



Hornsea Project Four: Environmental Statement (ES)

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Volume A4, Annex 6.5: Compensation EIA Annex Part 2

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1.2 Purpose of this Document

1.2.1.1 In order to consider the environmental impacts associated with the implementation of the proposed Compensation Measures, this Annex to the Hornsea Four ES has been produced (hereafter 'the Compensation Measures EIA'), accompanied by a Habitats Regulations Assessment (**B2.2.2 Compensation Measures HRA Plan** - 'the Compensation Measures HRA'). The focus of the EIA is on the assessment of the likely significant environmental effects.

1.2.1.2 The assessment provided in this document is based on the current understanding of the location, scope and nature of the proposed Compensation Measures. It should be noted, however, that ultimately, the Compensation Measures will not be consented through the Hornsea Four DCO application process and will be subject to (where necessary) standalone EIA and HRA processes as part of their own consenting process (for example a Marine Licence application and/or Planning Application). As part of that consenting process, further assessment work will be undertaken, based on refined design and methodology details.

1.3 Structure of this Document

1.3.1.1 This Compensation Measures EIA is set out in a number of stages as follows:

- Policy and Legislation (**Section 2**)
- Consideration of Alternatives (**Section 3**);
- A brief summary of the potential Compensation Measures for Hornsea Four (**Section 4**);
- Consultation (**Section 5**);
- A brief summary of the EIA Methodology used for the assessment (**Section 6**);
- An EIA section for each Compensation Measure (**Section 7 to 11.3**), with each section containing the following sections:
 - Baseline – a summary of the baseline environment for each Area of Search (AoS);
 - Assessment – identification of impacts and associated assessment.
- Conclusions (**Section 12.3**); and
- References (**Section 14**).

2 Policy and Legislation

2.1.1.1 **Volume A1, Chapter 2: Planning and Policy** of the Hornsea Four ES sets out the international, national, region and local planning policy context in relation to Hornsea Four and the EIA process. This detail is also relevant to the Compensation Measures EIA (to the extent they are located in areas where the policy applies e.g. national policy) and as such, not repeated within this Annex. Policies specific to each EIA topic are outlined in **Volume A2, Chapter 1 to 12** for offshore topics and **Volume A3, Chapter 1 to 10** for onshore topics. Regional and local planning policies for each Compensation Measure will be considered further via the relevant consenting process (as appropriate) once final details on location are known.

3 Consideration of Alternatives

3.1.1.1 This section outlines the process undertaken by the Applicant to site selection and consideration of alternative measures and alternative site/locations for their delivery. The scope of the consideration of alternatives relates specifically and directly to the compensation measures for kittiwake, *Rissa trydactyla*, large auks (common guillemot – hereafter guillemot, *Uria aalge*, and razorbill, *Alca torda*), and gannet, *Morus bassanus*, at Flamborough and Filey

Coast Special Protection Area (FFC SPA).

3.1.1.2 An important part of the Hornsea Four development process is the consideration of potential options, selection and the subsequent refinement of compensation options and their delivery. Well informed decisions on the selection and consideration of alternatives are critical and Hornsea Four recognise the need to ensure consultees and stakeholders understand how such decisions have been made.

3.1.1.3 In spring 2020, the Applicant commenced a process to identify compensation measures to inform the ‘without prejudice’ Derogation Case. Initially a long list of potential options was drawn up (see [Annex B2.6.1: Compensation measures of the FFC SPA: Compensation Criteria](#)). The draft long-list was presented to stakeholders at a workshop on 24th June 2020 (see [B2.9: Record of Consultation](#)). The initial long list for kittiwakes and auks are presented in [Table 2](#) and [Table 3](#) respectively.

Table 2: Long list of compensation options for kittiwake.

Habitat creation	i: Construction of ONSHORE artificial structures to encourage a new kittiwake colony outside of FFC SPA at a location lacking suitable nesting habitat (and preferably near to foraging ground and away from OWFs).
	ii: Construction of OFFSHORE artificial structures to encourage a new kittiwake colony outside of FFC SPA at a location lacking suitable nesting habitat (and preferably near to foraging ground and away from OWFs).
	iii: Creation of area of seabed habitat for prey spawning or nursery ground combined with management measures (potentially also to accommodate and mitigate effects of climate change on stocks) to boost prey stocks
Reserve creation	i: Designation of new marine SPA in important offshore foraging location.
Species recovery	i: Eradication of American mink from an island important to/used by kittiwake using trapping or poisoning techniques.
	ii: Eradication of feral cat from an island important to/used by kittiwake using trapping/ lethal technique.
	iii: Eradication of rat (brown rat and or black rat (and house mouse) from an island colony using trapping or poisoning techniques.
	iv: Exclusion of foxes from a colony using anti-predator fencing
	v: Exclusion of great skua from a buffer zone around a kittiwake colony
Incentives/ disincentives for certain activities	i: Management of recreational pressure at the FFC SPA (or another SPA)
	ii: Sandeel fishery exclusion zone
	iii: Sandeel fisheries exclusion zone within the Hornsea Project Four array area
	iv: Purchase of a sandeel fishery quota
	v: Work with ICES (and relevant key stakeholders) to change the sandeel quota for this region of the North Sea based on an ecosystem approach to management

Table 3: Long list of compensation for auk.

Species recovery	i: Eradication of rats from an island colony of guillemot and razorbill using rodent traps or poisoned bait.
Habitat creation	i: Encourage establishment of a new colony in an area close to heightened prey availability using models and call playback.

	ii: Creation of area of seabed habitat for prey spawning or nursery ground combined with management measures (potentially also to accommodate and mitigate effects of climate change on stocks) to boost prey stocks
Incentives/ disincentives for certain activities	<p>i: Sandeel and sprat fishery exclusion zone.</p> <p>ii: Sandeel and sprat fisheries exclusion zone within the Hornsea Project Four array area.</p> <p>iii: Purchase of a sandeel and sprat fishery quota</p> <p>iv: Sandeel and sprat fisheries exclusion in wintering areas.</p> <p>v: Work with ICES (and relevant key stakeholders) to change the sandeel quota for this region of the North Sea based on an ecosystem approach to management</p>
Reserve creation	i: Designation of new marine SPA at important offshore foraging location.
Reduction of other threats and pressures	i: Reduce bycatch.

3.1.1.4 The long list was presented to stakeholders in autumn 2020, with stakeholder agreement that there were no exclusions from long list (see [B2.9: Record of Consultation](#)). A long-listing exercise was also completed for gannet. However, following discussions with stakeholders it was determined that there were no other options we should be considering for compensation, therefore the conclusions of the measures to take forward for kittiwake and large auks are feasible and appropriate for gannet as well.

3.1.1.5 In order to evaluate the potential compensation measures in a robust and transparent manner, each of the options were evaluated against a set of criteria. The criteria are described in full in Table 3 of [Annex B2.6.1](#), and summarised below¹:

- Targeted - The compensatory measures must address the issue specifically;
- Effective – The compensatory measures must be feasible in reinstating the ecological conditions needed to ensure the overall coherence of the national site network;
- Technical feasibility – The technical feasibility of the measure taking into account requirements of the ecological features to be reinstated;
- Extent of compensation – The extent required for the compensatory measures to be effective is directly related to the quantitative and qualitative aspects inherent to the elements of integrity;
- Location of compensation - Compensatory measures should be located in areas where they will be most effective in maintaining the overall coherence of the National Site Network (note general agreement to be as close to the impacted site as feasibly possible);
- Timing of compensation – The timing of the compensation is difficult to specify and should be adapted using a case-by-case approach, and;
- Long-term implementation – The compensatory measures require a legal and financial basis for long-term implementation as well as for the protection, monitoring and maintenance of the site/species.

3.1.1.6 The application of the criteria to the long list options is referred to as “short-listing” and was undertaken to evaluate selected compensation measures in more detail and to decide which measures to advance. The results of this short-listing exercise were presented to stakeholders in autumn 2020 (see [B2.9: Record of Consultation](#)).

¹ Guidance criteria was built upon Defra Compensatory Measures guidance: [Best practice guidance for developing compensatory measures in relation to Marine Protected Areas \(defra.gov.uk\)](#)

3.1.1.7 The most promising options for compensation of kittiwakes were identified as:

- Habitat creation (onshore);
- Incentives/ disincentives for certain activities (change the sandeel quota);
- Habitat creation (offshore); and
- Species recovery (rat eradication).

3.1.1.8 The most promising options for compensation of guillemot and razorbill were:

- Reduction of other threats and pressures (bycatch reduction);
- Species recovery (rat eradication);
- Incentives/ disincentives for certain activities (change the sandeel quota); and
- Incentives/ disincentives for certain activities (sandeel and sprat fishery exclusion zone).

3.1.1.9 Despite the options of many different compensation measures, they vary in feasibility. The Applicant therefore took forward the following compensation measures for inclusion in the derogation case, as a result of the short-listing process combined with stakeholder feedback on the potential measures:

3.1.1.10 Kittiwake:

- Onshore artificial structures;
- Offshore artificial structures; and
- Habitat creation – seagrass restoration.

3.1.1.11 Guillemot and razorbill:

- Bycatch reduction;
- Predator eradication; and
- Habitat creation - seagrass restoration.

3.1.1.12 Areas of Search (AoS) have been identified for each Compensation Measure, with these shown in [Figure 1](#). These AoS range from small areas around islands or discrete sections of coastline, to larger areas spanning large areas of sea and coastlines. The AoS identification process is detailed for each compensation measure in [Volume A4, Annex 6.1: Compensation Project Description](#). Information on the consultation undertaken as part of the process to date is presented within [Volume B2, Annex 9 Record of Consultation](#). As noted above, the extent of the AoS remains broad to incorporate sub-options and numerous locations which will be refined as the process progresses.

4 Project Description

4.1 Project Description

4.1.1 Introduction

4.1.1.1 The project description is presented for each Compensation Measure as a Maximum Design Scenario (MDS), in line with the approach taken in the ES and the RIAA. This approach ensures that the scenario(s) that would have the greatest impact, relevant to the AoS and the Compensation Measure under consideration, is identified and assessed. As a result, we can be confident that any other (lesser) scenario(s) will have an impact that is no greater than that

assessed.

4.1.1.2 The following sections provide a description of the design and methodologies related to each of the proposed Compensation Measures referenced in [Table 1](#) and summarised below, presented as an MDS. These descriptions set out the design and components for any infrastructure, as well as the activities associated with the installation/ construction, implementation/ operation/ maintenance, and decommissioning of each Compensation Measure (where relevant). Further details on these measures can be found in [Volume A4, Annex 6.1: Compensation Project Description](#). The Compensation Measures are as follows:

- Offshore Artificial Nesting Structure (New and Repurposed);
- New Onshore Artificial Nesting Structure;
- Bycatch Reduction Technology;
- Predator Eradication; and
- Resilience Measure – Fish Habitat Enhancement (Seagrass).

4.1.2 Areas of Search (AoS)

4.1.2.1 As noted above, AoS have been identified for each Compensation Measure, with these shown in [Figure 1](#). These AoS range from small areas around islands or discrete sections of coastline, to larger areas spanning large areas of sea and coastlines. These have been identified and the AoS identification process is detailed for each compensation measure in [Volume A4, Annex 6.1: Compensation Project Description](#). Information on the consultation undertaken as part of the process to date is presented within [Volume B2, Annex 9 Record of Consultation](#). As noted above, the extent of the AoS remains broad but will be refined as the process progresses. The individual AoS for each Compensation Measure are shown in figures following each MDS.

4.1.3 Compensation Measures Commitments

4.1.3.1 All Commitments relevant to the Compensation Measures HRA are detailed in [Volume A4, Annex 6.4: Compensation Commitments Register](#).

4.1.4 Compensation Measures Programme

4.1.4.1 The high-level anticipated programme (may be subject to change) presented below is applicable to the implementation and delivery of all Compensation Measures:

- Hornsea Four development consent determination – 2022/23;
- Compensation implementation licencing – 2022/24;
- Compensation implementation – 2023/24;
- Offshore construction of Hornsea Four Foundations– 2026;
- Offshore construction of Hornsea Four Turbines– 2027; and
- First Power (partially operational windfarm) – 2028.

4.1.4.2 Implementation of compensation measures will be subject to successful progression of the Hornsea Four project. The timing of implementation of individual compensation measures are provisional as the timeframe for Examination, consent award, reaching final investment decision (FID) and Contracts for Difference (CfD) Allocation Round Five, have not yet been set. The programme has been carefully considered to ensure timely delivery of the compensation measure.

4.1.4.3 The requirement for, and the exact nature of, the decommissioning of the Compensation Measures will be determined in consultation with the relevant authorities towards the end of the 35-year operational life of Hornsea Four. The Applicant will design the bird nesting structures for a design life equal to that of the windfarm (i.e. 35 years plus 4 years to establish the compensation measures, pre-wind farm operation). Therefore, the lifetime of the structure is approximately 39 years. In the final few years of wind farm operation, the Applicant will commence inspections and surveys of the bird nesting structures to determine if an extension of the lifetime is possible.

4.1.4.4 It is currently anticipated that both the predator eradication and bycatch measures implementation will result in new management practices which shall continue for the lifetime of Hornsea Four. Fish habitat enhancement (seagrass) compensation measure sites will be left in perpetuity.

4.1.5 Offshore Artificial Nesting Structure (New and Repurposed)

4.1.5.1 The provision of new and/or repurposed artificial nesting sites is presented as a potential Compensation Measure for the black-legged kittiwake (*Rissa trydactyla*) (referenced throughout as kittiwake) and northern gannet (*Morus bassanus*) (referenced throughout as gannet).

4.1.5.2 Kittiwake have been observed readily (APEM 2021 and NIRAS 2021) utilising man-made structures. As such, the provision of an offshore artificial nest site to increase the annual recruitment of kittiwake into the regional population of the southern North Sea. This is considered a potential primary Compensation Measure relating to in-combination collision effects during the operation and maintenance phase of Hornsea Four on the kittiwake population designated at the FFC SPA. The aim of the Compensation Measure is to provide one structure that can collectively sustain a breeding population of kittiwake pairs, which would produce sufficient breeding adults to compensate for the estimated impact of Hornsea Four.

4.1.5.3 The Applicant is considering two options by which to achieve this:

- Repurposing an existing oil and gas platform(s) that is due for decommissioning (preferred option); or
- Construction of a new offshore nesting structure.

4.1.5.4 The Area of Search for offshore artificial nesting structures (both new and repurposed structures) is shown in [Figure 1](#). The site selection process for these offshore structures is outlined in the Without Prejudice Derogation Case (specifically [B2.7.1 Compensation measures for FFC SPA: Offshore Artificial Nesting: Ecological Evidence](#)). The purpose of the site selection process has been to identify an area, or existing structure (e.g., an oil and gas platform), to host artificial nesting sites that will be occupied by new recruits that will contribute to an increase of breeding adults to the Southern North Sea kittiwake population. The principles influencing optimal site selection include:

- Locations with connectivity to the Eastern Atlantic kittiwake population – based within the North Sea;
- Locations with proximity to reliable food resources – close to sea fronts (e.g. southern North Sea); and
- Locations with proximity to growing kittiwake colonies – near to known offshore sites with colonies of kittiwake (e.g., southern North Sea oil and gas platforms).

4.1.5.5 Ongoing consultation will involve conservation and ornithological groups with local knowledge and expertise. The detail of the continued site selection process will be presented within [B2.7.6: Outline Kittiwake Compensation Implementation and Monitoring Plan](#) that will be developed in consultation with relevant stakeholders (through the Hornsea Four OoEG).

New offshore artificial nesting structure

4.1.5.6 For the purpose of the assessment, a maximum design scenario of up to two new offshore artificial nesting structures are considered, to be installed on one of the following foundation types, noting that the requirement for new offshore structures, their number and location, and the exact foundation type are yet to be determined:

- Monopile;
- Mono-suction bucket;
- Gravity based foundation;
- Piled jacket; or
- Suction bucket jacket.

4.1.5.7 The overall design of a topside nesting structure is flexible, as long as suitable narrow nesting ledges are present. A summary of the key features an offshore platform for nesting might include is provided below:

- High and steep sided structure, narrow horizontal ledge for nests, small overhang above nest;
- Inaccessible to predators, which offshore would primarily be large gulls;
- Some shelter from high winds and other adverse weather conditions; and
- May include a shelter and potentially CCTV to enable monitoring of the seabirds.

4.1.5.8 The new offshore artificial nesting structure will likely be installed in two stages, firstly the foundation will be installed, and secondly the topside will be lifted from a jack -up vessel (JUV) onto the foundation. Some form of seabed preparation (boulder and sandwave clearance), unexploded ordnance (UXO) clearance and scour protection may be required for the foundations.

