Marine Management Organisation

East Marine Plan Futures Analysis

(MMO1370)

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1 Executive Summary

The East Inshore and Offshore Marine Plans were the first marine plans to be adopted in England in 2014. The Plans were reviewed in 2017, 2020, and 2023 in accordance with Marine and Coastal Access Act 2009 (MCAA). The aim of marine plans is to help enable sustainable development of marine areas, and to contribute to economic growth in a way that benefits society, whilst respecting the needs of local communities and protecting the marine environment.

The 2020 and 2023 review of the Plans revealed that amendments would be necessary to address the likely significant increase in marine activity, and marine planning response, over the coming years. Significant drivers of change are the expansion of offshore renewable energy developments (and resulting increasing spatial squeeze to other activities) and changes to climate change policies (e.g., net zero targets and legislation, UK climate emergency, and British Energy Security Strategy).

For the Plans to be amended appropriately, an analysis of potential future activity levels of relevant industrial and environmental marine sectors is required, over the next 6 and 20 years. These time points represent reasonable and maximum timespans over which marine plan remain relevant and is consistent with future analyses undertaken for previous marine plans[1]. The analysis considers information on historical trends for the last 10 years, industry projections (where available), and potential future changes in technological advancements, ecosystems, climate, and policy directions, as well as considering information from a geospatial perspective.

The scope of the report covers all the sectors listed in the Marine Policy Statement (MPS).

For each sector, assessment of the key political, economic, social, technological, legal, and environmental drivers (termed a PESTLE analysis) has been undertaken. The PESTLE analysis involved gathering and assessing evidence including policies and strategies that inform on national-level direction of travel as well as sector-specific plans.

The analysis found that there has been a significant increase in the amount of industrial activity occurring within the Plan areas over the last ten years, with further development and expansion projected in the future. Industries which currently have a large spatial footprint within the east inshore marine plan area include fisheries, tourism and recreation, and ports and shipping sectors. Industries which currently have a large spatial footprint across the east offshore marine plan area include the oil and gas, offshore wind, and the port and shipping sectors.

[1] Marine Management Organisation. 2017. Futures Analysis for the North east, North west, South east and South west marine plan areas. Available at: https://assets.publishing.service.gov.uk/media/5a8242c040f0b62305b93575/Futures_analysis_for_the_North_East__North_West__South_East_and_South_West_marine_plan_areas__MMO_1127_.pdf Accessed October 2024.

In regard to ecological features, an extremely high diversity of species and habitat types exist across the Plan areas. Areas of particularly high importance, where MPAs are designated include The Wash and the Humber estuary as globally important areas for migrating birds, extensive areas of saltmarsh, mudflats, and seagrass and oyster beds along The Wash and north Norfolk coast, and Dogger Bank as the largest sandbank in the UK.

Significant growth across the Plan areas is likely to include the development of the renewable energy sector and its associated cabling, and the developing CCUS and hydrogen sectors. This will likely lead to competition between industries for space and ultimately spatial squeeze within the Plan areas.

Given that large parts of the Plan areas are designated nature conservation areas, increasing numbers of byelaws are likely to be introduced in order to implement management measures. This is expected to improve environmental status and aid recovery of feature condition, but also contributes further to spatial squeeze on other sectors (for example the fisheries sector). This may also result in restrictions on certain activities including recreational and tourism activities in coastal areas, dredging, and cabling in offshore areas.

Future industrial and environmental trends in the Plan areas are influenced by several drivers, including political, economic, social, technological, legal, and environmental drivers, many of which are interlinked between industries. For example, the legal obligation under the Climate Change Act[2] to achieve net zero emissions by 2050 to mitigate against the impacts of climate change, is driving both development of some sectors, and mitigation actions which may transform existing sectors.

[2] UK Government. 2019. Climate Change Act 2008. Available at: https://www.legislation.gov.uk/ukpga/2008/27/section/1/2019-06-27 Accessed October 2024.

Climate pressures will likely result in, but not be limited to, sea level rise, increased storminess, and increased runoff which will have environmental consequences on features such as water quality and coastal erosion, as well as impacts on industries such as weather downtime and the need to build in contingency for these conditions. Climate change policies will influence the development of industries and technologies including the renewable energy sectors, those which can help to decarbonise existing industries (CCUS and hydrogen) and the associated requirements of the means of powering vessels and vehicles sustainably.

Overall, the Plan areas are a particularly busy part of English waters, both in regard to industrial activity and ecological importance. It is therefore essential that marine planning supports appropriate management to ensure that both the environment and industrial sectors have sufficient space to maintain their viability and adapt to the pressing impacts of climate change. This can be supported by identifying key areas for particular sectors, supporting co-location (for both environmental and industrial sectors), and ensuring effective evidence gathering and review through marine planning processes

2 Introduction

The East Inshore and Offshore Marine Plans (the Plans) were the first marine plans to be adopted in England in 2014. The Plans were reviewed in 2017, 2020, and 2023 in accordance with Marine and Coastal Access Act 2009 (MCAA). The aim of marine plans is to help enable sustainable development of marine areas, and to contribute to economic growth in a way that benefits society, whilst respecting the needs of local communities and protecting the marine environment. As such, the marine plans contain objectives and policies which aim to ensure that all sectors are managed fairly and proportionately. Marine plans have a 20-year life span, and therefore future analyses are required to assess anticipated changes in activity over that timescale.

The 2020 and 2023 review of the Plans revealed that amendments would be necessary to address the likely significant increase in marine activity, and marine planning response, over the coming years. Significant drivers of change are the expansion of offshore renewable energy developments (and resulting increasing spatial squeeze to other activities) and changes to climate change policies (e.g., net zero targets and legislation, UK climate emergency, and British Energy Security Strategy).

For the Plans to be amended appropriately, an analysis of potential future activity levels of relevant industrial and environmental marine sectors is required, over the next 6 and 20 years. These time points represent reasonable and maximum timespans over marine plan remain relevant and is consistent with future analyses undertaken for previous marine plans[3]. The analysis considers information on historical trends for the last 10 years, industry projections (where available), and potential future changes in technological advancements, ecosystems, climate, and policy directions, as well as considering information from a geospatial perspective.

The location encompassed by the Plans includes both the east inshore marine plan area and the east offshore marine plan area (see Figure 1). From this point onwards, unless stated otherwise, ‘the Plan areas’ is used to refer to both inshore and offshore marine plan areas.

[3] Marine Management Organisation. 2017. Futures Analysis for the North east, North west, South east and South west marine plan areas. Available at: https://assets.publishing.service.gov.uk/media/5a8242c040f0b62305b93575/Futures_analysis_for_the_North_East__North_West__South_East_and_South_West_marine_plan_areas__MMO_1127_.pdf Accessed October 2024.

Figure 1: Location of the East Marine Plan areas.

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2.1 Aim

The aim of this study is to provide an evidence base to support the development of the next iteration of the Plans by reviewing the current activity in the Plan areas and considering potential future scenarios for each sector.

2.2 Scope of the report

The scope of the report covers the following sectors. Many of these align with the sectors covered by the Marine Policy Statement (MPS), whilst others (marked with *) are sectors in addition to those in the MPS:

Industrial sectors

- Aquaculture
- Carbon capture usage and storage
- Defence
- Desalination *
- Dredging and disposal
- Energy production: Hydrogen energy *
- Energy production: Nuclear
- Fisheries
- Marine aggregates
- Oil and gas
- Ports and shipping
- Power cables *
- Renewables: offshore wind energy (static and floating)
- Renewables: wave and tidal energy
- Surface water management & wastewater treatment and disposal
- Telecommunication cables
- Tourism and recreation

Environmental sectors

- Air quality
- Coastal change and flooding
- Environmental restoration/improvement and its spatial requirements *
- Historic environment
- Marine ecology and biodiversity
- Marine protected areas
- Highly protected marine areas *
- Noise
- Seascape
- Water quality (ecological and chemical)

2.3 Structure of the report

This report is structured as follows:

- Section 1: Introduction to the report;
- Section 2: Methodology;
- Sections 3 to 29: Presentation of the industrial and environmental sectors. Each sector covers:
    - Sector definition;
    - Current activity;
    - Political, Economic, Social, Technological, Legal, and Environmental (PESTLE) analysis;
    - Future scenarios;
- Section 30: Summary.

3 Methodology

3.1 Historic trends and current activity

Historic trends, over the past 10 years, and current activity and status of each sector were assessed based on existing data sources and literature. Where relevant, information on the spatial activity of each sector has been presented in figures within each sector. The intensity and socio-economic value of each sector has also been presented where available and includes economic outputs such as gross value added (GVA), and employment.

3.2 PESTLE analysis

For each sector, assessment of the key political, economic, social, technological, legal, and environmental drivers (termed a PESTLE analysis) has been undertaken. The PESTLE analysis involved gathering and assessing evidence including policies and strategies that inform on national-level direction of travel as well as sector-specific plans. Document sources were supplemented by expert opinion from technical specialists in each sector. It is acknowledged that there is a vast number of drivers for each sector and in order to keep this analysis focused and specific to the Plan areas, only the key drivers have been assessed in each PESTLE analysis.

The resulting implication of each PESTLE driver to the Plan areas has been assessed and identified either '+' (a positive impact on the development of the sector, i.e., resulting in growth in the sector), '-' (a negative impact on the sector i.e., representing a barrier to sector growth), or 'Variable' (the impact could be either positive or negative depending on how external factors impact the driver (i.e., uncertainty of how a policy will be implemented).

3.3 Future scenarios

Information on possible future trends for the next 6, and 6 to 20 years for each industrial and environmental sector has been assessed and presented. These time periods were chosen in order to assess the reasonable (6 years) and maximum (6 to 20 years) timespan a marine plan will remain relevant, and is consistent with future analyses undertaken for previous marine plans. The future scenarios are based on best-available evidence, drawing on the plans and projected activity of each sector individually, and considering potential constraints where appropriate. Information on the possible future locations of activity is discussed, and mapped, where available.

An assessment, based on a critical review of datasets and expert opinion of the level of confidence (low, moderate, high) around each statement of future activity is incorporated. Low confidence is defined as a trend that has the potential to occur, largely based on expert opinion, medium confidence equates to there being evidence that trends will occur though there are uncertainties in the evidence (e.g., supporting policies), and high confidence refers to trends that are very likely to occur based on available evidence, such as dates for which infrastructure will be installed where there is an anticipated timeline with secured funds.

4 Aquaculture

4.1 Sector definition

For the purposes of this report, aquaculture includes the cultivation of shellfish, finfish and seaweed species in the marine environment. Land-based and freshwater aquaculture is excluded.

Shellfish marine aquaculture relates to the cultivation of shellfish species (molluscs and crustaceans) in coastal/marine based aquaculture installations (i.e. on trestles, ropes, wooden bouchot poles or in nets) or cultivated on the seabed (e.g. on-bottom cultivation). Finfish marine aquaculture relates to the cultivation of marine finfish species in marine-based aquaculture installations. Seaweed aquaculture involves farming of seaweed, for example on longline ropes, suspended in the water column[4].

4.2 Historic trends and current activity

Marine aquaculture in the UK is a growing sector, and in 2022, the UK cultivated 194,000 tonnes of fish and shellfish (including freshwater fish), worth £1,300 million[5]. The principal farmed product was Atlantic salmon (predominantly from Scotland).

In England, aquaculture is principally composed of small to medium sized enterprises (SMEs) which cultivate marine shellfish in marine inshore waters and trout in freshwater environments. Marine aquaculture is dominated by the cultivation of bivalve molluscs (predominantly mussels and oysters) with currently around 70 registered bivalve Aquaculture Production Businesses[6].

Overall production of the English marine aquaculture sector has fluctuated over the past ten years, driven mostly by changes in recorded cockle production (from harvest of wild-seeded production from aquaculture sites). In 2013, production was around 7,500 tonnes (including 2,500 tonnes of cockles) valued at £17 million[7]. In 2022, production was 5,200 tonnes (including 1,500 tonnes of cockles), valued at £10 million. The latest available information on employment indicates England's aquaculture sector was employing 1,080 persons in 2020[8] (freshwater and marine aquaculture sectors combined).

Within the Plan areas, The Wash (a large estuary embayment) is the predominant aquaculture production area, with private leases for seed mussel relaying and cultivation in the intertidal zone (Figure 2). Aquaculture activities in The Wash are

[4] Her Majesty Government. UK Marine Policy Statement. 2011. Available at: https://assets.publishing.service.gov.uk/media/5a795700ed915d042206795b/pb3654-marine-policy-statement-110316.pdf Accessed October 2024.
[5] Data provided by Cefas. 2022 reported UK aquaculture production tonnages, estimated £/tonne and imputed total value.
[6] Cefas. Public register of Aquaculture Production Businesses in England and Wales. Available at: https://www.cefas.co.uk/eu-register/molluscs/ Accessed September 2024
[7] Cefas reported UK aquaculture production data (2008-2022). Unpublished.
[8] Huntington, T., & R. Cappell (2020). English Aquaculture Strategy. Final Report. Produced by Poseidon Aquatic Resources Management Ltd for the Seafish Industry Authority. Available at: https://consult-poseidon.com/fishery-reports/English%20Aquaculture%20Strategy%20-%20full%20report%20%20Nov%202020.pdf Accessed October 2024.

managed by Eastern Inshore Fisheries and Conservation Authority (IFCA) under The Wash Several Order (2022), and access to the mussel relaying 'fishery' is determined annually based on stock assessments and management measures. There are also oyster farms located in coastal areas, particularly along the East Anglian coast. It should be noted that due to concerns associated with the invasive non-native species (INNS) status of the Pacific oyster, *Magallana gigas*, this species is not included as a prescribed species of The Wash Several Fishery Order (2022).

In 2010, aquaculture businesses in the Plan areas were responsible for 41% of English shellfish production and 51% of English mussel production[9]. However, over the past decade, poor reproductive success, high mortality, and EU export restrictions on bivalves from Class B waters[10] have led to a decline in mussel stock densities and cultivation[11]. This has resulted in restricted mussel relaying and cultivation in The Wash. In 2023, the highest total mussel stock density since 2002 was recorded, which permitted relaying of seed mussel for cultivation to take place during 2024[12].

The UK seaweed aquaculture sector is a young industry which has developed over the past 10 years. Whilst there are no official records on seaweed production in the UK, it has been estimated that 15,000 tonnes (wet weight) of seaweed was harvested in 2021[13]. Many of the seaweed businesses are still at the research and development stage, rather than being viable commercial cultivation activities. Seaweed products in development include food products (human and non-human), nutraceuticals, pharmaceuticals and biostimulants. Currently, there are around 17 registered seaweed cultivation businesses in the UK[14] (an increase from one in 2016[15]), with nine of them located in England.

Only one of England's registered seaweed cultivation businesses, The Norfolk Seaweed Farm, is in the Plan areas. It is a 25 hectare site positioned 2.8 NM off the north Norfolk coast, focusing on producing sugar kelp. The business was aiming to harvest their first offshore grown seaweed in Spring 2024[16].

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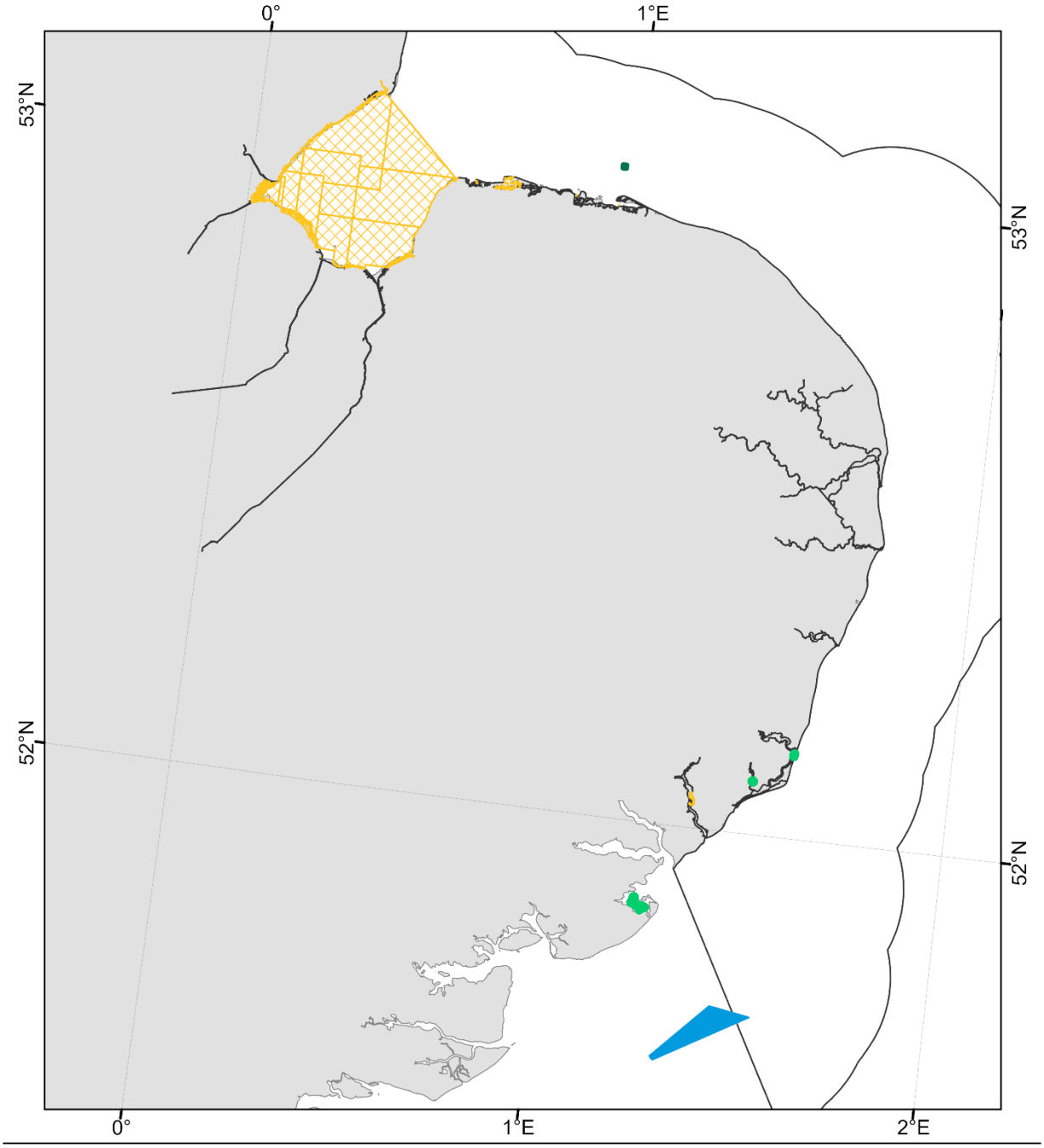
[9] MMO, 2014. Analysis of the East Inshore and East Offshore Marine Plans.
[10] The majority of English bivalve aquaculture takes place in Class B waters. As a result of the UK leaving the EU, limited depuration facilities in the UK, and the detrimental impact on mussel shelf life of undergoing depuration prior to long distance transportation, exports to the EU have declined, and production therefore decreased.
[11] 2023 Wash intertidal mussel stock assessment surveys. Eastern IFCA.
[12] EIFCA, 2024. Wash Mussel Fishery 2024. https://www.eastern-ifca.gov.uk/wash-mussel-fishery-2024/. Accessed October 2024.
[13] The Fish Site. 2023. Initiative aims to take UK seaweed sector to the next level Available at: https://thefishsite.com/articles/initiative-aims-to-take-uk-seaweed-sector-to-the-next-level Accessed October 2024.
[14] Phyconomy, 2024. Phyconomy tries to improve the flow of information in the seaweed industry. Available at: https://phyconomy.net/ Accessed October 2024.
[15] UK Government. 2022. The developing UK seaweed industry. Available at: https://marinescience.blog.gov.uk/2022/05/05/the-developing-uk-seaweed-industry/. Accessed October 2024.
[16] Norfolk Seaweed. 2024. Norfolk Seaweed. Available at: https://www.norfolkseaweed.com/. Accessed October 2024.

Figure 2: Production areas and aquaculture licence areas.



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4.3 PESTLE analysis

The key drivers expected to influence the aquaculture sector in the Plan areas are political and legal drivers as they dictate how and where aquaculture activities can take place in the Plan areas. These are listed in Table 1 below.

Table 1: PESTLE analysis for the aquaculture sector.

Driver	Details	Implications	Impact (+ / - / Variable)
Political	Post EU-exit political landscape[17]	EU-exit hindered shellfish export markets (e.g. prevention of exporting UK shellfish from Class B waters[18]).	-
Economic	Investment support including from the Fisheries and Seafood Scheme (FaSS)[19]	Support (including Government grants) for new and expanding aquaculture businesses, whose costs can be disproportionately high, is key to sectoral growth, and can help drive advancements and improve business efficiency.	+
	Markets for products	Global market fluctuations and producer access to markets will affect sectoral viability. This is particularly critical in creating a viable seaweed aquaculture sector. Continued restrictions on access to EU markets for live bivalves will also affect sectoral viability.	Variable
Social	Consumer perception	Can influence market demand (both positively and negatively). For example, perception of improved (or deteriorated) water quality and environmental impacts of cultivation methods.	Variable
	Availability of work force (both skilled and unskilled in aquaculture processes)[20]	Availability of work force will influence potential for sectoral growth, as well as business efficiency and viability.	Variable
Technological	Innovation and R&D	Technological advances (e.g. in seed production and cultivation methods) are pertinent to the sustainable growth and profitability of the sector.	+

[17] Seafish. 2024. Aquaculture water quality and classification for shellfish Available at: https://www.seafish.org/trade-and-regulation/regulation-in-aquaculture/aquaculture-water-quality-and-classification-for-shellfish/. Accessed October 2024.
[18] Seafish. 2024. Aquaculture water quality and classification for shellfish Available at: https://www.seafish.org/trade-and-regulation/regulation-in-aquaculture/aquaculture-water-quality-and-classification-for-shellfish/. Accessed October 2024.
[19] UK Government. 2024. Fisheries and Seafood Scheme. Available at: https://www.gov.uk/guidance/fisheries-and-seafood-scheme Accessed October 2024.
[20] World Aquaculture Society. 2021. The workforce needed to support future growth of aquaculture. Available at: https://www.was.org/article/The-workforce-needed-to-support-future-growth-of-aquaculture.aspx Accessed October 2024.

Driver	Details	Implications	Impact (+ / - / Variable)
Legal	Marine and Coastal Access Act 2009[21]	The UK MPS[22], associated Marine Plans, and marine licensing will influence when and where aquaculture activities can take place. In addition, determining and navigating local (or site-specific) licensing and permitting requirements may hinder sectoral growth.	-
Environmental	Water quality[23]	Aquaculture businesses are vulnerable to poor water quality. It affects public perception and prevents access to export markets (e.g. currently unable to export UK shellfish from Class B waters to the EU).	-
	Climate change[24]	May influence which species can be cultivated, and the spatial locations in which aquaculture is viable. May also influence spread of diseases and parasites which can affect aquaculture business viability.	Variable
	Environmental regulations such as MPAs are HPMAs[25]	The environmental regulations governing MPAs and HPMAs may influence where aquaculture activities can take place. For example, this prohibition of activities involving contact with the seabed could limit aquaculture activities in these areas.	-

4.4 Future scenarios

6-year projection

Marine aquaculture activities in the Plan areas are likely to remain stable over the next six years, both in terms of spatial location and species cultivated (moderate confidence). There may be **fluctuations in the number of small-scale aquaculture businesses** (in both bivalve and seaweed cultivation), because new enterprises may be trialled along the coast. **The bivalve export market will continue to be diminished until there are changes to export requirements to the EU** (high confidence).

[21] Her Majesty Government. 2009. Marine and Coastal Access Act. Available at: https://www.legislation.gov.uk/ukpga/2009/23/contents Accessed October 2024.
[22] Her Majesty Government. UK Marine Policy Statement. 2011. Available at: https://assets.publishing.service.gov.uk/media/5a795700ed915d042206795b/pb3654-marine-policy-statement-110316.pdf Accessed October 2024.
[23] Seafish. 2024. Aquaculture water quality and classification for shellfish Available at: https://www.seafish.org/trade-and-regulation/regulation-in-aquaculture/aquaculture-water-quality-and-classification-for-shellfish/. Accessed October 2024.
[24] Seafish. 2024. Climate Change Impacts and Adaptation. Available at: https://www.seafish.org/insight-and-research/current-and-future-trends-impacting-the-uk-seafood-industry/climate-change-impacts-and-adaptation/ Accessed October 2024.
[25] IUCN. 2017. Aquaculture and Marine Protected Areas. Available at: https://portals.iucn.org/library/sites/library/files/documents/Rep-2017-003.pdf Accessed October 2024

Pacific oyster cultivation is likely to remain stable due to existing policies reflecting concerns over the cultivation of this non-native species (moderate confidence). **Commercial farming of native oysters is also likely to remain stable**, however, there may be a slight increase in demand for the species if native oyster restoration projects continue (low confidence).

Seaweed aquaculture production is proposed to start from the Norfolk Seaweed Farm in the next six years (moderate confidence), and the business has applied for a licence variation to grow native oysters alongside their seaweed, but additional commercial production sites by other businesses or initiatives are unlikely (low confidence), due to barriers in creating a viable commercial aquaculture business, such as lack of seaweed processing facilities and lack of high-value seaweed products.

In **The Wash, mussel cultivation is likely to be variable over the next six years**, based on the fluctuations of mussel stock densities, which are driven by environmental factors (moderate confidence).

Large-scale offshore bivalve and seaweed aquaculture is unlikely to develop in the region in the next six years (high confidence), resulting from complex licensing and permitting requirements, availability of markets and financial investment. Currently, there are no open marine licence applications for offshore bivalve aquaculture ventures in the Plan areas.

6 to 20 year projection

Within the next 6 to 20 years, aquaculture (both marine bivalves and seaweed) may expand within the Plan area (low certainty). However, this will be **strongly influenced by the political and regulatory landscape** (including regulations on exporting live bivalves to the EU and future conservation management measures, improvements to water quality and waste water management – see Sections 18 and Section 30 on 'Surface water management & wastewater treatment and disposal' and 'Water Quality' respectively for further details), markets for products, consumer perceptions, water quality and climate change; all of which are difficult to predict and control with certainty. **In The Wash, mussel cultivation is likely to continue to be variable and determined on an annual basis, due to fluctuations in stock densities (moderate certainty).**

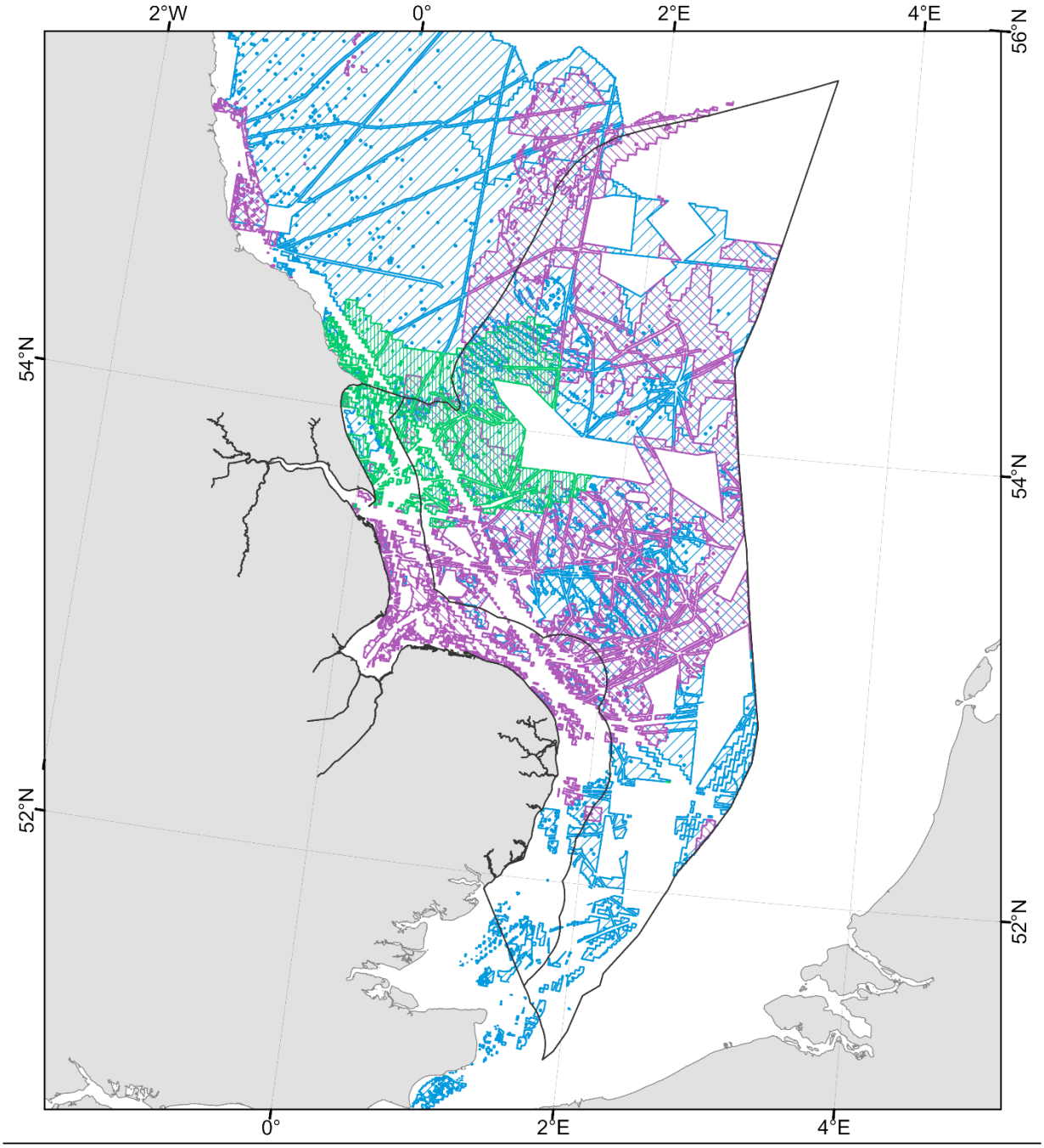
Investment support (including grant funding), technological innovation and R&D, improvements to the regulatory framework, and improvements to water quality are **likely to provide opportunities for sectoral growth within this timescale** (moderate confidence). In general, **availability of suitable habitat for aquaculture is not a constraint to sectoral growth** (high confidence). **Aquaculture installations are likely to be close to the coast** for ease of access, although there may be opportunities to co-locate aquaculture within offshore wind farms which encompass a large proportion of the Plan area (Figure 22) (moderate confidence).

The aquaculture sector may be composed of both small-scale aquaculture businesses (even if there are short term fluctuations in their numbers) **and large-scale enterprises** (e.g. offshore cultivation) (moderate confidence). Many of these aquaculture businesses may be new enterprises trialling alternative cultivation methods, species and/or locations. There is, however, potential for grant-funded seaweed aquaculture businesses to close, if grant funding is exhausted and a viable commercial business is unattainable (moderate confidence).

Figure 3 presents potential aquaculture areas in the Plan areas based upon spatial analysis of the pressures and opportunities of the sector undertaken by the Centre for Environment, Fisheries and Aquaculture (Cefas)[26].

[26] MMO. 2021. Identification of areas of aquaculture potential in English waters (MMO1184). Available at: https://www.gov.uk/Government/publications/identification-of-areas-of-aquaculture-potential-in-english-waters-mmo1184 Accessed October 2024.

Figure 3: Potential future aquaculture areas.



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5 Carbon Capture, Usage and Storage

5.1 Sector definition

Carbon capture, usage and storage (CCUS) aims to store carbon dioxide (CO_2) emissions produced from industrial activities such as energy generation, cement production and chemical production to reduce the amount of CO_2 in the atmosphere. Marine CCUS works in a three-step process: 1) capturing the CO_2 from large point sources (such as industrial facilities and power stations), 2) transporting it (usually via pipelines) to storage points, and 3) injecting the CO_2 deep into the seabed (e.g. deep saline aquifers or depleted oil and gas fields) where it is then permanently stored[27]. Alternatively, following capture, CO_2 can be used for other purposes such as in the fertiliser industry, or food and drinks industry. CCUS technology has the potential to significantly reduce the carbon emissions from energy production and industries that are hard to decarbonise, such as steel, concrete, and cement production[28].

5.2 Historic trends and current activity

Significant investment and political support from the UK Government are supporting the development of CCUS across the UK and the technology is increasingly becoming recognised as having a key role in decarbonising and reducing the amount of CO_2 in the atmosphere. Investment into the CCUS industry in the UK has grown by 29% since 2022[29].

It is estimated that by 2030 the CCUS sector could support 50,000 jobs and by 2050 could boost the UK economy by up to £5 billion per year[30].

The UK Government is deploying CCUS through two track processes, these are Track-1 and Track-2, with each track deploying two clusters. Two of the four clusters have parts of projects (e.g. pipelines, storage sites) overlapping the Plan areas: the East Coast Cluster (Track-1); and Viking (Track-2) as shown in Table 2. The location of the clusters is shown in Figure 4 and further detail on the projects located in the Plan areas is presented in Table 3.

[27] Her Majesty Government. UK Marine Policy Statement. 2011. Available at: https://assets.publishing.service.gov.uk/media/5a795700ed915d042206795b/pb3654-marine-policy-statement-110316.pdf Accessed October 2024.
[28] Department for Energy Security and Net Zero. 2023. Carbon Capture, Usage and Storage, A Vision to Establish a Competitive Market. Available at: https://assets.publishing.service.gov.uk/media/6594718a579941000d35a7bf/carbon-capture-usage-and-storage-vision-to-establish-a-competitive-market.pdf Accessed October 2024.
[29] Carbon Capture Storage Association. 2023. CCUS Delivery Update 2023. Available at: https://www.CCUSassociation.org/wp-content/uploads/2023/09/CCUS-Delivery-Plan-Update-2023-FINAL.pdf. Accessed October 2024.
[30] HM Government. 2023. CCUS Net Zero Investment Roadmap. Available at: https://www.gov.uk/Government/publications/carbon-capture-usage-and-storage-net-zero-investment-roadmap Accessed October 2024.

Table 2: Track-1 and Track-2 CCUS clusters.

	Track-1		Track-2	
Cluster	**HyNet**	**East Coast Cluster**	**Viking**	**Acorn**
Location	North-west England and North Wales	Humber (Teesside, Humber, and North-east England)	Humber (Immingham, offshore from Theddlethorpe)	North-east Scotland
Within Plan areas?	×	✓ [31]	✓	×

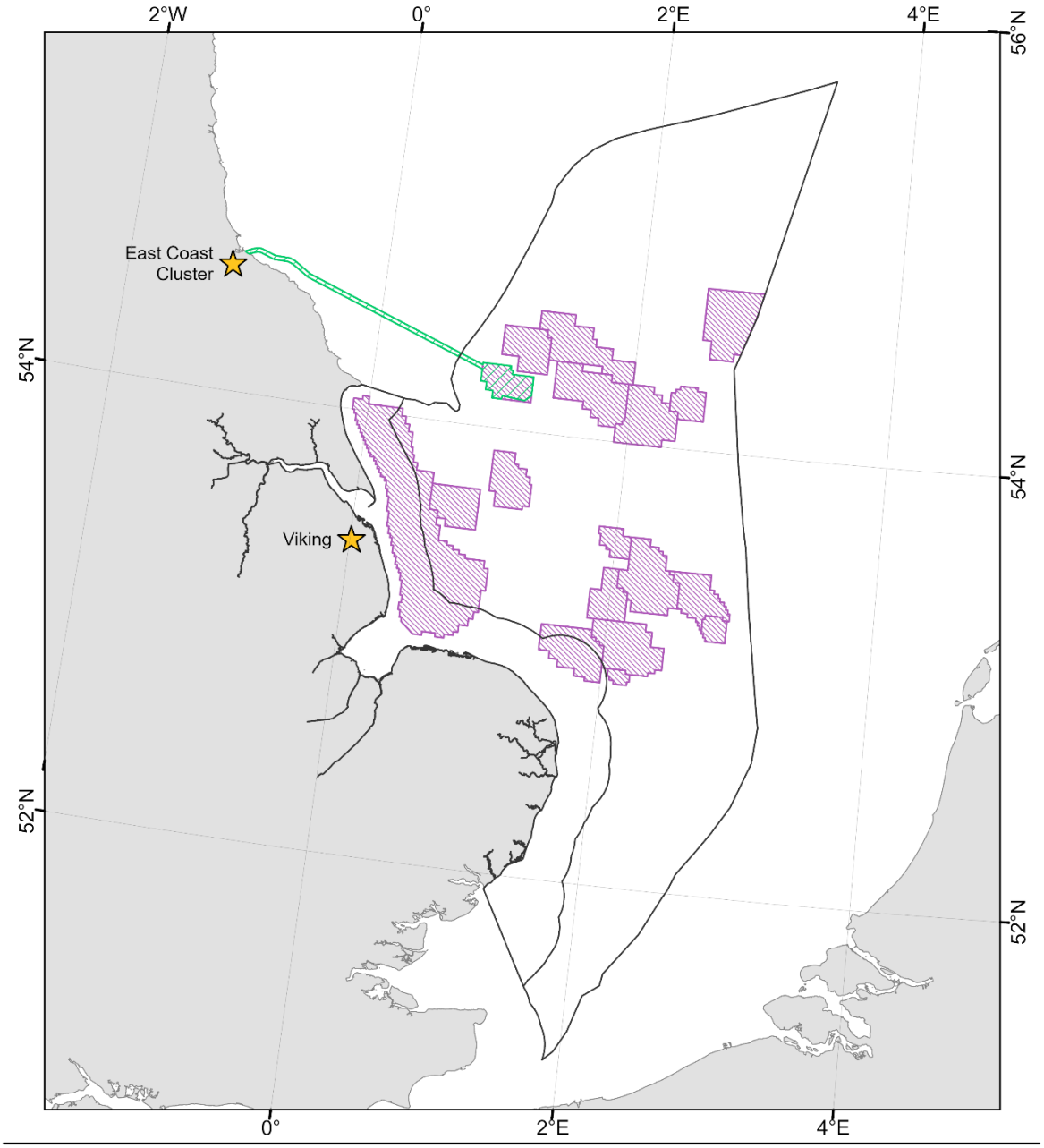
Table 3: CCUS projects in the Plan areas.

	East Coast Cluster[31]			Viking
Project	Net Zero Teesside Power	H_2 Teesside	Teesside Hydrogen CO_2 Capture	Viking CCS
Details	To create a gas-fired power station with CCUS capability. This will involve constructing the power station, harnessing the excess CO_2 and transporting it through pipelines to for storage in the Endurance geological store[32].	To create a hydrogen production facility, which will involve constructing infrastructure to take in natural gas, processes it to produce H_2, transport to offshore permanent storage sites[33].	To add CCUS technology (post-combustion capture) to an existing hydrogen production plant at North Tees. This will store the CO_2 produced from the plant whilst it continues to produce hydrogen[34].	To create a CO_2 capture, transportation, and storage network, involving a pipeline from Immingham to Theddlethorpe (a former gas terminal) where the CO_2 will be permanently stored at an offshore storage site in the North Sea[35].

The East Coast Cluster aims to capture and store an average of around 23 million tonnes of CO_2 per year by 2035[36] whilst the Viking cluster is estimated to store 10 million tonnes of CO_2 by 2030[37]. In regard to each project, Net Zero Teesside Power seeks to store up to 2 million tonnes of CO_2 per year, H_2 Teesside's aims to produce approximately 160,000 tonnes of low carbon hydrogen per year, and Teesside Hydrogen CO_2 Capture has the potential to capture over 200,000 tonnes of CO_2 per year[38].

[31] The East Coast Cluster is located in the North east Marine Plan area, however some assets overlap the Plan areas, including pipelines and storage locations. See Figure 4.
[32] Net Zero Teesside. 2024. Available at: https://www.netzeroteesside.co.uk/project/ Accessed October 2024.
[33] BP. 2024. H2Teesside. Available at: https://www.bp.com/en_gb/united-kingdom/home/where-we-operate/reimagining-teesside/h2teesside.html Accessed October 2024.
[34] DESNZ. 2023. UK CCUS Project Case Studies. Available at: https://az659834.vo.msecnd.net/eventsairwesteuprod/production-ieaghg-public/9bcc3d9dffcc42289cf5a8c2da8e8f2c Accessed October 2024.
[35] Viking CCS. 2024. The Project. Available at: https://pipeline.vikingccs.co.uk/the-project Accessed October 2024.
[36] East Coast Cluster. 2024. Available at: https://eastcoastcluster.co.uk/ Accessed October 2024.
[37] Viking CCS. 2024. The Project. Available at: https://pipeline.vikingccs.co.uk/the-project Accessed October 2024.
[38] BOC. Undated. BOC celebrates historic Teesside centenary with plans for future decarbonisation drive Available at: https://www.boconline.co.uk/en/images/BOC-celebrates-historic-Teesside-centenary_tcm410-674732.pdf Accessed October 2024.

Figure 4: Carbon capture leasing areas, and Track-1 and Track-2 clusters.



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5.3 PESTLE analysis

The key drivers expected to influence the use of the sea for CCUS in the Plan areas are political and legal drivers, particularly the CCUS net zero investment roadmap, and overall net zero commitments which will drive the change to the UK's energy mix. The key drivers are listed in Table 4 below.

Table 4: PESTLE analysis for the CCUS sector.

Driver	Details	Implications	Impact (+ / - / Variable)
Political	The CCUS net zero Investment Roadmap[39], CCUS Deployment Pathway Plan[40] and deployment of CCUS clusters.	Identification of areas most suitable for CCUS deployment. In the Plan areas this includes areas in the Humber and Bacton where oil and gas infrastructure can be re-purposed for CCUS[41]. Growth is therefore likely to continue in these areas.	+
	National and international political events and decisions including wars, the global economy, and pandemics.	The CCUS industry is particularly sensitive to these pressures due to being an expensive and nascent sector. These drivers could affect whether existing policies such as those driving CCUS are met.	Variable
	Carbon Capture Delivery Plan 2035[42] sets out the risks and opportunities of deploying CCUS across the UK. Key approaches that are required to expand CCUS include increased investment, technological advancements, and forming an attractive export industry.	There is uncertainty surrounding achieving the Carbon Capture Delivery Plan given the industry is in its infancy with little established expansion experience. If these approaches in the delivery plan are not delivered CCUS expansion in the Plan areas will slow.	Variable

[39] HM Government. 2023. CCUS Net Zero Investment Roadmap. Available at: https://www.gov.uk/Government/publications/carbon-capture-usage-and-storage-net-zero-investment-roadmap Accessed October 2024.
[40] HM Government. 2018. Clean Growth The UK Carbon Capture Usage and Storage deployment pathway, AN Action Plan. Available at: https://assets.publishing.service.gov.uk/media/655e35b83e1c2e0011693715/uk-ccus-deployment-pathway-action-plan.pdf Accessed October 2024.
[41] National Gas. 2024. Celebrating 55 years of Bacton Gas Terminal: a pillar of GB energy infrastructure. Available at: https://www.nationalgas.com/media/news/celebrating-55-years-bacton-gas-terminal-pillar-gb-energy-infrastructure Accessed October 2024.
[42] The Carbon Capture and Storage Association. 2022. CCUS Delivery Plan 2035. Available at:https://www.ccsassociation.org/all-news/ccsa-news/ccus-delivery-plan-update-2023/ Accessed October 2024.

Driver	Details	Implications	Impact (+ / - / Variable)
	Expansion of CCUS to a commercial scale will require co-ordination and alignment on political priorities to balance the spatial constraints.	Alignment on political strategies is needed to ensure industries can co-exist in a way that does not impact the strategies of other industries, (e.g., considering turbine spacing for offshore wind and the risk of sterilisation of storage sites).	+
Economic	CCUS Infrastructure Fund has invested £1 billion to provide the industry with the certainty required to deploy CCUS at pace[43]. It is essential to gain Government financial support due to the high cost of developing and implementing CCUS.	Increased Government support and investment will grow the CCUS sector by funding research and development and the construction of test infrastructure.	+
Social	Other energy producing sectors, such as oil and gas and nuclear energy, have a reliable and highly skilled workforce with transferable skills which can be used in the CCUS industry.	There is significant opportunity for the highly skilled workforce in declining energy producing sectors to transition to jobs within emerging renewable energy sectors including CCUS, which will help grow the sector.	+
	Social acceptance of CCUS, particularly as it is a nascent sector with environmental benefits, is currently not well understood.	Public consultation is often undertaken during the development of significant infrastructure projects (which will include large CCUS projects) and opposition to the sector could be a barrier to development.	-
Technological	Developing efficient CCUS methods on a commercial scale. Of key focus is developing technology to enable the co-location of CCUS at offshore wind sites and to more easily undertake CCUS monitoring surveys[44].	Co-ordination of technological advancements will enable the sector to expand to a commercial scale. Improved technology once established will also lower costs and reduce financial and technological barriers to implementing CCUS.	+

[43] UK Government. October 2021 update: Track-1 clusters confirmed. Available at: https://www.gov.uk/Government/publications/cluster-sequencing-for-carbon-capture-usage-and-storage-CCUS-deployment-phase-1-expressions-of-interest/october-2021-update-track-1-clusters-confirmed. Accessed October 2024..

[44] The Crown Estate. 2024. Offshore Wind and CCUS Co-Location Forum. Available at: https://www.thecrownestate.co.uk/our-business/marine/osw-and-ccus-co-location-forum Accessed October 2024.

Driver	Details	Implications	Impact (+ / - / Variable)
Legal	The legally binding target of reaching net zero by 2050, as set out in the 2019 amendment of the Climate Change Act 2008, will be challenging for some sectors, such as oil and gas, to achieve. This is due to the need to use small amounts of gas to provide flexible baseload power. CCUS could therefore be used to mitigate against residual emissions from this and help achieve net zero targets[45].	Increased support and recognition for CCUS as key for meeting net zero targets, particularly to act as a carbon sink for hard to decarbonise sectors, especially as there is significant oil and gas infrastructure, in the Plan areas.	+
	The Energy Act 2023 establishes a framework of economic regulation for the transport and storage of CO_2 in the UK[46].	The Act governs how CCUS in the UK will be managed, regulated and achieved.	Variable
Environmental	Mitigating the effects of global climate change.	The drive to mitigate Greenhouse gas (GHG) emissions and the impacts of climate change will likely lead to increased investment and Governmental support in CCUS to help decarbonise existing sectors.	+
	Environmental concerns and opportunities exist. They include concern surrounding the uncertainty of potential localised seawater acidification from CO_2 leakage, and CO_2 and noise generation from CCUS monitoring surveys (which use sonar). Opportunities that could reduce environmental impacts include re-using existing industrial infrastructure.	Environmental concerns and opportunities will be considered at the early stages of site development and will impact the viability of CCUS projects.	Variable

5.4 Future scenarios

6 year projection

By 2030, as stated in the CCUS net zero Investment Roadmap, **there will be expansion of the Track-1 clusters** which will include greater development of HyNet and **development of the Bunter Closure stores for the East Coast Cluster** (high confidence). Operation of Track-1 projects is targeted for 2028-29. Deployment of

[45] Climate Change Committee. 2020. Six Carbon Budget. Available at: https://www.theccc.org.uk/publication/sixth-carbon-budget/ Accessed October 2024.
[46] UK Government. 2023. Energy Act 2023. Available at: Energy Act 2023 - Parliamentary Bills - UK Parliament Accessed October 2024.

the Track-2 clusters, including the **Viking Cluster, is also expected to occur within the next 6 years (by 2030) (high confidence)[47,48].** There is uncertainty on the timescale to achieve expansion of Track-1 and the deployment of Track-2 clusters, as stated by the Climate Change Committee (CCC) in their Progress Report to Parliament 2023[49]. As the timeline of deployment of the clusters has slipped, delivery of Track-2 would have to occur at a significantly accelerated pace compared to the initial development of Track-1[50] to meet targets.

Expansion of CCUS in the Plan areas will be in the North Sea Transition Authority (NSTA) licence areas, which encompass the majority of the inshore waters across the Lincolnshire coastline, and the central region of the offshore waters in the Plan areas as shown in Figure 4 (high confidence that activity will occur in some of these areas). **Efforts to develop the licences into operational sites will likely continue over the next 6 years**, however the timeframe over which the licence areas will be developed is not known. As such there is low confidence on the nature of activities that will occur across the next 6 years, and how many licence areas will progress to project implementation.

The **development of the Bacton Energy Hub will play a key role for developing CCUS** capability in the Plan areas (high confidence)[51] (see also Section 9, Hydrogen Energy), it is however uncertain if this will be fully operational within the next 6 years (low confidence). **By 2030 it is expected that the Bacton Energy Hub has the potential to abate 1.6 million tonnes per year (MTpa) of CO_2** and deliver 3 Terra watt hours (TWh) of **CCUS-enabled hydrogen**. A roadmap detailing how this will be achieved has not been published and as such it is not possible to determine the nature of the activities that will occur at this location during this timeframe (low confidence). It is however **highly likely to include re-purposing existing pipelines for CO_2 transport**. In addition to re-purposing infrastructure, the **development of CCUS will create many jobs in the Plan areas** as jobs in the energy production sectors are located close to the plants.

[47] HM Government. 2023. CCS Net Zero Investment Roadmap. Available at: https://www.gov.uk/Government/publications/carbon-capture-usage-and-storage-net-zero-investment-roadmap Accessed October 2024.
[48] The Carbon Capture and Storage Association. 2022. CCUS Delivery Plan 2035. Available at: https://www.ccsassociation.org/wp-content/uploads/2022/03/CCSA-CCS-Delivery-Plan-2035-MASTER-Final.pdf. Accessed October 2024.
[49] Climate Change Committee. 2023. Progress in reducing emissions, 2023 Report to Parliament. Available at: https://www.theccc.org.uk/wp-content/uploads/2023/06/Progress-in-reducing-UK-emissions-2023-Report-to-Parliament-1.pdf Accessed October 2024.
[50] The Carbon Capture and Storage Association. 2022. CCUS Delivery Plan 2035. Available at: https://www.ccsassociation.org/wp-content/uploads/2022/03/CCSA-CCS-Delivery-Plan-2035-MASTER-Final.pdf. Accessed October 2024.
[51] North Sea Transition Authority. 2022. Bacton could provide decades of clean energy for up to 20 million homes and businesses. Available at: https://www.nstauthority.co.uk/news-publications/bacton-could-provide-decades-of-clean-energy-for-up-to-20-million-homes-and-businesses/ Accessed October 2024.

6 to 20 year projection

The **Bacton Energy Hub will continue to develop across the next 6-20 years** and has the potential to abate 17 MTpa by 2050 (low confidence)[52].

It is reasonable to assume that some of the 21 North Sea Transition Authority (NSTA) licensed storage areas will become operational across the next 20 years (moderate confidence), and it is expected that, combined, the licences could store over 50 million tonnes of CO_2 by 2035[53]. The exact quantity of CO_2 that could be stored within the Plan areas is not available as the licence areas have not become operational. However, **crudely, as 18 of the 21 licences are located in the Plan areas (Figure 4)** it is likely that the majority of the 50 million tonnes could be captured in the **Plan areas** (low confidence). There is also a chance of further licensing rounds (low confidence).

In regard to potential future socio-economic impacts, the **Viking project has the potential to create over 10,000 jobs during its construction and generate an estimated £4 billion of gross value added (GVA) to the Humber** and its surrounding areas[54]. Increased job opportunities and GVA can also occur from the other CCUS projects in the Plan areas, including projects in Teeside that overlap with the Plan areas, for example Net Zero Teesside Power anticipates creating more than 1,000 jobs annually during operations until 2050[55].

[52] North Sea Transition Authority. 2022. Bacton could provide decades of clean energy for up to 20 million homes and businesses. Available at: https://www.nstauthority.co.uk/news-publications/bacton-could-provide-decades-of-clean-energy-for-up-to-20-million-homes-and-businesses/ Accessed October 2024.
[53] Skopljak., N. 2023. 21 carbon storage licenses awarded in UK's landmark licensing round. Available at: https://www.offshore-energy.biz/21-carbon-storage-licenses-awarded-in-uks-landmark-licensing-round/ Accessed October 2024.
[54] Viking. 2024. Nicking CCS Project. Available at: https://www.vikingccs.co.uk/news/harbour-energy-and-bp-agree-to-develop-the-viking-ccs-project Accessed October 2024.
[55] Net Zero Teesside. 2024. Net Zero Teesside Power. Available at: https://www.netzeroteesside.co.uk/project/ Accessed October 2024.

6 Defence and National Security

6.1 Sector definition

This sector consists of activity undertaken to protect and provide security to people and assets across the UK[56]. The use of the marine environment for defence is predominantly as space to practise training, firing exercises and for submarine bases. These are undertaken by the Ministry of Defence (MOD), the Army, the Royal Navy, and the Royal Air Force (RAF).

Given the confidential nature of military defence, limited data are available to assess the use of the UK marine environment in detail, and how it changes over time. The static maps shown here have been produced using publicly available data.

6.2 Historic trends and current activity

Military activity occurs in the Plan areas, including practice of air-to-air combat manoeuvres, bombing and submarine exercises. The following MOD operation areas are within the Plan areas:

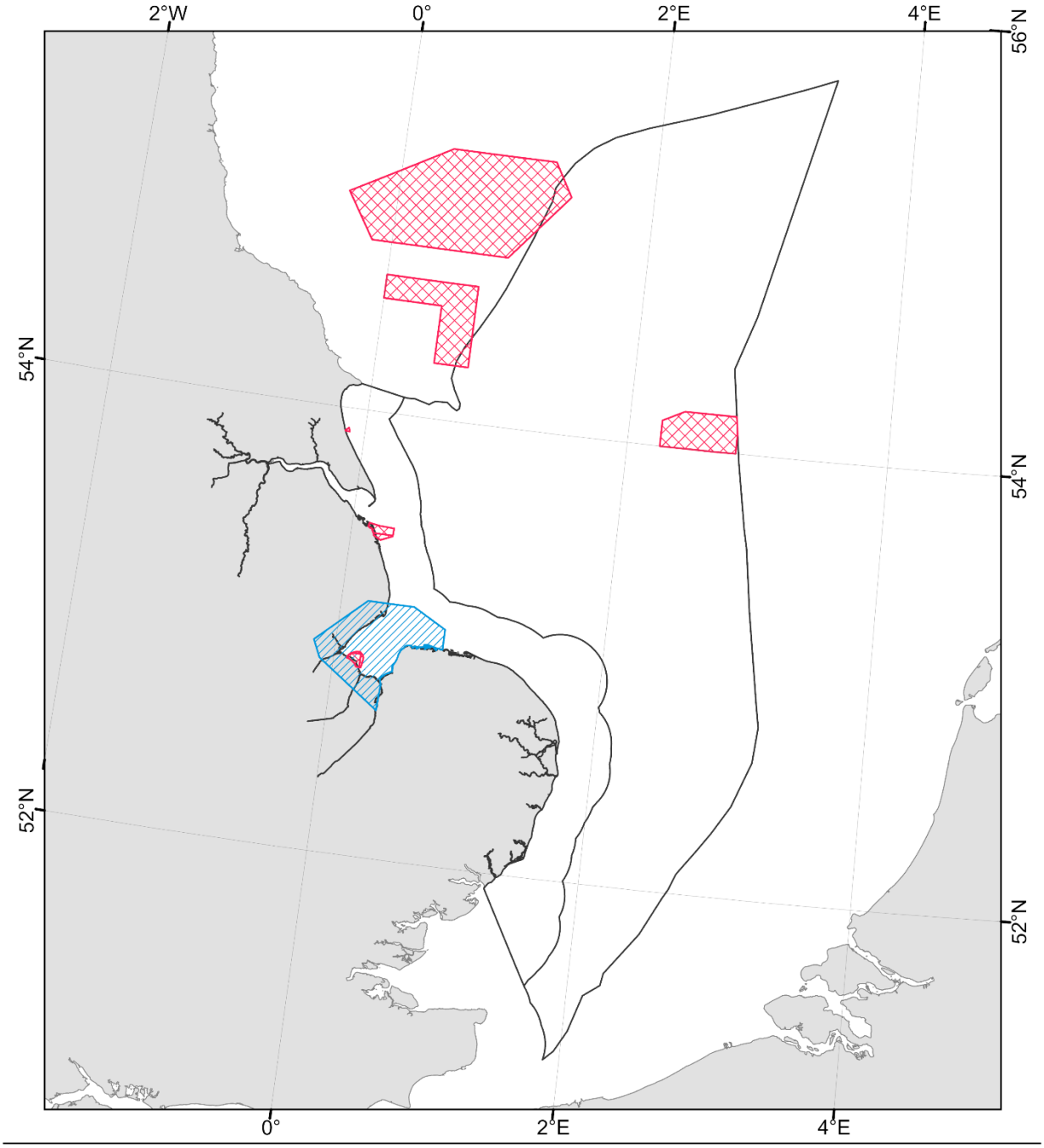
- RAF Donna Nook, south of the Humber;
- RAF Holbeach, an air weapons range on the Wash coastline, Lincolnshire;
- RAF Woodbridge, north of Felixstowe, Suffolk;
- A Remote Radar Head at RRH Neatishead, Norfolk.

It is not possible to quantify the socio-economic value of the defence sector in the Plan areas due to statistics such as employment and spending being classified for national security reasons. It is likely however that the socio-economic value is high due to the number of military activities taking place and personnel associated with it[57]. On a UK-wide scale the coarsest data available from the most recent annual report (2022 data)[58] presents the socio-economic value of the defence sector as consisting of 83,889 full time equivalent (FTE) employees, 5,418 (7.7%) of which are in East Anglia. In regard to economic value the UK defence sector is estimated to be worth £9.2 billion in GVA.

Military activity in the Plan areas is shown in Figure 5 below and includes military practice areas in The Wash, Donna Nook, and offshore at the centre of the western boundary of the Plan areas. In addition, there are military low flying zones which support training below 2000 feet along much of the coastline. There are no naval bases in the Plan areas, though the waters, as described in Section 22.4**,** contain a significant amount of military remains and munition dumping sites.

[56] Her Majesty Government. UK Marine Policy Statement. 2011. Available at: https://assets.publishing.service.gov.uk/media/5a795700ed915d042206795b/pb3654-marine-policy-statement-110316.pdf Accessed October 2024.
[57] MMO (2024). Social and Economic Baseline for the east marine plan areas (unpublished).
[58] Joint Economic Data Hub. 2024. 2024 Annual Economic Report. Available at: https://jedhub.org/docs/2024/20242904_JEDHub_Annual_Economic_Report_2024_v1.0.pdf Accessed October 2024.

Figure 5: Military practice areas.



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6.3 PESTLE analysis

The key drivers expected to influence the use of the sea for military activity in the Plan areas are political drivers, both from the political scene of the UK and other countries. These are listed in Table 5 below.

Table 5: PESTLE analysis for the defence and national security sector.

Driver	Details	Implications	Impact (+ / - / Variable)
Political	To reflect the rapidly changing distribution of power across the globe the Integrated Review Refresh 2023 has been published which sets out the most recent military priorities in the UK[59].	This review has identified the need for further investment and a greater proportion of national resource will be needed to deliver the UK's military objectives. This could lead to possible changes in the activity level or location of military activity in the Plan areas.	+
	One of the highest priorities for the UK military is to address the threat caused by Russia's invasion of Ukraine. This includes preventing Russia's ability to disrupt UK national security and continuing to provide financial and humanitarian aid to Ukraine.	Increased uncertainty of, and the possibility for, rapidly changing military activities in the Plan areas.	Variable
	Defence activities could impact the activity of many other industries which exist in the same location, for example defence activities on the seabed could impact the power cables sector (Section 15) or dredging (Section 8).	Use of the marine environment for defence related activities could involve competition between other industries. This could cause defence, or other sectors in the Plan areas to be displaced.	Variable
Economic	The newly elected Labour Government is set to conduct a Strategic Defence Review within its first year in office and set out the path to spending 2.5% of gross domestic product (GDP) on defence[60].	Increased investment into defence may lead to an increase in military activities and facilities in the Plan areas.	Variable
Social	The need for national security drives the defence sector. As a result, the defence sector provides significant job opportunities.	The need for national security in order to safeguard communities creates employment opportunities within the Plan areas, and the ability to protect the local community.	+

[59] UK Government. 2023. Integrated Review Refresh 2023: Responding to a more contested and volatile world. Available at: https://www.gov.uk/Government/publications/integrated-review-refresh-2023-responding-to-a-more-contested-and-volatile-world Accessed October 2024.
[60] Labour. 2024. Strong foundations. Available at: https://labour.org.uk/change/strong-foundations/ Accessed October 2024.

Driver	Details	Implications	Impact (+ / - / Variable)
Technological	Technological advancements through the use of more online and automated operations including use of drones, artificial intelligence, and online simulations[61].	The technological advancements and increased use of remote operations could result in fewer physical military training areas in the Plan areas. Submarine training exercises and air combat drills will however still be required for the foreseeable future.	-
	Technological advancements will continue to be made across all industries in the future, this could include advances in re-purposing existing defence infrastructure and changing capabilities of other sectors which use the marine environment.	These changes, brought about by technological advancements could help to decommission defence assets that are no longer needed due to increased use of online surveillance tools. This could enable certain activities to co-exist in the same location as military activities, which traditionally would not have been possible in the Plan areas.	+
Legal	The UK is a member of the North Atlantic Treaty Organisation (NATO) and must therefore comply with NATO policies in order to safeguard the security of all NATO members. This includes consulting and cooperating with members to decide defence-related strategies and carry out military crisis management if required[62].	The UK's membership of NATO dictates aspects of the UK's defence strategy including the operations and interaction between other countries within and outside of NATO. This could require a change in use of the marine environment in the Plan areas if a collective decision by NATO members is required.	Variable
Environmental	Climate change has the potential to increase the environmental impacts of the defence sector on the Plan areas, including by more extreme weather events, coastal erosion, and rising sea levels increasing the risk of damage to military infrastructure which will likely degrade the marine environment[63].	Damage to military infrastructure due to the impacts of climate change has the potential to increase the exposure risk of military assets which could cause physical damage (through for example exposure of unexploded ordinance) to marine species and habitats in the Plan areas.	-

[61] House of Commons. 2023. Emerging and disruptive defence technologies. Available at: https://commonslibrary.parliament.uk/research-briefings/cbp-9184/ Accessed October 2024.
[62] North Atlantic Treaty Organisation. 2024. Available at: https://www.nato.int/nato-welcome/index.html Accessed October 2024.
[63] European Defence Cooperation. 2023. Climate change and EU defence: released new report analysing the links between climate, energy and defence. Available at: https://eda.europa.eu/news-and-events/press-office/latest-press-releases/2023/06/08/climate-change-and-eu-defence-released-new-report-analysing-the-links-between-climate-energy-and-defence Accessed October 2024.

6.4 Future scenarios

6 year projection

Many aspects of the future activity of the defence sector are unknown given their highly confidential nature in order to effectively protect national security. The **military practice areas and RAF bases illustrated in Figure 5 are likely to remain** across the next 6 years and practice exercises will be undertaken in order to uphold military capability (high confidence). It is likely that additional **or changes to existing radar stations may be needed in the Plan areas in response to the increasing installation of offshore windfarms** which could be a barrier to radar activity (low confidence). It is not possible to determine where these additional or changes to radar location could be. In addition to the physical location of military activities it is **likely that there will be military activities including responding to cyber threats to offshore infrastructure** (e.g., undersea cables) and **increased surveillance** across the **Plan areas as a strategically important area** (moderate confidence).

It is not possible to predict the activities that will occur within the sector across the next 6 years although **it is reasonable to assume that should there be a threat to national security that requires the deployment of the Royal Air Force or Royal Navy, this will include use of the defence assets and personnel that exist within the Plan areas.** There could be a need for increased military activity in the Plan areas across the next 6 years given the ongoing conflict between Russia and Ukraine, it is however not known what the additional activity would consist of (low confidence).

6 to 20 year projection

Much of the future activity of the defence sector across the next 6 to 20 years is unknown due to the need for information to remain confidential in order to protect national security. Many of the trends described above will continue across the next 6-20 years including the **high likelihood for the location of RAF bases and practice areas to remain in their current location** (high confidence), and the potential for **increased military activity should conflict between Russia and Ukraine remain** beyond 6 years (low confidence). As above, the nature and location of the military activity required in this case will remain unknown.

7 Desalination

7.1 Sector definition

Desalination is the process of removing salts from seawater to produce water with a highly reduced salinity. This is mainly achieved by using reverse osmosis which is the process of passing water through a semi-permeable membrane to separate water and salts.

There are many applications for desalination including using desalination to produce drinking water, for use in major construction projects, as well as within the agriculture sector.

7.2 Historic trends and current activity

There is currently one operational desalination plant in the UK, this is Beckton Desalination Plant, a plant in east London that became operational in 2010. Beckton can produce 150 million litres of water per day, however it is currently offline due to maintenance issues[64]. In addition, small desalination plants exist on the Isles of Scilly[65], and in Jersey[66], although data are not available to determine if these sites are operational.

The potential for a second plant in the UK (in Par, Cornwall) is expected to be capable of producing between 2.5 and 5 million litres a day and is in the early stages of discussion[67]. The screening opinion for the project was submitted in April 2024. Once operational, there would be the potential for this site to be replaced with a larger site with a potential capacity of producing up to 20 million litres of drinking water per day.

There are currently no desalination plants for the purpose of producing drinking water in the Plan areas however Anglian Water have assessed desalination to be a viable option to provide additional water supply in the Plan areas[68]. Three types of potential desalination approaches were assessed, these are:

[64] Water Technology, Thames Water Desalination Plant, London. 2024. Available at: https://www.water-technology.net/projects/water-desalination/ Accessed October 2024.
[65] Hitachi. Energy Infrastructure Plan for the Isles of Scilly. 2016. Available at: https://www.scilly.gov.uk/sites/default/files/IoS_Infrastructure%20Plan_FINAL_IoS.pdf Accessed October 2024.
[66] Jersey Water. 2016. Desalination Plant. Available at: https://jerseywater.je/files/public-docs/jersey_water/factsheets/JW_Fact_Sheet_Desalination.pdf?x23940 Accessed October 2024.
[67] South West Water. Desalination, Find out more about our new South Cornwall desalination project. Available at: https://www.southwestwater.co.uk/about-us/what-we-do/improving-your-service/projects-and-investment/desalination Accessed October 2024.
[68] Anglian Water. 2024. Draft WRPM24 Technical Document. Supply-side option development. Available at: https://www.anglianwater.co.uk/siteassets/household/about-us/wrmp/draft-wrmp24-supply-side-option-development.pdf Accessed October 2024.

