Offshore
Wind
Leasing
Round 4

THE CROWN ESTATE

Resource and Constraints Assessment for Offshore Wind

Characterisation Area Report
Dogger Bank

2

38255-TCE-REP-007

Characterisation Area Report: 2 – Dogger Bank

Versions

38255-TCE-REP-007 Characterisation Area Report: 2 – Dogger Bank		
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 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	Dogger Bank, Teesside (Lackenby) A, Teesside (Lackenby) B, Creyke Beck A, Creyke Beck B are sited in the middle of the area.	This is potentially a significant concern as the wind farm is located in the centre of the area. 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. However, due to the potential proximity to existing rights any development in this area should consider the operation of the incumbent developer.		
	Offshore wind farm (OWF) export cable routes Offshore Transmission Owners (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. New projects may look to use similar landing locations that may cause cumulative impacts. Since cable crossings require cable protection (which may have adverse environmental effects), crossings should be minimised where practicable.		
	Hornsea Project Four – approx. 4 km to the south-west of the characterisation area.	Unlikely to be a significant concern as the wind farm is located at a sufficient distance away. However, 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.		
Other energy infrastructure	There are 12 oil and gas platforms in the area, one manifold and three wellheads. There is also some pipeline infrastructure associated with this activity. This is generally around the southern section of the characterisation area.	The infrastructure itself is dispersed so avoidance should be possible (hence amber receptor rating). However, 38% of the area is covered by 0-9 NM helicopter consultation buffers. This may dictate where development may be sited but leaves enough of the area to allow alternative opportunity.		
Navigation	None within the trigger distance.			
Social	None within the trigger distance.			

Restrictions model – Soft constraints			Receptor rating	Area rating
Economic tier				
Navigation	There is not a significant density of traffic in this area.			
Subsurface	Endurance Carbon Capture Storage (CCS) site: Intersects the south-west boundary of the characterisation area.	Would require liaison with customer but interaction will likely be limited to infrastructure rather than the store itself.		
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 of Annex II species have 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. The Wildlife Trusts (TWT) consider that white beaked dolphin, minke whale and harbour porpoise are particularly important for this characterisation area.

Type of designation		Name of designation (distance from area)	Designated features/species	Conservation objectives	Commentary	Receptor rating	Area rating
European marine designations	Special Areas of Conservation (SACs)	Dogger Bank	Subtidal sandbanks	JNCC's published view is that the Annex I Sandbanks feature is currently in unfavourable condition. The conservation objectives for this SAC are for the feature to be in favourable condition by maintaining or restoring the habitat subject to natural change.	Stakeholder feedback from Natural England and The Wildlife Trusts notes that Dogger Bank SAC is currently in unfavourable condition with conservation objectives to restore features to a favourable condition. It presented a significant consenting risk to projects in the Dogger Bank R3 zone due to in-combination impacts and the risk remains high for further development in the area. Proposals for further development should draw on the relevant Examiner's reports and Secretary of State's decision letters which include statements of reasons about which environmental risks were issues or the basis of discussion for projects which have been consented or gone through the planning process. Consideration of further projects within the Dogger Bank SAC will need to include assessment of benthic impacts in combination with consented projects and innovative solutions may need to be found to ensure that impacts on the benthic environment are reduced and managed appropriately. The Wildlife Trusts recommend complete avoidance of the SAC. 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'.		
	SAC (Netherlands)	Doggersbank (adjacent)	Grey Seal Common Seal Harbour Porpoise Subtidal sandbanks	Seal and porpoise features have conservation objectives to maintain in favourable condition. Sandbank features have a conservation objective to maintain the area of sandbank and improve the quality.	The site is contiguous with the German and UK SAC designations for the Dogger Bank as a whole. The site comprises the Dogger Bank sandbank and characteristic invertebrate fauna and fish fauna including the rare ray Raja clavata, anchovy, weever fish and scaldfish. The location of the site seaward of the characterisation area means that it is improbable that cabling would run through it and it is therefore unlikely that the sandbank features would be affected. Impacts of noise on seal and porpoise would need to be taken into consideration for developments within the characterisation area. Seal and porpoise using the area are likely to forage throughout the North Sea (and the area is obviously not a seal haul-out site) so impacts are likely to be manageable with appropriate mitigation. It is noted that adverse effects on integrity at this site have not been identified in UK North Sea offshore wind HRAs to date.		
	SAC (Netherlands)	Klaverbank (adjacent)	Grey Seal Harbour Seal Harbour Porpoise Reefs	Seal and porpoise features have conservation objectives to maintain at favourable condition. The reef features have a conservation objective to maintain the area of reef and improve the quality.	The site is a gravelly/stony reef alternating with coarse sand and shell – a unique site in the Dutch North Sea. It has a high biodiversity owing to the mosaic of habitats and the surprisingly clear water also allows red algae to grow. The average depth is 43 m but a 60 m deep silt-rich trench (the Botney Cut) crosses the southwest side. Klaverbank supports some indigenous invertebrate species as well as more common North Sea sandbank invertebrates and fish. The site may be important for ray and herring spawning (on hard substrates) and it supports large quantities of seabirds and harbour porpoise. The location of the site seaward of the characterisation area means that it is improbable that cabling would run through it and it is therefore unlikely that the reef features would be affected. Impacts of noise on seal and porpoise would need to be taken into consideration for developments within the characterisation area. Seal and porpoise using the area are likely to forage throughout the North Sea (and the area is obviously not a seal haul-out site) so impacts are likely to be manageable with appropriate mitigation. It is noted that adverse effects on integrity at this site have not been identified in UK North Sea offshore wind HRAs to date.		
	Harbour porpoise SAC	Southern North Sea	Harbour porpoise	To ensure that the integrity of the site is maintained and that it makes the best possible contribution to maintaining Favourable	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.		

