

Offshore
Wind
Leasing
Round 4

Resource and Constraints
Assessment for Offshore Wind

Characterisation Area Report
The Wash

4

Characterisation Area Report: 4 – The Wash

38255-TCE-REP-009 Characterisation Area Report: 4 – The Wash		
Version	Status	Issue date
1.1	Draft	July 2018
1.2	Draft	November 2018
1.3	Final	September 2019

The information included in this report should be read in conjunction with the *Resource and Constraints Assessment for Offshore Wind: Methodology Report* and the *Summary Stakeholder Feedback Report*. The trigger distance for constraints to be included in the constraints analysis section of this report is 1 nautical mile (NM).

The Crown Estate has undertaken the analysis in this report using the evidence available to it, internal expertise and support from external advisers where appropriate. The analysis does not obviate any potential need for any Habitat Regulations Assessment (HRA) or any project level consideration of the potential impact of development. The analysis does not supersede any statutory policies or marine plans. The analysis, including the data and information contained in this document, presents a point in time assessment with changes likely to both the presence and nature of constraints.

This report is provided for information purposes only and no party may rely on the accuracy, completeness or fitness of its content for any particular purpose. The Crown Estate makes no representation, assurance, undertaking or warranty in respect of the analysis in the report including all data and information contained in it.

Receptor rating		Area rating	
Receptor assessed but no interaction noted		Receptor assessed but no interaction noted	
Interaction acceptable with best practice/accepted mitigation		The constraint will present the need to implement best practice/accepted mitigation measures to enable acceptable development within the whole area	
Interaction acceptable with moderate mitigation		The constraint will present the need to implement moderate mitigation measures to enable acceptable development within the whole area	
Interaction acceptable with significant mitigation		The constraint will present the need to implement significant and/or strategic level mitigation measures to enable acceptable development within the whole area	
Significant/insurmountable issue that would be challenging to mitigate within the area of influence of a receptor		Significant/insurmountable issue that would be challenging to mitigate for any development within the whole area	
No data coverage across the area		No data coverage across the area	

Constraints analysis

Note that in addition to The Crown Estate leases/licences within this table, The Crown Estate has also identified key resource areas (KRAs) which may be suitable for the future development of different marine sectors. Information about overlapping KRAs that overlap this characterisation area is described in a latter section of this document.

Exclusions model – Hard constraints			Receptor rating	Area rating
Present	Commentary			
The Crown Estate agreements	Pipelines into Bacton: there are numerous active and inactive pipelines intersecting the characterisation area as they head into Bacton terminal. There are also pipelines into Mablethorpe.	The pipelines have been carved out of the characterisation area and will need to be avoided; this should be possible with best practice/accepted mitigation. However, the large number of pipelines, particularly in the south-east and east of the characterisation area may be a constraint on the area available for new arrays.		
	Triton Knoll Wind Farm: adjacent to the western boundary of the characterisation area.	The cumulative impact of offshore wind farm (OWF) developments and associated cable infrastructure will need to be considered in this area as there may be concerns around wind resource and proximity to the existing site. There will need to be a 5 km buffer around existing offshore wind projects – any new wind developments within 5 km will need the permission of the incumbent party.		
	Dudgeon Wind Farm: within the central part of the characterisation area.	The cumulative impact of offshore wind farm (OWF) developments and associated cable infrastructure will need to be considered in this area as there may be concerns around wind resource and proximity to the existing site. There will need to be a 5 km buffer around existing offshore wind projects – any new wind developments within 5 km will need the permission of the incumbent party.		
	Sheringham Shoal Wind Farm: within the south-western part of the characterisation area.	The cumulative impact of offshore wind farm (OWF) developments and associated cable infrastructure will need to be considered in this area as there may be concerns around wind resource and proximity to the existing site. There will need to be a 5 km buffer around existing offshore wind projects – any new wind developments within 5 km will need the permission of the incumbent party.		
	Race Bank Wind Farm: on the south-western boundary of the characterisation area.	The cumulative impact of offshore wind farm (OWF) developments and associated cable infrastructure will need to be considered in this area as there may be concerns around wind resource and proximity to the existing site. There will need to be a 5 km buffer around existing offshore wind projects – any new wind developments within 5 km will need the permission of the incumbent party.		
	East Anglia Norfolk Vanguard West Wind Farm: to the west of the characterisation area.	The cumulative impact of offshore wind farm (OWF) developments and associated cable infrastructure will need to be considered in this area as there may be concerns around wind resource and proximity to the existing site. There will need to be a 5 km buffer around existing offshore wind projects – any new wind developments within 5 km will need the permission of the incumbent party.		
	Sheringham Shoal Met Mast: located on the north-western tip of Sheringham Shoal Wind Farm within the south-western part of the characterisation area.	Given the proximity to Sheringham Shoal Wind Farm, the met mast itself is unlikely to be a significant concern as any future wind projects will need to consider proximity to the existing OWF and leave a safe distance from the wind turbine generators, and therefore also the met mast.		
	OWF export cable routes (OFTOS): numerous within and adjacent to the characterisation area.	The characterisation area cable routes should be avoided where possible and liaison would be required with existing customers. However, any concerns can likely be avoided with best practice/accepted mitigation. Significant cumulative impacts issues may arise where export cables exert pressure around the Wash and North Norfolk coast where there is already significant cumulative pressure over sensitive habitats. Since cable crossings require cable protection (which may have adverse environmental effects), crossings should be minimised where practicable.		
	Aggregates Area 484: approximately 500 m north east of the characterisation area.	Would require a 2 km buffer around the west site boundary and negotiations with customer, but due to the proximity to the area, this is not considered to be a significant concern.		
	Aggregates Area 481: approximately 1.1 km west of the characterisation area.	Would require a 2 km buffer around the west site boundary and negotiations with customer, but due to the proximity to the area, this is not considered to be a significant concern.		
	Aggregates Area 515/1-2: active dredge site within the central west part of the characterisation area.	Would require a 2 km buffer around it and negotiations with customer.		
	Deborah natural gas storage site: within the south-east of the characterisation area.	Would need to be avoided and may need a buffer distance around it, liaison with customer required.		
	The Crown Estate has completed a plan-level Habitats Regulations Assessment for 2017 Offshore Wind Extensions and intends to grant right for:	As with other OWF, a 5 km buffer will be in place around the final area under lease for these extensions projects. Any new wind developments within 5 km will need the permission of the incumbent party. Proposals for projects coming forwards through new leasing should be cognisant of these extensions and potential cumulative impacts on all receptors. There is potentially a significant increase to deployed capacity through these		