1) coastal plants that have a shoreside facility and intake and outfall to the sea;
2) estuarine plants which are plants located in the estuary and intake and outfall to the estuary; and
3) floating desalination plants which are plants located on barges moored offshore with freshwater being piped to land.

In regard to desalination for industrial uses there is a proposed desalination plant included in the Development Consent Order (DCO) for Sizewell C (see Section 10). This will be a temporary plant constructed to ensure Sizewell C has sufficient water supply until a permanent water main is constructed (which is expected to be by 2030)[69]. Nuclear energy can also be used to power the desalination processes[70].

In addition to the nuclear sector, desalination is used widely across the Plan areas to support the agricultural sector to increase the availability of fresh water for essential processes such as irrigation. This is particularly relevant as the east of England is one of the driest regions across the UK[71] and has a large agriculture sector.

7.3 PESTLE analysis

The key drivers expected to influence the development of desalination in the Plan areas are environmental drivers, as they affect regional water availability and consequently the need for desalination to meet water demand. These are listed in Table 6 below.

[69] Sizewell C. 2023. Sizewell C to power desalination plant with clean electricity. Available at: https://www.sizewellc.com/news-views/powering-szc-desalination-plant-with-clean-electricity/ Accessed October 2024.
[70] World Nuclear Association. 2024. Desalination. Available at: https://world-nuclear.org/information-library/non-power-nuclear-applications/industry/nuclear-desalination Accessed October 2024..
[71] Centre for Ecology & Hydrology. UK Water Resources Portal. 2024. https://eip.ceh.ac.uk/hydrology/water-resources Accessed October 2024.

Table 6: PESTLE analysis for the desalination sector.

Driver	Details	Implications	Impact (+ / - / Variable)
Political	The National Policy Statement for Water Resources Infrastructure[72] sets out the Government policies associated with the development of nationally significant infrastructure projects for water resources. This includes setting out the legal requirements that must be met when developing desalination plants.	This policy includes guidance and is therefore an enabler to developing desalination infrastructure in the Plan areas.	+
Economic	Desalination is an expensive technology compared to traditional water treatment processes of filtration and chemical dosing. The sector is in its infancy and will therefore require a significant amount of investment into research and development. For example, Thames Water's Beckton plant cost £250 million[73].	The high cost of developing desalination technology to a point where it is economically viable to be widely accessible is a barrier to the expansion of the sector.	-
	The Plan areas host a significant agriculture sector and without a reliable freshwater supply it will lead to significant economic loss from the sector (as well as food insecurity). The agriculture sector is therefore a key driver for desalination.	Desalination to support the agriculture sector is a key opportunity to explore in the Plan areas.	+
	Other industries that drive and benefit from desalination include the nuclear industry, as nuclear energy can be used to power desalination[74], and increasingly the hydrogen sector as desalinated water can be used to produce hydrogen[75].	Proposed economic growth in the nuclear and hydrogen sectors may drive both desalination demand and capability.	+
Social	Population increase.	Increasing population will affect whether desalination plants are necessary to meet demand for water.	+

[72] Department for Environment Food & Rural Affairs. 2023. National Policy Statement for Water Resources Infrastructure. Available at: https://assets.publishing.service.gov.uk/media/6437e3a2f4d420000cd4a1a7/E02879931_National_Policy_Statement_for_Water_Resources.pdf Accessed October 2024.
[73] Water Technology. 2024. Thames Water Desalination Plant, London. Available at: https://www.water-technology.net/projects/water-desalination/ Accessed October 2024.
[74] World Nuclear Association. 2024. Desalination. Available at: https://world-nuclear.org/information-library/non-power-nuclear-applications/industry/nuclear-desalination Accessed October 2024.
[75] Roland Berger. 2023. Green hydrogen as new growth pocket for desalination. Available at: https://www.rolandberger.com/en/Insights/Publications/Green-hydrogen-as-new-growth-pocket-for-desalination-Once-it-takes-off-at.html Accessed October 2024.

Driver	Details	Implications	Impact (+ / - / Variable)
	Social opposition due to concern over the potential environmental impact of desalination plants.	Decreased support and increased stakeholder push-back on future plants.	-
Technological	Increased capability and sophistication of desalination technology is needed.	Technology advancements could lead to the sector becoming more economically viable and efficient.	+
Legal	Water Resources Management Plans (WRMPs) set out the strategy water companies will take to manage water resources and demand in their catchment[76]. It is a legal requirement for a water company to prepare and maintain a WRMP every 5 years. This is set out in sections 37A to 37D of the Water Industry Act 1991[77]. The regional WRMP in the east of England (Water Resources East) sets out that the areas (encompassing the Plan areas) are particularly water scare and will likely require desalination to help meet water demand[78].	As detailed in Section 7.4 desalination in the Plan areas is likely to increase, as set out in Anglian Waters' WRMP[79].	+
Environmental	Climate change causing increased drought conditions and therefore reduced water availability. The impact of this is particularly significant as the Plan areas include some of the driest areas of the UK[80].	Given the exacerbated impacts of climate change and water scarcity in the Plan areas[81] this could lead to increased urgency and pressure to explore desalination options.	+

[76] Environment Agency. 2024. A summary of England's revised draft regional and water resources management plans. Available at: https://www.gov.uk/Government/publications/a-review-of-englands-draft-regional-and-water-resources-management-plans/a-summary-of-englands-draft-regional-and-water-resources-management-plans Accessed October 2024.
[77] UK Government. 2024. Water Industry Act 1991. Available at: https://www.legislation.gov.uk/ukpga/1991/56/contents Accessed October 2024.
[78] Water Resources East. 2023. Available at: https://wre.org.uk/launch-of-new-water-resources-plan-for-eastern-england-aims-to-alleviate-pressures-on-the-environment-and-constraints-on-growth/ Accessed October 2024.
[79] UK Government. 2024. Appendix C: Revised draft water resources management plans supply options. Available at: https://www.gov.uk/Government/publications/a-review-of-englands-draft-regional-and-water-resources-management-plans/appendix-c-draft-water-resources-management-plans-supply-options Accessed October 2024.
[80] Centre for Ecology & Hydrology. UK Water Resources Portal. 2024. https://eip.ceh.ac.uk/hydrology/water-resources Accessed October 2024.
[81] Climate UK. 2021. A Summary of Climate Change Risks for the East of England. Available at: https://www.greensuffolk.org/app/uploads/2021/05/Summary-of-climate-change-risks-to-East-of-England.pdf Accessed October 2024.

7.4 Future scenarios

6 year projection

Across the six years **both water demand and water scarcity will increase** and as such the **need for desalination will increase** (high confidence). As set out in the Revised Draft Water Resources Management Plan's supply options[82] **Anglian Water have proposed to build two desalination plants in the Plan areas**, these are at **Mablethorpe and Bacton**[83], illustrated in Figure 6. Also illustrated in Figure 6 is the location of the **desalination plant that will be constructed at Sizewell C, which is expected to be operational by the early 2030s**[84]**.**

If the plans are progressed it is unlikely that construction of physical assets will occur within the next 6 years and instead **desalination-related activity within the Plan areas will likely include administrative tasks such as undertaking environmental assessments and consultations to obtain consent.**

6 to 20 year projection

If the plans for the two plants at Mablethorpe and Bacton are realised, 88 million litres of water could be produced in the Plan areas by desalination by 2040, as illustrated in Table 7 below.

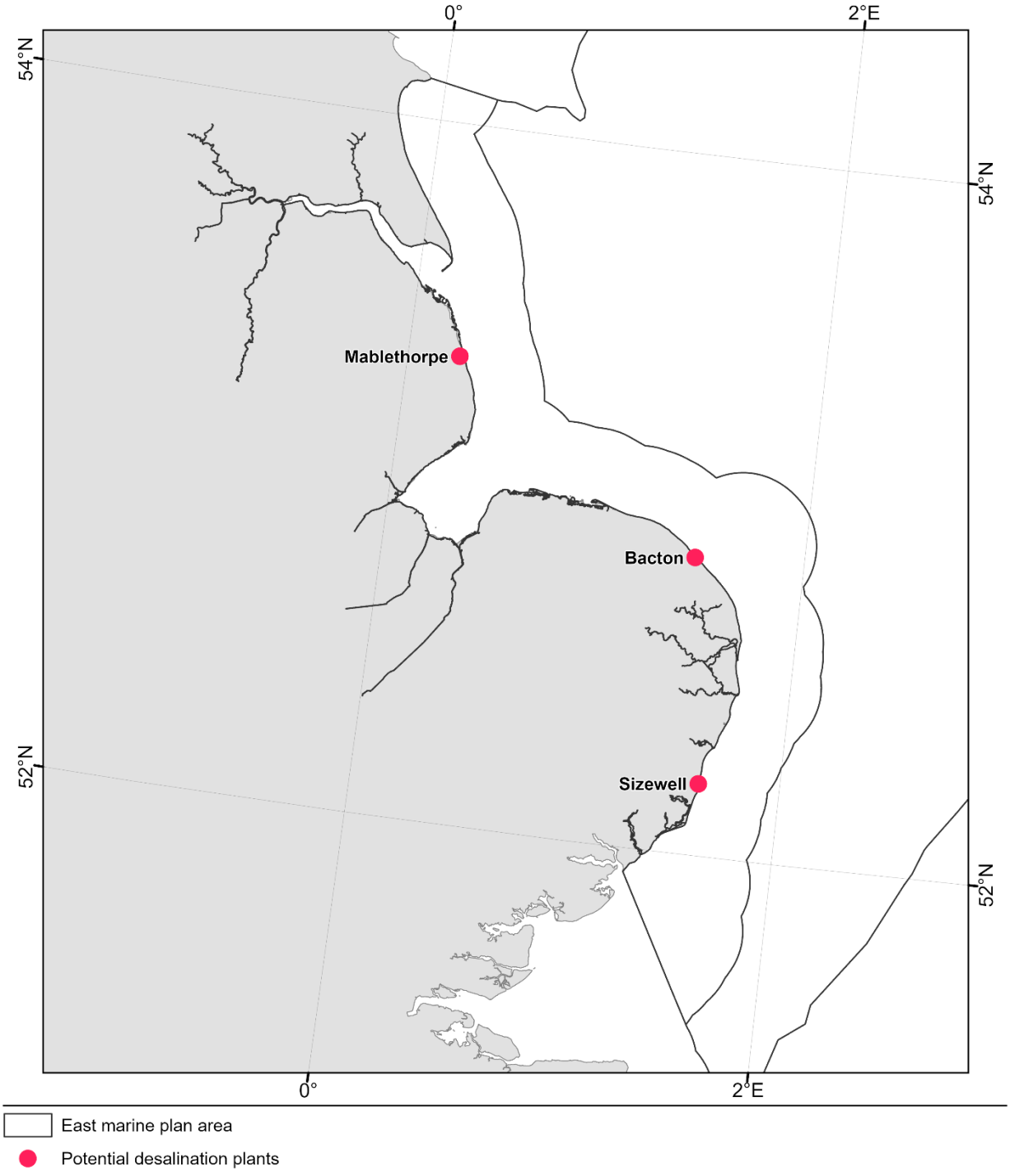
Table 7: Potential desalination plants and their capacity.

Plant	Daily supply (Ml/d)	Start year
Mablethorpe	63	2040
Bacton	25	2040

The certainty of achieving this depends on the ability to obtain public backing, consent, and sufficient funding, all of which are yet to be evidenced. If this capacity is realised it is likely that desalination assets will be installed at both sites within the next 20 years (moderate confidence), the exact location of the assets is however not available and commercially sensitive.

[82] Environment Agency. 2024. A summary of England's revised draft regional and water resources management plans. Available at: https://www.gov.uk/Government/publications/a-review-of-englands-draft-regional-and-water-resources-management-plans/appendix-c-draft-water-resources-management-plans-supply-options#desalination Accessed October 2024.
[83] UK Government. 2024. Appendix C: Revised draft water resources management plans supply options. Available at: https://www.gov.uk/Government/publications/a-review-of-englands-draft-regional-and-water-resources-management-plans/appendix-c-draft-water-resources-management-plans-supply-options Accessed October 2024.
[84] Sizewell C. 2023. Sizewell C to power desalination plant with clean electricity. Available at: https://www.sizewellc.com/news-views/powering-szc-desalination-plant-with-clean-electricity/ Accessed October 2024.

Figure 6: Potential desalination plants.



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8 Dredging And Disposal

8.1 Sector definition

Dredging is the excavation of materials from a water environment, involving the use of a device to move material (whether or not suspended in water) from one part of the sea or seabed to another part, and/or the total removal of materials from the seabed[85]. There are two main types of dredging: capital dredging and maintenance dredging. Capital dredging enables new activities to proceed by creating new or improved existing navigational channels and berths, often making them deeper and wider. Maintenance dredging is required to maintain water depths in areas where sedimentation occurs and is a routine activity required for the preservation of navigable depths. Other types of dredging activity include clearance dredging, which is the removal of accumulated material around a structure or asset for a purpose other than to facilitate navigation. Dredging of marine aggregates is covered in Section 12.

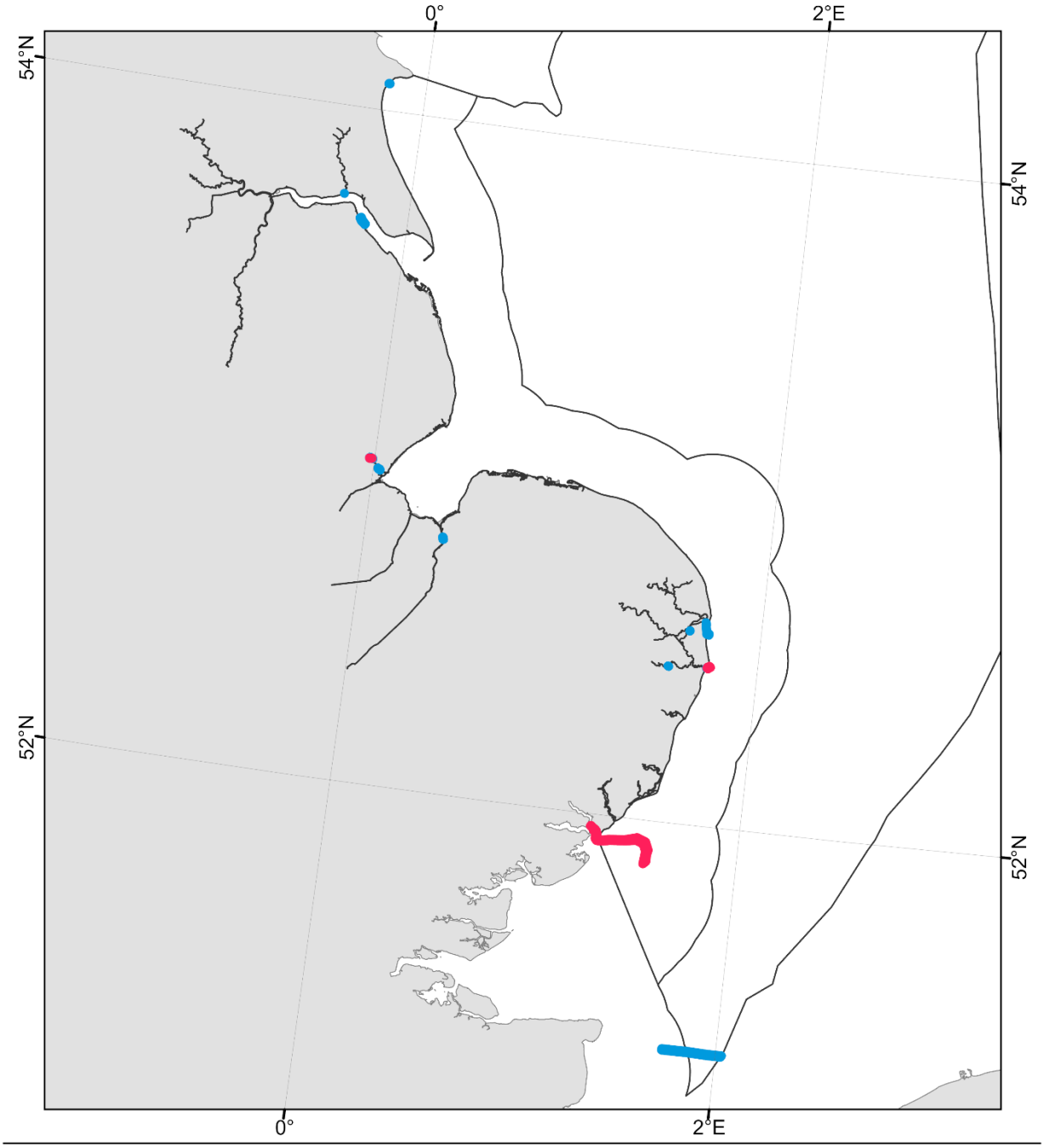
Many dredging techniques result in the collection of dredged materials which require subsequent disposal. Most dredged material is disposed of at sea but material can also be reused beneficially for purposes such as beach nourishment, habitat creation, and land reclamation[86]. Disposal and alternative beneficial reuse of dredged material at sea can only occur within designated marine disposal sites subject to compatibility with the characteristics of the dredge material[87]. Disposal sites are assessed and classified into open, disused, and/or closed sites on a case-by-case basis.

8.2 Historic trends and current activity

The location of existing capital and maintenance dredge activities within the Plan areas that are licensed under the Marine and Coastal Access Act (MCCA) and are reported on the MMO's Marine Case Management System (MCMS)[88] are shown in Figure 7. Based on this data, there are a number of licensed dredge activities that take place in the Plan areas, including within the Humber Estuary, as well as at Lowestoft, Great Yarmouth and Harwich Haven. There may also be some dredging operations carried out by or on behalf of a harbour authority that do not require a marine licence as they are authorised by a Harbour Order or Local Act[89]. There is, however, no publicly available spatial data for dredging activities that do not require a marine licence.

[85] MMO (2019) Guidance: Dredging. Available at: https://www.gov.uk/guidance/dredging Accessed October 2024.
[86] OSPAR (n.d.) 'Dredging and dumping'. Available at: https://www.ospar.org/work-areas/eiha/dredging-dumping Accessed October 2024.
[87] MMO (2019). Guidance: Deposits. Available at: https://www.gov.uk/guidance/deposits Accessed October 2024.
[88] MMO (2022) Navigation dredge areas (capital and maintenance) from MMO MCMS Data.
[89] MMO (2019). Statutory guidance: Marine licensing exempted activities. Available at: https://www.gov.uk/Government/publications/marine-licensing-exempted-activities/marine-licensing-exempted-activities--2#dredging Accessed October 2024.

Figure 7: Location of existing licensed dredge activities.



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In the Humber Estuary, Associated British Ports' (ABP) Humber Estuary Services has a legal duty to provide a safe harbour, and is responsible for maintenance dredging of the Humber Estuary[90]. There are no current planned activities to widen or deepen navigation channels through capital dredging in the Humber Estuary but there are a number of proposed developments which would involve capital dredging new or existing berths in the near future (see Section 14.4).

ABP Lowestoft is currently undertaking port construction works as part of the Port of Lowestoft Masterplan, which includes elements of capital dredging associated with the Lowestoft Eastern Energy Facility[91]. ABP Lowestoft are responsible for the maintenance dredging of the Port of Lowestoft, while Great Yarmouth Port Authority (Peel Ports) are responsible for the maintenance dredging of Great Yarmouth Inner Harbour and the River Yare, and the Harwich Haven Authority has a licence to deepen Harwich Haven approach channel.

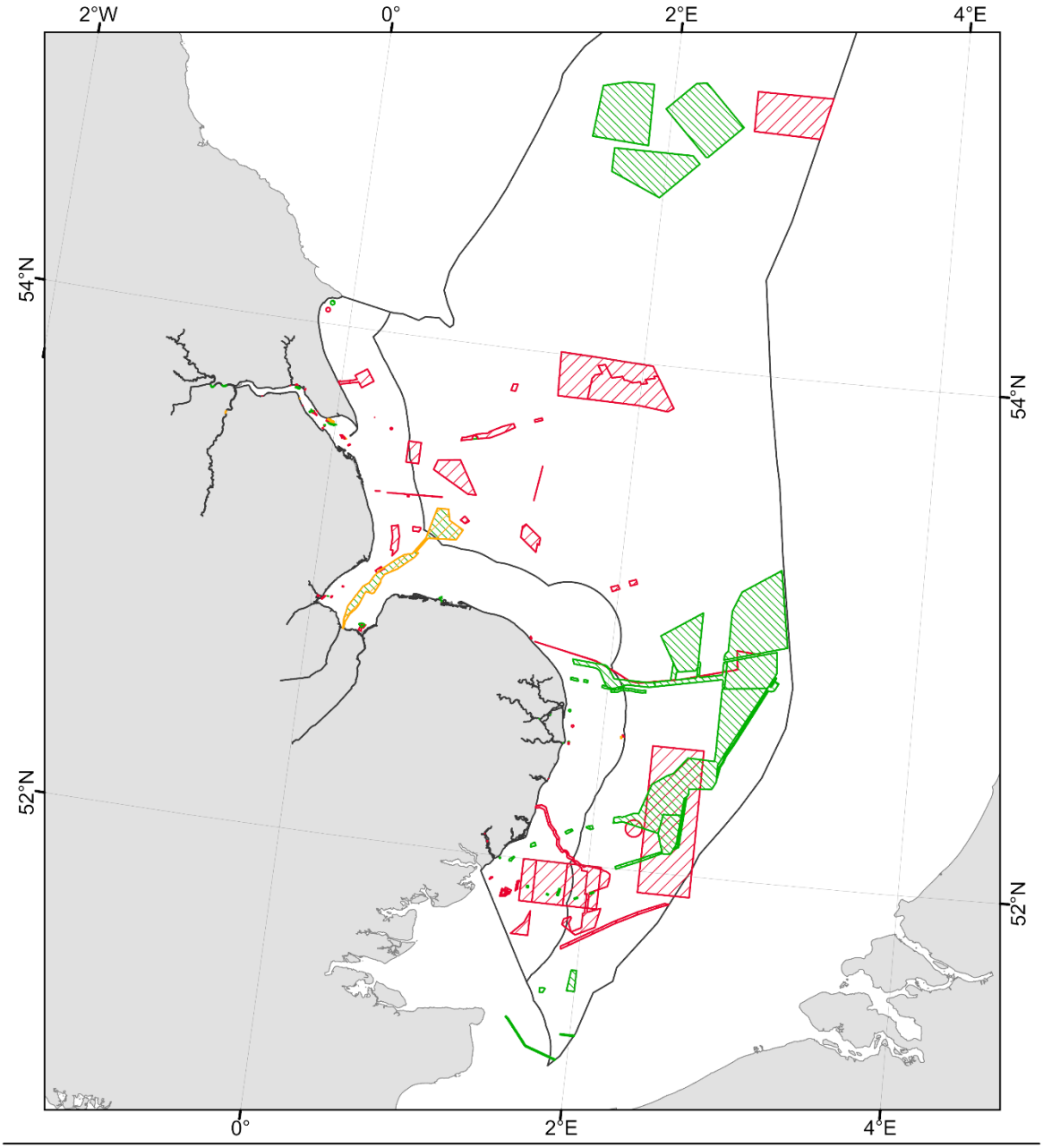
Within the Plan areas, there are currently 60 open, 7 disused and 83 closed marine disposal sites[92] (Figure 8). Over the past 10 years, the areas permitted for disposal have changed. These alterations have largely been in response to the construction of offshore wind farms and associated export cable corridors in the Plan areas (Section 14.4). For example, a number of sites have been opened (e.g., Race Bank, East Anglia One and Galloper) and others have been closed following the completion of construction (e.g., Hornsea, Triton Knoll and Dudgeon). The use of these licensed disposal sites generally involves marine licence conditions that limit their use to the disposal of material that has been collected during ground preparation works for the associated offshore wind farm project. The reasoning for this is to try to keep the sediment near or within the same sediment cell.

Available Disposal at Sea (DAS) records[93] indicate that the marine disposal sites that are currently open within the Plan areas and which have received the highest tonnages of material since 2014 are (in order of decreasing tonnages) Humber 3A (HU060), Inner Gabbard East (TH056), Inner Gabbard (TH052), Humber 1A (HU080) and Humber 4B/Hook (HU020). Over the past decade, there has been no consistent trend in the volume of material that has been disposed of at these five disposal sites within the Plan areas. Short-term, inter-annual fluctuations are evident in the amount of material disposed of at each site although these typically reflect contributions from capital dredge projects in nearby ports and harbours.

Although there is no central source of information on turnover, GVA or employment associated with dredging and disposal, these activities are recognised as crucial for enabling the maintenance and expansion of ports and navigation, and other relevant marine construction and/or clearance works.

[90] ABP (2024). Humber Estuary Services: Marine Information. Available at: https://humber.com/Estuary_Information/Marine_Information/ Accessed October 2024.
[91] Associated British Ports (2021) 'The Port of Lowestoft: Our future'. Available at: https://vision.abpmer.net/lowestoft-masterplan/ Accessed October 2024.
[92] Cefas (2022) 'UK Disposal Site Layer'. Available at: https://data.cefas.co.uk/view/407 Accessed October 2024.
[93] Cefas (2024) Disposal at Sea (DAS) Records: 2014 to 2022. Available at: https://data.cefas.co.uk/view/407 Accessed October 2024.

Figure 8: Current location of marine disposal sites.



East marine plan area

UK Licensed marine disposal sites (accurate as of June 2023)

Closed

Disused

Open

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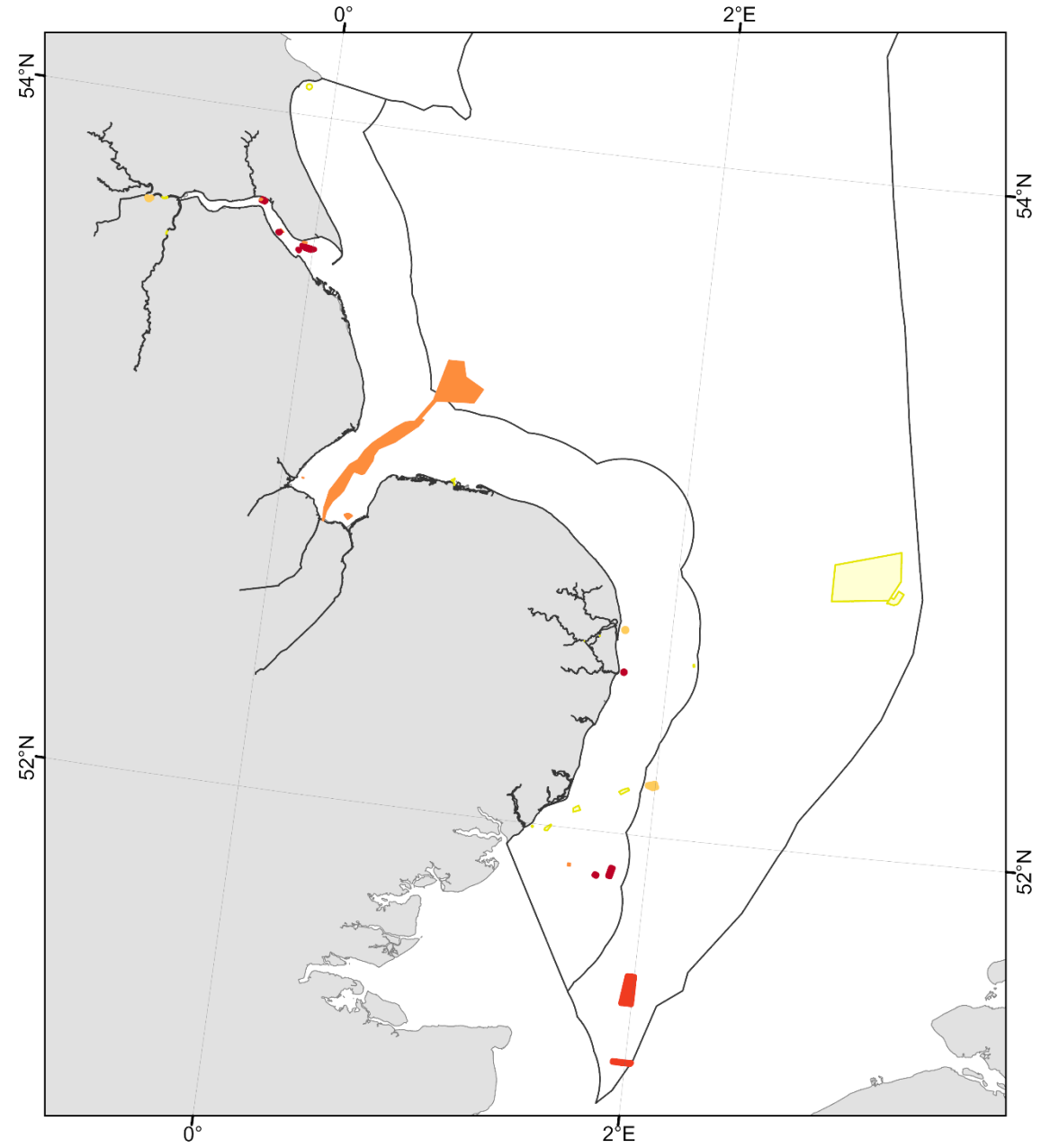
Figure 9: Total wet tonnes of material disposed at open marine disposal sites.



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8.3 PESTLE analysis

The key drivers expected to influence the use of the Plan areas for dredging and disposal are political drivers that relate to increasing development in the marine environment (requiring dredging), and environmental drivers that result in stringent regulations surrounding disposal. These drivers are listed in Table 8 below.

Table 8: PESTLE analysis for the dredging and disposal sector.

Driver	Details	Implications	Impact (+/-/Variable)
Political	National Policy Statement for Ports[94] considers ports to be of national significance to infrastructure and indicates that it may be a relevant consideration for MMO decision making.	Maintaining a competitive and efficient port industry that meets the needs of shipping companies is likely to require an increase in capital dredging and disposal. This is primarily in response to the introduction of larger vessels to achieve improved economies of scale in the transportation of cargo and passengers.	+
	The Energy Security Plan sets out the steps the Government is taking to ensure the UK is more energy independent, secure and resilient[95]. This builds on the Government's ambitions set out in the British Energy Security Strategy[96] and the Net Zero Strategy[97].	Increased investment and development of offshore wind and CCUS will likely involve a greater need for dredging and disposal activities. In particular, there will be a greater need for larger vessels and new port infrastructure to support offshore wind development, as is already the case at the Port of Lowestoft[98].	+
	UK Hydrogen Strategy[99] sets out the UK Government's ambitions to increase hydrogen production and includes aims to encourage CCUS clusters and the development of offshore wind.	Increased development in the marine environment will likely involve a greater need for dredging and disposal activities.	+

[94] Department for Ports. 2012. National Policy Statement for Ports. Available at: https://assets.publishing.service.gov.uk/media/5a78c20ae5274a277e68f3b1/national-policy-statement-ports.pdf Accessed October 2024.
[95] DESNZ (2023) Policy paper: Powering Up Britain: Energy Security Plan. Available at:. https://assets.publishing.service.gov.uk/media/626112c0e90e07168e3fdba3/british-energy-security-strategy-web-accessible.pdf. Accessed October 2024.
[96] DESNZ (2022) Policy paper: British Energy Security Strategy. Available at: https://www.gov.uk/Government/publications/british-energy-security-strategy. Accessed October 2024.
[97] DESNZ and BEIS (2022) Policy paper: Net Zero Strategy: Build Back Greener. Available at: https://www.gov.uk/Government/publications/net-zero-strategy. Accessed October 2024.
[98] ABP (2024) Capital dredging commences for Lowestoft Eastern Energy Facility. Available at: Associated British Ports | Capital dredging commences for Lowestoft Eastern Energy Facility (abports.co.uk) Accessed October 2024.
[99] Department for Energy, Security & Net Zero. 2023. Hydrogen Strategy Update to the Market: August 2023. Available at: https://assets.publishing.service.gov.uk/media/64e36b294002ee000d560c9f/hydrogen-strategy-update-to-the-market-august-2023.pdf Accessed October 2024.

Driver	Details	Implications	Impact (+/-/Variable)
	As custodians of the seabed, The Crown Estate plays a major role in the development of the offshore renewable energy sector and associated infrastructure (e.g. subsea cables)	Future leasing of the seabed will determine potential areas of development and associated dredging and disposal activities.	Variable
Economic	Responding to new global demand and consumption patterns linked to economic cycle, and more fragmented, localised or regionalised operating and trading environments[100].	Demand for maritime transport and associated navigational dredging and disposal requirements will fluctuate according to economic factors and the level of UK and global economic growth.	Variable
	Changing needs for shipping and other related industries drives the need for construction and upgrading of port infrastructure.	Ports required to expand to handle changes in shipping and other sectors may require capital dredging of berths and navigation channels, and the disposal of dredge material.	+
	Economies of scale drive trend towards larger and deeper draught ships[101].	Increased demand for capital dredging and disposal activities.	+
Social	No significant drivers identified.		
Legal	The legally binding target of reaching net zero by 2050 is set out in the 2019 amendment of the Climate Change Act 2008[102]. This has led to the UK's strategy to reduce emissions and increase renewable energy generation.	Increased renewable energy development in the marine environment is likely to require dredging and disposal activities during construction.	+
Environmental	The Environmental Improvement Plan 2023 requires greater consideration of impacts on the marine environment, such as noise and changes to the seabed[103]. It also aims to reuse materials wherever possible and meet all existing waste targets.	More stringent regulation of dredging and disposal activities. In addition, dredge and disposal marine licence applications will likely require a more robust consideration of alternative beneficial reuse options.	Variable

[100] United Nations (2022) Review of Maritime Transport 2022: Navigating stormy waters. United Nations Conference on Trade and Development. Available at: https://unctad.org/system/files/official-document/rmt2022_en.pdf Accessed October 2024.
[101] Notteboom, T. and Pallis, A. (2022). Port Economics, Management and Policy: Optimal Ship Size: Container Ships and Cruise Vessels. Available at: https://porteconomicsmanagement.org/pemp/contents/part9/optimal-ship-size-container-ships-cruise/ Accessed October 2024.
[102] UK Government. (2019). Climate Change Act 2008. Available at: https://www.legislation.gov.uk/ukpga/2008/27/section/1/2019-06-27 Accessed October 2024.
[103] Defra (2023) Environmental Improvement Plan 2023. Available at: https://www.gov.uk/Government/publications/environmental-improvement-plan Accessed October 2024.

Driver	Details	Implications	Impact (+/-/Variable)
	The Environmental Improvement Plan will lead to the enhanced protection of MPAs[104].	More stringent regulation on dredging and disposal activities (e.g. additional licence conditions).	Variable
	Management and designation of MPAs and HPMAs.	Greater consideration of protected sites for dredging and disposal activities seeking consent.	Variable
	Climate-induced changes in currents, waves, winds, water levels and tidal range may influence sediment supply. Extreme weather events may also result in a greater need for reactive dredging.	Potential implications for dredging and disposal activities, particularly in terms of ensuring safe navigational access to crucial ports in or near to the Plan areas are maintained.	Variable

8.4 Future scenarios

6 year projection

Over the next 6 years, the level of maintenance dredging will be sustained to ensure continued operation of the major ports in the Plan areas (high confidence).

The level of capital dredging is dependent on the extent of potential port expansion projects that are consented and constructed, consequently leading to potential new job opportunities and associated socio-economic benefits. Port developments involving capital dredging are anticipated to include Immingham Eastern Roll-on/Roll-off (Ro-Ro)Terminal (IERRT)[105] and Immingham Green Energy Terminal (IGET)[106] which will each involve a capital dredge of up to 190,000 m³ and approximately 4,000 m³ respectively to create new berthing areas in the Humber Estuary (moderate confidence) (Figure 7). **Both maintenance and capital dredge activities are likely to use existing disposal sites (high confidence).**

Securing economic growth is a fundamental mission for the new UK Government, which, together with their commitment to the energy transition and planning reform,[107] is anticipated to increase investment in marine and coastal infrastructure, increasing the potential demand for dredging and disposal activity (high confidence).

[104] Defra (2023) Corporate report Environmental Improvement Plan 2023. Available at: https://www.gov.uk/Government/publications/environmental-improvement-plan Accessed October 2024.
[105] Planning Inspectorate (2024) Immingham Eastern Ro-Ro Terminal: Project information. Available at: https://national-infrastructure-consenting.planninginspectorate.gov.uk/projects/TR030007 Accessed October 2024.
[106] Planning Inspectorate (2024) Immingham Green Energy Terminal: Project information. Available at: https://national-infrastructure-consenting.planninginspectorate.gov.uk/projects/TR030008 Accessed October 2024.
[107] UK Government. (2024) Oral statement to Parliament The King's Speech 2024 His Majesty's most gracious speech to both Houses of Parliament. Available at: https://www.gov.uk/Government/speeches/the-kings-speech-2024 Accessed October 2024.

This is likely to lead to new job opportunities and associated socio-economic benefits.

6 to 20 year projection

Over the next 20 years, economic growth, increased shipping activity and vessel size/draught are likely to result in **applications to increase the depth or width of existing navigation channels and berths, as well as to maintain existing dredge areas more frequently** (moderate confidence).

It is considered **unlikely that there would be applications to dredge in completely new areas of the seabed** that are located far from existing shipping channels (moderate confidence).

An increase in dredge requirements will have a direct effect on the amount of disposal material to be managed at sea. Subject to the carrying capacity of existing disposal sites, which are generally positioned at dispersive locations to avoid any capacity issues, this material is most likely to be disposed of at existing designated sites (moderate confidence). There may also be a possible increase in the number of disposal licence applications within the Plan areas. Dredge and disposal applications that are successful may lead to opportunities for the creation of new jobs in the dredging and disposal sector, with associated socio-economic benefits.

For non-navigation projects, capital dredging may be required in new areas of the seabed to facilitate installation of marine infrastructure. Based on the PESTLE analysis, this is most likely to be associated with the development of offshore wind energy and CCUS projects given the anticipated growth of these sectors (Section 5, Section 16, Figure 4, Table 8). These projects may also require the designation of new disposal sites to allow for the disposal of any dredge material closer to the location of the dredging activity than existing designated sites (low confidence).

There are also several national policies, plans and strategies that could positively or negatively affect the dredging and disposal sector in the Plan (Table 8). In addition, the implications of climate change, in terms of sediment supply and extreme weather events, as well as environmental regulations on future dredging and disposal requirements are uncertain (Table 8).

9 Energy production: Hydrogen

9.1 Sector definition

Hydrogen can be sourced by a variety of processes. For example, steam reformation can be used to produce hydrogen from sources such as natural gas, while hydrogen can also be produced by electrolysis, which uses electricity to split water (H_2O) into hydrogen (H_2) and oxygen (O_2)[108]. 'Low-carbon hydrogen' production methods can be used to produce H_2 which can be harnessed and used as a sustainable fuel source. Low-carbon hydrogen production methods include producing H_2 via electrolysis, powered by renewable energy ("Green" hydrogen), and producing H_2 by steam reformation coupled with CCUS ("Blue" hydrogen)[109].

9.2 Historic trends and current activity

The hydrogen industry is in its infancy with no commercially operational sites in the UK. So far hydrogen projects in operation are small scale facilities mainly for demonstration and pilot projects and are focussed on developing infrastructure for hydrogen transport[110]. In 2020 the UK Government launched the Hydrogen Taskforce to set out, through the UK Hydrogen Strategy (developed in 2021), its ambition to deliver up to 10 Gigawatts (GW) of low carbon hydrogen production capacity by 2030 (subject to affordability and value for money), half of which is to be from electrolytic hydrogen. This could support over 12,000 jobs[111].

The NSTA have established a business case for Bacton to become a key area for hydrogen energy by providing an opportunity to establish itself as a low carbon hydrogen energy hub (the Bacton Energy Hub)[112]. A core project of the Bacton Energy Hub is the potential for a plant with 355 Megawatt (MW) capacity to deliver 3 terawatt hours (TWh) of CCUS-enabled hydrogen production annually by 2030[113]. Several other projects are underway to support the growth of the hydrogen sector within the Plan areas[114] including the Immingham Green Energy Terminal at the Port of Immingham, a project which aims to build a new green-energy jetty and

[108] Department for Energy. Hydrogen Production: Electrolysis. 2024. Available at: https://www.energy.gov/eere/fuelcells/hydrogen-production-electrolysis Accessed 18/10/2024
[109] National Grid. 2024. The hydrogen colour spectrum. Available at: https://www.nationalgrid.com/stories/energy-explained/hydrogen-colour-spectrum Accessed October 2024.
[110] Hydrogen UK. 2024. Hydrogen Protect Directory. Available at: https://projectmap.hydrogen-uk.org/ Accessed October 2024.
[111] Department for Energy, Security & Net Zero. 2023. Hydrogen Strategy Update to the Market: August 2023. Available at: https://assets.publishing.service.gov.uk/media/64e36b294002ee000d560c9f/hydrogen-strategy-update-to-the-market-august-2023.pdf Accessed October 2024.
[112] North Sea Transition Authority. Bacton Energy Hub. Available at: https://www.nstauthority.co.uk/the-move-to-net-zero/energy-integration/bacton-energy-hub/ Accessed October 2024.
[113] North Sea Transition Authority. Bacton Energy Hub. Available at: https://www.nstauthority.co.uk/media/8629/bacton-energy-hub-business-opportunity-report.pdf Accessed October 2024.
[114] Hydrogen UK. 2024. Hydrogen Protect Directory. Available at: https://projectmap.hydrogen-uk.org/ Accessed October 2024.

associated infrastructure to trial the use of hydrogen in port equipment[115]. In addition, the Lowestoft PowerPark Hydrogen is a project (currently at the feasibility stage) to build a green hydrogen production plant in Lowestoft, with an initial capacity of 2 MW[116] and peak of 23 MW, and Hydrogen to Humber (H2H) Easington project, a project to generate electrolytic hydrogen at the Easington terminal[117].

In addition to these projects, the UK Government delivered its first Hydrogen Allocation Round (named HAR1) in 2022. Eleven projects across the UK were selected, equating to the generation of 152 MW[118]. The majority of these projects are land based involving obtaining energy from onshore solar and windfarms. While development of marine assets progress is less established, it is developing. One coastal project is underway through HAR1 in the Plan areas. The Aldbrough Hydrogen Pathfinder project aims to support the evidence base for deploying flexible hydrogen power and will source renewable energy to produce electrolytic hydrogen to be stored in salt caverns[119].

Hydrogen technology is being developed and deployed as part of the CCUS clusters (See Section 5). This includes projects in the East Coast Cluster which originate in the north east marine plan areas but extend into the Plan areas such as Humber H2ub Project and H2H Saltend both of which are to produce green hydrogen[120,121].

The second allocation round (HAR2) has been announced and has a capacity aim of 875 MW. The applications for HAR2 closed in April 2024[122]. The nature and location of the potential projects are not yet known at time of writing but given the East coast region is an industry hub with a highly skilled workforce, and has available sources of offshore wind energy, it is reasonable to assume some projects could be in the Plan areas. However, as mentioned above, development of marine based hydrogen infrastructure is in its infancy.

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[115] Viking CCUS. Transforming the Humber into a net zero SuperPlace. Available at; https://vikingCCUS.co.uk/assets/images/Viking-CCUS-Transforming-the-Humber-into-a-net-zero-SuperPlace-web.pdf Accessed October 2024.
[116] Conrad Energy. 2023. Conrad Energy delighted to confirm Net Zero Hydrogen Funding for Lowestoft Available at: https://conradenergy.co.uk/2023/03/30/conrad-energy-delighted-to-confirm-net-zero-hydrogen-funding-for-lowestoft/ Accessed October 2024.
[117] Hydrogen UK. 2024. Hydrogen Protect Directory. Available at: https://projectmap.hydrogen-uk.org/ Accessed October 2024.
[118] Department for Energy Security and Net Zero. 2023. Hydrogen Production Business Model / Net Zero Hydrogen Fund: HAR1 successful projects (published December 2023). Available at: https://www.gov.uk/Government/publications/hydrogen-production-business-model-net-zero-hydrogen-fund-shortlisted-projects/hydrogen-production-business-model-net-zero-hydrogen-fund-har1-successful-projects Accessed October 2024.
[119] SSE Thermal. 2024. Aldbrough Hydrogen Pathfinder. Available at: https://www.ssethermal.com/flexible-generation/development/aldbrough-hydrogen-pathfinder/ Accessed October 2024.
[120] Uniper. 2024. Humber H2ub (Green Project). Available at: https://www.uniper.energy/solutions/energy-transformation-hubs/energy-transformation-hub-killingholme/humber-h2ubr-green Accessed October 2024
[121] Equinor. 2024. H2H Saltend. Available at: https://www.equinor.com/energy/h2h-saltend Accessed October 2024.
[122] UK Government. 2024. Hydrogen Allocation Rounds. Available at: https://www.gov.uk/Government/collections/hydrogen-allocation-rounds Accessed October 2024.

9.3 PESTLE analysis

The key drivers expected to influence the hydrogen sector in the Plan areas are political and economic drivers due to the need to decarbonise industry and be located close by to these other industrial sectors. These drivers are listed in Table 9.

Table 9: PESTLE analysis for the hydrogen energy sector.

Driver	Details	Implications	Impact (+ / - / Variable)
Political	UK Hydrogen Strategy[123] and Energy Security Strategy[124] sets out the UK Government ambitions to increase hydrogen production to meet the 2030 goal of delivering 10 GW of low carbon hydrogen[125]. This includes investing in a resilient supply chain to delivering the 'Hydrogen 2020s Roadmap'.	Increased Government support and investment in hydrogen production across the UK.	+
	The strategic decision, by the UK Government, to enable up to 20% hydrogen to be blended into the UK's gas distribution network[126] increases its ability to be used within the grid network, thus increasing its value.	Increases the value of hydrogen produced in the Plan areas which will help to facilitate growth of the sector.	+
	The East Coast Hydrogen Delivery Plan[127] sets out the ambitions of how the hydrogen industry can be developed in the East Coast region.	Increased delivery of hydrogen in the Plan areas.	+
Economic	Net zero Hydrogen Fund provides up to £240 million of funds to support the development and deployment of new low carbon hydrogen production[128].	Increased investment into hydrogen production.	+
	The expansion of hydrogen will depend to some extent on its cost competitiveness and political decisions on how funds are allocated.	The potential for cost competition may restrict the development of hydrogen given it is costly.	Variable

[123] UK Government. 2021. UK Hydrogen Strategy. Available at: https://assets.publishing.service.gov.uk/media/64c7e8bad8b1a70011b05e38/UK-Hydrogen-Strategy_web.pdf Accessed October 2024.
[124] UK. Government. 2022. British Energy Security Strategy. Available at: https://www.gov.uk/Government/publications/british-energy-security-strategy/british-energy-security-strategy Accessed October 2024.
[125] The Hydrogen Strategy Delivery Update: December 2023. Available at: https://assets.publishing.service.gov.uk/media/65841578ed3c3400133bfcf7/hydrogen-strategy-update-to-market-december-2023.pdf Accessed October 2024.
[126] UK Government. 2023. Hydrogen blending in GB distribution networks: strategic decision. Available at: https://www.gov.uk/Government/publications/hydrogen-blending-in-gb-distribution-networks-strategic-decision Accessed October 2024.
[127] East Coast Hydrogen. 2023. East Coast Hydrogen Delivery Plan. Available at https://www.eastcoasthydrogen.co.uk/wp-content/uploads/2023/11/East-Coast-Hydrogen-Delivery-Plan-Report-1.pdf Accessed October 2024.
[128] UK Government. Net Zero Hydrogen Fund strands 1 and 2: Round 2 (closed to applications). Available at: https://www.gov.uk/Government/publications/net-zero-hydrogen-fund-strand-1-and-strand-2 Accessed October 2024.

Social	There is a need to create a strong workforce for the industry to execute all aspects of the supply chain.	The upskilling of individuals to form a resilient workforce will be needed in parallel with technological developments. If this is not achieved, the development of the industry may be slowed.	Variable
Technological	As stated in the UK Hydrogen Strategy[129] and East Coast Hydrogen Delivery Plan[130] the UK Government will invest in and support the significant advances in technology that are required to grow the hydrogen sector.	Increased delivery of hydrogen in the Plan areas including expansion of local technical capability.	+
	Availability of sufficiently technologically advanced storage infrastructure is needed to explore storage sites, particularly in areas of challenging geology.	The need to develop technologically advanced infrastructure to expand industry capabilities will influence the expansion of the sector.	Variable
	Water availability has been identified as a technological challenge for the hydrogen sector and therefore technological advancements to ensure there is sufficient water availability for both hydrogen production and communities are needed[131].	The need to develop sophisticated technology to obtain sufficient water is a key blocker to enable the hydrogen sector in the Plan areas to expand, particularly given it is one of the most water-stressed areas of the UK.	-
Legal	The development of hydrogen is mostly driven by the need to decarbonise industrial sectors in order to achieve the UK Government's net zero targets, as set out in the Climate Change Act[132].	Increased investment in hydrogen production.	+
	It has currently not been discussed as to how offshore hydrogen production and transportation will be licensed and who the legal Government operator (including the Department for Energy Security and Net Zero (DESNZ), NSTA, and MMO) will be. In 2023 it was however decided that hydrogen is to be classed as a gas	The licensing process will influence how (including the rate and location) the hydrogen industry expands through the Plan areas.	Variable

[129] UK Government. 2021. UK Hydrogen Strategy. Available at: https://assets.publishing.service.gov.uk/media/64c7e8bad8b1a70011b05e38/UK-Hydrogen-Strategy_web.pdf Accessed October 2024.
[130] East Coast Hydrogen. 2023. East Coast Hydrogen Delivery Plan. Available at https://www.eastcoasthydrogen.co.uk/wp-content/uploads/2023/11/East-Coast-Hydrogen-Delivery-Plan-Report-1.pdf Accessed October 2024.
[131] UK Water Industry Research. 2023. Integrating and Producing Hydrogen, Available at: https://ukwir.org/integrating-and-producing-hydrogen Accessed October 2024.
[132] UK Government. 2019. Climate Change Act 2008. Available at: https://www.legislation.gov.uk/ukpga/2008/27/section/1/2019-06-27 Accessed October 2024.

	and blended into gas networks[133], meaning the Offshore Petroleum Regulator for Environment and Decommissioning (ORPRED) and NSTA share responsibilities for transportation and storage.		
Environmental	The need to mitigate the impacts of climate change by decarbonising industrial sectors is a driver for hydrogen development in the Plan areas.	Increased delivery of hydrogen in the Plan areas.	+

9.4 Future scenarios

6 year projection

The **hydrogen industry is likely to expand in the Plan areas in** the next 6 years, this will include the **development of the Bacton Energy Hub and the Immingham Green Energy Terminal** (high confidence), and the potential successful projects identified in HAR2 and HAR3 (low confidence, as their location is not known). In addition, legislation and strategies will become more defined across the next 6 years (high confidence). **The East Coast Cluster will likely have projects within these future allocation rounds** which, whilst the East Coast Cluster is primarily located in the north east marine plan areas, will likely include deployment of infrastructure in the Plan areas which will be operational towards the end of this decade (moderate confidence as a development pathway has not been laid out).

HAR2 seeks to deliver up to 875 MW with projects becoming operational between 2026 to 2029, and HAR3 seeks to deliver up to 750 MW with projects becoming operational between 2028 to 2030. The location across the UK and nature of the projects are not yet available[134], and it is likely that the majority of infrastructure would be on land.

6 to 20 year projection

The hydrogen industry in the Plan areas is likely to continue to expand across the next 20 years (moderate certainty). **A further four HARs encompassing the UK have been proposed** (HAR4 to HAR7). HAR4 seeks to deliver up to 750 MW with projects becoming operational between 2028 to 2031, while the capacity and delivery date for HAR5, 6 and 7 have not yet been published though contract awards are scheduled for 2028, 2029, and 2030 respectively. The location and nature of the projects are not yet known[135], but it is likely that there will be development of

[133] UK Government. 2023. Hydrogen blending in GB distribution networks: strategic decision. Available at: https://www.gov.uk/Government/publications/hydrogen-blending-in-gb-distribution-networks-strategic-decision Accessed October 2024.
[134] DESNZ. 2023. Hydrogen Delivery Production Roadmap. Available at: https://assets.publishing.service.gov.uk/media/6662f36b716b14967fe341e1/hydrogen-production-delivery-roadmap-2023.pdf Accessed October 2024.
[135] DESNZ. 2023. Hydrogen Delivery Production Roadmap. Available at: https://assets.publishing.service.gov.uk/media/6662f36b716b14967fe341e1/hydrogen-production-delivery-roadmap-2023.pdf Accessed October 2024.

hydrogen production in the Plan areas over 6-20 years (high confidence) as it is highly likely that the **strategy for developing the industry will involve having a wide spread of assets across UK** to maximise where the benefits are realised rather than installing all assets in one location.

Across the next 6 to 20 years it is likely that all methods for producing and harnessing hydrogen will be explored, including **Green hydrogen (hydrogen produced by electrolysis powered by renewable energy), Blue hydrogen (produced by steam reformation with coupled CCUS)**, and most recently **Pink hydrogen (hydrogen produced by electrolysis powered by nuclear energy)** with Sizewell C being identified as a potential source[136].

Hydrogen infrastructure is **more likely to be land-based** than sited within the marine plan areas, although infrastructure may be coastal and energy for **the production of hydrogen may be derived from offshore wind farms in the Plan areas** (moderate confidence).

[136] Sizewell C. 2024. Hydrogen and SZC. https://www.sizewellc.com/environment/szc-energy-hub/hydrogen/ Accessed October 2024.

10 Energy Production: Nuclear

10.1 Sector definition

Nuclear power stations generate heat and thus energy from carefully managed nuclear chain reactions. In the UK, nuclear reactors have generally used seawater to cool and control the reactors. There is also potential for nuclear power plants to be co-located with other infrastructure, for instance, seawater may be desalinated using nuclear energy (see Desalination in Section 7).

The disposal of nuclear waste is also included in this sector.

10.2 Historic trends and current activity

Approximately 15% (6.5 GW) of electricity in the UK is generated by nuclear power which, if current UK Government targets are realised, will increase to 25% (24 GW) by 2050[137]. In 2022, a total of 324 TWh of nuclear power was generated in the UK[138].

There are two nuclear power stations in the Plan areas, Sizewell A and B, with a third (Sizewell C) currently under construction. These are all located in Leiston, as shown in Figure 10.

Sizewell A became operational in 1966 and ceased operation in 2006[139]. Its electricity production capacity increased significantly over its lifetime and in 2006 (last year of operation) produced 1,645 GWh[140]. Sizewell B became operational in 1995 and generates 6,709 GWh of electricity per year, and currently supplies 3.1% of the UK's energy needs[141]. It employs over 520 FTEs and over 250 FTE contractors[142].

It is expected that Sizewell C will operate two European Pressurised Reactors (EPRs) and produce up to 3.2 GW of electricity equating to generating low-carbon electricity for around 6 million homes[143]. The application for Sizewell C was

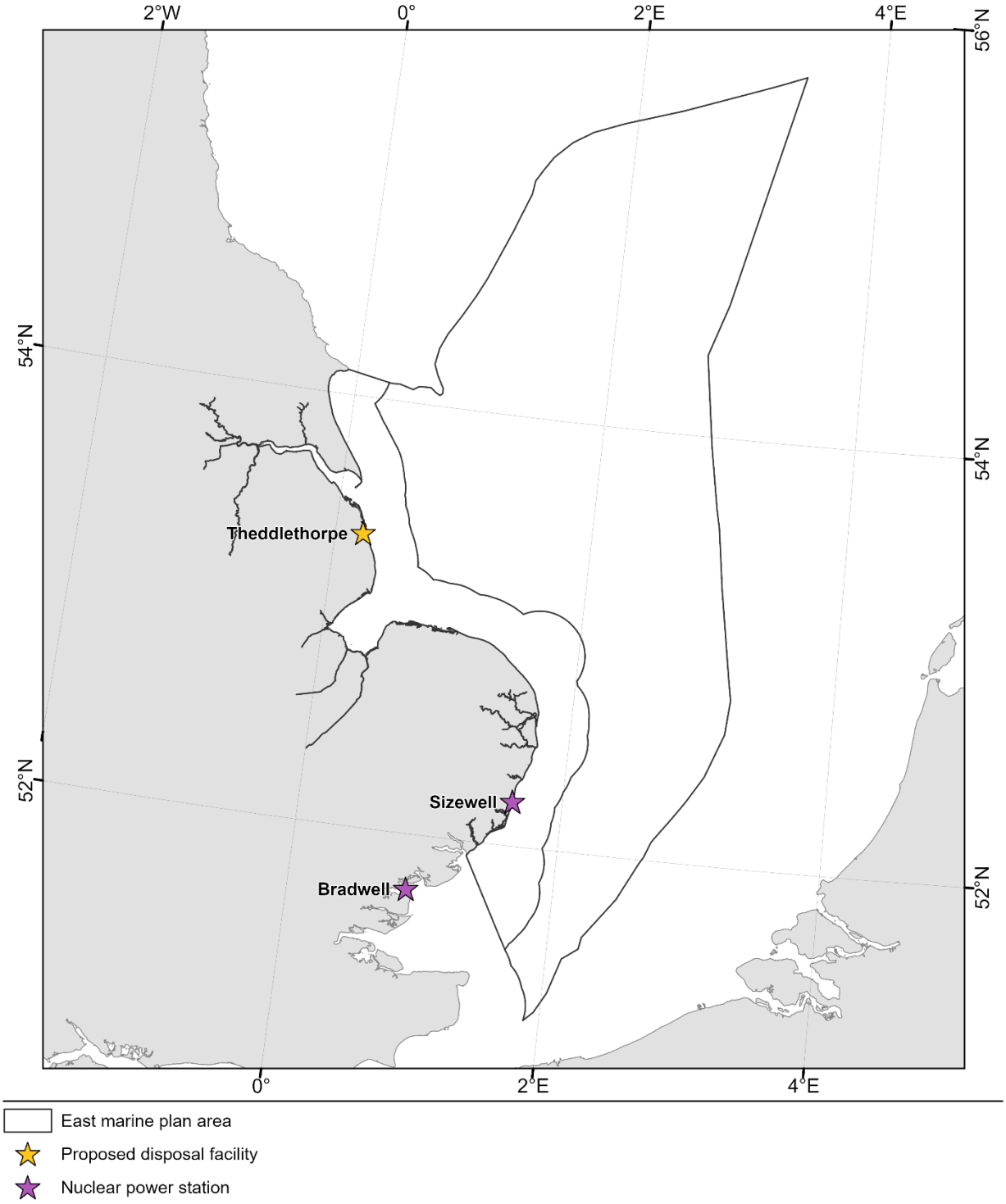
[137] World Nuclear Association. 2024. Nuclear Power in the United Kingdom. Available at: https://world-nuclear.org/information-library/country-profiles/countries-t-z/united-kingdom Accessed October 2024.
[138] World Nuclear Association. 2024. Nuclear Power in the United Kingdom. Available at: https://world-nuclear.org/information-library/country-profiles/countries-t-z/united-kingdom Accessed October 2024.
[139] World Nuclear Association. Sizewell A1. Available at: https://world-nuclear.org/nuclear-reactor-database/details/SIZEWELL%20A-1. Accessed October 2024.
[140] World Nuclear Association. Sizewell A1. Available at: https://world-nuclear.org/nuclear-reactor-database/details/SIZEWELL%20A-1. Accessed October 2024.
[141] ICE. 2024. Sizewell B. Available at: https://www.ice.org.uk/what-is-civil-engineering/what-do-civil-engineers-do/sizewell-b Accessed October 2024.
[142] Nuclear Industry Association. 2024. NIA Jobs Maps. Available at: https://www.niauk.org/nia-jobs-map-2024/ Accessed October 2024.
[143] Power Technology. 2024. Sizewell C Nuclear Power Station, England, UK. Available at: https://www.power-technology.com/projects/sizewell-c-nuclear-power-station-england-uk/ Accessed October 2024.

submitted in 2020[144], by January 2023 the UK Government confirmed its contribution of £1.3 billion to the plant, and in May 2024 the nuclear site licence was awarded[145]. The construction of Sizewell C is expected to employ approximately 7,900 people and when operational will create at least 1,500 apprenticeships and thousands of additional jobs across the supply chain[146].

Nuclear waste across the UK is currently stored in surface facilities. The Government is committed to maintaining safe disposal of nuclear waste[147] and plans to construct a geological disposal facility. This facility will involve burying highly radioactive waste deep underground, contained within multiple barriers, to ensure long-term storage which does not harm the environment or future generations. One location currently being considered for development of a geological disposal facility is Theddlethorpe[148], where the planned facility would extend beneath the seabed in the east inshore marine plan area, see Figure 10. This project is in the early stages of development with current activities including stakeholder engagement and evaluation of site suitability.

[144] World Nuclear Association. 2024. Nuclear Power in the United Kingdom. Available at: https://world-nuclear.org/information-library/country-profiles/countries-t-z/united-kingdom Accessed October 2024.
[145] World Nuclear Association. 2024. Nuclear Power in the United Kingdom. Available at: https://world-nuclear.org/information-library/country-profiles/countries-t-z/united-kingdom Accessed October 2024.
[146] World Industry Association. Sizewell C agrees 'best in class' conditions for workers. Available at: https://www.niauk.org/sizewell-c-agrees-best-in-class-conditions-for-workers/ Accessed October 2024.
[147] Department for Business, Energy and Industrial Strategy. 2019. National Policy Statement for Geological Disposal Infrastructure. Available at: https://assets.publishing.service.gov.uk/media/5d1db84ae5274a08df3d35cd/national-policy-statement-geological-disposal-infrastructure.pdf Accessed October 2024.
[148] UK Government. 2022. NWS welcomes Theddlethorpe GDF Community Partnership formation. Available at: https://www.gov.uk/Government/news/nws-welcomes-theddlethorpe-gdf-community-partnership-formation Accessed October 2024.

Figure 10: Nuclear power facilities.



Date of Publication:29/10/2024
Coordinate System:ETRS 1989 LAEA
Projection:Lambert Azimuthal Equal Area

10.3 PESTLE analysis

The key drivers that influence the development of nuclear energy in the Plan areas are predominantly political, namely through the Civil Nuclear Roadmap to 2050, and the British Energy Security Strategy. These are further affected by environmental drivers, including net zero agreements. The key drivers are listed in Table 10 below.

Table 10: PESTLE analysis for the nuclear sector.

Driver	Details	Implications	Impact (+ / - Variable)
Political	The National Policy Statement for nuclear power generation[149] published in 2011 is due to be updated to provide a framework for beyond 2025. The update is due for consultation in 2024. Updates to the policy will likely include the ability to use a wider range of nuclear technologies, including modular reactors, and the ability for developers to suggest potential nuclear sites rather than being restricted to sites selected by the Government.	The updated nuclear National Policy Statement could change how the nuclear energy sector is developed in the future. This could include new technologies (such as modular reactors) being used in the Plan areas.	Variable
	The National Policy Statement for Geological Disposal Infrastructure[150] sets out the framework for planning decisions relating to the management of nuclear waste, including the future use of geological disposal facilities.	This National Policy Statement sets out the need for a geological disposal facility for highly radioactive waste, which may extend beneath the east inshore marine plan area.	+
	The Civil Nuclear Roadmap to 2050[151] sets out how the UK will achieve its nuclear energy targets, including the role of Great British Nuclear.	Increased growth in the sector as it provides guidance to developers and is therefore an enabler for development.	+
	The British Energy Security Strategy sets out the UK's ambition to deploy 24 GW of nuclear energy by 2050 and	Increased growth in the sector, as setting out the UK's ambitions provides the basis	+

[149] UK Government, Department for Energy Security and Net Zero. 2023. A National Policy Statement for new nuclear power generation, Consultation on the new approach to siting beyond 2025. Available at: https://assets.publishing.service.gov.uk/media/659fa3313308d2000d1fbe04/nps-new-nuclear-siting-consultation.pdf Accessed October 2024.

[150] Department for Business Energy & Industrial Strategy. 2019. National Policy Statement for Geological Disposal Infrastructure. Available at: https://assets.publishing.service.gov.uk/media/5d1db84ae5274a08df3d35cd/national-policy-statement-geological-disposal-infrastructure.pdf Accessed October 2024.

[151] Department for Energy Security & Net Zero. 2024. Civil Nuclear: Roadmap to 2050. Available at: https://assets.publishing.service.gov.uk/media/65c0e7cac43191000d1a457d/6.8610_DESNZ_Civil_Nuclear_Roadmap_report_Final_Web.pdf Accessed October 2024.

Driver	Details	Implications	Impact (+ / - Variable)
	the commitments to do so including financial investment to advance technology and streamlining licensing regulations[152].	for investment, guidance, and roadmaps.	
Economic	Great British Nuclear (GBN) has been launched as part of the UK Government's Powering Up Britain plan and will deliver the Government's long-term ambition for expanding the nuclear sector in the UK[153]. GBN is a trading body which will work with successful bidders to co-fund selected technologies.	Increased investment into nuclear technology and supporting the supply chain will help deliver the Government's nuclear commitment.	+
	The cost of new nuclear facilities is far higher than new low carbon production facilities such as for wind and wave energy. This could lead to potential competition between energy industries.	The high cost of building nuclear facilities may be a barrier to the expansion of the sector.	-
Social	Social acceptance of nuclear energy can be a barrier for expanding the nuclear sector, particularly during public consultation[154,155].	Factors which can impact social acceptance of nuclear developments include any visual impact it will have on the land and seascape, employment opportunities and associated local infrastructure projects.	Variable
	Nuclear power stations and a geological disposal facility may impact on other marine industries and therefore create tension with other sea users[156].	In the Plan areas this could include tension between nuclear developments and activities such as CCUS, environmental protection, fisheries and recreational sea uses.	-

[152] UK Government. 2022. British Energy Security Strategy. Available at: https://assets.publishing.service.gov.uk/media/626112c0e90e07168e3fdba3/british-energy-security-strategy-web-accessible.pdf Accessed October 2024.
[153] UK Government. 2023. Great British Nuclear: Overview. Available at: https://www.gov.uk/Government/publications/great-british-nuclear-overview/great-british-nuclear-overview#about-gbn Accessed October 2024.
[154] UK Government. 2014. Social impacts and interactions between marine sectors (MMO 1060). Available at: https://www.gov.uk/Government/publications/social-impacts-and-interactions-between-marine-sectors-mmo-1060 Accessed October 2024.
[155] Ramana, M. V. (2011). Nuclear power and the public. Bulletin of the Atomic Scientists, 67(4), 43-51. Available at: https://doi.org/10.1177/0096340211413358 Accessed October 2024.
[156] Marine Management Organisation. 2023. https://www.gov.uk/Government/publications/east-marine-plan-spatial-assessment-mmo1274 Accessed October 2024East Marine Plan Spatial Assessment (MMO127). https://www.gov.uk/Government/publications/east-marine-plan-spatial-assessment-mmo1274 Accessed October 2024.

