Perhaps even more significantly, working under these conditions provided an opportunity to reflect on how investigation of submerged Pleistocene deposits might be adapted to respond to changing site conditions. Visibility at the Wallet location is not always 0m, at times meteorological and hydrological conditions are such that 1–2m visibility is possible. However, having a boat on station at exactly the right time is currently a matter of luck. If investigation of submerged prehistory is to proceed using these methods this needs to be addressed. This is a topic we return to in Section 6.

4.3 Sediment Sampling

Three types of sediment samples were retrieved from the Wallet: grab samples, short cores and occasional anchor samples for reference (Table 1).

Table 1 Samples taken during fieldwork

Sample	Date	Dive site	Dive number	Description	Notes	Depth
1	25/08/2016	1	ANCHOR	Anchor sample	Site 1	-
2	25/08/2016	1	1	Shells	From surface	*c*.11m
3	26/08/2016	1	2	Sub-surface shot sample	Grab sample	10.9m
4	26/08/2016	1	2	Sample 10m NNE of shot	Grab sample	10.9m
5	26/08/2016	2	3	Grab sample at shot	Grab sample	10.6m
6	26/08/2016	2	3	Sub-surface shot sample	10-15cm, harder clay	10.6m
7	26/08/2016	2	3	Edge of segment, east of shot *c*.10m	Gravel on clay	10.6m
8	29/08/2016	3	5	Sample at shot	Core sample	12.7m
9	29/08/2016	3	5	Sample at edge - west of shot *c*.10m	Grab sample	13.3m
10	29/08/2016	4	6	Sample at shot	Core sample	12.6m
11	29/08/2016	-	ANCHOR	Anchor sample	51 48.064N 01 16.738E	-
12	29/08/2016	5	7	Sample at shot	Core sample	10.7m
13	29/08/2016	5	7	Sample at edge	Grab sample	10.9m
14	29/08/2016	6	8	Sample at shot	Core sample	9.5m

Whilst visibility was zero below 8m, it was possible to take a series of samples in order to characterise the seabed. These were mainly comprised of grab samples from the surface and immediate sub-surface, but four short cores were also retrieved (Figure 9). Short cores were taken using 40cm lengths of tube, 5cm in diameter, which were hammered into the seabed by the divers. Longer lengths were not used due to the difficulties of pulling these out of clay-rich sediments by hand.

The result of an initial analysis of these cores is in Section 5.2.

Fig. 9: Core <10>, cropped

5 RESULTS

5.1 Introduction

The expectation of delivering a positive result within a single diving project has been noted to be high risk when working on submerged landscapes (Sturt *et al* 2015), as was discussed in this project's Project Design. It was, however, also noted that null results are not insignificant as they open up questions about how we are dealing with the resource, why methodologies are not working and how we can refine future work (Section 6).

This project was successful in meeting aims three and four as well as delivering on objectives two and four. Several short cores were taken for analysis (Section 5.2), the results of which can be tied into the sub-bottom survey to provide further information on the deposits in the area. Discussions were also held with local trawlers who have been recovering material, providing potential for further refinement of the current picture. In addition to this, work is ongoing to engage with the local community. It has been noted that faunal and lithic remains have been collected from beaches in the local area and appear to be coming from deposits offshore. A talk was given to a local society, which led to meeting several people collecting this material and visiting their extensive collections, and a short paper was published in The Essex Society for Archaeology and History newsletter (Winter 2016).

5.2 Sediment Analysis–(Aim 4, Objectives 2 and 4)

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5.2.1 Introduction

During site investigations of the seabed within the Wallet area, short cores were taken from the seabed. The cores were plastic tubes, 40cm in length and 5cm in diameter, and were hammered vertically into the seabed by divers in four locations within the study area. Samples were carefully extracted from the seabed, wrapped, labelled and returned to the dive boat for transport back to the University of Southampton. The core tubes were cut open using a Marinetechnik Kawohl core liner saw, cleaned, and then scanned using a Geotek MSCL-CIS (Core Imaging System) within the BOSCORF (British Ocean Sediment Core Research Facility).