	<ul style="list-style-type: none"> • Sheringham Shoal Wind Farm (extension of up to 317 MW). • Dudgeon Wind Farm (extension of up to 402 MW). <p>These extensions are situated around the south-eastern edge of the characterisation area.</p>	projects in the area which could have a material impact on the level of constraint across the rest of the characterisation area.				
Other energy infrastructure	48 Platforms, eight wellheads and two manifolds intersecting or within 1 NM of the area.	Significant levels of activity and hard infrastructure, which may present a barrier to development. In addition, the 0-3 and 3-6 NM helicopter consultation zones around platforms cover 79% of the area. There are significant gaps that could present opportunity.				
Navigation	There is a major traffic separation scheme and deep-water route abutting the south-eastern edge of this characterisation area.	The schemes have meant that traffic is concentrated into defined routes due to volume and navigation and safety reasons. Any impact on the traffic separation scheme should be avoided where possible. Constraint is relatively limited in terms of coverage of the characterisation area, therefore there is significant potential for development in the rest of the area.				
Social	None within the trigger distance.					
Restrictions model – Soft constraints			Receptor rating	Area rating		
Economic tier						
Navigation	Significant traffic following the short sea routes. Mainly covering the south-west quarter of the area.	These are important trade routes which are heavily trafficked. The shallow water and numerous other obstructions in the area (e.g. wind turbines and oil and gas platforms) make this a significant and material constraint.				
Subsurface	None within the trigger distance.					
Fishing	See fisheries commentary below.		N/A			
Environmental tier						
The assessment of the sensitivity of Marine Protected Areas (MPAs) to pressures caused by offshore wind development and operation is assessed in a separate spreadsheet which will be made available as part of the Round 4 evidence base. Commentary has been noted in the relevant characterisation document where MPAs either overlap or are within 1 NM of the characterisation area and have been assessed as a yellow rating or above. For more information on the methodology for this assessment, please refer to the methodology report.						
Assessments Annex II species has not been made as part of the characterisation process. Such assessments will need to be undertaken at project level for individual developments within the characterisation area.						
Type of designation	Name of designation	Designated features/species	Conservation objectives	Commentary	Receptor rating	Area rating
European marine designations	Special Areas of Conservation (SACs)	Haisborough; Hammond and Winterton	Subtidal sandbanks Reefs	Currently in unfavourable condition. Conservation objectives are to restore features to favourable condition.		
	SAC	Inner Dowsing; Race Bank and North Ridge	Subtidal sandbanks Reefs	Currently in unfavourable condition. Conservation objectives are to restore		
				The sandbank and reef features are both considered sensitive to pressures exerted by offshore wind development and operation (including cabling) and an assessment of impact will need to be made at project level. The area will be sensitive to significant changes in sediment dynamics as well as direct impacts on the features. Impacts are likely to be avoidable with appropriate locating of project/cable, especially since the majority of the site has been excluded from the characterisation area.		
				The Wildlife Trusts note that the current unfavourable condition of the site should mean that further development within it is excluded. Consideration should also be given to the SNCB's report on cable sensitivity entitled 'Natural England and JNCC advice on key sensitivities of habitats and Marine Protected Areas in English Waters to offshore wind farm cabling within Proposed Round 4 leasing areas'.		
				The sandbank and reef features are both considered sensitive to pressures exerted by offshore wind development and operation (including cabling) and an assessment of impact will need to be made at project level. The area will be sensitive to significant changes in sediment dynamics as well as direct		