				Conservation Status (FCS) for Harbour Porpoise in UK waters In the context of natural change, this will be achieved by ensuring that: 1. Harbour porpoise is a viable component of the site; 2. There is no significant disturbance of the species; and 3. The condition of supporting habitats and processes, and the availability of prey is maintained. 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.	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. 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 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: 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. 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. 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. 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.		
	Sites of Community Importance (SCIs)	None within the trigger distance					
	Ramsar	None within the trigger distance					
	Special Protection Areas (SPAs)	None within the trigger distance					
Marine Conservation Zones (MCZs)		None within the trigger distance					
Recommended Marine Conservation Zones (rMCZs)		None within the trigger distance					

Sites of Special Scientific Interest (SSSIs)	None within the trigger distance					
Spawning and nursery grounds	There is a maximum count of high-intensity nursery and spawning overlaps of four which is not significant. There are, however, two herring spawning grounds that intersect the characterisation area and two immediately adjacent. There is one cod spawning area which overlaps to the west, one within proximity to the south and two close by to the north-east/east.			Noise disturbance has the potential to be an issue with the potential for seasonal restrictions on piling during breeding. The cod areas are identified as low-intensity spawning grounds. However, the wide coverage of these spawning grounds, and the sensitivity of the species to noise, means that, to mitigate impacts, seasonal restrictions will likely be applied which may impact on the deliverability of projects.		

Social tier				
Royal Yachting Association (RYA) Automatic Identification System (AIS) intensity	No data coverage.			
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 OSEA3[1] 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, Area 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)	0%	No visibility this far from shore.	
	13-20 km (4-8 MW turbines)	0%		
	20-30 km (10-15 MW turbines)	0%		
High sensitivity receptors	0-30 km	0%		

Visibility of sea surface from landscape designations		Receptor rating	Area rating
• None triggered	No visibility this far from shore		

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 modelling 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)
- 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

[1] BEIS (2016), OESEA3 Environmental Report. Crown copyright 2016, p 291. URN 16D/033.