Driver	Details	Implications	Impact (+ / - Variable)
Technological	Technological capability drives the efficiency of nuclear energy and therefore requires sufficient investment into research and development. Current technological advancements driving development in the sector include Advanced Nuclear Technologies which are allowing for smaller, more efficient, reactors[157], as well as nuclear fusion[158].	Improved technology will improve the capability of the sector including reducing the sizes of reactors, which could also lower construction costs. Improving the efficiency of electricity generation would also accelerate meeting the UK's nuclear and net zero targets.	+
	Technological advancements that influence the location of nuclear power stations include the development of more efficient cooling systems, or those which do not rely on water, enabling reduced dependence on seawater[159].	Developments in cooling technologies could influence the location of power stations by enabling these to be sited in non-coastal areas.	Variable
Legal	Ambition to produce low carbon energy in order to meet the net zero obligation set out by the amended Climate Change Act 2019[160].	Increased investment in nuclear energy.	+
Environmental	The operation of nuclear power stations is highly dependent on environmental factors, which will be affected by climate change[161].	As new power stations in coastal locations (e.g. Sizewell C) are expected to operate for the next 100 years there is a key need to ensure facilities are resilient to the effects of climate change, including sea-level rise and increases in seawater temperature.	-

[157] UK Government. 2023. Advanced Nuclear Technologies. Available at: https://www.gov.uk/Government/publications/advanced-nuclear-technologies/advanced-nuclear-technologies Accessed October 2024.
[158] UK Government. 2024. Fusion energy facilities: new National Policy Statement and proposals on siting. Available at: https://www.gov.uk/Government/consultations/fusion-energy-facilities-new-national-policy-statement-and-proposals-on-siting Accessed October 2024.
[159] UK Government. 2023. Advanced Nuclear Technologies. Available at: https://www.gov.uk/Government/publications/advanced-nuclear-technologies/advanced-nuclear-technologies Accessed October 2024.
[160] UK Government. 2019. Climate Change Act 2008. Available at: https://www.legislation.gov.uk/ukpga/2008/27/section/1/2019-06-27 Accessed October 2024.
[161] International Atomic Energy Agency. 2022. Climate Change and Nuclear Power 2022. Available at: https://www.iaea.org/topics/nuclear-power-and-climate-change/climate-change-and-nuclear-power-2022 Accessed October 2024.

Driver	Details	Implications	Impact (+ / - Variable)
	Processing and storing the waste from nuclear plants needs to be carefully managed to prevent damage to the environment. Of most relevance is storing radioactive waste in a geological disposal facility which may extend beneath the seabed[162].	Potential for negative impacts and environmental concern over processing and storing nuclear waste may slow the pace at which the sector develops.	-

10.4 Future scenarios

6 year projection

Sizewell B will continue to operate over the next 6 years, unless unforeseen circumstances prevent this (high confidence that operation will remain). The **construction of Sizewell C is likely to gather pace over the next 6 years**, and the site could be operational by 2030 (moderate confidence).

No additional nuclear reactors are expected to become operational in the Plan areas within the next 6 years, given the lack of any current proposals and the lengthy process involved in developing a reactor to its operational stage (high confidence). **The spatial extent of the sector across the next 6 years will therefore remain the same as the current day**, with nuclear power facilities at Sizewell (Figure 10).

6 to 20 year projection

The Sizewell site is likely to continue to host at least one operational nuclear reactor throughout the next 20 years (moderate confidence). The UK Government has expressed an ambition to **explore ways of extending the lifetime of existing nuclear reactors,** and EDF are **looking to extend the lifetime of Sizewell B from 2035 to 2055**[163]. Meanwhile, **Sizewell C is planned to be operational for much of this period**, as outlined above. There is moderate confidence that the operational lifetime of Sizewell B will be extended; this proposal aligns with Government ambitions, but a final decision is yet to be announced. If the decision was made to extend the lifetime of Sizewell B, it would be subject to having sufficient capital investment, safety enhancements, and obtaining consent.

[162] World Nuclear Association. 2024. Storage and Disposal of Radioactive Waste. Available at: https://world-nuclear.org/information-library/nuclear-fuel-cycle/nuclear-waste/storage-and-disposal-of-radioactive-waste Accessed October 2024.
[163] EDR. 2022. Sizewell B starts review to extend operation by 20 years. Available at: https://www.edfenergy.com/media-centre/news-releases/sizewell-b-starts-review-extend-operation-20-years Accessed October 2024.

Technological developments may lead to increased development of dispersed small-scale modular reactors across the next 6 to 20 years (low confidence). Development of small-scale modular reactors within existing nuclear plants could also occur across the next 6 to 20 years at the Sizewell site, as technological advancements and upgrades are made during the maintenance and operational lifetime of the Sizewell B and C power plants (low confidence).

The **process of nuclear waste disposal could change across the next 6 to 20 years** and this **may include development of the geological disposal facility, possibly in Theddlethorpe** (low confidence as the development is subject to borehole explorations, and at any stage the community can withdraw from consideration). The process of creating a disposal facility is very lengthy and as such is not likely to be operational within 20 years. Current plans suggest that a geological disposal facility could start to receive waste by 2050 (low confidence)[164].

[164] UK Government. 2024. Geological Disposal - a programme like no other. Available at: https://www.gov.uk/guidance/geological-disposal#the-uks-nuclear-history Accessed October 2024.

11 Fisheries

11.1 Sector definition

Commercial fisheries relates to the activity of catching fish and/or shellfish from wild fisheries for commercial profit (i.e. 'catch sector' activity). This sector does not include subsistence fishing, recreational angling or downstream supply chain activity (e.g. processing). Commercial fishing activities are defined as those taking place at sea and on the foreshore by licensed operators[165].

11.2 Historic trends and current activity

In 2022, UK vessels landed 396,000 tonnes of fish and shellfish, valued at £786 million (at first point of sale), into UK ports[166]. For comparison, in 2012, landings were 393,000 tonnes, with a value of £567 million (nominal terms). In 2022, the UK fishing fleet was composed of 5,541 vessels (a 14% reduction since 2012) with 89% of the fleet being small-scale fishers (i.e. vessels under 10 metres). The UK commercial fishing sector in 2022 employed 6,557 FTE fishers (a 24% reduction since 2012).

Landings from UK vessels from the Plan areas were worth £56 million in 2022[167]. The predominant species group was shellfish (principally lobsters and crabs caught in pots along the Holderness coast), accounting for £43.2 million (78%) of landings from the area, with demersal species (principally plaice, sole and red mullet) accounting for £7.9 million (14%), and pelagic species (principally herring and horse mackerel) £4.5 million (8%) (Figure 14). Landings have increased since 2012, when UK vessels landed £36 million from the Plan areas. The increase was largely attributable to shellfish (£20.5 million, 56.6% in 2012), with £15.5 million (42.8%) of demersal species, and £0.2 million (0.6%) of pelagic species (Figure 13 and Figure 14). Figure 11 (for 2012) and Figure 1Figure 11 (for 2022) present values of landings by UK vessels from individual International Council for the Exploration of the Sea (ICES) rectangles. The size of the circle denotes the total value of catch, with the colours apportioning values to each of three sectors (shellfish, demersal and pelagic).

The majority of landings by value are taken by vessels over 10m in length (72% in 2022). This has remained relatively stable, with 76% having been taken by vessels over 10m in length in 2012. In 2022, there were 66 UK vessels over 10m in length registered and based at ports within the Plan area, and 172 UK vessels under 10m in length. Compared with 2015, this is a decrease of 30% and 11%, respectively.

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[165] MMO (2022). East Marine Plan Spatial Assessment. A report produced for the Marine Management Organisation, MMO Project No: 1274. Available at: https://assets.publishing.service.gov.uk/media/64ff10281886eb000d9770b7/220331_MMO1274_Final_Report_Spatial_Assessment.pdf Accessed October 2024.

[166] MMO. UK Sea Fisheries Annual Statistics. Available at: https://www.gov.uk/Government/collections/uk-sea-fisheries-annual-statistics Accessed October 2024.

[167] Based on ICES rectangle landing data, for ICES rectangles that wholly or partially overlap the east marine plan areas. This therefore overestimates the total landings from the east marine plan areas, as some landings will have come from outside the marine plan boundaries.

The Wash hosts three main target shellfisheries – cockle, whelk and shrimp. For the cockle fishery, landings and effort data for 2014-2020 indicate that the fishery is currently in a relatively steady state overall[168], despite fluctuations in stock status. However, in 2022, the cockle fishery landed only 13 tonnes, with a value of £9,700, which is substantially lower than previous years. The Wash whelk fishery has rapidly expanded over the last ten years. In 2015, 36 tonnes were landed, increasing to 900 tonnes in 2019, with a total of 16,833 and 329,324 whelk pots hauled in 2015 and 2019, respectively. The shrimp fishery in The Wash has declined over the last ten years, with 455 tonnes landed in 2012 (with a value of £1 million), compared with 244 tonnes landed in 2022 (with a value of £925,000).

Fisheries have an important role in the culture and heritage of the Plan areas, with several iconic fisheries and a rich fishing heritage. The distant water fleet in the 1970s worked out of Grimsby, and the herring fishery was particularly important in the ports of Great Yarmouth and Lowestoft up to the 1960s when the herring stocks crashed. Cromer is famous for its crab fishery, with crabs caught in pots on the chalk reefs off Cromer, providing an additional attraction to tourists visiting the region. This is illustrated by the Cromer and Sheringham Crab and Lobster Festival which celebrates local restaurants, music and heritage.

Non-UK vessels also fish in the Plan areas. Notable fisheries are Dutch vessels that beam trawl for flatfish (sole and plaice) on sandbanks such as the North Norfolk Sandbanks, and Haisborough, Hammond and Winterton, and the Danish sandeel fishery on Dogger Bank. However, both these fisheries are reducing, with a number of Dutch vessels being decommissioned after the pulse trawl method was banned, and a demersal trawling restriction was implemented in Dogger Bank Special Area of Conservation (SAC), followed by a ban on sandeel fishing in English waters.

There are 18 fishing ports in the Plan areas. The top five ports in terms of value of landings are Bridlington, Hull, Grimsby, Wells-next-the-Sea and Kings Lynn (Figure 13). Landings to Bridlington and ports around The Wash are predominantly of shellfish, whereas ports in Suffolk and Great Yarmouth receive more demersal fish than shellfish. Since 2012, the value of landings to Bridlington has increased, and Hull has overtaken Grimsby as the main location of demersal landings (Figure 13 and Figure 14). This was the result of £22 million of cod landed to Hull in 2022, which was caught in Norwegian waters.

[168] S. Stephenson, C.C. James, A.F. Johnson. 2021 Wash Fisheries Economic Assessment.

Figure 11: Fisheries landings by UK vessels by ICES rectangle and species, 2012.

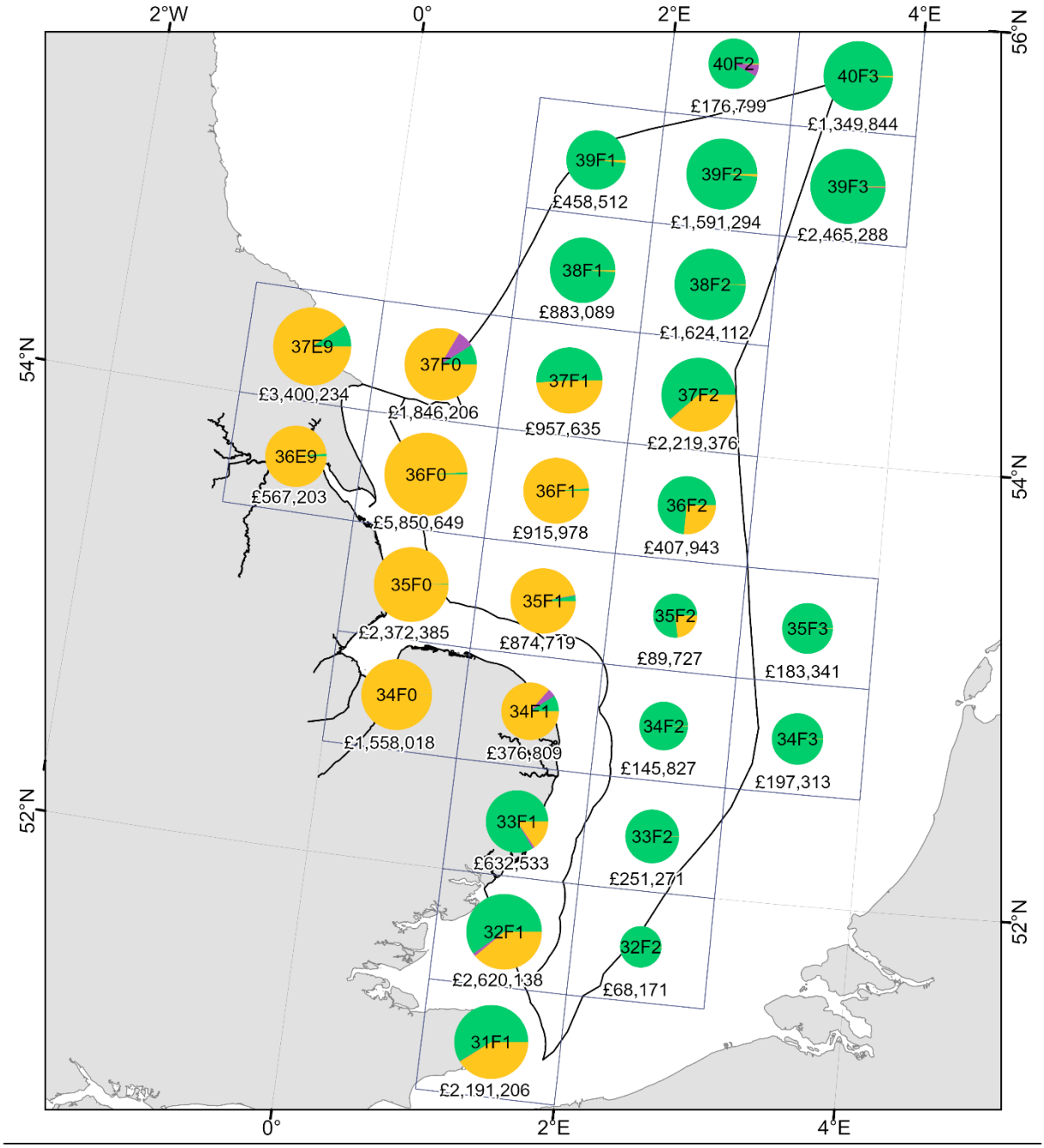

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Figure 12: Fisheries landings by UK vessels by ICES rectangle and species, 2022.

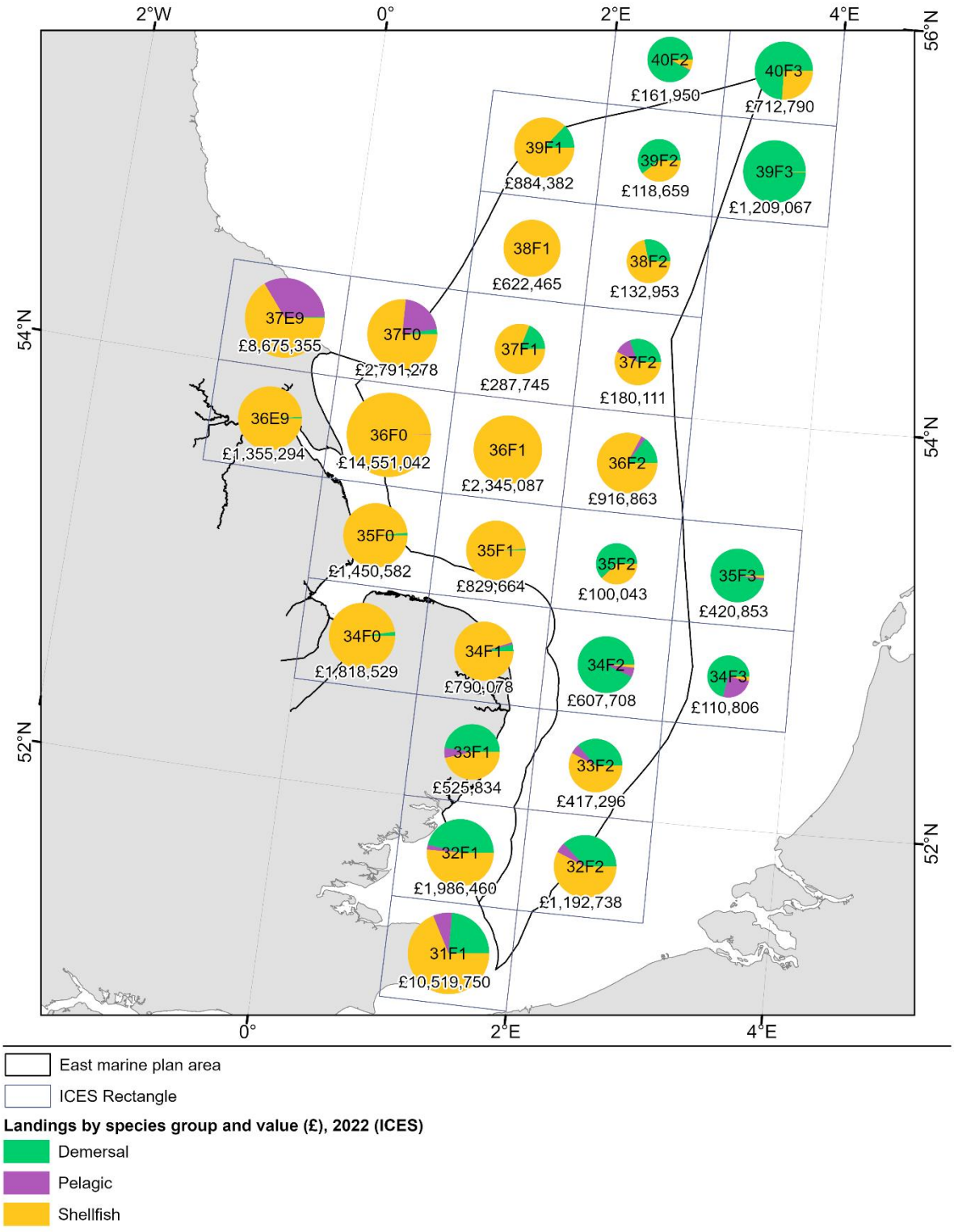

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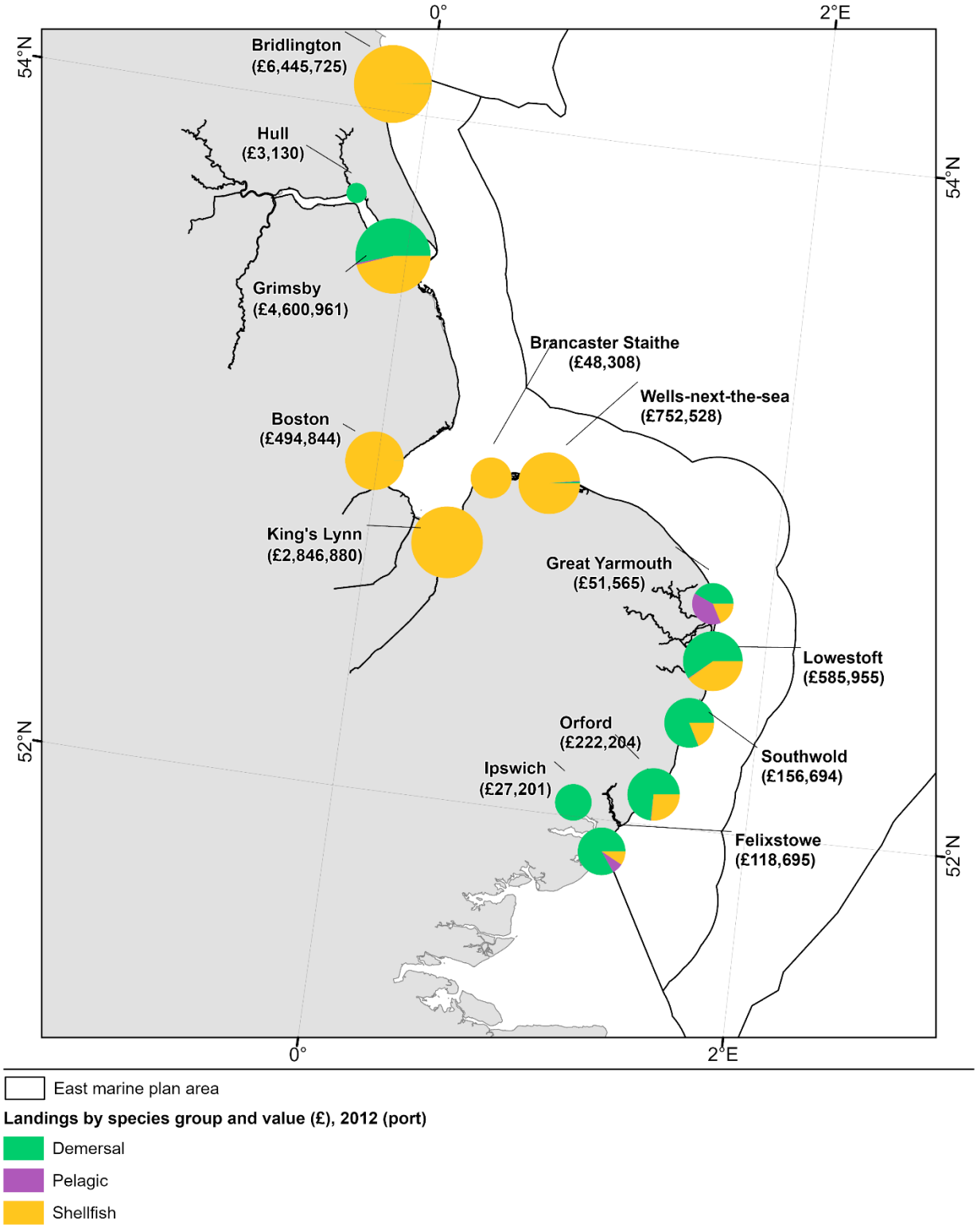
Figure 13: Landings into fishing ports, 2012.



Date of Publication:21/10/2024
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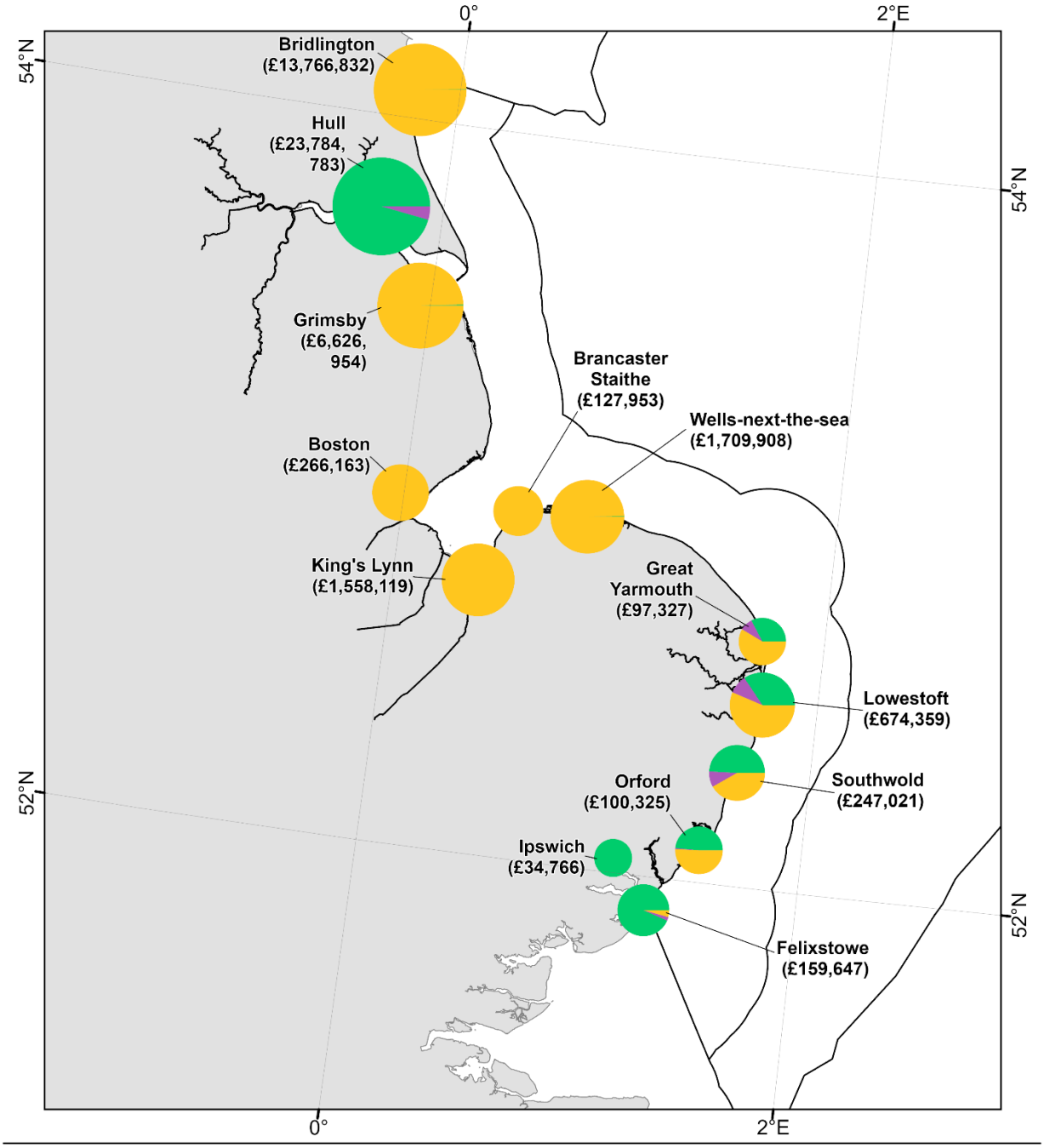
Figure 14: Landings into fishing ports, 2022.



Date of Publication:15/10/2024
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11.3 PESTLE analysis

The key drivers affecting the fisheries sector include political drivers relating to fisheries policy as well as policies for other maritime sectors which have implications for access to marine space for fisheries. Social, economic, legal and environmental drivers are also important. These are listed in Table 11 below.

Table 11: PESTLE analysis for the fisheries sector.

Driver	Details	Implications	Impact (+ / - / Variable)
Political	Post-EU exit (e.g. revised fisheries agreements and implementation of skilled work visas for Europeans working in UK territorial waters	New fisheries agreements on quotas and access to waters which involves annual bilateral and multilateral negotiations with the EU, Norway and other coastal states. Cessation of free movement of people between EU and UK may have implications for labour recruitment.	Variable
	EU-UK Trade and Cooperation Agreement[169]	UK is receiving a gradual increase in quota allocation, which may provide additional opportunities. Trade with the EU is tariff-free, but there are increased bureaucracy and operating costs. The TCA runs until June 2026	Variable
	Policies driving net zero, decarbonisation, and marine protection leading to 'spatial squeeze'	Government policy-driven actions associated with other marine industries, environmental protection measures, and marine spatial planning may displace fishing activities, particularly if co-existence is not viable.	-
Economic	Marine fuel and energy costs	High prices detrimentally impacting business profitability. May also change fishing behaviours (e.g. where and how to fish, what species to target).	Variable
	Availability of Government funding schemes, such as FaSS, and UK Seafood Fund (UKSF)	Availability of financial support can help the sector to improve health and safety, adopt more sustainable practices and adaptation to new regulations, supporting growth and sustainability of the sector. The £100m UKSF was introduced after the TCA was agreed, to help the sector adapt post EU-Exit. Follow-on funding has not yet been confirmed.	Variable
	Fish and shellfish landing prices	Fluctuations in fish and shellfish landing process can affect business profitability.	Variable

[169] European Commission. 2021. Trade and Cooperation Agreement. Accessed at: https://assets.publishing.service.gov.uk/media/608ae0c0d3bf7f0136332887/TS_8.2021_UK_EU_EAEC_Trade_and_Cooperation_Agreement.pdf Accessed October 2024.

Driver	Details	Implications	Impact (+ / - / Variable)
Social	Aging workforce, access to, and recruitment of, labour	There is currently a lack of young people choosing commercial fishing as a career, resulting in an aging workforce and risk to sustainability as older fishers leave the sector. Labour shortages (including both skilled and unskilled workers residing in - or willing/able to work in - the UK) will impede growth and sustainability of the sector.	-
	Animal Welfare (Sentience) Bill (approved by Parliament in April 2022). Decapod crustaceans and cephalopod molluscs now classified as sentient beings	May affect the sector's social licence to operate, particularly for the crab and lobster fisheries. It has encouraged the production of codes of good practice (e.g. Codes of Practice for the Welfare of Crabs, Lobsters, Crawfish and Nephrops[170]) which cover the whole supply chain.	Variable
Technological	Vessel Monitoring Systems (VMS) (including Inshore Vessel Monitoring Systems (iVMS)), remote electronic monitoring (REM) and electronic catch recording	Data improvements (e.g. robust data on catch, bycatch, and landings data; fishing location; and fishing effort) will support sustainable sectoral development, and improve understanding of the importance of fishing grounds, particularly for inshore vessels.	+
	Improvements in environmental sustainability of the fishing fleet (e.g. decarbonisation and lower impact gear types)	Will help to decrease the environmental footprint of the sector, however it may incur financial investment, changes in fishing behaviour and value of catch.	Variable
Legal	UK Government's net zero targets, as set out in the Climate Change Act[171].	Increased development of renewable energy and other infrastructure (e.g. export cables, and interconnectors) will increase the level of spatial constraint experienced by the sector. Decarbonisation of the fishing sector may result in some vessels being decommissioned, and a shift from more fuel-intensive to less fuel-intensive fishing methods.	-

[170] Shellfish Association of Great Britain. 2024. Codes of Practice for the Welfare of Crabs, Lobsters, Crawfish and Nephrops. Available at: https://shellfish.org.uk/codes-of-practice-for-the-welfare-of-crabs-lobsters-crawfish-and-nephrops/ Accessed October 2024.
[171] UK Government. 2019. Climate Change Act 2008. Available at: https://www.legislation.gov.uk/ukpga/2008/27/section/1/2019-06-27 Accessed October 2024.

Driver	Details	Implications	Impact (+ / - / Variable)
	UK Fisheries Act 2020 and introduction of Fisheries Management Plans (FMPs)	FMPs should help stocks to recover where they are overfished, and help ensure the long-term sustainability of UK fish stocks. However, there may be restrictions on effort and gears required to achieve this.	Variable
	New and updated regulations (e.g. The Code of Practice for the Safety of Small Fishing Vessels of less than 15m Length Overall, and Certificate of Medical Fitness)	Increasing levels of regulation and requirements for certifications disincentivises working in the sector, and makes it harder for existing fishers to continue to meet requirements.	-
Environmental	Climate change leading to changes in productivity and spatial distribution of fish stocks	Affects access to fish stocks. Current target species may become less available in the area, but new species and fisheries may emerge. However, a mis-match in businesses' quota holdings and stock availability on the ground may constrain the adaptation of the sector to these changes.	Variable
	Stock status improvements or declines	Stock status determines the level of quota and fishing opportunities available (e.g., total allowable catch (TACs), licences, permits and quotas; days at sea; gear restrictions).	Variable
	Management and designation of MPAs and HPMAs	Likely to reduce the area available for fishing, particularly for mobile demersal gears, as more restrictions are introduced in SACs, Marine Conservation Zones (MCZs) and HPMAs.	-

11.4 Future scenarios

6 year projection

Fishing activities in the Plan areas are likely to remain fairly stable in volume and value over the next 6 years (moderate confidence). However, improvements in catch recording and data management, and environmental sustainability of the fishing fleet, have the potential to support the long-term sustainability of the sector.

Spatial pressures on fisheries are likely to increase in the Plan areas over the next 6 years, with an **increase in offshore wind farm development** (see Section 16), **associated cables** (see Section 15), **aggregate dredging** (see Section 12) and **environmental restrictions** (see Sections 26 and Section 27) (high confidence). Although fisheries are only legally temporarily excluded from offshore wind farms during their construction phase, it appears that fishing does not return to

pre-construction levels, once the offshore wind farm is operational[172,173]. Despite fishing activities using static gear, such as shellfisheries, being more likely to co-locate within offshore wind farms, there is still **potential for shellfisheries to be reduced and/or displaced due to spatial squeeze within the Plan area over the next 6 years** (moderate confidence). Safety issues associated with fishing over subsea cables are one of the pertinent factors in determining where fishing will take place inside and outside of offshore wind farms[174] (high confidence).

An **aging workforce and access to labour, and new regulations** (e.g. new Maritime and Coastguard Agency (MCA) Codes of Practice, Certificate of Medical Fitness), **are also likely to impact the future of fisheries in the Plan areas in terms of a reduction in the number of active vessels** (particularly small-sized vessels) (moderate confidence). However, the overall economic impact of this reduction will be influenced by other factors such as the value and volume of catch of the remaining vessels (high confidence). There is also the potential for the Animal Welfare (Sentience) Bill to affect the sector's social licence to operate (low confidence). In addition, **regulatory changes** (as a result of Brexit), **changes to quotas, and increasing operational costs** (namely the increased price of fuel) are also a key concern for the fishing sector therefore **creating uncertainty on the trend in the sector** across the next six years.

Shellfish landings, in general, are likely to remain stable, balancing the effects of increases over the past decade with influences of market demand and price, marine fuel and energy costs, seasonal fluctuations in stock status, implementation of FMPs, spatial squeeze, and incentives for fishers to target alternative species (low confidence). **The shellfisheries in The Wash (i.e., cockle, whelk and shrimp) are less likely to be impacted by spatial squeeze** (moderate confidence), in comparison to fishing activities taking place further offshore, however, The Wash may still be subject to environmental protection measures and export cables (and landing points) for offshore renewable energy sites. Cockles are subject to fluctuations in their annual reproductive success, and hence stock status, therefore **the trajectory for the cockle fishery over the next six years is unpredictable** (high confidence). **The Wash whelk fishery is likely to reduce in terms of volume** (moderate confidence), because the stock is currently over-exploited (Figure 15) and there are local management measures in place to halt increases in fishing effort. **The whelk FMP is likely to introduce further management measures to address the overexploitation.** Stable or (increased) market demand for whelks may increase the value of the fishery (moderate certainty). **The well-managed shrimp fishery in The Wash is likely to remain stable in terms of volume of catch over the next six years,** however, market demand may result in an increase in value (moderate certainty).

[172] Haggett et al. (2020). Offshore wind projects and fisheries: conflict and engagement in the UK and the US. Oceanography, 33:38–47.
[173] Dunkley & Solandt (2022) Windfarms, fishing and benthic recovery: Overlaps, risks and opportunities. *Marine Policy* 145: 105262. doi.org/10.1016/j.marpol.2022.105262.
[174] ABPmer & MRAG, (2023). Adaptations to Offshore Wind Farms and Fishing Methods to Enable Co-location, Final Report, ABPmer Report No. R.4184. A report produced by ABPmer for Defra, May 2023. Available at https://randd.defra.gov.uk/ProjectDetails?ProjectId=21313. Accessed October 2024.

In contrast to shellfisheries, within the next six years **there may be changes to demersal and pelagic fisheries management** (e.g. TAC and quota allocations), **with subsequent changes to catches from the Plan areas, as well as landings into Plan areas ports** (moderate confidence). The extent of such changes is currently unknown. Demersal and pelagic fisheries are generally located further offshore, **therefore marine fuel and energy costs, the value of disposable income from consumers, and changes in the fleet to adapt to net zero targets, may also determine fishing behaviour** (e.g. fishing closer to port; changing target species, gear type and/or engine technology) (moderate certainty). The extent of the fishing fleet's ability to adapt to net zero and the subsequent impact on fishing activities in the Plan areas is currently unknown (high confidence).

6 to 20 year projection

Over the next 6 to 20 years, climate change (in particular, changes to seawater temperature and ocean acidification) **is likely to affect the distribution and productivity of commercial fish stocks,** which in turn will affect fishing activities (moderate confidence); however, the details are uncertain. The southern North Sea has been noted as a regional 'hotspot' for increases in seawater temperature over the past 50 years[175]. A **northward distribution shift, in response to rising seawater temperatures, is the common consensus for fish populations in UK waters**. It has also been documented that North Sea demersal fish populations are moving to cooler deeper waters[176]. **There may be opportunities to increase catches of incoming species, but the extent of such opportunities is unknown**, and will depend on species assemblages present in the Plan areas over the next 6 to 20 years, quota availability at individual business level, and future international fishing agreements on quota allocations and access to waters[177] (moderate certainty).

Over the next 6 to 20 years, within the Plan areas, **there is likely to be a shift in species composition of the commercial fish and shellfish stocks, with reductions in plaice, sole and cod fisheries**[177,178], **and increases in 'incoming' warm water species,** such as red mullet, tub gurnard, John Dory, anchovy, and squid[177,179] (moderate confidence).

Climate change, including increased seawater temperature and ocean acidification, is unlikely to significantly affect shellfish stocks in the Plan areas over the next 6 to 20 years (moderate confidence). The Plan areas are currently at the centre of the natural distribution range for lobsters and crabs, and therefore changes in seawater temperature are unlikely to displace lobster and crab from the

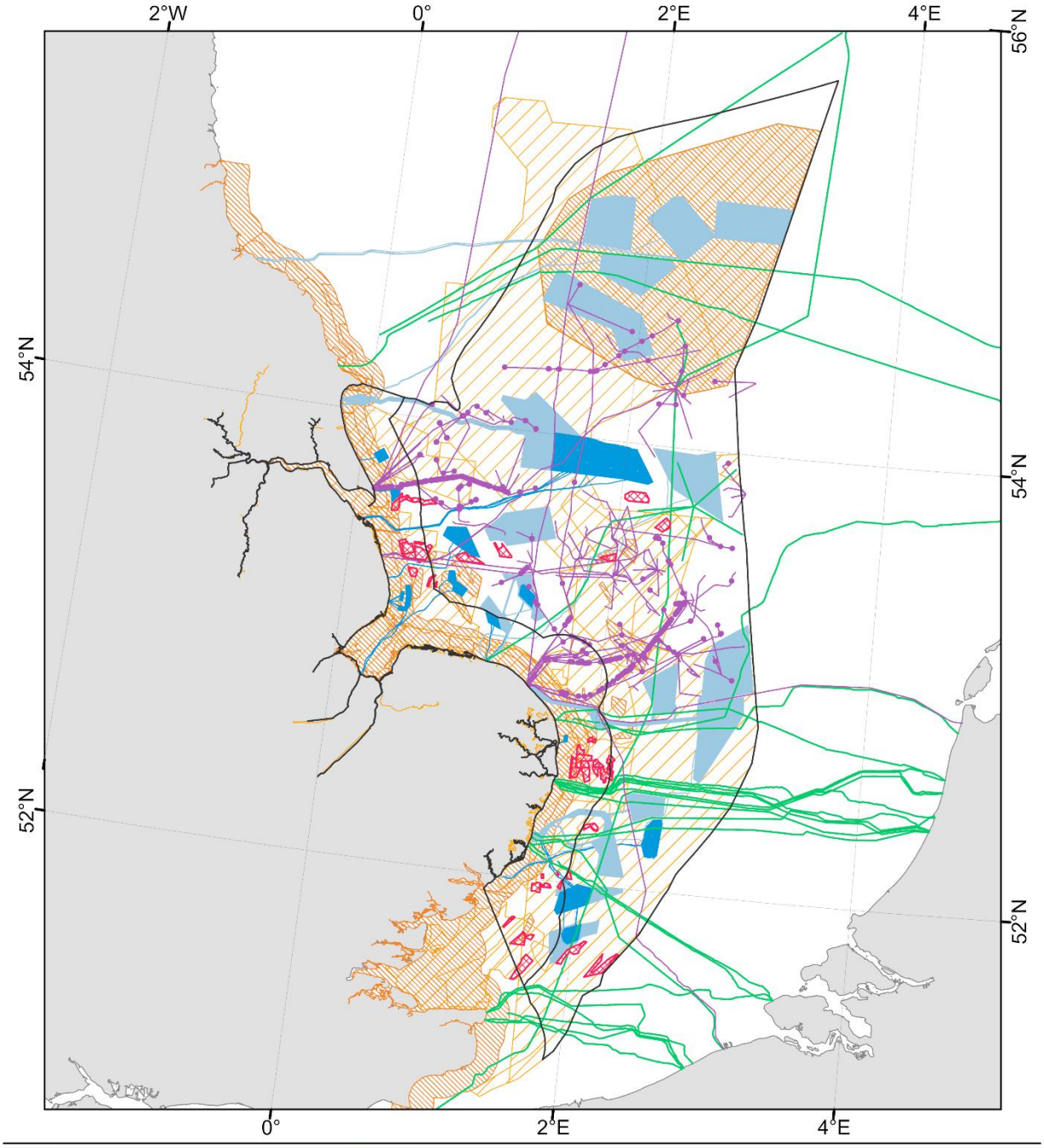
[175] Hobday and Pecl (2013). Identification of global marine hotspots: sentinels for change and vanguards for adaptation action. Rev Fish Biol Fisheries. https://doi.org/10.1007/s11160-013-9326-6 Accessed October 2024.
[176] Dulvy et al. (2008). Climate change and deepening of the North Sea fish assemblage: a biotic indicator of warming seas. https://doi.org/10.1111/j.1365-2664.2008.01488.x Accessed October 2024.
[177] Townhill et al. (2023). Climate change projections of commercial fish distribution and suitable habitat around north western Europe. Fish and Fisheries, 24:848–862. DOI: 10.1111/faf.12773
[178] Engelhard et al. (2011) Nine decades of North Sea sole and plaice distribution. ICES Journal of Marine Science, 68: 1090–1104
[179] Beare et al. (2004). Long-term increases in prevalence of North Sea fishes having southern biogeographic affinities. Marine Ecology Progress Series, 284, 269–278.

Plan areas (high certainty). The pH of seawater varies greatly around UK, and therefore lobsters and crabs are adapted to such variation. It is unlikely that the pH of seawater will decrease to values low enough (via ocean acidification) to detrimentally affect lobsters and crabs over the next 6 to 20 years (moderate confidence). It should be noted, however, that it is the early life stages of crustaceans (i.e. planktonic larvae) which are most susceptible to ocean acidification[180,181], therefore, the distribution and survival of lobster and crab larvae may change over the next 6 to 20 years (low confidence). The extent of this change within the Plan areas is unknown (high confidence).

It is also likely that spatial squeeze within the Plan areas will limit the opportunities for the fishing industry to adapt to changes in fish stock composition and distribution resulting from climate change over the next 6 to 20 years (moderate confidence). Figure 15 highlights the potential spatial squeeze that may be felt by commercial fisheries from other marine industries and environmental protections in the Plan areas.

[180] Gravinese et al. (2018). Warming and pCO2 effects on Florida stone crab larvae. Estuarine and Coastal Shelf Science. 204, 193–201.
[181] Bednaršek, et al. (2020). Exoskeleton dissolution with mechanoreceptor damage in larval Dungeness crab related to severity of present-day ocean acidification vertical gradients. https://doi.org/10.1016/j.scitotenv.2020.136610

Figure 15: Current and future marine spatial squeeze.



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12 Marine Aggregates

12.1 Sector definition

Marine aggregates are a mixture of natural sands and gravels used in construction and civil engineering, derived from marine sources[182]. Once dredged from the seabed, the marine aggregates are typically delivered to discharge wharves in markets close to the dredging licence area[183], although they can also be delivered to wharves further afield as well as to mainland Europe[183,183,184,185]. Marine aggregates are used both within the region they are delivered and further afield domestically and in European markets[185]. Additionally, marine aggregate resources are used for beach replenishment purposes that play an important role in coastal defence management and protection and as construction fill for large infrastructure projects[184].

Marine aggregates are pumped up with seawater from the seabed through a draghead and dredge pipe, and into a vessel's hopper. Many aggregate dredgers have the ability to part-process the sediment whilst loading operations are underway. This involves a process of 'screening', in which the proportion of sand to gravel in the cargo is adjusted to meet customer requirements[183].

12.2 Historic trends and current activity

The Plan areas (which cover the Humber, East Coast and Thames Estuary aggregate regions) typically account for half of the total extraction of marine aggregates (by weight) and two thirds of the total area dredged at a national level. Almost half of the national commercial extraction licences are also located in the Plan areas[185]. Marine aggregates play an important role in supply of aggregates nationally. Demand is predominantly for use in construction projects, with associated benefits such as investment and jobs, and the contribution to the economy both in the UK and in Europe. Over 50% of Plan areas sourced aggregates were delivered to the Thames Estuary with a significant proportion also delivered to mainland Europe. There has also been local demand for sand for beach recharge within the Plan areas due to the high susceptibility to erosion along most of the coast within the region (see Section 22 Coastal change and flooding). There are a substantial number of existing licensed areas for aggregate extraction in the Plan areas (Figure 16) with 14 licence areas requiring renewal by the end of 2029[186]. There are also

[182] The Crown Estate. Marine Aggregate Terminology. Available at: https://bmapa.org/documents/BMAPA_Glossary.pdf Accessed October 2024.
[183] Aggregate dredging and the marine environment: an overview of recent research and current industry practice. Available at: https://bmapa.org/documents/Aggregate_Dredging_and_the_Marine_Environment.pdf Accessed October 2024.
[184] Marine Aggregates Info. Available at: https://www.marineaggregates.info/images/publications/marine-aggregates-capability-portfolio-2020_FINAL.pdf Accessed October 2024.
[185] The Crown Estate. Marine Aggregates Annual Report 2022. Available at: https://downloads.ctfassets.net/nv65su7t80y5/2nDt90um0vkUeumS8Ti7OV/a7c65bb53dd43b14925322c820779b80/marine-aggregates-annual-review-2022.pdf Accessed October 2024.
[186] The Crown Estate. 2024. The Crown Estate Open Data: Aggregates Site Agreements (England, Wales & NI). Available at: https://opendata-

three ‘exploration’ areas. An aggregates ‘exploration’ area includes what The Crown Estate (TCE) refers to as the ‘*act of investigating, through survey techniques for commercially viable aggregate resources within a defined area of seabed, and is subject to the exclusive option agreement*’. Aggregate exploration occurs within a defined search area which is larger than the area of the final production agreement. Dredge licence applications have been submitted for all three exploration areas.

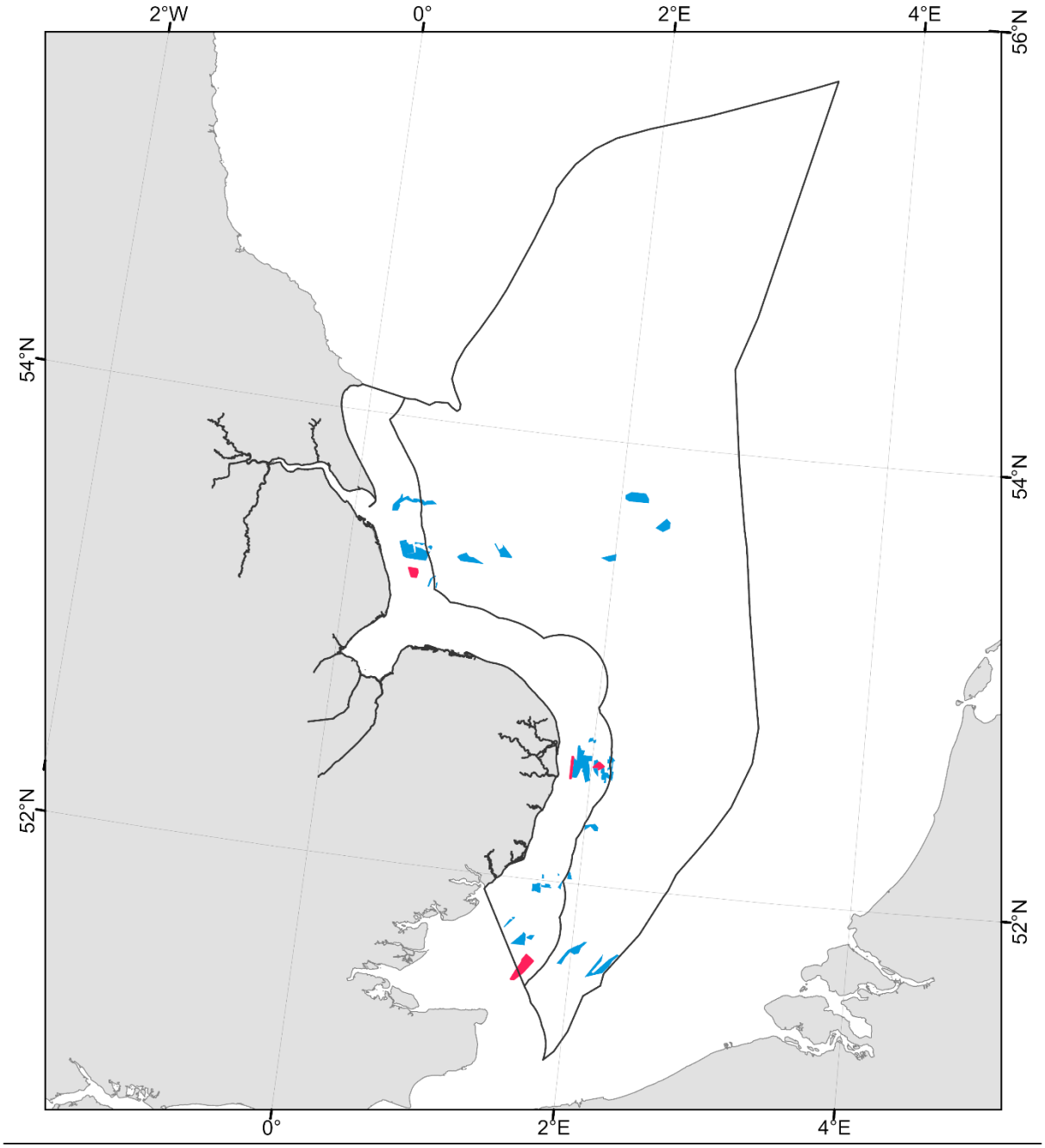
A joint initiative between TCE and members of the British Marine Aggregate Producers Association (BMAPA) aims to minimise the area of seabed licensed and area of seabed dredged. This reduces the spatial impact of the activity, and the potential for conflict with other users as a result. This has been supported by the introduction of active dredge area zones and Regional Active Dredge Area charts that are produced bi-annually. Compliance is ensured through electronic monitoring systems that are required on all marine aggregate dredgers.

Within the Plan areas, the total area of seabed licensed for aggregates extraction nearly doubled between 2014 and 2017 with the total active dredge area also doubling between 2015 and 2019; both have remained relatively stable since[187]. Despite this increase, total area dredged and total amount of sand and gravel dredged (in million tonnes) has remained relatively unchanged between 2013 and 2022 with only small fluctuations reported.

thecrownestate.opendata.arcgis.com/datasets/thecrownestate::aggregates-site-agreements-england-wales-ni-the-crown-estate/explore Accessed October 2024.

[187] BMAPA. Reference Library. Available at: https://bmapa.org/downloads/reference.php Accessed October 2024.

Figure 16: Marine aggregate production agreement areas, and exploration and option areas.



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Projection:Lambert Azimuthal Equal Area

12.3 PESTLE analysis

The primary drivers of marine aggregate extraction are construction demand, for example for housing and infrastructure projects (requiring increased provision of aggregate from alternative sources, including marine, as the availability of land-won sand and gravel reduces, largely through exhaustion), and climate change, which will result in an increased demand for marine aggregate for beach nourishment, sandscaping and major projects aimed at reducing carbon emissions.

Political and economic drivers point to an increase in housing and infrastructure in the short-term and therefore an increase in demand for aggregate resources is anticipated. The Crown Estate estimates that there is potential for marine aggregate demand to increase nationally to 29 million tonnes per year by 2030[188].

The most important drivers that could impact marine aggregate extraction in the Plan areas are listed in Table 12 below.

Table 12: PESTLE analysis for the dredging and marine aggregates sector.

Driver	Details	Implications	**Impact (+ / - / Variable)**
Political	The Levelling Up and Regeneration Act 2023[189] introduced a number of measures to incentivise faster build-out of housing sites. The National Infrastructure Strategy[190] outlined the previous Government's plans to build new homes, and the current administration will set mandatory targets to build 1.5 million new homes[191].	Continued demand for aggregates to support growth and construction.	+
	The National Planning Policy Framework[192] sets out the Government's planning policies for England and how these are expected to be applied, including: • Delivering a sufficient supply of homes • Building a strong, competitive economy	Continued demand for aggregates to support growth and construction.	+

[188] The Crown Estate. 2023. Marine Aggregates Annual Review 2023. Available at: marine-aggregates-annual-review-2023.pdf (thecrownestate.co.uk) Accessed October 2024.
[189] UK Government. Levelling-up and Regeneration Act 2023. Available at: https://www.legislation.gov.uk/ukpga/2023/55/contents Accessed October 2024.
[190] HM Treasury. National Infrastructure Strategy. Available at: https://assets.publishing.service.gov.uk/media/5fbd810dd3bf7f5736c1a18f/NIS_final_web_single_page.pdf Accessed October 2024.
[191] https://www.gov.uk/Government/news/housing-targets-increased-to-get-britain-building-again. Accessed October 2024.
[192] UK Government. 2012. National Planning Policy Framework. Available at: https://www.gov.uk/guidance/national-planning-policy-framework Accessed October 2024.

Driver	Details	Implications	**Impact (+ / - / Variable)**
	• Meeting the challenge of climate change, flooding and coastal change • Conserving and enhancing the natural environment • Conserving and enhancing the historic environment • Facilitating the sustainable use of minerals.		
	The UK MPS[193] acknowledges the key role played by the marine aggregate industry in safeguarding supplies for future use and meeting demand.	Continued demand for (marine) aggregates to support growth and increased reliance on marine aggregates.	+
Economic	Demand for marine aggregates from construction industry linked to economic cycle and public/private investment.	Demand for marine aggregates will fluctuate in response to economic cycles.	Variable
	Large-scale infrastructure project demand (e.g. port development (e.g. Immingham Green Energy Terminal and Immingham Eastern Ro-Ro Terminal), nuclear new build (e.g. Sizewell C), renewable energy developments and export markets).	Demand linked to policy drivers of other sectors, and economic climate.	Variable
Social	No significant drivers identified.		
Technological	Increased efficiency with new vessels resulting in reduced costs and reduced emissions.	Influences ability to meet increased demand.	+
	Ability of the fleet to extract marine aggregates from deeper waters.	Increased area where marine aggregates can potentially be extracted.	+
	Ability of industry to deliver more marine aggregates relates to the capacity of the fleet and the wharf facilities to allow landings, processing and distribution.	Influences ability to meet increased demand.	+
Legal	No significant drivers identified.		
Environmental	Targets of The Marine Strategy Regulations 2010.	Potential constraints/ restriction on areas within which aggregates can be dredged.	Variable

[193] HM Government. 2012. UK Marine Policy Statement. Available at: https://assets.publishing.service.gov.uk/media/5a795700ed915d042206795b/pb3654-marine-policy-statement-110316.pdf Accessed October 2024.

Driver	Details	Implications	**Impact (+ / - / Variable)**
	UK Government focus on offshore wind developments. The British Energy Security Strategy sets out the UK's ambitions to produce 50GW of electricity from renewable energy sources. The target of reaching net zero by 2050 as set out in the Climate Change Act[194] is a significant driver to increase offshore renewable development as a priority.	Potential constraints/ restriction on areas within which aggregates can be dredged or additional restrictions stipulated within marine licence conditions due to cumulative pressures on environmental receptors.	Variable
	Increased pressure on coastal areas from rising sea levels, leading to increased need for coastal defences, beach nourishment and sand reclamation.	Increased demand for marine aggregate.	+
	Balance of land-won versus marine aggregate; reduced availability of land-won sand and gravel (largely through exhaustion).	Increased demand from alternative sources, including marine resources.	+
	MPAs may affect some marine aggregates activities.	Increased regulation of marine aggregates activities (e.g. additional licence conditions).	Variable
	Management and designation of MPAs and HPMAs.	Potential constraints/ restriction on areas where aggregate extraction can take place.	Variable

12.4 Future scenarios

6 year projection

Licence renewals are issued for 15-year periods. Fourteen licence areas require renewal by the end of 2029, with another three due for renewal by the end of 2030. Assuming all licence areas will be successfully renewed, **the location of marine aggregate extraction will continue in the existing licence areas** (high confidence). Additionally, **production from the three existing application areas for new marine aggregate production is expected** (moderate confidence). If approved this would **slightly increase the total area of seabed licensed** for aggregates extraction and would result in an increased permitted tonnage by 1.65 million tonnes.

[194] UK Government. 2019. Climate Change Act 2008. Available at: https://www.legislation.gov.uk/ukpga/2008/27/section/1/2019-06-27 Accessed October 2024.

Despite the predicted increase in demand in the short term, due to the long timescales involved in obtaining a licence it is unlikely that any new areas will be identified and progressed to a licence area within the 6-year scenario in the Plan areas (high confidence).

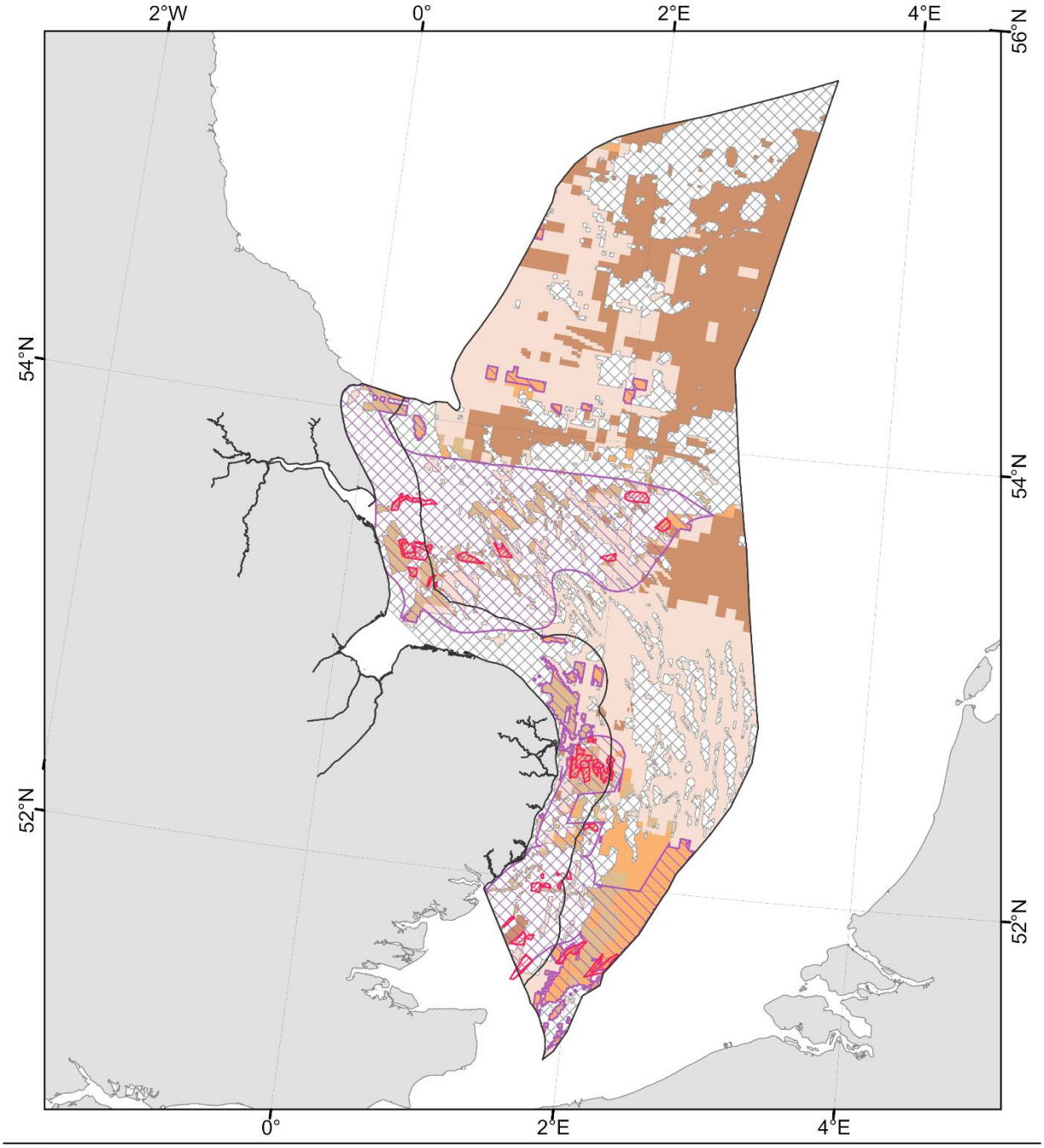
6 to 20 year projection

Marine aggregate **production is likely to continue within the existing licence areas** (seven require renewal before the end of 2033 with another two due to be renewed before the end of 2037) (high confidence). Additionally, **production from the three existing application areas for new marine aggregate production is expected to start in the next 6 years and continue beyond** (moderate confidence).

Current estimates suggest there are 16 years of primary marine aggregate production permitted in the Humber region, 10 years in the East Coast region and 25 years in the Thames region[188].

With demand for marine aggregate anticipated to increase in the next 20 years, it is **likely that production will expand further into areas of optimal aggregate resource**, within spatial constraints from other sectors (especially offshore renewable development), MPAs etc (moderate confidence).

Figure 17: Future potential for marine aggregates.[195]



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13 Oil and Gas

13.1 Sector definition

This sector relates to the domestic extraction of oil and gas from offshore reserves.

13.2 Historic trends and current activity

Oil and gas is the biggest source of energy (including electricity and all other fuel use) in the UK. The UK oil and gas industry provided 76% of the UK's energy source in 2023, equating to 39% from gas and 36% from oil. This is a slight increase on 2021 (75%) and little changed for over a decade[196]. Despite this however oil and gas production is in long-term decline, in the UK gas use has fallen by approximately 30% and oil has fallen by 20% since 2002 respectively[197].

In 2023, the oil and gas industry supported 12,800 jobs in the East of England, 9,400 in the East Midlands, and 10,900 in Yorkshire and the Humber[198]. These regions do not make up the entirety of the Plan areas but provide indicative figures that illustrate the importance of the sector to the East of England. In regard to GVA the industry supported £1,540 million, £7,000 million, and £270 million in the East of England, East Midlands, and Yorkshire and the Humber respectively.

The sector operates by extracting gas and oil from designated areas known as licensed blocks. The Plan areas have a large number of oil and gas infrastructure including surface and subsea points (wells and extraction points) and pipelines (Figure 18). Most of the assets are located in the central area of the Plan areas, seaward from Bacton gas terminal, Theddlethorpe gas terminal, and Easington gas terminal. The northern- and southern-most areas of the Plan areas contain very limited oil and gas infrastructure.

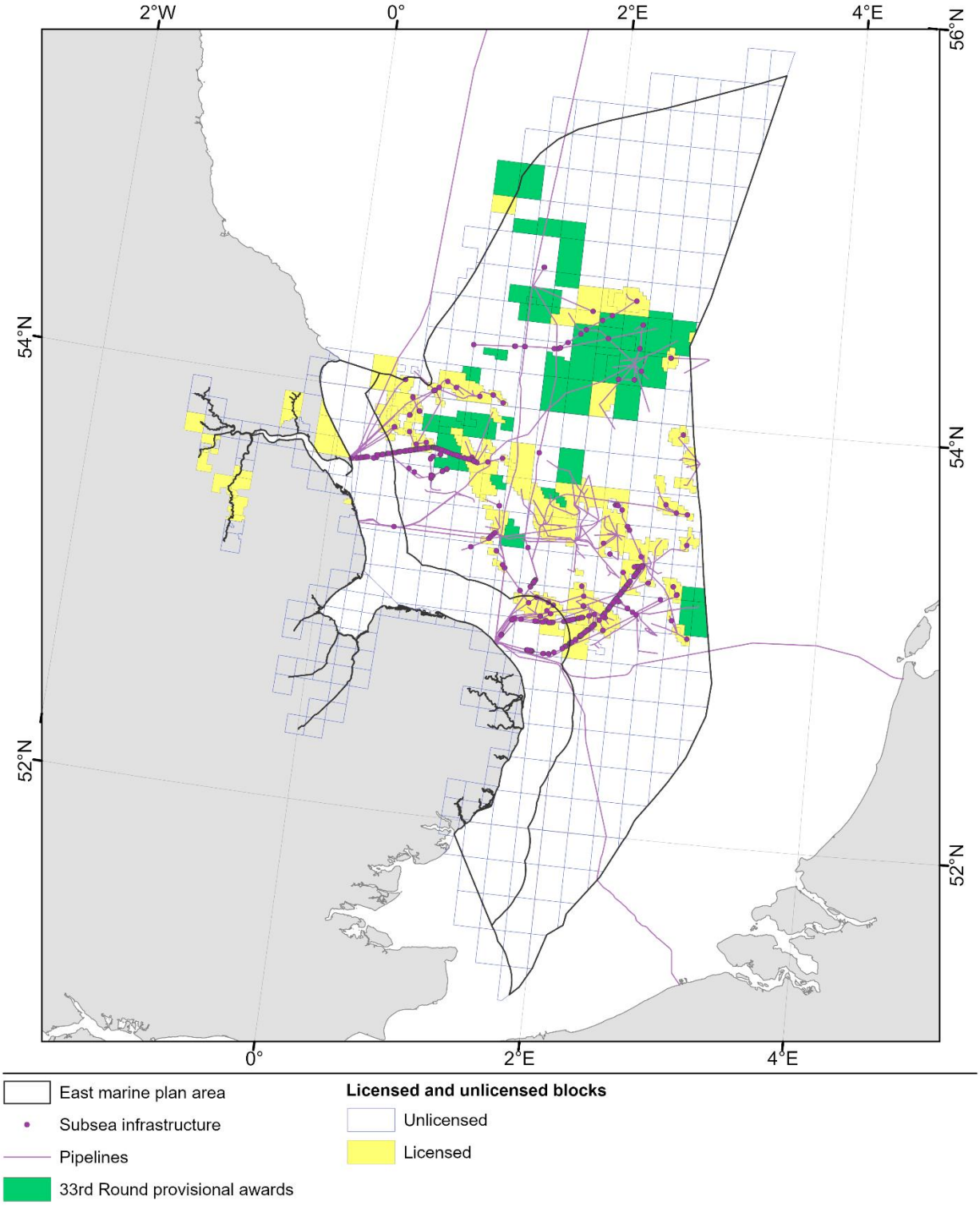
[195] Microsoft Word - East_Inshore_and_East_Offshore.docx

[196] Offshore Energies UK. 2023. Economic Report 2023. Available at: https://oeuk.org.uk/wp-content/uploads/2023/09/Economic-Report-2023-Offshore-Energies-UK-OEUK.pdf Accessed October 2024.