4.1.5.9 The maximum design scenario parameters for a new offshore nesting structure is presented below in [Table 4](#).

Table 4: Maximum design parameters for a new offshore nesting platform.

Parameter	Maximum design parameter
Number of offshore nesting platforms	2
Topside structure length (m)	25
Topside structure width (m)	25
Topside structure height (m above LAT)	20
Topside thickness (from topside to upper level of foundation) (m)	10

Parameter	Maximum design parameter
NOTE: Foundation dimensions are dependent on topside dimensions. Which in turn are dependent upon the design of the final topside, which is dependent upon the number of kittiwakes to be compensated.	

4.1.5.10 Full details regarding the potential development can be found in [Volume A4, Annex 6.1: Compensation Project Description](#).

Repurposed offshore artificial nesting structure

4.1.5.11 The Applicant could utilise a single existing offshore platform (potentially an existing oil and gas structure or similar), and use the foundation to either design, construct and install a new topside once the existing topside structure has been removed and decommissioned or repurpose the existing topside structure by adding additional nesting ledges.

4.1.5.12 The topside of the repurposed structure will be up to 19 m above LAT, up to 16 m long, and 13 m wide. The topside design will follow the same principles as outlined in [Table 4](#).

4.1.5.13 Foundation installation is not required if repurposing an existing offshore platform. However minor modifications to the existing offshore platform foundation may be required. Foundation repurposing installation activities could include repairs, modifications, or reinforcement of existing foundation infrastructure. All modifications would be undertaken using either or a combination of Dynamic Positioning (DP) and JUV vessels.

4.1.6 New Onshore Artificial Nesting Structure

4.1.6.1 The Applicant is proposing an onshore artificial nesting structure for kittiwake if during Examination, the Secretary of State considers that an alternative (to a preferred repurposed or new offshore nesting) measure is required to the proposed primary measures outlined in [Section 4.1.5](#). The approach to site selection and design are primarily driven by ecological/habitat requirements of the ornithology interests to increase the likelihood of colonisation and ensure the success of the structures. The onshore artificial nesting structures will be located within one of two search zones. The Areas of Search for onshore artificial nesting structures (both new and repurposed structures) is shown in [Figure 1](#).

4.1.6.2 The structure will be designed to accommodate the level of compensation required for both kittiwake and gannet with greater proportion of the capacity available for kittiwake, relative to gannet (i.e. 80% kittiwake nests to 20% gannet nests; the exact ratio to be determined) and will accord with the design principles and indicative maximum parameters set out below.

4.1.6.3 The design principles for onshore artificial nesting structures are subject to significant further development; however, design principles of direct relevance to the size or appearance of the structures are as follows:

- Steep sided with a near vertical back wall and narrow horizontal ledges.
- Located close to water, facing out to sea (i.e. nest adjacent to/above harbour waters/sea).
- Inaccessible to predators (additional anti-predation features may be required at some sites
 - e.g. fences/ barriers to deter mammalian predators (e.g. foxes and rats) and

dependent

on design bird spikes may be required as avian predator deterrents).

- Nesting ledges located above the level of highest astronomical tide and beyond the reach of wave or tidal action.
- Adequate ledge dimensions: Horizontal ledges 20 cm width; length per pair from 30 cm (working length 40 cm); and height between ledges at a minimum of 40 cm and maximum of 60cm. (Note these may be subject to change based on feedback from the stakeholders during detailed design).
- Minimum height at which the lowest shelves should begin depends whether the structure is located directly over water or set back slightly, as well as the level of human disturbance anticipated.
- Overhang/roof to buffer against weather conditions as to act as and additional predator deterrents.
- Vertical wall leaning slightly forward (working angle of 5°; to minimise lower ledges becoming fouled by droppings and reduce predation risk).
- Using materials which are in-keeping with the structure's surroundings whilst ensuring they meet the requirements of kittiwake's natural habitat as much as possible.
- Higher ledges could be wider than lower ledges (to prevent lower ledges becoming fouled by droppings) (BTO Field Guide No. 23, du Feu (2015)). However, wider upper ledges may increase predation risk/ allow non target species to nest.

Construction

4.1.6.4 The construction of the onshore artificial nesting structures depends on whether the structure comprises a building, or prefabricated structure (dependant on monitoring and access requirements for tagging). Building construction works, are anticipated to comprise:

- Site preparation works, including vegetation clearance (if required), erection of site fencing and small-scale enabling works;
- Establishment of a site compound and temporary site infrastructure, including a site cabin and welfare facilities;
- Delivery of construction materials and equipment;
- Installation of necessary foundations (to be confirmed, dependant on detailed design and site location); and
- Construction of the nesting structures on-site, methodology of which is dependent on the materials to be used (to be agreed as part of detailed design). Materials used for the building may comprise concrete, wood, or metal).

4.1.6.5 Prefabricated structure construction works are anticipated to comprise:

- Site preparation works, including vegetation clearance (if required), erection of site fencing and small-scale enabling works;
- Establishment of a site compound and temporary site infrastructure, including a site cabin and welfare facilities;
- Delivery of pre-fabricated components of the nesting structures and equipment;
- Installation of necessary foundations (to be confirmed, dependant on detailed design and site location); and
- Assembly and Installation of the nesting structures on-site, methodology of which is dependent on the materials to be used (to be agreed as part of detailed design). Materials used for the pre-fabricated structure may comprise wood or metal.

- 4.1.6.6 Construction is anticipated to comprise a maximum of 10 Annual Average Daily Traffic (AADT) Heavy Goods Vehicle (HGV) movements (subject to detailed design). The site may require a temporary construction access track (dependant on site location), using crushed aggregate on geo-textile, soil stabilisation or temporary trackway. The access track will be 10 m wide, comprising 6m wide road (with 7 m wide passing places) and additional width for topsoil storage. The maximum depth of the access track would be 1 m.
- 4.1.6.7 A temporary logistics compound may be required and the dimensions of which would be approximately 70x70 m.

Operation

- 4.1.6.8 Once the construction of the onshore artificial nesting structure is complete, the site will be secured using fencing and the structures will be operational. Whilst operational activities are under development, **Table 5** outlines some design principles that may be of relevance, dependant on stakeholder input and detailed design consideration.

Table 5: Onshore nesting structure design principles.

Importance	Principle Description
Optimising monitoring	Capacity for remote monitoring devices e.g. cameras to be fitted to the structure. Ideally these would need to provide coverage of all available ledges at a sufficiently high resolution to monitor individual nests and their contents e.g., chicks and eggs, to be inspected.
Optimising monitoring / essential at some sites	Complex monitoring, to include: <ul style="list-style-type: none"> • Internal access; • Enclosed structures where the personnel monitoring within would be hidden from view, including to birds flying above and therefore minimising any disturbance; • Either with hatches to allow access from behind/within the structure to individual nests by suitably qualified ornithologists undertaking monitoring works; • And / or one-way glass to allow observations to be made from interior/back of structure; • Capacity for additional monitoring equipment to be accommodated within/on the structure (nice to have, not essential); and • Sanitation facilities (requirement to be determined).
Desirable (a, d) Optimising success (b, c, e)	Capacity for the structure to be modified to facilitate adaptive management design features after they have been operational for some time and if required. These may include: <ul style="list-style-type: none"> • Extension of structure to facilitate further nesting spaces. This would require either sufficient space to expand (laterally or vertically) or designed-in expansion points – for example a modular structure which can be extended; • Relocation of nesting structure. This would require straightforward assembly of components and potential to disassemble, balanced against longevity and stability of the structure; • Additional protection from elements e.g. wind/weather shield location points; • Enhanced predator deterrent e.g. straightforward roof and fencing maintenance, including opportunities to add avian predator deterrents; and • Provision of nesting material, such as seaweed. This would require additional protected space around or under the structure.

- 4.1.6.9 The number of monitoring visits is anticipated to be low, accessing the site on foot where possible. It is acknowledged that the location of the nesting structure is to be determined. Therefore, noise and odour levels are to be determined during detailed design phase once the

proximity to local communities has been calculated. This is anticipated to be post-consent of Hornsea Four.

4.1.6.10 Monitoring and maintenance activities could theoretically comprise the following:

- Removal of kittiwake guano from structure and appropriate disposal;
- Remedial works to structure (i.e. storm damage to nesting ledges);
- Ensuring structure is structurally sound;
- Changing batteries used for speakers playing kittiwake calls; and
- Removal of litter, graffiti or any objects deemed hazardous to kittiwakes.

4.1.6.11 Further project description details in relation to new onshore artificial nesting structures can be found in [Volume A4, Annex 6.1: Compensation Project Description](#).

4.1.7 Bycatch Reduction Technology

4.1.7.1 The implementation of bycatch reduction technology is presented as a potential Compensation Measure for guillemot (*Uria aalge*) and razorbill (*Alca torda*).

4.1.7.2 Bycatch, which is the incidental capture of non-target species in fisheries, can present a significant pressure on seabird populations (Miles et al. 2020). Within recent decades, seabird populations have plummeted, largely due to commercial fisheries (direct competition and bycatch) (Croxall et al. 2012). Monitoring of the issue is extremely low with onboard observer monitoring coverage relatively low compared to the number of fishing vessels (Pott and Wiedenfeld 2017). To mitigate against the number of seabirds, specifically razorbills and guillemots that may be at risk of displacement, the Applicant proposes to support the overall numbers of these birds through the reduction of bird bycatch in selected UK fisheries with connectivity to the populations from FFC SPA.

4.1.7.3 The reduction of bird bycatch will be achieved through the use of additional deterrent equipment attached onto fishing gear. Different bycatch reduction techniques are more suited to specific fishing gear types and specific target bycatch species of birds. The proposed bycatch reduction methods being considered as a package of compensation measures are above water deterrents (AWDs), net lights, and net panels.

4.1.7.4 Potential fisheries with reported bird bycatch and population connectivity with the FFC SPA include the UK South coast, Cornwall, and the Thames Estuary. All of these locations are being considered for potential bycatch reduction trials and future implementation. Specifically, bycatch hotspots have been identified in both the South East and South West of the UK, along with reports of bird bycatch at other locations along the south coast and in the Thames Estuary. The AoS for bycatch reduction technology is shown in [Figure 1](#); these depict areas where fishing takes place and where bycatch reduction trials may be targeted.

Fishery selection

4.1.7.5 Current research suggests that gillnetting, depending on location and seasonality, suffers high levels of bird bycatch (Northridge et al. 2020). As such, many of the bycatch reduction types currently available are focussed on bycatch from gillnets. This Compensation Measure will therefore include bycatch reduction of bird bycatch from gillnet fisheries. There is less evidence to support the contribution of other fishing methods on bycatch, including mid-water trawl bycatch. Evidence gathering by the Applicant is ongoing for mid-water trawl bycatch,

however, there is not currently enough evidence to demonstrate the efficacy of above water deterrents as bycatch reduction for mid-water trawls at the moment. However, currently all above bycatch reduction methods are being considered for mid-water trawling.

- 4.1.7.6 From April to July (breeding season), both guillemot and razorbill are located tightly around their colonies (around the coasts of the UK except for the Humber to the Isle of Wight). Outside of the breeding season, both species move further offshore, then start moving south. By December both species are located offshore around all UK coasts. As seabird distributions change throughout the year, it is likely that bycatch rates will also vary as higher seabird densities increase the bycatch risk (Bradbury et al., 2017). It is therefore important to evaluate temporal variations when identifying areas of high bycatch vulnerability for the purpose of planning bycatch reduction measure locations.
- 4.1.7.7 Potential fisheries with reported bird bycatch and population connectivity with the wider site network and include the UK South coast, Cornwall, and the Thames Estuary. All of these locations are being considered for potential bycatch reduction trails and future implementation.). Bycatch hotspots have been identified in both the South East and South West of the UK, along with reports of bird bycatch at other locations along the south coast and in the Thames Estuary.

AWDs

- 4.1.7.8 AWDs are typically structures fixed to buoys or markers attached to set fishing gear, which work to scare birds away from fishing nets. Current nets are often made from monofilament nylon, which is nearly invisible to seabirds underwater and so the aim of deterrents is to deter birds from approaching the nets and becoming entangled. Specifically, the proposed AWD is a looming eye boy, which is comprised of a floating buoy, topped by a long stick and a marker on the top that includes an eye-like pattern (**Figure 2**). The aim of the buoy is to work like a scarecrow in scaring birds away from nets. The eye design on the top panel may mimic deterrent eye patterns found in nature, whilst the bobbing and spinning of the buoy will result in a “looming” effect over the birds, thus deterring them from approaching the buoys. They are not designed to make any noise or light and are attached to the fishing equipment already in place. No additional vessel presence and/or movement or equipment is required.

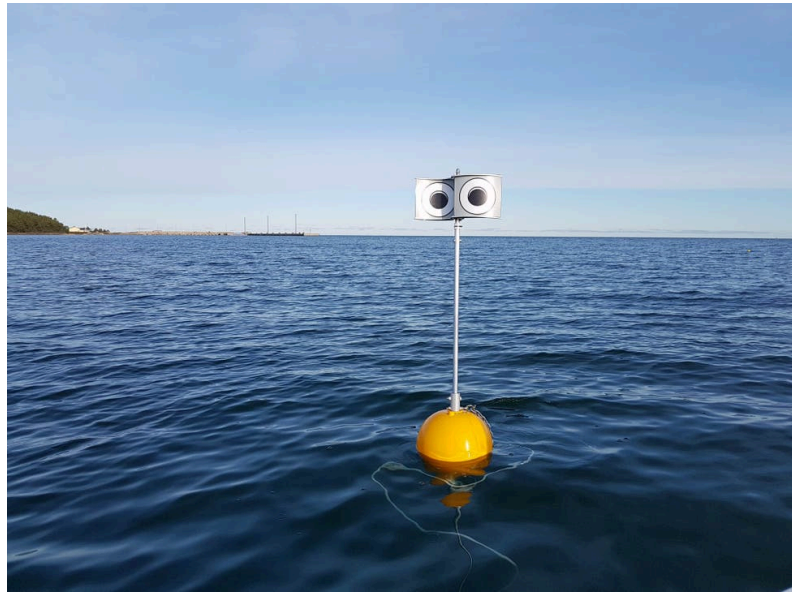


Figure 2: Looming Eye Buoy (Source: The Independent²).

Net lighting (Light Emitting Diodes [LEDs])

4.1.7.9 LED net lights are small simple lights which can be attached to existing fishing gear to act as a deterrent to non-target species. The aim of the lights is to increase the visibility of the nets in the water to birds and marine mammals so that they do not become entangled with the nets. There are multiple designs available of these lights, with the majority being pre-attached to the nets ahead of deployment and remaining in place until the nets are hauled in. No additional vessel presence and/or movement or equipment is required.



Figure 3: A commercially available net light (Source: Fishtek³)

Net panels

4.1.7.10 Attaching highly visible panels to nets may increase the visibility of the nets to diving birds and therefore reduce bycatch. Panels may comprise equally spaced black and white squares, attached to the surface of nets, to ensure they are highly visible to diving birds. The panels often require holes in them to reduce the effect of currents on the set gear. The panels are pre-attached to nets and are deployed as the nets are set. No additional vessel presence and/or

² <https://www.independent.co.uk/news/science/science-googly-eye-mammoth-pasta-b1845394.html>

³ <https://www.fishtekmarine.com/netlight/>

movement or equipment is required.

Implementation, operation and monitoring

4.1.7.11 Bycatch reduction trials for Looming Eye buoys are planned for October 2021-January 2022, with potential for further trials under consideration. Following the trials to gather further evidence on the efficacy of each bycatch reduction method, a specific measure or combination of measures will be selected to take forward. Implementation of the planned compensation will begin following determination of the DCO application by the Secretary of State. To ensure that the equipment continues to be used and that further evidence can be gathered to confirm the success of the measures, a monitoring programme may be required during the operational use of the measures. There are many examples of fishing gear monitoring around the world, which include but are not limited to gear cameras, self-reporting, blue-tooth tags, and equipment trackers. The exact method of monitoring to be used will be decided based upon further evidence gathering and discussion with industry experts. The Wind Farm is expected to operate for 35 years following construction. If required, the accepted bycatch reduction measure(s) would be used and monitored throughout the operational lifespan of the Wind Farm. Following the monitoring programme, overall measure uptake and success of the bycatch reduction measure, the equipment may continue to be used as a deterrent.

4.1.8 Predator Eradication

4.1.8.1 To compensate the potential displacement impact on guillemot and razorbill from the operation of the Hornsea Four Wind Farm, The Applicant proposes to implement a predator eradication programme at selected guillemot and/ or razorbill breeding colonies. The selected colony will be chosen based on delivery and connectivity to the populations from FFC SPA. This would be part of a package of compensation measures for these species.