				features to favourable condition.	<p>impacts on the features. Impacts are likely to be avoidable with appropriate locating of project/cable, especially since the majority of the site has been excluded from the characterisation area.</p> <p>The Wildlife Trusts note that the current unfavourable condition of the site should mean that further development within it is excluded. Cable impacts are considered possible from development in any of the North Sea characterisation areas. Consideration should be given to the SNCB's report on cable sensitivity entitled 'Natural England and JNCC advice on key sensitivities of habitats and Marine Protected Areas in English Waters to offshore wind farm cabling within Proposed Round 4 leasing areas'.</p>		
SAC	North Norfolk Sandbanks and Saturn Reef	Subtidal sandbanks Reefs	Currently in unfavourable condition. Conservation objective: Subject to natural change, restore the sandbanks and reefs to favourable condition (maintain feature extent and supporting natural processes, and restore physical structure and biological communities).	<p>The sandbank and reef features are both considered sensitive to pressures exerted by offshore wind development and operation (including cabling) and an assessment of impact will need to be made at project level. The area will be sensitive to significant changes in sediment dynamics as well as direct impacts on the features. Impacts are likely to be avoidable or mitigable with appropriate foundation choice and location of project/cable, especially since the majority of the site has been excluded from the characterisation area.</p> <p>The Wildlife Trusts consider that this site should be avoided for both array and cabling since it is in unfavourable condition and needs to recover. Cable impacts are considered possible from development in any of the North Sea characterisation areas.</p>			
SAC	The Wash and North Norfolk Coast	Subtidal sandbanks Intertidal mudflats and sandflats Lagoons Shallow inlets and bays Reefs Glasswort and other annuals colonising mud and sand Atlantic salt meadows Mediterranean saltmarsh scrub Otter Common seal	Currently in 'unfavourable declining' condition overall. Full Conservation Advice package available for the site (see links to relevant docs). Conservation objectives are to maintain/restore as appropriate.	<p>The exclusion of the SAC from the characterisation area means that most of the features will not be exposed to impacts from offshore wind development unless cable landfall is made through the site.</p> <p>The Wildlife Trusts have significant concerns over the cumulative effects of cabling on this SAC, and as the site is already in unfavourable declining condition, it should be avoided as a landfall location. There would be a high consenting risk should any wind farm development or cabling activity be planned within the site. Consideration should also be given to the SNCB's report on cable sensitivity entitled 'Natural England and JNCC advice on key sensitivities of habitats and Marine Protected Areas in English Waters to offshore wind farm cabling within Proposed Round 4 leasing areas'.</p>			
Harbour porpoise SAC	Southern North Sea	Harbour porpoise	<p>To ensure that the integrity of the site is maintained and that it makes the best possible contribution to maintaining Favourable Conservation Status (FCS) for Harbour Porpoise in UK waters In the context of natural change, this will be achieved by ensuring that:</p> <p>1. Harbour porpoise is a viable component of the site;</p>	<p>This site was fully designated in February 2019. Harbour porpoise could be affected by offshore wind development in the area, mainly through acoustic impacts (disturbance and hearing damage) from pile driving, UXO clearance and possibly some geotechnical surveys. Disturbance and barrier effects arising from vessel movements and presence of turbines may also occur.</p> <p>The noise disturbance during wind farm construction is likely to be significant if using pile-driving to install the turbine foundations, and there is also a risk from UXO clearance. There will be a need to consider population level effects of disturbance (mainly during construction), and there may be some additional requirements to investigate potential impacts on prey species.</p> <p>The designation of harbour porpoise SACs will undoubtedly have consequences as to how some activities operate, and measures may need to be put in place to reduce disturbance. Implementation of any disturbance management is likely to be challenging given the complexity of marine activities, regulatory arrangements and scientific uncertainty surrounding the</p>			

				<p>2. There is no significant disturbance of the species; and</p> <p>3. The condition of supporting habitats and processes, and the availability of prey is maintained.</p> <p>This is similar to the protection afforded to harbour porpoise throughout their range by the European Protected Species (EPS) regulations in the UK. However, the Natura 2000 principles and HRA tests set the bar higher than EPS protection for impacts on the site as the protection is no longer solely considering effects on the population as a whole but making sure that the site is contributing positively to the species' Favourable Conservation Status.</p>	<p>significance of noise impacts on harbour porpoise. The approach recommended by SNCBs is that developers should ensure that there is sufficient time between the assessment and the start of construction for them to effectively implement mitigation/management, which could include:</p> <ol style="list-style-type: none"> 1. Careful spatial planning and phasing of noisy activities. 2. Use of alternative foundations that do not require pile driving (e.g. suction buckets, gravity bases), noting that these may have other impacts. 3. Use of alternative methods of installation (e.g. vibropiling) to reduce the noise footprint. 4. Use of technology to reduce the sound levels at source or to minimise sound propagation and reduce the noise footprint. <p>Harbour porpoise occur in elevated densities in some parts of the site compared to others during summer and winter. This may make mitigation slightly easier since summer is likely to be the most important construction season.</p> <p>The SNCBs and The Wildlife Trusts have concerns over the potential cumulative impacts on harbour porpoise within this SAC, and note that currently there is no mechanism to ensure that a strategic approach to the management of impacts is taken. They consider that this could be a significant consenting risk for offshore wind development in the North Sea characterisation areas.</p> <p>In parallel to new offshore wind leasing, The Crown Estate has committed to fund a collaborative programme of strategic enabling actions to increase the evidence base and support sustainable and coordinated expansion of offshore wind. Underwater noise and its management, assessment of impacts on sensitive receptors, and approaches to modelling and assessment, are all likely to form a key priority area for further work, and we anticipate collaborating with stakeholders on new work streams under the programme to help address outstanding evidence gaps.</p>		
Sites of Community Importance (SCIs)	None within the trigger distance						
Ramsar	None within the trigger distance						
Potential Special Protection Area (pSPA)	None within the trigger distance						
Special Protection Area (SPA)	Greater Wash	<p>Red-throated diver (Non-breeding)</p> <p>Common scoter (Non-breeding)</p> <p>Little gull (Non-breeding)</p> <p>Sandwich tern (Breeding)</p> <p>Common tern (Breeding)</p> <p>Little tern (Breeding)</p>	<p>SPA objectives:</p> <p>Protect wintering populations of Red Throated Diver, Common Scoter and Little Gull</p> <p>Protect feeding waters of breeding Common, Sandwich and Little Tern</p>	<p>Classified as a SPA March 2018. The species which form part of the designation are sensitive to offshore wind through disturbance and collision. Red-throated diver and common scoter are sensitive to displacement from both OWF areas and cable construction. Little gull is sensitive to collision. Terns are potentially sensitive to some impacts associated with cable installation and are also sensitive to collision. Impacts on these populations could make consenting offshore wind projects highly problematic. It is noted, however, that the majority of the SPA has been excluded from the characterisation area, which should greatly reduce the level of impact on the birds and make impacts mitigable (if not avoidable).</p>			