The geoarchaeological assessment followed the guidelines given in Historic England (2015), with descriptions according to Hodgson (1997) including sediment type, depositional structure, texture and colour. Interpretations regarding mode of deposition, formation processes, likely environments represented and potential for palaeoenvironmental analysis were also noted. The results have been tabulated and are given below. A photographic record of the samples, including key stratigraphic features, has been made to supplement the sedimentary descriptions.

5.2.2 Results

Sediment descriptions are provided in Tables 2 to 5. All four cores contained a similar stratigraphic sequence, consisting of a thin veneer of modern seabed sediments (mainly broken shell and rounded stone) overlying a probable estuarine alluvial clay deposit. This was best shown in core <10> where the estuarine alluvium is laminated and contains a series of horizontally bedded intact gastropods and bivalves. Within core <8> there were also pockets of organic-rich clay within the estuarine alluvium. Within the top of core <12> was a single large angular piece of flint that showed clear signs of thermal fracturing, suggesting it had been subject to cold environmental conditions (Figure 10). The angular shape of the stone, coupled with a white patination on only one surface and the remnants of both molluscan and organic adhesions to the stone surface, suggests that this stone has not been moved around the marine environment. There were no signs of working on the flint.

The age of the estuarine alluvium cannot be estimated but the assessment of the sediments indicated that there is good palaeoenvironmental potential, notably from molluscs, diatoms and foraminifera, and for core <8> in particular, pollen. Dating of these sediments may be best catered for by Amino Acid Racemization of the intact shell component as the clays appeared to be very poor in sand content, and could be too old for radiocarbon dating (if pre-Holocene). However it would be advisable to take larger stratified samples from the seabed as the amount of shell material within the core samples was very low, so larger volume samples would be preferred.

Table 2: Core <8>

Depth (m)	Description	Interpretation
0–0.07	2.5Y 4/3 olive brown silty clay loam. 20% broken shell, <2mm, plus *c.* 25% angular to subrounded stone (flint). Sharp boundary to:	Seabed stone, shell and clay
0.07–0.30	10YR 5/1 grey silty clay. Small organic mottles (at 0.075 to 0.11 and 0.24 to 0.28m). Organics are fine with no fibrous material present. No shell, stoneless.	Estuarine alluvium

Table 3: Core <10>

Depth (m)	Description	Interpretation
0–0.045	2.5Y 4/1 dark greyish brown silty clay, 15% shell fragments (<2mm), with a single rounded flint stone on surface, 20mm diameter. Sharp boundary to:	Seabed stone, shell and clay
0.045–0.18	5Y 4/1 dark grey clay, rare (<1%) intact small gastropods (<4mm) and bivalves (10–20mm), horizontally bedded. Stoneless	Estuarine alluvium

Table 4: Core <12>

Depth (m)	Description	Interpretation
0–0.05	Single large angular flint stone, 50mm diameter, which includes organic crustations (probably barnacles), fine organic fibres and shell, 1–2mm. Flint contains a series of thermal fractures throughout, with patination on one side. Stone is located within a matrix of 2.5Y 4/1 drak grey clay, very slightly shelly. Gradual boundary to:	Seabed stone, shell and clay
0.05–0.195	5Y 5/1 grey clay, stoneless, no shell.	Estuarine alluvium

Table 5: Core <14>

Depth (m)	Description	Interpretation
0–0.04	10YR 5/2 greyish brown clay with moderately stoney (35%) rounded small stones, up to 20mm diameter, and *c.* 20% broken shell (<5mm). Clear boundary to:	Seabed stone, shell and clay
0.04–0.195	10YR 5/2 greyish brown clay, very slightly stoney (up to 10mm diameter; subrounded), broken shell (*c.* 2%). Clear boundary to:	Seabed stone, shell and clay
0.195–0.28	5Y 5/2 olive grey to 10Y-5GY 4/5GY dark greyish green clay (mottled). Fine organic fibrous remains, with horizontal bedding, stoneless with no shell	Estuarine alluvium