4.1.8.2 Predator eradication will be undertaken using well established methods evidenced throughout the wealth of previous predator eradication examples from the UK and further afield. For ground predators, such as rats, this usually involves poison bait stations. The primary species the measures of predator eradication would be focussed upon are rat and house mouse but could extend to include mink or crow as a supportive measure pending ecological advice and stakeholder discussions, whilst ensuring non-targeted species are not accidentally eradicated.

4.1.8.3 Following the removal of the invasive species, biosecurity measures will subsequently be installed to prevent re-invasion. Biosecurity measures form a vital consideration in ensuring that efforts to remove invasive species have not been undertaken in vain. There are a significant number of biosecurity measures available depending on the location and species being considered, all of which have been tried and tested at previous predator eradication schemes (i.e., Biosecurity for LIFE project).

Location

4.1.8.4 It is proposed that predator eradication will be undertaken on an island or islands where both invasive mammalian predators and guillemot and/or razorbill are present. The Applicant is currently liaising with site managers at multiple islands to understand the prevalence of invasive mammalian species and ascertain the level of pressure posed to breeding guillemot and razorbill. The potential broad areas currently being considered for predator eradication include:

- Rathlin Island;
- Channel Islands;
- Isles of Scilly; and
- Islands off the south coast of Devon.

4.1.8.5 The specific locations within these broad areas are continuing to be explored and The Applicant will remain open to considering other locations if identified and/or deemed suitable. Those islands where invasive mammalian predators have increased access to breeding locations will be favoured due to the high degree of overlap.

4.1.8.6 Before any predator eradication schemes are implemented at a specific location, an eradication feasibility assessment will be undertaken to ensure measures can be employed to remove the invasive species and that biosecurity measures can be subsequently installed to prevent reinvasion, whilst not affecting the native species and/or species that may not affect guillemot and/or razorbills.

Operation, implementation, and monitoring

4.1.8.7 The objective of the eradication programme will be to remove mammalian predators from the island(s) that are currently suppressing the breeding success (and therefore, population size) of guillemot and razorbill (amongst other species) at these locations. The removal of this pressure will therefore lead to an increase in productivity and ultimately an increase in the population size of these species, whilst not affecting any other species that are not known to be detrimental to guillemot and/or razorbills.

4.1.8.8 Following the feasibility assessment and in partnership with site managers, invasive species eradication specialists will be contracted to undertake the island(s) eradication. Consideration of the timing of a predator eradication programme will be made to ensure that they are undertaken at the optimal time and that will not for example affect a species/habitat that are not known to be detrimental to guillemot and/or razorbills.

4.1.8.9 The primary aim of an eradication scheme is always to completely remove the introduced animal from the chosen area. In theory, just a single pregnant female of the invasive animal could repopulate the area. Two years intensive monitoring for the presence of the eradicated animal is required to receive the invasive-free status (Nathan et al., 2015; Russell et al., 2017). For example, this was the process taken for the eradication of rats on Canna and Sanday under contract by Wildlife Management International, starting in late 2005. By February 2006 the last rat sign was detected, and after a two-year period of intensive monitoring, the island was declared rat-free in 2008 (see Bell, et al., 2011). The predator eradication programme would only be undertaken by appropriate qualified people and all methods will be agreed with the appropriate stakeholders.

4.1.8.10 Following the invasive species status, seabird recovery monitoring will continue for the lifetime of Hornsea Four. Monitoring will include population census and productivity monitoring. This will be compared to pre-eradication data (which will be collected to characterise the baseline and supplement historic seabird data for the location where available). The presence of invasive species will also be monitored to detect signs of repopulation.

Summary of Predator Eradication Compensation Measure

4.1.8.11 Predator eradication is a primary Compensation Measure. In-combination with other primary razorbill and guillemot measures, predator eradication will be able to deliver the required level of compensation for Hornsea Four. A detailed evidence report, and roadmap will be submitted with the DCO application to demonstrate the potential compensation deliverable by the predator eradication programme both alone and combined with the other primary compensation measures. The evidence report will include a summary of the supporting evidence for predator eradication compensation and the roadmap will outline the further steps that will be undertaken from submission to demonstrate that the Compensation Measure can be secured. These Compensation Measures are effective, feasible and securable measures that can be implemented prior to the impact occurring and sustainable for the lifetime of the project. In designing this compensation measure the Applicant has consulted and worked with Natural England, JNCC, the RSPB, The Wildlife Trust, other statutory bodies and other relevant stakeholders to seek to ensure this compensation measure is both robust, deliverable and effective.

4.1.9 Resilience Measure – Fish Habitat Enhancement (Seagrass)

4.1.9.1 Fish habitat enhancement (as a concept) seeks to improve vital habitats for fish species such as those that provide spawning or nursery grounds, with an aim of increasing the productivity of fish populations. This in turn will increase prey abundance for many seabird species (e.g. kittiwakes, guillemots) who are known to forage in coastal shallow water areas when nesting (Bugge et al. 2011; Redfern and Bevan 2014) and consume young fish known to be abundant in seagrass (Bugge et al. 2011; Lilley and Unsworth 2014). Therefore, the restoration of seagrass habitats is being considered as a potential Resilience Measure to boost key forage fish densities for kittiwake, Northern gannet, guillemot and razorbill breeding adults to compensate for the estimated impact of Hornsea Four.

4.1.9.2 The Applicant recognises the importance of seagrass as a measure that can provide resilience to the compensation measures such as predator eradication, habitat management, bycatch reduction and provision of artificial nesting. The Applicant proposes to provide a package of measures that will support the seabird populations such as kittiwake, gannet, guillemot and razorbill locally and in the North Sea. The measures will be designed to seek opportunities to be spatially co-located to maximise the benefits of the measures and located to ensure the overall coherence of the network is maintained. The Applicant is exploring opportunities to expand existing seagrass restoration projects that are already underway and opportunities to create new projects with the academic community that could potentially improve the resilience of the measure.

4.1.9.3 The site selection process for these seagrass locations is outlined in the Without Prejudice Derogation Case (specifically **B2.8.5 Compensation measures for FFC SPA: Fish Habitat Enhancement: Ecological Evidence**). The purpose of the site selection process has been to identify areas supporting all the target seabird species and are suitable for seagrass restoration projects. The resulting AoS are shown in **Figure 1**, with these areas consistently supporting all of the target seabird species, providing options for seagrass restoration as well as supporting the compensation measures. Specifically, potential existing seagrass meadows located within proximity of the primary razorbill and guillemot compensation measures (i.e. bycatch and predator eradication), with reported connectivity with the wider site network and the North Sea populations including the Solent, Channel Islands, Cornwall, Isles of Scilly, Essex, Rathlin Island and Humber Estuary. All of these locations are being considered for potential feasibility

trails and future implementation.

- 4.1.9.4 Consultation will commence with conservation and ornithological groups with local knowledge and expertise. The detail of the continued site selection process and consultation is presented within [B2.9: Record of Consultation](#).

Feasibility

- 4.1.9.5 Prior to any field studies commencing, detailed feasibility studies will be undertaken to assess the physical parameters for seagrass to be restored. These studies will be complemented by further stakeholder engagement. The Applicant recognises the need for feasibility studies to inform site selection and methodology to increase the likelihood of a successful restoration programme and efficacy of the resilience measure (with monitoring discussed below). Factors that will be considered prior to restoration efforts being initiated include looking for sites sheltered from wave action, with good water quality, suitable topographical and hydromorphological conditions (including sedimentation rates, sufficient nutrients and available light), and avoidance of sites with activities that could cause significant physical disturbance.
- 4.1.9.6 A key component of the fish habitat enhancement compensation measure will be research, to gather evidence to contribute towards filling current knowledge gaps. We have identified a number of initial potential research projects (in addition to feasibility studies) that the research could cover including: foraging seagrass habitat study for seabirds including species counts, behavioural observations and habitat mapping, fish surveys within seagrass meadows using seine and/or fyke netting, further seabird diet studies, and migratory fish tagging to understand fish movements.

Restoration techniques

- 4.1.9.7 The Applicant is considering two major techniques by which to restore seagrass habitats: replanting and reseeding.
- 4.1.9.8 Seagrass restoration has been formally conducted for over 50 years and the means of doing this can principally be split into two major techniques: reseeding and replanting. Both techniques have their relative merits and have exhibited varying levels of success. Reseeding generally relates to the collection and targeted redistribution (and sometimes processing) of wild seed. Seeds can be directly deployed from the boat and often hessian bags are used to help anchor the seeds in place during germination. It is expected that up to two vessels would be required for the seagrass restoration at each location.
- 4.1.9.9 Adult shoot replanting normally involves harvesting plants from an existing meadow and transplanting them to the restoration site. For the replanting process, the reproductive fronds of wild seed is collected by hand by SCUBA divers. In most cases, shoot planting involves some means of anchoring the shoots to the bottom until the roots can take hold (root into the bottom). Replanting uses either labour intensive diving techniques or various mechanistic approaches to planting various sizes and ages of seagrass plants into new localities. Planting of seedlings in the UK is typically undertaken by a team of divers who are transported to the site by boat. It is expected that up to two vessels would be required for the seagrass restoration at each location.

Monitoring and Adaptive Management

- 4.1.9.10 Hornsea Four is expected to operate for 35 years following construction. Monitoring of restoration will be essential to demonstrate the efficacy of the compensation measure and if required, the seagrass meadow would be monitored throughout the operational lifespan of the Hornsea Four. The exact method of monitoring will be decided based upon further evidence gathering and discussion with restoration experts and stakeholders. A monitoring programme will be developed and at key stages the results of the restoration will be shared to improve the knowledge and evidence for seagrass restoration.
- 4.1.9.11 Adaptive management is an iterative process which combines management measures and subsequent monitoring with the aim of improving effectiveness whilst also updating knowledge and improving decision making over time. Adaptive management will be an important component of the compensation measure and will be used as a method to address unforeseen issues or deviations from expected time scales (i.e. additional infill planting required).
- 4.1.9.12 It is assumed that any onshore access to the area chosen for seagrass restoration will be through existing highways and/or footpaths. It is considered that no new access roads will be required and that no construction is required as part of the measure. Any requirement for vehicle movements during site suitability surveys, the restoration process or subsequent monitoring are considered to be negligible. Therefore, onshore impacts have been scoped out of the assessment.

5 Consultation

- 5.1.1.1 The Applicant has undertaken extensive consultation with relevant stakeholders as part of the preparation of the Without Prejudice Derogation Case (namely, Natural England, Joint Nature Conservation Committee (JNCC), the Royal Society for the Protection of Birds (RSPB), the Marine Management Organisation (MMO), PINS, Defra, Local Planning Authorities, The Wildlife Trusts, the National Federation of Fisherman's Organisations (NFFO) and relevant local organisations with key knowledge) regarding compensation for Hornsea Four. Relevant stakeholders will be engaged through the Hornsea Four Offshore Ornithology Engagement Group (OOEG). Further detail on this consultation is presented in the Record of Consultation (**B2.9: Record of Consultation**). Consultation will be ongoing with various stakeholders for all proposed compensation measures at various stages through the process.
- 5.1.1.2 The Applicant has undertaken further consultation specifically in relation to the Compensation Measures with statutory consultees who may have an interest in the proposed Compensation Measures, and certain stakeholders located in the vicinity of the land potentially affected by the measures. This targeted consultation ran from 5th August to 6th September 2021. All responses and comments are presented in **Volume A1, Annex 1.37 Non-Statutory Targeted Compensation Measures Consultation Responses** alongside the regard the Applicant has had to these consultation responses.

6 EIA Methodology

6.1 Introduction

- 6.1.1.1 **Volume A1, Chapter 2: Environmental Impact Assessment Methodology** of the Hornsea Four ES sets out the EIA methodology followed for Hornsea Four. Specifically, the chapter describes

the approach used to identify, evaluate and mitigate potential likely significant effects (LSE), in EIA terms, using a defined proportionate approach to the assessment process. The requirement for EIA and the proposed temporal, spatial and technical scope of the assessments are described along with details of the Applicant's specific 'commit – design – consult' ethos to developing Hornsea Four. This detail is equally relevant to the Compensation Measures EIA and as such, most of this detail is not repeated within this Annex. To enhance the readability of this Compensation Measures EIA, some elements of EIA methodology are repeated below to allow this document to be read and understood without extensive cross-referencing to other documents required.

6.1.1.2 It is important to note that given the broad nature of the proposed Compensation Measures and the extensive refinement of the site selection process that will be undertaken as part of their own consenting process (for example a Marine Licence application and/or Planning Application), the assessment presented within this Annex broadly follows the approach set out in Volume A1, Chapter 2: Environmental Impact Assessment Methodology of the Hornsea Four ES in terms of the stages followed (i.e. characterisation of the existing environment, identification of receptors, assessment, and commitments). More specifically, the stages followed in this Annex are summarised in the following sections. Where elements of the approach outlined in this Annex vary from that which is outlined in [Volume A1, Chapter 2: Environmental Impact Assessment Methodology](#), this is noted in the sections below with justification for the approach provided.

6.2 Overview of Process

6.2.1.1 EIA is a systematic, iterative and prescribed process framed by statutory requirements as well as the relevant planning and policy context (see [Volume A1, Chapter 2: Planning and Policy Context](#)). Furthermore, consideration of best, good and advised EIA practice and adoption of a Proportionate EIA approach (see [Volume A1, Chapter 2: Environmental Impact Assessment Methodology](#)) has guided the specific approach followed by the Applicant in relation to this Compensation Measures EIA.

6.2.1.2 The key elements of the Compensation Measures EIA process and the identification of significant effects are described in the following sections. While these provide a general framework for identifying impacts and assessing the significance of their effect(s), in practice the approaches and criteria applied across different EIA topics vary.

6.2.1.3 An overview of the approach to the Compensation Measures EIA is provided in [Figure 4](#).

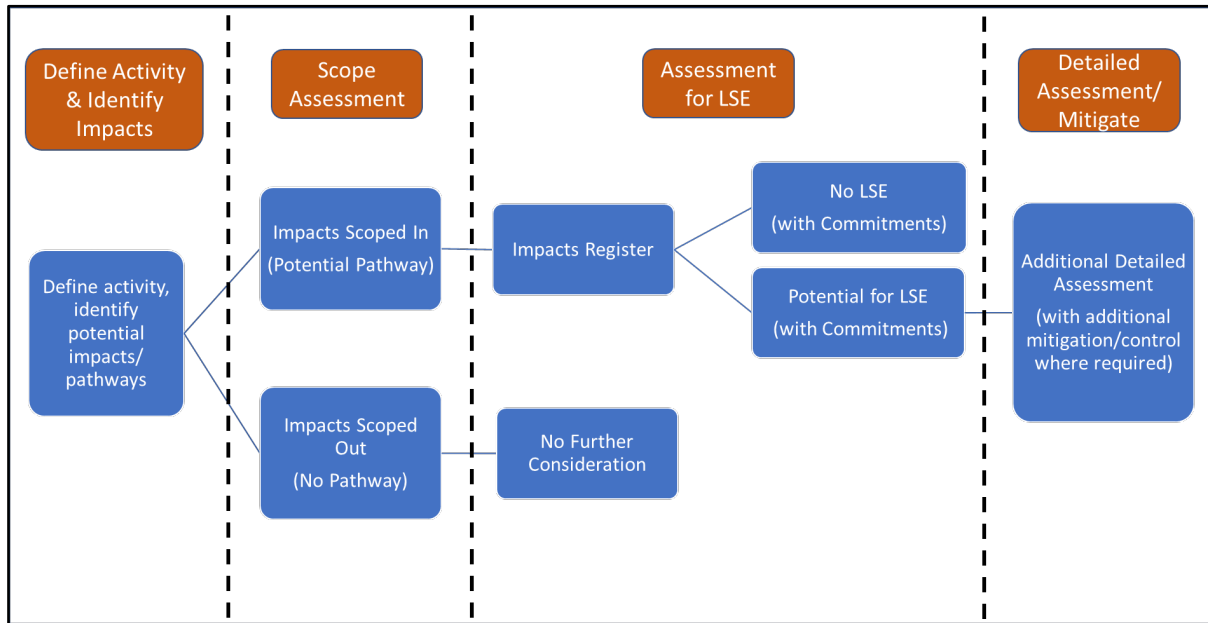


Figure 4: Compensation Measures EIA Process.