					<p>Royal Society for the Protection of Birds (RSPB) notes that developments within this region will need to include consideration of in-combination displacement of non-breeding common scoter and red-throated diver and collision risk to little gull from this SPA. Natural England notes that displacement impacts on red-throated diver may be significant up to 8 km away from existing wind farms. Natural England also notes that the overlap of the SPA with the offshore wind region creates significant risk of potential impacts on all of the features of the Greater Wash SPA.</p> <p>RSPB, Natural England and JNCC consider that offshore wind development in the North Yorkshire Coast, Wash and Southern North Sea characterisation areas could have impacts on this SPA.</p> <p>The SPA covers the areas of highest density foraging for sandwich tern from the North Norfolk Coast SPA. Natural England have advised that the distribution of sandwich tern extends beyond the SPA boundary and developments in this region may still have impacts on them. Refer to Wilson et al 2014: Quantifying usage of the marine environment by terns <i>Sterna</i> sp. around their breeding colony SPAs. JNCC Report No. 500.</p>		
Marine Conservation Zones (MCZs)	Cromer Shoal Chalk Beds	<p>High energy circalittoral rock</p> <p>High energy infralittoral rock</p> <p>Moderate energy circalittoral rock</p> <p>Moderate energy infralittoral rock</p> <p>North Norfolk coast (subtidal) (geological feature)</p> <p>Peat and clay exposures</p> <p>Subtidal chalk</p> <p>Subtidal coarse sediment</p> <p>Subtidal mixed sediments</p> <p>Subtidal sand</p>	The general management approach for this site is to maintain all features in favourable condition.	<p>The majority of the MCZ has been excluded from the characterisation area, and this means that impacts on the features would only occur if cables were run through the site. Features in the site would be very sensitive to the pressures of cable installation, particularly chalk reef which would be permanently lost. It is considered likely that cumulative impacts would preclude additional export cabling crossing the site. Impacts on the site from cables are unlikely to be mitigable and the site would probably best be avoided.</p> <p>The Wildlife Trusts note that this site would be very sensitive to cabling owing to the inability of the chalk reef to recover from cable installation. They consider that the site should be avoided. Cabling impacts are considered possible from any of the North Sea characterisation areas. Consideration should also be given to the SNCB's report on cable sensitivity entitled 'Natural England and JNCC advice on key sensitivities of habitats and Marine Protected Areas in English Waters to offshore wind farm cabling within Proposed Round 4 leasing areas'.</p>			
Sites of Special Scientific Interest (SSSIs)	None within the trigger distance						
Spawning and nursery grounds	<p>Maximum overlap of four high-intensity spawning and nursery grounds to the north-west of the area.</p> <p>There is, however, a herring spawning area around Flamborough Head which overlaps with the north west of the characterisation area. There are also spawning grounds to the northern and western parts of the characterisation area.</p> <p>There is a cod spawning area to the north-east which is relatively close to the area.</p>			<p>Noise disturbance has the potential to be an issue with the potential for seasonal restrictions on piling during breeding. It will depend if the spawning grounds are still active and their precise locations (which may need to be determined by surveys). Cod are particularly sensitive to noise impacts.</p>			
Social tier							
Royal Yachting Association (RYA) Automatic	Not significant activity in the area for recreational vessels (generally further inshore).						

Identification System (AIS) intensity				
Marinas	None within the trigger distance.			
Bathing beaches	None within the trigger distance.			
Visibility from sensitive receptors	See visibility analysis below.			

Review layers

Visibility from landscape designations and from the coast

The bands of significant visual impact are taken from the OSEA3¹ environmental report. It should be noted that these bands were challenged through the statutory stakeholder engagement by the Statutory Nature Conservation Bodies (SNCBs) so further analysis and engagement should be conducted to understand the visual constraint in potential development areas more fully.

The visibility from landscape designations analysis has been conducted using designations which include protections for landscapes and settings namely: National Parks, Areas of Outstanding Natural Beauty (AONBs), Heritage Coasts and World Heritage sites. For more information on these, please consult the methodology report. The analysis draws on visibility from these designations but not the sensitivity of them to offshore wind developments. Proposals should draw on the relevant management plans or local policies to fully understand the level of constraint that exists in the vicinity of these landscape designations. As such, more analysis is required to fully understand the potential constraint.

	Band of significant visual impact	% of overlap with the characterisation area	Commentary	Area rating
Medium sensitivity receptors	0-13 km (3.6 MW turbines)	1%	A significant amount of this characterisation area is far enough from shore to avoid any significant impacts through appropriate siting of proposals.	
	13-20 km (4-8 MW turbines)	4%		
	20-30 km (10-15 MW turbines)	10%		
High sensitivity receptors	0-30 km	15%		

Visibility of sea surface from landscape designations		Receptor rating	Area rating
The south-western portion of the area is visible from: <ul style="list-style-type: none"> Norfolk Coast AONB North Norfolk Heritage Coast 	The analysis shows that the 12 NM area will be sensitive to development from a visual context especially considering the number of developments already existing in this area. However, the constraint is relatively limited in terms of coverage of the characterisation area as a whole, therefore there is significant potential for development in the rest of the area.		

Ornithology outside of Special Protection Areas (SPAs) for high-risk species

Joint Nature Conservation Committee (JNCC), Natural England and Royal Society for the Protection of Birds (RSPB) advise that there are a number of information sources which should be taken into consideration in the assessment of potential impacts from offshore wind development in this characterisation area. These are:

- Site Information Centres on the JNCC website (<http://jncc.defra.gov.uk/page-6895>) which provide up-to-date information on protected areas, their features and status.
- Marine Ecosystems Research Programme (MERP) seabird distribution maps (https://marine-ecosystems.org.uk/Research_outcomes/Top_predators)
- Future of the Atlantic Marine Environment (FAME) and Seabird Tracking and Research (STAR) tracking data from the RSBP (<https://rspb.maps.arcgis.com/apps/Cascade/index.html?appid=d6c3aa1ec7184a2895a01cebf451c7b3>)
- Wakefield, E., Owen, E., Baer, J., Carroll, M., Daunt, F., Dodd, S., Green, J., Guilford, T., Mavor, R., Miller, P., Newell, M., Newton, S., Robertson, G., Shoji, A., Soanes, L., Votier, S., Wanless, S. & Bolton, M. (2017) Breeding density, fine-scale tracking, and large-scale modeling reveal the regional distribution of four seabird species. Ecological Applications <https://doi.org/10.1002/eap.1591>
- Cleasby, I.R., Owen, E., Wilson, L.J., Bolton, M. (2018) Combining habitat modelling and hotspot analysis to reveal the location of high density seabird areas across the UK: Technical Report. RSPB Research Report no. 63
- Kober, K., Webb, A., Win, I., Lewis, M., O'Brien, S., Wilson, L.J., Reid, J.B. (2010) An analysis of the numbers and distribution of seabirds within the British Fishery Limit aimed at identifying areas that qualify as possible marine SPAs. JNCC Report 431 (and the distribution maps therein) (<http://jncc.defra.gov.uk/page-5622>)