- Thaxter, C.B., Ross-Smith, V., Bouten, W., Clark, N., Conway, G., Rehfisch, 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
Gannet	Flamborough and Filey Coast (FFC) SPA	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 Dogger Bank area, which lies in the east 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. Cumulative collision risk will also be affected by pre-application developments within the foraging range, e.g. Hornsea Project Three, Norfolk Boreas and Norfolk Vanguard West developments. Summer density decreases further offshore and to the east of the FFC SPA. The Dogger Bank area lies in an area of relatively low gannet density, with a slightly increased density in the northern part of the characterisation area that could be related to foraging gannet from the Bass Rock colony in Scotland. However, cumulative impacts on gannet will be a key HRA consideration for development in the Dogger Bank area given the existing wind farm development within the FFC SPA gannet foraging range and wider North Sea. Data from the FAME/STAR databases (available from the RSPB and analysed in Cleasby *et al.* 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 use of Sansom *et al.* 2018, Bradbury *et al.* 2014 and the modelled MERP seabird distribution maps. 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 imperative reasons of overriding public interest (IROPI) may be required.	
Kittiwake	Flamborough and Filey Coast (FFC) SPA	The kittiwake mean maximum seaward foraging range extends 60 km from the source colony and, as such, the Dogger Bank area is located outside this FFC SPA foraging range. However, the Dogger Bank area lies within the maximum foraging range of kittiwake (120 km), 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 to development within the Dogger Bank area. Four other characterisation areas lie within this maximum range. Cumulative collision risk will also be affected by potential future developments within this range, e.g. Hornsea Project Four. Summer density of kittiwake increases east of the FFC colony, with an area of higher density continuing beyond the 60 km mean maximum foraging range which the western part of the Dogger Bank area overlaps with. Locating any development east of this high-density area and beyond the maximum foraging range (i.e. > 120 km) would help minimise impacts on this SPA population. Data from the FAME/STAR databases (available from the RSPB and analysed in Cleasby *et al.* 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 use of Sansom *et al.* 2018, Bradbury *et al.* 2014 and the modelled MERP seabird distribution maps. 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 IROPI may be required.	

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)	No ATC concerns.	No ATC concerns.	
Air defence radar (ADR)	Staxton Wold and Brizlee Wood ADR concerns on the very western section of the area.	Staxton Wold and Brizlee Wood ADR concerns on the very western section of the area.	
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	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.	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.	
Area commentary			Area rating
There are ADR concerns, however, these will generally be to the south-west of the area only. There will be a lighting requirement and consideration of UXO as per standard industry practice.			

Fishing activity

Gear type	Location and comments
Mobile gear	▪ The big fishery in this area is sand eel which is targeted by Danish midwater trawling. This is a high-value fishery and is turned into fish meal for livestock. ▪ There is some seine netting to the north-west of the area using an anchor bashing technique (15 vessels at most). This activity lands in Grimsby and will endure as it is a cheap method of fishing. Seine netting may not be possible within wind farm areas owing to insufficient turbine spacing. ▪ The south of the area is dominated by Dutch beam trawlers using twin rigs and some seine netters as well. They target plaice and other flatfish species. Some local boats operate from Whitby and a few from Boulogne in France (these provided data to the Hornsea Project). ▪ The Cleaver Bank to the south of the area would be very difficult to develop from a fisheries perspective due to the importance of the area. It is fished by vessels from many EU countries and Norway. ▪ To the south of the area, there are the Outer Silver Pits which provide a profitable *Nephrops* fishery that services Scottish and Belgian fishermen. The areas only slightly overlap with the characterisation area but consideration of vessels accessing and utilising this fishery should be considered.
General	▪ Sand eels are a very important food source for a number of seabird colonies on the east coast (puffin and gannets). The west of the Dogger Bank is an especially sensitive area. ▪ *Nephrops* fisheries are limited to appropriate muddy habitats which are dispersed across the UK seabed making displacement of effort difficult to mitigate. ▪ Commercial fisheries stakeholders have expressed concern over the cumulative and in-combination impacts on fisheries in this area which arise from offshore wind development and fisheries management measures associated with MPAs.

Area commentary	Area rating
The value and number of countries utilising fisheries in this area makes it very difficult to see significant further development, however there may be some pockets of less activity. There is UK Fisheries Information Mapping data in this area.	