6.2.2 Maximum Design Scenario (MDS)

6.2.2.1 The MDS parameters for the relevant Compensation Measures are considered to be a worst case for any given assessment. This approach ensures that the scenario that would have the greatest impact (e.g. largest footprint, longest exposure, or tallest dimensions, depending on the topic) is assessed; and there is confidence that any other (lesser) scenarios will have an impact that is no greater than that assessed.

6.2.2.2 Impact-specific MDS relevant to this Compensation Measures EIA, as they apply to each receptor group, are defined within [Volume A4, Annex 6.3: Compensation Impacts Register](#) for each Compensation Measure. For clarity regarding the differences between receptor groups, the information is presented according to individual project parameters, including a note regarding why the scenario is relevant to that receptor. Where relevant, the information includes any designed-in features which, whilst also providing mitigation, are integral to the design or physical characteristics of the project.

6.3 Compensation Impacts Register

6.3.1.1 A cornerstone of the Hornsea Four approach to delivering both proportionate EIA and delivery of commitments, is the development of an Impacts Register and this process has been followed for the Compensation Measures EIA. The Compensation Measures Impacts Register ([Volume A4, Annex 6.3: Compensation Impacts Register](#)) provides the following discrete and separate functions:

- Details all potential impacts associated with each Compensation Measure and provides a unique identification reference which can be traced through the subsequent steps/documents;
- Sets the scope of the Compensation Measures EIA with appropriate justification;
- States the magnitude, sensitivity and significance for all potential impacts associated with all activities, in all phases of development of each Compensation Measure;

- Identifies Commitments to reduce or eliminate LSE; and,
- Defines the Maximum Design Scenario (MDS) for any given impact.

6.3.1.2 The Compensation Measures Impacts Register ([Volume A4, Annex 6.3: Compensation Impacts Register](#)) is an Excel spreadsheet which identifies the potential impacts (and the resultant effects) that could possibly result from the installation/construction, implementation/O&M, and/or decommissioning phases of each Compensation Measure, relating to each technical topic under consideration in the EIA process. The register allows the user to sort and filter the impacts that are most relevant to them. The measures described within the impacts register that result in a potential for LSE have been considered for assessment within this EIA and are presented within the relevant sections.

6.4 Compensation Measures Commitments

6.4.1.1 All Commitments relevant to the Compensation Measures EIA are detailed in [Volume A4, Annex 6.4: Compensation Commitments Register](#). As advocated in EIA guidance (e.g. IEMA 2004), it is only necessary to assess potential effects arising from the final design, incorporating all primary and tertiary mitigation (only pre-mitigation effects and residual effects need both be set out where secondary mitigation is required). In this respect, the Applicant has considered the Commitments in making an initial assessment of the likely significant effects.

6.5 Characterisation of the Existing Environment (Baseline)

6.5.1.1 As noted in [Section 4.1.2](#), AoS have been identified for each Compensation Measure. These AoS range from small areas around islands or discrete sections of coastline, to larger areas spanning large areas of sea and coastlines. As these AoS can cover extensive areas, a high-level characterisation of the existing environment for each AoS has been undertaken to determine the baseline conditions in each AoS and relevant surrounding areas. The scope of baseline characterisation has been made relevant to the scope of the EIA in that if a specific EIA topic has been scoped out of the assessment in relation to particular Compensation Measure, then the baseline for that particular topic is not presented. The baseline characterisation includes usage of readily available information from desktop study. It is important to note that the Compensation Measures will not be consented through the Hornsea Four DCO application process and where applicable will be subject to standalone EIA and HRA processes as part of their own consenting process (for example a Marine Licence application and/or Planning Application). As part of that consenting process, further baseline and assessment work will be undertaken, based on refined design and methodology details.

6.6 Impacts, Effects Mitigation and Significance

6.6.1.1 'Impacts' are defined as the physical (or chemical) changes that will be caused by Hornsea Four activities. 'Effects' are defined as the consequences of these impacts to biological populations, ecosystems and humans (including their physical and cultural assets).

6.6.1.2 For many technical topics, the likely significance of an effect is established by combining the magnitude of an impact with the sensitivity of the receptor to that impact (noting that sensitivity is not considered as an inherent characteristic but how something specifically responds to an external factor). The value of a resource or receptor is also considered. For more information on the methodology for assessing the likely significance of effects, including the significance matrix utilised in this assessment, see [Volume A1, Chapter 2: Environmental Impact Assessment Methodology](#).

6.7 Cumulative, Inter-Relationships and Transboundary Effects

- 6.7.1.1 For consideration of cumulative aspects, it is assumed that where potential for LSE applies to the project alone, that potential for LSE applies cumulatively with other plans or projects. However, until the precise locations of any of the Compensation Measures are finalised, it is not possible to identify relevant plans and projects to include within a cumulative assessment cannot be made.
- 6.7.1.2 In addition, given the nature of the proposed Compensation Measures and the extensive refinement of the site selection process that will be undertaken, the consideration of inter-relationships and transboundary effects cannot be made at this stage.
- 6.7.1.3 It should be noted, however, that ultimately, the Compensation Measures will not be consented through the Hornsea Four DCO application process and so far as applicable, will be subject to standalone EIA and HRA processes as part of their own consenting process (for example a Marine Licence application and/or Planning Application). As part of that consenting process, further assessment work will be undertaken, including consideration of cumulative effects, inter-relationships and transboundary effects, based on refined design and methodology details.

7 EIA – New Offshore Artificial Nesting Structures

7.1 Introduction

- 7.1.1.1 This section considers the potential impacts arising from the new offshore artificial nesting structures Compensation Measure. A regional environmental characterisation of the physical, biological and human environmental baseline is presented alongside the results of an assessment of potential significant effects arising from the proposed Compensation Measure. Only one AoS has been identified for the new offshore artificial nesting structures Compensation Measure (A1: Southern North Sea) and as such, the baseline and assessment within this section relates to this AoS alone.

7.2 Baseline

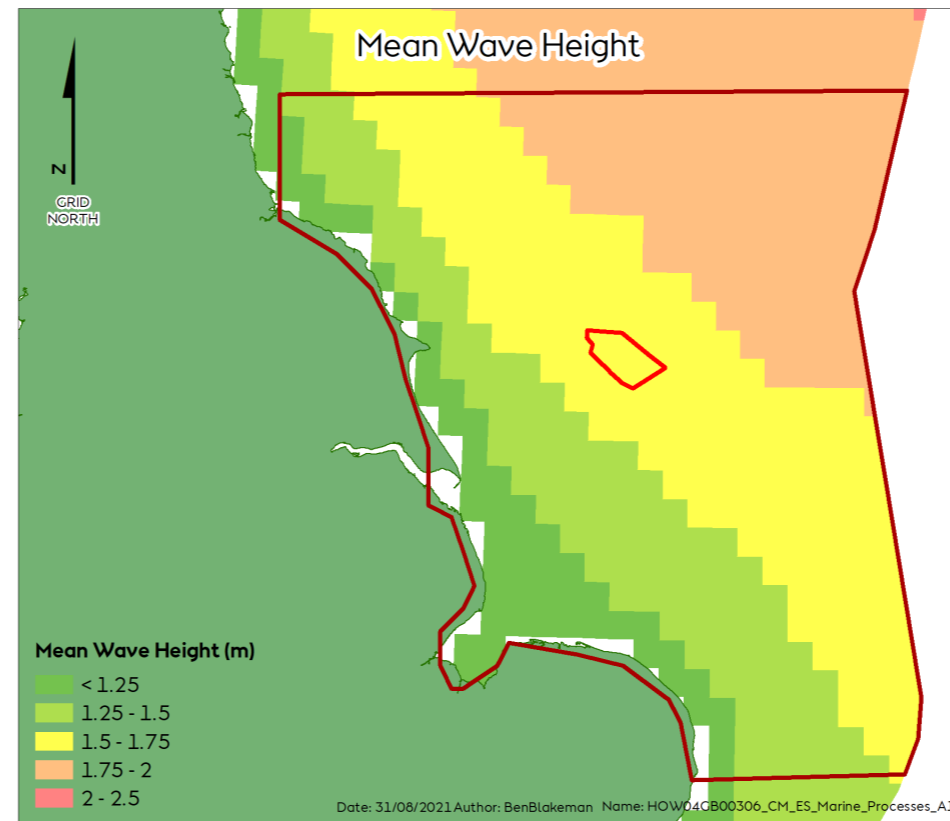
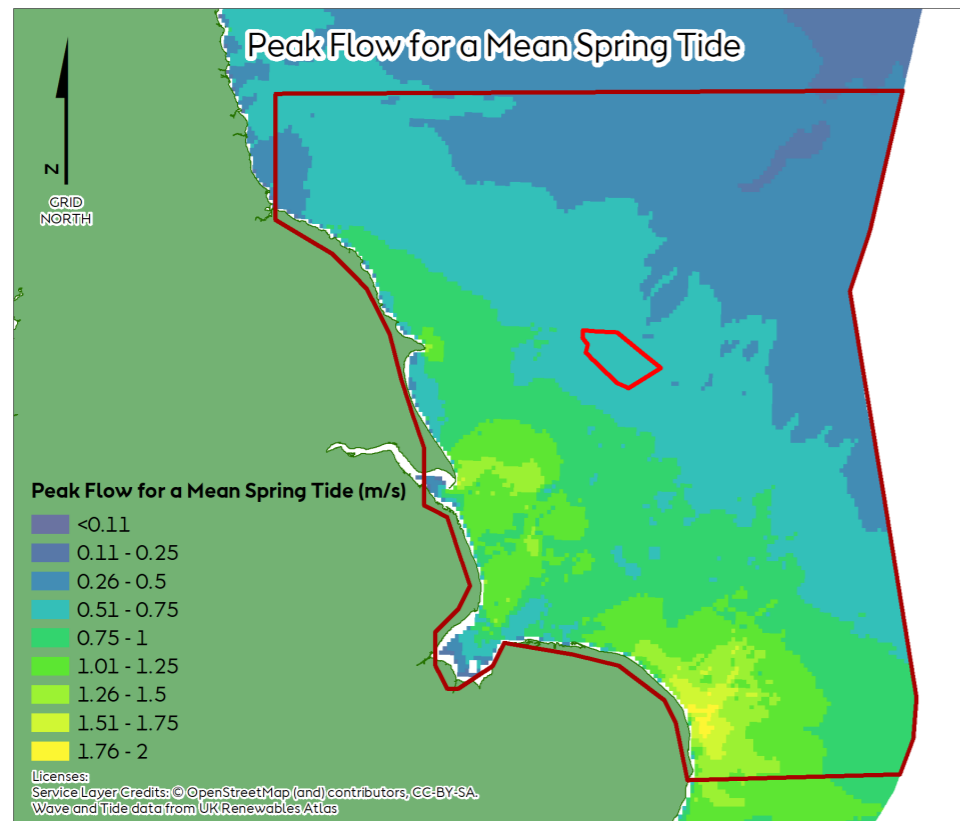
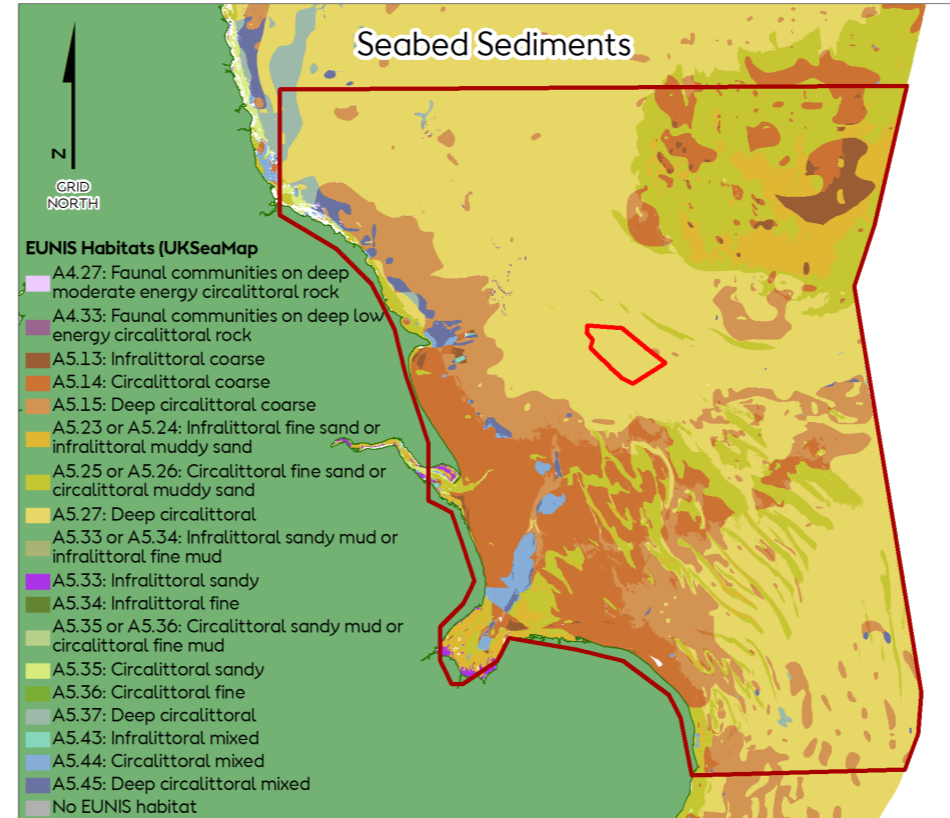
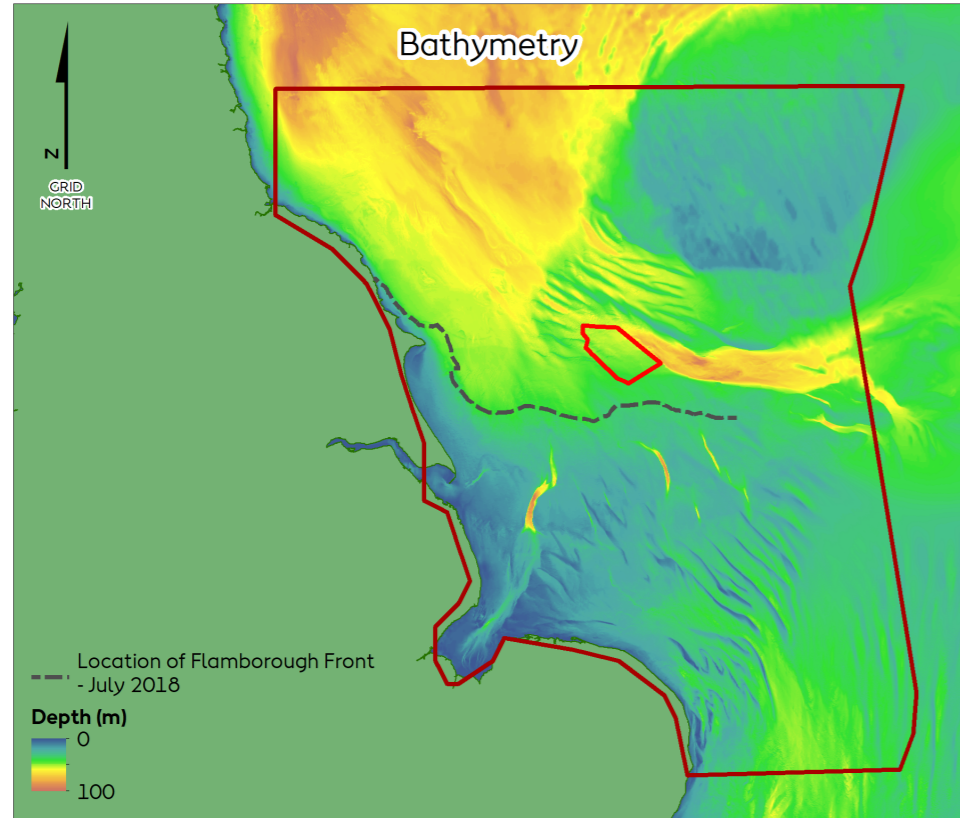
- 7.2.1.1 **Table 6** provides a summary of the baseline environment for AoS A1 (Southern North Sea).

Table 6: Summary of baseline environment in relation to the Area of Search (Southern North Sea) for new and repurposed offshore nesting structures.