5.3 Geophysical Survey–(Aim 4, Objective 2)

The seismic stratigraphy identified from the Chirp profiles supports the core descriptions presented in Section 5.2. In the vicinity of cores 8 and 10 we see clear horizontally stratified material at just beneath the seabed and extending up to 4 m beneath the surface (Figure 11). This facies has a consistent thickness, over a distance of 350m from the western edge of the survey block to the eastern margin of the western topographic high where it rapidly laterally changes into a series of more chaotic reflectors. This stratified facies overlies a series of stacked facies with inclined internal reflectors that have opposing geometry. These are potentially indicative of older sand sheets/gravel spreads at depth. Along this northern section, these sheets have a continuous thickness of *c.* 3.6m and lie on a well-defined basal reflector. Although not seen in Figure 11, laterally the facies beneath this unit exhibits the classic offset, high impedance reflectors, typical of the Tertiary London Clay bedrock in the Outer Thames Estuary area. To the east of these sections we see the development of classic small scale sand/gravel dune (maximum heights *c.* 2m) facies which rest directly on the London Clay.

To the south of the surveyed region a similar seismic stratigraphy can be identified but the horizontally stratified facies has reduced considerably in thickness and is now only a metre thick (Figure 12). The underlying facies does not have the same coherent structure as the stacked, potentially sand/gravel sheets identified in the north but are definitely of a coarser stratigraphy and again rest directly on the London Clay.

Building on the conclusions from the core work it would suggest in the north-western sector at least there is a thick sequence of organic-rich alluvium close to the seabed. Retrieving a deeper core at this locality would provide an excellent opportunity for dating of this sequence.

Fig. 10: Large stone derived from the top of Core <12>

Tying these conclusions into the broader region is not easy given the lack of information for the immediate area. However, data acquired by DONG Energy for the area relating to the Gunfleet Sands windfarm gives some potential support for the tentative pre-Holoc ene interpretation (Section 6.1).

5.4 Community Engagement–(Aim 3)

Whilst this project was focussed on the recovery via trawler of faunal remains from the seabed, there is another potentially important avenue of research that has come to light: specimens washing onto local beaches. In response to this project, a talk was given to the local Café Scientifique branch in Colchester on the 9th November 2016 regarding the offshore Palaeolithic landscapes and work being done to locate and investigate them. As a result, several members of the community came forward with large collections of faunal remains and lithic material that they had been collecting from the beaches at Holland-on-Sea to Clacton-on-Sea. On initial inspection these are dominated by species similar to those coming from the Wallet, in that they appear to be later Pleistocene species such as woolly mammoth and woolly rhino, with occasional interglacial elements such as molars from straight tusked elephants. Given the dominance of these later deposits in the southern North Sea in general, this is not a surprising picture (van Kolfshoten and Laban 1995; Mol *et al.* 2006; Bynoe *et al.* 2016).

There are a few potential options for the movement of this material onto the beaches. In certain areas, notably at Holland-on-Sea and Jaywick, near Clacton-on-Sea, there are gravel deposits relating to the ancestral river Thames (both pre and post-diversion). These specimens could possibly be eroding out of these deposits and being transported along the beach. The second option relates to the possibility that these remains could be eroding out of similar deposits outcropping offshore that are being transported onshore, possibly during high energy storm events. The final option, however, ties in, anecdotally, with when the collectors who are recovering material and relates to beach re-charge. Area 447 (Figure 13) has been used since 2014 to dredge sands to replenish the falling beach levels from Hollandon-Sea to Clacton-on-Sea and it is since this time that these finds have come to light. Ongoing work is looking at linking these finds with some of the dredged areas and can potentially provide further clues to the locations of Palaeolithic-aged deposits offshore in this area.

In terms of the trawled record, it can sometimes be difficult to gain the trust, and time, of people who rely on trawling the seabed for a living. However, through the serendipitous connections of the skippers used for this project we are currently in the process of building ties with trawlers who are currently working these areas. This will provide us with ever more information with which we can further refine the locations of the deposits we are searching for.

5.5 Archive

All dive logs, geophysical data and sediment interpretations have been digitized and are housed on an enterprise class server at the University of Southampton.