[197] Offshore Energies UK. 2023. Economic Report 2023. Available at: https://oeuk.org.uk/wp-content/uploads/2023/09/Economic-Report-2023-Offshore-Energies-UK-OEUK.pdf Accessed October 2024.

[198] Offshore Energies UK. 2023. Economic Report 2023. Available at: https://oeuk.org.uk/wp-content/uploads/2023/09/Economic-Report-2023-Offshore-Energies-UK-OEUK.pdf Accessed October 2024.

Figure 18: Oil and gas infrastructure and licensed blocks.



Note: The 33rd offshore licensing round is the most recent licensing round inviting companies to apply for licences to extract oil and gas from within the oil and gas licence blocks.

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The NSTA launched its most recent, 33rd offshore leasing round in 2022, and by 2024 had awarded 74 blocks/part blocks in the West of Shetland, Northern North Sea and Central North Sea (through Tranche 2), and 31 new licences made up of 88 blocks/part blocks in the Central North Sea, East Irish Sea and the Southern North Sea (through Tranche 3). Many of these are located in the Plan areas (Figure 18).

13.3 PESTLE analysis

The key drivers expected to influence the oil and gas industry in the Plan areas are political drivers, which govern the licensing requirements for the exploration and abstraction and future trends of activities fuelled by oil and gas. These are listed in Table 13 below.

Table 13: PESTLE analysis for the oil and gas sector.

Driver	Details	Implications	Impact (+ / - / Variable)
Political	Russia's invasion of Ukraine and the increasing supply politicisation has led to the UK decrease its reliance on oil and gas supplied by Russia by increasing dependence on its own energy production. As of 2022 the UK banned the import and ancillary services associated with Russian oil products[199].	Growth in the sector may increase, and the decommissioning of rigs may slow. Additional oil and gas infrastructure in the UK may have knock-on limitations for other marine industries and sea users including increasing power cabling, and spatial squeeze with offshore wind.	+
	The UK Government elected in 2024, has committed to honouring existing oil and gas licences, and will consult on its manifesto position to not issue further licences[200].	During the period of adjustment as these policies are enforced there is uncertainty remains as to how the oil and gas industry will transition towards a more renewable energy market.	-
Economic	Changing oil and gas price.	Changes in oil and gas prices drive extraction of reserves and thus the impact of the sector to the Plan areas. If prices are high extraction will be more profitable leading to increased extraction, the same is true vice-versa.	Variable

[199] UK Government. 2023. UK ban on Russian oil and oil products. Available at: https://www.gov.uk/Government/publications/uk-ban-on-russian-oil-and-oil-products Accessed October 2024.
[200] https://www.gov.uk/Government/news/certainty-for-oil-and-gas-industry-in-light-of-landmark-ruling. Accessed October 2024.

Driver	Details	Implications	Impact (+ / - / Variable)
Social	Social pressure from environmental groups and public relations concerns around emissions and oil spills.	Oil and gas companies may be concerned about their environmental impact and how they are perceived by consumers. This could be a barrier to the growth of the industry.	-
	The oil and gas sector supports a significant number of jobs in the Plan areas[201]. This highly skilled and resilient workforce keeps the sector operational.	Employment opportunities in the sector will change looking ahead in response to the change in activity, this could include more jobs associated with dismissing and fewer jobs available due to the sector decline.	Variable
Technological	Increasingly sophisticated technology will improve the capability of the sector, including by improving the ability to extract from deeper wells or adapt the purpose of part-depleted wells. Specific technologies being explored includes platform electrification to decarbonise the sector, and digitisation and artificial intelligence to improve monitoring capabilities.	Improved technology will increase the ability to extract more oil and gas from existing wells.	+
Legal	The legally binding target of reaching net zero by 2050 is set out in the 2019 amendment of the Climate Change Act 2008[202]. Achieving this reduction in emissions will involve both investing in renewable energy as well as maximising oil and gas reserves in the North Sea.	The oil and gas sector in the Plan areas (and nationally) is expected to continue declining as a result of the increased need and ability for renewable energy to provide the majority of the UK's energy.	-

[201] Offshore Energies UK. 2023. Workforce Insight 2023. Available at: https://oeuk.org.uk/product/oeuk-workforce-insight-2023/ Accessed October 2024.
[202] UK Government. 2019. Climate Change Act 2008. Available at: https://www.legislation.gov.uk/ukpga/2008/27/section/1/2019-06-27 Accessed October 2024.

Driver	Details	Implications	Impact (+ / - / Variable)
Environmental	Environmental concerns in line with combating the impacts of climate change could drive a reduction in carbon emissions from the oil and gas sector. The ambitions to reduce emissions are set out in Offshore Energies' Emissions Report 2023[203].	Reduction in the emissions from oil and gas extraction, and improved efficiency of the sector to limit emissions from current activities.	Variable

13.4 Future scenarios

6-year projection

The licensed blocks in the **NSTA's 33rd offshore leasing round (Figure 18) will be progressed in the next 6 years,** with some areas being developed into operational sites for oil and gas extraction (moderate confidence). Some of these newly licensed blocks are in areas which overlap with currently existing offshore wind leases, which may constrain development or require co-location opportunities to be explored (e.g. through temporal separation)[204]. **Activity within the next 6 years is likely to include undertaking environmental assessments and obtaining licences** (high confidence), and dependent on the outcome, reach operation (low confidence).

Further licences are unlikely to be awarded in the Plan area beyond the 33rd licensing round given the UK Government has stated it will not issue new licences to explore new fields (moderate confidence[205]). It is therefore likely that **activities will focus on maintaining operation of existing sites, developing new sites where licences have already been awarded, and decommissioning of oil and gas assets** (high confidence). The highly skilled workforce supporting the oil and gas industry will likely shift away from the oil and gas industry due to the expected decline in activity and instead support renewable energy industries which require a similar skillset to the oil and gas sector (moderate confidence), this is backed by the roadmap to deliver 'energy skills passports', which aims to recognise cross-sector skillsets[206]. In the Plan areas this could equate to the oil and gas workforce supporting the developing CCUS and hydrogen industries.

[203] Offshore Energies. 2023. Emissions Report 2023. Available at: https://oeuk.org.uk/product/emissions-report-2023/ Accessed October 2024.
[204] UK Parliament. 2024. Oil and Gas Overlaps: Offshore Wind Projects. Available at: https://hansard.parliament.uk/commons/2024-05-24/debates/24052447000010/OilAndGasOverlapsOffshoreWindProjects Accessed October 2024.
[205] The Spectator. 2024. Is Starmer now a friend of the oil and gas industry? Available at: https://www.spectator.co.uk/article/it-didnt-take-starmer-long-to-change-his-tune-on-north-sea-oil-and-gas/ Accessed October 2024.
[206] Offshore Energies UK. 2024. Roadmap for energy skills transition secures backing from wind, oil and gas sectors. Available at: https://oeuk.org.uk/roadmap-for-energy-skills-transition-secures-backing-from-wind-oil-and-gas-sectors/ Accessed October 2024.

6 to 20 year projection

The oil and gas industry will continue to operate in its existing locations and in the 33rd round licence blocks (should the licences remain) with no geographical expansion of the industry beyond these locations (high confidence).

Other activity that will occur across the next 6-20 years is likely to include activities to decommission existing oil and gas infrastructure (high confidence), particularly as the NSTA is carrying out investigations into missed deadlines for well decommissioning[207]. **Additional activities will include the potential for re-purposing existing infrastructure for use by other industries such as CCUS.** There is low confidence of how existing assets can be re-purposed as the rate of growth of CCUS is uncertain and some reservoirs may contain historic wells that have not been decommissioned in a way that is suitable for re-use for CO_2 injection[208].

Given these activities will continue to support the **transition of the oil and gas workforce towards other rapidly developing energy sectors, such as renewable energy, CCUS and hydrogen**, which if achieved, will continue to support economic income for the communities in the Plan areas that were previously supported by the oil and gas industry.

[207] North Sea Transition Authority. 2024. Regulator clamping down on well decommissioning delays. Available at: https://www.nstauthority.co.uk/news-publications/regulator-clamping-down-on-well-decommissioning-delays/ Accessed October 2024.
[208] Department for Business Energy and Industrial Strategy. 2020. Carbon Capture, Usage and Storage: A Government Response on Re-use of Oil and Gas Assets for Carbon Capture and Storage Projects. Available at: https://assets.publishing.service.gov.uk/media/5f36c6df8fa8f51744decfe4/CCUS-Government-response-re-use-of-oil-and-gas.pdf Accessed October 2024.

14 Ports and Shipping

14.1 Sector definition

Ports provide the infrastructure by which goods and people are transported between land and sea[209]. Within England, there are three types of ports that operate on a commercial basis, independently from Government: Trust ports, Municipal ports and Private ports[210]. The Ministry of Defence also own a number of ports used as naval bases.

Shipping provides for the transport of freight and passengers both within English waters and internationally. Commercial shipping routes can be split into two distinct types: transiting vessels passing through marine plan areas; and vessels with either their origin or destination port or anchorage within the area. The sector here does not include any recreational or leisure activities.

14.2 Historic trends and current activity

Ports and shipping are a vital segment of the UK economy. Together they facilitate the capability for seagoing trade both nationally and internationally. As an island nation, the UK is particularly dependent upon its ports and shipping industry which is calculated to have directly contributed £37.1 billion in turnover in 2019[211]. The Plan areas encompass a substantial amount of shipping activity and nationally significant ports.

Major ports are defined by the Department of Transport (DfT) as ports with cargo volumes of at least one million tonnes annually. The major ports in the Plan area include Grimsby & Immingham, Hull, Great Yarmouth and Rivers Hull & Humber (includes the smaller terminals and jetties along the Humber). Goole and River Trent were major ports but have recently fallen below the one million tonnes handled annually target. There are four major ports in the Plan areas of which three are located in the Humber tidal estuary. The only major port in the Plan areas not located along the Humber is Great Yarmouth. While Felixstowe and Harwich are technically outside the Plan area, their proximity will have an impact on the activity in the area.

The combined volume of cargo handled by the ports in the Plan areas was 68.9 million tonnes and accounts for 16% of the total UK seagoing trade in 2023[212]. The volume handled in the Plan areas has slightly decreased over the last 10 years. In Grimsby and Immingham, which is the second largest port in the UK, 46 million

[209] Her Majesty Government. UK Marine Policy Statement. 2011. Available at: https://assets.publishing.service.gov.uk/media/5a795700ed915d042206795b/pb3654-marine-policy-statement-110316.pdf Accessed October 2024.
[210] House of Commons. 2022. Ports and Shipping FAQs. Available at: https://researchbriefings.files.parliament.uk/documents/CBP-9576/CBP-9576.pdf Accessed October 2024
[211] The economic contribution of the UK Ports industry https://www.maritimeuk.org/media-centre/publications/2022-cebr-reports/ Accessed October 2024.
[212] Maritime statistics: interactive dashboard https://maps.dft.gov.uk/maritime-statistics/index.html Accessed October 2024.

tonnes of freight is handled annually. The creation of Humber and East freeports (outer boundary extends into Plan area) have also driven growth in this area via the specialised tax and customs rules.

Table 14: Cargo volume handled by ports in the Plan areas during 2023[213].

Major Port	Volume (millions)
Grimsby & Immingham	45.97
Rivers Hull & Humber	10.40
Hull	8.17
Great Yarmouth	1.87
Goole	0.90
River Trent	0.81
Boston	0.74
Total	**68.86**

The majority of cargo handled by ports in the Plan areas is imports (75% of cargo). Freight traffic is mainly made up of dry bulk, liquid bulk, Roll-on/Roll-off (Ro-Ro) and Lift-on/Lift-off (Lo-Lo) cargos. Plan areas ports rely heavily on trade with Europe; 68.5% of the total volume is routed to or from Europe. Since the UK has left the EU, the volume routed to and from the EU and the Plan area has fallen 9% from 2022 to 2023.

Ports in the Plan areas also handle a small number of short sea ferry journeys to and from mainland Europe. Approximately 480,000 passengers used the services to or from the Humber with the majority of the crossings to the Netherlands.

The proximity of ports in the Plan areas to offshore wind farms has resulted in them playing an important role in the construction and transportation of turbines. Hull has become a hub for offshore wind and services both inshore and offshore wind farms in the Plan areas. However, the construction of these wind farms has encroached on the navigable space, making it ever more important for marine planning to ensure both sectors can co-exist.

The global drive to reduce carbon emissions and prevent climate change has had a significant impact on the ports and shipping industry in the UK. The International Maritime Organisation (IMO), which the UK is a party to, has set targets to reduce emissions by 2030 and reach net zero by 2050. In 2021 regulations were introduced to limit the amount of sulphur in marine fuels that are used by ships to 0.5%. However, as the entirety of the Plan areas are in an emission control area it is already limited to only 0.1%. This has led to increased costs and operational challenges for vessel owners transiting the Plan areas.

[213] Maritime statistics: interactive dashboard https://maps.dft.gov.uk/maritime-statistics/index.html Accessed October 2024.

Figure 19: IMO routeing measures.

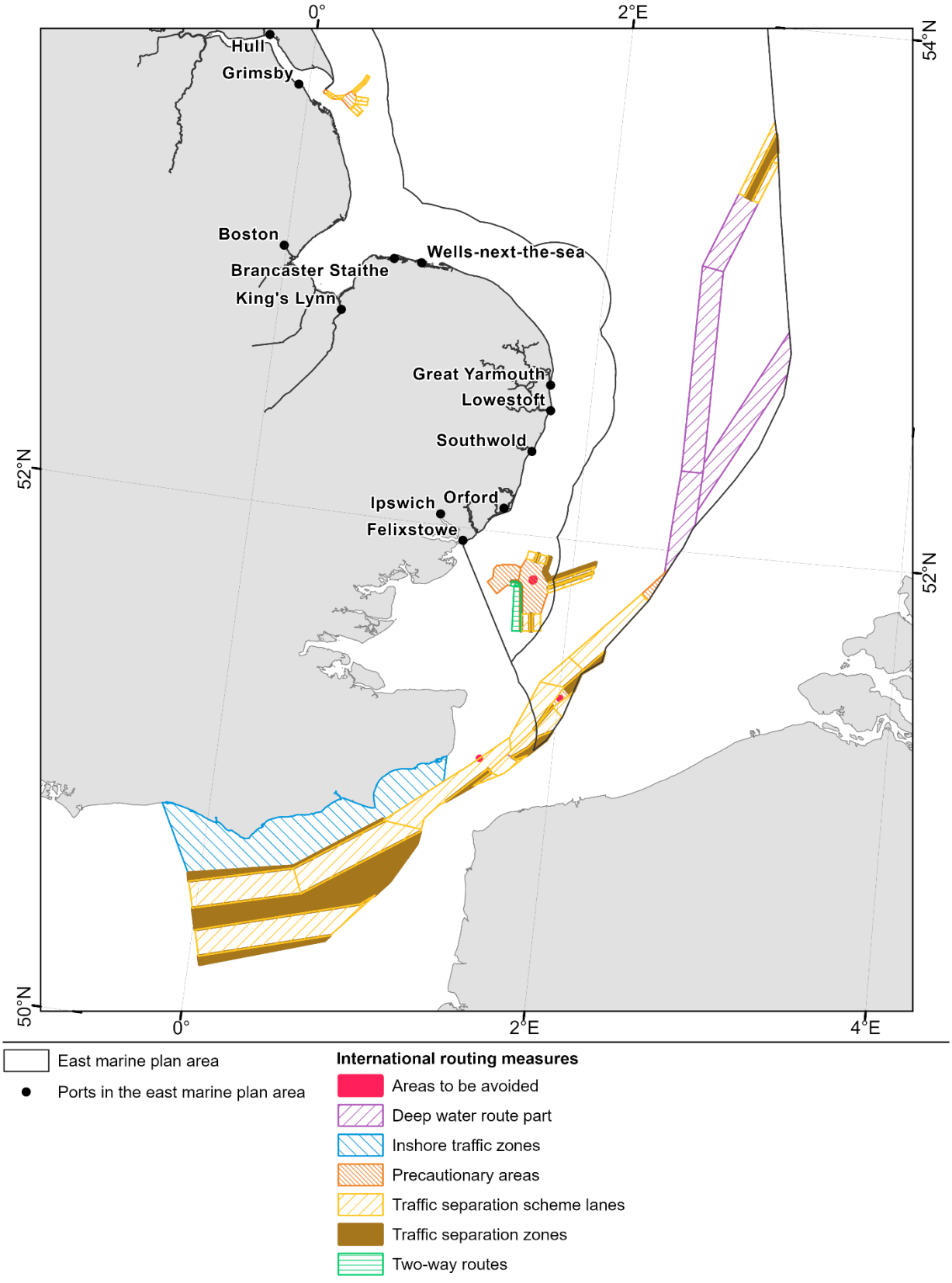

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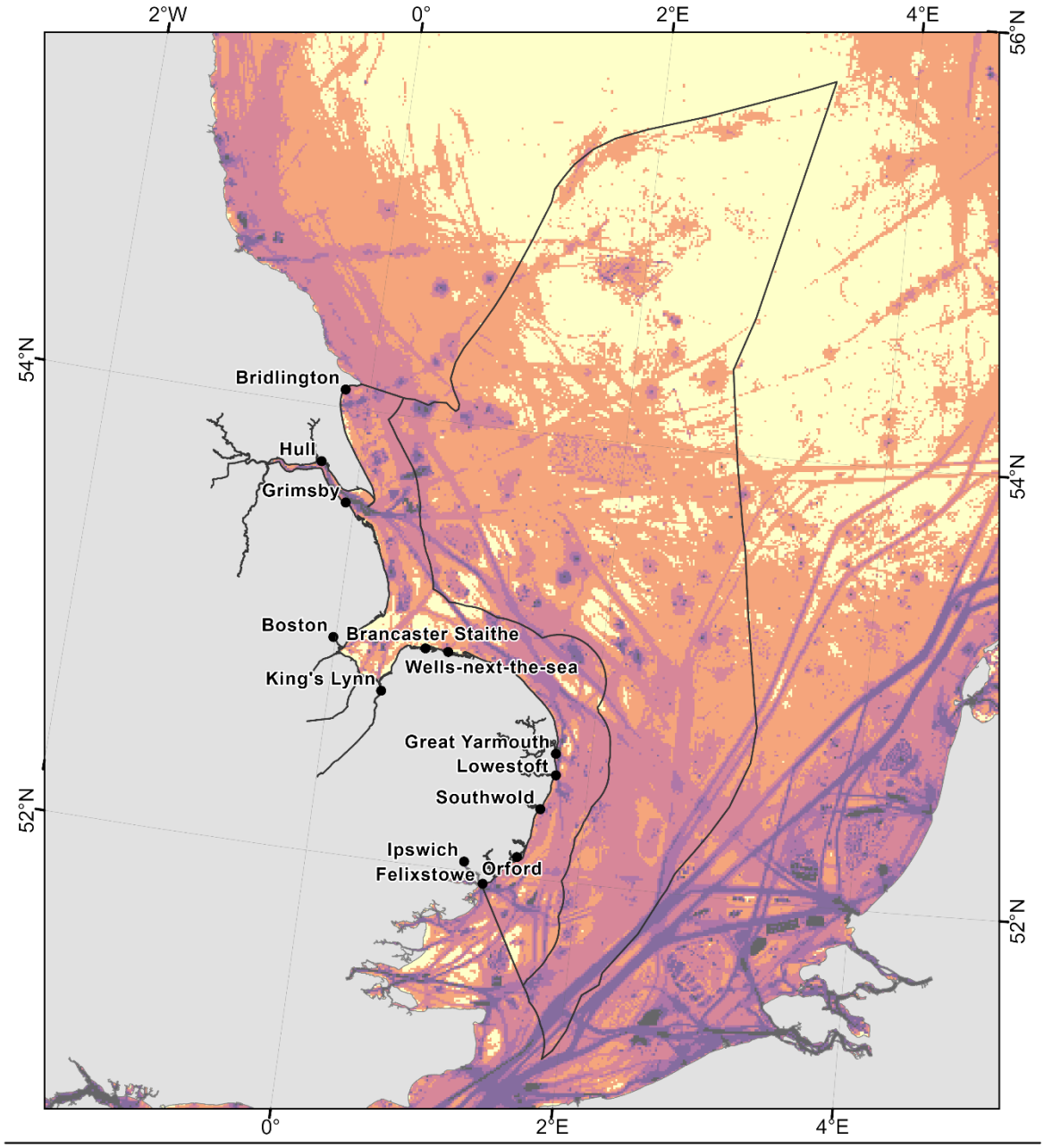
Figure 20: Ports and vessel density.



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Coordinate System:ETRS 1989 LAEA
Projection:Lambert Azimuthal Equal Area

The large amount of trade coming through ports inherently results in UK waters being heavily used by commercial shipping vessels and this is especially true in the Plan areas as shown in Figure 19 and Figure 20[214]. Regularly used navigation passages can be clearly seen. Particularly high areas of vessel activity can be seen in and near to the entrance to the Humber estuary, around the coast of East Anglia, in proximity to Felixstowe and, the northern exit to the Dover Strait Traffic Separation Scheme (TSS). There are also noticeable patterns of activity relating to the various wind farms located in the Plan areas.

For the ports and shipping sector to thrive economically, safety of navigation is essential. To minimise collision risk, some heavily used areas have a TSS which divides opposing traffic into lanes. Within the Plan area there are three TSSs used to manage high traffic areas: the Humber entrance TSS, the Sunk TSS and a portion of the North Hinder TSS.

14.3 PESTLE analysis

The key drivers that will influence the future activity of ports and shipping in the Plan areas are technological and environmental, as these advancements and legislations will impact how shipping occurs. Whilst the need for shipping is heavily driven by economic considerations, technological and environmental changes will be key for advancement into novel sectors such as decarbonisation. These drivers are listed in Table 15 below.

Table 15: PESTLE analysis for the ports and shipping sector.

Driver	Details	Implications	Impact (+ / - / Variable)
Political	UK's future trade deals post-Brexit e.g., Comprehensive and Progressive Agreement for Trans-Pacific Partnership[215]	Potential trade deals made by the UK can have a substantial effect on the volume of traffic handled and the specific port it heads to.	Variable
	Change in energy security demands for the UK.	Increased demand for UK to be more energy independent will lead to less energy imports (oil, gas, biofuels etc.)	Variable
	The Maritime 2050 strategy[216].	Aims to ensure the UK will continue to be a world-leading maritime nation by meeting the challenges and opportunities of the future.	+

[214] EMODnet Human Activities, Vessel Density Map. Available at: https://ows.emodnet-humanactivities.eu/geonetwork/srv/api/records/0f2f3ff1-30ef-49e1-96e7-8ca78d58a07c Accessed October 2024.
[215] UK Government. 2023. UK strikes biggest trade deal since Brexit to join major free trade bloc in Indo-Pacific Available at: https://www.gov.uk/Government/news/uk-strikes-biggest-trade-deal-since-brexit-to-join-major-free-trade-bloc-in-indo-pacific Accessed October 2024.
[216] Department for Transport. 2019. Maritime 2025: Navigating the Future. Available at: https://assets.publishing.service.gov.uk/media/5e6a248786650c7272f4c59d/Maritime_2050_Report.pdf Accessed October 2024.

Driver	Details	Implications	Impact (+ / - / Variable)
Economic	The economic growth performance of the UK.	The activity of UK ports and shipping into the UK has strong ties to the overall economic growth of the country.	Variable
	Creation of Freeports to be national hubs for global trade and investment.	Encourages business investment (manufacturers, freight forwarders etc.) in the Freeport area and additional levels of activity.	+
Social	Worsening public perception of ports and shipping due to noise and environmental pollution[217].	Less investment in ports and shipping. Pressure to transition to greener shipping technologies or power from onshore while in port. The Clean Maritime Plan and Port Air Quality Plans were introduced to eliminate this issue.	-
Technological	Increased use of automation in ports and shipping.	Automation in this sector may improve efficiency and safety but result in loss of sector jobs. Larger buffer zones may be required including around OWFs.	Variable
	Increased size and length of vessels	Ports require extra investment in infrastructure and capital dredging to accommodate larger vessels.	Variable
	Creation or expansion of offshore wind farms in Plan areas.	Ports such as Lowestoft and Great Yarmouth may need to expand activities to accommodate additional demand but will limit navigational space.	Variable
	Electrification of vessels and introduction of a wide range of alternative fuels	New shoreside infrastructure required to match fuel/energy demands of vessels. Fuel costs and availability large factor in route planning.	Variable
Legal	Introduction of global sulphur limits to 0.5% by volume to improve air pollution from vessels.	Increased operating costs for vessels. Green shipping investment and increased industry reputation from local communities.	Variable
Environmental	Climate Change Act 2008[218] and net zero has set targets for reducing carbon emissions.	Increased investment in green shipping and accompanying port infrastructure.	Variable

[217] Felício, J.A., Batista, M., Dooms, M. et al. 2023. How do sustainable port practices influence local communities' perceptions of ports?. Marit Econ Logist 25, 351–380 . https://doi.org/10.1057/s41278-022-00237-7

[218] UK Government. (2019). Climate Change Act 2008. Available at: https://www.legislation.gov.uk/ukpga/2008/27/section/1/2019-06-27 Accessed October 2024.

Driver	Details	Implications	Impact (+ / - / Variable)
	Mitigating the effects of global climate change.	Increased investment in green shipping and accompanying port infrastructure.	Variable
	Water quality standards have the potential to affect port activities as vessels must comply with standards to reduce the potential for vessels to contaminate the water supply in ports[219].	Meeting water quality standards could increase costs for ports in the Plan areas to meet the standards.	Variable

14.4 Future scenarios

6 year projection

The UK ports and shipping industry is undergoing a transformative period driven by technological advancements and environmental regulations. Over the next six years **the primary trend for investment and development will be decarbonisation and the transition to green energy.**

As part of this transition, **the Immingham Green Energy Terminal will be developed to support hydrogen production and transportation** (moderate confidence)[220]. **Plan area ports will continue to play a significant role in North Sea offshore wind developments** supporting the upcoming Hornsea Three and Four projects (high confidence)[221]. There is also the **possibility that a port in the Plan area is selected to be in the Green Shipping Corridor** initiative with its location being ideal for the link between the UK and Europe (low confidence).

It is also **likely that the planned developments** in the Plan area of the Immingham Eastern Roll-on/roll-off (ro-Ro) Terminal (moderate confidence)[222] and a Western Docklands Cruise terminal expansion in Hull (moderate confidence)[223] **will be implemented**. If these developments go ahead they will increase the number and **variety of vessels transiting in the Plan area and provide a positive outlook for the near future for the sector.**

[219] The Association of Port Health Authorities. 2024. Water Quality. Available at: https://www.porthealthassociation.co.uk/seaports/water-quality/ Accessed October 2024.
[220] Associated British Ports. 2024. Immingham Green Energy terminal. Available at: https://imminghamget.co.uk/proposals/ Accessed October 2024.
[221] Orsted. 2024. Hornsea Projects. Available at: https://hornseaprojects.co.uk/ Accessed October 2024.
[222] Planning Inspectorate. 2024. Immingham Eastern Ro-Ro Terminal. Available at: https://national-infrastructure-consenting.planninginspectorate.gov.uk/projects/TR030007 Accessed October 2024.
[223] BBC. 2023. Hull cruise ship terminal plans as part of dockland regeneration. Available at: https://www.bbc.co.uk/news/uk-england-humber-67417434 Accessed October 2024.

6 to 20 year projection

The Green Energy transition will continue to occur with the following zero emission ambitions for the maritime sector planned for the next 6 to 20 years:

- **by 2035 the 'clean maritime clusters'** will have been completed and low- or zero- emission fuel bunkering will be widely available across the UK;
- **by 2050 the UK will have established itself as a global leader in the zero-emission maritime sector** and that the UK Ship Register will be a global leader in clean shipping[224]

In this period it is likely that **vessels will move away from the traditional hydrocarbon-powered combustion engines towards more sustainable methods of power with biofuel or nuclear** power being the prospective alternatives. This will coincide with the falling demand for hydrocarbon products. **Ports in the Plan will need to meet the changing demands of vessels and cargo** (moderate confidence).

Projections of UK port freight traffic covering the years 2017 through to 2050 by the DfT reported **that overall port traffic is forecast to remain relatively flat over the short term, but then grow over the long term, with tonnage 39% higher in 2050 compared to 2016**[225]. The growing economies in Africa and Asia could also shift UK trade patterns away from Europe which would be unfavourable for ports in the Plan area (moderate confidence).

It is estimated that 125 GW of offshore wind capacity will be required in the UK by 2050[226]. With the total in 2023 being 14 GW (see Section 16) and the North Sea and Plan area **ports already being a hub for offshore wind there are likely to be continued port developments to service this need** (high certainty).

New technologies that are currently emerging can have a vast impact on ports and shipping**. Artificial intelligence, blockchain technologies and digitisation all have been put forward as solutions to increasing safety and efficiency of the industry.** While the form of implementation is to be determined, **automated vessels will likely become a mainstream concept in the 6 to 20 year period.** Ensuring the safe navigation of these vessels in the busy shipping lanes of the Plan areas including along the coast of the UK and the Humber estuary is essential.

[224] UK Government. 2019. Clean maritime plan: Maritime 2050 environment route map. https://www.gov.uk/Government/publications/clean-maritime-plan-maritime-2050-environment-route-map Accessed October 2024.
[225] UK Government. 2019. UK port freight traffic: 2019 forecasts. Available at: https://www.gov.uk/Government/publications/uk-port-freight-traffic-2019-forecasts Accessed October 2024.
[226] UK Government. 2023. Offshore wind net zero investment roadmap. Available at: https://www.gov.uk/Government/publications/offshore-wind-net-zero-investment-roadmap/offshore-wind-net-zero-investment-roadmap#ftnref-8 Accessed October 2024.

15 Power Cables

15.1 Sector definition

Subsea power cables transmit power as electrical current through the marine environment and form electricity networks on a national and international scale. Short distance power cables form links amongst the islands of the UK; long distance cables are termed interconnectors and link the UK to other countries and regions such as Europe. Subsea export cables connect offshore infrastructure such as renewable energy platforms to onshore substations where the electricity can be transmitted through the grid system. Offshore renewable assets in the Plan areas are discussed in Section 16 for offshore wind, and Section 17 for wave and tidal energy.

Subsea power cables transmitting power seaward from the coastline to other countries and areas of the UK (i.e., not from renewable sources) are an additional sector to those identified in the MPS, as only export cables are identified in the existing East Marine Plan (published in 2014) and the MPS.

15.2 Historic trends and current activity

Maintaining a strong network of power cables is required to meet the UK's energy needs, and as demand for energy is increasing so too is the need for a reliable network of power cables. It was estimated that by 2020 the subsea power cables industry could generate £6.7 billion per year and support 150,000 jobs[227]. In 2022, for the first time, Britain exported more power than it imported and with the increased production of energy from offshore sources it is expected that this trend will be maintained into the future[228].

Power interconnectors originating or landing in Great Britain are globally important and enable the transmission of power predominantly to and from France, Norway, Northern Ireland, and the Netherlands. There is one subsea power cable within the Plan areas, this is the Viking Link High-Voltage Direct Current (HVDC) and connects Lincolnshire and Denmark. This interconnector became operational in 2023, it is 757 km long and carries 1,400 MW[229].

There are also many export cables landing on the coastline of the Plan areas connecting the Plan areas to offshore energy devices, such as offshore oil and gas stations and windfarms. The Plan areas, as well as surrounding Liverpool and Lancaster (in the north west) are the areas of the UK with the most export cables (See Section 15.4).

[227] European Subsea Cables Association. 2016. Subsea Cables UK. Available at: https://www.escaeu.org/articles/submarine-power-cables/ Accessed October 2024.
[228] HM Government. 2023. Powering Up Britain, Energy Security Plan. Available at: https://assets.publishing.service.gov.uk/media/642708eafbe620000f17daa2/powering-up-britain-energy-security-plan.pdf Accessed October 2024.
[229] VikingLink. 2024. The Project. Available at: https://www.viking-link.com/ Accessed October 2024.

15.3 PESTLE analysis

The key drivers that will impact power cables in the Plan areas relate to technical advancements (which will increase cable laying capabilities) and economic and political drivers that dictate the financial support received by the industry. The key drivers that will impact the power cables in the Plan areas are listed in Table 16 below.

Table 16: PESTLE analysis for the power cables sector.

Driver	Details	Implications	Impact (+ / - / Variable)
Political	The need for reinforcing and reconfiguring the grid network to respond to net zero challenges and maintaining a reliable energy supply is set out in the Holistic Network Design (HND2)[230] and Interconnector Analysis Report[231]. The need for this re-enforcement is increasingly important at times of conflict between countries and as energy production in the UK increases.	Given maintaining power security and subsea assets (such as deference infrastructure) in the UK is essential there will likely be continual support and investment into the sector to maintain a strong power network and continue to support the transition to net zero.	+
	As part of Power Up Britain's Energy Security Plan, the UK's ambition is to increase interconnection capacity to at least 18 GW by 2030, as well as to build the first multi-purpose interconnectors which connect interconnectors to offshore platforms to form a coordinated approach to cable expansion[232].	Potential change in the power network in the UK to include an increased expansion of cabling manufacturing and power export.	+
	Labour's Great British Energy partnering with the Crown Estate to accelerate investment in, and the development of, offshore renewables projects is driving the need to reinforce and expand the network of interconnectors across the UK[233]. See Section 16 for further detail of the offshore wind sector.	Part of Great British Energy's manifesto is to develop Local Power Plans which are projects for local communities to develop renewable energy. This could see changes to the network of interconnectors in the Plan areas in the future.	Variable

[230] National Gird. 2023. Beyond 2030: A national blueprint for a decarbonised electricity system in Great Britain. Available at: https://www.nationalgrideso.com/document/304756/download Accessed October 2024.
[231] National Grid. 2024. Interconnector Analysis Report. Available at: https://www.nationalgrideso.com/document/304771/download Accessed October 2024.
[232] HM Government. 2023. Powering Up Britain: Energy Security Plan. Available at: https://assets.publishing.service.gov.uk/media/642708eafbe620000f17daa2/powering-up-britain-energy-security-plan.pdf Accessed October 2024.
[233] Great British Energy. 2024. Great British Energy. https://www.gov.uk/Government/organisations/great-british-energy Accessed October 2024.

Driver	Details	Implications	Impact (+ / - / Variable)
Economic	There is significant financial support for growing the offshore power network, including the Offshore Coordination Support Scheme[234] to support the growth of renewable energy industries. As the capacity of the network of export cables improves so too will the UK's overall energy security which will improve the UK's reliance on long distance HVDC cables, interconnectors, and export cables.	Increased support and investment into maintaining a strong power network.	+
	The activity of other sea users will influence where and how subsea cables are placed in the future, this includes competition for space with sectors such as fishing, dredging, and marine protected areas, as well as the necessity to be laid close to offshore energies sources.	Spatial squeeze in the marine environment could change or restrict how and where cables are laid in the future.	Variable
Social	Community opposition is a barrier to the subsea power cables sector in the Plan areas, particularly in Suffolk through Suffolk Energy Action Solutions[235].	Opposition by community interest groups could lead to future power cables in the Plan areas (such as LionLink and SeaLink) being challenged and delayed.	-
Technological	Advances in technology could make it easier to repair and replace undersea cables, this would lead to a more resilient network. This is particularly important as the risk of damage to cables is likely to increase as activities such as shipping, dredging, and fishing increase in intensity.	Expand the capability of power cabling in the UK.	+
	Advances in HVDC technology will improve the efficient of power transmission, this could increase the distance over which power can be transmitted and expand the capability of power cabling in the UK.	Technologies such as the use of Offshore Hybrid Assets could allow the clusters of offshore wind farms in the Plan to form one connection point energy systems of neighbouring countries[236].	+
Legal	No significant drivers identified.		

[234] UK Government. 2023. Offshore Coordination Support Scheme. Available at: https://www.gov.uk/Government/publications/offshore-coordination-support-scheme Accessed October 2024.
[235] Suffolk Energy Action Solution. 2024. Available at: https://www.suffolkenergyactionsolutions.co.uk/ Accessed October 2024.
[236] National Gird. 2024. Offshore Hybrid Assets. Available at: https://www.nationalgrid.com/national-grid-ventures/interconnectors-connecting-cleaner-future/offshore-hybrid-assets Accessed October 2024.

Driver	Details	Implications	Impact (+ / - / Variable)
Environmental	There is increasing concern regarding the impact subsea cables on the marine habitats and species, this includes impact of the electromagnetic field emitted by cables on fish and benthic species, as well as the physical disturbance involved in their placement.	Increased environmental concern could impact how and where cables are laid to avoid adverse effects to the environment.	-
	The presence of MPAs and protected seabed features will restrict where future cables are able to be laid, for example Dogger Bank SAC is protected for its large sandbank and this would affect cable laying in this area.	Potential to restrict where future cables can be laid.	-

15.4 Future scenarios

6 year projection

Several power cables are expected to be installed, and/or operational in the Plan areas over the next 6 years. This includes the Offshore High Voltage Direct Current (HVDC) Link (HND1) which will connect Grimsby to Walpole[237]. It is in early stages of development, public consultation is due to complete in 2025, the DCO is due to be submitted in 2027, and construction is expected to start in 2029. There is moderate confidence it will be on track to reach full operation in 2033[238].

The Eastern Green Link 2 (EGL 2) will connect Peterhead to Drax in North Yorkshire, construction is planned to commence in 2024**,** and it is expected to reach full operation by 2029[239]. Given construction is expected to commence there is moderate confidence that this cable will be operational by 2030.

LionLink is another HVDC in the Plan area that is expected to be operational by 2030. The interconnector will connect Suffolk (at either Southwold or Walberswick, a final decision has not been made) to The Netherlands and Dutch offshore windfarms. It is in its pre-planning phase with the planning application due to be submitted in 2025[240], as such it is reasonable to assume that there is moderate confidence of it being under construction by 2030[241].

[237] National Gid. 203. The Great Grid Upgrade, Grimsby to Walpole. Available at: https://www.nationalgrid.com/electricity-transmission/network-and-infrastructure/infrastructure-projects/grimsby-to-walpole Accessed October 2024.
[238] National Grid. 2024. Project timeline and next steps. Available at: https://www.nationalgrid.com/electricity-transmission/network-and-infrastructure/infrastructure-projects/grimsby-to-walpole/project-timeline Accessed October 2024.
[239] National Grid. 2024. Eastern Green Link 2. Available at: https://www.easterngreenlink2.co.uk/ Accessed October 2024.
[240] National Grid. 20224. LionLink Community Newsletter. Available at: https://www.nationalgrid.com/document/151266/download Accessed October 2024.
[241] National Grid. 20224. LionLink Community Newsletter. Available at: https://www.nationalgrid.com/document/151266/download Accessed October 2024.

SeaLink, an interconnector that will connect Suffolk and Kent, as shown in Figure 21. The planning application for this project is due to be submitted in 2025 and construction is expected to commence between 2026 to 2030[242]. SeaLink is in its early development stage, therefore there is low to moderate confidence that construction will occur within the next 6 years.

See Figure 21 for the location of all potential future power cables in the Plan areas.

6 to 20 year projection

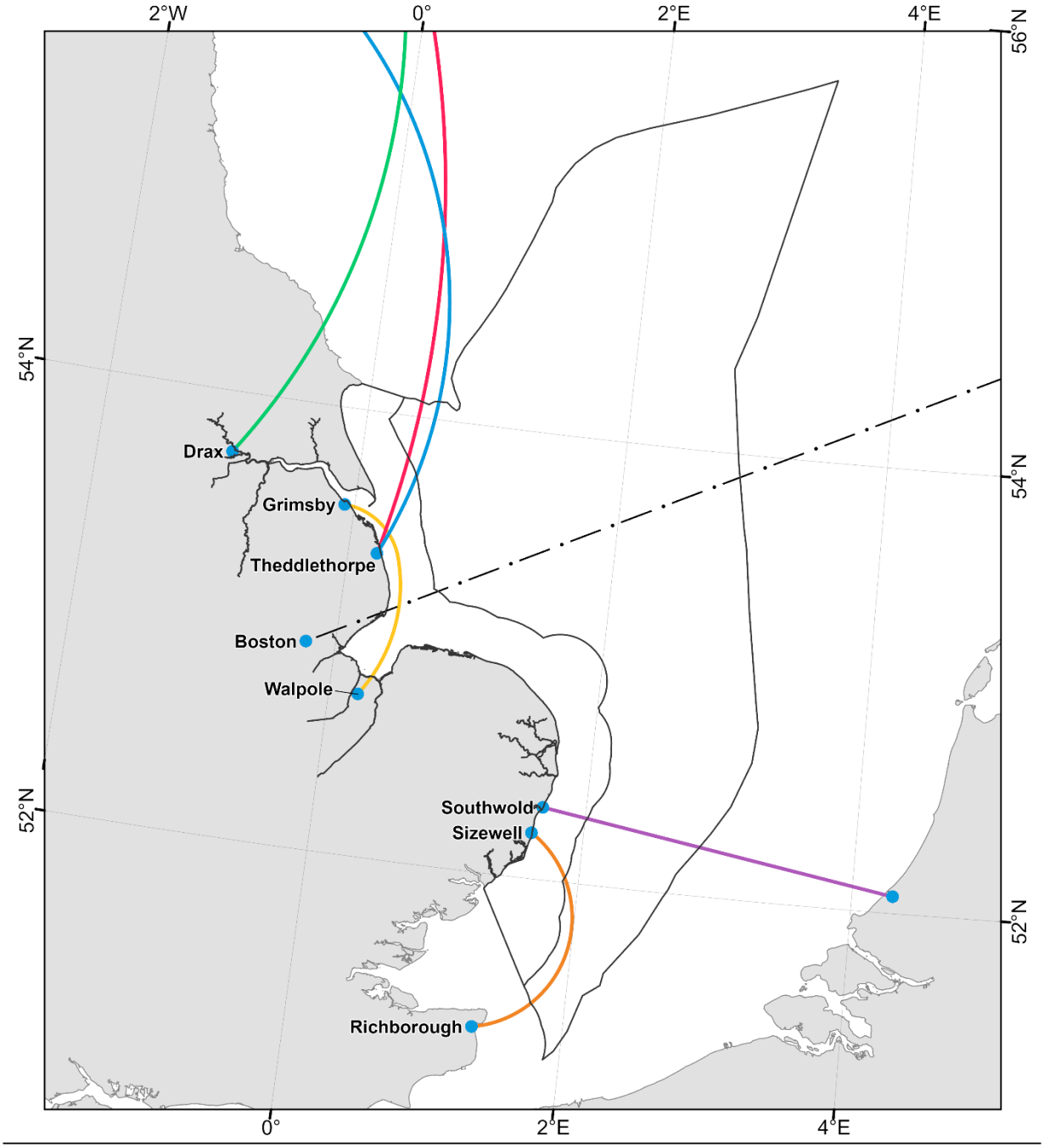
A number of additional power cables are likely to be laid and become operational over the 6 to 20 year period. Since construction of SeaLink is due to commence by 2030 it is likely that it will become operational within the next 6 to 20 years (with high confidence given the long timeframe over which it can progress to operation).

By 2033 HND1 is expected to be fully operational. In addition, two Eastern Green Link (EGL) cables are also due to begin operation by 2033, these are EGL 3 and EGL 4. EGL 3 will connect Peterhead to either Theddlethorpe or Anderby Creek, and EGL 4 will connect Westfield to the same location as EGL 3[243].

See Figure 21 for the location of all potential future power cables in the Plan areas.

[242] National Grid. SeaLink. Available at: https://www.nationalgrid.com/the-great-grid-upgrade/sea-link Accessed October 2024.
[243] National Grid. 2024. Eastern Green Link 3 and Eastern Green Link 4. Available at: https://www.nationalgrid.com/the-great-grid-upgrade/eastern-green-link-3-and-4 Accessed October 2024.

Figure 21: Current and future power cables.



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16 Renewables: Offshore Wind Energy (Static and Floating)

16.1 Sector definition

Offshore wind energy is energy generated by wind turbines at sea, which collect the kinetic energy of wind and turn it into electrical energy. Turbines can be either fixed or floating. Fixed wind turbines have foundations that are 'piled' or drilled into the seabed. Floating wind turbines are installed on floating platforms which are anchored and moored to the seabed. Multiple turbines make up an array. Within the array, the turbines are connected to each other with interconnector cables, which transport the energy generated by the turbines to an offshore substation. An export cable is used to transfer the energy generated by the turbines to an onshore substation, which connects the electricity to the national grid.

16.2 Historic trends and current activity

Offshore wind power has been a key focus of the UK's energy transition in an effort to meet net zero targets and increase energy security. The UK has the greatest wind energy potential in Europe, and has been at the forefront of the offshore wind industry since 2008[244]. In 2023, 22% of global offshore wind operating capacity was located in the UK[245].

To further offshore development, the UK Government has set targets to quadruple offshore wind capacity to 60GW by 2030[246]. Current operational offshore wind capacity is 15 GW, which in 2023 supplied the equivalent electricity needs of 50% of UK households, up from 10% of homes in 2013[245]. TCE has 268,000 km^2 of seabed under management, which is included in the 2050 Marine Delivery Routemap. With an additional 4.5 GW of capacity of floating offshore wind to come from Leasing Round 5, the UK has a current total capacity of 96.2 GW[247].

The development of fixed offshore wind farms is spatially restricted to areas with an appropriate water depth, a suitable substrate and plentiful wind resource. Consequently, offshore wind developments are not distributed evenly through the UK. Due to favourable seabed conditions, the Plan areas are currently the most developed plan areas for fixed offshore wind[248].

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[244] Kota, Sandhya & Bayne, Stephen B. & Nimmagadda, Sandeep. 2015. "Offshore wind energy: A comparative analysis of UK, USA and India," Renewable and Sustainable Energy Reviews, Elsevier, vol. 41(C), pages 685-694.
[245] The Crown Estate (2023) UK Offshore Wind Report 2023. Available at: https://www.thecrownestate.co.uk/our-business/marine/offshore-wind-report-2023 Accessed October 2024.
[246] Offshore Energies UK (2024) Offshore Energies UK welcomes renewable energy boost for prospective windfarm developers. Available at: https://oeuk.org.uk/offshore-energies-uk-welcomes-renewable-energy-boost-for-prospective-windfarm-developers/#:~:text=Investing%20in%20exciting%20new%20opportunities,every%20home%20in%20the%20country Accessed October 2024.
[247] RenewableUK. 2024. EnergyPulse. Offshore Wind February 2024. Available at: https://www.renewableuk.com/energypulse/about/ Accessed October 2024.
[248] The Crown Estate (2018) Resource and Constraints Assessment for Offshore Wind: Methodology Report. Report content available at: https://www.thecrownestate.co.uk/media/3331/tce-r4-resource-and-constraints-assessment-methodology-report.pdf Accessed October 2024.

Offshore wind energy generation has been active in the Plan areas since 2004. In 2014, the Plan area accounted for 37% (1.7 GW) of offshore wind which was operational or under construction in English Waters. The majority of possible capacity not yet operational or under construction leased under Round 2 and extensions and Round 3 was also in the Plan areas (54% or 3.4 GW and 76% or 24 GW respectively)[9].The offshore wind industry has rapidly expanded in the Plan areas since then. Currently, in 2024, the total capacity of the Plan area is 32.6 GW[249]

Currently, of the 45 operational offshore wind farms in the UK, 14 (32%) are located within the Plan areas. Of the seven in construction, four (57%) are also in the Plan areas[250]. Figure 22 provides the location of offshore wind developments in the Plan areas, as well as their associated export cables.

The 14 operational windfarms within the Plan areas have a capacity of 7,001 MW, 49% of the total generating capacity of the UK[251]. There is similarly a large capacity of under construction (6,400 MW), consented (11,600 MW), in-planning (3,300 MW) and pre-planning (540 MW) capacity in the Plan areas, as listed in Table 17[252].

[249] Department for Energy and Net Zero (2024) Renewable Energy Planning Database: quarterly extract. Available at: https://www.gov.uk/Government/publications/renewable-energy-planning-database-monthly-extract Accessed October 2024
[250] Department for Energy and Net Zero (2024) Renewable Energy Planning Database: quarterly extract. Available at: https://www.gov.uk/Government/publications/renewable-energy-planning-database-monthly-extract Accessed October 2024
[251] Department for Energy and Net Zero (2024) Renewable Energy Planning Database: quarterly extract. Available at: https://www.gov.uk/Government/publications/renewable-energy-planning-database-monthly-extract Accessed October 2024
[252] Department for Energy and Net Zero (2024) Renewable Energy Planning Database: quarterly extract. Available at: https://www.gov.uk/Government/publications/renewable-energy-planning-database-monthly-extract Accessed October 2024

Table 17: All proposed static offshore wind farms for the Plan area, categorised by status, with capacities in MW.

Windfarm	Status	Capacity (MW)
East Anglia One	Operational	714
Greater Gabbard	Operational	504
Galloper	Operational	353
Hornsea 1 – Heron & Njord	Operational	1,218
Hornsea 2 – Optimus and Breesea	Operational	1,320
Dudgeon	Operational	402
Triton Knoll	Operational	857
Race Bank	Operational	573.3
Scroby Sands	Operational	60
Sheringham Shoal	Operational	317
Inner Dowsing	Operational	97.2
Lincs	Operational	270
Humber Gateway	Operational	219
Lynn	Operational	97.2
Dogger Bank A & B	Under Construction	2,400
Dogger Bank C	Under Construction	1,200
East Anglia Three	Under Construction	1,400
Sofia	Under Construction	1,400
East Anglia Two	Consented	900
East Anglia One North	Consented	800
Norfolk Vanguard East	Consented	1,400
Norfolk Vanguard West	Consented	1,400
Hornsea Project Four	Consented	2,600
Dudgeon Extension	Consented	402
Sheringham Shoal Extension	Consented	317
Norfolk Boreas	Consented	1,400
Hornsea Project 3	Consented	2,400
R4 Project 1 (Dogger Bank South West)	In-Planning Pre-Planning Application	1,500
R4 Project 2 (Dogger Bank South East)	In-Planning	1,500
Five Estuaries	In Planning – Application Submitted	300
R4 Project 3 (Outer Dowsing)	In Planning – Application Submitted	1,500
North Falls	Pre-Planning Application	504
Total		**30,324.7**

Offshore wind will continue to drive economic investment and employment in the Plan areas as there are earmarked investments of £50 million to accelerate offshore wind supply chain projects by TCE. There are offshore wind projects in the construction, consented, in-planning and pre-application phases in the Plan area. These developments will all require construction, maintenance and decommissioning and will rely on associated supply chain industries. This activity will increase the availability of low-skilled and high-skilled employment in the area and boost the regional economy.

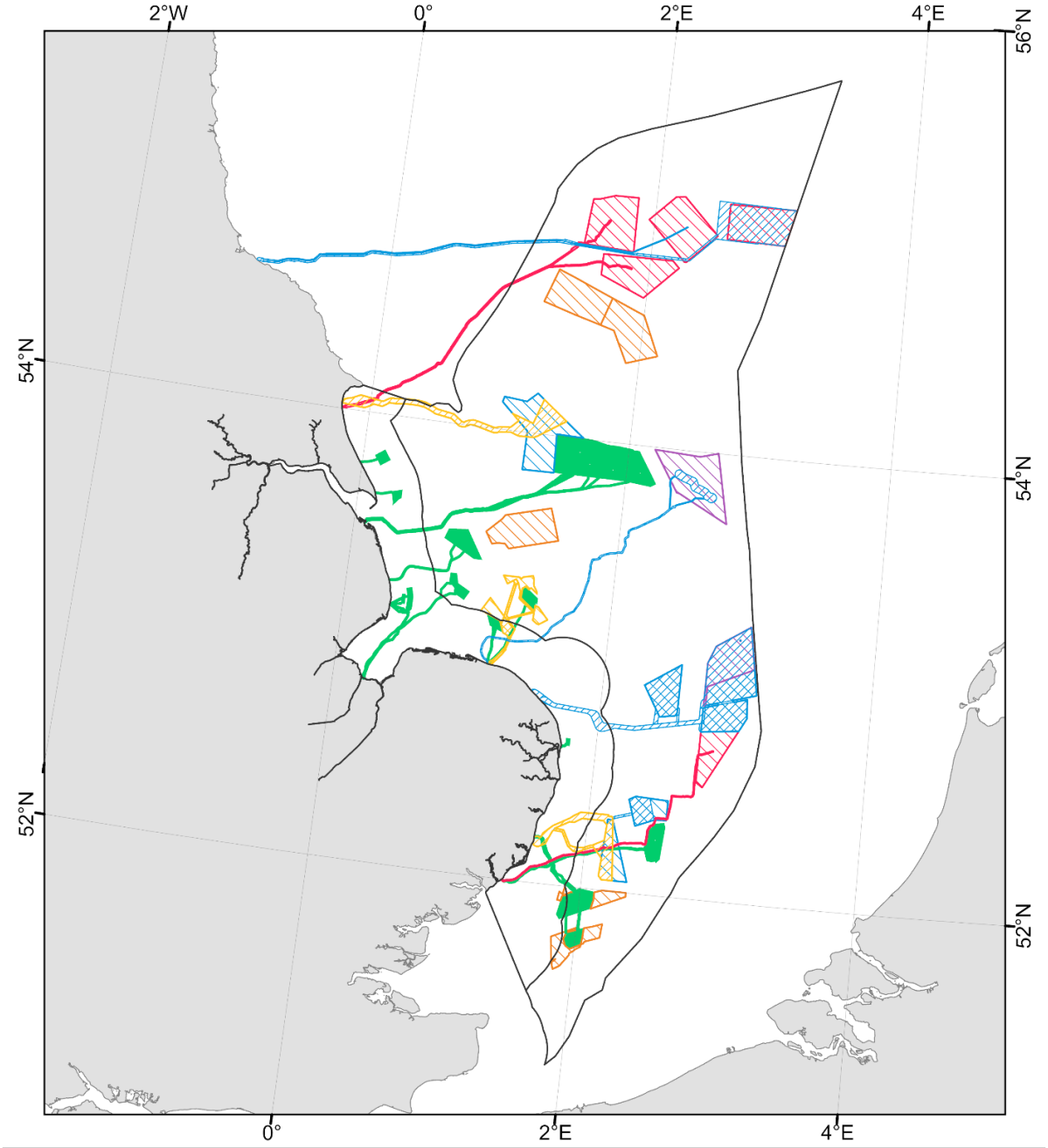
There are currently 32,257 people employed in the offshore wind workforce in the UK (17,394 direct and 14,863 indirect jobs) which is predicted to rise to 104,401 by 2030, split into 56,296 direct and 48,105 indirect jobs[253] In the Plan area, there are approximately 6,464 jobs in the offshore wind sector, representing 24.6% of employment in the sector[253]. Should the proportion of employment in the offshore wind sector remain the same in the Plan area looking towards 2030 (24.6%), 25,683 of the future projected 104,401 jobs could be found here[253].

Estimated GVA for the offshore wind energy sector in the Plan areas is £13.1 billion. This is based on GVA per GW of renewable energy capacity installed of £1.8 billion[254], and 7.28 GW of installed capacity in the Plan areas.

To drive interest and engagement in the offshore wind sector for young people, TCE are offering internships located on the east coast. These interns gain work experience and build relationships in renewable energy, marine ecology and community engagement, and they conduct marine research projects in and around the east coast area, further supporting the development of skills and research in this region. The Crown Estate have also invested an initial £50,000 in a new educational and cultural hub in Grimsby, which showcases the benefits of renewable energy and aims to inspire the next generation of renewable energy experts. The Crown Estate are also working with the Department of Work and Pensions to build a pilot programme designed to help employment coaches in East Anglia better understand the career opportunities offered by offshore wind development[245].

[253] Offshore Wind Industry Council (2023) Offshore Wind Skills Intelligence Report. Report content available at: https://www.owic.org.uk/work/people-and-skills/ Accessed October 2024.
[254] ORE Catapult (2017) The Economic Value of Offshore Wind. Website content available at: https://cms.ore.catapult.org.uk/wp-content/uploads/2017/12/SP-0012-The-Economic-Value-of-Offshore-Wind-1.pdf Accessed October 2024.

Figure 22: Active and planned wind farms.



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16.3 PESTLE analysis

Political, legal and economic factors will be most influential in driving future offshore wind developments, while there may be social constraints such as community concerns to altered seascapes.

The most important factors driving offshore renewable wind energy developments are increasing energy security and reducing energy prices by reducing reliance on imported energy. Imported energy leaves the UK vulnerable to volatile oil and gas market prices. The UK Government's commitment to net zero by 2050 and public demand for greater availability of renewable energy will further accelerate offshore renewable energy growth. The Government are aiming to reduce the time for offshore developments to move from application to construction phases. There are a range of research programmes aiming to increase the understanding of impacts of offshore wind developments in order to reduce consenting times, including the Offshore Wind Evidence and Change programme, the Offshore Renewables Joint Industry Programme, and Pathways to Growth. Technological advancements will further improve the efficiency and capacity of turbines to deliver offshore wind energy and drive down costs for further expansion. The key drivers that will influence the development of offshore wind in the Plan areas are listed in Table 18 below.

Table 18: PESTLE analysis for the offshore wind energy sector.

Driver	Details	Implications	Impact (+ / -/ Variable)
Political	The British Energy Security Strategy sets out the UK's ambitions to produce 50GW of electricity from renewable energy sources. This will secure a diverse energy mix, reducing reliance on imported energy and increasing energy security.	Increased investment in renewable technologies.	+
	The Offshore Wind Sector Deal sets a target of having at least 30GW of operational offshore windfarms by 2030 providing over 30% of UK electricity.	Increased investment in renewable technologies.	+
	Great British Energy has partnered with The Crown Estate to accelerate investment in and the development of offshore renewables projects in the UK[255].	Increased investment in renewable technologies, which will improve energy security and reduce reliance on imported energy, as well as reducing the price for consumers.	+
	Government to consult on Labour's manifesto commitment of no new oil and gas licences[256].	Increased investment in renewable technologies.	+

[255] UK Government. 2024. Great British Energy. Available at: https://www.gov.uk/Government/organisations/great-british-energy Accessed October 2024
[256] UK Government. 2024. Certainty for oil and gas industry in light of landmark ruling. Available at: https://www.gov.uk/Government/news/certainty-for-oil-and-gas-industry-in-light-of-landmark-ruling Accessed October 2024.

Driver	Details	Implications	Impact (+ / -/ Variable)
Economic	Availability of Contracts for Difference.	Affects level of investment in offshore wind developments, providing a guaranteed electricity price for developers.	Variable
	Cost of construction.	This heavily influences the ultimate price of energy from offshore wind.	Variable
	Oil and gas prices.	Increasing oil prices boosts the attractiveness of renewable energy and may increase investment in the sector.	+
Social	Increased demand for electrical energy driven by increased population and increased use of electric vehicles.	Potential for greater investment in renewable technologies and electrification of the grid.	+
	Location of arrays and offshore substations are influenced by other sectors, including cables/shipping/fisheries/recreation[257].	Constrains/ restricts areas within which renewables can be developed.	-
	Impacts on seascape from onshore substations and offshore arrays (See Section 29).	Perceived negative effects towards aesthetics may mellow over time, so wind farms become an accepted part of the view. However, strong local resentment in some locations towards onshore substations may deter development due to concerns that it may irreversibly damage the natural landscape.	-
Technological	Developments in the technology used to generate clean energy and the infrastructure used to connect energy to the onshore grid.	Increased efficiency and changes to device size and spacing may reduce the area of seabed impacted. Development of technology will also drive down cost of energy generation.	+

[257] The Crown Estate (2023) Celtic Sea Floating Offshore Wind Leasing Round 5 Site Selection Methodology. Report content available at: https://www.datocms-assets.com/136653/1720790173-site-selection-methodology-v2.pdf Accessed October 2024.

Driver	Details	Implications	Impact (+ / -/ Variable)
	The full exploitation of renewable energy resources, and maximum economic benefit, is dependent on the construction and improvement of both onshore and offshore grid capacity, through projects such as the Holistic Network Design[258] (HND) and HND2[259], an integrated approach to connect 23 GW of wind energy to the UK, and The Strategic Spatial Energy Plan (SSEP), which aims to spatially map out the energy assets necessary to meet net zero by 2050[260].	The development of future renewable energy sites will be linked to growth in grid capacity.	Variable
Legal	The legally binding target of reaching net zero by 2050 is set out in the 2019 amendment of the Climate Change Act 2008[261].	Increased investment in renewable technologies including offshore wind as fossil fuel production is lessened e.g. the closure of coal fired power stations by 2025.	+
Environmental	Assessments of proposed developments against a wide range of environmental receptors, increased survey/monitoring effort.	Increased costs for developers, potential disincentive to investors, constraints to further development of offshore wind.	-
	Management and designation of MPAs and HPMAs.	Potential constraints/ restriction on areas within which renewable devices can be developed. Currently, offshore wind farms are permitted to be built in MPAs but not HPMAs.	-
	The introduction of Biodiversity Net Gain (BNG) [262] and Marine Net Gain (MNG)[263] development compensation may increase costs and timelines.	This could affect the number of developments going ahead and the speed at which they're completed, impacting energy delivery.	-

[258] ESO. A Holistic Network Design for Offshore Wind, Available at: https://www.nationalgrideso.com/future-energy/beyond-2030/holistic-network-design-offshore-wind. Accessed October 2024.
[259] ESO. Beyond 2030. Available at: https://www.nationalgrideso.com/future-energy/beyond-2030 Accessed October 2024.
[260] UK Government. 2024. Strategy and policy statement for energy policy in Great Britain. Available at: https://www.gov.uk/Government/publications/strategy-and-policy-statement-for-energy-policy-in-great-britain/strategy-and-policy-statement-for-energy-policy-in-great-britain-accessible-webpage Accessed October 2024.
[261] UK Government. 2019. Climate Change Act 2008. Available at: https://www.legislation.gov.uk/ukpga/2008/27/section/1/2019-06-27 Accessed October 2024.
[262] Uk Government. 2024. Biodiversity net gain. Available at: https://www.gov.uk/Government/collections/biodiversity-net-gain Accessed October 2024.
[263] UK Government. 2022. Marine net gain – leaving the marine environment in better state. Available at: https://naturalengland.blog.gov.uk/2022/06/07/marine-net-gain-leaving-the-marine-environment-in-better-state/ Accessed October 2024.

Driver	Details	Implications	Impact (+ / -/ Variable)
	Underwater noise limits e.g. in the Southern North Sea SAC, affect when construction can occur to protect species in the area.	This may affect development timelines, but this may be species and development dependent.	Variable

16.4 Future scenarios

6 year projection

Over the next 6 years, **offshore wind farms will continue to be built to meet the UK Government's target** of 60 GW of offshore wind capacity by 2030[264]. Figure 22 shows consented sites which would be expected to be constructed within the next 6 years, as well as sites currently under construction which are likely to become operational in the next six years. **It is also expected that the active/in operation wind farms will remain in operation** (high confidence). Of the consented sites expected to add 8,764 MW to UK capacity, 7,430 MW will come from sites within the Plan areas (85%)[245] (high confidence).

6 to 20 year projection

Figure 22 also shows planned wind farms expected within the next 6 to 20 years, including those that are in planning, or pre-planning application. Dependent on the level of Government support on offer, developments currently being offered help may also finish construction within the next 6 to 20 years (low confidence). **It is expected that newly active sites will continue operation**, however active sites which are **operational now may start to become decommissioned**. Of the in-**planning and pre-planning sites expected to add 42,482 MW to the network, only 3,076 MW will come from the Plan areas (7%)** (719 MW and 2,357 MW respectively)[245] (moderate confidence). This demonstrates that much of the anticipated UK development of offshore wind is not expected to occur in the Plan areas in the next 20 years, as much of the suitable area has already been developed. However, the **offshore wind sector will continue to be a key source of employment in this region due to existing arrays.**

TCE have identified further dispersed areas of single project-scale opportunities in the Southern North Sea, overlapping with the Plan areas. Due to shallower water conditions suitable for fixed sub-structures, and a lower build and connection cost due to the location close to onshore electricity demand, this area is favourable, and it is expected that these will be leased by 2030, and in operation from 2035 to 2040[265] (moderate confidence).

[264] UK Government. 2024. Offshore Wind. Available at: https://www.great.gov.uk/campaign-site/innovating-energy-europe/offshore-wind/ Accessed October 2024.
[265] The Crown Estate (2024) Future of Offshore Wind. Report content available at: https://www.datocms-assets.com/136653/1725984848-tce_future-offshore-wind.pdf Accessed October 2024.

It is further important to note that wind farms reaching the end of their operational lifespan will not all be fully decommissioned. Developers may choose partial decommissioning, repowering or life extensions. As offshore wind farms in the Plan areas are in key locations (close to areas of high energy demand and already connected to the grid), it is unlikely that those sites will stop producing offshore wind energy.