Topic	Summary of Baseline Environment
Marine Geology, Oceanography and Physical Processes	<p>The baseline environment for marine geology, oceanography and physical processes is illustrated in Figure 5 and can be summarised in terms of:</p> <ul style="list-style-type: none"> • Bathymetry: The A1 Area of Search covers a large area of the southern North Sea, a large, shallow continental platform that has experienced successive emergences and flooding during the Quaternary regression and transgression. The area is generally shallow but is in the north-west where depths of up to 100m are seen, between the north-east coast of England and Dogger Bank, a large, shallow sandbank feature in the southern North Sea. The south of the area is dominated by sandwave features off the Lincolnshire and East Anglian coast. • Geology and seabed sediments: The sedimentary environment consists of a mixture of sands, muds and gravels but is dominated by coarse sediments. In shallow waters, in particular in areas where there are sandwaves, the sediments tend to be coarser, whilst greater levels of fine sediments are found in deeper areas. • Hydrographic and metocean conditions: The southern North Sea is associated with distinct hydrographic conditions including shallow, well-mixed waters. The waters of the southern North Sea are slow moving with a southerly drift; they occasionally stratify and have considerable freshwater input from the River Humber. Spring tidal flows peak off the East Anglia coast and in The Wash closer to shore, decreasing with distance from shore. A similar pattern is observed for wave heights. Off Flamborough head, the Flamborough Front extends eastwards and roughly divides the Area of Search in half.
Benthic and Intertidal Ecology	<p>The baseline environment for benthic and intertidal ecology is illustrated in Figure 6 and can be summarised in terms of:</p> <ul style="list-style-type: none"> • Seabed habitats: The Area of Search contains a variety of benthic habitats across the southern North Sea, consisting of sands and mixed sediments with varying proportions of muds and gravels. • Species: the region is inhabited by various benthic infauna and epifauna, including polychaetes, bivalves, echinoderms, crustaceans and amphipods. • Designations: A number of designated SACs and MCZs for seabed habitats and benthic species are present across the Area of Search, including the Dogger Bank SAC, the Holderness Inshore and Offshore MCZs, the Markham’s Triangle MCA and several SACs in the southern North Sea for sandbanks off the north coast of East Anglia.
Fish and Shellfish Ecology	<p>The baseline environment for fish and shellfish ecology is illustrated in Figure 7 and can be summarised in terms of:</p> <ul style="list-style-type: none"> • Species: A variety of fish and shellfish species are present in the southern North Sea region within the Area of Search, including commercially important species like plaice (<i>Pleuronectes platessa</i>), sole (<i>Solea solea</i>), dab (<i>Limanda limanda</i>) and whiting (<i>Merlangius merlangus</i>), as well as smaller non-commercially important species like weaver (<i>Tranchinidae</i>), gurnard (<i>Chelidonichthys cuculus</i>) and solenette (<i>Buglossidium luteum</i>). Shellfish species include the edible crab (<i>Cancer pagurus</i>), velvet swimming crab (<i>Necora puber</i>), brown and pink shrimp (<i>Pandalus borealis</i> and <i>Crangon crangon</i>), lobster (<i>Homarus gammarus</i>) and <i>Nephrops</i>. • Spawning and nursery habitats: The Area of Search overlaps with spawning and nursery areas for several species including herring (<i>Clupea harrengus</i>), sandeel (<i>Ammodytidae</i>), plaice, and sole. An important area for herring spawning is located just off Flamborough Head. Most of the commercially important species in the Area of Search spawn in the spring, between January and June, with the exception of the demersal spawning herring and sandeel.
Marine Mammals	<p>The baseline environment for marine mammals is illustrated in Figure 8 and can be summarised in terms of:</p>

Topic	Summary of Baseline Environment
	<ul style="list-style-type: none"> Species: Several marine mammal species have been observed in the southern North Sea, including harbour porpoise (<i>Phocoena phocoena</i>), white beaked dolphin (<i>Lagenorhynchus albirostris</i>), minke whale (<i>Balaenoptera acutorostrata</i>), grey seal (<i>Halichoerus grypus</i>) and harbour seal (<i>Phoca vitulina</i>). A population of bottlenose dolphin from the Moray Firth also extends down into the southern North Sea. Designated sites: The Southern North Sea SAC is an area of importance for harbour porpoise, an Annex II species. This site includes key winter and summer habitat for this species and covers an area of 36,951 m², making it the largest SAC in the UK and European waters at the point of designation in 2019.
Offshore and Intertidal Ornithology	<p>The baseline environment for offshore ornithology is illustrated in Figure 9 and can be summarised in terms of:</p> <ul style="list-style-type: none"> Species: At least 19 species of seabird breed on the coasts of the Greater North Sea, in particular large numbers of northern gannet (<i>Morus bassanus</i>), herring gull (<i>Larus argentatus</i>), lesser black-backed gull (<i>Larus fuscus</i>), black-legged kittiwake (<i>Rissa tridactyla</i>), common guillemot (<i>Uria aalge</i>), razorbill (<i>Alca torda</i>) and puffin (<i>Fratercula arctica</i>). Kittiwake have a mean-max foraging range of 156.1 km and are concentrated around Flamborough Head in the north-west of the Area of Search. Guillemot and razorbill are also concentrated in the north-east of the Area of Search and have mean-max foraging ranges of 73.1 km and 88.7 km, respectively. Gannet have a larger mean-max foraging range (315.2 km) and are more widely distributed across the Area of Search, but are still found in highest density in the north east. Designated sites: The key designated site within the Area of Search is the Flamborough and Filey Coast SPA, designated for a variety of breeding seabird colonies. The Area of Search also intersects with the Greater Wash SPA.
Commercial Fisheries	<p>The baseline environment for commercial fisheries is illustrated in Figure 10 and can be summarised in terms of:</p> <ul style="list-style-type: none"> Fishing activity: Approximately 6,600 fishing vessels operate in the Greater North Sea, with the largest numbers coming from the UK, Norway, Denmark, the Netherlands and France. Total landings have been decreasing since the early 1970s. Fishing methods: The primary fishing methods used in the southern North Sea specifically are otter and beam trawls for demersal fisheries, and pelagic trawls and seines for pelagic fisheries, along with potting for crustacea including brown crab, lobster and whelk, and dredging for scallop. Within the Area of Search, beam trawling is concentrated in the south east, dredging is focused off the Northumberland coast around Flamborough Head, otter trawling is mainly undertaken in the north, particularly around Dogger Bank, and potting is focused off the Lincolnshire coast and outside the Humber Estuary.
Shipping and Navigation	<p>The baseline environment for shipping and navigation is illustrated in Figure 11 and can be summarised in terms of:</p> <ul style="list-style-type: none"> Vessel density: The southern North Sea is a busy area in terms of vessel traffic with regular transit between major European ports. Much of the traffic is coastal, in particular between the Humber across the coast of East Anglia to and from the English Channel. Clusters of traffic are also seen around offshore wind farms and oil and gas platforms within the Area of Search. Navigational features: Traffic separation scheme lanes feature at the mouth of the Humber to manage traffic entering and exiting the port. To the south east of the Area of Search, there are main deep water routes between the North Sea and the English Channel.
Aviation and Radar	<p>The baseline environment for aviation and radar is illustrated in Figure 12 and can be summarised in terms of:</p> <ul style="list-style-type: none"> Airspace: This AoS is in an area of Class G uncontrolled airspace, which is established from the surface up to Flight Level (FL) 195 (approximately 19,500 ft). Radar stations: A number of civilian and military radar stations are located along the east coast of the UK looking out into the southern North Sea, including the MoD remote radar head locations are Staxton Wold and Trimingham. Helicopter main routes: Figure 12 identifies numerous helicopter main routes that are used to transfer equipment and personnel out to operational oil and gas platforms.

Topic	Summary of Baseline Environment
Marine Archaeology	<p>The baseline environment for marine archaeology is illustrated in Figure 11 and can be summarised in terms of:</p> <ul style="list-style-type: none"> • Seabed archaeology: The archaeological resource contained within the Holocene sediments of the seabed remains poorly understood, primarily due to the practical limitations of carrying out archaeological investigations. • Archaeological resource: The North Sea marine archaeological resource is presented by three main classes of material and features: (1) submerged prehistoric landscaped caused by changes to sea level and eventual stabilisation of sea level at or near to the present position; (2) archaeological remains of watercraft deposited when vessels sank while at sea or became abandoned in an inter-tidal context which subsequently became inundated; and (3) remains of aircraft crash sites, either coherent assemblages or scattered material, usually the result of Second World War military conflict, but also numerous passenger casualties, particularly during the peak of seaplane activity during the inter-war period. • Wrecks: Numerous wrecks are illustrated in Figure 11, however in addition there are thought to be many more wrecks and features of interest that are currently undiscovered.
Seascape, Landscape and Visual Resources	<p>The baseline environment for seascape, landscape and visual resources is illustrated in Figure 13 and can be summarised in terms of:</p> <ul style="list-style-type: none"> • Seascape: This AoS can be described as open sea with occasional offshore structures, such as oil and gas platforms and offshore wind farms. There is regular passage of use by sea-going vessels for a variety of purposes, including recreational and commercial fishing activities, commercial ferry routes, tankers, cargo vessels and recreational cruising. Additionally, combat training exercises in aeroplanes, search and rescue activities and standard helicopter operations to offshore infrastructure regularly occur across this location. • Designations: Numerous landscape designations including National Parks, Areas of Outstanding Natural Beauty and Heritage Coasts overlap with the coastline of the Area of Search, with views out to sea being a prominent part of these landscapes.
Infrastructure and Other Users	<p>The baseline environment for infrastructure and other users is illustrated in Figure 14 and can be summarised in terms of:</p> <ul style="list-style-type: none"> • Offshore development: The Area of Search sits within the southern North Sea, an area which contains a high density of offshore developments and marine industries due in part to its relatively shallow bathymetry. These includes offshore wind farms, oil and gas extraction, marine aggregate extraction, subsea cables and pipelines as well as emerging industries such as carbon capture and storage. Additionally, the baseline environment includes the activities associated with the construction, operation, maintenance and decommissioning of these activities.



Hornsea Four
Compensation Measures
Areas of Search
Offshore Nesting
A1: Southern North Sea
Marine Processes

Array Area
 Compensation Measures Areas of Search
 Offshore nesting

Coordinate system: ETRS 1989 UTM Zone 31N

0 50 100 Kilometres
0 25 50 Nautical Miles

REV	REMARK	DATE
---	First Issue	31/08/2021

Compensation Measures
Marine Processes
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Figure 5: Compensation Measures Area of Search Offshore Nesting A1: Southern North Sea Physical Processes.

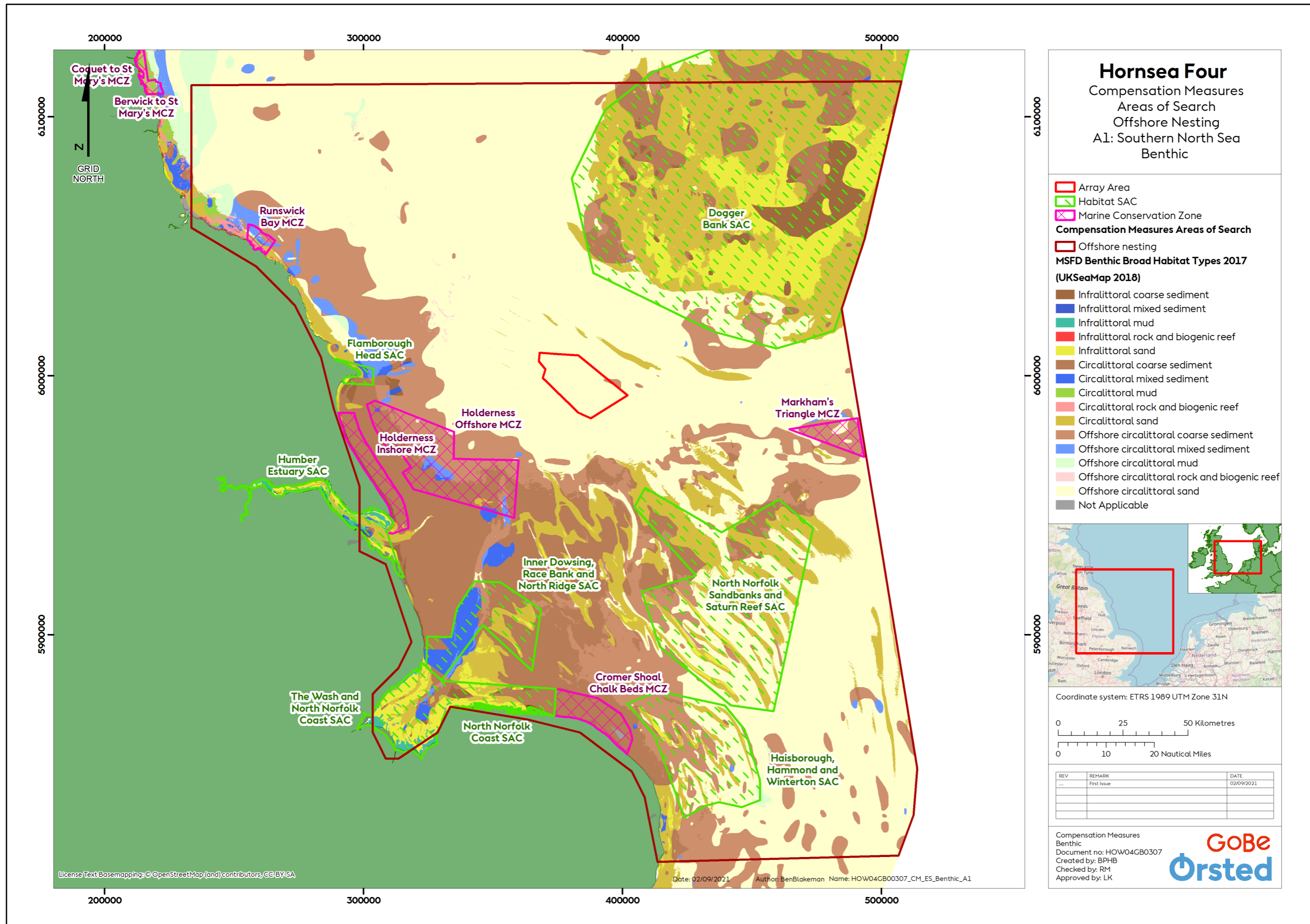


Figure 6: Compensation Measures Area of Search Offshore Nesting A1: Southern North Sea Benthic.