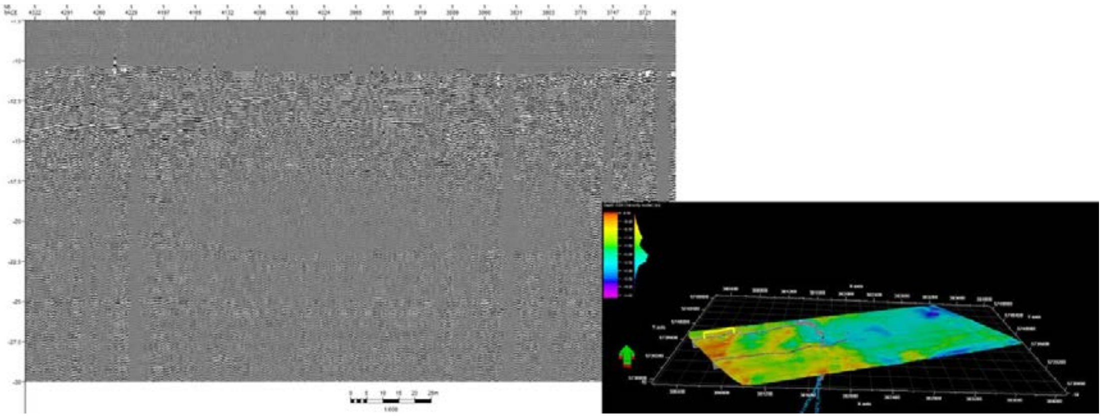

Fig. 11: A Chirp line from the north-western sector of the surveyed area in the vicinity of Cores 8 and 10. The inset panel shows the location of the seismic window.

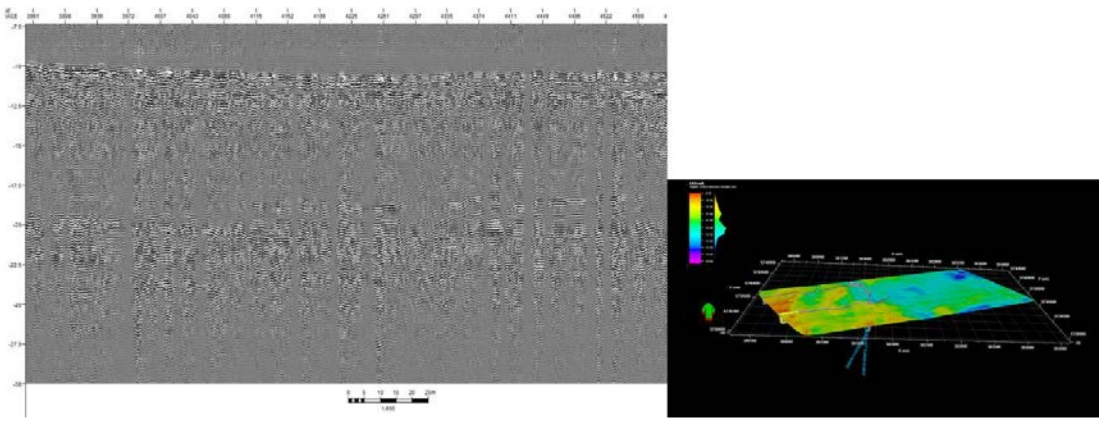

Fig. 12: A Chirp line from the south-western sector of the surveyed area. The inset panel shows the location of the seismic window.

6 DISCUSSION

At the outset, this project was one of our best opportunities for using the derived, prolific, faunal record to locate fossiliferous Pleistocene deposits in the North Sea, addressing issues raised by Ransley *et al*. 2013 and White *et al*. 2014 through the HE Action Plan, Corporate Plan Objective 2.2.2, supporting surveys and investigative techniques to further our understanding of archaeological sites on the seabed. Several of the aims and objectives were successfully achieved, specifically aim 4 ('Develop methods for targeting diver-based investigations of Pleistocene deposits