¹ BEIS (2016), OSEA3 Environmental Report. Crown copyright 2016, p 291. URN 16D/033.

- Sansom, A., Wilson, L.J., Caldow, R.W.G. & Bolton, M. 2018. Comparing marine distributions maps for seabirds during the breeding season derived from different survey and analysis methods. PLOS ONE <https://doi.org/10.1371/journal.pone.0201797>
- Bradbury, G., Trinder, M., Furness, B., Banks, A.N., Caldow, R.W.G. & Hume, D. 2014. Mapping Seabird Sensitivity to Offshore Wind Farms. PLoS ONE 9(9): e106366. doi:10.1371/journal.pone.0106366
- Thaxter, C.B., Ross-Smith, V., Bouten, W., Clark, N., Conway, G., Rehfishch, M. & Burton, N. (2015) Seabird–wind farm interactions during the breeding season vary within and between years: A case study of lesser black-backed gull *Larus fuscus* in the UK. *Biological Conservation* 186: 347-358

Species	Site	Commentary on coverage	Area rating
Sandwich tern	North Norfolk Coast (NNC) SPA	<p>The Sandwich tern mean maximum seaward foraging range extends 49 km from the NNC SPA, with the south-western edge of The Wash characterisation area overlapping this foraging range. Given the existing offshore wind development within this foraging range and within proximity to the maximum range (54 km), and that impacts on sandwich tern have been a consenting issue for other developments in the past, cumulative impacts of development within The Wash area with other offshore wind development are likely to be a key consent constraint.</p> <p>Summer density of Sandwich tern is concentrated around the North Norfolk Coast SPA, gradually decreasing with distance from the colony; however, the density of sandwich tern is relatively high throughout the foraging range. Locating any development in The Wash area further offshore and to the east, beyond the maximum sandwich tern foraging range, will help minimise any impacts on this SPA colony.</p> <p>Natural England, JNCC and RSPB consider that cumulative impacts on sandwich tern from the North Norfolk Coast SPA/Greater Wash SPA (collision mortality and barrier effects) have the potential to be a significant consent risk for new offshore wind projects in this area, particularly in the light of the outcome of the Race Bank/Docking Shoal/Dudgeon Appropriate Assessment. Natural England consider that the acceptable limit for impact to sandwich tern from these sites has already been reached by existing offshore wind projects and that there is little or no scope for consenting additional capacity without potentially resorting to a HRA derogation process. Natural England also note that the distribution of sandwich tern extends beyond the SPA boundary and developments in this area may still have impacts on them (refer to Wilson <i>et al.</i> 2014: Quantifying usage of the marine environment by terns <i>Sterna sp.</i> around their breeding colony SPAs. JNCC Report No. 500). RSPB consider that post-consent monitoring data for sandwich tern from Dudgeon should be used in considering cumulative impacts.</p>	
Gannet	Flamborough and Filey Coast (FFC) SPA	<p>The gannet mean maximum seaward foraging range extends 229 km from the source colony at FFC SPA. This range encompasses five other characterisation areas in addition to wholly encompassing The Wash area, which lies in the southern part of the foraging radius. As a result, cumulative collision risk effects should be considered if development is taken forward in more than one characterisation area. This cumulative effects constraint will also be affected by planned developments within the foraging range, e.g. Hornsea Project Three, Norfolk Boreas and Norfolk Vanguard West developments.</p> <p>Summer density decreases further offshore and to the east and south of the FFC SPA. The Wash area lies in an area of relatively low gannet density, with a slightly increased density in the south-eastern part of the characterisation area. However, cumulative impacts on gannet will be a key HRA consideration for development in The Wash area given the existing wind farm development within the FFC SPA gannet foraging range and wider North Sea.</p> <p>Data from the FAME/STAR databases (available from the RSPB and analysed in Cleasby <i>et al.</i> 2018) and from the Hornsea strategic monitoring tracking data should be used to inform future assessment of cumulative impact to the FFC SPA. Natural England also recommends the use of Sansom <i>et al.</i> 2018, Bradbury <i>et al.</i> 2014 and the modelled MERP seabird distribution maps.</p> <p>When taking into consideration the cumulative impact of existing and planned offshore wind projects in this area and nearby, Natural England considers that there is a significant consenting risk to future projects in this area, and that it may not be possible to conclude no adverse effects on site integrity. RSPB do not consider that there is any headroom for development of further offshore wind in this area owing to the potential scale of cumulative impacts to gannet and kittiwake from FFC SPA.</p>	
Kittiwake	Flamborough and Filey Coast (FFC) SPA	<p>The kittiwake mean maximum seaward foraging range extends 60 km from the source colony and as such, the southern North Sea area is located outside this FFC SPA foraging range but partly within the maximum foraging range of kittiwake (120 km). Four other characterisation areas overlap this maximum range, and given concerns over the cumulative impacts of other North Sea offshore wind developments on the FFC kittiwake population, the species is likely to represent a key consent risk for any development within The Wash area.</p>	