Development may be constrained by spatial squeeze due to the needs of other industries such as fishing, shipping, and recreation, and this will need to be effectively managed in the Plan areas so the sector can continue to contribute to social and environmental benefits. Offshore wind in the Plan areas is one of the most dominant activities and this requires a large spatial footprint for both the arrays and associated cabling. This will require careful management across sectors to ensure co-existence and co-location is maximised where possible.

17 Renewables: Wave and Tidal Energy

17.1 Sector definition

This sector is concerned with the generation of energy through wave and tidal energy converter devices.

Wave Energy: Ocean wave energy technologies rely on the up-and-down motion of waves to generate electricity. Wave energy is produced when electricity generators are placed on the surface of the ocean and usually tethered to the seabed. The oscillating low-frequency energy created by wave movement can be converted into electricity and then exported to the national grid. Energy output is determined by wave height, wave speed, wave length and water density.

Tidal Energy: Tidal energy is produced through the use of tidal energy generators. Tidal technologies include tidal range (barrages and lagoons that rely on the static pressure differential created by the rise and fall of tides) and tidal stream technologies (which utilise the flow of water generated by the change of tidal height). Both tidal range and tidal stream energy generation are limited to a few locations around the UK e.g. funnels and headlands (tidal stream) and estuaries with specific dynamics (tidal range).

17.2 Historic trends and current activity

The UK has the largest wave and tidal resource in Europe. This is a result of the UK's exposure to Atlantic winds, which boost the wave resource, and the existence of a number of headlands and islands, which concentrate tidal flows. Marine energy technologies such as tidal and wave have the potential to displace coal and natural gas generation and reduce CO_2 emissions permanently by at least 1 $MtCO_2$ per year after 2030 and at least 4 $MtCO_2$ per year after 2040[266].

The development of wave and tidal infrastructure is spatially restricted to areas with an appropriate water depth, geology, metocean conditions and resource availability. Consequently, the deployment of wave and tidal developments will be concentrated in specific areas around the UK[267].

In the UK, there are currently 21 tidal sites, ranging from pre-planning to decommissioning phases, and 6 wave sites, with 5 in operation and one in pre-planning. However, the majority of these projects are test sites. In the UK, the current and planned wave and tidal developments are located along the west coast, particularly around Wales, in Scotland around the Shetland and Orkney Islands, in the Inner Sound, and in the Sound of Islay, and in England off the coast of the Isle of Wight, and off the coast of Falmouth. To date, there are only two commercial tidal

[266] ORE Catapult (2018) Tidal Stream and Wave Energy Cost Reduction and Industrial Benefit. Website content available at: https://cms.ore.catapult.org.uk/wp-content/uploads/2018/11/Tidal-Stream-and-Wave-Energy-Cost-Reduction-and-Industrial-Benefit.pdf Accessed October 2024

[267] MMO (2016). Marine Plan Areas Sustainability Appraisal. Sustainability Appraisal Scoping Report. A report produced for the Marine Management Organisation. Report content available at: https://assets.publishing.service.gov.uk/media/5a7f9e6ced915d74e622b8de/SA_Scoping_Report_NE_NW_SE_SW_April_2016.pdf Accessed October 2024

developments operating in UK waters, MeyGen's Inner Sound, and Bluemull Sound by Nova Innovation Ltd. These are both located in Scotland, in the Pentland Firth.

No wave or tidal developments are currently planned or active in the Plan areas.

Generally, 30 MW was regarded as the springboard to array scale commercialisation by the majority of tidal stream developers. This coincides with the existing 30 MW capacity ceiling for Crown Estate Scotland's existing ad-hoc leasing option[268]. Wave energy technologies are currently lagging behind tidal developments; thus, there are currently no current plans for any commercial wave arrays in UK waters.

When considering the planned wave and tidal sites, there is potential for 182 MW installed capacity of wave power in the UK by 2030. This compares to a projection of 1 GW installed capacity by 2040[266]. There is potential for 0.55 GW installed tidal capacity by 2030 based on the existing sites in the planning system. This compares to a projection of 1 GW deployed by 2030[266]. Projections for both wave and tidal have been over optimistic in the past.

17.3 PESTLE analysis

Technological and economic factors will be most influential in driving future wave and tidal developments. Technological developments will be crucial for wave and tidal developments to become more viable. With the current UK Government focus on energy security, reducing energy imports is important and coupled with public demand for greater availability of renewable energies, demand for wave and tidal energy may increase. Whilst wave development is lagging behind tidal developments, and infrastructure is not as developed for these renewable energy technologies compared to offshore wind, test sites in both could drive research to inform future commercial developments. Although this is not expected to be within the Plan areas, the movement from pre-commercial arrays to commercial projects will also create significant cost reductions in the near future. The key drivers are listed in Table 19 below.

[268] ORE Catapult (2024) Crown Estate Scotland: Market Engagement of Industry on Current and Future Leasing Opportunities for Wave and Tidal Energy. Report content available at: https://www.crownestatescotland.com/sites/default/files/2024-05/CES%20market%20engagement%20future%20leasing%20WT_executive%20summary%20FINAL.pdf Accessed October 2024.

Table 19: PESTLE analysis for the wave and tidal energy sector.

Driver	Details	Implications	Impact (+ / - / Variable)
Political	The British Energy Security Strategy sets out the UK's ambitions to produce 50 GW of electricity from renewable energy sources.	Increased investment in renewable technologies.	+
	Reduce imports of energy to increase energy security through securing a diverse energy mix.	Increased investment in renewable technologies.	+
	Great British Energy has partnered with the Crown Estate to accelerate investment in, and the development of, offshore renewables projects such as wind in the UK.	Increased investment in renewable technologies, which will provide energy for the company improving energy security and reduce reliance on imported energy, as well as reducing the price for consumers.	+
	Government to consult on Labour's manifesto commitment of no new oil and gas licences[269].	Increased investment in renewable technologies.	+
Economic	Increasing or decreasing oil and gas prices.	Increasing oil price increases the attractiveness of renewable energy and may increase investment in the sector. Decreasing oil price makes renewables less competitive and some planned developments may not go ahead.	Variable
	Wave and Tidal compete in 'Pot 2' of the Contracts for Difference mechanism[270]. Dependent on supply chain cost pressures, administrative strike prices may increase or decrease.	Affects level of investment in projects.	Variable
Social	Increased demand for electrical energy driven by increased population and increased use of electric vehicles.	Potential for greater investment in renewable technologies and electrification of the grid.	+
	Interactions with fisheries/shipping/recreation.	Constraints/ restriction on areas within which renewables can be developed.	-
Technological	Developments in successful technology used to generate tidal and wave energy.	Expansion of renewable energy generation devices to offshore areas.	+

[269] UK Government. 2024. Certainty for oil and gas industry in light of landmark ruling. Available at: https://www.gov.uk/Government/news/certainty-for-oil-and-gas-industry-in-light-of-landmark-ruling Accessed October 2024.

[270] UK Marine Energy Council (2024) The Marine Energy Council welcomes the continuation of the tidal stream ringfence. Website content available at: https://www.marineenergycouncil.co.uk/news/the-marine-energy-council-welcomes-the-continuation-of-the-tidal-stream-ringfence#:~:text=Tidal%20stream%20and%20wave%20energy,energy%20to%20%C2%A3257%2FMWh Accessed October 2024.

Driver	Details	Implications	Impact (+ / - / Variable)
	Reduction in manufacturing/ installation costs through the expansion of viable tidal and wave technologies.	Increased competitiveness of renewables against alternative energy sources.	+
	The full exploitation of renewable energy resources, and maximum economic benefit, is dependent on the construction and improvement of both onshore and offshore grid capacity, through projects such as the Holistic Network Design (HND) and HND2, an integrated approach to connect 23GW of wind energy to the UK. The Strategic Spatial Energy Plan (SSEP) will be delivered by ESO in 2025. The SSEP aims to spatially map out the energy assets necessary to meet net zero by 2050.	The development of future renewable energy sites will be linked to growth in grid capacity.	Variable
	The Climate Change Act commits the UK to a legally-binding target to reduce CO_2 emissions by at least 80% of 1990 levels by 2050. Obligations to bring all UK emissions to net zero by 2050 falls within this legislation.	Increased investment in renewable technologies as fossil fuel production is reduced e.g. the closure of coal fired power stations by 2025	+
Legal	No significant drivers identified.		
Environmental	Assessments of proposed developments against a wider range of environmental receptors, increased survey/monitoring effort.	Increased costs for developers, potential disincentive to investors, and restriction of development due to environmental concerns.	-
	Management and designation of MPAs and HPMAs.	Potential constraints/ restriction on areas within which renewable devices can be developed.	-

17.4 Future scenarios

6 year projection

Over the next 6 years, there is no development of wave or tidal energy anticipated in the Plan areas (moderate confidence). The main drivers of wave and tidal energy expansion will be political and legal obligations to meet 2050 commitments to the UK net zero target, the Paris Agreement and the Climate Change Act. Previously, wave and tidal energy has been constrained by lack of technological development, and all developments have been test sites thus far. To overcome this constraint, significant investment will be required to facilitate growth, research and necessary job creation. To provide this necessary investment, the

implementation of Great British Energy's and Labour's Green Prosperity Plan will be critical for the expansion of commercial tidal and wave energy in the UK. However, this investment will be gradual, and so rapid expansion is not predicted (moderate confidence).

6 to 20 year projection

Looking towards 2050, should wave and tidal energy receive further investment and become more commercialised, these developments may be constrained by spatial squeeze in the same way as offshore wind, particularly from commercial fishing, recreation and shipping. However, it has been reported that there could be 6.4 GW of wave and 6.2 GW of tidal deployments by 2050 in Great Britain, if the Strategic Energy Technology Plan targets are reached by 2030. These are European Commission targets stating that it will cost €100 per MWh for tidal stream by 2030 and €150 per MWh for wave energy by 2030[271]. Whilst these are European Commission targets, these are relevant for future development here, as reduced costs for manufacturing and deployment can be utilised in Great Britain.

Wave and tidal developments could increase over the next 6 to 20 years, but expansion into the Plan areas is unlikely (moderate confidence). Sites of greatest potential for wave, tidal range and tidal stream technologies are located on the west coast of the UK[272]. A proposal has been put forward to build a tidal barrage across The Wash[273], however this is considered unlikely to proceed due to the likelihood of significant environmental impacts, and the company involved is currently dormant (high confidence).

[271] Supergen (2023) What are the UK power system benefits from the deployments of wave and tidal stream generation? Website content available at: https://supergen-ore.net/uploads/Supergen-ORE-Power-System-Benefits-Study-2023.pdf Accessed October 2024.
[272] The Crown Estate (2012) UK Wave and Tidal Key Resource Areas Project. Website content available at: https://www.marineenergywales.co.uk/wp-content/uploads/2016/01/Summary-Report-FINAL.pdf [last accessed July 2024]
[273] The Wast Tidal Barrier Cooperation Plc. 2024. Home. Available at: https://www.washbarrier.org/ Accessed October 2024.

18 Surface water management & wastewater treatment and disposal

18.1 Sector definition

Surface water and wastewater can enter the marine environment by three main types of discharge:

- Surface-water drainage that collects rainwater run-off from roads and urban areas and discharges direct to local waters;
- Effluent drainage that collects domestic wastewater from premises (no rainwater is collected); and
- Combined sewer overflows (CSOs) that collect rainwater run-off, wastewater from domestic, industrial, commercial and other premises, and untreated sewage.

Discharge of surface runoff is unregulated whereas the discharge of wastewater is regulated, to manage the impact of water pollution to the marine environment[274]. Since the 1980s, disposal of waste to sea such as radioactive wastes, industrial wastes, and sewage sludge have progressively been prohibited. There has been increasing control with time over the disposal of effluents into the marine environment.

The Environment Agency (as well as Defra and the Water Services Regulation Authority (Ofwat) is responsible for working with water companies to reduce wastewater pollution events such as the unpermitted discharge from CSOs, and discharge of poorly or untreated treated effluent from the outfall of a sewage treatment works.

Coastal power stations abstract large volumes of water for cooling purposes. This represents a non-consumptive use because the water is returned to the environment. However, its properties (heat and chemical composition) are changed, so these returned waters are discussed in this section as wastewater discharges.

18.2 Historic trends and current activity

Three water companies are responsible for wastewater management in the Plan areas: Anglian Water, Yorkshire Water, and Seven Trent Water. The vast majority is managed by Anglian Water.

All water companies are able to discharge to the environment through CSOs during storm events under the conditions of their permit issued by the EA. Permit conditions are that discharges can only occur during periods of heavy rainfall (or snow melt) and when internal storage capacity has been reached. If the wastewater discharge does not comply with the permit conditions the water company could be prosecuted. There has been a significant increase in public scrutiny of wastewater discharge to the environment with many activist groups such as Surfers Against Sewage, who

[274] Her Majesty Government. UK Marine Policy Statement. 2011. Available at: https://assets.publishing.service.gov.uk/media/5a795700ed915d042206795b/pb3654-marine-policy-statement-110316.pdf Accessed October 2024.

have published an interactive tool to map water quality status and provides sewage pollution alerts in ‘real-time’.

Event Duration Monitors (EDMs) are sensors that measure the flow of water through CSOs. In 2012 only 7% of CSOs in the Plan areas had EDMs installed, this increased to 100% by 2023. This includes sensors at Anglian Water’s CSOs that have outfalls into the North Sea. The CSOs in the Plan areas are shown in Figure 23 below.

An Environmental Performance Assessment (EPA) that presents the compliance of water companies to metrics such as the number of pollution events, and the delivery of the Water Industry National Environment Programme (WINEP) is carried out annually to present the compliance of each company[275]. The 2022 EPA ratings for each wastewater company in the Plan areas is presented in Table 20. The Environment Agency uses a red, amber, green status to score for each EPA metric where red is significantly below target, amber is below target, and green where the target is achieved or exceeded[276].

The EPA compliance for Anglian Water for both metrics has in general remained amber since 2014, although there have been years of green including total pollution incidents in 2015 and 2018, discharge compliance in 2020, 2016 and 2015.

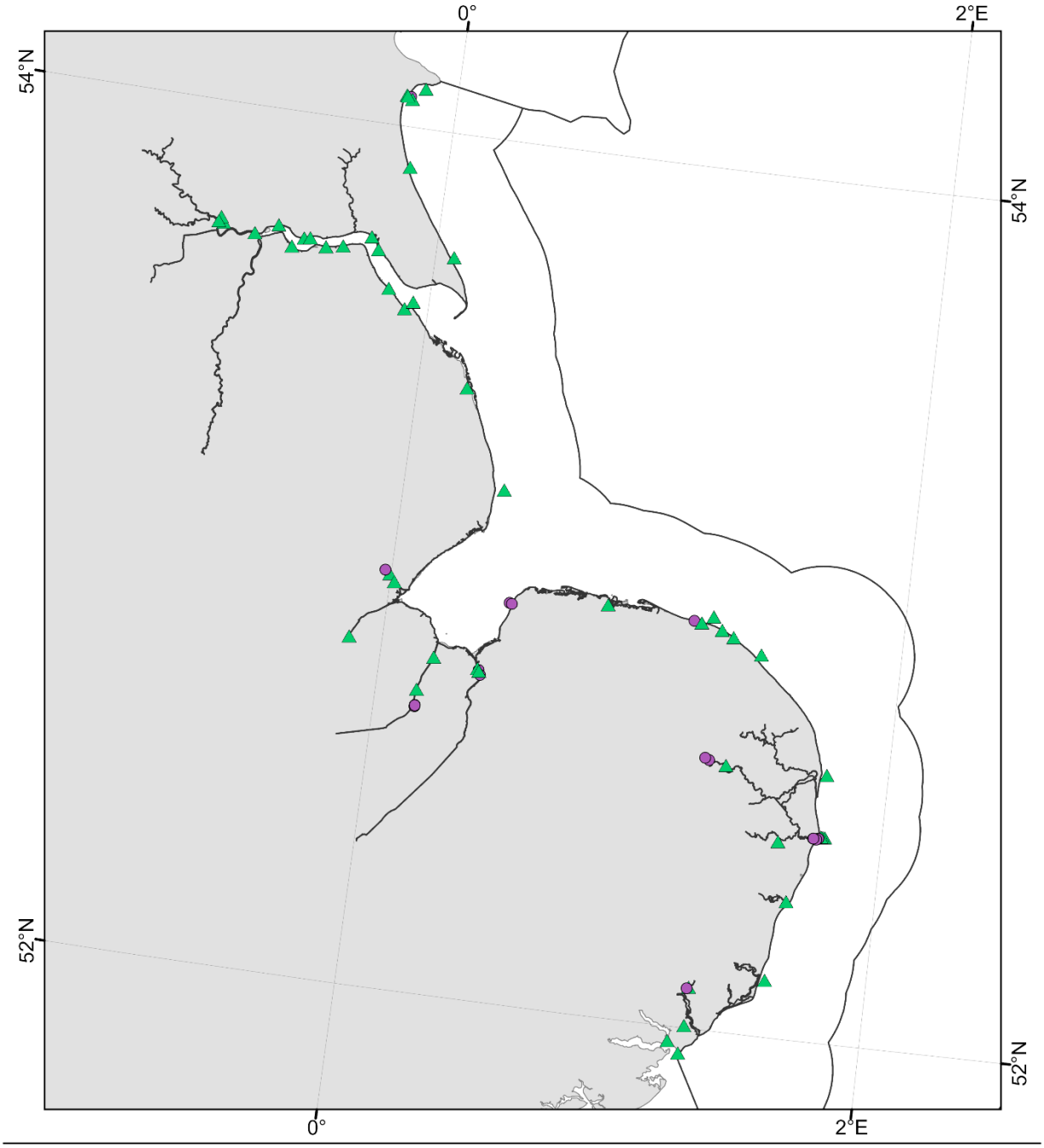
Table 20: 2022 Environmental Performance Assessment ratings for water companies operating in the Plan areas.

Water company	Discharge permit compliance (%)	Total pollution incidents (sewerage)	Overall EPA rating
Anglian Water	98.6	33	2 star
Yorkshire Water	99.7	21	3 star
Severn Trent Water	99.3	22	4 star

[275] Environment Agency. 2023. Water and sewerage companies in England: environmental performance report 2022. https://www.gov.uk/Government/publications/water-and-sewerage-companies-in-england-environmental-performance-report-2022/water-and-sewerage-companies-in-england-environmental-performance-report-2022 Accessed October 2024.

[276] Environment Agency. 2023. https://www.gov.uk/Government/publications/water-and-sewerage-companies-in-england-environmental-performance-report-2022/water-and-sewerage-companies-in-england-environmental-performance-report-2022 Accessed October 2024.

Figure 23: Combined sewer overflow discharge points.



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Projection:Lambert Azimuthal Equal Area

18.3 PESTLE analysis

The key drivers expected to influence surface and wastewater management in the Plan areas are political and have formed in response to concerns on the impact of pollution to the marine environment (Table 21). These should be considered alongside the drivers presented in the Water Quality sector (Section 30.3).

Table 21: PESTLE analysis for the surface water management & wastewater treatment and disposal sector.

Driver	Details	Implications	Impact (+ / - / Variable)
Political	Storm Overflows Discharge Reduction Plan (2023)[277] sets new targets to reduce environmental impact from sewage discharges.	Increased investment to reduce wastewater discharge, subsequently improving wastewater management.	+
	Following the UK's General Election in July 2024, the new UK Government plans to give regulators additional powers to issue penalties when illegal discharge occurs. The UK Government also plans to impose automatic and severe fines for wrongdoing and ensure independent monitoring of sewage discharges to the rivers and seas.	Improved/maintained water quality and improvement in management practices.	Variable
	The Urban Waste Water Treatment Directive[278] sets treatment levels on the basis of sizes of sewage discharges and the sensitivity of waters receiving the discharges to better protect the environment from the adverse effects of sewage discharge.	Improve and maintain water quality and the impact of discharge to the environment.	+
Economic	The cost of upgrading the CSO network to reduce the number of discharges is very high and will involve increasing storage capacity at sewage treatment works, replacing and repairing very old pipes and outfalls, and upgrading above ground flood water transport.	The high cost may slow the pace at which wastewater discharges are reduced.	-

[277] Defra. 2023. Storm Overflows Discharge Reduction Plan Updated: 25 September 2023. Available at: https://assets.publishing.service.gov.uk/media/6537e1c55e47a50014989910/Expanded_Storm_Overflows_Discharge_Reduction_Plan.pdf Accessed October 2024.

[278] European Environment Agency. 1991. Urban Waste Water Treatment Directive. Available at: https://www.eea.europa.eu/policy-documents/urban-waste-water-treatment-directive Accessed October 2024.

Driver	Details	Implications	Impact (+ / - / Variable)
Social	Increasing public interest and activism on the discharge of sewage into the marine environment.	Increased pressure on sewage and treatment works to better manage wastewater treatment.	+
	Increasing population will add pressure to the sewerage network by increasing the volume of sewage needing to be treated.	An increase in population will result in added pressure to the sewage network which could lead to additional assets being required in the Plan areas and increased risk of pollution if assets become broken.	+
Technological	Improvement of Event Duration Monitoring technology (monitoring CSO discharge) to better understand discharge compliance[279].	Increased robustness of wastewater discharge data.	+
Legal	Environmental Permitting Regulations are the permit conditions under which a permit to discharge wastewater through CSOs can occur.	Change in permitting regulation may impact how CSOs are used in the future.	Variable
Environmental	Water Industry National Environment Programme[280]	Increased investment to reduce wastewater discharge, subsequently improving wastewater management.	+
	Climate change leading to increased severe weather events including increased rainfall which adds pressure on sewer systems.	Increased rainfall will lead to storage capacity being reached faster and therefore increased use of CSOs. Additional as there is significant agricultural land in the Plan areas there could be increased agricultural run-off into the sewage system and waterways.	-

18.4 Future scenarios

6 year projection

Surface water management and wastewater treatment is likely to be maintained over the next 6 years due to continual maintenance of EDMs, storage tanks, and CSOs (low confidence). Surface water management also has the potential to be improved as degraded pipes are replaced which will reduce the risk of sewage blockages and spills. Many of the maintenance activities and upgrades will be delivered through the current Water Industry National Environment

[279] Environment Agency. 2022. Environment Agency publishes Event Duration Monitoring data for 2022. Available at: https://www.gov.uk/Government/news/environment-agency-publishes-event-duration-monitoring-data-for-2022 Accessed October 2024.
[280] UK Government. 2024. Water Industry National Environment Programme. Available at: https://www.data.gov.uk/dataset/a1b25bcb-9d42-4227-9b3a-34782763f0c0/water-industry-national-environment-programme Accessed October 2024.

Programme (WINEP) cycle to 2025, and the subsequent cycle from 2025–2030 (high confidence). By 2025, Anglian Water is expected to invest over £10 million to reduce spills at 11 priority sites[281], although the nature and location of the activities undertaken through WINEP is unknown and commercially sensitive.

6 to 20 year projection

Surface water management and wastewater treatment over the next 6 to 20 years will involve the continual maintenance of existing wastewater assets to minimise pollution (high confidence). However, the **intensity of maintenance and level of investment in infrastructure improvements are uncertain** in the longer term.

There is likely to continue to be a degree of wastewater pollution to the Plan areas from sewage spills (moderate confidence). This is due to the impacts of climate change that will result in more frequent and intense storm events which add pressure to the wastewater network, alongside the degree of investment into assets to mitigate against this environmental influence. **Overall, given increased public pressure to invest in assets to reduce water pollution, the frequency and intensity of pollution events may reduce** (low confidence).

[281] Anglian Water. Undated. Action on Storm Overflows: Our plan to 2050. Available at: https://www.anglianwater.co.uk/siteassets/household/services/aw0784-storm-overflow-action-plan.pdf Accessed October 2024..

19 Telecommunication Cables

19.1 Sector definition

This sector refers to subsea telecommunication cables, which predominantly employ the use of fibre optic cables to carry information across long distances in the form of telephone, internet, and data[282]. The cables are generally owned and operated by private or corporate entities. In general, telecommunication cables are buried under the seabed to protect them from activities near the shore but are laid directly on the ocean floor in the deep sea[283]. This is however dependent on factors such a substrate type, which means not all cables can be buried. In this case, alternative protections are set in place taking into consideration an individual cable's circumstances including normal depth limitations[284].

Maintenance of the cables is an important aspect of the sector, with fishing and anchor accidents accounting for two-thirds of cable faults and other faults occurring internally[284].

19.2 Historic trends and current activity

Subsea cables carry more than 95% of the world's international traffic, with ones in the UK carrying more than 70% of Europe's transatlantic internet traffic[285]. More specifically, the Plan areas contain 20% of English submarine cables by length, second only to the northeast marine plan areas[286].

The telecommunications sector in the UK is represented by Subsea Cables UK. The seven individual companies operating the cables in the Plan areas are BT, ASN, EU Networks, Tampnet, Zayo, Verizon, and Lumen[287]. There are eighteen telecommunication cables within the Plan areas, with six labelled as disused and eleven remaining active[288] (Figure 24). Of the eleven active cables, ten connect to

[282] MarineScotland (2018) Sectoral Marine Plan for Offshore Wind Energy (encompassing Deep Water Plan Options) Social and Economic Impact Assessment. Report content available at: https://www.gov.scot/publications/sectoral-marine-plan-offshore-wind-energy-encompassing-deep-waterplan-options/documents/ Accessed October 2024.
[283] Bernhard, A. (2023). Submarine cables carry electricity and information across vast oceans and seas, but we're only beginning to understand their possible impact on delicate marine life. Article available at: BBC Future Available at: https://www.bbc.com/future/article/20230201-how-undersea-cables-may-affect-marine-life Accessed October 2024.
[284] Department for Science, Innovation and Technology (2024). Economic Estimates: Earnings 2023 and employment Oct 2022 to Sept 2023 for the DCMS Sectors and Digital Sector. Data available at: (https://www.gov.uk/Government/statistics/economic-estimates-earnings-2023-and-employment-october-2022-to-september-2023-for-the-dcms-sectors-and-digital-sector#:~:text=Headline%20findings%3A,previous%20equivalent%2012%2Dmonth%20period.) Accessed October 2024.
[285] NOAA (2024) Submarine Cables. Article available at: (https://www.noaa.gov/submarine-cables). Accessed October 2024.
[286] MMO (2013) Strategic Scoping Report for marine planning in England August 2013. Report content available at: https://assets.publishing.service.gov.uk/media/5a7493d5ed915d0e8e399516/ssr-august2013.pdf Accessed October 2024.
[287] KIS-ORCA (2024). Map Data Layers. Available at: https://kis-orca.org/map/ Accessed October 2024.
[288] KIS-ORCA. (2024) Map Data Layers. Available at: https://kis-orca.org/map/ Accessed October 2024.

the Netherlands. Six make landing at Lowestoft and two at Sizewell, and two make landing at Aldeburgh and Winterton-on-Sea in the east. The remaining cable passes through the Plan areas and makes landing at Whitesands Bay in the south-west (Figure 24).

There has been a recent increase in new telecom cables being laid, with a cable that has recently been completed in 2024 being the Iceni, connecting Callantsoog in the Netherlands to Winterton-on-Sea in the UK. Other recent additions since 2021 include Scylla and Zeus, both of which also land at the Netherlands.
A robust estimate for the GVA of the telecommunication cables sector in the Plan area cannot be pinpointed due to a lack of availability of regional figures, suitable apportioning data and lack of figures specific to subsea cables. Two methods have been tested by the MMO and TCE, however they have not been deemed sufficient to estimate the GVA of the sector, with a potential risk of undervaluing the importance of subsea cables to telecommunications.

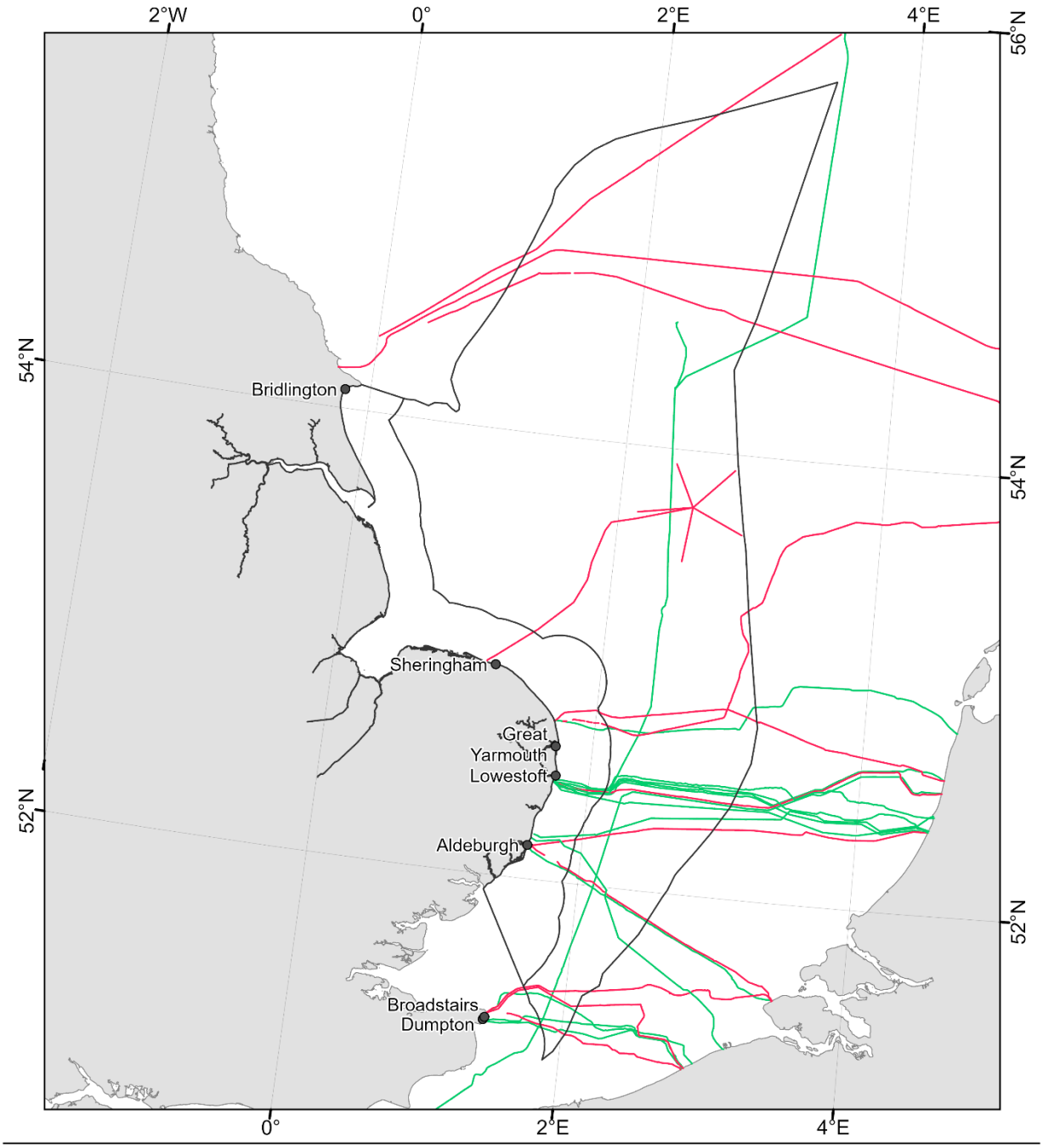
A preliminary estimate of the economic value of the UK telecommunications subsea cables industry to the digital economy valued it at £62.8 billion per annum[289]. However, given the date at which the report was produced, there is an uncertainty around the accuracy of this figure and relevance in the current market.

The telecommunication sector is part of the wider digital sector. It plays an important part in supporting the digital sector, contributing to its growth in recent years. As of December 2023, the telecommunication sector, not specific to subsea cables, was worth £2.8 billion in GVA, compared to £1.8 billion in January 2019, and having increased by 300% in 2022 from 2010.

Employment estimates indicate that within the telecoms sector, there were approximately 188,000 filled jobs across the UK, 15,000 of which are in the East[290]. However, these statistics do not specify whether these relate to terrestrial or offshore activity. Thus, there is a lack of both UK-wide and regional data regarding employment within the subsea cable industry specifically as well as a lack of a specific Standard Industrial Classification code (used for economic analysis by the Office for National Statistics) for the sector.

[289] Elliott, C., Al-Tabbaar, O., Semeyutin, A., and Tchouamou Njoya, E. (2016). An Economic and Social Evaluation of the UK Subsea Cables Industry. A report commissioned by The European Subsea Cables Association and The Crown Estate.
[290] Department for Science, Innovation and Technology (2024). Economic Estimates: Earnings 2023 and employment Oct 2022 to Sept 2023 for the DCMS Sectors and Digital Sector. Data available at: https://www.gov.uk/Government/statistics/economic-estimates-earnings-2023-and-employment-october-2022-to-september-2023-for-the-dcms-sectors-and-digital-sector Accessed October 2024.

Figure 24: Telecommunication cables.



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Projection:Lambert Azimuthal Equal Area

19.3 PESTLE analysis

There are several factors that drive future developments in the telecommunication cable industry, notably economic, technological, social, and environmental factors. A rise in the consumer demand for internet and mobile data services prompts more pressure on the development of faster and newer cable technologies as well as additional cabling systems coming into the UK. With that increase in demand comes concern for different environmental factors hindering such developments and increasing limits on areas where cable placement is possible. The key drivers that will impact the development of telecommunication cables in the Plan areas in the future are listed in Table 22 below.

Table 22: PESTLE analysis for the telecommunication cables sector.

Driver	Details	Implications	Impact (+ / - / Variable)
Political	EU-Exit	EU-Exit concerns have factored into a surge of investment in subsea telecommunications cables, including several that directly connect Ireland to Europe, bypassing the UK. However, in the Plan areas, telecom cables are still likely to connect the UK to the EU.	Variable
	UK Digital Strategy[291]	The UK's digital infrastructure must be able to support the rapid increase in global internet traffic, and support growth across the economy. This is likely to require investment in connectivity including telecom cables for further development of the network.	+
Economic	Potential economic losses due to interferences with or by other users in the area, such as fishing (trawling), anchoring and cable laying and maintenance (i.e., high traffic areas).	Could cause restrictions on location of cables and higher cost in areas of high traffic to protect cables.	-
Social	Increased consumer demand for internet and mobile data services, as well as oppositions to landing sites.	This will increase the requirement for further development of network and subsea cables coming into the UK. However, opposition to landing sites could set this progress back.	+

[291] GOV.UK (2017). UK Digital Strategy 2017. [online] GOV.UK. Available at: https://www.gov.uk/Government/publications/uk-digital-strategy/uk-digital-strategy. Accessed October 2024.

Driver	Details	Implications	Impact (+ / - / Variable)
Technological	New developments in cable technology and capacity: Development of high-speed internet (5G)[292], increased bandwidth/data capacity[293], and other technological advancements such as monitoring systems and mapping[294].	Technologies can advance cable capabilities. Technological advancements could improve the functionality of telecommunication cables in the Plan areas for instance, Automatic Identification System can alert cable owners to suspicious ship behaviour around their cables. Additionally, initiatives such as the Science Monitoring and Reliable Telecommunications (SMART) Cables aims to equip transoceanic telecommunications cables with sensors to provide novel and persistent insights into the state of the ocean[295].	+
	Technological advancements including the SMART Subsea Cables initiative is improving cable monitoring capabilities which will lead to a more resilient network[296].	Increase the resilience of the network of telecom cables across the Plan areas by more effectively monitoring the impact of cables on the marine environment.	+
Legal	The United Nations Convention on the Law of the Sea[297] sets out laws establishing the rules governing all uses of the oceans and their resources, including the use of the sea for activities related to telecommunication cables.	Mitigate risks of natural and human damage to cables; promote scientific research addressing how cables exist in the marine environment; promote the rule of law for the oceans. However, cables beyond 12 NM do not require a marine licence which limits the influence of the planning system.	+

[292] Thales. 2024. 5G technology and networks (speed, use cases, rollout. Available at: https://www.thalesgroup.com/en/markets/digital-identity-and-security/mobile/inspired/5G Accessed October 2024.
[293] Thales. 2024. 5G technology and networks (speed, use cases, rollout. Available at: https://www.thalesgroup.com/en/markets/digital-identity-and-security/mobile/inspired/5G Accessed October 2024.
[294] SMART Cables. 2024. SMART Cables. Available at: https://www.smartcables.org/ Accessed October 2024.
[295] SMART Cables. 2024. SMART Cables. Available at: https://www.smartcables.org/ Accessed October 2024.
[296] SMART Cables. 2024. SMART Cables. Available at: https://www.smartcables.org/ Accessed October 2024.
[297] United National. 1982. United Nations Convention on the Law of the Sea of 10 December 1982 Overview and full text. Available at: https://www.un.org/depts/los/convention_agreements/convention_overview_convention.htm Accessed October 2024.

Driver	Details	Implications	Impact (+ / - / Variable)
Environmental	Natural environmental change for example due to strong currents could cause shifting seabed sediment and expose and scour to subsea cables.	Natural environmental variability which may expose and damage cables will require more repairs/maintenance and/or cable protection measures.	Variable
	Management and designation of MPAs and HPMAs.	May restrict where cables can be laid.	-

19.4 Future scenarios

6 year projection

While more cables may be laid to meet increasing demands in the long term, none are expected in the Plan areas over the next six years (moderate confidence). The number of new cables will largely depend on factors such as the destination countries and suitable starting points for such a cable. Any future cable zones would need to be assessed to avoid socio-economic constraints and other aspects such as sensitive seabed habitats, limited locations available to set cables and activities of other sectors. **Other sectors could conflict with subsea cables and increase the risk of damage to telecommunication cables.** Hence future considerations will need to be given to activities inside and outside areas where cables are lain that may prevent the expansion of cable networks.

6 to 20 year projection

Despite this sector being an economically valuable sector, its footprint is relatively small and is unlikely to drastically change over the next 20 years, especially with further technological advancements (moderate confidence). **Further development of subsea telecommunication cables will likely continue to incorporate more resilient and diverse networks and cables, such as for different bandwidths.** Additionally, the typical life of subsea cables is 15-20 years, meaning there is **likely to be a need for the replacement of most current cables during the next 6 to 20 years** (high confidence). **A potential new cable system called IOEMA that will pass through the Plan areas is outlined in the IOEMA project** and will be connecting the UK from Dumpton Gap to Eemshaven in the Netherlands, Wilhelmshaven in Germany, and Blaabjerg in Denmark.[298] A launch date and timeline has not yet been released. **The location of future cables, however, is uncertain**, as it will be based on several factors such as availability of suitable landfall areas and space from other marine activities.

[298] IOEMA (2024). The IOEMA Project: A new state-of-the-art Data Backbone will provide vital connectivity in the southern North Sea. Content available at: (https://ioemafibre.eu/wp-content/uploads/2024/05/IOEMA-Press-Release-290524-web.pdf) Accessed October 2024.

20 Tourism and Recreation

20.1 Sector definition

Tourism incorporates all day and overnight visits by domestic and international visitors. Coastal tourism includes activities reliant on the coastal environment, such as visiting the beach, hiking, cycling and birdwatching. Coastal tourism in England is mostly driven by a desire to relax, spend quality time with friends or family, and to sightsee or explore[299]. Recreation includes all activities undertaken in the inshore and offshore coastal areas, for leisure purposes. This includes sports such as sailing, powerboating, angling, paddle sports and manual activities, as well as ancillary activities such as manufacturing, retail and marinas[300]. Tourism and recreation are sources of income for coastal communities and are recognised as important contributors to the local economy.

20.2 Historic trends and current activity

The marine recreation sector contributed £1.68 billion in GVA to the UK economy in the 2022/2023 financial year[301], which has increased from £1.57 billion in 2021/22[302]. Since the Covid-19 pandemic, the general public are re-prioritising outdoor holidays and off the grid experiences, resulting in more people taking part in marine recreation and tourism activities[303]. Industries such as boating tourism have increased by 32.7%. UK boat sale revenue has grown from 106.3 (revenue growth index, RGI) in 2019 to 128.9 RGI in 2023[304]. With this, the workforce of the marine recreation sector has also grown by 6.6%, with 38,336 full-time equivalents working marine industry jobs in the UK during 2022/2023[305].

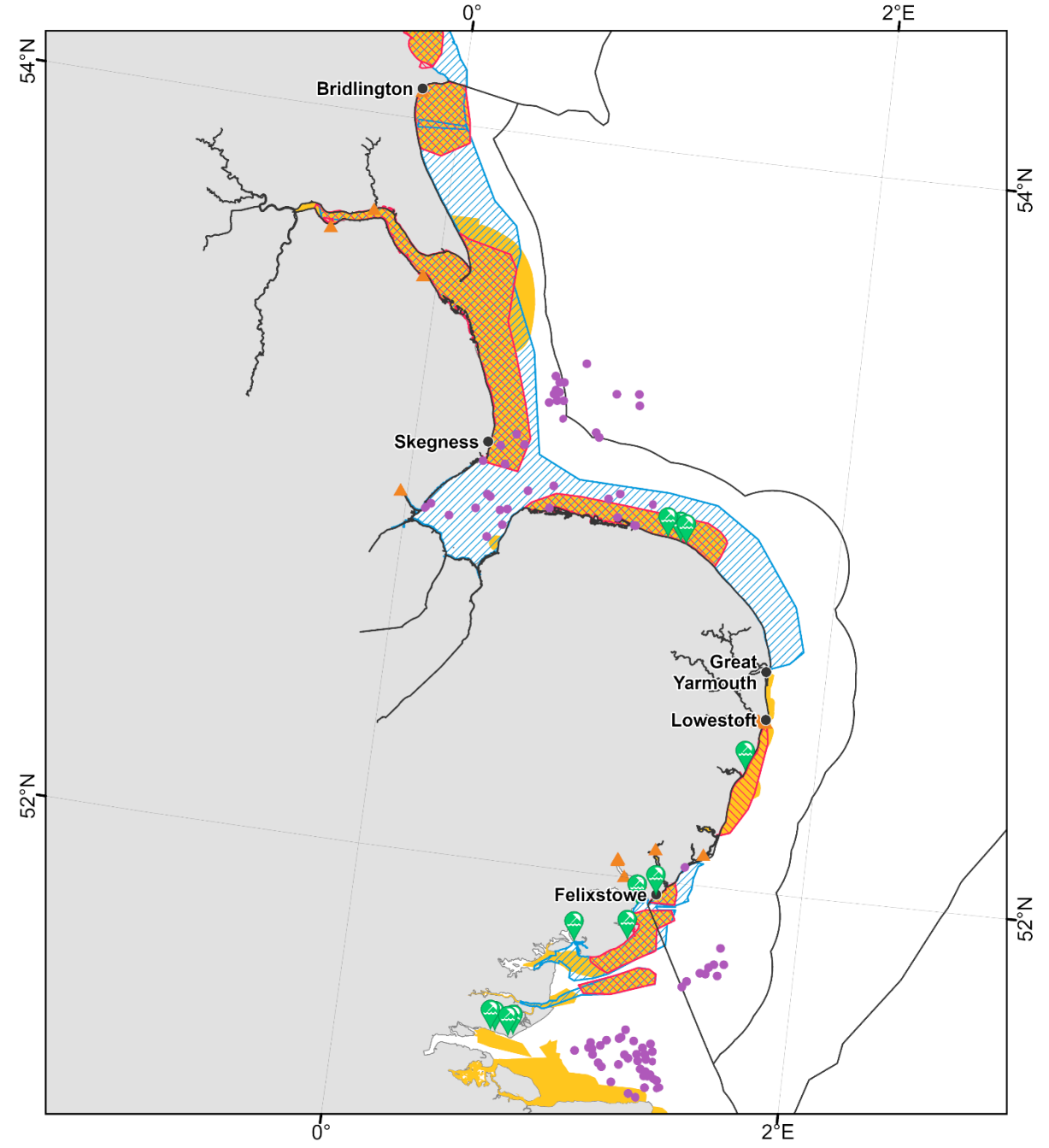
[299] National Coastal Tourism Academy (2024) 'Coastal Tourism Overview'.
[300] British Marine (2023) 'Key Performance Indicators for the Leisure, Superyacht & Small Commercial Marine Industry, 2021-22'Available at: https://www.marinebusinessworld.com/news/260405/British-Marine-releases-2021-22-KPI-report Accessed October 2024.
[301] British Marine (2024) 'Key Performance Indicators for the Leisure, Superyacht & Small Commercial Marine Industry, 2022-23'. Available at: https://www.britishmarine.co.uk/resources/knowledge-centre/economic-benefits-leisure-superyacht-and-small-commercial-marine-industry-2022-2023 Accessed October 2024.
[302] CEBR (2022) 'The economic contribution of the UK Leisure Marine industry'. Available at: https://www.maritimeuk.org/documents/1137/2022_CEBR_Report_Leisure_Marine_industry.pdf
[303] World Travel & Tourism Council (2020) 'To Recovery & Beyond: The Future of Travel & Tourism in the Wake of COVID-19' Available at: To Recovery & Beyond | Future of Travel & Tourism | World Travel & Tourism Council (WTTC) Accessed October 2024.
[304] British Marine (2024) 'The Economic Benefits of the Leisure, Superyacht & Small Commercial Marine Industry, 2022-23. Available at: The Economic Benefits of the Leisure, Superyacht & Small Commercial Marine Industry, 2022-2023 :: British Marine Accessed October 2024.
[305] British Marine (2024) 'Key Performance Indicators for the Leisure, Superyacht & Small Commercial Marine Industry, 2022-23'. Available at: https://www.britishmarine.co.uk/resources/knowledge-centre/economic-benefits-leisure-superyacht-and-small-commercial-marine-industry-2022-2023 Accessed October 2024.

Within the Plan areas, there are four principal seaside towns (Bridlington, Skegness, Great Yarmouth and Lowestoft)[306], 12 smaller seaside towns[307], five holiday parks[308] and two 'other' seaside towns[309,310] (Figure 25). The Lincolnshire coast, and a large part of the East Anglian coast (which are both within the Plan areas), make up the largest proportion of the Lincolnshire and East Anglian visitor economies.

The GVA of UK coastal tourism was £7.2 billion in 2018[311]. The National Coastal Tourism Academy's most recent data provides insight into coastal tourism since the Covid-19 pandemic. Tourism spend decreased by 31-40% between 2019 and 2022[312] and many coastal tourism employees were without jobs during the pandemic. Skegness had the highest number of coastal tourism employees unable to work at 54.7%[313]. However, in more recent years, 37% of coastal tourism businesses have achieved a better turnover in 2023 than 2022, indicating a recent recovery within the tourism industry since all Covid-19 restrictions have been lifted[314].

[306] Principle seaside towns: places with a population of at least 10,000 where coastal tourism is a significant component of the local economy
[307] Smaller seaside towns: places with a population of at least 1,500 but less than 10,000 where coastal tourism is a significant component of the local economy
[308] Holidays parks: places where there are individual holiday parks, or, where there is a high concentration of camping and caravan sites.
[309] 'Other' seaside towns: places where coastal tourism is an additional component of the local economy, or sub-parts of larger urban areas that, taken as a whole, could not be described as a 'seaside resort.'
[310] Beatty, C., Fothergill, S., Gore, T. & Wilson, I (2010) 'The Seaside Tourist Industry in England and Wales'. Available at: https://www.shu.ac.uk/centre-regional-economic-social-research/publications/the-seaside-tourist-industry-in-england-and-wales Accessed October 2024.
[311] European Commission (2020) 'Blue Economy Report'. Available at: https://s3platform.jrc.ec.europa.eu/w/the-eu-blue-economy-report-2020 Accessed October 2024.
[312] National Coastal Tourism Academy (2024) 'Coastal Tourism Overview – May 2024'.
[313] Centre for Towns (2020) 'The effect of the Covid-19 pandemic on our towns and cities'. Available at: https://www.coalfields-regen.org.uk/wp-content/uploads/2020/05/COVID_19-and-Towns.pdf Accessed October 2024.
[314] National Coastal Tourism Academy (2024) 'Coastal Tourism Business Survey 2024 Spring Wave'

Figure 25: Seaside towns, tourism and recreation activities.



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Coordinate System:ETRS 1989 LAEA
Projection:Lambert Azimuthal Equal Area

There are 18 marinas within the Plan areas, mostly situated in Norfolk and Suffolk[315], as shown in Figure 25[316]. Due to the flat geography and resulting shallower inshore water along the Norfolk and Suffolk coasts, access is limited for larger boats. Therefore, there is less demand for marinas in the area than in coastal stretches with deeper inshore waters, such as the Solent on the south coast. Activities such as recreational angling, small sailing boat and powerboat hire, canoes, kayaks and small ferry boat trips, are popular in the Plan areas. In 2019, the Plan areas contributed approximately 12.7% of turnover[317] to the marine recreation sector in the UK[318]. Figure 25 illustrates popular areas for coastal tourism and marine recreation.

20.3 PESTLE analysis

The most important drivers that will influence recreation and tourism in the Plan areas are economic, social and environmental. The key drivers are listed in Table 23 below.

Table 23: PESTLE analysis for the tourism and recreation sector.

Driver	Details	Implications	Impact (+ / - / Variable)
Political	The Marine Policy Statement[319] promotes sustainable economic development to drive to societal benefits of the marine area.	Increased investment and preservation of the east inshore marine plan area, improving coastal tourism.	+
	The Tourism Recovery Plan[320] aims to improve the tourism industry by 2024 in response to the significant negative impact of Covid-19.	Increased investment and development of the tourism sector.	+
Economic	The tourism sector deal aims to develop the visitor economy and places that people want to visit[321]. Additionally, it notes that to do this there needs to be an upgrade of tourism related infrastructure.	Increased investment, development and job-creation within the tourism and recreation sector in the Plan areas.	+

[315] Marinas.com (n.d.) 'Map'. Available at: https://marinas.com/map?lat=52.02540320907329&lon=1.3441441689208204&zoom=10.626643263286079&markers=marina&style=dockwa/cja1gtn25aemq2rt24d01c57w&pin_id=xgtl1e Accessed October 2024.
[316] Marinas.com (n.d.) 'Map'. Available at: https://marinas.com/map?lat=52.02540320907329&lon=1.3441441689208204&zoom=10.626643263286079&markers=marina&style=dockwa/cja1gtn25aemq2rt24d01c57w&pin_id=xgtl1e Accessed October 2024.
[317] East marine plan value includes 2.5% from East midlands and 10.3% from the East of England.
[318] Cebr. 2022. 'The economic contribution of the UK Leisure Marine Industry' A Cebr report for Maritime UK and British Marine. Available at: https://www.maritimeuk.org/media-centre/publications/2022-cebr-reports/ Accessed October 2024.
[319] Her Majesty Government. UK Marine Policy Statement. 2011. Available at: https://assets.publishing.service.gov.uk/media/5a795700ed915d042206795b/pb3654-marine-policy-statement-110316.pdf Accessed October 2024.
[320] UK Government. 2021. Tourism Recovery Plan (2021) https://assets.publishing.service.gov.uk/media/6447ec19814c6600128d061d/Select_Committee__TRP_update.pdf Accessed October 2024.
[321] UK Government. 2019. Tourism Sector Deal (2019) Available at: https://assets.publishing.service.gov.uk/media/6447ec19814c6600128d061d/Select_Committee__TRP_update.pdf Accessed October 2024.

Driver	Details	Implications	Impact (+ / - / Variable)
	Economic impacts not fully exploited by activity from other sectors for example marine and harbour developments for increased shipping activity could restrict the location for tourism activities.	Could restrict boating and cruise ship activities and other associated tourism activities	-
Social	Competition for space with other sectors (e.g. shipping, renewables, commercial fishing and aquaculture)	Other sectors could result in negative impacts to valued landscapes, decreasing levels of coastal tourism in some locations. However, some sectors may contribute to landscapes and seascapes which attract tourists, such as maintaining the special characteristics afforded by Areas of Outstanding Natural Beauty (AONBs) and National Parks.	Variable
	Post-pandemic re-prioritisation of family and holidays. Including increase of 'staycations' since Covid-19.	Increase in tourism and recreation in the UK, resulting in economic benefits.	+
	Increased public awareness and value of marine environments.	Increase in eco-tourism and recreation resulting in economic benefits.	+
Technological	Social media advertising and the ability to share travel and recreation advice online.	Increase in tourism and recreation.	+
Legal	Destination development plan[322] focuses on improving coastal access presents an opportunity to boost tourism in the east inshore marine plan area.	Facilitating access will increase tourism and recreation, further resulting in wellbeing benefits for local users.	+
Environmental	The Environment Improvement Plan 2023[323] revised the 25 Year Environment Plan which aims to conserve and enhance the beauty of the natural environment, and make sure it can be enjoyed, used by and cared for by everyone.	Increased investment and preservation of the Plan areas.	+

[322] New Anglia LEP. 2021. East of England Destination Development Plan. Available at: https://newanglia.co.uk/wp-content/uploads/2021/10/FINAL-LR-East-Of-England-Tourism-Action-Plan-September-2021-WEB.pdf Accessed October 2024.
[323] Defra. 2023. Environmental Improvement Plan 2023. Available at: https://www.gov.uk/Government/publications/environmental-improvement-plan Accessed October 2024

Driver	Details	Implications	Impact (+ / - / Variable)
	The Heritage Coasts and AONB aim to conserve undeveloped coasts in England.	Increased investment and preservation of the east inshore marine plan area, such as the Suffolk and Essex Heaths and Coasts AONB and Broads National Park is expected to improve coastal tourism in surrounding areas.	+
	Management and designation of MPAs and HPMAs.	This could result in increased investment and preservation of the east inshore marine plan area, improving coastal tourism, but also HPMAs may restrict some recreational activities.	+
	Managing marine non-licensable activities in marine protected areas.	Restrictions to associated tourism activities.	-
	Water quality	Water quality impacts recreational use of the coast. Three North Norfolk beaches are losing their blue flag status in 2023 due to water contamination likely caused contamination with bacteria originating from animals, with high tides and bad weather stirring up bacteria from the seabed [324], resulting in a decrease of marine recreation and tourism.	-

20.4 Future scenarios

6 year projection

An increase in the development of the tourism industry, consequently leading to new job opportunities is likely, as the Tourism Recovery Plan works to recover the industry after the impacts of the Covid-19 pandemic (moderate confidence).

There has been a steady growth in the natural tourism and recreation market, including cultural, wildlife and nature tourism since the pandemic, which is expected to continue. The England Coast Path currently spans less than half the coastline of the east onshore marine plan area**, however a stretch of the path between Sutton Bridge and Skegness has been approved for development and three more**

[324] North Norfolk Times. 2023. Sewage not the cause of Norfolk losing Blue Flag beaches, agency says. Available at: https://www.northnorfolknews.co.uk/news/23868061.sewage-not-cause-norfolk-losing-blue-flag-beaches-agency-says/ Accessed October 2024

stretches are either approved in part or have had proposals published.[325] Once complete, there will likely be a significant opportunity for the coastal tourism sector (high confidence).

Whilst there are opportunities for the tourism sector to grow, **restrictions may also be associated with tourism and recreation activities within the Plan area as non-licensed activities in MPAs are managed.** A map of MPAs in the Plan Area is shown in Figure 41.

It is also possible for there to be **physical constraints that may impact future development of the tourism sector** as there is a **competition with other sectors for space,** in particular with the energy sector for the use of onshore and offshore areas. The **potential development of the nuclear power plant Sizewell C in Suffolk has already become a point of disagreement between key stakeholders** in each sector. Despite the proposed £250 million investment to mitigate the impact of the project on local communities, East Suffolk Council predicts a 5% drop in visitor numbers which could lead to an annual loss of £30 million for the tourism industry, however it can also be argued Sizewell C will not cause a significant effect on tourism numbers due to already existing nuclear plants within the area (low confidence).

Offshore wind farms also present similar issues to that of Sizewell C. However, in recent years, **opportunities have arisen for the tourism sector to benefit from these offshore energy projects.** Over the next six years, it can be expected to see an increase in tourism opportunities to visit offshore wind farms such as boat trips to observe seals against the backdrop of Scroby Sands offshore wind farm (moderate confidence).

6 to 20 year projection

Over the next 20 years, it is expected the **Environment Improvement Plan 2023 will increase investment and preservation of the east inshore marine plan area** along with further designations of MPAs, HPMAs and AONB (moderate confidence).

With time, **the competition with other sectors for space will continue to grow** and there are expected to be uncertainties in the global consumption patterns, in which the tourism industry is expected to mirror and fluctuate. **Changes in the tourism sector interlinks with many other sectors,** an example being that increased use of land and water vehicles could add environmental pressures such as air quality (see Section 21) and water quality (Section 30). With these changes in leisure and tourism, job opportunities within the Plan area are expected (moderate confidence).

[325] Natural England (2024) 'King Charles III England Coast Path – Stretch Progress: East Hub Team'. Available at: https://www.gov.uk/Government/publications/england-coast-path-in-the-east-of-england Accessed October 2024.

There are **large concerns over the future impact of extreme weather events on the tourism sector** within the next 20 years (low confidence). Extreme weather events have an impact on both **coastal erosion and increases the likelihood of storm overflows by wastewater management companies**. Coastal erosion rates along the Plan areas are some of the highest in Europe, with the Holderness Coast retreating at a rate of 2 metres per year[326] and in 2023, three North Norfolk beaches lost their blue flag status due to water contamination from wastewater overflows in popular swimming spots.

Changing technologies are also expected to impact the tourism and recreation sector over the next 20 years as electric vehicle sales are expected to continue to rise. Whilst the current infrastructure to support this growth is not in place and could result in a decrease in tourism in rural areas, installation of charging points is also expected to grow. With this growth, the Plan area will be able to accommodate more electric vehicles, resulting in an increase in tourism and recreation (moderate confidence).

[326] Aggregate Industries (2024) 'The True Cost of Coastal Erosion to the UK'. Available at: https://www.aggregate.com/sites/aiuk/files/2024-03/the-true-cost-of-coastal-erosion-to-the-uk-reasearch-paper.pdf Accessed October 2024.

21 Air Quality

21.1 Sector definition

Air quality is a measure of the concentrations of pollutants in the air we breathe. Poor air quality is associated with several adverse health impacts, particularly affecting the most vulnerable in society, and has significant impacts on the natural environment and biodiversity[327].

21.2 Historic trends and current activity

The UK compiles an annual report featuring a consistent time series of the majority of anthropogenic air pollutant emissions, from 1970 onwards, the National Atmospheric Emissions Inventory. This encompasses emissions by industries, transport, waste, domestic sources, and agricultural waste[328]. While these emission sources are main drivers of poor air quality in the UK, other sources include secondary formation of air pollutants, emissions that originate externally from the UK, and geographical/ meteorological factors. The Automatic Urban and Rural Network monitors the most well-known pollutants on an hourly basis, in turn providing long-term trends in air quality. The main types of pollutants monitored are oxides of nitrogen (NO_x), sulphur dioxide (SO_2), ozone (O_3), carbon monoxide (CO) and particulate matter (PM_{10}, $PM_{2.5}$)[328].

Air quality has improved in England over recent decades due to environmental legislation introduced over the past 50 years, however, the UK recognises the urgency of the current situation, naming poor air quality as “the largest environmental risk to public health”[328,329]. To tackle this, the UK Government has strengthened policies and formed concrete plans to reduce the presence of harmful air pollutants. Legislation stems from a range of measures including international, retained EU law and national law.

Data on offshore air quality are not readily available, however there is a wide range of data concerning onshore statistics which are relevant to coastal areas. Air quality measures are dependent on several “pollutants of concern” and are scaled from 1 to 10, with 10 being very high and 1-3 being low. There has been a general decrease in air pollutants across the UK and in the Plan areas from 2010 to 2022[330]. The following air pollution summaries were derived from UK AIR with data provided by the Environment Agency[331] for the past two years (2023-2024). They indicate that in the East, starting January 2024, air quality has generally stayed at low levels of air

[327] Her Majesty Government. UK Marine Policy Statement. 2011. Available at: https://assets.publishing.service.gov.uk/media/5a795700ed915d042206795b/pb3654-marine-policy-statement-110316.pdf Accessed October 2024.
[328] DEFRA. 2020. Air quality and emissions statistics. Content available at: Collection Air quality and emissions statistics Available at: https://www.gov.uk/Government/collections/air-quality-and-emissions-statistics Accessed October 2024.
[329] Smith, L. 2024. Air quality: policies, proposals and concerns. Available at: Available at: https://commonslibrary.parliament.uk/research-briefings/cbp-9600/ Accessed 24/06/2024
[330] DEFRA. 2023. Air Pollution in the UK 2022. Available at: https://uk-air.defra.gov.uk/library/annualreport/index Accessed October 2024.
[331] UK AIR DEFRA. 2024. Measurement summary based on data provided by the Environment Agency. Available at: https://uk-air.defra.gov.uk/ Accessed October 2024.

pollution (between levels 1 and 3), with a few instances of lower moderate levels in early March and April (level 4) and a few mid moderate days in May (Levels 4 and 5). During the same period over the past two years, the same levels as above were experienced. However, during March, the measurements in 2023 remained at low levels, yet in 2022, they soared into high levels (levels 7-8).

Ten Air Quality Management Areas (AQMAs) are adjacent to the east inshore marine plan area[332].

While not readily detected by onshore air quality monitoring (which primarily focus on traffic/roads), shipping, ports and oil & gas have a significant contribution to poor air quality in the UK.

The Plan areas contains some of the busiest shipping ports and channels in Europe, including the Port of Felixstowe which is the busiest port in the UK and handles 4 million TEUs (twenty-foot equivalent units) of cargo each year[333] (see section 0 for further details on shipping in the Plan areas). Whilst shipping is a growing sector, it is one of the least regulated sources of emissions of pollutants, which include NO_x, SO_2, and primary $PM_{2.5}$. There have been, however, recent moves to mitigate and improve this, including Emission Control Zones, Sulphur Emission Control Areas, and use of low sulphur fuel and scrubbers on ships[334].

There is a large number of oil and gas installations in the Plan areas (see Figure 18) where it is also a contributor to air pollutants, from flaring off excess gas to burning oil/gas to power the platforms themselves.

21.3 PESTLE analysis

The main drivers influencing the development of the air quality sector are political, economic, and legal. An increase in concern for air quality prompt increased policies, strategies, and regulations. While these regulations will ultimately help reduce emissions and hence improve air quality, such efforts also incur costs. The key drivers that will influence air quality in the Plan areas in the future are listed in Table 24 below.

[332] DEFRA. 2024. UK AIR. Available at: https://uk-air.defra.gov.uk/aqma/maps/ Accessed October 2024.
[333] Highway Logistics. 2023. The UK's Top 5 Busiest Shipping Ports. Available at: https://www.highway-logistics.co.uk/the-uks-top-5-busiest-shipping-ports Accessed October 2024.
[334] DEFRA. 2017. Impacts of Shipping on UK Air Quality. Available at: https://uk-air.defra.gov.uk/library/reports?report_id=934 Accessed October 2024.

Table 24: PESTLE analysis for the air quality sector.

Driver	Details	Implications	Impact (+ / - / Variable)[335]
Political	Clean Air Strategy 2019[336]	Includes reducing emissions across the ports and associated waterways, including both emissions from shore activities and visiting ships. Infrastructure changes required could prove costly, however could lead to opportunities to innovate further into new technologies and leaning into sustainable strategies that will marginally improve emission rates.	+
Economic	Decarbonisation and associated costs of implementation	The cost of decarbonising shipping or using lower sulphur/ different type of fuel could delay improvements in air quality and even increase emissions if not executed correctly. Solutions like slow steaming and bulbous bows designed to reduce speed and increase fuel efficiency also come with downsides in terms of time and costs. The principal assets- the vessels- have long lifetimes which will involve further investment in commissioning and refitting vessels with new technology[337]. Conversely, Government funding (e.g. £77 million Government investment in clean maritime technology: Zero Emission Vessels and Infrastructure) will help accelerate the decarbonisation of the UK's maritime sector [338].	Variable
Social	No significant drivers identified.		
Technological	A range of options for technological advances including electrification of vessels.	Trends within the ports and shipping industry (Section 13.3 (PESTLE analysis)) indicate air quality will improve due to investments and technologies involving reduced emissions and decarbonisation. Substantial work and Government support will need to be provided to adapt and meet the needs and electrification of the fishing fleet.	+
Legal	National Emissions Ceiling Regulations 2018[339]	Sets national (UK wide) emission limits or 'ceilings' for sulphur dioxide, oxides of nitrogen, ammonia non-methane volatile organic compounds in 2010, 2020 and 2030 and for $PM_{2.5}$ in 2020 and 2030.	+

[335] '+' refers an improvement to air quality, and '-' refers is a reduction in air quality.
[336] UK Government. 2019. Clean Air Strategy. Available at: https://www.gov.uk/Government/publications/clean-air-strategy-2019 Accessed October 2024.
[337] House of Commons (2024). Net zero and UK shipping. Available at: https://committees.parliament.uk/publications/45178/documents/223685/default/ Accessed October 2024.
[338] Department for Transport (2023). Major milestone in UK's race to net zero maritime with £77 million boost. Available at: https://www.gov.uk/Government/news/major-milestone-in-uks-race-to-net-zero-maritime-with-77-million-boost Accessed October 2024.
[339] UK Government. 2028. The National Emission Ceilings Regulations 2018. Available at: https://uk-air.defra.gov.uk/air-pollution/uk-policy-context Accessed October 2024.

Driver	Details	Implications	Impact (+ / - / Variable)[335]
	UK Government's net zero targets, as set out in the Climate Change Act[340].	The UK's transition to net zero has the potential to reduce air pollution in nearly every sector, ranging from transport, and home heating to energy production. However, this is dependent on which replacement technologies are used and how they are managed, in a way that would not counteract progress.	+
	Introduction of global sulphur limits to 0.5% by volume to improve air pollution from vessels.	While this would increase operating costs for vessels, it would improve air quality and encourage investment in green shipping.	Variable
Environmental	Climate change	Increases in temperature may affect the formation of ozone, increasing the frequency and severity of summer smog. Persistent weather events could cause stagnated air to accumulate, and stormier weather could increase mixing of air pollutants, potentially slowing efforts in reducing emissions.	-

21.4 Future scenarios

6 year projection

Air quality is set to improve over the next 6 years based on several analyses and plans (high confidence). An analysis by Defra details the positive impact the Clean Air Strategy will have on annual mean $PM_{2.5}$ levels, with an anticipated 95% reduction in population exceedance of this goal in 2030 from 2016 (moderate confidence)[341]. It is important to note that limits in the scope of the analysis means a lack of certainty regarding the measures it would take to meet the guideline measures for everyone in the UK by 2030. There are gaps in offshore air quality monitoring, where there is a lack of evidence projects on air quality and outcome indicators in place for monitoring. While spatial data exists that provides some scope, it is not specifically designed for air quality monitoring. Despite this, whilst challenging, it would be technically feasible to meet these guidelines across the UK in the future.