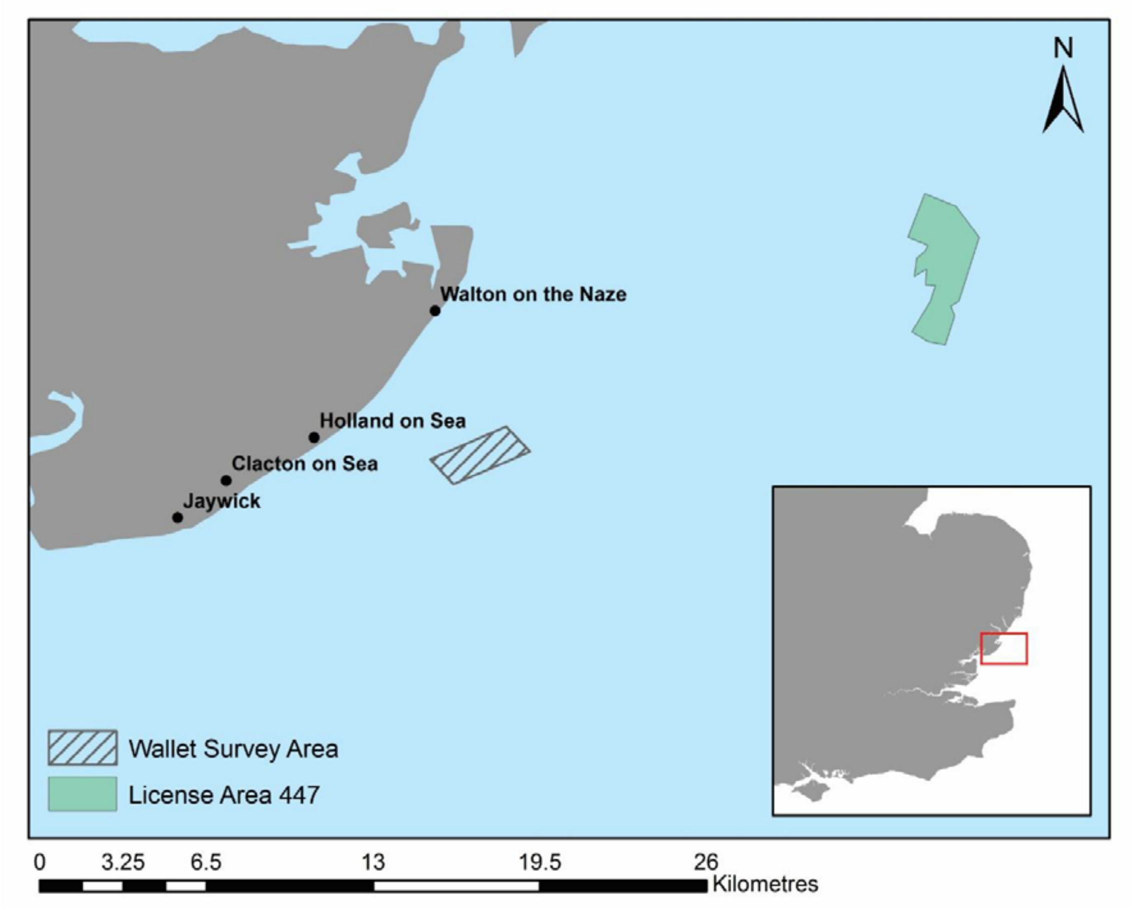

Fig. 13: Location of Area 447 in relation to both Clacton/Holland-on-Sea beaches as well as the Wallet survey area.

on the seabed') and aim 3 ('Expand on and develop the relationship with fishing communities used to identify the study area for this project') as well as objectives 2 and 4 (to carry out diver assessment and sample sedimentary bodies).

The faunal material that was being searched for was not encountered. In large part the work was hindered by the zero visibility conditions, meaning that divers would have had to land almost directly on top of the faunal remains to find them. When dealing with what are presumably small outcroppings of material, this is far from ideal.