		<p>Summer density of kittiwake generally decreases south and east of the FFC colony, with an area of slightly higher density overlapping the northern part of The Wash Area. South of this, kittiwake density is relatively low, therefore locating any development in the south of The Wash area and beyond the maximum foraging range (i.e. > 120 km) would help reduce impacts on this species so that the development's contribution towards cumulative impacts on the FFC colony could be considered manageable.</p> <p>Data from the FAME/STAR databases (available from the RSPB and analysed in Cleasby <i>et al.</i> 2018) and from the Hornsea strategic monitoring tracking data should be used to inform future assessment of cumulative impact to the FFC SPA. Natural England also recommends the use of Sansom <i>et al.</i> 2018, Bradbury <i>et al.</i> 2014 and the modelled MERP seabird distribution maps.</p> <p>When taking into consideration the cumulative impact of existing and planned offshore wind projects in this area and nearby, Natural England considers that there is a significant consenting risk to future projects in this area, and that it may not be possible to conclude no adverse effects on site integrity. RSPB do not consider that there is any headroom for development of further offshore wind in this area owing to the potential scale of cumulative impacts to gannet and kittiwake from FFC SPA.</p>	
Lesser black-backed gull	Alde-Ore Estuary SPA	<p>The lesser black-backed gull mean maximum seaward foraging range extends 141 km from the Alde-Ore Estuary SPA, with the southern half of The Wash characterisation area overlapping this foraging range. Given the high level of existing offshore wind development within this foraging range, cumulative impacts of development within The Wash area with other offshore wind development are likely to be a key consent consideration.</p> <p>Summer density of lesser black-backed gull is relatively high, with those patches of highest densities being concentrated along the coast extending either side of the colony; The Wash area overlaps a relatively low lesser black-backed gull density. Locating any development in The Wash area in the north, beyond the lesser black-backed gull mean maximum range (i.e. > 141 km from the Alde-Ore Estuary) would help reduce any impacts on this SPA colony.</p>	

Ministry of Defence (MoD) activity

	Issues when using 250 m tip heights	Issues when using 350 m tip heights	Receptor rating
Air traffic control (ATC)	Royal Air Force (RAF) Coningsby Primary Surveillance Radar (PSR) concerns in south-west corner of the area only.	RAF Coningsby PSR concerns only in south-west corner of the area.	
Air defence radar (ADR)	Trimingham and Staxton Wold ADR concerns.	Trimingham and Staxton Wold ADR concerns.	
Threat radar	No threat radar concerns.	No threat radar concerns.	
Low flying	No low flying concerns, however, there will be a lighting requirement.	No low flying concerns, however, there will be a lighting requirement.	
Ranges, danger and exercise areas	<p>UXO should be taken into account. The MoD would need to review cable routes to ensure highly surveyed routes are not obstructed by cables or turbines.</p> <p>The MoD would have concerns if the cables came ashore or went through the D207 Holbeach bombing range.</p>	<p>UXO should be taken into account. The MoD would need to review cable routes to ensure highly surveyed routes are not obstructed by cables or turbines.</p> <p>The MoD would have concerns if the cables came ashore or went through the D207 Holbeach bombing range.</p>	

Area commentary	Area rating
<p>Moderate ATC issues but significant ADR concerns exist. This could be difficult to mitigate due to the cumulative impacts of other developments in the area.</p> <p>The Holbeach bombing range should also be avoided in cable routing.</p> <p>There will be a lighting requirement and consideration of UXO as per standard industry practice.</p>	

Fishing activity

Gear type	Location and comments	Area rating
Mobile gear	<ul style="list-style-type: none"> There isn't significant activity outside of the territorial waters although there is some Dutch activity. There is a small amount of trawling and anchor seining activity outside the 12 NM limit. Note that navigation is very tightly restricted around this area due to shallow waters. Therefore, this could also present an issue for accessing grounds. Brown shrimp are also targeted by the inshore fleet. 	
Static gear	<ul style="list-style-type: none"> Significant and important fisheries inside the 12 NM limit targeting crab, lobster and whelk with local processing facilities and strong market demand. There are some French vessels which fish inside the 12 NM limit with the UK fleet in the area generally based in Kings Lynn. National Federation of Fishermen's Organisations (NFFO) note that the pot fisheries also extend outside 12 NM and are exploited by larger vessels operating out of Bridlington and Grimsby. 	
Area commentary		Area rating
Difficult to mitigate interactions inside 12 NM due to well-established fleet with significant local importance, it is easier outside 12 NM. However, there are still issues mainly due to navigation (both fisheries and other vessels) through the shallow banks in the area.		

Future oil and gas

Licensing round	Commentary	Receptor rating	Area rating
28 th and 29 th rounds — mainly in the north of the area	One new oil and gas licence (Block 48/22c) issued through 28 th licensing round. Overlaps with existing 0-6 NM helicopter buffer so low additional constraint.		
30 th round- central and north of the area	In the 30 th offshore licensing round, there were 14 licence blocks awarded which overlap with The Wash characterisation area. These are located predominantly in the central to northern part of the characterisation area and may present a significant additional constraint. However, not all of these will require platforms.		

Marine plans

East Marine Plan	Spatially explicit policies	Issues	Area rating
Aggregates	<p>AGG3: within defined areas of high potential aggregate resource, proposals should demonstrate in order of preference:</p> <ol style="list-style-type: none"> that they will not prevent aggregate extraction; how, if there are adverse impacts on aggregate extraction, they will minimise these; how if the adverse impacts cannot be minimised, they will be mitigated; and, the case for proceeding with the application if it is not possible to minimise or mitigate the adverse impacts. 	<p>Almost the entirety of the characterisation area overlaps with the area of optimal aggregate resource area identified in the East Marine Plan. Any new offshore wind development would need to consider impacts to the aggregates industry and negotiation with the aggregates sector would be required.</p> <p>Whilst The Crown Estate leases/licences seabed for offshore wind and aggregate extraction it should be noted that aggregates tendering rounds currently run every two years, and so the requirement for liaison between industries will be ongoing.</p>	
Tidal energy	<p>TIDE1: in defined areas of identified tidal stream resource proposals should demonstrate, in order of preference:</p> <ol style="list-style-type: none"> that they will not compromise potential future development of a tidal stream project; how, if there are any adverse impacts on potential tidal stream deployment, they will minimise them; how, if the adverse impacts cannot be minimised, they will be mitigated; and, the case for proceeding with the proposal if it is not possible to minimise or mitigate the adverse impacts. 	There is no overlap of the characterisation area with the area of identified tidal stream resource in the East Marine Plan.	