More specifically to the maritime sector, the Clean Maritime Plan (2019), issued under the Maritime 2050 strategy, is designed to complement the Clean Air Strategy. The plan sets out the following zero-emission ambitions for the maritime sector:

[340] UK Government. 2019. Climate Change Act 2008. Available at: https://www.legislation.gov.uk/ukpga/2008/27/section/1/2019-06-27 Accessed October 2024..
[341] DEFRA (2019). Assessing progress towards WHO guideline levels of PM2.5 in the UK. Report available at: (https://assets.publishing.service.gov.uk/media/5f9945fdd3bf7f168fd92e97/air-quality-who-pm25-report.pdf) Accessed October 2024.

- by 2025, all vessels in UK waters are to operate with maximum energy efficiency measures;
- by 2025 the UK will have begun developing ports and coastal localities into 'clean maritime clusters' to provide zero emission infrastructure, including 'bunkering' (refuelling facilities) with low- or zero-emission fuel.

Climate change can impact air quality through changes in meteorology, in turn impacting the emission, transformation, and deposition of air pollutants[342]. Climate change could hence set back the plans and goals mentioned above, impacting judgement on the forecast air quality improvements over the next few years.

Technological advancements, Government funding and competitions are anticipated to push the sector forward to improve air quality (moderate confidence). For instance, through the Government unit formed in January 2023 - UK Shipping Office for Reducing Emissions (UK SHORE) and the Government innovation agency Innovate UK opened a competition to provide £77 million in match funding to support research into close-to-commercial clean maritime technology. The funding that covers the set up and construction of projects is set to extend to March 2025, with partners expected to fund all further costs up until the close of the competition in March 2028[343]. Other such funding and competitions exist that will help achieve the net-zero shipping goal.

6 to 20 year projection

Air quality is expected to further improve over the 6 to 20 year period, based on current plans and objectives set to achieve acceptable air quality (moderate confidence). The improvement of air quality is dependent on addressing the following challenges:

- Delivering enhancements that are integrated with Net Gain and Natural Capital approaches;
- Supporting the delivery of specific targets, with an increased focus on particulate matter;
- Embedding net zero into policy in an actionable method at local level;
- Developing monitoring indicators relevant to the different policy outcomes; and
- A better link between/mapping of the Plan areas and local measures within spatial boundaries such us AQMAs.

The Environmental Improvement Plan 2023 has set, amongst other commitments, a legal target of a maximum annual mean $PM_{2.5}$ concentration of 10µg/m^3 by 2040[344]. However, this is still double the annual 5µg/m^3 average recommended by the World

[342] DEFRA (2023b). 'Environmental Improvement Plan 2023'. Report available at: (https://assets.publishing.service.gov.uk/media/6570a68b7469300012488948/HECC-report-2023-chapter-4-outdoor-air-quality.pdf) Accessed October 2024.
[343] Transport Committee (2023), Maritime 2050: Government Response to the Committee's Fifth Report, Fifth Special Report of Session 2022–23, HC 1420, p. 7. Accessed October 2024.
[344] DEFRA (2023b). 'Environmental Improvement Plan 2023'. Report available at: (https://assets.publishing.service.gov.uk/media/6570a68b7469300012488948/HECC-report-2023-chapter-4-outdoor-air-quality.pdf) Accessed October 2024.

Health Organisation (WHO), **indicating potential challenges in meeting this goal. While current levels as of 2023, for instance, fall under that maximum annual mean, they would need to be further reduced to meet the recommended levels**.

Additionally, to make a full contribution to the IMO's initial GHG objective of a 50% reduction in emissions from a 2008 baseline by 2050, the CCC advises that the UK's transition to alternative fuels such as zero-emission hydrogen or ammonia would need to be well under way before 2050, with "refuelling infrastructure established, and a substantial fraction of the fleet already switched"[345]. These transitions have already begun taking place, providing a promising step towards the 50% reduction goal (moderate confidence). For instance, the Government proposed a ban on the sale of new petrol and diesel cars starting 2035[346]. Additionally, a target of 25% of the Government's car fleet being ultralow emission by December 2022 was surpassed three months early, and the pace of emissions reduction in 2023 sees a significant increase from recent rates and is in line with the pace of change needed to meet goals[347].

While further reductions need to be in place, should the above plans come to fruition and changes resume, **air quality should improve in the next 6 to 20 years**. However, this will involve an integrated approach and addressing the aforementioned challenges.

[345] CCC (2019). Letter: International aviation and shipping and net zero. Letter available at: (https://www.theccc.org.uk/publication/letter-international-aviation-and-shipping/). Accessed October 2024.
[346] Department for Transport (2021). Decarbonising Transport – A Better, Greener Britain. Report available at: https://publications.parliament.uk/pa/cm5804/cmselect/cmenvaud/509/report.html#footnote-140. Accessed October 2024.
[347] CCC (2024). 2024 Progress Report to Parliament. Available at: (https://www.theccc.org.uk/publication/progress-in-reducing-emissions-2024-report-to-parliament/) Accessed October 2024.

22 Coastal change and flooding

22.1 Sector definition

Coastal change can be defined as physical modification to the shoreline through one (or more) of the following processes:

- Coastal erosion – driven by currents and waves mobilising and transporting material;
- Coastal landslip – relates to the downslope movement of material, exacerbated by high rainfall and erosion of the cliff top;
- Coastal inundation – caused by rising sea level, tidal surges and/or managed realignment of the coast; and/ or
- Coastal accretion – resulting from sediment deposition by natural marine (e.g. hydrodynamic and waves) and terrestrial (e.g. fluvial) processes.

Coastal change can be significantly influenced by (anthropogenic) management measures; these are discussed later in this section.

Coastal flooding typically occurs with the coincidence of high tides, low pressure weather systems, and surge conditions caused by strong winds. Strong winds can also contribute to flooding though wave overtopping.

Sea-level rise is often considered a key factor in causing coastal flooding and erosion. Concerns about both coastal change (specifically erosion) and flooding have mounted in the light of increased rates of sea-level rise and possibly increased storminess predicted due to climate change[348].

22.2 Historic trends and current activity

In England and Wales, responsibility for the management of coastal erosion and flooding primarily rests with the Environment Agency and Lead Local Flood Authorities, with policy for England set through the National Flood and Coastal Erosion Risk Management Strategy[349]. Coastal Partnership East is a key initiative in this region and was established by East Suffolk Council, North Norfolk District Council and Great Yarmouth Borough Council to manage coastal erosion and flooding around the coast of East Anglia, between Holkham in North Norfolk and Landguard Point in Felixstowe.

[348] Masselink, G., Russell, P., Rennie, A., Brooks, S. and Spencer, T. (2020) Impacts of climate change on coastal geomorphology and coastal erosion relevant to the coastal and marine environment around the UK. MCCIP Science Review 2020, 158– 189.
[349] Environment Agency (2020). National Flood and Coastal Erosion Risk Management Strategy for England. Available at: https://assets.publishing.service.gov.uk/media/5f6b6da6e90e076c182d508d/023_15482_Environment_agency_digitalAW_Strategy.pdf. Accessed October 2024.

At a regional level, strategic guidance for coastal management is provided through (non-statutory) Shoreline Management Plans (SMPs). These plans provide an assessment of, and approach to managing the risks associated with coastal processes in the short-term (0–20 years), medium-term (20–50 years) and long-term (50–100 years). The SMPs provide the policy context for local flood risk management plans and coastal strategies. The management approaches are defined in Environment Agency (2024)[350] and are as follows:

- Hold the line - maintain or upgrade protection from flooding or erosion by holding the shoreline in broadly the same position;
- No active intervention - maintain or encourage a more natural coastline, which may involve discussing adaptation to the risk from flooding or erosion;
- Managed realignment - change the position of the shoreline in a controlled way, such as by slowing erosion or creating areas of habitat to help manage flooding; and
- Advance the line - actively move shoreline defences significantly seawards.

There are five Shoreline Management Plans and three Coastal Change Management Areas (CCMA) in the Plan areas (Figure 26) (the three CCMAs are labelled for ease). CCMAs are defined in the National Planning Policy Framework[351] as areas '*identified in plans as likely to be affected by physical change to the shoreline through erosion, coastal landslip, permanent inundation or coastal accretion.*' They provide a useful mechanism to plan for adaptation where projected rates of shoreline change are significant over the next 100 years and enable the effects of climate change to be fully considered[352]. The East Suffolk CCMA is approximately 56 km in length, Great Yarmouth's CCMA is approximately 25 km, and North Norfolk CCMA is around 64 km.

Coastal characteristics within the inshore Plan areas are diverse, ranging from the exposed sandy beaches and soft cliffs of north Norfolk, to the estuarine saltmarshes, mud and sandflats of the Humber (Figure 28). Most of the coast has a high susceptibility to erosion[353], with defences in place in many areas (Figure 29). In fact, Norfolk and Suffolk have some of the fastest eroding coasts in Europe, with over 2,500 homes at direct coastal risk and thousands more properties and businesses directly and indirectly affected by loss of property, infrastructure and utilities[354].

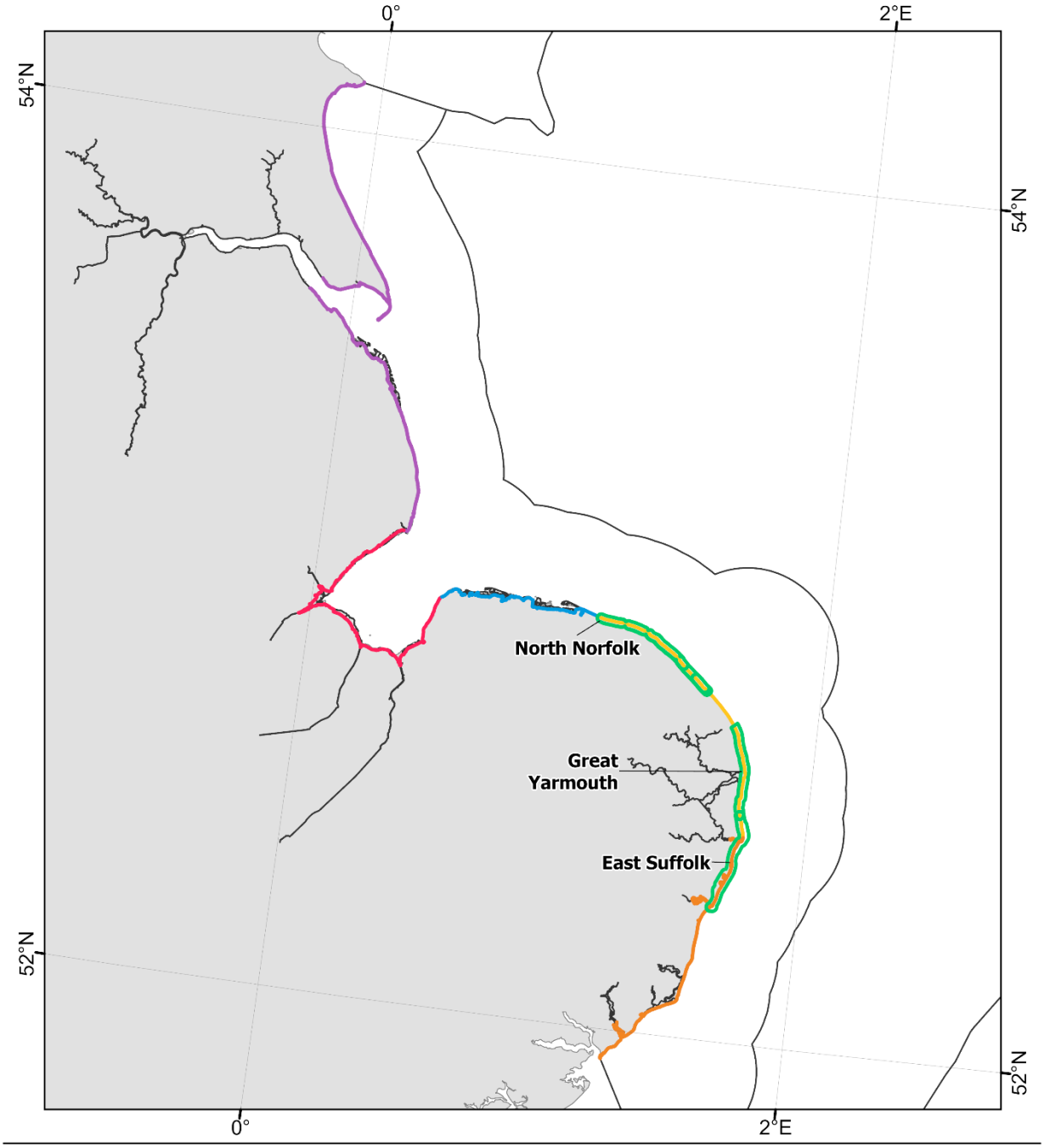
[350] Environment Agency (2024). Shoreline management plans. Available at: https://www.gov.uk/guidance/shoreline-management-plans. Accessed October 2024.
[351] Department for Levelling Up, Housing & Communities (DLHC) (2023). National Planning Policy Framework. Available at: https://assets.publishing.service.gov.uk/media/65a11af7e8f5ec000f1f8c46/NPPF_December_2023.pdf Accessed October 2024.
[352] Natural England (2019). Coastal Change Management Areas: Opportunities for sustainable solutions in areas subject to coastal change. Natural England Commissioned Report NECR275.
[353] British Geological Survey (2022). BGS GeoCoast V1. British Geological Survey Open Report, OR/21/001. 48pp.
[354] Environment Agency (2024). Resilient Coasts: Great Yarmouth & East Suffolk. Available at: https://engageenvironmentagency.uk.engagementhq.com/esf008-coastal Accessed October 2024.

The location of flood risk zones within 1 km of the inshore Plan area is shown in Figure 30. There are three zones in total, with Zone 3 having the highest risk. Flood Zones 2 and 3 (Figure 30) have been identified by the Environment Agency, and are defined as follows:

- Flood Zone 3: land with a 1 in 100 (1%) or greater chance of flooding each year from rivers; or with a 1 in 200 (0.5%) or greater chance of flooding each year from the sea (not accounting for the presence of flood defences); and
- Flood Zone 2: land between Zone 3 and the extent of the flooding from rivers or the sea with a 1 in 1000 (0.1%) chance of flooding each year (not accounting for the presence of flood defences).

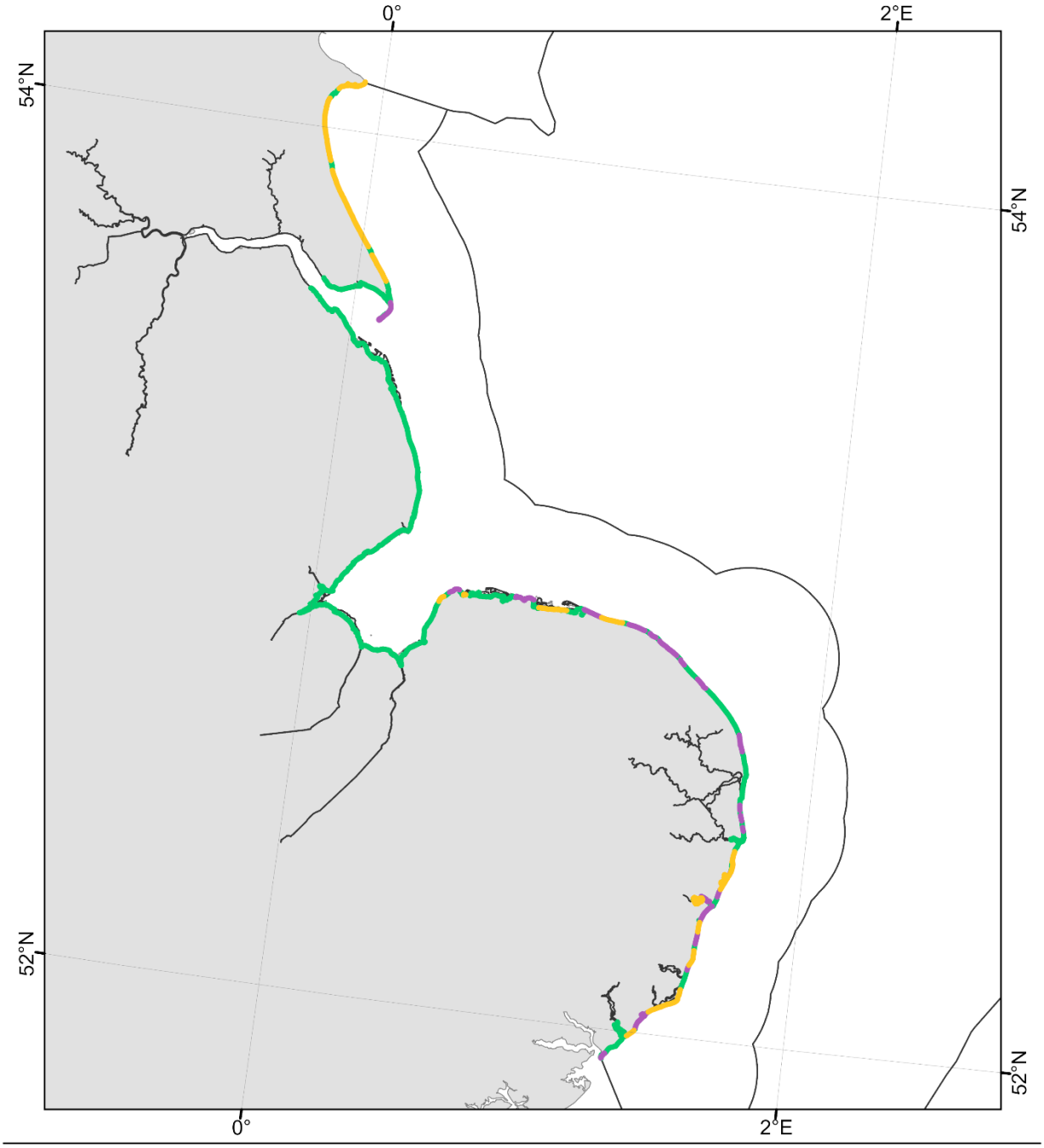
A number of areas are at high risk from flooding, including around Hull, Skegness and Great Yarmouth.

Figure 26: Shoreline management plans & coastal change management areas.



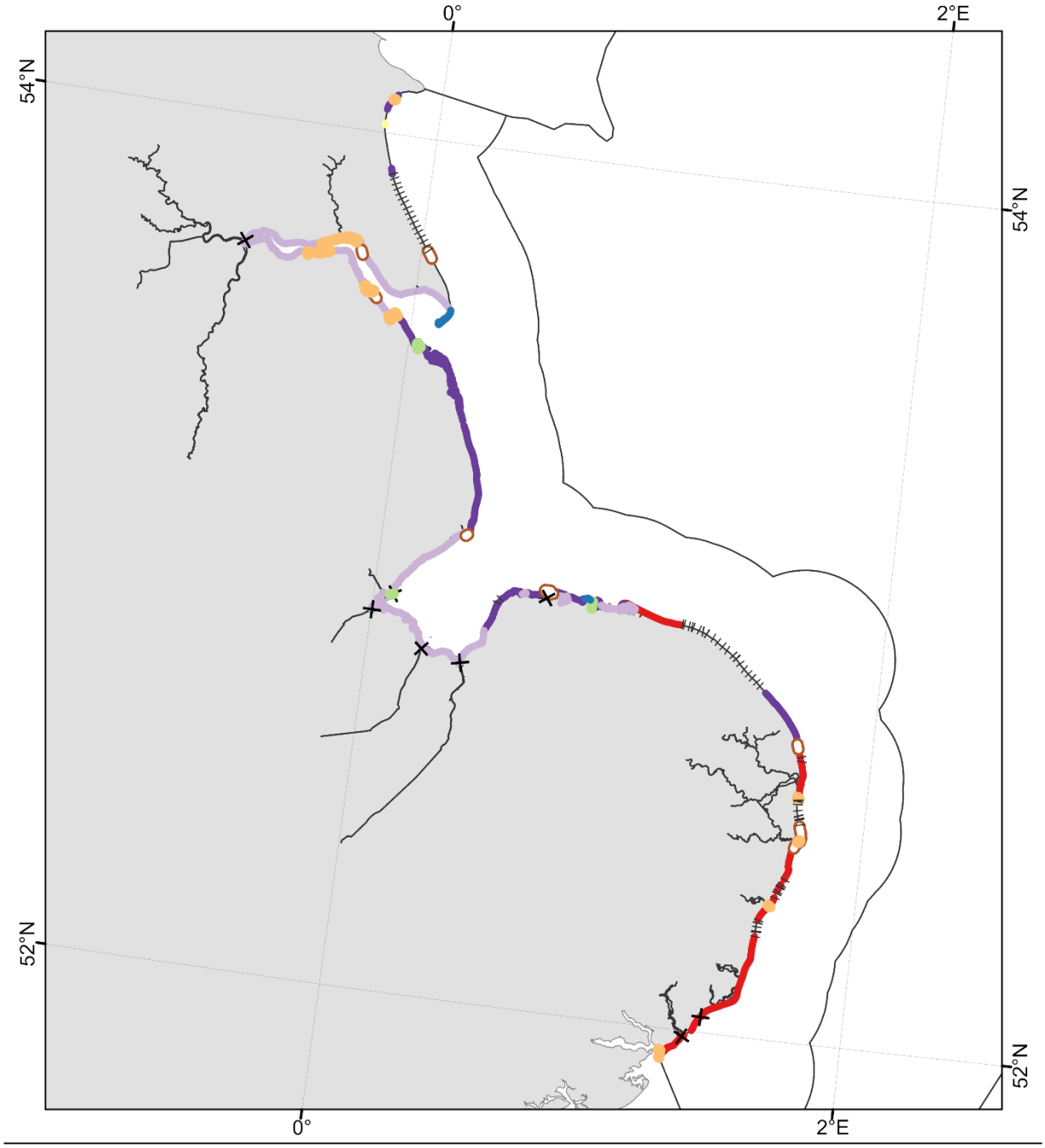
Date of Publication:15/10/2024
Coordinate System:ETRS 1989 LAEA
Projection:Lambert Azimuthal Equal Area

Figure 27: Shoreline management plan policy (0-20 years).



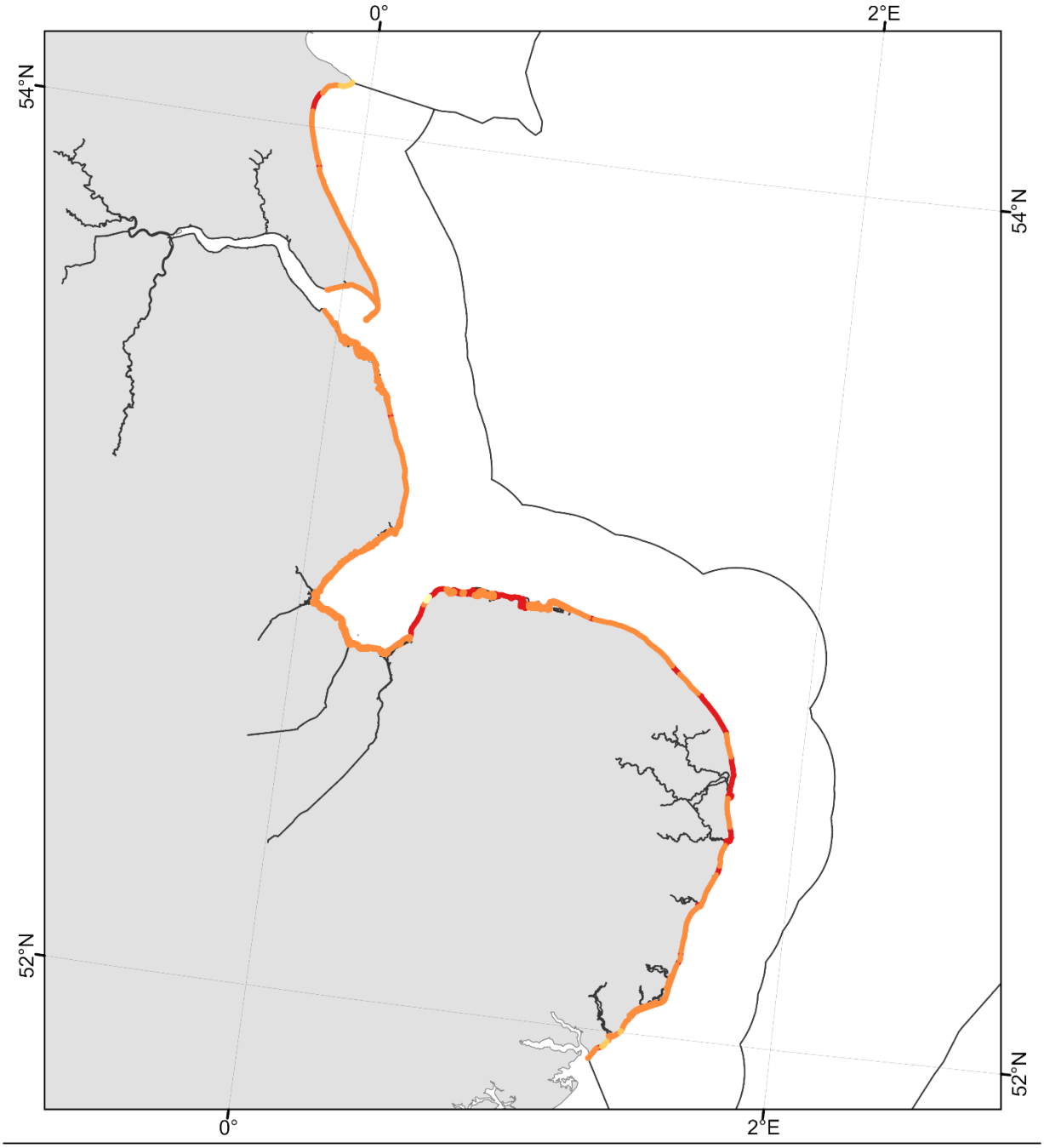
Date of Publication:15/10/2024
Coordinate System:ETRS 1989 LAEA
Projection:Lambert Azimuthal Equal Area

Figure 28: Coastal characteristics.



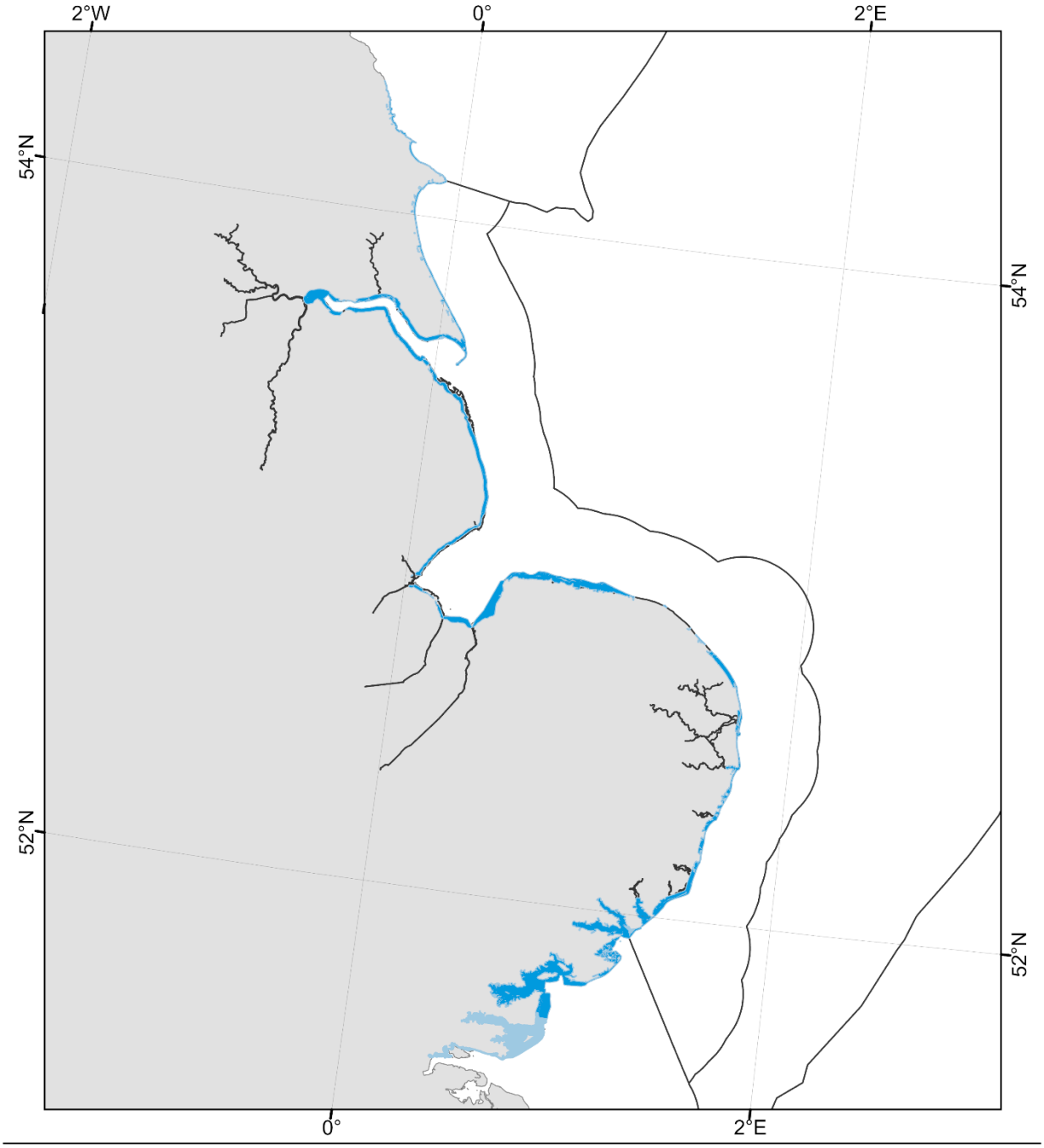
Date of Publication:15/10/2024
Coordinate System:ETRS 1989 LAEA
Projection:Lambert Azimuthal Equal Area

Figure 29: Sediment susceptibility to coastal erosion.



Date of Publication:15/10/2024
Coordinate System:ETRS 1989 LAEA
Projection:Lambert Azimuthal Equal Area

Figure 30: Flood risk zones (within 1km of the coast).



East marine plan area

Flood risk areas (within 1km of the coast)

Flood zone 2

Flood zone 3

Note: Flood Zone 1 areas have less than a 1 in 1000 (0.1%) annual probability of flooding in any given year (Flood Zone 1 is the lowest risk flood zone)

Date of Publication:15/10/2024
Coordinate System:ETRS 1989 LAEA
Projection:Lambert Azimuthal Equal Area

22.3 PESTLE analysis

The key drivers affecting coastal change and flooding in the Plan areas are environmental, although the sector is also affected by political and economic drivers relating to responding to the environmental and climate pressures. Key drivers are described in Table 25.

Table 25: PESTLE analysis for the coastal change and flooding sector.

Driver	Details	Implications	Impacts (+ / - / Variable)[355]
Political	Adoption of measures set out in the National Flood and Coastal Erosion Risk Management Strategy[356] including implementation of Shoreline Management Plans[357] and Flood Risk Management Plans[358]. Defending the coast from erosion involves taking decisions on which locations to protect: the presence of key infrastructure – such as Sizewell C, Bacton Gas Terminal and offshore wind farm export cable landfalls – will play a major role in defining future protection efforts.	This will influence decision making around the installation, maintenance and removal of coastal defences which will exert significant control over future coastal form.	Variable

[355] '+' refers an improvement to coastal change and flooding, and '-' refers to a reduction in coastal change and flooding.

[356] Environment Agency. 2022. National Flood and Coastal Erosion Risk Management Strategy for England. Available at: https://www.gov.uk/Government/publications/national-flood-and-coastal-erosion-risk-management-strategy-for-england--2 Accessed October 2024
[357] Environment Agency. 2024. Shoreline management plans. Available at: https://www.gov.uk/guidance/shoreline-management-plans Accessed October 2024
[358] Environment Agency. 2022. Flood risk management plans 2021 to 2027. Available at: https://www.gov.uk/Government/collections/flood-risk-management-plans-2021-to-2027 Accessed October 2024

Driver	Details	Implications	Impacts (+ / - / Variable)[355]
Economic	Availability of funding for coastal defence projects – as the height of extreme water levels increases due to sea level rise, the cost of maintaining the existing standard of defence will also rise. This will put greater pressure on coastal and flood defence budgets. Authorities will make greater use of funding and financing from non-public sector sources to contribute to the investment needs of flood and coastal resilience.	Budgetary pressures are expected to lead to greater prioritisation of the defence of more densely populated areas and/or economically important locations including the locations of key infrastructure assets (such as Bacton Gas Terminal and Sizewell C). Where an economic case for defence cannot be made, a policy of No Active Intervention may occur. This can lead to some coastal communities no longer being defended and some infrastructure (such as access routes) not being reinstated following episodes of erosion.	Variable
Social	Ongoing coastal retreat has led to the formation of community action groups (e.g. Happisburgh, Norfolk).	These groups highlight the social cost of erosion, campaigning for schemes to slow down the rate of erosion and cliff recession. This may result in mobilisation of additional funds to address community concerns.	+
Technological	Enhanced data collection and analysis methods (including the use of drone based remote sensing technologies and sophisticated numerical models).	In flood risk and erosion management, advances in data collection and analysis helps improve understanding of the risk and consequences of flooding and erosion, enabling better decision making.	+
Legal	Through the Climate Change Act 2008[359], Government has required certain public bodies and utilities companies to identify and plan for future climate risks, such as flooding and accelerated rates of coastal erosion.	Improved management of risk and consequences of flooding and erosion on assets and infrastructure located within the Plan areas.	+

[359] UK Government. 2019. Climate Change Act 2008. Available at: https://www.legislation.gov.uk/ukpga/2008/27/section/1/2019-06-27 Accessed October 2024.

Driver	Details	Implications	Impacts (+ / - / Variable)[355]
	The Marine and Coastal Access Act 2009[360] aims to improve public access to and enjoyment of the English coast, providing secure and consistent access rights for people to enjoy the coast with greater confidence and certainty	Makes provision to enable coastal access routes to roll back where the coast is subject to erosion	+
	The National Planning Policy Framework (2021)[361]: Meeting the challenge of climate change, flooding and coastal change aims to ensure that the planning system supports the transition to a low carbon future in a changing climate, taking full account of flood risk and coastal change.	Stipulates that plans take a proactive approach to mitigating and adapting to climate change, taking into account the long-term implications for flood risk, such as coastal change. Inappropriate development in areas at risk of flooding should be avoided by directing development away from areas at highest risk (whether existing or future). Also sets out circumstances under which development will be considered 'appropriate' in CCMAs.	+
Environmental	Climate-induced increase in sea level increases the frequency of extreme water levels (exacerbated by changes in winds and waves) and associated flooding and coastal erosion.	More people and communities affected by flooding and erosion with associated economic impacts to homeowners and businesses. Increasing costs for insurance, and increasing risk, may make some homes uninsurable. Release of waste from historic landfalls in undefended coastal locations, with potential for damaging effects to ecology within environmentally sensitive areas	-

[360] Her Majesty Government. 2009. Marine and Coastal Access Act. Available at: https://www.legislation.gov.uk/ukpga/2009/23/contents Accessed October 2024.
[361] Ministry of Housing Communities & Local Government. 2021. National Planning Policy Framework. Available at: https://assets.publishing.service.gov.uk/media/669a25e9a3c2a28abb50d2b4/NPPF_December_2023.pdf Accessed October 2024

Driver	Details	Implications	Impacts (+ / - / Variable)[355]
	Strategic objective 1.4 of the Coastal Erosion Risk Management strategy for England (Environment Agency, 2020)[362] states that between now and 2030 risk management authorities will use nature-based solutions (e.g. flood storage, beach nourishment and wetland creation) and improve the environment through their investments in flood and coastal resilience.	More flood and coastal erosion risk management projects should be based upon or include nature-based solutions such as the Bacton to Walcott sandscaping project.	Variable
	Increasing awareness of the need for coastal energy infrastructure to be climate resilient.	Existing coastal infrastructure will need to be defended from rising sea levels and coastal erosion whilst future developments will need to demonstrate that they are robust to the effects of climate change.	Variable
	The loss of coastal habitats through coastal squeeze; namely the loss or deterioration of habitat where anthropogenic structures or actions prevent the landward movement (rollback) of those habitats in response to sea level rise.	Loss of intertidal habitats and coastal habitats.	-

22.4 Future scenarios

6 year projection

Over the next 6 years, any major change to coastal morphology or occurrence of flood events will most likely be driven by weather-related phenomena, associated with storm surges and/or wave induced erosion of the coast. Indeed, a major storm event (e.g. the North Sea storm surge on 5 December 2013; storm Eleanor on 3 January 2018; storm Emma on 3 March 2018) or a series of storm events (e.g. winter 2013/14) can spike erosion and flooding impacts in a given year. The annual mean number of storms has increased since the 1990s[363]; should this trend continue the rate of coastal change and/or occurrence of flood events may increase. However, because of the high natural variability and limited understanding of driving mechanisms a low confidence level is assigned to this prediction.

[362] Environment Agency. 2020. National Flood and Coastal Erosion Risk Management Strategy for England. Available at: https://www.gov.uk/Government/publications/national-flood-and-coastal-erosion-risk-management-strategy-for-england--2. Accessed October 2024

[363] Bricheno, L.M., Amies, J.D., Chowdhury, P., Woolf, D. and Timmermans, B. 2023. Climate change impacts on storms and waves relevant to the UK and Ireland. MCCIP Science Review 20pp.

6 to 20 year projection

Over the next 6 to 20 years, the effects of climate change will become more apparent. According to UKCP18, sea level around the UK is expected to increase over the 21st century and beyond under all Representative Concentration Pathway climate-change scenarios. By 2045, sea level may have risen by approximately 0.15 m (from 2024) in the Plan areas[364] and this rise in sea level will contribute to an increase in the frequency and magnitude of extreme water levels over this time. An increase in the frequency and magnitude of extreme water levels will exacerbate coastal flooding and erosion, especially in undefended areas or in areas where existing coastal defences are no longer being maintained or sustained (raised in line with sea level rise) to offer the present day level of protection. This is particularly the case along the north Norfolk and east Suffolk coast.

Coastal change and flooding are not necessarily due to climate change; multiple driving factors are involved which are often difficult to isolate. These driving factors may include, for instance, long-term changes in sediment transport patterns and associated movement of shingle spits and nearshore banks, leading to significant change at the coast. Changes in management practices at the coast over the next 20 years also have the potential to significantly affect patterns of coastal change at a local scale. This is especially the case where the SMP may change from a policy of 'Hold The Line' to 'No Active Intervention' or 'Managed Realignment'. Areas where this could potentially occur include Kilnsea (East Riding of Yorkshire), Old Hunstanton dunes (Norfolk) and Trimley Marsh (Suffolk). In these areas, erosion of the coast and loss or retreat of coastal habitats is expected. Confidence in this prediction is moderate to low as erosion will be influenced by a range of factors including the frequency and intensity of future storms and the rate at which any existing defences degrade once they are no longer actively maintained.

Longer-term natural cycles unrelated to climate change also have the potential to affect the coast and influence flood and erosion risk. The lunar nodal cycle influences extreme water levels through change to tidal range. The next lunar nodal minima will occur in 2034, with the height of high waters increasing over the preceding (approximate) 9-year period, from 2025. This increase in the height of high water could potentially exacerbate flooding and erosion over this period although confidence in this prediction is low.

In locations where defences are not present (or are no longer maintained in future) there may be a social impact on communities from coastal erosion. This can lead to loss of homes, savings and retirement funds due to being unable to remortgage or sell houses. It also has the potential to contribute to a lack of inward investment leading to higher unemployment, social deprivation and loss of community cohesion.

[364] Palmer, M., Howard, T., Tinker, J., Lowe, J., Bricheno, L., Calvert, D., Edwards, T., Gregory, J., Harris, G., Krijnen, J., Pickering, M., Roberts, C., Wolf, J. 2018 UKCP18 marine report. Met Office Hadley Centre, 133pp.

23 Environmental restoration and its spatial requirements

23.1 Sector definition

This sector is concerned with the restoration and improvement of the environment, and the space required for this to happen effectively. The Government is committed to halting the loss of biodiversity and restoring it so far as is feasible. It aims to ensure the following:

- Halting and, if possible, reversing biodiversity loss, with species and habitats operating as a part of healthy, functioning ecosystems;
- The general acceptance of biodiversity's essential role in enhancing the quality of life, with its conservation becoming a natural consideration in all relevant public, private and non-Governmental decisions and policies.

There are four main ways in which environmental restoration can be achieved[365]:

- **Seawall realignment**: Relocating or removing often vulnerable coastal defences and extending areas of tidal inundation to create intertidal habitats across low-lying land (often in coastal areas that have been historically claimed from the sea);
- **Coastal intervention**: Influencing or adjusting existing coastal processes to change environmental conditions to protect habitats or promote their recovery;
- **Sediment recharge**: Replenishing deteriorating habitats, islands and barriers with sediment, including silt, sand, shell and/or shingle, as appropriate to the habitat in question; and
- **Habitat recreation**: Adopting techniques to restore and create specific habitat types either by (re)introducing keystone species (e.g. seagrass, kelp or native oyster *Ostrea edulis*) and/or altering seabed substrata to promote species recruitment and habitat change.

23.2 Historic trends and current activity

Environmental restoration and improvement are accelerating as the level of interest in, and need for, habitat restoration is increasing. This is a result of trying to address the challenges posed by the biodiversity crisis and a changing climate.

To counteract the biodiversity loss and environmental degradation in the UK, targets are now being set for restoration in legislation such as the 2021 Environment Act and the 25 Year Environment Plan, and mechanisms are being developed to achieve Biodiversity Net Gain (BNG). BNG is an approach to development that aims to ensure that habitats for wildlife are left in a measurably better state than they were before development in the terrestrial and intertidal zone. Developers are obliged to

[365] Scott, C., and Armstrong, S. (2022) Marine Nature-based Solutions: Time to do Better and Think Bigger Colin Scott and Susanne Armstrong. Inpractice Bulletin of the Chartered Institute of Ecology and Environmental Management (CIEEM). Nature-based Solutions. Issue 116, June 2022.

incorporate planned habitat gain of 10%[366]. This includes measures to deliver Local Nature Recovery Strategies and achieve BNG following terrestrial development. Marine Net Gain (MNG) is further being developed to restore marine habitats by requiring that all in-scope developments leave the environment in a better state than before.

Key influencing legislation also includes the UK's commitments to 30 by 30, a global target to protect 30% of the planet for nature by 2030. Not only does this include extending and creating habitat, but also strengthening the environment in existing protected areas[367].

A maximum of 8% of English waters are effectively protected for nature, again an increase on 4% in 2021[368]. In order to make strides towards achieving the 30 by 30 targets, Defra have identified key areas in which this restoration could take place. They have particularly highlighted areas within the Plan area for this, especially from Felixstowe, stretching up towards the Humber. The Royal Society for the Protection of Birds (RSPB's) 'Sustainable Shores' project, reviewed sites for intertidal habitat creation and restoration, and highlighted a potential 14,500 hectares in the North East of England and East Anglia that could be restored[369].

Additional studies have been carried out by RSPB, Wildfowl and Wetlands Trust (WWT), Joint Nature Conservation Committee (JNCC), and MMO which have published data where restoration could be most likely to occur. Figure 31 and Figure 32 demonstrate current key habitat restoration sites using both unmanaged and managed realignment, and dredged sediment for beneficial use. Figure 32 also shows areas of potential saltmarsh restoration located predominantly around the coast of East Anglia. These figures show that many restoration sites are in the Plan area, showcasing the potential of this region to contribute to environmental restoration.

[366] Defra (2024) Factsheet 2: Understanding biodiversity net gain. Website content available at: Understanding biodiversity net gain - GOV.UK (www.gov.uk) Accessed October 2024.
[367] Defra (2023) Delivering 30by30 on land in England. Report content available at: https://assets.publishing.service.gov.uk/media/65807a5e23b70a000d234b5d/Delivering_30by30_on_land_in_England.pdf Accessed October 2024.
[368] Wildlife and Countryside Link (2023) 30x30 England 2023 Progress Report. Website content available at: https://www.wcl.org.uk/docs/WCL_2023_Progress_Report_on_30x30_in_England.pdf Accessed October 2024.
[369] RSPB (2018) Factsheet 2: Sustainable Shores habitat creation opportunities. Website content available at: https://opendata-rspb.opendata.arcgis.com/datasets/sustainable-shores-habitat-creation-opportunities-indicative-locations/explore?location=8.442244%2C-102.644027%2C2.31 [last Accessed October 2024.

Figure 31: Existing habitat restoration sites.

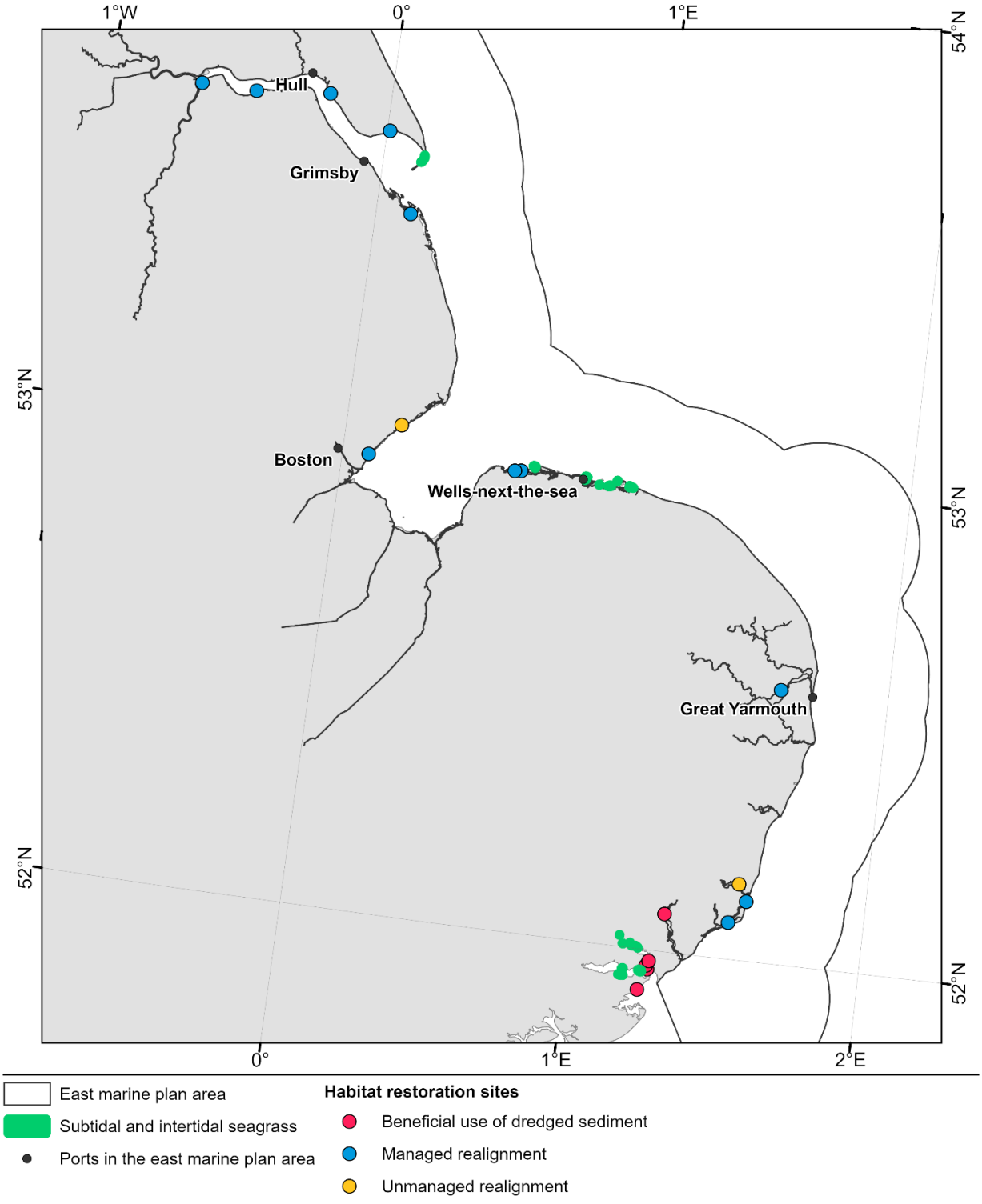


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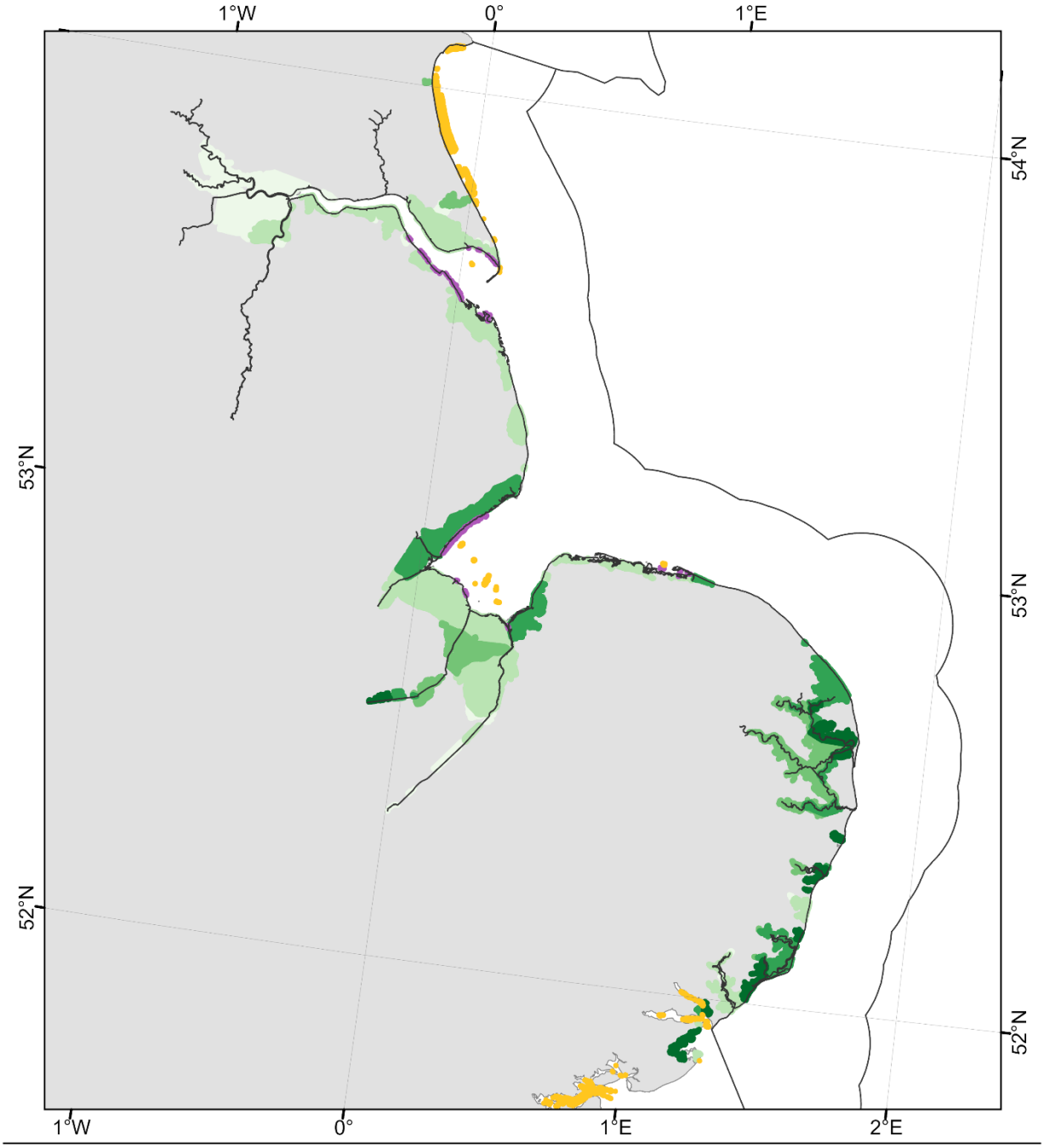
Figure 32: Potential areas of saltmarsh restoration.



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Recent examples of habitat restoration within the Plan areas include a large-scale beach nourishment example, the 'sandscaping' project at Bacton, Norfolk. In 2019, 1.8 million metres cubed of sand was used to build up the Bacton and Walcott beaches and protect Bacton Gas Terminal. This project has transformed the beach, notably the beaches' height and width.[370]. This has been crucial as a 2013 sea surge damaged and flooded homes and business in both Bacton and Walcott and they saw the loss of up to 10 metres off the cliff at the Gas Terminal[370].

Other examples of projects that are already taking place in the Plan areas include the RSPB dredging sediments to protect saltmarsh in Horsey Island, Essex[371], the Essex Native Oyster Restoration Initiative (ENORI) looking to restore native oysters in the Blackwater estuary with Zoological Society of London (ZSL) and the Native Oyster Network[372], and ReMEDIES Save Our Seabed, Project Seagrass, Essex Wildlife Trust and Natural England restoring seagrass across the Plan Area[373].

Organisations involved in current restoration efforts such as the RSPB, National Trust and WWT are further working to make the East Atlantic Flyway (a migration route) a recognised UNESCO World Heritage Site to ensure restoration efforts continue in the East of England. The wetlands have been deemed irreplaceable, and the East Atlantic Flyway covering 170,000 hectares from the Humber to the Thames Estuary is home to 155 species of birds. The area is a global flyway for birds and one of eight flyways used by birds across the globe[374].The area is also a significant global exemplar of coastal adaptation and nature conservation management in the face of climate change. It has world-leading examples of coastal adaptation projects achieving multiple benefits including flood protection, habitat restoration, recreation, water quality, and carbon storage[375].

Multiple societal and economic benefits are provided by the restoration of the environment. These include the benefits that can be assigned a monetary value for demonstrating ecosystem services and natural capital potential (e.g. flood protection, carbon sequestration) as well as other wider benefits which may often be very important for natural capital but may not be as readily 'monetisable' (e.g. improved mental and physical health through more accessible outside space). Nature restoration can further lead to job creation and economic growth, where in post-industrial regions and landscapes, nature restoration can boost the local economy

[370] North Norfolk District Council (2019) Find out about the new sandscaping solution. Website content available at: https://www.north-norfolk.gov.uk/sandscaping Accessed October 2024.
[371] Manning, Scott and Leegwater (2021) Restoring Estuarine And Coastal Habitats With Dredged Sediment: A Handbook. Website content available at: https://catchmentbasedapproach.org/wp-content/uploads/2021/10/Restoring-Estuarine-and-Coastal-Habitats-with-Dredged-Sediment.pdf Accessed October 2024.
[372] Zoological Society London (ZSL) (2019) Essex Oyster Conservation. Website content available at: https://www.zsl.org/news-and-events/feature/essex-oyster-conservation Accessed October 2024.
[373] Essex Wildlife Trust (2024) Saving Seagrass. Website content available at: https://www.essexwt.org.uk/what-we-do/protecting-wildlife/projects/seagrass Accessed October 2024.
[374] Tubby and Gordon-Farleigh (2023) East Atlantic Flyway wetlands must be cherished, says RSPB. Website content available at: https://www.bbc.co.uk/news/uk-england-norfolk-67288889 Accessed October 2024 .
[375] ABPmer (2023) English east coast wetlands added to UK's Tentative List of World Heritage Sites. Website content available at: https://www.abpmer.co.uk/blog/english-east-coast-wetlands-added-to-uk-s-tentative-list-of-world-heritage-sites/ Accessed October 2024.

through employment, recreational and tourism opportunities[376]. For example, every $1 invested in restoring degraded forests, it can yield between $7-30 in economic benefits[377].

23.3 PESTLE analysis

The most important drivers for environmental restoration in the Plan areas are political and legal commitments which are driving environmental restoration policies and positive environmental change. These drivers are listed in Table 26 below.

Table 26: PESTLE analysis for environmental restoration sector.

Driver	Details	Implications	Impact (+ / - / Variable)
Political	The UK vision of "clean, healthy, safe, productive and biologically diverse oceans and seas" under the Marine Strategy, supporting targets and plans for attaining Good Environmental Status (GES)	Facilitates the need for ongoing environmental protection and restoration to achieve this	+
	The Environmental Improvement Plan 2023 builds on the 25 Year Environmental Plan vision where 10 goals have been created for the natural world to regain and retain good health in England. These include restoring 15% priority habitats on English coasts by 2043, and restoring or creating 500,000 ha of wildlife-rich habitat in England outside of protected areas by 2042.	Favours the restoration of the environment	+
	MNG is building upon the principles of BNG, to improve the status of marine habitats following development. Whilst there is currently no set date for MNG implementation, MNG principles were consulted upon in 2022, and responses were publicised in 2023.	This will drive environmental restoration through the mandated removal of pressures on habitats, for example, through the removal of marine litter[378] In combination with BNG, this will affect both terrestrial and marine developments, boosting restoration efforts in development.	+

[376] WWF (2023) Factsheet 2: Economic Benefits of Investing in Nature Restoration. Website content available at: wwf_factsheet_nature_restoration_soc_economic_web.pdf (panda.org) Accessed October 2024.
[377] Verdone, M., Seidl, A. (2017) Time, space, place, and the Bonn Challenge global forest restoration target. Restoration Ecology No: 25, 903-911pp.
[378] Defra (2022) Marine Net Gain: Consultation on the principles of marine net gain. Content available at: https://consult.defra.gov.uk/defra-net-gain-consultation-team/consultation-on-the-principles-of-

Driver	Details	Implications	Impact (+ / - / Variable)
Economic	Economic development and industrial uses can impact species protection through the degradation of the environment and subsequent biodiversity loss.	This may lead to depletion of the environment and limit environmental restoration, however economic gain and species protection can be achieved simultaneously. It has also been shown that higher income levels are associated with increasing real demand for biodiversity conservation[379].	Variable
	The ecosystem services provided by the environment, encompassing provisioning, regulating, cultural and supporting services such as air quality, water cycling and recreation and ecotourism.	This gives incentive for the environment to be protected and restored to provide more of these services and can create political drive for natural capital approaches in legislation	+
	Incurred cost of restoration through legislation such as BNG	This may postpone and prolong the restoration process, resulting in less restoration. The licensing and regulatory process is seen as one of the top barriers for restoration projects[380] as additional requirements extends the planning process.	-
	The implementation of the Marine Recovery Fund providing an optional route for wind farm developers to discharge their compensation obligations	This fund will be used to finance strategic compensatory measures ensuring that environmental degradation is minimised. However, this should be considered as a last resort and restoration should be incorporated in development.	+
Social	Recreational use of the terrestrial and marine environment	Favours the restoration of the environment so these activities can continue. However, anthropogenic use of the environment can cause degradation through examples such as trampling and anchoring.	Variable

marine-net-gain/supporting_documents/Consultation%20on%20the%20Principles%20of%20Marine%20Net%20Gain.pdf Accessed October 2024.

[379] Dietz, S., Adger, W. (2003) Economic growth, biodiversity loss and conservation effort. Journal of Environmental Management No: 68, 23-35pp.

[380] ABPmer and ICF (2021) Regulatory Decision Making to Enable Marine Nature-based Solutions. Report content available at: Regulatory decision making to enable marine Nature Based Solutions - ME5238 (defra.gov.uk) Accessed October 2024.

Driver	Details	Implications	Impact (+ / - / Variable)
	The social capital gains through interaction with the environment, through pathways such as green/blue prescribing which utilises nature-based interventions and activities to improve wellbeing and health	Favours the restoration and access to the environment and associated ecosystem services,	+
	Public demand for action against climate change and environmental loss.	Drives political action so restoration can take place through the implementation of legislation and policies.	+
Technological	Advances in methods and data availability to assess habitat coverage and suitability of sites for restoration	Facilitates the knowledge base, approaches to and locations for restoration	+
	Further development of initiatives and methods to implement BNG and MNG in construction activities.	Favours and drives the restoration of the environment, such as the construction of kittiwake compensation infrastructure[381].	+
Legal	The UK's commitments to 30x30 at the UN Biodiversity Conference where the UK formally made a commitment to protect and conserve a minimum of 30% of land and sea for biodiversity by 2030.	Favours the restoration of the environment.	+
	The Kunming-Montreal Global Biodiversity Framework (2022) consists of new set of global targets, indicators to measure progress against the targets, and a reporting framework. The key elements of this are four goals for 2050 and 23 targets for 2030. All Parties to the Convention on Biological Diversity are expected to report on their progress towards these goals and targets in 2026 and 2029.	Favours the restoration of the environment.	+

[381] Orsted (nd) Developing green energy solutions in harmony with nature. Supporting kittiwake, a vulnerable seabird. Content available at: https://hornseaproject3.co.uk/kittiwake-compensation Accessed October 2024.

Driver	Details	Implications	Impact (+ / - / Variable)
	BNG is mandatory in terrestrial and intertidal areas under Schedule 7A of the Town and Country Planning Act 1990 (as inserted by Schedule 14 of the Environment Act 2021). This enforces developers to create BNG of 10%.	This ensures that habitats for wildlife are left in a measurably better state than they were before the development, implementing environmental restoration.	+
	The need to continue the provision of compensatory habitat for losses incurred due to development activities under the Habitats Regulations.	Whilst this creates new habitat, rather than restoring it, this still promotes environmental conservation.	+
Environmental	Habitat and species declines – one in six species are at risk of being lost in the UK and species have on average, declined by 19% in the UK since monitoring began in 1970[382].	This drives the need to restore the environment to prevent further loss and meet targets for GES.	+
	Climate change impacts on habitats and species.	Climate change is likely to lead to shifts in species distributions and changes in status. However, advances in mitigation and adaptation may help prevent climate-related biodiversity losses and shifts, maintaining the current baseline.	Variable
	Initiatives to improve water quality, including Government investments, regulation and enforcement[383].	This will improve the health of ecosystems and the species within them.	+

23.4 Future scenarios

6 year projection

With the introduction of the new Labour Government in July 2024, **environmental restoration is being prioritised.** The Secretary of State for the Department for Environment, Food and Rural Affairs has unveiled 5 core priorities for the department, one of which is to ensure nature's recovery[384].

[382] Natural History Museum. 2023. One in six species at risk of going extinct in Great Britain. Available at: https://www.nhm.ac.uk/discover/news/2023/september/one-in-six-species-at-risk-of-going-extinct-in-great-britain.html Accessed October 2024

[383] Defra (2024) Steps to improve water quality in England. Content available at: https://deframedia.blog.gov.uk/2024/05/23/steps-to-improve-water-quality-in-england/ Accessed October 2024.

[384] Mills & Reeve (2024) Labour sets out its 5 Priorities for the Environment, Food & Rural Affairs. Website content available at: https://www.mills-reeve.com/insights/blogs/food-and-agribusiness/july-2024/labour-sets-out-its-5-priorities-for-the-environme Accessed October 2024.

Existing restoration projects are likely to continue towards 2030, with expansion on the existing locations indicated in Figure 31 (high confidence). To ensure this occurs, many organisations have been involved in restoration projects, such as saltmarsh restoration in Horsey Island, Essex[385], oyster bed restoration in the Blackwater estuary[386], and ReMEDIES Save Our Seabed. The organisations involved drive local participation in environmental restoration where volunteers are essential to complete each project. This will generate not only environmental benefits, but social benefits through this involvement including a sense of community pride and improved mental health through exposure to the environment. With the ever-increasing urgency for environmental restoration, local communities within the Plan areas are likely to remain engaged and a key component of conservation efforts within this region (high confidence).

6 to 20 year projection

Designation of the East Atlantic Flyway as a UNESCO World Heritage Site may occur during the next 6 to 20 years, with an announcement expected in 2030 (moderate confidence).

In the next 20 years, there will be an increasing number of initiatives to restore nature in the Plan areas, aiming to reverse centuries of decline. Three priority estuarine and coastal habitats are likely to be the focus of future initiatives: seagrass meadows, saltmarshes, and the European native oyster (*Ostrea edulis*) reefs[387], all of which can be found in the Plan areas, although initiatives may extend to wider habitats and species. The ReMeMaRe project aims to restore at least 15% of the current extent of saltmarsh habitats within the next 20 years[388]. Decision making for environmental restoration will be governed by the UK's Environmental Improvement Plan.

Approximately five shoreline management plans are within the Plan area, bringing together key stakeholders such as the Environment Agency, Natural England and local councils to coordinate environmental restoration for the next 100 years. Figure 32 has shown that restoration of saltmarsh is possible throughout large areas of the Norfolk and Suffolk coastal areas, as well as in The Wash, and to a lesser extent, further north into the Humber estuary (moderate confidence). As **Defra have identified the Plan areas as a key location for restoration, in combination with extensive existing restoration projects** (Figure 31), it is of high confidence that **restoration efforts will continue**, and become more numerous.

[385] RSPB. 2024. Building Beaches. Available at: https://www.omreg.net/query-database/126-horsey-island-recharge/ Accessed October 2024
[386] Blue Marine Foundation. 2024. Blackwater. Available at: https://www.bluemarinefoundation.com/projects/blackwater/ Accessed October 2024
[387] Estuarine & Coastal Sciences Association (2024) Restoring Meadow, Marsh and Reef (ReMeMaRe). Website content available at: https://ecsa.international/rememare/restoring-meadow-marsh-and-reef-rememare Accessed October 2024.
[388] Estuarine & Coastal Sciences Association. 2024. Restoring Meadow, Marsh and Reef (ReMeMaRe). Available at: https://ecsa.international/rememare/restoring-meadow-marsh-and-reef-rememare Accessed October 2024

24 Historic Environment

24.1 Sector definition

The historic environment is defined as aspects of the environment resulting from the interaction between people and places through time, this includes all visible, buried or submerged physical remains of past human activity[389]. The Plan areas host a range of heritage assets, including buildings, monuments, landscapes and seascapes[390]. Marine and maritime cultural heritage generates significant social and economic benefits[391].