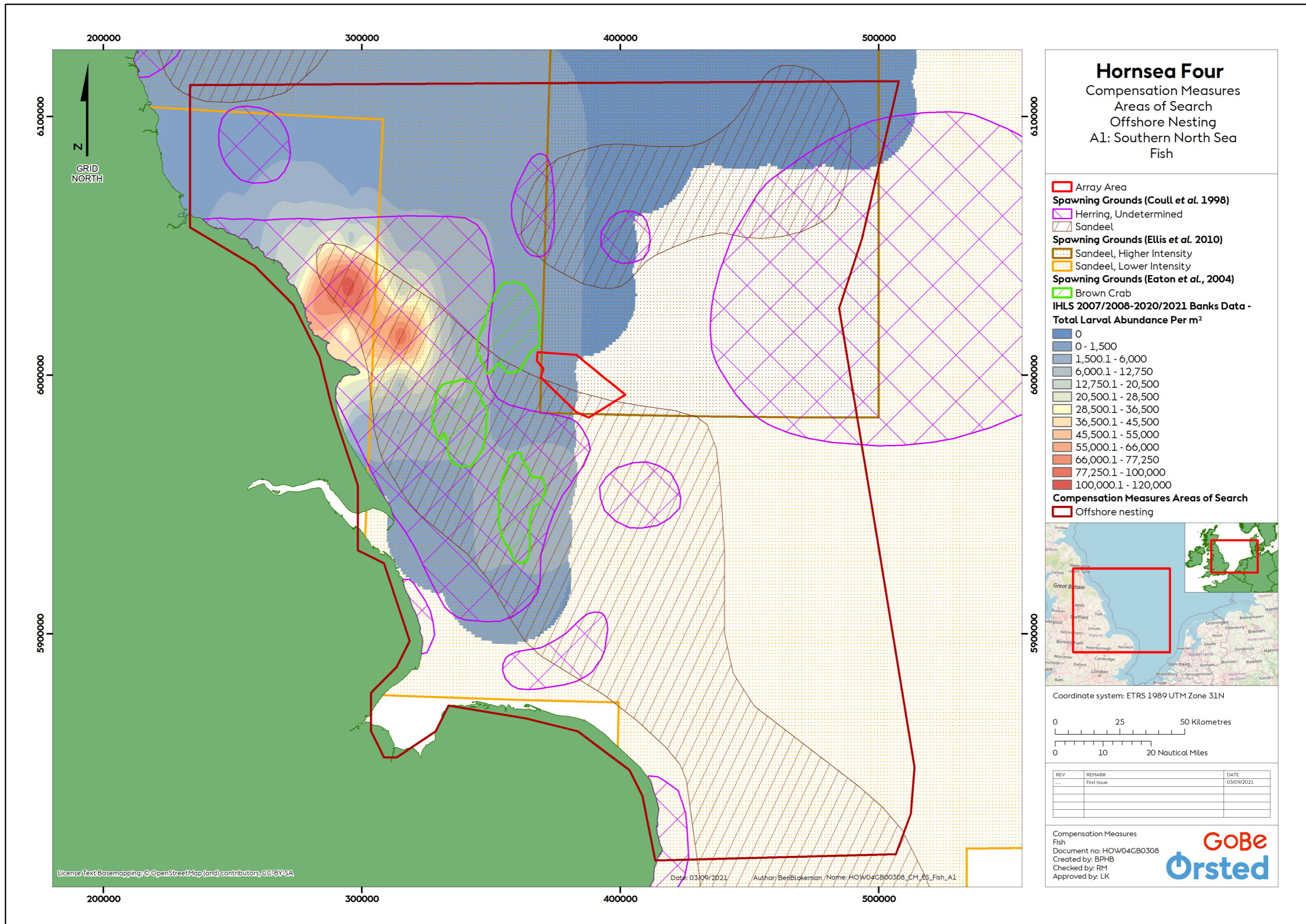
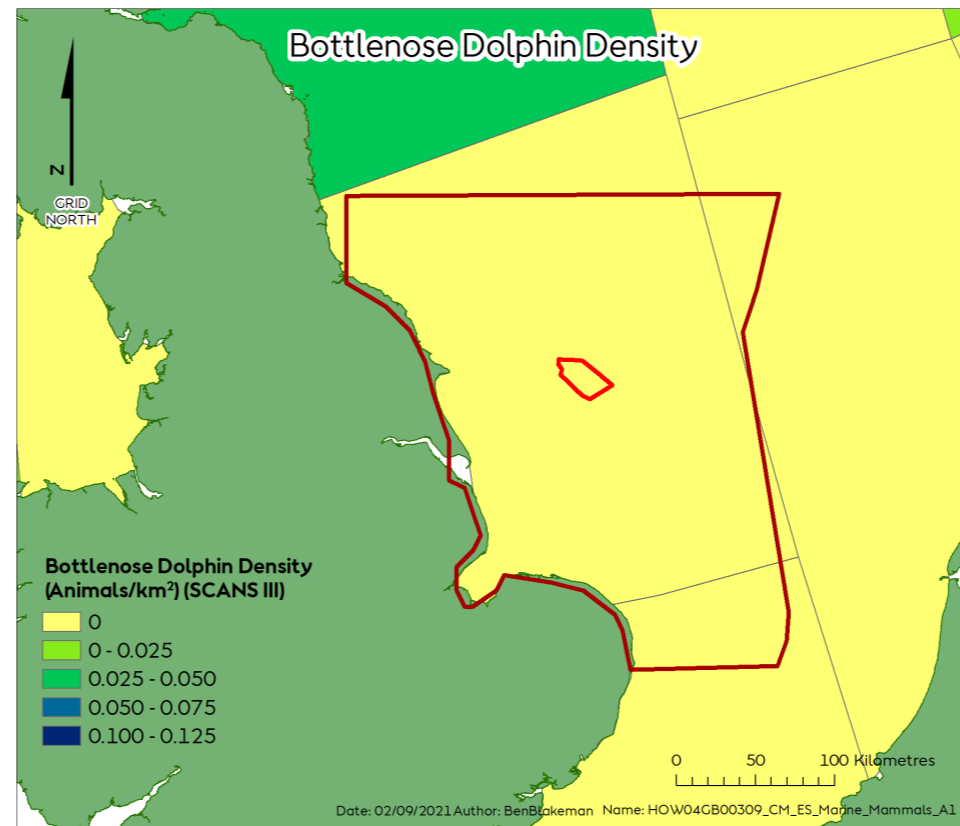
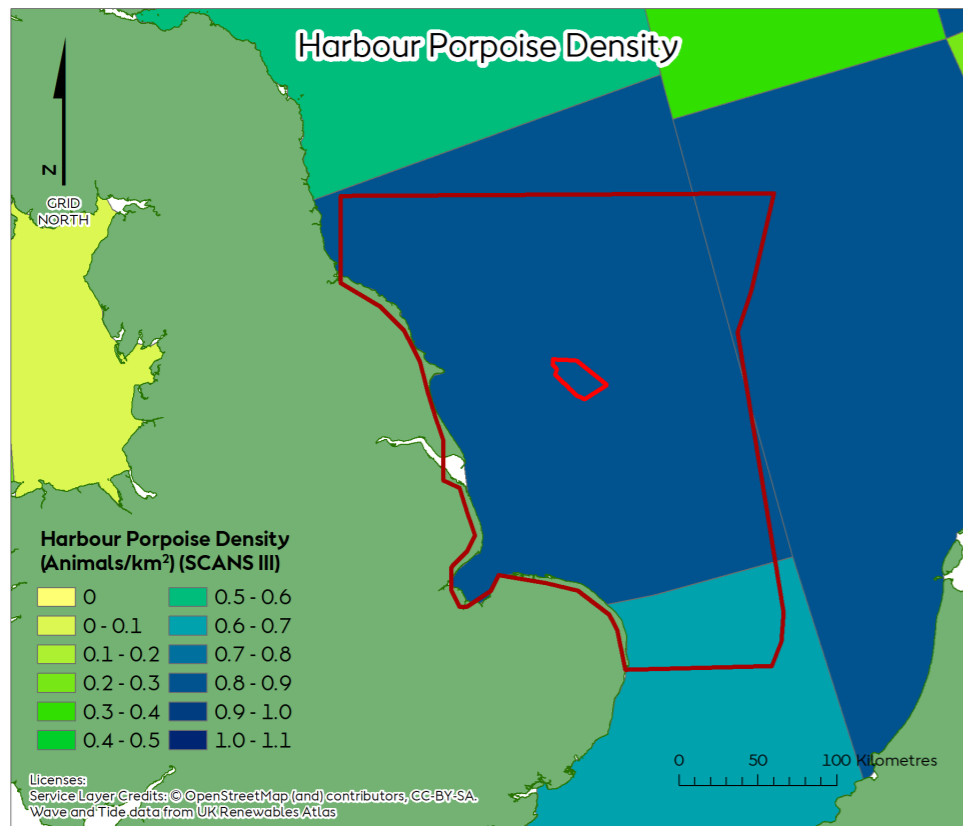
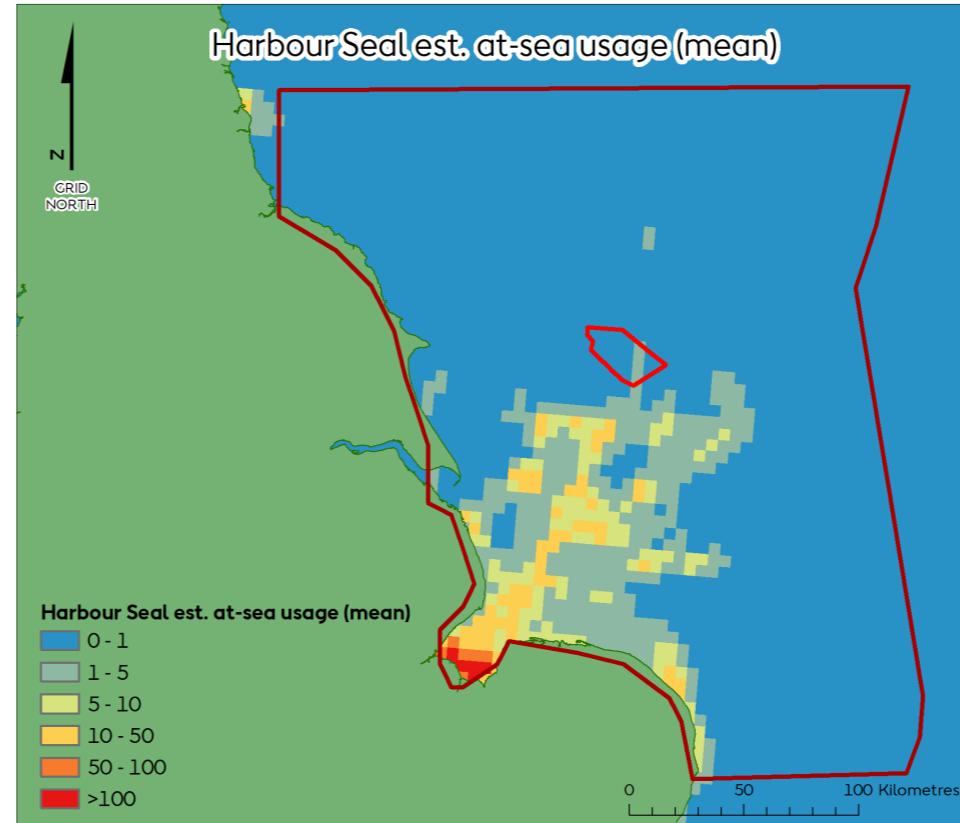
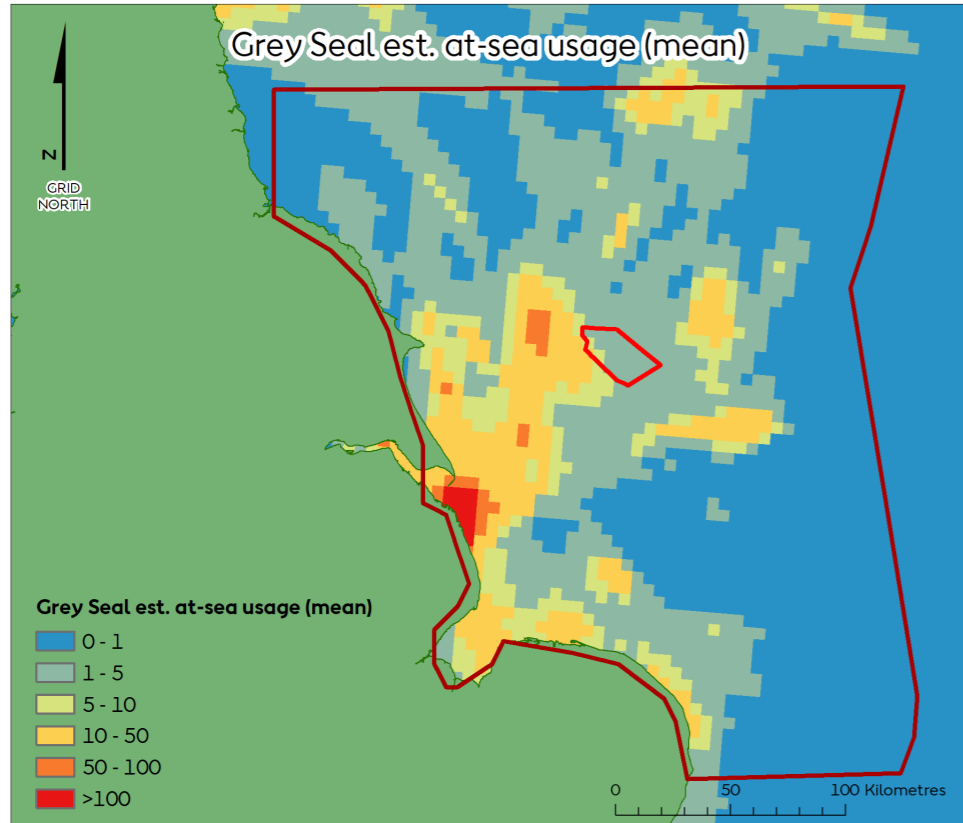


Figure 7: Compensation Measures Area of Search Offshore Nesting A1: Southern North Sea Fish.

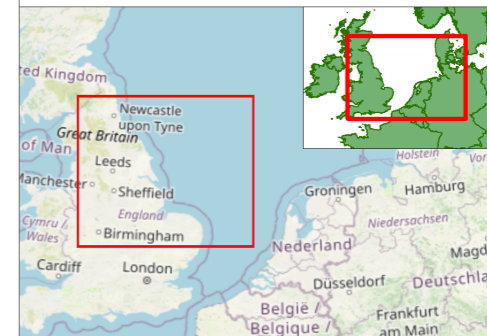


Hornsea Four

Compensation Measures
Areas of Search
Offshore Nesting
A1: Southern North Sea
Marine Mammals

- Array Area
- Compensation Measures Areas of Search**
- Offshore nesting

Estimated at-sea Distribution of Grey and Harbour Seals maps data from Sea Mammal Research Unit (SMRU) and Marine Scotland, 2017