Future oil and gas activity

Licensing round	Commentary	Receptor rating	Area rating
28th and 29th rounds — mainly in the north of the area.	10 new licence blocks have been awarded through the 28th and 29th leasing rounds. Block 43/21b licensed via 29th supplementary round, blocks 37/28b, 37/23a, 37/24 licensed via 29th Round, and blocks 42/19, 42/20b, 43/11, 42/10b, 37/27, 44/27 via 28th Round. Several of these are in the north of the characterisation area which has previously not been developed and therefore do not overlap with existing infrastructure or helicopter consultation zones. They may therefore present a significant additional constraint in the northern part of the characterisation area.		
30th round — central and west of the area.	In the 30th offshore licensing round there are 16 licences that have been awarded that intersect the Dogger Bank characterisation area. They are located in the central and western parts of the characterisation area and may present a significant additional constraint.		
31st round — mainly in the north of the area.	In the 31st offshore licensing round there are 11 licences that have been awarded that intersect the Dogger Bank characterisation area. They are located in the northern part of the characterisation area and may present a significant additional constraint.		

Marine Plans

East Marine Plan	Spatially explicit policies	Issues	Area rating
Aggregates	AGG3: within defined areas of high potential aggregate resource, proposals should demonstrate that (in order of preference): a) They will not prevent aggregate extraction b) If there are adverse impacts on aggregate extraction, they will minimise these c) If the adverse impacts cannot be minimised, they will be mitigated d) The case for proceeding with the application if it is not possible to minimise or mitigate the adverse impacts.	A small part of the southern extent 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, however, given the limited area of overlap this is not considered to be a significant concern. 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.	
Tidal energy	TIDE1: in defined areas of identified tidal stream resource proposals should demonstrate that, (in order of preference): a) They will not compromise potential future development of a tidal stream project b) If there are any adverse impacts on potential tidal stream deployment, they will minimise them c) If the adverse impacts cannot be minimised, they will be mitigated d) 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	AQ1: within sustainable aquaculture development sites (identified through research), proposals should demonstrate that (in order of preference): a) 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) If there are adverse impacts on aquaculture development, they can be minimised c) If the adverse impacts cannot be minimised, they will be mitigated d) 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 optimum sites of aquaculture potential identified in the east marine plan.	
Carbon Capture Storage (CCS)	CCS1: within defined areas of potential carbon dioxide storage, proposals should demonstrate in order of preference: 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 d) The case for proceeding with the proposal if it is not possible to minimise or mitigate the adverse impacts.	There is a small area of overlap in the southern part 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.	
Ports and shipping	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: 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	There is no overlap of the characterisation area with the important navigation routes identified in the east marine plan.	

	c) Account for impacts upon navigation in-combination within other existing and proposed activities.		

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	Overlaps with a number of 'Moderate' and 'Limited' rated stores and the bunter aquifer. These are distributed across the area.	These sites are not the most favourable in terms of development potential so present little constraint.		
CCS infrastructure	Wide coverage across the area.	This KRA is significant in size due to the opportunity for CCS infrastructure development generally dictated by the shortest distance between connection points. Due the significant number of alternative options for landing CCS infrastructure, the risk of sterilising valuable resource is deemed to be minimal.		
Minerals	Overlaps with a number of Moderate and Limited rated stores and the bunter aquifer. These are distributed across the area.	These sites are not the most favourable in terms of extraction potential so present little constraint.		
Pipelines	No interaction.			
Sandscaping	No interaction.			
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) (200m turbines)	Commentary	Area rating
5.58%	Minimal overlap on the south eastern edge. Further assessment is unlikely to be required.	