Evidence proves that visiting heritage sites can boost life satisfaction and happiness. Heritage assets can have significance to bond people to place by providing reminders of meaningful personal experiences. Attachments to places can help people feel stability, continuity, security and relaxation[392]. Research also demonstrates that our shared heritage can inspire curiosity, imagination, critical thinking and new perspectives. This enhances people's innovative capacity; leading to greater productivity and economic growth[393].

24.2 Historic trends and current activity

English Heritage manages numerous historic sites along the coast of the Plan areas, including Skipsea Castle, St Peter's Church, Thornton Abbey, Creake Abbey, Blakeney Guildhall, Baconsthorpe Castle, Caister Roman Fort, Great Yarmouth Row Houses, Leston Abbey and Orford Castle[394].

The Humber has a rich maritime heritage connected with industry and trade. The Humber River facilitated maritime trade, whilst Grimsby and Hull have long been important centres for shipping and fishing. Coastal towns like Wells-next-the-Sea, Cromer and Sheringham preserve their maritime heritage through fishing and its wildlife-rich habitats, including internationally renowned reserves like the Norfolk

[389] Her Majesty Government. UK Marine Policy Statement. 2011. Available at: https://assets.publishing.service.gov.uk/media/5a795700ed915d042206795b/pb3654-marine-policy-statement-110316.pdf Accessed October 2024.4

[390] HM Government (2014) East Inshore and East Offshore Marine Plans. Available at: https://assets.publishing.service.gov.uk/media/5a7ec0eced915d74e33f2342/east-plan.pdf Accessed October 2024.

[391] Honor Frost Foundation (2015) 'The Social and Economic Benefits of Marine and Maritime Cultural Heritage'. Available at: https://honorfrostfoundation.org/wp-content/uploads/2019/06/HFF-Report_Social-Economic-Value-of-Marine-and-Maritime-Cultural-Heritage.pdf Accessed October 2024.

[392] Historic England (2023) 'People's attachment to historic places and the benefits'. Available at: https://historicengland.org.uk/research/heritage-counts/heritage-and-society/attachment-historic-places/ Accessed October 2024.

[393] Historic England (2024) 'Culture, Heritage, Creativity and the Creative Economy. Available at: https://historicengland.org.uk/research/heritage-counts/heritage-and-economy/creative-economy/ Accessed October 2024.

[394] English Heritage (n.d.) 'Heritage Sites Map'. Available at: https://www.visitbritainshop.com/sites/default/files/2023-05/English%20Heritage%20Overseas%20Visitor%20Pass%20sites%20map.pdf Accessed October 2024.

Broads and Snettisham Nature Reserve. There are also many shipwrecks within the Plan areas as shown in Figure 33.

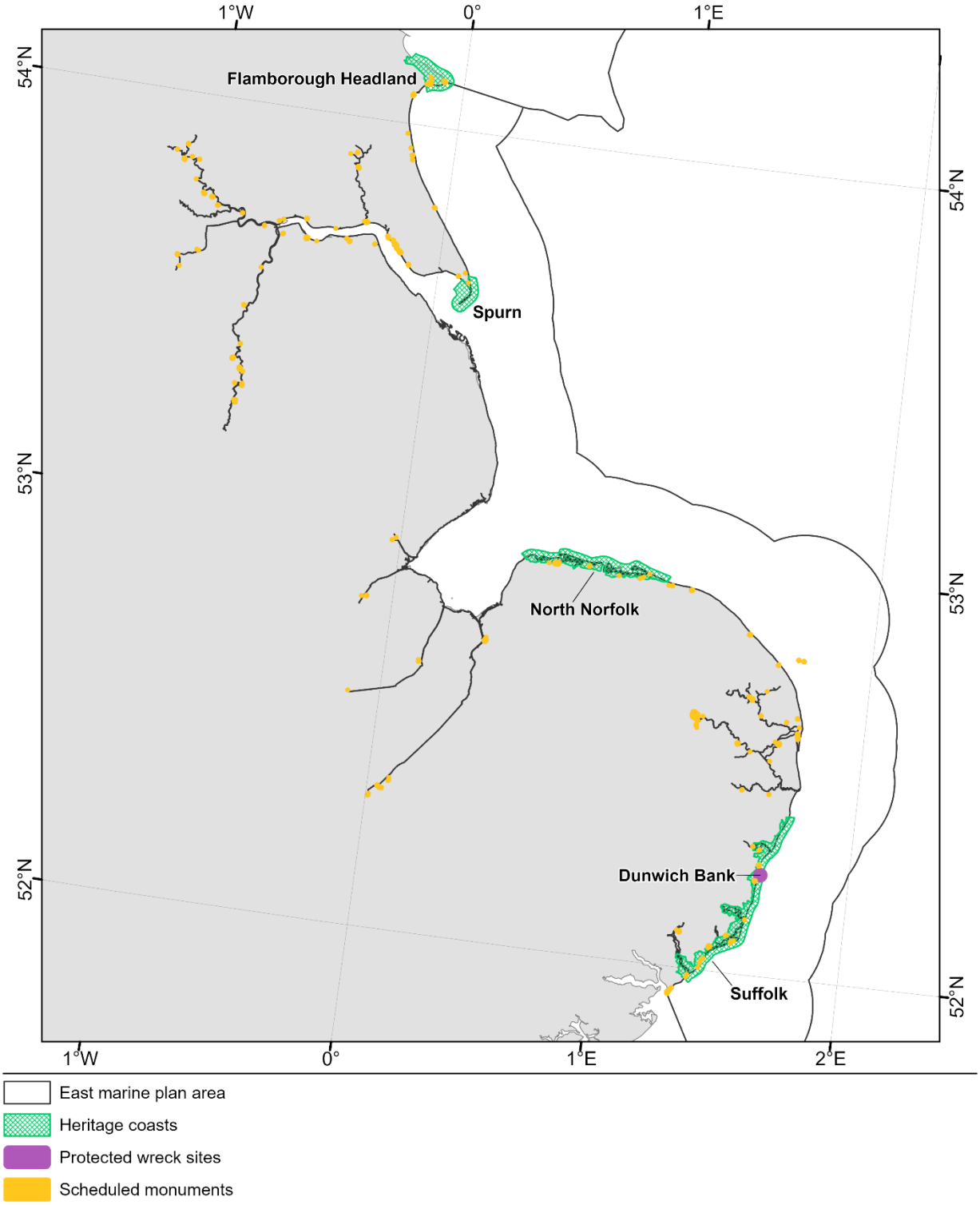
The Plan areas are home to the Cromer Shoals Chalk Beds MCZ (Norfolk), as well as Dogger Bank, which holds important archaeological potential as the site of 'Doggerland'[395].

England's historic environment is estimated to have contributed £45.1 billion in GVA to the UK economy in 2021 and employed over 538,000 workers, including direct, indirect and induced impacts[396]. However, the East of England area contributes very little in comparison to other regions. The East of England contributed 0.78% to the national GVA, the contribution has remained relatively constant[397].

Whilst apportionment to the Plan areas is not possible, The Royal Society for the Encouragement of Arts, Manufactures and Commerce has produced a tool to evaluate the value of heritage assets at local authority level[398]. The tool found that some areas within the Plan areas coastline have particularly high heritage value. North Norfolk, for example, ranks 25th out of 316 in the UK, whilst Great Yarmouth ranks 38th [399].

[395] Doggerland was an area of land in Northern Europe, now submerged beneath the North Sea, that connected Britain to continental Europe.
[396] Direct benefits are primary benefits that are a result of a direct action on the industry. Indirect benefits are secondary benefits that are a result of the actions in the wider supply chain that have a knock-on effect to the industry. Induced benefits are the estimate of the flows of money in and out of households and the effect of these transactions upon industries.
[397] CEBR (2023). 'The heritage sector in England and its impact on the economy: An updated report for Historic England.' Available at: https://historicengland.org.uk/content/heritage-counts/pub/2023/heritage-sector-in-england-and-its-impact-on-the-economy-2023/ Accessed October 2024.
[398] RSA (2020) 'Pride in place: The RSA Heritage Index 2020'. Available at: https://www.thersa.org/reports/heritage-index-2020 Accessed October 2024.
[399] CITiZAn (n.d.) 'Explore Our Coastal Map' Available at: https://www.citizan.org.uk/interactive-coastal-map/#zoom=1&lat=7000000.42789&lon=-449143.99347&layers=B00000FT Accessed October 2024.

Figure 33: Protected wrecks, heritage coasts and scheduled monuments.



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24.3 PESTLE analysis

The key drivers expected to influence the historic environment in the Plan areas are legal drivers as they dictate the required approaches and activities that should occur to preserve and manage historic features. The most important drivers are listed in Table 27 below.

Table 27: PESTLE analysis for the historic environment sector.

Driver	Details	Implications	Impact (+ / - / Variable)
Political	The MPS[400] aims to protect marine habitats, species and heritage assets.	Increased protection and investment in heritage assets.	+
Economic	A less healthy economy could lead to having insufficient funds to maintain heritage assets. This sector is arguably seen as less of a priority for investment when there is less economic stability compared to other marine industries such as energy production, ports, and cables[401].	The potential for less economic investment during the unstable economic climate may result in degradation of heritage assets.	-
	Increase in survey, construction, dredging and disposal activities' (e.g. with increased offshore development), may result in the discovery of previously unknown heritage assets.	Potential for increased discovery of heritage assets.	+
Social	Public appreciation for heritage assets has an impact on their preservation.	Increased public appreciation may lead to new assets being preserved, whilst some recreational activities such as diving, unregulated salvage and sailing (anchoring) have the potential to damage or disturb underwater sediment and result in the loss of artefacts.	Variable
Technological	Movement to digitise cultural heritage assets, and increased capability to discover assets[402].	Increased preservation efforts.	+
Legal	The Heritage Coasts and AONBs aim to conserve undeveloped coasts in England.	Increased protection of heritage assets.	+

[400] Her Majesty Government. UK Marine Policy Statement. 2011. Available at: https://assets.publishing.service.gov.uk/media/5a795700ed915d042206795b/pb3654-marine-policy-statement-110316.pdf Accessed October 2024.
[401] Historic England (2023) Funding and Resources Indicator Data | Heritage Counts | Historic England Accessed October 2024.
[402] European Commission (2019) Cultural Heritage: Digitisation, Online Accessibility and Digital Preservation European Commission report on Cultural Heritage: Digitisation, Online Accessibility and Digital Preservation | Shaping Europe's digital future (europa.eu) Accessed October 2024.

Driver	Details	Implications	Impact (+ / - / Variable)
	The National Heritage Protection Plan[403] aims to identify those parts of England's heritage that matter to people most and are at greatest risk.	Increased protection of heritage assets.	+
	The 2001 UNESCO Convention on the Protection of the Underwater Cultural Heritage[404].	Increased protection of heritage assets.	+
Environmental	Management and designation of MPAs and HPMAs, where they contain or are designated for heritage assets.	Increased protection of heritage assets.	+
	A rise of temperatures, sea levels and extreme weather events that come with climate change.	Potential for damage to heritage assets, as well as the discovery of new assets, particularly on the coast where, for example, storms could both damage and expose assets.	Variable

24.4 Future scenarios

6 year projection

The **historic environment sector is expected to receive increased protections in the next six years** due to the 2001 UNESCO Convention on the Protection of the Underwater Cultural Heritage, the National Heritage Protection Plan and designation of additional Heritage Coasts, AONB, MPAs and HPMAs. **While the creation of 'new' historic environment features and landscapes takes considerable time**, the **discovery of new and previously unknown sites is ongoing** and additional sites may be discovered within the Plan areas within the next six years, although specific locations cannot be predicted (moderate confidence).

As the activity of other marine sectors increases, there is **expected to be an increase in survey, construction, offshore development, dredging and disposal activities.** Whilst **all activities have the potential to cause accidental damage to heritage sites**, activities may also result in the discovery of previously unknown heritage assets (moderate confidence).

[403] English Heritage. 2012. The National Heritage Protection Plan Framework. Available at: https://historicengland.org.uk/images-books/publications/nhpp-plan-framework/nhpp-plan-framework/ Accessed October 2024.
[404] UNESCO. 2024. Underwater Cultural Heritage 2001 Convention. Available at: https://www.unesco.org/en/underwater-heritage/2001-convention Accessed October 2024.

The **completion of the England Coast Path between Sutton Bridge and Skegness**[405], due to open in 2024[406] (moderate confidence) has the potential to **improve access and visitor numbers**, connecting people with unexplored parts of the coast and heritage assets that may not have previously been possible, which is likely to benefit the public appreciation for heritage assets.

6 to 20 year projection

A **positive impact to the historic environment sector over the next 6 to 20 years is likely** due to the 2001 UNESCO Convention on the Protection of the Underwater Cultural Heritage, the National Heritage Protection Plan and designation of additional Heritage Coasts, AONB, MPAs and HPMAs (moderate confidence).

The **efforts to protect and preserve heritage assets is expected to mirror the publics appreciation for the historic environment**. Whilst the public appreciation over the next 6 to 20 years is difficult to predict, projects such as Coasts in Mind is expected to have a positive impact on this sector. Coasts in Mind is a people-powered project run by the Museum of London which intends to record information from communities on coastal change in the past 100 years. This could lead to the discovery of new sites and features, and improved information on existing features[407]. **As such it is likely that additional heritage assets will be designated within the Plan areas in the next 20 years** (moderate confidence).

Climate change events such as increases in extreme weather events, rising sea levels, and high rates of coastal erosion and flooding (see Section 22) **may cause future damage to heritage assets** (moderate confidence). The areas most susceptible to coastal erosion (see Figure 29 in Section 22) and the areas with the highest flood risk (Figure 30) indicate areas of the coastline where damage to historic artifacts is most likely. For example, the rapid degeneration of the cliffs at Happisburgh, on the North Norfolk Coast, risks the loss of archaeological records like the series of 800,000 year old hominin footprints, as well as a historic village and a 14th century church[408]. Nonetheless, **climate change could afford opportunities for the heritage sector, as funding needed for the protection of heritage assets could increase with an increased intensity of extreme weather events and sea level rise** (low confidence).

With sites facing threats of climate change and protections being put in place, job opportunities within this sector are expected to increase (moderate confidence).

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[405] UK Government. 2022. England Coast Path: plan of the Sutton Bridge to Skegness stretch. Available at: https://www.gov.uk/Government/publications/england-coast-path-plan-of-the-sutton-bridge-to-skegness-stretch Accessed October 2024.
[406] Natural England (2024) 'King Charles III England Coast Path – Stretch Progress: East Hub Team'. Available at: https://www.gov.uk/Government/publications/england-coast-path-in-the-east-of-england Accessed October 2024.
[407] CITiZAN (2023) 'Coasts in Mind update: exploring archives'. Available at: https://www.citizan.org.uk/blog/2023/Dec/08/coasts-mind-exploring-archives/#:~:text=Coasts%20in%20Mind%20is%20a,and%20Intertidal%20Zone%20Archaeological%20Network. Accessed October 2024.
[408] North Norfolk District Council (n.d.) 'Coastal Adaptation at Happisburgh'. Available at: https://www.north-norfolk.gov.uk/media/3078/happisburgh-case-study.pdf Accessed October 2024.

25 Marine ecology and biodiversity

25.1 Sector definition

Marine ecology and biodiversity in the Plan areas is defined as the following four key categories: benthic habitats, marine mammals, birds, and fish. Benthic ecology relates to seabed sediments and habitats within the boundaries of the Plan areas, and the species associated with this. Marine mammals, birds, and fish are all highly mobile and therefore include the species that are present in the Plan areas or use the areas for feeding, breeding, as nursery grounds, or migrating.

25.2 Historic trends and current activity

25.2.1 Benthic

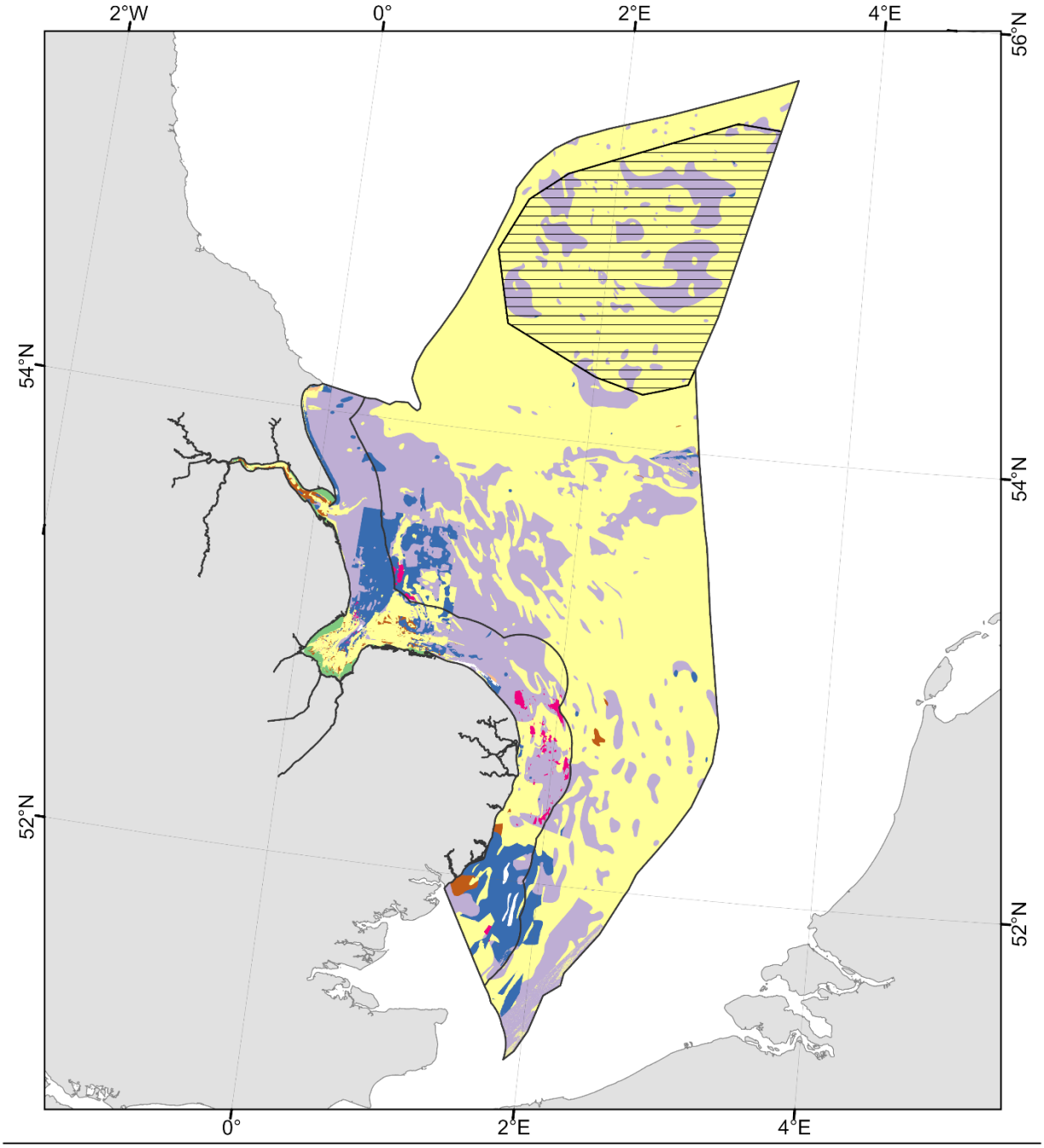
Benthic habitats and species are highly diverse in the Plan areas. Coastal habitats include saltmarsh and mudflats, seagrass beds, and oyster beds. These coastal habitats provide ecosystem goods and services for the species present in them and are increasingly being identified as areas for potential habitat creation as a nature-based solution to compensation.

Figure 34 shows the seabed sediment types in the Plan areas, which are characterised as mixed sediment with granular sand with high turbidity[409]. Figure 35 shows the water depth in the Plan areas, which is varied, reaching depths of 160 m in the northern part of the east offshore marine plan area. The Wash consists predominately of sand with some areas of sublittoral biogenic reefs and the coastline of the inshore Plan area is mainly high energy circalittoral muddy and fine sand. The offshore Plan area consists predominately of deep circalittoral sand which form sandbanks, such as at Dogger Bank which is the largest sandbank in the UK[410]. The location of Dogger Bank is shown in Figure 34.

The habitat supports a high diversity of benthic species including commercially important crustaceans including crabs and lobsters, as well as several species who depend on hard substrates such as bivalves, anemones, echinoderms, and ross worms. The finer sandy sediment supports species including commercially important sandeel and flat fish.

[409] Benthic Solutions. 2024. East Marine Ecosystem Conference, 2024.
[410] JNCC. Dogger Bank MPA. Available at: https://jncc.gov.uk/our-work/dogger-bank-mpa/ Accessed October 2024.

Figure 34: Seabed sediment types.



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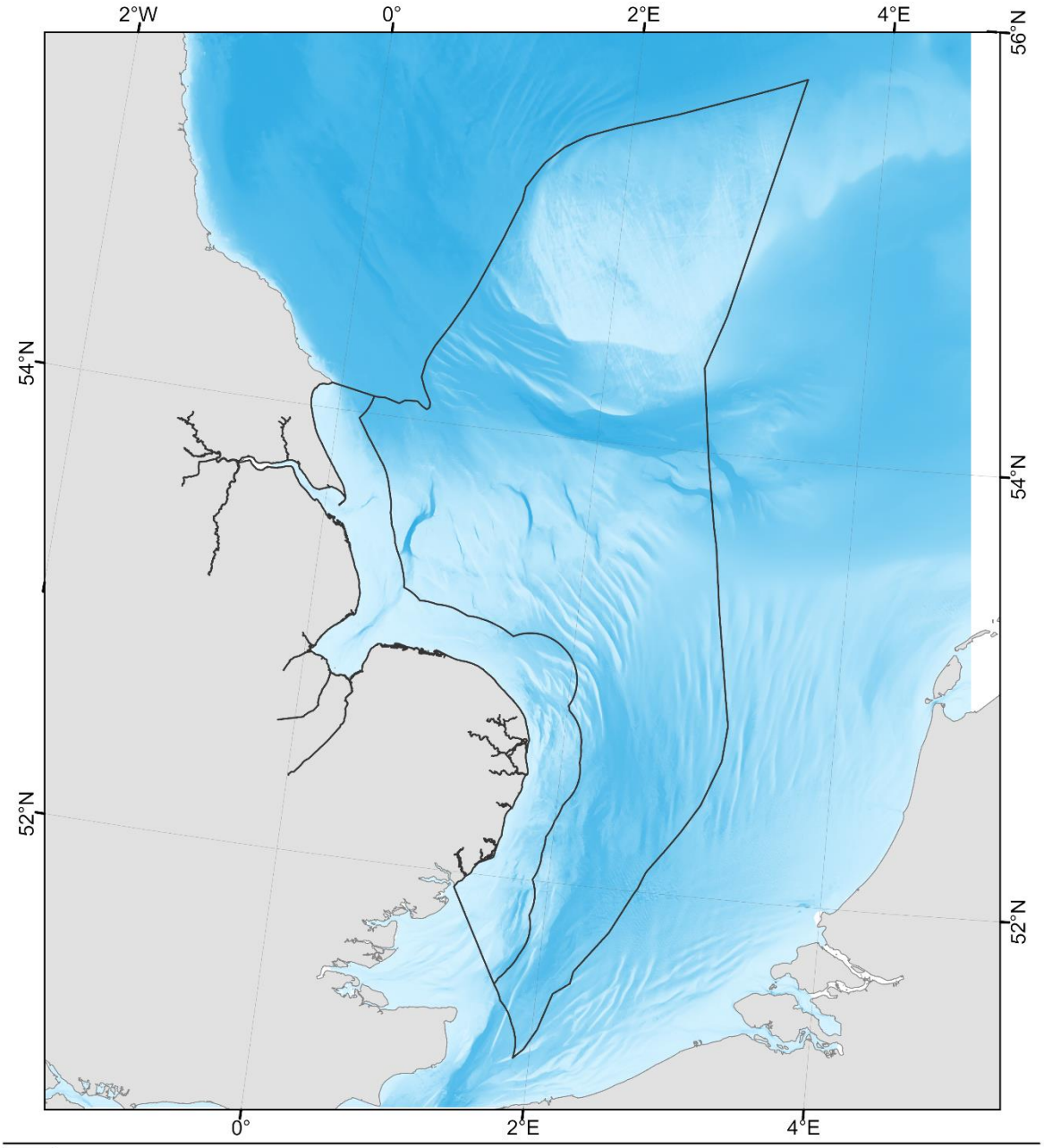
Projection:Lambert Azimuthal Equal Area

Figure 35: Water depth.



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Projection:Lambert Azimuthal Equal Area

25.2.2 Fish

Fish communities are highly diverse in the Plan areas with many being of high commercial importance, as discussed in the Aquaculture and Fisheries sectors in Sections 4 and Section 11, respectively. Fish species in the Plan areas cover all the main groups including demersal, midwater, and pelagic species, as well as shellfish and migratory fish. Key species that use the Plan areas for nursery grounds include sandeel, thornback ray, cod, whiting and plaice. Species which use the Plan areas as spawning grounds include sandeel, herring, plaice and sole[411]. Many of these species rely on the Plan areas for spawning, foraging, and as nursery grounds. The modelled key spawning, foraging, and nursery areas in the Plan areas are shown in Figure 36, Figure 37, and Figure 38[412].

Dogger Bank has strong established fisheries for plaice, cod, haddock, herring, and sandeel due to its expansive and nutrient rich waters[413]. Sandeel, and herring, are important commercial species, and are the main food source for the many bird and marine mammal species who use the offshore Plan area.

[411] Ellis, J.R., Milligan, S.P., Readdy, L., Taylor, N. and Brown, M.J. 2012. Spawning and nursery grounds of selected fish species in UK waters. Sci. Ser. Tech. Rep., Cefas Lowestoft, 147: 56pp.
[412] Marine Management Organisation. 2021. Essential Fish Habitat validation, MMO1133. Available at: https://environment.data.gov.uk/dataset/8d2f3822-b3f3-464e-9e74-ae342caefac3 Accessed October 2024.
[413] Dogger Bank IMMA, 2024. Available at: https://www.marinemammalhabitat.org/factsheets/dogger-bank-imma/ Accessed October 2024.

Figure 36: Spawning grounds based on modelled data.

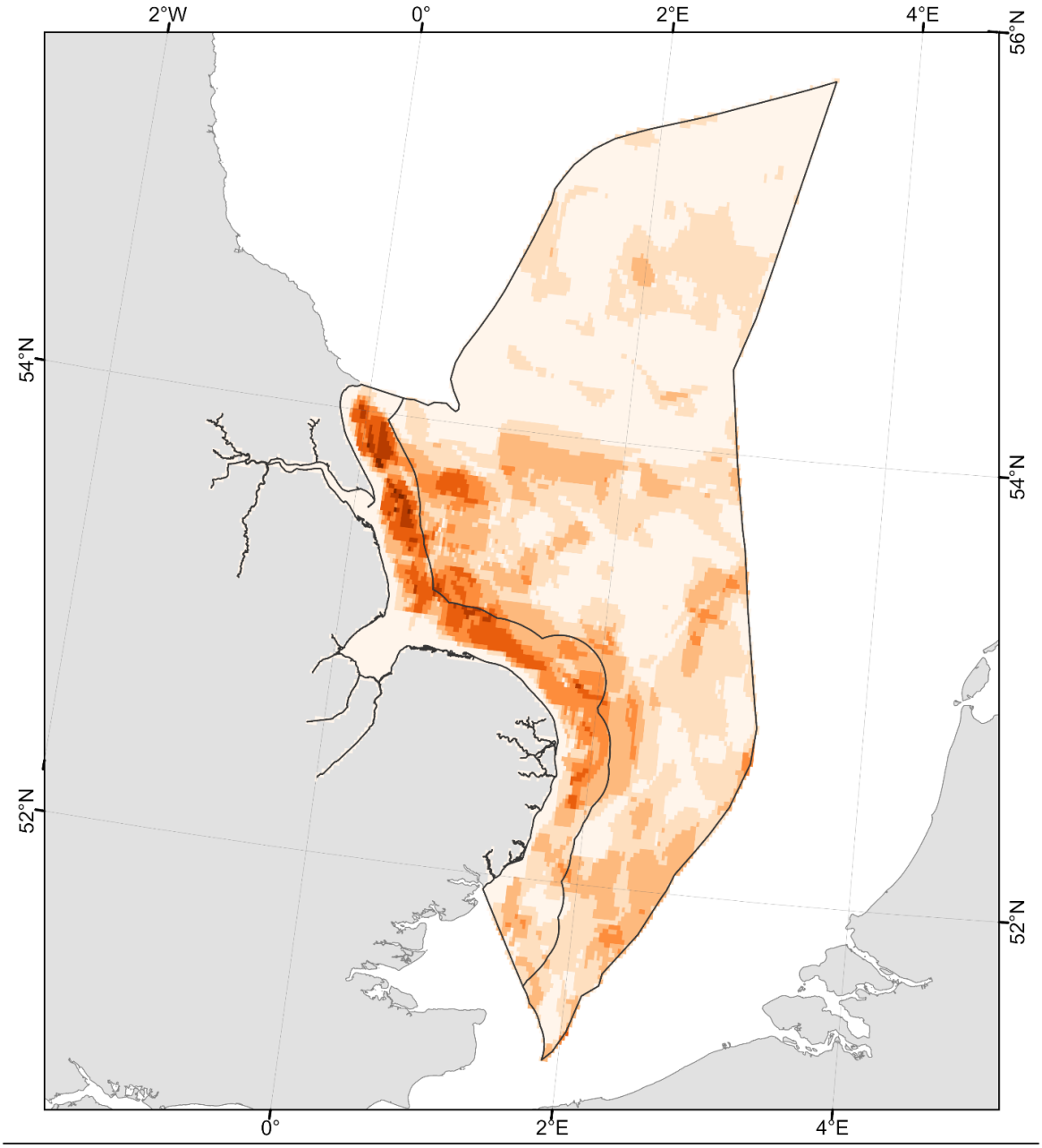

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Figure 37: Nursery grounds.

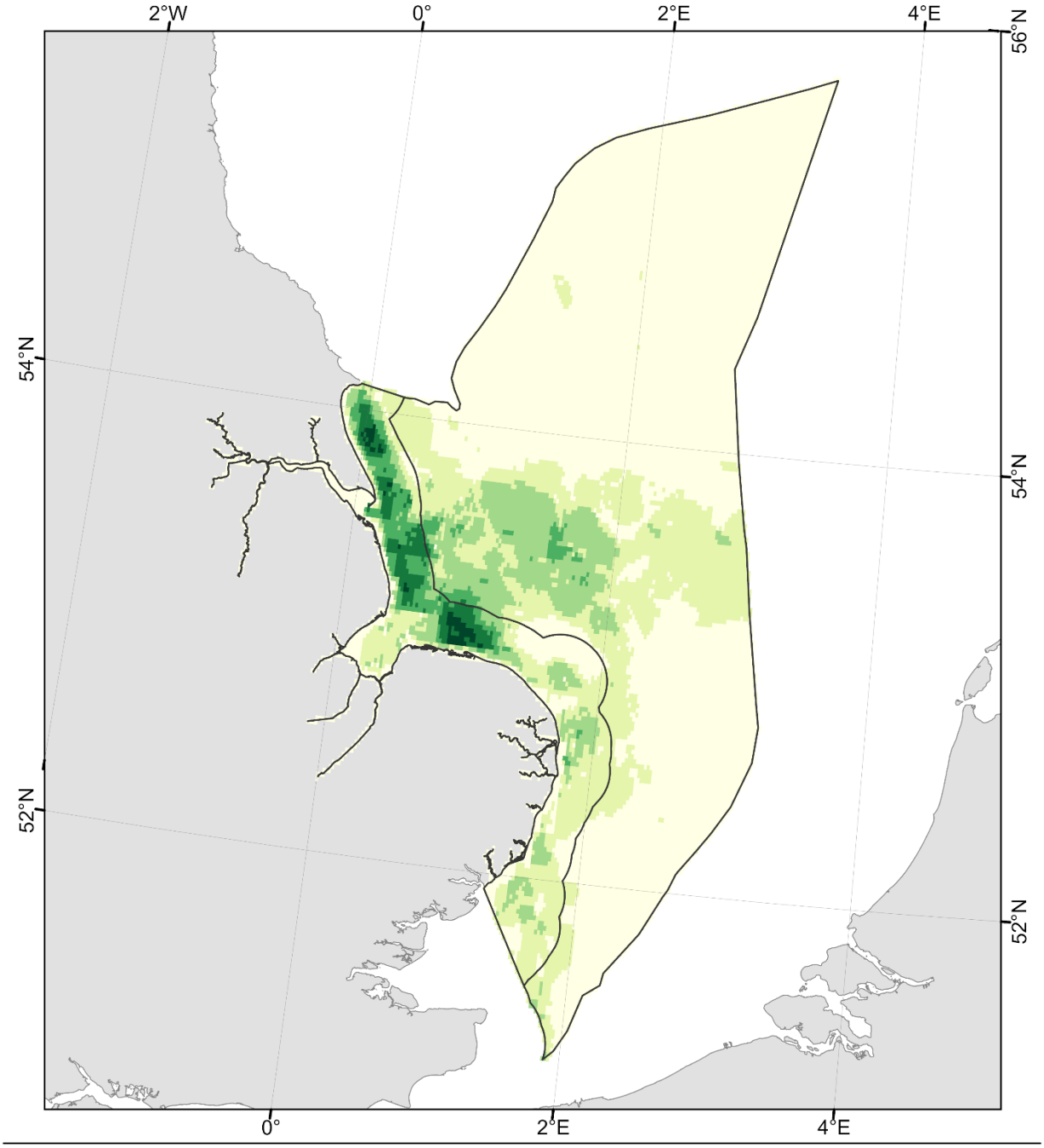

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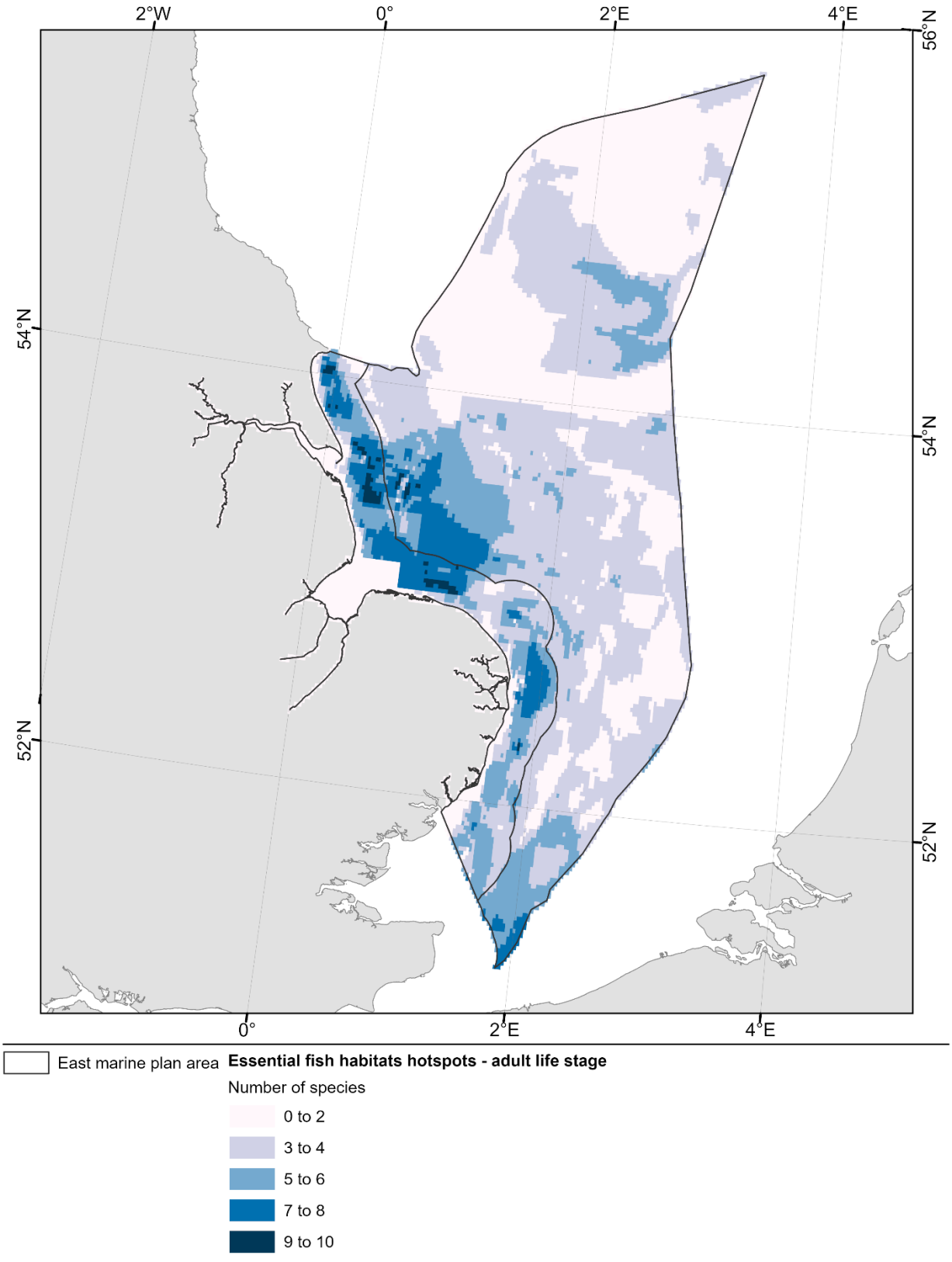
Figure 38: Foraging grounds.



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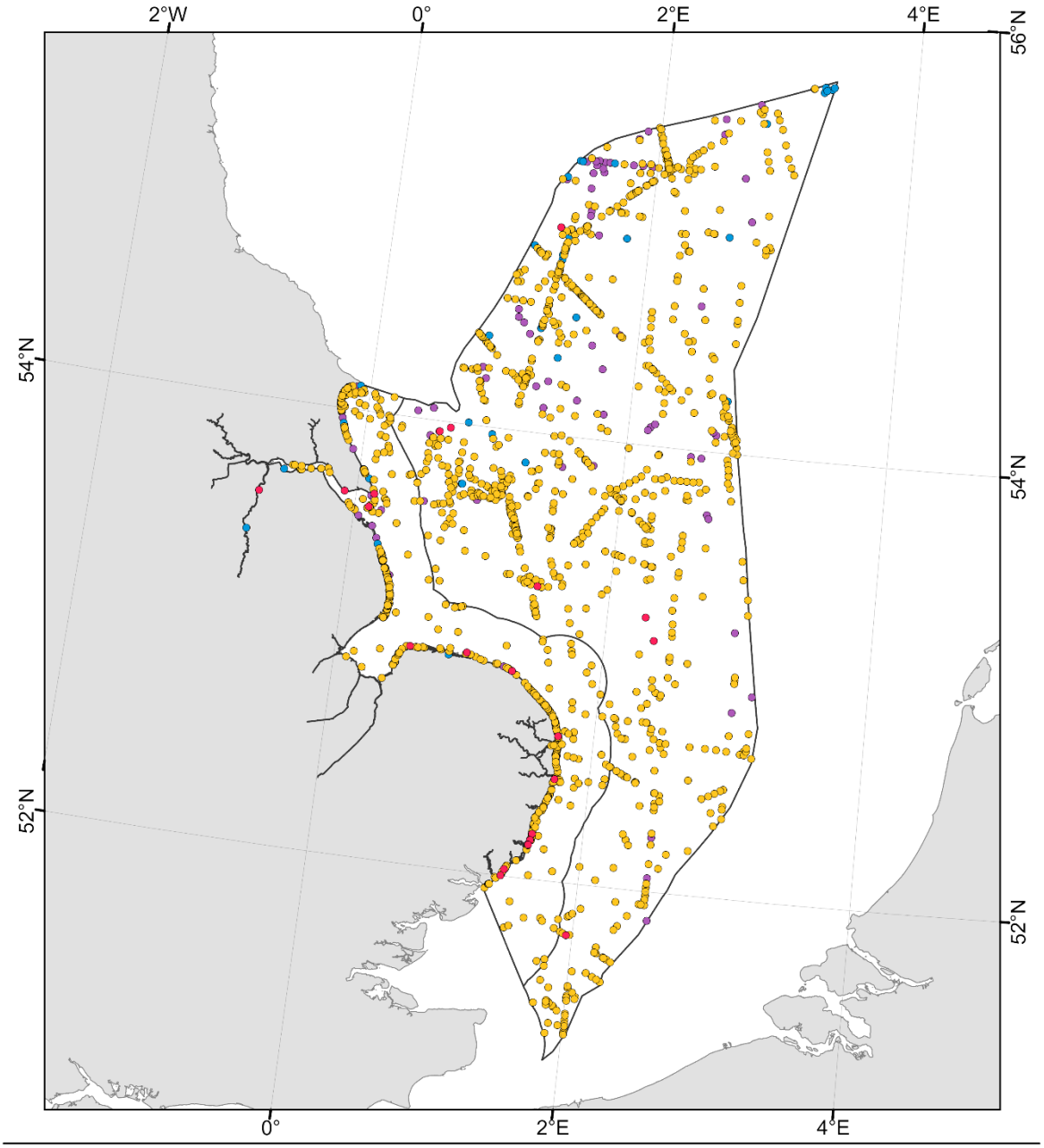
25.2.3 Marine mammals

Fifteen species of cetaceans can be sighted in UK waters, of these four species are regularly sighted in the Plan areas: harbour porpoise, bottlenose dolphin, white beaked dolphin and minke whale[414]. The location of sightings of these four species is shown in Figure 39. Sightings of harbour porpoise in the region have increased since 2010, with the number of sightings similar in 2023 and 2022, both of which are an increase on the 2021 sightings. bottlenose dolphins were scarce in the region before 2010 but have since been steadily increasing in numbers with larger groups of individuals. It is thought this is due to the southward movement of individuals from Scotland[414]. There have been relatively few white beaked dolphin and minke whale sightings since 2010 as these species are uncommon in coastal waters and rather occur in deeper offshore waters. Three new species were recorded in the Plan areas in 2023, these were humpback whale, common dolphin, and Pilot whale[414]. harbour porpoise were the most commonly seen cetacean in the Plan areas in 2023[414].

[414] Seawatch Foundation. 2024. East Marine Ecosystems Conference 2024.

Figure 39: Cetacean sightings.



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Projection:Lambert Azimuthal Equal Area

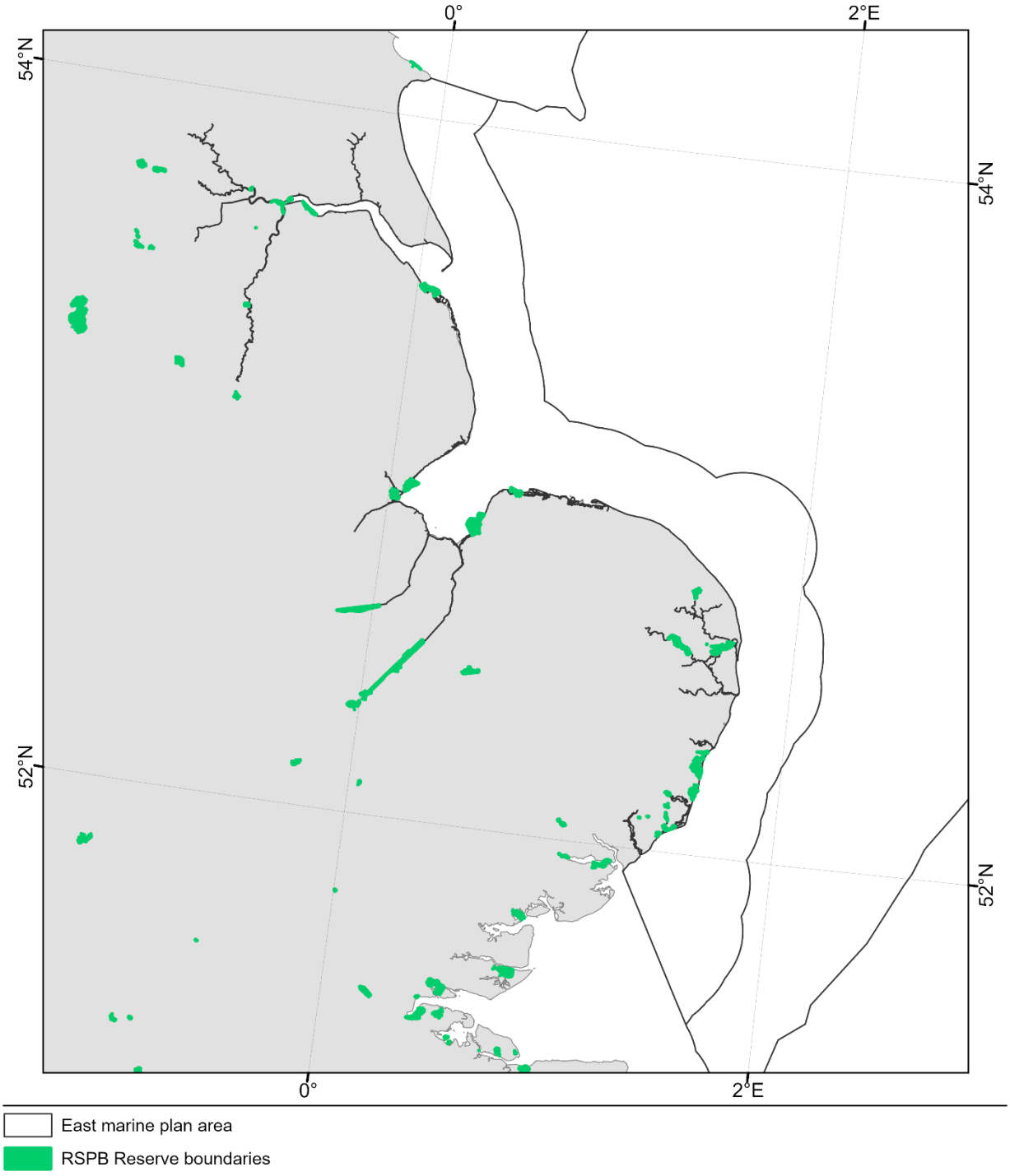
Two species of seals are present in the UK, both of which are present in the Plan areas, these are grey seal and harbour seal. The UK has 40% of the world population and 95% of the EU population of grey seals, and 5% of world's population and 50% of the EU population of Harbour seal[415]. Last year (2023) was considered a typical year for both species in the Plan areas, this being a steady decline in the harbour seal population, and a stable to increasing grey seal population. Hornsey point, Donna Nook, and Blakeney Point are important seal colonies in the Plan areas in addition to The Wash and North Norfolk Coast which hosts the largest harbour seal colony in the UK.

25.2.4 Ornithology

The Plan areas are a globally important area for breeding seabirds and wintering wildfowl. Areas of particular importance include Flamborough, the Outer Wash, and the Humber estuary. Approximately 11,000 breeding pairs of gannets nested at Bempton cliffs RSPB reserve in 2023, however, this population is in decline[416]. Fifty-eight breeding pairs of little terns with 107 chicks were recorded at Spurn in 2023. Several species of Auks are present across the Plan areas including guillemots, razorbills and puffins, oystercatchers, kittiwakes, and more recently the cory's shearwater. Many RSPB reserves, as illustrated in Figure 40, exist in the Plan areas to protect the species present. The large abundance and diversity of seabirds in the Plan areas is due to the food rich sea (containing sprat and herring) within flight distance of the nests, in addition to the cliffs which provide suitable habitat for cliff-nesting birds. The importance of seabird species in the area is demonstrated by actions such as the closure of the North Sea sandeel fishery in 2024 in order to maintain a food supply for seabirds during the nesting period, and the designation of the East Atlantic Flyway, a migration route used by 90 million birds each year that was added to the UNESCO tentative list in 2023[417].

[415] JNCC. 2024. 1364. Grey seal *Halichoerus grypus.* Available at: https://sac.jncc.gov.uk/species/S1364/ Accessed October 2024.
[416] RSPB. Marine & Coastal Birds presentation, East Marine Ecosystem Conference. 2024.
[417] ABPmer. 2023. Technical advice for English wetlands World Heritage Site nomination. Available at: https://www.abpmer.co.uk/blog/english-east-coast-wetlands-added-to-uk-s-tentative-list-of-world-heritage-sites/ Accessed October 2024.

Figure 40: RSPB reserves.



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25.3 PESTLE analysis

The key drivers expected to influence marine ecology in the Plan areas are environmental and legal drivers. Environmental drivers impact the occurrence of species and habitats in the Plan areas, whilst the legal drivers impact the protection of these features (further detail on marine protection in the Plan areas is presented in Section 26). All drivers of marine ecology are listed in Table 28.

Table 28: PESTLE analysis for the marine ecology and biodiversity sector.

Driver	Details	Implications	Impact (+ / - / Variable)
Political	The Energy Act sets out the UK Government's policy for strategic compensation[418], this being to undertake activities to compensate for any negative environmental impacts caused by offshore wind development. The activities undertaken will therefore have an impact on the species and habitats that occur as a result of the development.	The development and implementation of strategic compensation is in its infancy and rapidly advancing, therefore the long-term impacts of the compensation measures is unknown.	Variable
	The UK Marine Strategy Regulations target to achieve GES is due for re-assessment in 2024[419].	The outcome of the assessment could lead to increased management and conservation measures to meet GES.	+
	The Environment Improvement Plan 2023[420] revised the 25 Year Environment Plan, setting out a plan to achieve 'thriving plants and wildlife', which will involve 'promoting biodiversity' and 'supporting marine protected areas'.	The actions set out will drive protection and therefore recovery of biodiversity in the Plan areas.	+

[418] UK Government. Energy Security Bill Policy Statement Offshore Wind Environmental Improvement Package Measures Available at: https://assets.publishing.service.gov.uk/media/65b13f381702b1000dcb1209/energy-security-bill-offshore-wind-environmental-improvement-measures.pdf Accessed October 2024

[419] Tate of Nature. 2023. State of Nature. Available at: https://stateofnature.org.uk/wp-content/uploads/2023/09/TP25999-State-of-Nature-main-report_2023_FULL-DOC-v12.pdf Accessed October 2024

[420] Defra. 2023. Environmental Improvement Plan 2023. Available at: https://www.gov.uk/Government/publications/environmental-improvement-plan Accessed October 2024

Driver	Details	Implications	Impact (+ / - / Variable)
Economic	UK economic outlook and availability of funding for nature conservation[421].	Economic recessions can have significant effects on Government funding for environmental conservation. The impact of a recession on conservation funding depends on several factors, including the severity of the recession, Government priorities, and the availability of resources.	Variable
Social	Public awareness and engagement with marine issues[422].	Increased awareness and engagement of marine issues and ecological features could drive improvements in marine ecology and biodiversity.	+
Technological	Advances in technological capabilities can have many impacts on marine ecology.	Both positive and negative impacts can result from the use of more sophisticated technology such as leading to advances in mitigation methods and the development of nature inclusive designs[423]. On the other hand, negative impacts could include enabling activities to occur in areas where they previously could not.	Variable
Legal	Several pieces of legislation are in place to support biodiversity in the Plan areas including The Environment Act 2021[424] and law to protect European Protected Species[425].	UK and international legislation help to protect and support biodiversity to a point where it can thrive.	+

[421] Taylor & Francis. 2024. Economic growth versus the environment: Government spending, trust, and citizen support for environmental protection. Available at: https://www.tandfonline.com/doi/full/10.1080/23251042.2024.2398503 Accessed October 2024.
[422] United Kingdom Marine Monitoring & Assessment Strategy. 2018. Social value and public perceptions of the UK marine environment. Available at: October 2024.
[423] Crown Estate Scotland. 2024. Collaboration for Environmental Mitigation & Nature Inclusive Design (CEMNID). Available at: https://www.offshorewindscotland.org.uk/media/kcghvske/collaboration-for-environmental-mitigation-nature-inclusive-design-full-report.pdf Accessed October 2024.
[424] UK Government. 2021. The Environment Act 2021. Available at: https://www.legislation.gov.uk/ukpga/2021/30/contents Accessed October 2024
[425] UK Government. 2023. Protected species and development: advice for local planning authorities. Available at: https://www.gov.uk/guidance/protected-species-how-to-review-planning-applications Accessed October 2024

Driver	Details	Implications	Impact (+ / - / Variable)
	Fisheries Management Plans in the Plan areas are being introduced and are due to be released in 2024. They include The North Sea and Channel Sprat FMP, Southern North Sea and Eastern Channel Mixed Flatfish FMP, Southern North Sea Non-Quota Demersal FMP, and Southern North Sea and Channel Skates and Rays FMP. In addition, a ban on sandeel fishing in English waters was introduced in 2024.	Measures introduced through the FMPs, and the sandeel fishing ban could improve fish populations and have knock-on effects on wider species (marine mammals, seabirds).	+
	Important Marine Mammal Areas (IMMAs) are present in the Plan areas, these are The Wash, the Moray Firth to Humber Estuary, and Dogger Bank[426].	Potential increase in protection for marine mammals in the Plan areas if the IMMAs in the Plan areas are formally designated as an MPA.	+
Environmental	Ornithology – Support for the East Atlantic Flyaway to become a UNESCO world heritage site[427].	If designated protection of the birds could increase, it is also likely to increase public awareness and appreciation of the Plan areas for birds.	+
	Increased use of the marine space including marine traffic, renewable energy development, recreational use, fisheries activity, and pollution by marine litter.	Benthic: degradation of habitat and species due to increased dredging, anchorage, mineral extraction, and seabed development. Potential increase in benthic colonisation on newly deployed seabed structures.	-
		Fish: disruption to populations due to changing fishery activity, increased underwater noise, and changing seabird and marine mammal activity. In addition, impacts from marine litter and pollution includes entanglement, ingestion of microplastics and chemical contaminants.	-

[426] Marine Mammal Protected Areas Task Force. 2024. Available at: https://www.marinemammalhabitat.org/imma-eatlas/ Accessed October 2024.
[427] UNESCO. 2024. Available at: https://whc.unesco.org/en/tentativelists/6689/ Accessed October 2024.

Driver	Details	Implications	Impact (+ / - / Variable)
		Cetaceans: change in population due to increased underwater noise, increased risk of entanglement and collision, and change in fish populations. and marine litter. Seals: decrease in seal population due to disturbance and pollution at haul out sites, increased underwater noise, and changes to fish populations.	-
		Ornithology: change in population due to increased risk of collision from turbines and marine traffic, change in fish populations, and increased human disturbance of nesting sites. In addition to the risk of ingesting microplastics and other types of marine litter.	-
	Climate change will continue to drive changes to species population, and habitat integrity. Key impacts include range shifts of species away from good quality spawning and feeding grounds, and degradation of habitats.	Climate change will inevitably degrade habitats and cause species range shifts, it is therefore key to ensure important habitats are species are protected, to conserve biodiversity in the Plan areas.	-
	BNG requires all new developments in the Plan areas (up to MLWS) to have 10% net gain in biodiversity on all new development. This will mostly impact developments in the intertidal area in the Plan inshore area where birds are of key importance.	BNG brings both opportunities and challenges for biodiversity in the Plan region. Impacts will include increased biodiversity in the newly improved or created habitat, displacement of species from their pre-development habitat, and potential changes to the wider ecosystem functioning as a result of changes in prey abundance. Overall, however, BNG aims to positively impact biodiversity in the Plan areas.	Variable
	MNG takes the same approach to BNG but operates in the marine environment. The implementation process of MNG is not yet defined, but it will impact the future state of the marine environment[428].	MNG is in its infancy but has the potential to change the marine ecology in the Plan areas through approaches such as compensation and habitat creation (see Section 0). Similarly to above, whilst the impact is variable, the drive is to have a positive impact.	Variable

[428] UK Government. 2023. Marine Net Gain Consultation outcome, Summary of responses. Available at: https://www.gov.uk/Government/consultations/consultation-on-the-principles-of-marine-net-gain/outcome/summary-of-responses#introduction-and-context Accessed October 2024.

25.4 Future scenarios

6 year projection

The distribution, abundance, and quality of benthic habitats, fish, marine mammals, and birds may change to some extent over the next 6 years (moderate confidence) namely due to the impacts of climate change, squeeze due to the growth of other industries, and management measures that could be put in place to protect the marine environment. In regard to climate change it is however not possible to predict the exact nature and location of change to individual species or habitats. It is reasonable to assume increased extreme weather events causing local scale flooding, coastal erosion and/or desertification **may impact on the extent and quality of habitats such as saltmarsh, mudflats, and oyster beds** (moderate confidence). **Rising sea temperatures** and acidification may also **result in range shifts of highly mobile species of fish, marine mammals, and birds** (low confidence, as there may be little change over 6 years).

It is similarly not possible to predict with absolute certainty the impacts that spatial squeeze and management measures will have on the marine species and habitats in the Plan areas. In regard to spatial squeeze it is reasonable to assume **species occurrence and habitat condition will change at the areas where there is industrial growth,** including at the location of offshore energy infrastructure installation (moderate confidence).

Local scale change within the Plan area has been observed and will likely continue across the next 6 years, such as the increased occurrence of grey seals in what has traditionally been Harbour seal habitat in The Wash, and the southward movement of bottlenose dolphins from Scotland[429].

6 to 20 year projection

Further ecological change is likely to occur across the next 6 to 20 years, including **species' range shifts in response to climate change** (moderate confidence), **changes to habitats as a result of habitat restoration** (high confidence), and **changes to populations as a result of management measures** which will include FMPs (high confidence). It is not possible to predict the precise change that will occur at the species level; however, **it is likely to include the northward movement of species, resulting in cold water species shifting northwards out of the Plan areas, and potentially warm water species expanding their range into the Plan areas,** and behavioural changes in response to occupying new environments (moderate confidence).

There is a chance that the **migration routes of migrating fish and seabirds could change if sea temperatures and currents change the location and richness of prey species for the migrants** (low confidence). The Plan areas could also provide a refuge area for pelagic fish species in response to climate change, but how the

[429] Sea Mammal Research Unit. 2024. East Marine Plan Ecosystems Conference 2024.

area will be used, and by which species, is uncertain (low confidence)[430]. In addition, it is likely that changes to (generally) slow-growing benthic habitats could be seen across the next 6 to 20 years, this could include the degradation of sensitive biogenic reefs as a result of physical disturbance from dredging and trawling (moderate confidence).

Habitat restoration in the inshore Plans area is likely to increase (see Section 24) (high confidence). **This would result in the creation of more intertidal habitat which should increase the diversity and richness of coastal birds and fish species** in the restored habitat (moderate confidence). In addition, the need to achieve MNG, and strategic compensation in response to the impact of development in the marine environment could also increase the need for increased creation of intertidal habitats (moderate confidence).

Management measures that are likely to impact marine ecology across the next 6 to 20 years include FMPs in inshore waters, additional measures to manage fisheries in offshore MPAs, maintaining management of existing MPAs (Section 26) and a potential increase in the conservation of birds and marine mammals across the Plan areas (high confidence). The aim of management measures is to conserve species and habitats whilst balancing the need for economic development, and as such **it is reasonable to assume that some level of ecological change will occur in areas of rapid development** (such as for energy production), though it is not possible to determine the nature of any change.

Overall, **there will be ecological change across the next 6 to 20 years** but it is **extremely difficult to predict the nature and location of the change** due to the **natural variation** and unpredictability of the natural environment.

The potential ecological change in the Plan areas across the next 20 years is also **likely to lead to socio-economic impacts.** This could include impacting **the degree of appreciation and interaction with marine environment** by communities, as a richer, **more diverse marine environment will likely provide more opportunity to spark interest** (moderate confidence).

[430] Ana M Queirós, Susan Kay, Marija Sciberras, Elizabeth Talbot, Mike Kaiser, Robert J. Wilson, Sevrine Sailley, Stefano Marra, Liam Matear, Jose Fernandes, John Aldridge, Rob McEwan, Kate Morris, Caroline Louise McNeill, Joana Nunes, Kirsty Woodcock, Stephen Duncombe-Smith, Adam Smith, Chris Lynam, Cristina Vina-Herbon, Phil Boulcott, Billy Hunter, Ruth Parker, Karen Robinson, Fiona Trappe, Steve Mackinson, Chris Sweeting, Matt Frost and Paul J Somerfield. (2023) Early-warning system: Climate-smart spatial management of UK fisheries, aquaculture and conservation. A report of the NERC/ESRC Marine Spatial Planning Addressing Climate Effects project. 58 pp. doi: 10.14465/2023.msp02.tec

26 Marine Protected Areas

26.1 Sector definition

Marine Protected Areas (MPAs) are areas of the sea with defined boundaries that are designated for the conservation of the specific species and/ or habitats of interest (termed 'features') [431]. The level and type of protection varies depending on factors such as the characteristics of the feature and the type of site, but all MPAs provide protection while allowing sustainable use to continue within the boundaries of the MPA.

26.2 Historic trends and current activity

The legislation set out in the Wildlife and Countryside Act (1981)[432] enabled the UK to begin designating marine nature reserves and Sites of Special Scientific Interest in 1981. This was furthered by the Habitats and Species Regulations[433] (enabling the designation of Special Protection Areas and Special Areas of Conservation), and the Marine and Coastal Access Act[434] (enabling the designation of MCZs). Collectively this has led to the designation of 181 MPAs across the UK, encompassing 40% of the UK's marine area[435]. This equates to just over 78% of waters in the Plan areas.

There are 140 MPAs present in the Plan areas (presented in Figure 41 and listed in Annex A):

- 17 Special Protection Areas (SPAs);
- 12 Special Areas of Conservation (with a marine component) (SACs);
- 7 Marine Conservation Zones (MCZ);
- 93 Sites of Special Scientific Interest (SSSIs);
- 11 Ramsar sites.

The key features of conservation importance of each SPA, SAC and MCZ sites are listed in Table 29.

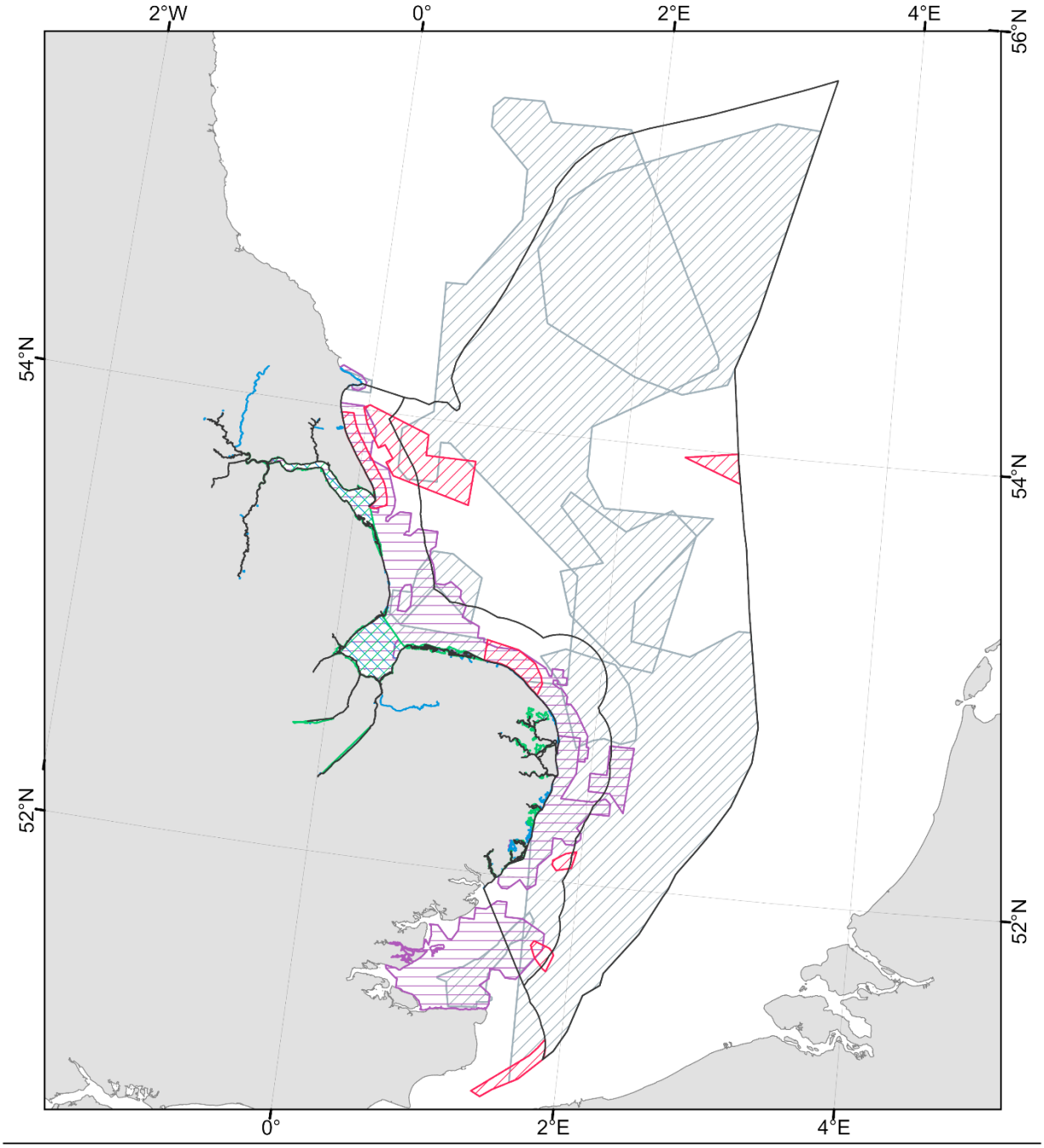
[431] UK Government. 2023. Guidance: Marine Protected Areas (MPAs). Available at: https://www.gov.uk/guidance/marine-protected-areas-mpas Accessed October 2024
[432] UK Government. 1981. Wildlife and Countryside Act 1981. Available at: https://www.legislation.gov.uk/ukpga/1981/69/contents Accessed October 2024.
[433] UK Government. 2017. The Conservation of Habitats and Species Regulations 2017. Available at: https://www.legislation.gov.uk/uksi/2017/1012 Accessed October 2024.
[434] UK Government. 2009. Marine and Coastal Access Act 2009. Available at: https://www.legislation.gov.uk/ukpga/2009/23/contents/2024-05-09 Accessed October 2024.
[435] UK Government. 2024. Vital marine ecosystems in an additional 4,000 square km of our seas to receive protection. Available at: https://www.gov.uk/Government/news/vital-marine-ecosystems-in-an-additional-4000-square-km-of-our-seas-to-receive-protection Accessed October 2024

Table 29: Marine protected areas in the Plan areas.