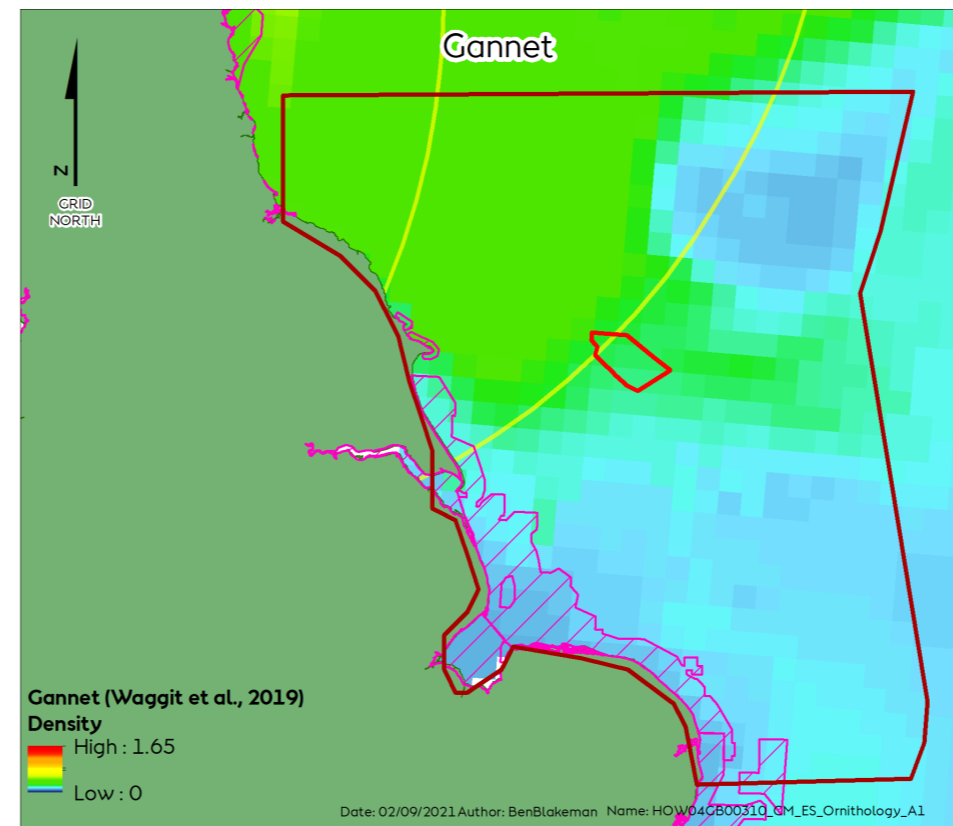
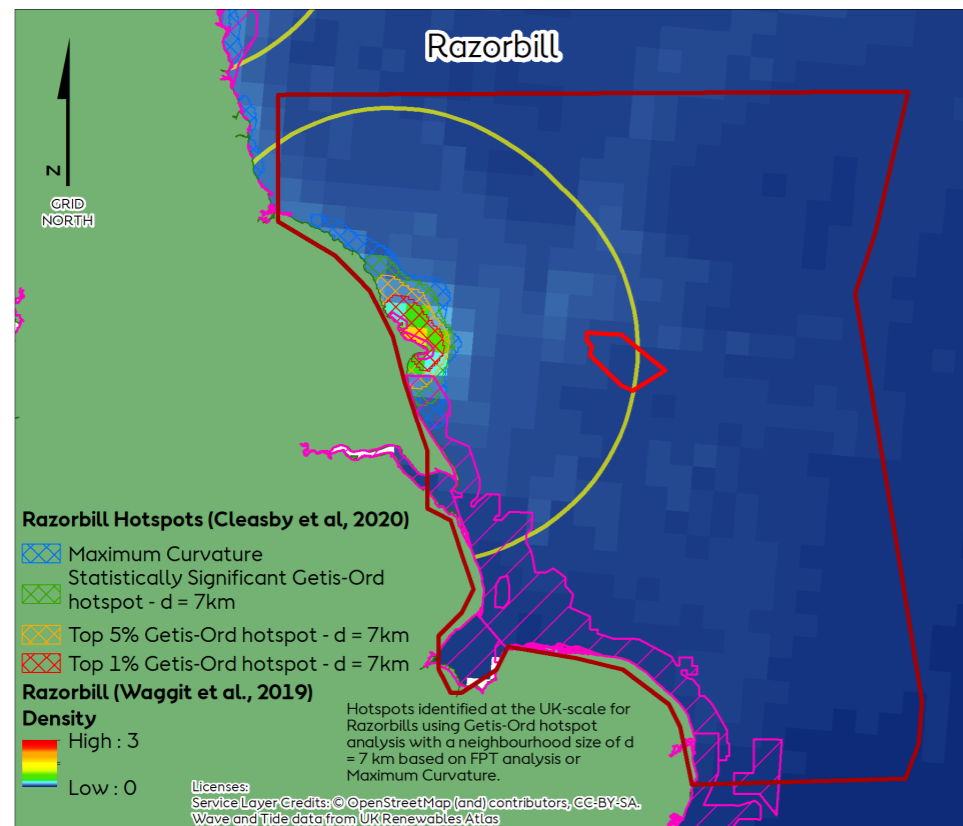
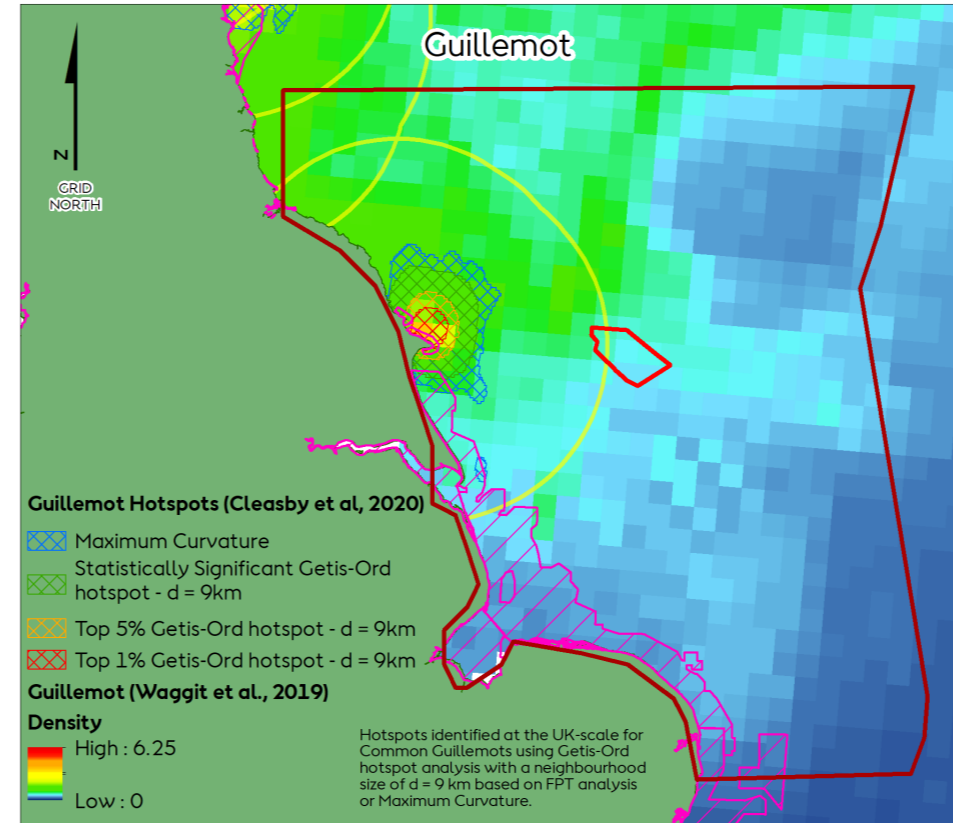
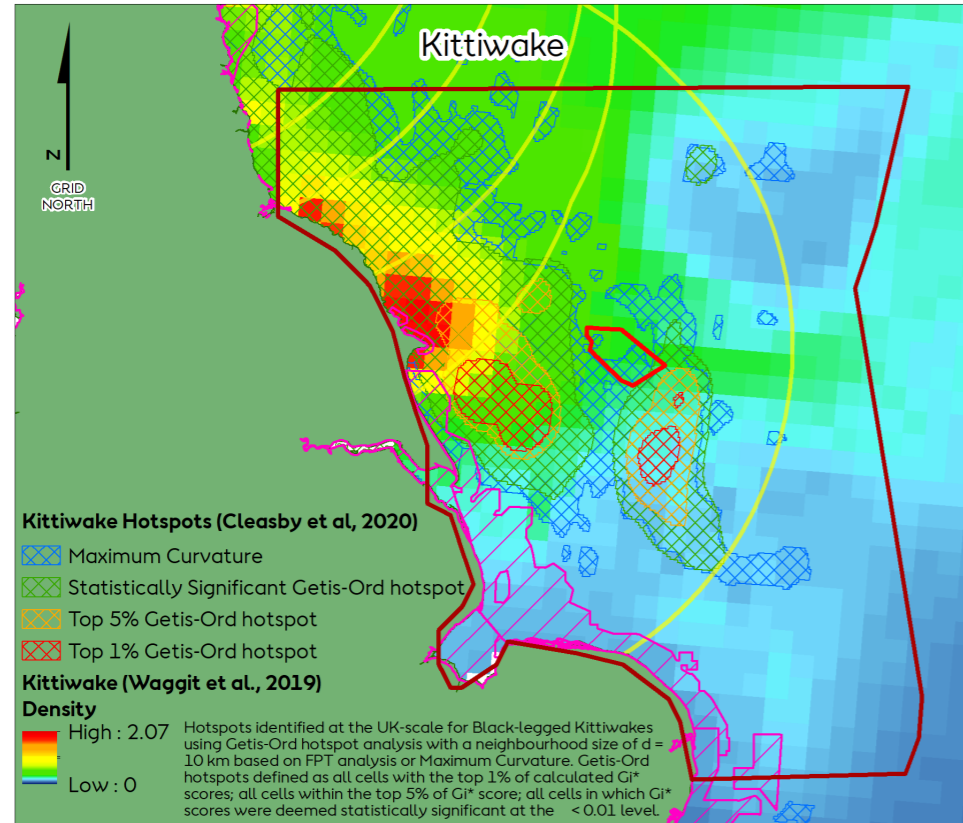
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Compensation Measures
Marine Mammals
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Figure 8: Compensation Measures Area of Search Offshore Nesting A1: Southern North Sea Marine Mammals.



Hornsea Four Compensation Measures Areas of Search Offshore Nesting A1: Southern North Sea Ornithology

- Array Area
- Special Protection Area (SPA) with Marine Components

Mean-Max Foraging Range (Woodward 2019)

- Common Guillemot - 73.2km Buffer
- Gannet - 315.2km Buffer
- Kittiwake - 156.1km Buffer
- Razorbill - 88.7km Buffer

Compensation Measures Areas of Search

- Offshore nesting

Waggitt et al 2019 densities data. Spatial variation in predicted densities (animals per km) of seabird species in July in the North-East Atlantic. Values are provided at 10km resolution.

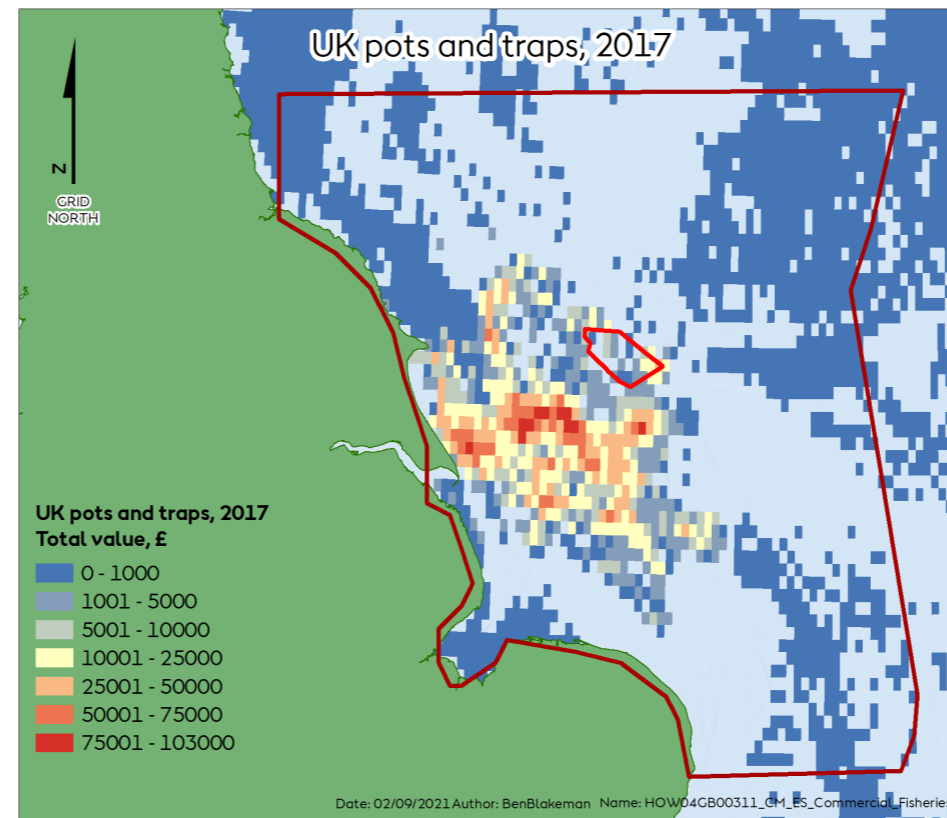
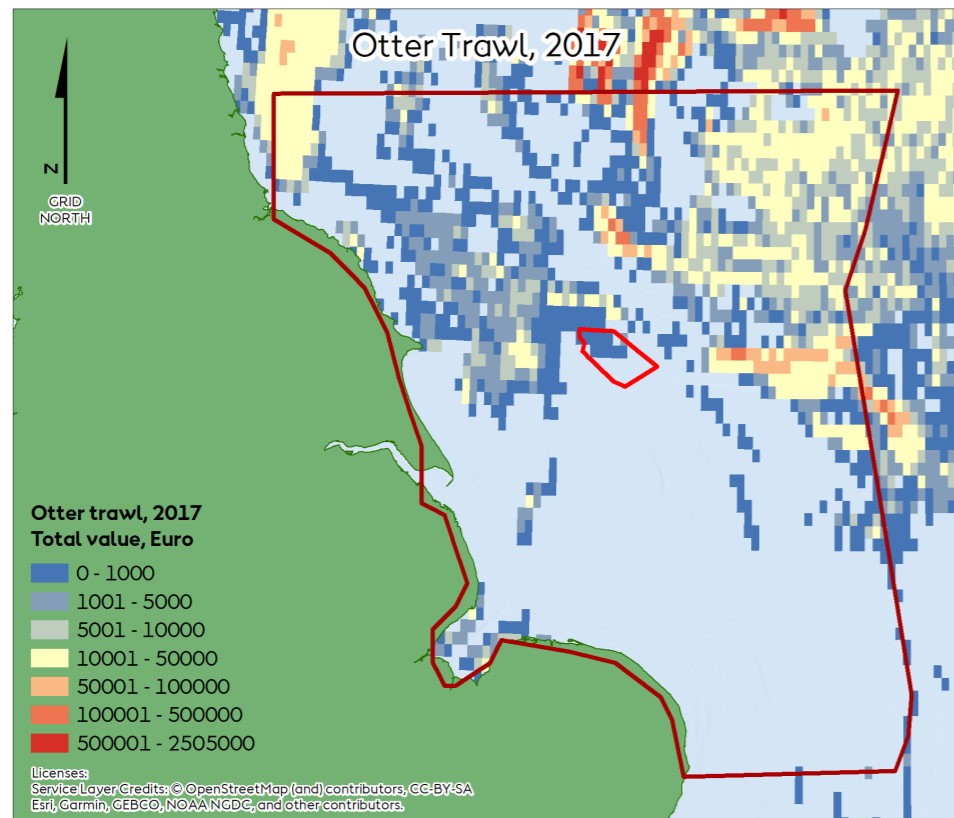
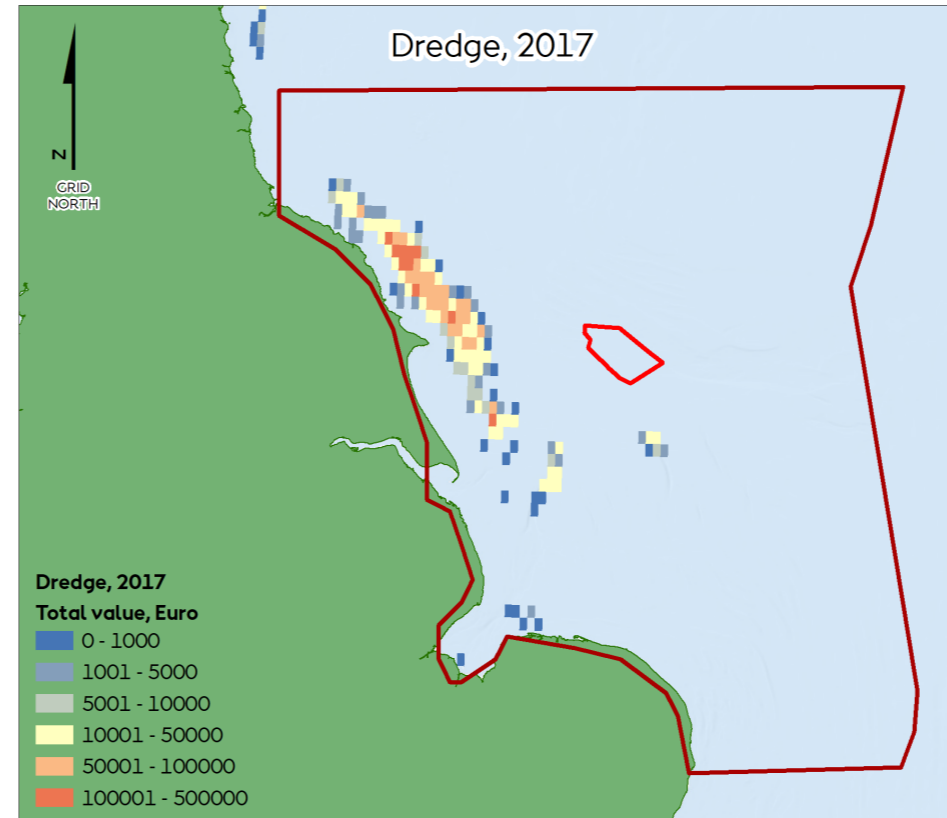
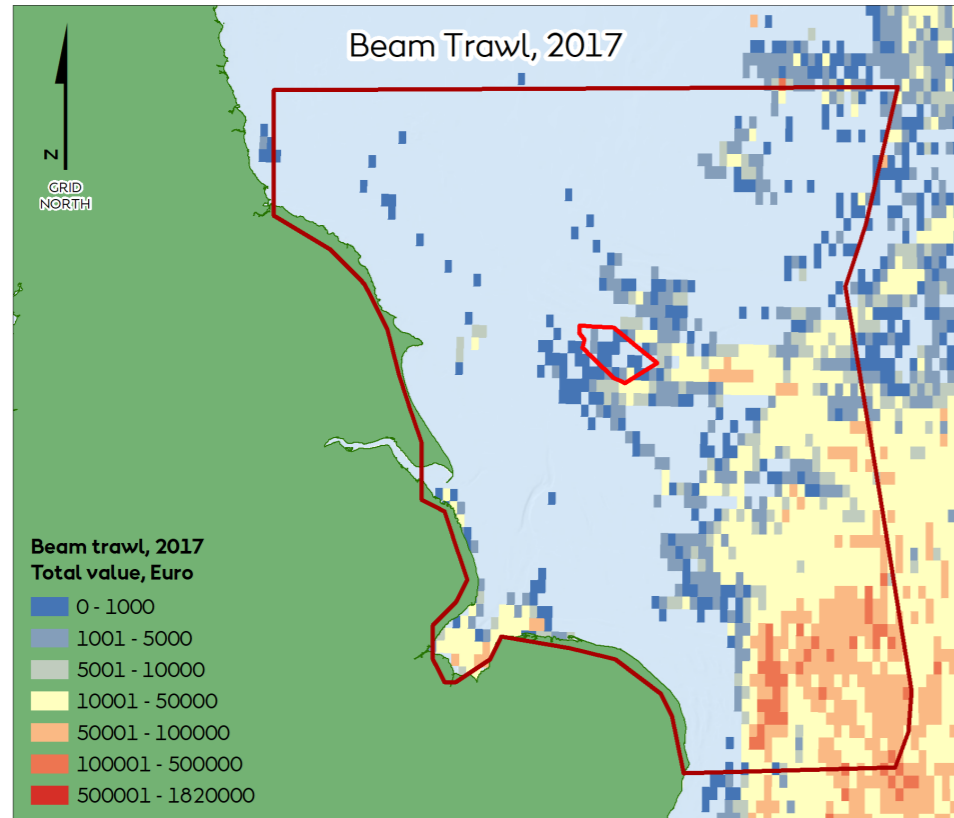
Coordinate system: ETRS 1989 UTM Zone 31N

0 50 100 Kilometres
0 25 50 Nautical Miles

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Compensation Measures Ornithology
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Figure 9: Compensation Measures Area of Search Offshore Nesting A1: Southern North Sea Ornithology.