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	Potential throughout area but with particular concentrations of known wrecks and assets in the east and northern parts of the characterisation area.	Historic wreck including known wrecks and assets on the seabed, and the associated cultural material such as vessel contents, cargo, isolated finds and historic losses all have the potential to be affected by the OWF development in the Dogger Bank characterisation area. The area contains a large number of vessels associated with losses on the bank itself, with particular concentrations of losses in the east and northern parts of the characterisation area. There is a particular dominance of steel and metal vessels from the 19th and 20th centuries and also a significant number of wrecks associated with losses in the First and Second World Wars (refer to https://historicengland.org.uk/whats-new/first-world-war-home-front/what-we-already-know/sea/war-channels-of-the-east-coast/), with potential for the recovery of remains from the earliest seafaring in the prehistoric period to the present day. There is, however, a more limited potential for seafaring craft from periods of prehistory at this distance offshore (although not zero) due to the current capabilities of the vessels. A number of established procedures exist to ensure that any historic wrecks, both known and unknown, and the associated remains are identified as part of any proposed OWF development and impacts are mitigated and minimised.	
Aviation archaeology	Moderate potential for recovery of aviation archaeological remains throughout characterisation area.	The area is known to have been subject to significant hostile activity in the Second World War as a key battleground between defensive forces and the Luftwaffe, and therefore the greatest potential for recovery of aircraft remains in the area that relates to this period. While losses have occurred in the area, the density is anticipated to be much lower than in closer proximity to the coast, or in the south-east of England. 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 *in sit*u was not a feasible option.	
Submerged prehistoric landscapes	Potential across characterisation area with enhanced potential in areas in close proximity to geomorphological features such as palaeochannels and other identified features such as lagoons and gravel terraces.	During periods of lower sea level caused by three major glaciations (the Anglian, Wolstonian and Devensian) the characterisation area would have been covered by the ice sheets and, as such, there is limited potential for recovery of cultural material associated with these periods. Any remains, if present, would be expected to be associated with geomorphological features such as palaeochannels and valleys, and the geological deposits from these periods, although potential for survival of material from these periods is limited. However, following the formation of the Dogger Bank, and retreat of the Devensian ice sheet (c. 13,000BP) much of the area would have provided accessible and attractive habitat for Late Upper Palaeolithic and Mesolithic ancestors. Faunal remains and evidence collected from previous studies of the area attest to this potential (e.g. the North Sea Palaeolandscape projects and data collected from offshore wind developments such as Russell J.W. & Stevens C.J (2014) Palaeoenvironmental assessment of peat samples (published by The Crown Estate), Brown A., Russell J., Scaife R., Tizzard L., Whittaker J & Wyles S.F (2018) Late glacial/early Holocene palaeoenvironments in the southern North Sea Basin: new data from the Dudgeon offshore wind farm. J. Quat. Res 33 (6) 597-610). 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. As such, there is potential for remains from this period to be present and impacted by OWF development in the characterisation area. A number of established procedures exist to ensure that any submerged prehistoric landscapes, associated geographical and geomorphological features, and the associated deposits, features and finds are identified as part of any proposed OWF development and impacts are mitigated and minimised.	

Area commentary	Area rating
There are extensive heritage assets and potential for recovery of further remains across the area, with particular concentrations of historic wreck losses on the northern and eastern edges of the characterisation area. The main issue for this area lies in the consideration of the cumulative impact of further wind development on the submerged prehistoric resources and on the historic seascape (refer to Historic England's work on Historic Seascapes Characterisation).	

Strategic mitigation may include exclusion of certain parts of the characterisation area to minimise these effects, but further research may be required to better understand the cumulative impacts of development on this receptor class. In assessing the potential level of cumulative impacts, use should be made of the growing body of information from surveys undertaken within this area, and the records available through the Online AccesS to the Index of archaeological investigationS (OASIS) (https://oasis.ac.uk/pages/wiki/Main)	

Glossary of acronyms and abbreviations

ADR	Air Defence Radar
AONB	Area of Outstanding Natural Beauty
ATC	Air Traffic Control
CCS	Carbon Capture Storage
EPS	European Protected Species
FAME	Future of the Atlantic Marine Environment
FFC	Flamborough and Filey coast
HRA	Habitat Regulations Assessment
IROPI	Imperative reasons of overriding public interest
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
NM	Nautical Mile
OESEA3	Offshore Energy Strategic Environmental Assessment 3
OFTO	Offshore Transmission Owners
OWF	Offshore Wind Farm
PSR	Primary Surveillance Radar
Ramsar	Ramsar Convention on wetlands of international Importance especially as waterfowl habitat, also known as the ‘Convention on Wetlands’.
rMCZ	Recommended Marine Conservation Zone
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