Several projects working on submerged prehistoric landscapes, funded by HE as well as the ALSF, have encountered similar issues. Time and money have been spent but we are still coming up against problems finding in situ material to help us answer questions about the nature of these deposits and the artefacts they contain. Meanwhile, development in these offshore locations is increasing and deposits are being trawled. When compared with the amount of time available to terrestrial archaeologists on a given site, these projects are at a huge disadvantage: not only are fewer marine interventions taking place but the time available underwater is limited and is easily lost to poor conditions above and below water. One of the primary reasons for this project was to trial new methods for targeting the archaeology, but it is clear that on a more fundamental level we need to think about the ways that we are doing this. Two options provide ways around this:

1. Get divers in the water more frequently.

This could involve professional archaeologists, but could also look to include local dive groups. Whilst this is not a new idea—local divers have been finding and working on wreck sites for many years—there is currently a lack of communication with divers regarding the remains of submerged landscapes and what these might look like. This could look to include groups such as Sea Search, who are regularly in the water and have experienced dealing with seabed deposits. This relationship could work both ways, with data collected from archaeological projects (film footage, photography, results from sediment samples etc) being made available to these groups for their own, marine biological, work.

Getting professional teams in the water more often would incur more costs, but would potentially improve the likelihood of locating archaeoligical material. Alternatively this could mean changing the way dive seasons on particular sites are planned, with fewer days over a longer period, although this would require a certain amount of flexibility.

2. Improve our understanding of the conditions that we will be encountering.

The southern North Sea is unlikely to have excellent visibility, but even a few metres can help enormously when conducting these types of searches. They not only allow you to cover a far wider area, but provide safer, easier working conditions for all involved, potentially allowing for more divers in the water at any one time. If we are to continue to diver groundtruth sites, preserving context and gaining a greater understanding of submerged archaeology, then this needs to be addressed.

Local fishermen have indicated that there are times in the year, known as the ‘black water’, when the waters in and around the Wallet are markedly clearer. Knowing precisely when this is, however, and planning projects around it, is not simple as it changes year by year. Being able to target this period would help immensely.

One possible solution that this project proposes is implementing the use of sediment monitoring by telemetric turbidity meters at strategic points. This would allow real-time monitoring of conditions on-site and allow projects to time their work around periods when they can get the best results. Whilst this does rely on relatively rapid mobilisation, it may also help in the long-term to identify regularly occurring periods of prolonged good or bad visibility. The development of this on archaeological sites could benefit all forms of marine archaeology from work in areas such as the Wallet to ongoing wreck surveys and excavations.

6.1 Outcomes And Future Work In The Wallet

The main outcome of this project was the characterisation of the seabed in the vicinity of the Wallet. Whilst this is not directly linked to the Pleistocene faunal remains, the combination of the geophysical data and the mini-core analysis suggests that there is a thick (up to 4m in the northern section, thinning to ~1m in the south), stratified, organic-rich alluvium throughout the surveyed area. This in turn appears to overlie a coarser deposit that, in the north-western extent of the survey area, can be interpreted as earlier sands and gravels. In this location these could potentially relate to either the Crag deposits of the late Pliocene, which locally overlie the London Clay, or to Pleistocene sands and gravels relating to the Thames–Medway system.

The well consolidated nature of the alluvial deposit possibly indicates that it is pre-Holocene. This interpretation seems to be supported be the presence of patinated, nonrounded and thermally fractured flint in the deposit overlying the alluvial clays from core <12>, suggesting that the contemporary deposit was subjected to cold, possibly glacial, conditions and indicating that the alluvium is Pleistocene. Furthermore, anecdotally the faunal material is recovered from a competent clay seabed within the area that was investigated. The survey results indicate that this alluvium is present throughout at least the western extent of the area surveyed, possibly supporting the suggestion that a facies/several facies within this alluvial deposit are the source of the Pleistocene faunal material. However, without a secure date or further palaeoenvironmental evidence this remains uncertain. As such, if additional work were to take place then the retrieval of a core through this alluvial deposit could yield some significant information regarding the date and associated palaeoenvironments.