Aquaculture	<p>AQ1: within sustainable aquaculture development sites (identified through research), proposals should demonstrate in order of preference:</p> <ul style="list-style-type: none"> a) that they will avoid adverse impacts on future aquaculture development by altering the seabed or water column in ways which would cause adverse impacts to aquaculture productivity or potential; b) how, if there are adverse impacts on aquaculture development, they can be minimised; c) how, if the adverse impacts cannot be minimised they will be mitigated; and, d) the case for proceeding with the proposal if it is not possible to minimise or mitigate the adverse impacts. 	<p>There is a small area of overlap in the southern part of the characterisation area with the optimum sites of aquaculture potential identified in the East Marine Plan. The overlap would need to be considered as part of any future offshore wind development, however, it is not anticipated that this would be a significant barrier for any future offshore wind development.</p>	
Carbon Capture Storage (CCS)	<p>CCS1: within defined areas of potential carbon dioxide storage, proposals should demonstrate in order of preference:</p> <ul style="list-style-type: none"> a) that they will not prevent carbon dioxide storage; b) how, if there are adverse impacts on carbon dioxide storage, they will minimise them; c) How, if the adverse impacts cannot be minimised, they will be mitigated; and, d) the case for proceeding with the proposal if it is not possible to minimise or mitigate the adverse impacts. 	<p>There is some overlap of the characterisation area with the areas of potential opportunity for CCS identified in the East Marine Plan. The overlap would need to be considered as part of any plans for future offshore wind development and negotiation with the sector would be required.</p>	
Ports and shipping	<p>PS2: proposals that require static sea surface infrastructure that encroaches upon important navigation routes should not be authorised unless there are exceptional circumstances. Proposals should:</p> <ul style="list-style-type: none"> a) be compatible with the need to maintain space for safe navigation, avoiding adverse economic impact; b) anticipate and provide for future safe navigational requirements where evidence and/or stakeholder input allows; and, c) account for impacts upon navigation in-combination within other existing and proposed activities. 	<p>The characterisation area, particularly the western and southern extents, overlaps with the important navigation routes identified in the East Marine Plan. Any new offshore wind development would need to account for navigation routes when locating the project area.</p>	

The Crown Estate key resource areas (KRAs) for other sectors

KRA category	Where?	Commentary	Receptor rating	Area rating
Cables	No interaction			
Carbon Capture Storage (CCS) stores	Intersects the Hewett Field which has been assessed through a Front End Engineering Design (FEED) study. The area also intersects a number of moderate and limited rated stores. These are distributed across the area.	This site has been characterised and the subject of significant investment. This is grouped among the most commercially attractive storage options and as such, presents a significant constraint. However, there is other opportunity in the area. Constraint is relatively limited in terms of coverage of the characterisation area, therefore there is significant potential for development in the rest of the area.		
CCS infrastructure	Wide coverage across the area	This KRA is significant in size however there is significant opportunity for potential deployment of CCS infrastructure from industrial hubs on the east coast and Europe, transporting captured CO2 through the characterisation areas to potential stores in the Southern North Sea. Proposals should consider potential impacts on these potential infrastructure corridors that may be developed in the near to medium term.		

Minerals	Covering most of the area	Likely to be pockets of interest in the area but this KRA is a larger zone of higher prospectivity that is less spatially defined than the resource in the other characterisation areas.		
Pipelines	Only slightly covering the south-eastern part of the area within 12 NM	This KRA is significant in size due to the landing resource for pipeline infrastructure which is generally being dictated by the shortest distance between connection points. Due to the significant number of alternative options for landing pipeline infrastructure, the risk of sterilising valuable resource is deemed to be minimal.		
Sandscaping	Covers all of the area inside 12 NM	This KRA is significant in size due to the knowledge of potential sites and resources for sandscaping schemes not being well known currently. As such, significant conclusions cannot be drawn from this KRA.		
Tidal range	No interaction			
Tidal stream	No interaction			
Wave	No interaction			

National Air Traffic Services (NATs) radar overlap

% Overlap with Primary Surveillance Radar (PSR) assessment buffer (200 m turbines)	Commentary	Area rating
100.00%	Intersect throughout the area so a further risk assessment will be required with site-specific mitigation options only available rather than mitigation by siting.	

Water Framework Directive (WFD)

% of the area covered	Spatial overlap with the area	Area rating
No intersect.		