Hornsea Four
Compensation Measures
Areas of Search
Offshore Nesting
A1: Southern North Sea
Commercial Fisheries

Array Area
 Compensation Measures Areas of Search
 Offshore nesting

Coordinate system: ETRS 1989 UTM Zone 31N

0 50 100 Kilometres
0 25 50 Nautical Miles

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Compensation Measures
Commercial Fisheries
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Figure 10: Compensation Measures Area of Search Offshore Nesting A1: Southern North Sea Commercial Fisheries.

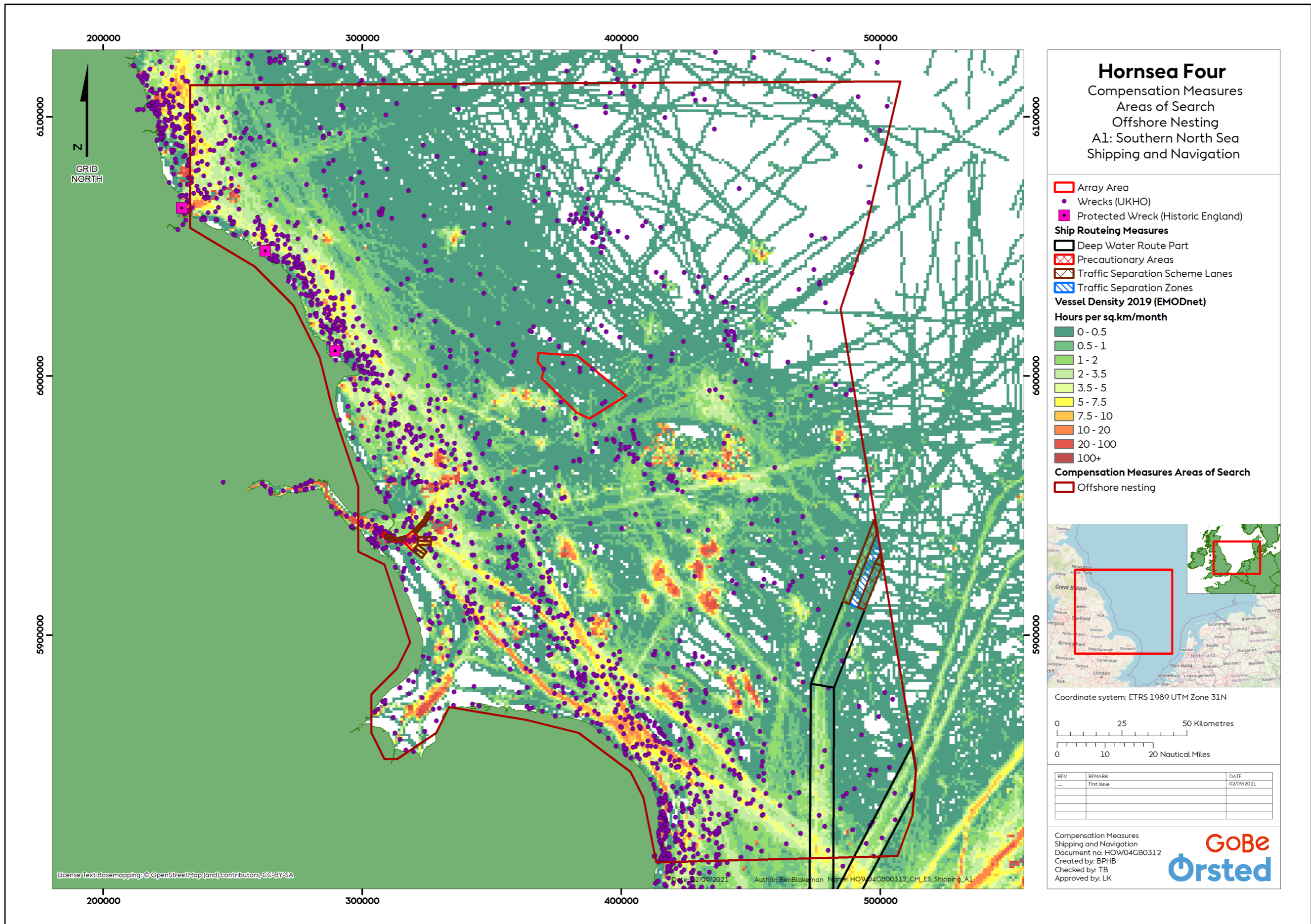


Figure 11: Compensation Measures Area of Search Offshore Nesting A1: Southern North Sea Shipping and Navigation.

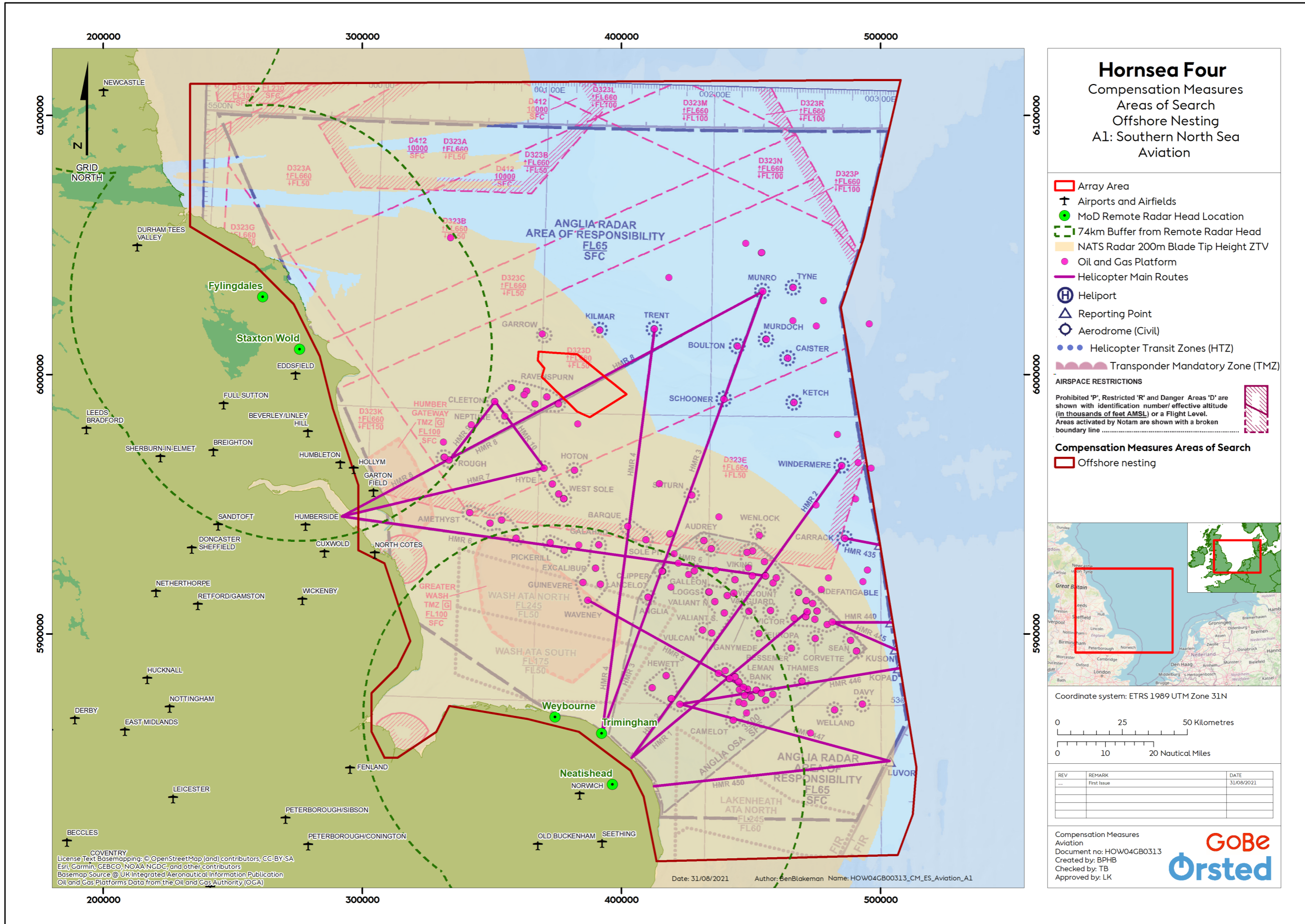


Figure 12: Compensation Measures Area of Search Offshore Nesting A1: Southern North Sea Aviation.

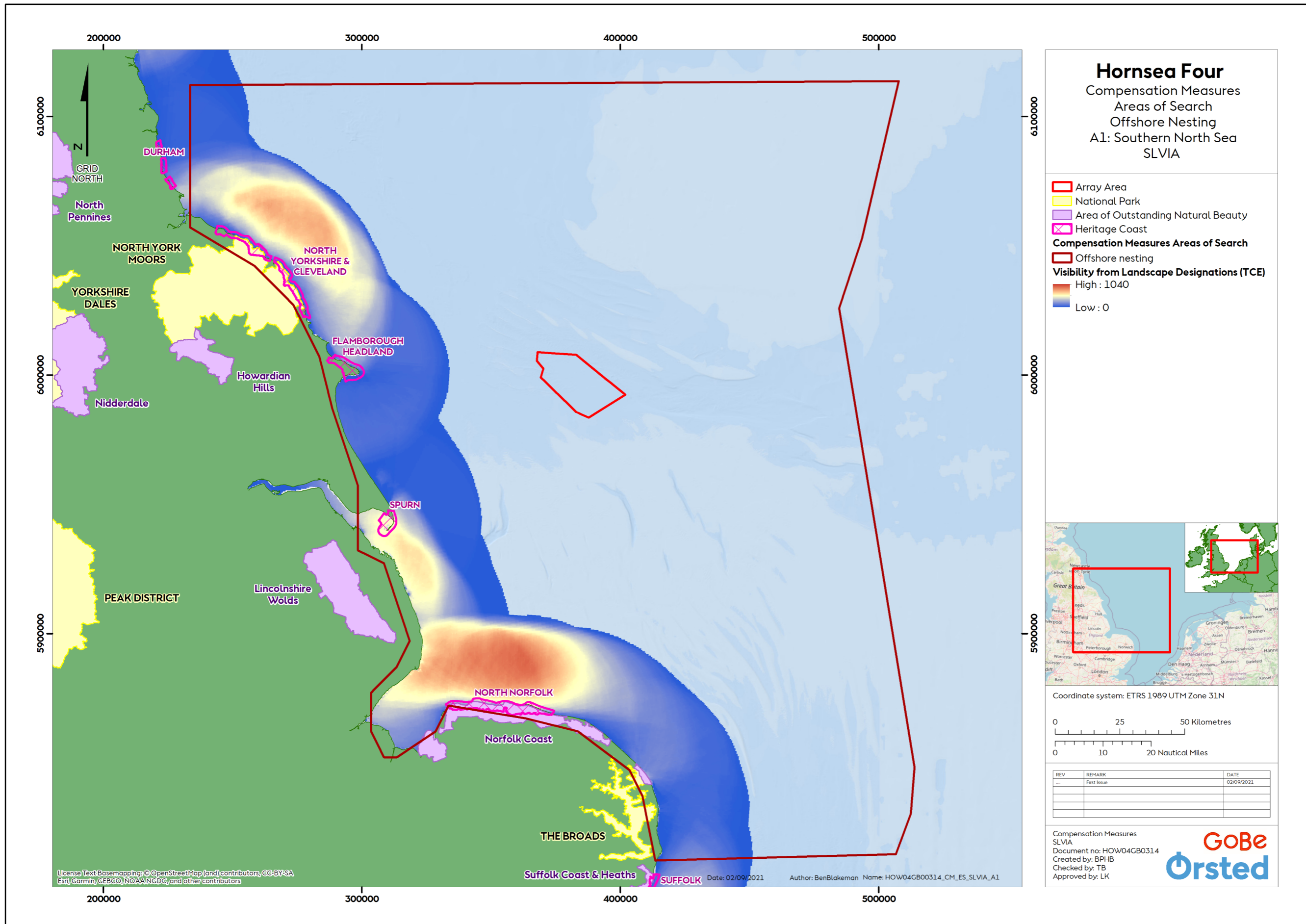


Figure 13: Compensation Measures Area of Search Offshore Nesting A1: Southern North Sea SLVIA.

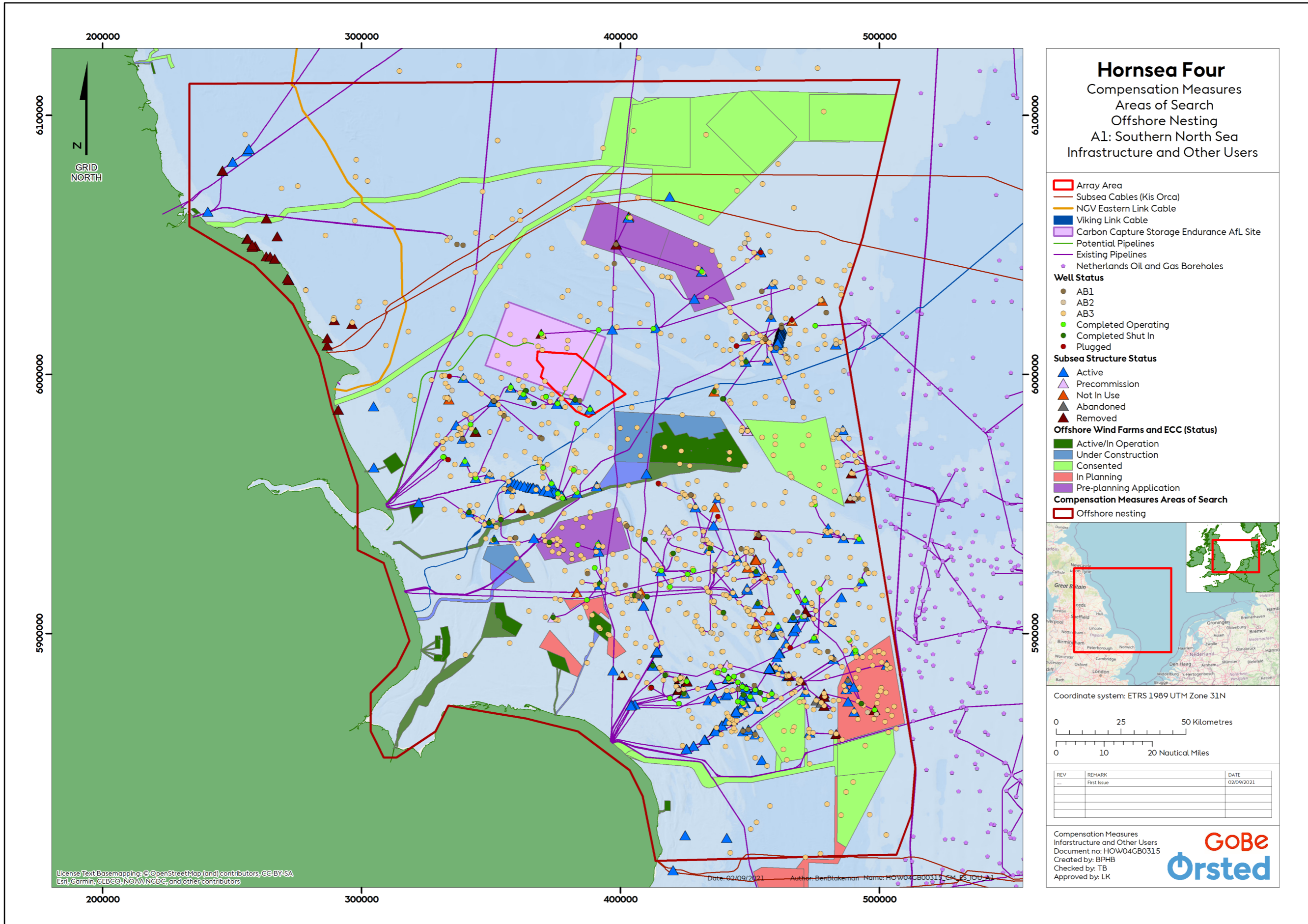


Figure 14: Compensation Measures Area of Search Offshore Nesting A1: Southern North Sea Infrastructure and Other Users.