Some possible support for a pre-Holocene date comes from the results of the Gunfleet Sands windfarm investigations (DONG Energy 2006; 2011) <4km to the south-west (Figure 14). The vibracore logs and seismic interpretation for the cable route show the presence of Pleistocene deposits at varying thickness throughout this area, as well as the existence of two palaeochannels with Pleistocene deposits apparently dating to either MIS 7 or 9 (DONG Energy 2011, 154). Whilst this does not provide any chronological control for the deposits within the Wallet, it does support the interpretation of the existence of Pleistocene deposits in the region.

Future work should therefore look to further characterise these deposits and to draw upon connections being made with current trawlers in this area, in combination with the knowledge of the skipper who made the initial discoveries to further refine locations. This has the potential to add significantly to the level of information known about the offshore deposits in this area, which is currently relatively poor. Given the complex array of fluvial activity in this area throughout the Pleistocene, as seen through onshore river terrace mapping (Bridgland and D'Olier 1995; Bridgland and Allen 1996; Bridgland 2003; 2006) as well as the mapping of the palaeochannel system immediately to the north (Dix and Sturt 2011) and south (DONG Energy 2011), it is likely that there is significant information in this area relating to previously exposed Pleistocene landscapes. Gaining an understanding of these landscapes is crucial for appreciating the physical as well as environmental context of hominin occupation.

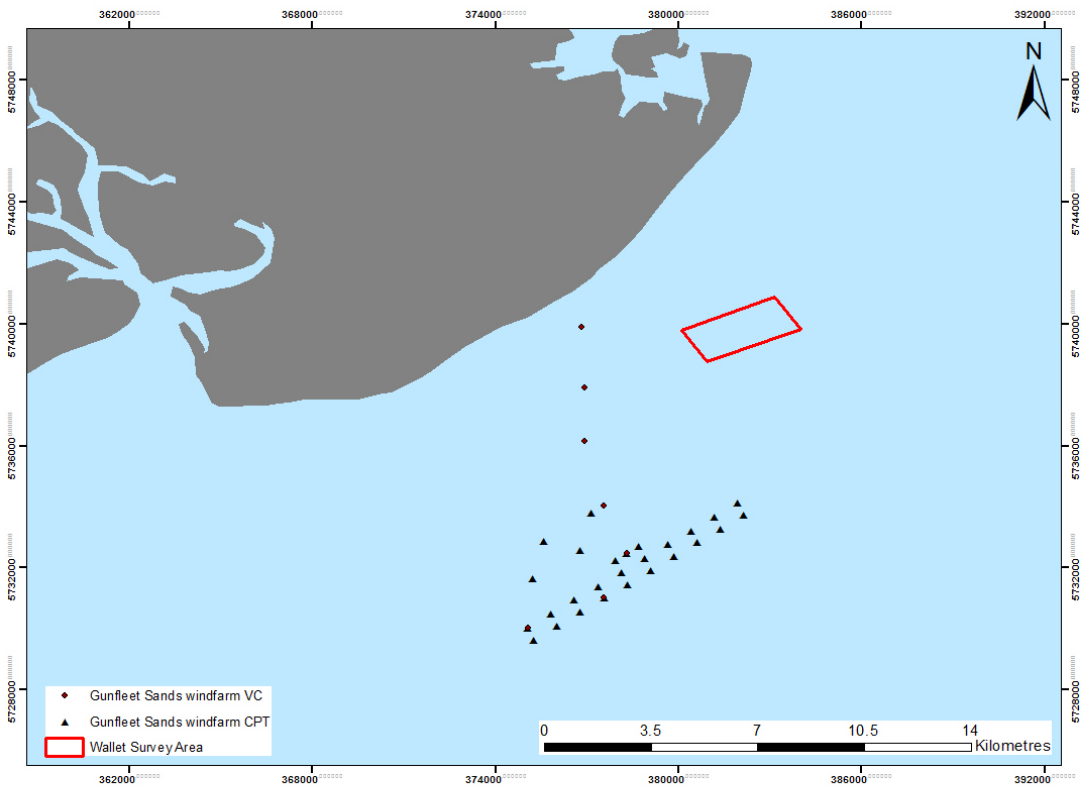

Fig. 14: Gunfleet Sands windfarm geotechnical investigations in relation to the location of the Study Area within the Wallet.

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