Marine cultural heritage

Heritage asset type	Where?	Commentary on sensitivity from offshore wind development	Receptor rating
Maritime archaeology and wrecks	Significant potential throughout the characterisation area, but with particular concentrations of known wrecks and obstructions in the parts of the area closer to the coast e.g. Inner Wash, and to the south	<p>Maritime archaeology including known wrecks represented by a physical asset on the seabed, historic losses of vessels where precise location is uncertain and associated cultural material such as isolated finds, all have potential to be affected by OWF development in The Wash characterisation area. The area contains a large number of wrecks and obstructions, with particular concentrations of known wrecks in closer proximity to the coast and the Inner Wash and the navigational hazards present - e.g. Sheringham Shoal.</p> <p>There is potential for the recovery of remains from the earliest seafaring in the prehistoric period to the present day, as evidenced by the recovery of some of the earliest examples of sewn plank boat remains dating to the Bronze Age from the wider Humber basin at Ferriby. A number of isolated maritime finds have been reported from the area indicating the potential for recovery of previously unknown sites and features, owing to reports of this material made from the offshore wind</p>	

	<p>of the area off the North Norfolk coast and associated with navigational hazards such as Sheringham Shoal.</p>	<p>farms and marine aggregate areas that are present in the east and north of the area. As is commonplace throughout UK waters, there is a particular dominance of steel and metal vessels from the 19th and 20th centuries, and there are also a significant number of wrecks associated with 20th century military activity. The characterisation area is located along the East Coast War Channels (ECWCs), which were maintained and patrolled routes for civilian shipping between the Scottish border and the North Kent Coast, in operation during the First and Second War Wars. The characterisation area therefore contains large numbers of heritage assets including known wreck sites and documented losses associated with the ECWCs.</p> <p>Established procedures exist to ensure that any historic wrecks, both known and unknown, and associated remains, are identified as part of any proposed offshore wind farm development and impacts are mitigated and minimised.</p>	
<p>Aviation archaeology</p>	<p>There is potential for recovery of aviation archaeological remains throughout the characterisation area.</p>	<p>There is potential within The Wash characterisation area for the discovery of remains from crashed aircraft and associated cultural material from the birth of aviation at the start of the 20th century to the present. The greatest potential is associated with losses from the Second World War, and the numerous airborne battles, and defence of strategic locations around the Lincolnshire and North Norfolk coast, as well as vital shipping routes and targets within the area that took place at this time. Several RAF bases were located in close proximity to the characterisation area and the historic records indicate a significant number of aircraft losses from the Second World War off the Lincolnshire coast (118 – Lincolnshire).</p> <p>While existing standard mitigation measures may be utilised for specific projects in the area, further site-specific mitigation including excavation and recovery of significant remains that are encountered and where impacts are unavoidable may be required, although it should be noted that this is an extreme example and would only be undertaken following significant discussion with advisors and in rare cases where preservation <i>in situ</i> was not a feasible option.</p>	
<p>Submerged prehistoric landscapes</p>	<p>There is potential across the characterisation area, with enhanced potential in those close to geomorphological features such as the palaeochannels being worked in the west of the area by the marine aggregate industry, and in closer proximity to the coast.</p>	<p>During the three major glaciations of the Pleistocene, the majority if not all of the characterisation area would have been covered by ice sheets. This means there is limited potential for recovery of cultural material associated with these periods. It is expected that any remains would be associated with geomorphological features such as palaeochannels and valleys, and the geological deposits from these periods.</p> <p>There is some potential for the survival of sediments and secondary context artefactual material in areas where glacial activity has not eroded earlier sedimentary deposits. There have been several finds of early prehistoric date reported in the area through the British Marine Aggregate Producers Association (BMAPA) protocol owing to the presence of a number of marine aggregate licence areas in the north and east of the area, and significant study of the wider potential of the area through work completed for other offshore wind farm developments as part of rounds one – three.</p> <p>Following the retreat of the Devensian ice sheet (c. 13,000 BP) much of the area would have provided accessible and attractive habitat for our Late Upper Palaeolithic and Mesolithic ancestors. Significant deposits and possible finds may therefore be anticipated in association with the early Mesolithic channel systems and other geomorphological features that were present and exposed prior to marine transgression. Therefore, there is potential for remains from this period to be present and impacted by offshore wind farm development in the characterisation area.</p> <p>Established procedures exist to ensure that any submerged prehistoric landscapes, associated geographical and geomorphological features, and associated deposits, features and finds are identified as part of any proposed offshore wind farm development so any impacts can be mitigated and minimised.</p>	
<p>Area commentary</p>			<p>Area rating</p>
<p>There are extensive heritage assets and potential for recovery of further remains across the area, with particular concentrations of known wrecks and obstructions in proximity to the coast. The area is also an important location for potential recovery of aviation and submerged prehistoric archaeology. The application of standard mitigation measures on a strategic and project-specific basis will reduce the risk to underwater cultural heritage in this area.</p>			

Glossary of acronyms and abbreviations

ADR	Air Defence Radar
AONB	Area of Outstanding Natural Beauty
ATC	Air Traffic Control
BMAPA	British Marine Aggregate Producers Association
CCS	Carbon Capture Storage
ECWCs	East Coast War Channels
EPS	European Protected Species
FAME	Future of the Atlantic Marine Environment
FEED	Front End Engineering Design
FFC	Flamborough and Filey coast
HRA	Habitat Regulations Assessment
JNCC	Joint Nature Conservation Committee
km	Kilometre
KRA	Key Resource Area
m	Metre
MCZ	Marine Conservation Zone
MERP	Marine Ecosystems Research Programme
MoD	Ministry of Defence
MPA	Marine Protected Area
MW	Mega watt
NATS	National Air Traffic Services
NFFO	National Federation of Fishermen's Organisation
NM	Nautical Mile
NNC	North Norfolk Coast
OESEA3	Offshore Energy Strategic Environmental Assessment 3
OFTO	Offshore Transmission Owners
OWF	Offshore Wind Farm
pSPA	Potential Special Protection Area
PSR	Primary Surveillance Radar
Ramsar	Ramsar Convention on wetlands of international Importance especially as waterfowl habitat, also known as the 'Convention on Wetlands'.
RAF	Royal Air Force
RSPB	Royal Society for the Protection of Birds
RYA AIS	Royal Yachting Association (RYA) Automatic Identification System (AIS)
SAC	Special Area of Conservation
SCI	Site of Community Importance
SNCB	Statutory Nature Conservation Body
SPA	Special Protection Area
SSSI	Site of Special Scientific Interest
STAR	Seabird Tracking and Research
TWT	The Wildlife Trusts
UXO	Unexploded Ordnance
WFD	Water Framework Directive