Name of MPA	Key features of conservation of importance
Alde, Ore and Butley Estuaries SAC, SPA	Estuaries, mudflats and sandflats not covered by seawater at low tide, and Atlantic salt meadows.
Benacre to Easton Bavents SPA	Birds including the eurasian bittern, western marsh harrier, and little tern.
Breydon Water SPA	Birds including bewick's swan, ruff, european golden plover, pied avocet, common tern, and northern lapwing.
Broadland SPA	Water birds including northern shoveler, eurasian wigeon, gadwall, eurasian bittern, western marsh, hen harriers, bewick's swan, and whooper swan.
Deben Estuary SPA	Birds including the brent goose, and pied avocet.
Dogger Bank SAC	It is designated as being a nationally important site for sandbanks which are slightly covered by sea water all of the time. It is also the largest area that supports sandeels in the North Sea, and a population harbour porpoise, as well as visiting grey and harbour seals.
Flamborough and Filey Coast SAC, SPA	Supports nationally important seabirds including one of the largest populations of kittiwake in Britain. It also the only mainland colony of gannets in England.
Foreland MCZ	English Channel outburst flood feature, subtidal sand, high energy circalittoral rock, moderate energy circalittoral rock, and subtidal coarse sediment supporting a range of benthic species including bivalves, anemones and commercially important lobsters and crabs.
Gibraltar Point SPA	Birds including sanderling, bar-tailed godwit, grey plover, and little tern.
Great Yarmouth North Denes SPA	Habitat that supports little terns.
Greater Wash SAC, SPA	Supports the breeding and wintering population of Annex II bird species: red-throated loon, little gull, common scoter, little tern, common tern, and sandwich tern.
Haisborough, Hammond and Winterton SAC	Habitats including reef and sandbanks which are slightly covered by sea water all the time, as well as the presence of grey seal and harbour porpoise.
Holderness Inshore MCZ	Its diverse sediment of rock, sand bank, and mud, supports benthic species such as red algae and sponges, as well as european eel and commercially important crustacea.
Holderness Offshore MCZ	Its diverse seabed habitats (that support high diversity of benthic species) include subtidal course sediment, subtidal sand, subtidal mixed sediment, ocean quahog, and the North Sea glacial tunnel valleys.
Hornsea Mere SPA	Subtidal coarse sediment, subtidal sand, subtidal mixed sediments, and ocean quahog.
Humber Estuary SAC, SPA	Fish species including allis and twait shad, european river lamprey and sea lamprey, as well as grey and harbour seals.
Inner Dowsing, Race Bank and North Ridge SAC	Habitats including reef and sandbanks which are slightly covered by sea water all the time, as well as the presence of grey seal and harbour porpoise.
Kentish Knock East MCZ	Its subtidal coarse sediment, subtidal sand and subtidal mixed sediments support a high diversity of species including benthic molluscs, echinoderms, anemones, as well as burrowing shrimp, the small spotted catshark, and many flat fishes.
Margate and Long Sands SAC	Habitats including reef and sandbanks which are slightly covered by sea water all the time, no other designated features exist.
Markham's Triangle MCZ	Its subtidal coarse sediment, subtidal sand and subtidal mixed sediments support a high diversity of species including benthic molluscs and echinoderms, commercially important flat fishes.

Name of MPA	Key features of conservation of importance
Minsmere-Walberswick SPA	Several bird species, some of which include little tern, northern shoveler, eurasian teal, gadwall, greater white-fronted goose, berwick swan, european nightjar, hen harrier, and pied avocet.
Nene Washes SPA	Several bird species some of which include northern pintail, northern shoveler, eurasian teal, and black-tailed godwit.
North Norfolk Coast SAC, SPA	Several waterbird species including eurasian wigeon, pink-footed goose, red knot, western marsh harrier, and little tern.
North Norfolk Sandbanks and Saturn Reef SAC	Habitats including reef and sandbanks which are slightly covered by sea water all the time supporting a high diversity of species including fragile sand-tubes made by ross worms which have consolidated to create solid structures rising above the seabed.
Orford Inshore MCZ	Subtidal mixed sediments which are nursery and spawning grounds for many fish species include sandeel and sharks.
Orfordness - Shingle Street SAC	Habitats including coastal lagoons, annual vegetation of drift lines, and perennial vegetation of stony banks.
Ouse Washes SPA	Several bird species some of which including little tern, eurasian coot, common pochard, ruff, and great cormorant.
Outer Thames Estuary SPA	Bird species including red-throated diver, common tern and Little tern.
The Cromer Shoal Chalk Bed MCZ	Contains significantly important chalk habitats (including subtidal chalk, peat and clay exposures) across the UK and Europe.
The Southern North Sea SAC	It is a nationally important winter and summer site for of Harbour porpoise.
The Wash and North Norfolk Coast SAC	It is the largest and most important estuarine system in the UK consisting of vast estuarine mudflats, sandbanks, and saltmarsh. The area supports internationally important bird species on passage and overwintering. In addition, it is as an important shell fish fishery, and a Harbour seal breeding colony.
The Wash SPA	

Figure 41: Marine Protected Areas.



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26.3 PESTLE analysis

The main drivers that influence the implementation and management of MPAs within the Plan areas are environmental and political drivers, and to a lesser extent social factors. As such, the designation of MPAs is informed by strategies ranging from local interest to international law. The key drivers are listed in Table 30 below.

Table 30: PESTLE analysis for the marine protected areas sector.

Driver	Details	Implications	Impact (+ / - / Variable)
Political	The 25 Year Environment Plan[436] sets out the Government's ambition to restore, and if possible, enhance the health of the marine environment.	Potential increase in management of MPAs in the Plan areas, including managing damaging fishing activities and reducing marine pollution (litter and worsening water quality).	+
	In 2022 the UK Government joined the international commitment to achieve '30 by 30'[437]. This is a commitment to protecting 30% of England's land and seas by 2030.	Potential to increased MPA designation in the Plan areas in order to contribute to reaching 30 by 30. It is also likely there could be increased protection within existing MPAs in the Plan areas.	+
	The MPS set out the commitment by the UK Administrations to create a network of MPAs to protect vulnerable habitats and species as it is a key tool to achieving GES[438].	Potential increase in management of MPAs in the Plan areas reaching GES.	+

[436] UK Government. A Green Future: Our 25 Year Plan to Improve the Environment. Available at: https://assets.publishing.service.gov.uk/media/5ab3a67840f0b65bb584297e/25-year-environment-plan.pdf Accessed October 2024

[437] House of Lords. 2023. Available at: https://committees.parliament.uk/publications/41074/documents/200340/default/ Accessed October 2024

[438] Her Majesty Government. UK Marine Policy Statement. 2011. Available at: https://assets.publishing.service.gov.uk/media/5a795700ed915d042206795b/pb3654-marine-policy-statement-110316.pdf Accessed October 2024

Driver	Details	Implications	Impact (+ / - / Variable)
Economic	Opposition from industries with an interest in working within or near to MPAs[439].	New designations and the introduction of management measures place constraints on other sea users. Proposed marine designations must be consulted on, with no guarantee of the outcome, as barriers to designation can arise at any time throughout this process[440]. Preserving the coherence of the network in the face of opposition could include increased engagement and open communication between stakeholders.	Variable
Social	Due to the rapidly increasing recreational use of the marine environment, evidence is being gathered to assess if and how non-licensable activities can be managed in MPAs. See Tourism and Recreation PESTLE (Section 20.3) regarding non-licensable activities in MPAs[441].	Six priority MPAs have been selected for assessment of mNLA, two of which are in the Plan areas – Cromer Shoal Chalk Bend MCZ, The Wash and North Norfolk Coast SAC. If measures are introduced, protection in these areas will increase.	Variable
Technological	No significant drivers identified.		
Legal	Section 110 of the Environment Act (2021) affords Natural England the ability to prepare and publish 'Protected Site Strategies' (PSS) aimed at: a) Improving the conservation and management of a protected site; by b) Managing the impact of plans, projects, or other activities (wherever undertaken) on the conservation and management of the protected site.	Whilst PSSs are in their infancy, with guidance in development, they could be applied in the future to MPAs, where relevant and required. This could secure improved management to an area to help achieve conservation outcomes of the area.	+

[439] Sarah C. Gall, Lynda D. Rodwell. 2026. Evaluating the social acceptability of Marine Protected Areas. Marine Policy, Volume 65. Pages 30-38. Available at: https://doi.org/10.1016/j.marpol.2015.12.004. Accessed October 2024.

[440] Department for Environment Food & Rural Affairs. 2021. Best practice guidance for developing compensatory measures in relation to Marine Protected Areas Available at: https://consult.defra.gov.uk/marine-planning-licensing-team/mpa-compensation-guidance-consultation/supporting_documents/mpacompensatorymeasuresbestpracticeguidance.pdf Accessed October 2024

[441] Marine Management Organisation. Management of Marine Non-Licensable Activities in England. Available at: https://assets.publishing.service.gov.uk/media/629745f7e90e07039ae3ec0a/Management_of_Marine_Non-Licensable_Activities.pdf Accessed October 2024

Driver	Details	Implications	Impact (+ / - / Variable)
	Environmental Targets (Marine Protected Areas) Regulations 2022 sets the target for at least 70% of protected features in MPAs to be in a favourable condition by the end of 2042, with the remaining features to be in a recovering condition[442].	It is anticipated that the necessary measures to manage the most damaging activities in MPAs will be in place by 2024. Therefore, if not already in place, this will lead to increased management in MPAs in the Plan areas. Areas in the Plan areas that will benefit from increased management will include Haisborough, Hammond and Winterton, protected from the impacts on bottom trawling, and the Southern North Sea for the presence of Harbour porpoise[443].	+
Environmental	Degradation of habitat and species quality due to impacts from factors including climate change, over exploitation, pollution, and human disturbance. Disturbance caused by offshore wind development in the marine environment is being addressed, in part, through strategic compensation efforts [444].	The degradation of species and habitats could lead to an increase in designations in order to protect vulnerable species as set out in Governmental targets. In regard to disturbance from offshore wind development (which is significant in scale in the Plan areas) this could include an increase in strategic compensation in the Plan areas to maintain cohesion of the MPA network and achievement of GES under the UK Marine Strategy[445].	Variable
	As detailed in Section 25.3 climate change is impacting the quality and location of marine species and habitats in the Plan areas.	Given MPAs play a role in protecting important habitats and species, as these habitats and species shift in range and become more vulnerable, as a result of climate change, protection in the Plan areas may increase.	Variable

[442] UK Parliament. 2023. Environmental Targets (Marine Protected Areas) Regulations 2022. Volume 827. Available at: https://hansard.parliament.uk/Lords/2023-01-24/debates/BE258E23-1CA7-4607-804B-FD42A0EC3DEE/EnvironmentalTargets(MarineProtectedAreas)Regulations2022 Accessed October 2024

[443] UK Government. 2024. Managing fishing in marine protected areas. Available at: https://www.gov.uk/Government/collections/managing-fisheries-in-marine-protected-areas Accessed October 2024.

[444] UK Government. Energy Security Bill Policy Statement Offshore Wind Environmental Improvement Package Measures Available at: https://assets.publishing.service.gov.uk/media/65b13f381702b1000dcb1209/energy-security-bill-offshore-wind-environmental-improvement-measures.pdf Accessed October 2024

[445] Department for Environment Food & Rural Affairs. 2021. Best practice guidance for developing compensatory measures in relation to Marine Protected Areas Available at: https://consult.defra.gov.uk/marine-planning-licensing-team/mpa-compensation-guidance-consultation/supporting_documents/mpacompensatorymeasuresbestpracticeguidance.pdf Accessed October 2024

26.4 Future scenarios

6 year projection

It is highly likely that **activity in regard to MPAs in the Plan areas will focus on ensuring management measures are in place and effective in the existing sites**. Management measurements that will likely be considered across the next 6 years including management of fisheries in offshore MPAs and management of non-licensable activities in Cromer Shoal and The Wash (high confidence). It is likely that consultation to identify the measure to appropriately manage the impacts of fishing gear will continue across the next 6 years[446] following on from the measure banning trawling in the North Norfolk Sandbanks and Saturn Reef MPA in 2024[447]. **Given there are no candidate MPAs** (at the time of writing) it is **unlikely that additional MPAs will be designated in the next 6 years** (moderate confidence). However, the value of MPAs as potential compensation measures for the impacts of OWFs is recognised by the UK Government.

As discussed in Section 25 the **East Atlantic Flyaway is currently listed on the UNESCO tentative list and therefore has the potential to become a designated UNESCO World Heritage Site, the earliest this could be achieved is 2030[448].** It is uncertain (moderate confidence) whether the site will be designated as although its listing on the tentative list demonstrates there is an appreciation of the significance of the site, the process to become designated is lengthy and depends upon multiple external review processes.

6 to 20 year projection

Three Important Marine Mammal Areas (IMMAs) have been identified in the Plan area, and these may be further advanced to formal designations (low confidence). The IMMAs in the Plan areas include The Wash (designated for high usage by breeding Harbour seals)[449], the Moray Firth to Humber Estuary (designated for its high diversity of cetaceans and seals including a small resident population of Bottlenose dolphin)[450], and Dogger Bank IMMA (designated as a foraging and aggregation areas for Harbour porpoise, Minke whale, and Grey seals)[451].

[446] UK Government. 2023. Marine Protected Areas (MPAs). Available at: https://www.gov.uk/guidance/marine-protected-areas-mpas Accessed October 2024
[447] UK Government. 2024. Bottom towed fishing gear prohibited over reef habitats in 13 marine protected areas. Available at: https://www.gov.uk/Government/news/bottom-towed-fishing-gear-prohibited-over-reef-habitats-in-13-marine-protected-areas Accessed October 2024
[448] ABPmer. 2023. Available at: https://www.abpmer.co.uk/blog/english-east-coast-wetlands-added-to-uk-s-tentative-list-of-world-heritage-sites/ Accessed October 2024..
[449] Marine Mammal Protected Areas Task Force. 2023. The Wash IMMA. Available at: https://www.marinemammalhabitat.org/factsheets/the-wash-imma/ Accessed October 2024
[450] Marine Mammal Protected Areas Task Force. 2023. The Moray Firth to Humber Estuary IMMA. Available at: https://www.marinemammalhabitat.org/factsheets/moray-firth-to-humber-estuary-imma/#:~:text=Summary,open%20waters%20off%20the%20coast. Accessed October 2024
[451] Marine Mammal Protected Areas Task Force. 2023. The Dogger Bank IMMA. Available at: https://www.marinemammalhabitat.org/factsheets/dogger-bank-imma/ Accessed October 2024

Across the next 6 to 20 years, use of the marine environment is expected to increase significantly, driven mainly by offshore energy generation to reach net zero targets. Furthermore, **climate change impacts are likely to alter the spatial distribution of areas that are suitable for different species and habitats.** It is not clear whether MPA designations will need to be adjusted to adapt the MPA network to these future challenges (low confidence).

The future status of MPAs in the Plan areas will have a variety of social impacts on the communities in the Plan areas, including increased understanding and appreciation of the marine and coastal environment due to the areas becoming more attractive. There will likely be a range of socio-economic impacts in response to the management measures in place in the Plan areas. This could include reduced fishing activity (which will reduce the economic value and employment of the fishing sector) as well as an increase in tourism to the area, resulting in increased economic value and employment in the sector.

27 Highly Protected Marine Areas

27.1 Sector definition

Highly protected marine areas (HPMAs) are similar to MPAs in that they are areas with defined boundaries which are designated for environmental protection. HPMAs however differ to MPAs as their designation is based on the 'whole site approach' protecting all species and habitats in the boundaries of the HPMA, rather than specific features. It is hoped by taking this approach it will enable full recovery of species and habitats to their natural state[452]. To achieve this the HPMAs must exclude all extractive and depositional use and prevent damaging levels of other activities.

27.2 Historic trends and current activity

The designation of HPMAs will help the UK Government achieve many of its environmental goals and targets, this includes but is not limited to, the 25 Year Environment Plan[453], 'Good Environmental Status' as set out in the UK Marine Strategy[454], and The Commonwealth Blue Charter[455].

Five candidate HPMAs were identified as potential HPMAs; this was refined to three pilot HPMAs, all of which were designated in July 2023. The candidate HPMAs were assessed under ecological criteria[456] developed by JNCC and Natural England, along with the Centre for Environment, Fisheries and Aquaculture Science (Cefas) based on the principles outlined in the Benyon Review[457]. The criteria fall under one of three Principles: i) ecological importance, ii) naturalness, sensitivity and potential to recover, and iii) ecosystem service. All of criteria are considered in relation to minimising social and economic impact.

Of the five candidate HPMAs, one was located in the Plan areas – Inner Silver Pit South[458]. Inner Silver Pit South is 62.5 km^2 and is located approximately 28 km off

[452] UK Government. 2023. Highly Protected Marine Areas (HPMAs). https://www.gov.uk/Government/publications/highly-protected-marine-areas/highly-protected-marine-areas-hpmas Accessed October 2024
[453] Defra (2018) Policy Paper: 25 Year Environment Plan. Available at: https://www.gov.uk/Government/publications/25-year-environment-plan Accessed October 2024
[454] Department for Environment Food & Rural Affairs. 2019. Marine Strategy Part One. Available at: https://assets.publishing.service.gov.uk/media/5f6c8369d3bf7f7238f23151/marine-strategy-part1-october19.pdf Accessed October 2024
[455] The Commonwealth. 2022. The Commonwealth Blue Charter. Available at: https://production-new-commonwealth-files.s3.eu-west-2.amazonaws.com/s3fs-public/2022-02/Commonwealth%20Blue%20Charter.pdf?VersionId=Ddy0_2fwqEyM8Aunbg2miUHkFTzmj6_k Accessed October 2024
[456] JNCC. English Highly Protected Marine Areas. Available at: https://jncc.gov.uk/our-work/english-highly-protected-marine-areas/ Accessed October 2024
[457] https://assets.publishing.service.gov.uk/media/5eda52cbe90e071b78731f0d/hpma-review-final-report.pdf Accessed October 2024
[458] Department for Environment Food & Rural Affairs. 2022. Inner Silver Pit South. Consultation factsheet for candidate Highly Protected Marine Area (HPMA). Available at: https://consult.defra.gov.uk/hpma/consultation-on-highly-protected-marine-areas/supporting_documents/Annex%20E%20Inner%20Silver%20Pit%20South%20candidate%20HPMA%20factsheet.pdf Accessed October 2024

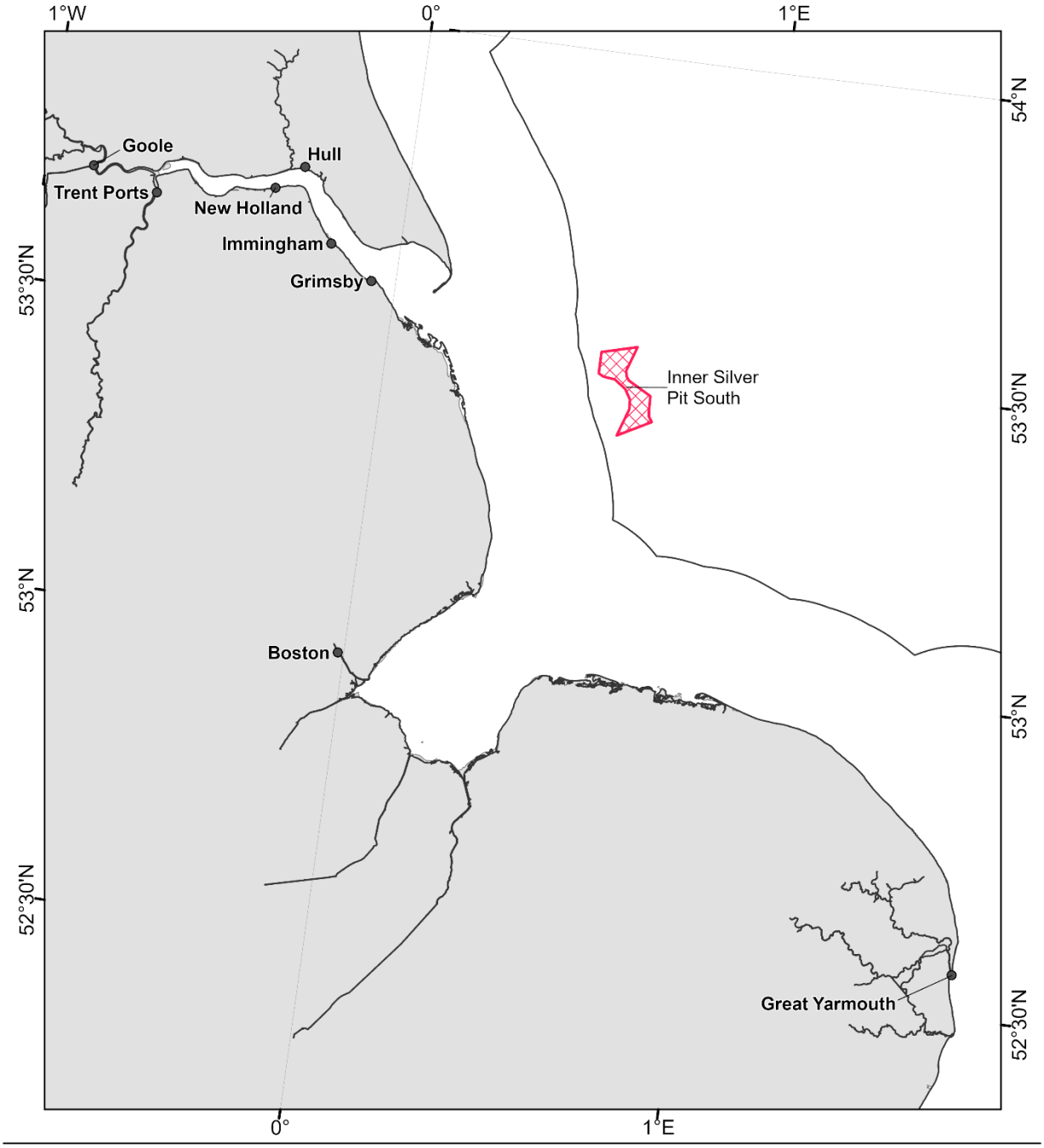
the coast of Lincolnshire (Figure 42). It was considered as an HPMA due to the importance of the area for its highly diverse habitats including biogenic reefs that support a wide range of benthic species, as well as 19 mobile species including commercially important fish species, marine mammals, and seabirds. However, it was not taken forward as one of the three HPMAs to be designated, due to the high productivity of commercial fishing in the area, and is no longer a candidate HPMA[459]. There are therefore no HPMAs in the Plan areas.

The Benyon Review was carried out to review the barriers and opportunities for HPMA designations in the UK. The review recommended implementation of HPMAs, more specifically that:

- HPMAs should be defined as areas of the sea that allow the protection and recovery of marine ecosystems. They prohibit extractive, destructive and depositional uses and allow only non-damaging levels of other activities.
- The Government should introduce HPMAs in conjunction with the existing MPA network, and in many instances, sections of existing MPAs can be upgraded to HPMAs.
- The Government must set conservation objectives for HPMAs that allow full recovery of the marine environment and its ecological processes.
- The Government must take a 'whole site approach' to HPMAs to conserve all habitats and species within the site boundary. This includes mobile and migratory species that visit or pass through the site.

[459] UK Government. 2023. Highly Protected Marine Areas pilot sites, Summary of Responses. Available at: https://www.gov.uk/Government/consultations/highly-protected-marine-areas-pilot-sites/outcome/summary-of-responses Accessed 09/09/2024.

Figure 42: Candidate HPMA identified in 2022.



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27.3 PESTLE analysis

The key drivers that influence the future development of HPMAs within the Plan areas are environmental and political drivers, and to a lesser extent economic and social factors. The drivers listed below closely align with the criteria considered during the designation process. The drivers and their potential impact are listed in Table 31.

Table 31: PESTLE analysis for the highly protect marine areas sector.

Driver	Details	Implications	Impact (+ / - / Variable)
Political	The Benyon review was carried out and recommended the implementation of HPMAs into Highly Protected Marine Areas.	This has led to the designation of pilot HPMAs and further HPMAs may be designated based on the success of the pilots.	Variable
Economic	Economic and social data are gathered to identify candidate HPMAs in order to determine the activities that will be impacted by a designation[460]. This data includes socio-economic value of industries (such as commercial fisheries and recreational use).	The socio-economic importance of industries within the Plan areas will influence the designation of any future HPMAs.	Variable
Social	Level of opposition and support from sea users such as commercial fisheries and recreational users, exemplified by the Inner Silver Pit.	Opposition and support could influence which potential sites are taken forward.	Variable
Technological	No significant drivers identified.		
Legal	No significant drivers identified.		
Environmental	Continued research and environmental monitoring could lead to new data becoming available which in turn could lead to a better understanding of the state of local and national habitats and species populations.	An increase in HPMA designations to safeguard sensitive marine features.	+
	Climate change may alter species' distributions which may result in a change in where MPAs and HPMAs could or should be located.	An increase in HPMA designations to safeguard sensitive marine features.	+
	A decline in species' abundance and habitat quality.	Shift in the strategy for designations, including management strategies.	+

[460] UK Government. 2023. Highly Protected Marine Areas (HPMAs). Available at: https://www.gov.uk/Government/publications/highly-protected-marine-areas/highly-protected-marine-areas-hpmas Accessed October 2024

27.4 Future scenarios

6 year projection

The outcomes of the HPMA pilot phase will inform the future HPMA policy and therefore the potential location of HPMAs in the Plan across the next 6 years. It is **unlikely that HPMAs will be designated in the Plan areas in the next 6 years**, as Inner Silver Pit South was not taken forward, and it is not clear what the pathway for designating additional HPMAs could be (moderate confidence). An evaluation is currently underway of the HPMA pilot phase, to understand its outcomes and determine future policy.

The Benyon review recommends the pilot sites be used as a starting point in any future HPMA policy[461]. The location of important habitats and MPAs could, in part, indicate where future HPMAs could be designated as the Benyon review recommends HPMAs be located within existing MPAs[462]. Figure 41 shows the location of MPAs in the Plan area which therefore indicates where future HPMAs could (with low certainty) be designated in the Plan areas, should it be agreed that additional HPMAs should be designated.

6 to 20 year projection

The designation of HPMAs across the UK contributes to the UK achieving its long-term key environmental goals and targets, such as in the Environmental Improvement Plan. There is therefore the potential for additional HPMAs to be designated across the UK in the next 6 to 20 years. Decisions on this however are uncertain and it is not possible to determine if and where these could be located in the Plan areas in the future.

[461] Benyon review Into Highly Protected Marine Areas: Final report. 2022. Available at: https://assets.publishing.service.gov.uk/media/5eda52cbe90e071b78731f0d/hpma-review-final-report.pdf Accessed October 2024

[462] Benyon review Into Highly Protected Marine Areas: Final report. 2022. Available at: https://assets.publishing.service.gov.uk/media/5eda52cbe90e071b78731f0d/hpma-review-final-report.pdf Accessed October 2024

28 Noise

28.1 Sector definition

Underwater noise is defined here as when sound which is produced by anthropogenic activities is transmitted as sound-pressure waves through the water column and is heard by marine organisms. Underwater noise is produced in the marine environment from many activities including offshore construction involving piling (impulsive noise), and drilling, dredging, seismic surveys, and shipping (continuous noise).[463]

The propagation of sound from these sources in the marine environment has the potential to have adverse effects on biodiversity, particularly marine mammals, fish, and benthic species with potential to cause behavioural changes (such as displacement) and physical injury (such as damage to hearing organs creating less ability to hear resulting in hearing loss)[464]. Understanding the extent of noise impacts is limited and there are few systematic monitoring programmes to verify adverse effects[465].

28.2 Historic trends and current activity

The UK Marine Noise Registry (MNR) has been developed by JNCC to record activities in UK seas that produce loud, low to medium frequency (10Hz – 10kHz) impulsive noise[466] such as seismic surveys, sub-bottom profiling, and impact pilling. Data uploaded to the MNR includes where and when the activity takes place, the noise source properties such as the frequency and sound exposure levels.

The MNR is updated annually, the last of which was in 2023 where new features were added which improve the ability to identify and understand the in-combination effects of noise from multiple projects. This will include the ability to monitor and identify underwater noise from activities in the Plan areas. The latest available data from the MNR is 2021[467], Figure 43 , shows levels measured in pulse-block-day[468] in the Plan areas. Comparatively, underwater noise in the Plan areas is lower than

[463] Her Majesty Government. UK Marine Policy Statement. 2011. Available at: https://assets.publishing.service.gov.uk/media/5a795700ed915d042206795b/pb3654-marine-policy-statement-110316.pdf Accessed October 2024
[464] Her Majesty Government. UK Marine Policy Statement. 2011. Available at: https://assets.publishing.service.gov.uk/media/5a795700ed915d042206795b/pb3654-marine-policy-statement-110316.pdf Accessed October 2024
[465] Scottish Government. 2022. Fish and fisheries research to inform ScotMER evidence gaps and future strategic research in the UK: review. Available at: https://www.gov.scot/publications/review-fish-fisheries-research-inform-scotmer-evidence-gaps-future-strategic-research-uk/pages/10/ Accessed October 2024
[466] JNCC. JNCC - Marine Noise Registry: Welcome. Available at: https://mnr.jncc.gov.uk/ Accessed October 2024
[467] JNCC, 2023. UK Marine Noise Registry Data, 2021. Available at: https://hub.jncc.gov.uk/assets/82710732-43c2-4c5e-9f14-b4dfe07c73cc Accessed 24/06/2024
[468] The number of days within a set period of time (January to December 2021) that impulsive noise has been generated within each UK Oil and Gas licensing block.

areas such as the north-east, and south-west areas of the UK[469]. As shown in Figure 44, the main sources of underwater noise in the Plan areas consist of (in order of abundance) seismic surveys, sub-bottom profiling, piling, and explosive surveys. This is similar to 2018 (the earliest year that data is available for)[470]. Hotspots within the Plan areas where there is relatively high noise level include explosives that are eastward from Cromer, piling along the coast from Felixstowe to Lowestoft and the Humber due to offshore wind construction.

The latest assessment to determine if GES has been achieved for underwater noise in the UK was in 2018 and concluded that the achievement of GES was uncertain and required increased monitoring. Increased monitoring has since been achieved through the implementation of the Marine Noise Registry (MNR), however there has been no update in regard to an overall GES assessment[471].

[469] JNCC, 2023. UK Marine Noise Registry Data, 2021. Available at: https://hub.jncc.gov.uk/assets/82710732-43c2-4c5e-9f14-b4dfe07c73cc Accessed October 2024
[470] JNCC. UK Marine Noise Registry: 2018 outputs. Available at: https://hub.jncc.gov.uk/assets/3fd8fd3b-2e87-43fe-ae6f-c6887ada3541 Accessed October 2024
[471] Defra. 2019. Marine Strategy Part One: UK updated assessment and Good Environmental Status. Available at: https://assets.publishing.service.gov.uk/media/5f6c8369d3bf7f7238f23151/marine-strategy-part1-october19.pdf Accessed October 2024

Figure 43: Marine underwater noise in total pulse days per block.

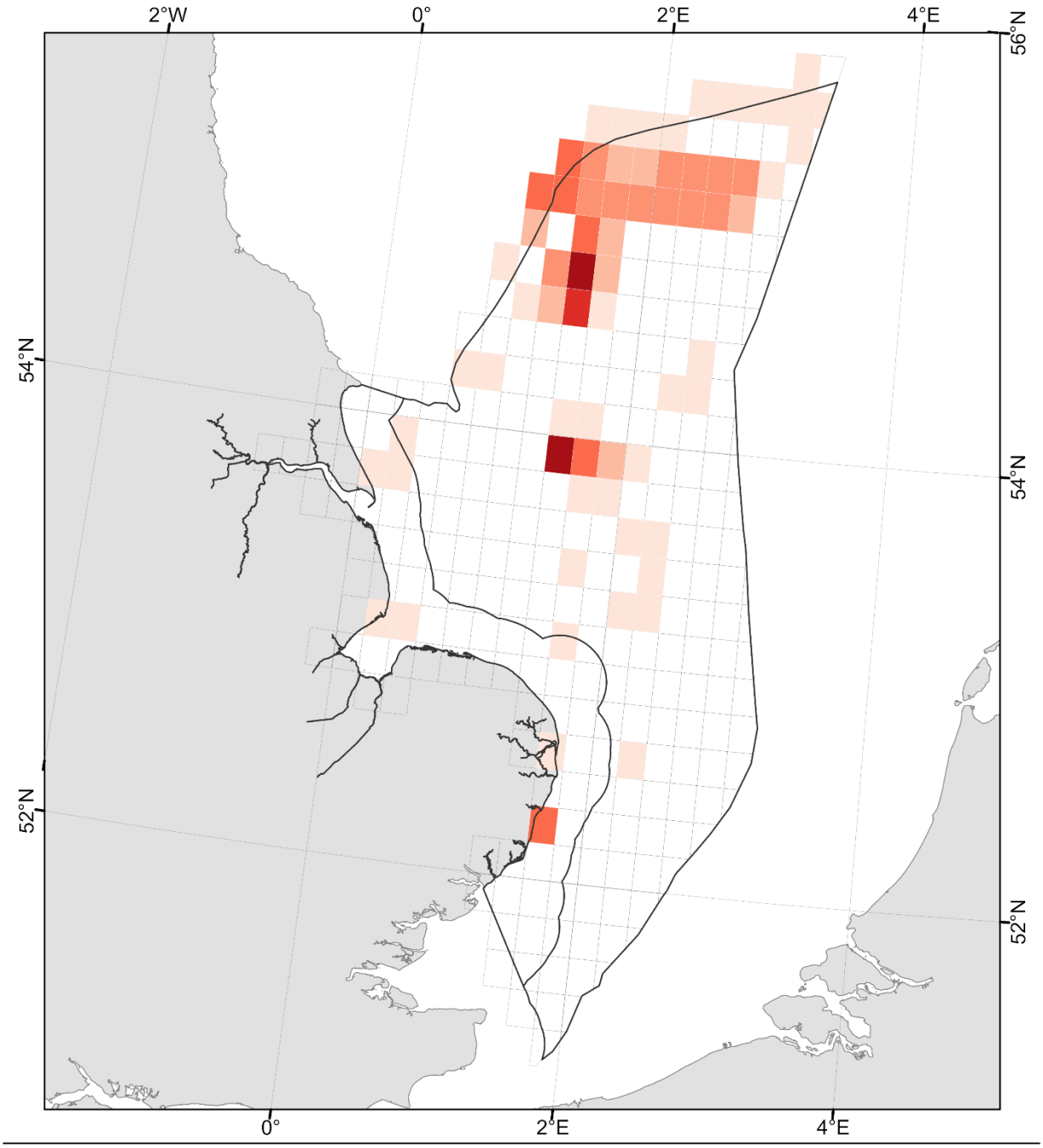

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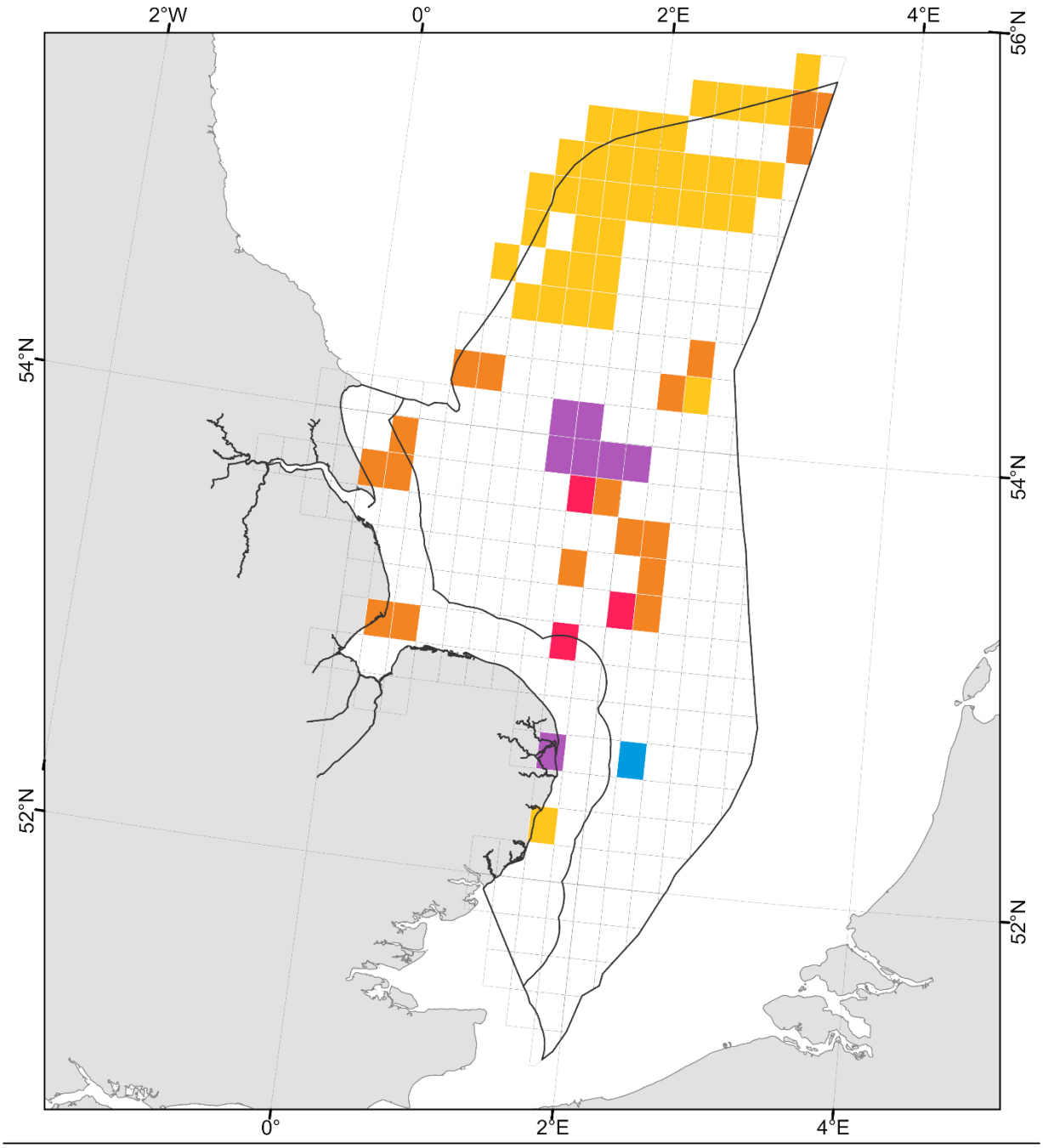
Figure 44: Type of underwater noise produced in blocks.



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28.3 PESTLE analysis

The key drivers expected to influence underwater noise in the Plan areas are political, economic and legal drivers. Whilst growing levels of development in the marine environment may lead to increased levels of underwater noise, technological developments and legal and environmental drivers will act to limit and reduce these pressures. These are listed in Table 32 below. In all cases the production of underwater noise is not positive on the marine environment. In this table '+' indicates having a positive impact on the Plan areas and '-' indicates having a negative impact.

Table 32: PESTLE analysis for the noise sector.

Driver	Details	Implications	Impact (+ / - / Variable)
Political	The strategy to achieve GES for Underwater Noise is set out in the Marine Strategy Part One[OBJ]. This requires that impulsive sounds should be managed to a level that does not have adverse effects on marine ecosystems and animals at the population level.	Continued recording of underwater noise through the MNR and the inclusion of underwater noise in marine licence applications. Additionally, more resource may be directed towards researching the effect of underwater noise on species.	+
Economic	Many commercial activities contribute to producing underwater noise, these activities are likely to increase in spatial scale and intensity in the future due to increased use of the marine environment. These include shipping (Section 087[OBJ]), and the construction and operation of renewable energy.	Increase in the intensity of underwater noise in the marine environment could lead to negative environmental impacts on marine species. As new activities occur, the spatial occurrence of underwater noise in the Plan areas will also change.	-
Social	No significant drivers identified		
Technological	Technological advancements related to developing new technologies to reduce underwater noise would benefit noise sensitive species, this could include more effective bubble curtains, acoustic deterrent devices, and piling methods.	Development and usage of technologies to reduce underwater noise will reduce negative impacts on the marine species in the Plan areas from activities such as construction and seismic surveys. This could change where and when these activities are permitted to take place.	+

Driver	Details	Implications	Impact (+ / - / Variable)
Legal	European Protected Species (EPS) licences are required if there is the potential for underwater noise to negatively impact an EPS[472]. This requirement is expected to remain in place into the future and dictates what mitigation is required when producing underwater noise.	Continued deployment of mitigation which mainly includes using both visual, and passive acoustic monitoring, adapting piling methods where possible, and using soft-starts (gradually ramping up noise levels until full operating power is reached). These will occur in the Plan areas where needed, such as at coastal and offshore construction sites.	-
	Marine licensing under the Marine and Coastal Access Act (2009) requires many activities to obtain a marine licence.	The marine licensing system is well established. Potential impacts of underwater noise are considered in a licence determination, where relevant, and conditions can be attached, if required to manage potential impacts.	Variable
Environmental	There is a need for management of underwater noise within MPAs and HPMAs. This includes management by the MMO's Strategic Renewables Unit (SRU) which encompasses the Southern North Sea SAC designated for noise sensitive Harbour porpoise[473].	This could result in increased restrictions on noise in the marine environment, to achieve conservation objectives for protected features, including protecting noise sensitive Harbour porpoise, a designated feature of the Southern North Sea SAC.	-
	There is an increasing need to assess the cumulative effect of underwater noise as development in the sea increases. Steps to address this includes the SRU[474] which brings together developers in a co-ordination forum to discuss when and where activities are likely to breach thresholds and therefore require management.	The SRU[475] covers the Southern North Sea and thus the activities that will occur in the Plan areas. This will help to manage underwater noise levels from exceeding acceptable thresholds.	-

[472] Species include all cetaceans, seals, turtles, and Atlantic sturgeon.
[473] UK Government. 2024. Strategic Renewables Unit – Update. Available at: https://marinedevelopments.blog.gov.uk/2024/08/30/strategic-renewables-unit-update/ Accessed October 2024
[474] UK Government. 2024. Strategic Renewables Unit – Update. Available at: https://marinedevelopments.blog.gov.uk/2024/08/30/strategic-renewables-unit-update/ Accessed October 2024
[475] UK Government. 2024. Strategic Renewables Unit – Update. Available at: https://marinedevelopments.blog.gov.uk/2024/08/30/strategic-renewables-unit-update/ Accessed October 2024

28.4 Future scenarios

6 year projection

Underwater noise will continue to be produced in the Plan areas through many of the same activities that currently occur in the region, this includes the use of multibeam echosounder, sub-bottom profiling, and undersea explosives within geophysical surveys (high confidence). The MNR presents proposed activities that will generate underwater noise, which in the Plan areas include sub-bottom profiling seaward from Skegness and Great Yarmouth, and use of multibeam-echosounder north-east from Felixstowe[476]. **The date and intensity of these activities is however unknown,** although it is reasonable to assume this will be within the next six years given the relatively short period of time it takes to complete geophysical or explosive surveys.

Underwater noise will continue to be produced at operational windfarms (see Figure 21), **aggregate extraction sites** (see Figure 16) and **in navigation** channels (see Figure 19) in the Plan areas which will therefore **result in similar spatial areas compared to current activities**.

In addition, **new sources of underwater noise within the next 6 years are highly likely** to include **offshore windfarms undergoing construction** and during port development works (Immingham and Grimsby), although the nature (sound level) of the underwater noise that could be produced is unknown. There is therefore low certainty of the impacts the underwater noise produced across the next 6 years, will have on the species present in the Plan areas.

6 to 20 year projection

Ongoing activities and the future development of the other marine industries will continue to indicate where underwater noise could be produced in the Plan areas. The **development of renewable energy infrastructure will likely be a key contributor** (moderate confidence) of underwater noise over the next 6 to 20 years given the long timescales taken to progressing from site development through to site operation, and the long-term trend of increasing the installation of offshore wind infrastructure in the Plan areas. Alongside this, offshore windfarms in the Plan areas are predicted to be in **decommissioning or repowering by early 2040[477], adding further noise to the area** (moderate confidence). **Underwater noise will continue to be produced by shipping** in the Plan areas. It is highly **likely for this to be in the same spatial location** as the current activity although could also include other areas as vessel traffic is certain to increase in the Plan areas across the next 20 years (high confidence). There is low confidence on where additional underwater noise from shipping could occur, as well as a low confidence as to the noise level from vessel movements as although traffic is likely to increase, technological advances could see vessels become quieter.

[476] JNCC. Marine Noise Register. Available at: https://mnr.jncc.gov.uk/public-app/activity-outputs Accessed October 2024.
[477] ORE Catapult. 2021. End-of-life planning in offshore wind. Available at: https://cms.ore.catapult.org.uk/wp-content/uploads/2021/04/End-of-Life-decision-planning-in-offshore-wind_FINAL_AS-1.pdf Accessed October 2024

Other sectors that will contribute to underwater noise in the next 20 years could include CCUS (Section 5) and Hydrogen (Section 9) as these sectors are expected to develop during the 6 to 20 year projection (moderate confidence) (see Figure 4 for the indicative location based on future CCUS leasing blocks).

As the monitoring of underwater noise is a key part of helping to achieve GES it is **reasonable to assume the MNR will continue to operate and the location and impact of underwater noise in the Plan areas will continue to be better understood** (moderate confidence). This will **include continued monitoring and management in the Southern North Sea SAC through the SRU** (high confidence). This could in turn help to resolve the evidence gap surrounding the impact of underwater noise on the ecological receptors in the Plan areas and therefore better safeguard the area from the negative impacts of underwater noise particularly as development increases in the future.

29 Seascape

29.1 Sector definition

There is no legal definition of seascape, but the European Landscape Convention (ELC) defines landscape as “an area, as perceived by people, whose character is the result of the action and interaction of natural and/or human factors”[478]. Seascapes have a view of the coast or seas and are important in reinforcing the sense of conserving nationally important coastal and marine spaces.

29.2 Historic trends and current activity

The ‘East Seascape Assessment’ undertaken by Natural England (2011)[479] and the ‘Seascape Character Assessment (SCA)’ undertaken by the MMO (2012)[480] provide the historic baseline for the Plan areas. In these assessments the Plan areas have been divided into 10 Marine Character Areas (MCAs), shown in Figure 45, representing 10 different seascapes. Most recently the report ‘Understanding Change in Seascape Character in the East Marine Plan Areas’ (2024)[481] undertaken by the MMO, updates this baseline to provide current characteristics of the MCAs.

Across these assessments the boundaries of the MCAs have not changed but location of activities within them has changed significantly.

The baseline and key changes to the characteristics of the MCAs illustrated in Figure 45 (based on the 2024 report – ‘Understanding Change in Seascape Character in the East Marine Plan Areas’) are listed below, and can be viewed on the MMO’s Explore Marine Plans[482].

[478] Her Majesty Government. UK Marine Policy Statement. 2011. Available at: https://assets.publishing.service.gov.uk/media/5a795700ed915d042206795b/pb3654-marine-policy-statement-110316.pdf Accessed October 2024
[479] Natural England. 2012. Seascape Characterisation around the English Coast (Marine Plan Areas 3 and 4 and Part of Area 6 Pilot Study) (NECR106). Available at: https://publications.naturalengland.org.uk/publication/2736726 Accessed October 2024.
[480] MMO. 2012. Seascape character area assessment East Inshore and East Offshore marine plan areas. Available at: https://assets.publishing.service.gov.uk/Government/uploads/system/uploads/attachment_data/file/312481/east_seascape.pdf Accessed 24/06/2024
[481] MMO. 2024. Understanding Change in Seascape Character in the East Marine Plan Areas (MMO1369). in press.
[482] MMO. 2024. Seascape assessment for the South marine plan areas (MMO 1037). Available at: https://www.gov.uk/Government/publications/seascape-assessment-for-the-south-marine-plan-areas-mmo-1037 Accessed October 2024

MCA 1 Dogger Bank

- Baseline:
  - Expansive open waters with few surface features.
  - Widespread sand banks.
- Key changes:
  - Dogger bank windfarm is currently under construction and once finished will add approximately 277 turbines to offshore views[483].
  - Prominent decommissioned activity of offshore oil and gas infrastructure.
  - The 2024 change to fishing regulation banning bottom trawling in MPAs (including within Dogger Bank MPA) sees a reduction in fishing activity.

MCA 2 Dogger Deep Water Channel

- Baseline:
  - Outer Silver Pit – a deep channel that intersects Dogger Bank, once a lake supplied by glacial waters.
  - Significant historic fishery activity including beam trawling.
- Key changes:
  - Major shift to transition offshore oil and gas infrastructure to support renewable energy generation. This is evidenced by the consent for Hornsea 4 being designated in 2024, and the carbon storage licences awarded (see Figure 4) in the MCA.

MCA 3 East Midlands Offshore Gas Fields

- Baseline:
  - Widespread sandbanks supporting fish spawning and nursery grounds.
  - Numerous offshore gas and aggregate extraction infrastructure.
- Key changes:
  - Prominent decommissioned activity of offshore oil and gas infrastructure and transition towards renewable energy, including the construction of Triton Knoll, Inner Dowsing, and Dudgeon Offshore Wind Farms in the MCA and designation of carbon storage licence awards (see Figure 4).

MCA 4 East Anglian Shipping Waters

- Baseline:
  - Designated shipping route.
  - Extensive offshore commercial activities including offshore wind developments and gas fields.
- Key changes:
  - Continue development of offshore wind infrastructure.
- Installation of subsea cables to strength electricity transmission to Europe, specifically the installation and landing sites of the LionLink[484] and Sea Link[485].

[483] Dogger Bank Wind Farm. 2023. World's largest offshore wind farm produces power for the first time. Available at: https://doggerbank.com/construction/worlds-largest-offshore-wind-farm-produces-power-for-the-first-time/ Accessed October 2024

[484] National Grid. 20224. LionLink Community Newsletter. Available at: https://www.nationalgrid.com/document/151266/download Accessed 08/08/2024.

[485] National Grid. SeaLink. Available at: https://www.nationalgrid.com/the-great-grid-upgrade/sea-link Accessed October 2024.

MCA 5 Holderness Coastal Waters

- Baseline:
  - Extensive soft tall cliffs (undergoing erosion) which provide roosting and feeding habitats for seabirds and are highly susceptible to erosion.
  - Highly used by the tourism, fishing, defence, and oil and gas sectors.
- Key changes:
  - Increased tourism along the coastal edge including increase in holiday parks and beach use, though these are at continued risk of erosion (including risk to beaches, car parks, coastal paths).
  - Continued development of offshore wind Hornsea Project and Dogger Bank wind farms are in view from the MCA. Impact of landfall from subsea cables will also cause changes to the seascape.
  - The 2024 temporary closure of the sandeel fishery aimed to boost sandeel population in the areas therefore increasing seabird usage.

MCA 6 Humber Waters

- Baseline:
  - The UK's second largest estuary containing expansive intertidal mud and sand flats, and saltmarsh.
  - Hosts UK's largest port complex.
  - Internationally important bird nesting grounds and important port complex with up to 40,000 ship movements per year[486].
- Key changes:
  - Designation of the Lincolnshire Coronation Coast National Nature Reserve (NNR) extends the existing NNR of Donna Nook and Saltfleetby to Theddlethorpe Dune which is hoped to benefit the habitats and species in the MCA[487].
  - Several habitat creation projects are changing the view and character of the MCA, including mudflats, saltmarsh and wet grassland creation in the Humber[488].
  - Expansion of commercial infrastructure in the Humber including port infrastructure at Grimsby and Hull and offshore wind at Out Newton and Bishopthorpe.
  - Continued use of the area for nesting and feeding seabirds of international importance.

MCA 7 East Midlands Coastal Waters

- Baseline:
  - Extensive sand flats, saltmarsh, dune systems, and grazing marsh.
  - Numerous commercial offshore activities, including dredging, influence benthic environments.

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[486] MMO. 2012. Seascape character area assessment East Inshore and East Offshore marine plan areas. Available at: https://assets.publishing.service.gov.uk/Government/uploads/system/uploads/attachment_data/file/312481/east_seascape.pdf Accessed October 2024.

[487] Natural England. 2023. Lincolnshire Coronation Coast National Nature Reserve. Available at: https://www.gov.uk/Government/publications/lincolnshire-coronation-coast-national-nature-reserve Accessed October 2024.

[488] Natural England. 2018. Humber habitat creation scheme plans on show. Available at: https://www.gov.uk/Government/news/humber-habitat-creation-scheme-plans-on-show Accessed October 2024.

- Key changes:
  Increased focus on nature recovery and the use of the area for education and non-damaging recreational activities, such as the newly constructed visitor centre at Cley Marshes.

MCA 8 The Wash

- Baseline:
  - Low lying coast containing intertidal sand banks, mudflats, saltmarsh and tidal creeks, including England's largest tidal embayment.
  - Extensive views from Hunstanton Cliffs, the Eastern Wash, Lincolnshire Wolds, and Carstone/Chalk escarpments.
  - Internationally important habitat designated as a European marine site supporting the largest number of migrating waterfowl in the UK.
- Key changes:
  - Continued offshore wind development at the coast edge including visible turbines at Red House wind farm, Dowsing and Race Bank wind farm.
  - Continued focus on conserving the area to maintain the importance of the MCA for migrating waterfowl across the UK.
  - Accretion of saltmarsh resulting in natural habitat creation.

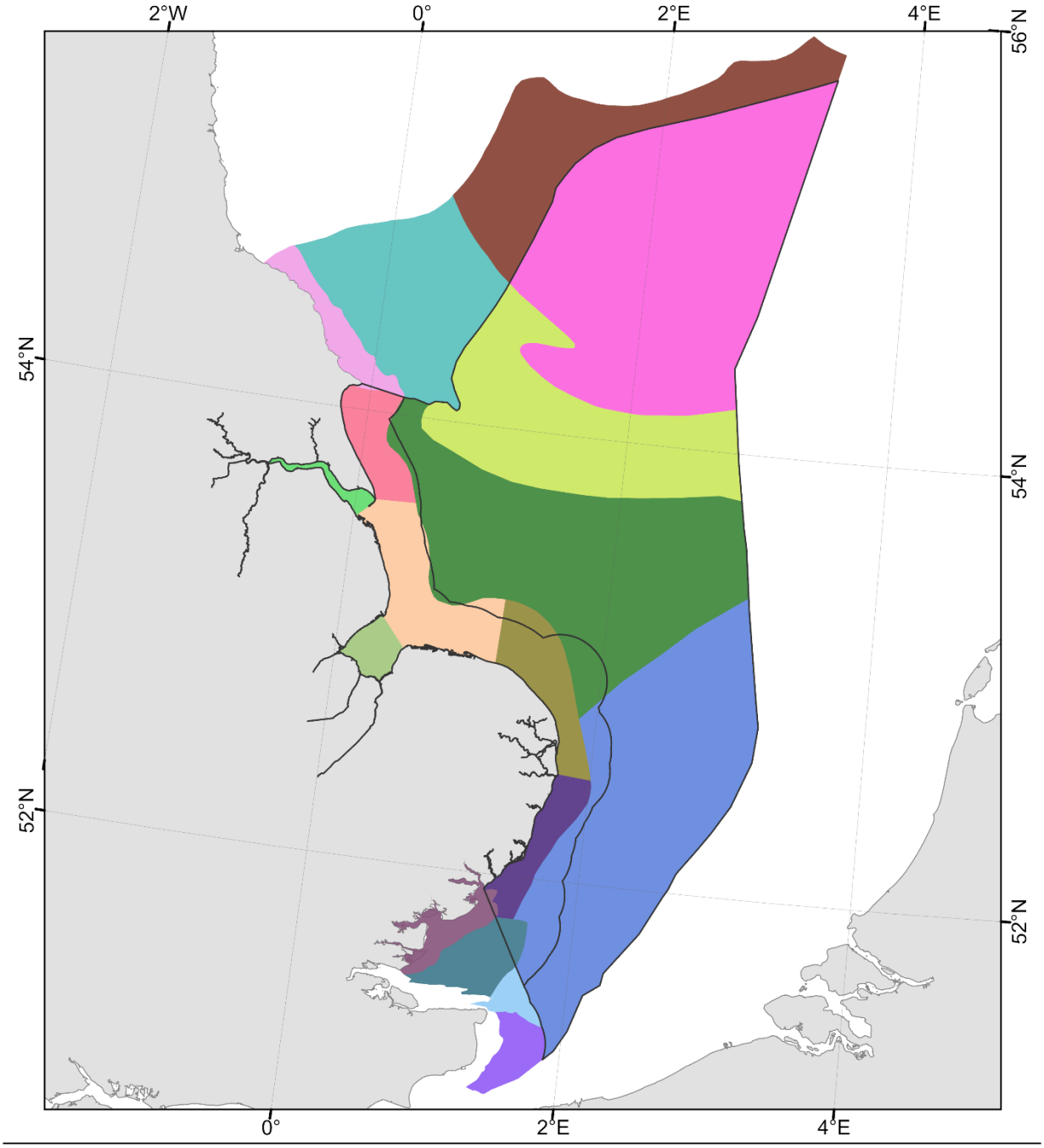
MCA 9 Norfolk Coastal Waters

- Baseline:
  - Extensive exposed sandy beaches and soft glacial cliffs undergoing erosion.
  - Extensive offshore chalk reefs.
  - Submerged gas pipelines and Bacton Gas refinery associated with North Sea gas.
  - Important area for marine mammals.
- Key changes:
  - Increasing development of coastal infrastructure to support the expansion of the CCUS and hydrogen sectors at Bacton and of port infrastructure at Great Yarmouth.
  - Continued erosion of soft cliffs leading to damage to coastal paths and roads, as well as loss of tourist hotspots.

MCA 10 Suffolk Coastal Waters

- Baseline:
  - Extensive saltmarsh, mudflat, soft cliffs, and sloping beaches.
  - Coastal features including Sizewell nuclear power stations and long-distance coastal footpaths.
- Key changes:
  - Increased commercial infrastructure is changing the views of the coastline, this includes the ongoing development of Sizewell C, development at Hamilton Dock in Lowestoft, and the development at the Port of Felixstowe.
  - Continued risk of coastal erosion causing loss of residential and holiday properties.

Figure 45: The seascape Marine Character Areas.



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29.3 PESTLE analysis

The key drivers expected to influence the seascape of the Plan areas include the environmental processes that occur in the Plan areas in addition to anthropogenic activity that alters the seascape from its natural state. These are listed in Table 33 below.

Table 33: PESTLE analysis for the seascape sector.

Driver	Details	Implications	Variable (+ / - / Variable)
Political	Increased development of offshore renewable energy infrastructure due to the target of reaching net zero by 2050 as set out in the Climate Change Act[489].	Increased views of industrial infrastructure from statutory designated landscapes and changing character of the Plan areas.	Variable
	Seascape has the potential to disrupt or enable national policy such as for offshore wind development.	Having the right activities in the right place are important considerations for maintaining seascape character particularly in designated landscape areas. Future policy could consider seascape issues and be specific to different spatial areas (e.g. inshore and offshore).	Variable
Economic	Increased commercial activity for economic gain including shipping, energy exploration, dredging, fishing, and tourism.	Increasing commercial activity could impact the views and character of the Plan areas including increasing the amount of commercial infrastructure seen from the coastline, and specifically adjacent to designated landscapes. Increased tourism could result in positive appreciation of the landscape.	Variable
Social	The population in England is projected to increase, with the East Midlands (encompassing the coastline in the Humber) projected to increase by the greatest amount (current projection is to 2028)[490]. The population in the East of England (encompassing the Norfolk coastline) is also projected to increase significantly by 2028.	Increased urbanisation due to the need for more domestic infrastructure such as homes, shops, and roads. Increased recreational use of the Plan areas by recreational vessels and holiday parks. Increased use of coast paths and cliffs causing erosion. Both an increase in infrastructure and recreation could lead to increased employment opportunities.	Variable

[489] UK Government. 2019. Climate Change Act 2008. Available at: https://www.legislation.gov.uk/ukpga/2008/27/section/1/2019-06-27 Accessed October 2024.
[490] Office for National Statistics. Available at: https://www.ons.gov.uk/peoplepopulationandcommunity/populationandmigration/populationprojections/bulletins/subnationalpopulationprojectionsforengland/2018based Accessed October 2024.

Driver	Details	Implications	Variable (+ / - / Variable)
	Increased recognition of sense of place, and health and wellbeing benefits of outdoor activities and connections with seascape. It is therefore important to understand people's perceptions of the local environment and how this could change with changes to seascape.	Impacts of a changing seascape can be both positive and negative including an increased appreciation of cultural heritage or loss of personal connection with places. This could lead to loss of certain aspects of seascape, or increased designation of landscapes through NNRs or AONBs for future generations.	Variable
Technological	No significant drivers identified.		
Legal	No significant drivers identified.		
Environmental	Coastal processes that impact the views and character in the Plan areas (see Section 22.3) include climate change, which particularly impacts low lying areas in addition to important ecological features of designated sites (see Section 26).	Changes to the character and views of designated sites in the Plan areas, caused by natural environmental variability and anthropogenic climate change, include damage to heritage assets, erosion of cliffs and coastal paths due to more frequent extreme weather events, and alterations to species and habitats that may impact the designated status of these sites.	-
	The important qualities and characteristics of landscapes, including rare habitats, features, and species that provide ecosystem services, help define how and why landscapes are designated, highlighting which landscapes are viewed as more important.	There is a high abundance of special features and designated sites in the Plan areas (see Section 26). These designations will influence how the seascape in the Plan areas is managed.	Variable

29.4 Future scenarios

6 year projection

Across the next 6 years **urbanisation of the coastline of the Plan areas will continue** to occur in order to meet the changing needs of coastal industries and communities (high confidence). This will include **expansion of port infrastructure to serve sectors such as: the offshore wind and aggregate industries**; the **development of Sizewell C to support the nuclear industry**; **and development of amenities such as caravan parks, shops, and beaches to support the tourism industry** (high confidence). This development will lead to a variety of socio-economic impacts including increased job opportunities in the expanding industries, particularly to support the renewable energy sector, as well as changes to the seascape that communities are likely to have differing views about.

Increased industrial infrastructure will also occur in the offshore Plan area including the installation of offshore wind turbines and other assets to expand **offshore renewable energy** (high confidence). Figure 21 in Section 16 illustrates where industrial change could occur from the increased installation of offshore wind turbines. The further offshore that infrastructure is installed, the less visible it will be from the coastline and to the coastal population. How these changes to seascape are viewed is subjective and vary with an individual's perception.

Across the next 6 years **ecological change will also occur due to coastal processes** such as erosion (see Figure 28, Section 22) and **environmental restoration** (see Figure 31, Section 23) which have the potential to cause changes to seascape (moderate confidence).

Overal, there **is likely to be subtle change in the physical characteristics and views of the MCAs** across the next 6 years as a result of the drivers listed in Table 33 (moderate confidence). It is however **unlikely that the physical boundaries and overall classification of the MCAs in the Plan areas will change** (moderate confidence). MCAs will continue to be used as a baseline to inform impact assessments as to the impact of a development on the physical characteristics of an area.

6 to 20 year projection

There is **greater certainty on what the physical change to seascape could be than the ecological aspects,** as the location of increased development is typically better understood and is likely to include the result of increased activity of tourism, ports, and offshore renewables, as well as other sectors (moderate confidence). **Popular tourist towns may expand** and encompass more of the coastal landscape (moderate confidence), **vessel traffic may increase** (moderate confidence), **offshore wind turbine installation will increase** (high confidence), and terrestrial developments linked to submarine cabling will increase (high confidence). The impact from **less established industries such as CCUS and hydrogen will likely be seen to the offshore seascape** in the next 6 to 20 years (moderate confidence). Decommissioning of oil and gas infrastructure may reduce the impact of this industry on the seascape (moderate confidence).

It is anticipated that **there will be significant change to the MCAs** in the Plan areas across the next 6 to 20 years (moderate confidence, as it is highly likely for change to occur, in the ways stated above, though there is some uncertainty on the nature of the changes further into the future).

All of these potential changes will impact how the seascape is valued and appreciated by society, however **it is not possible to accurately predict how societal views will evolve** across the next 6 to 20 years given changes to **seascape is subjective** and based on the priorities of different people.

30 Water quality (ecological and chemical)

30.1 Sector definition

Water quality is defined as the ecological and chemical characteristics of a water body. Under the Water Environment (Water Framework Directive) (England and Wales) Regulations 2017 (known as the Water Framework Regulations), the ecological status of surface waters is classified using information on the biological (e.g. fish, benthic invertebrates, phytoplankton, angiosperms and macroalgae), physico-chemical (e.g. dissolved oxygen (DO) and salinity) and hydromorphological (e.g. hydrological regime) quality of the body of water, as well as several specific pollutants (e.g. copper and zinc)[491]. Compliance with chemical status objectives is assessed in relation to environmental quality standards (EQS) for a specified list of 'priority' and 'priority hazardous' substances.

Water quality is fundamental to the health of the marine environment, and poor water quality can have significant impacts on biodiversity and human health.

30.2 Historic trends and current activity

Water quality has generally improved in the UK (including the Plan areas) over recent decades, largely due to increased environmental legislation and improved regulation. However, more recently, the progress in improving water quality has slowed. Overall water quality is now remaining stable, due mainly to ongoing pollution to estuarine and coastal waters, and growing pressure on the water environment due to population growth, industrial development and climate change.

Water quality standards and objectives are implemented through a range of legislation in England including the Water Environment Regulations[492]. The overall objective is to achieve GES[493] in all inland, transitional, coastal and ground waters by 2027, unless alternative objectives are set and there are appropriate reasons for time limited derogation. River Basin Management Plans (RBMP) set out programmes of measures through which compliance with Water Framework Directive (WFD) objectives will be achieved over a number of regional areas. There are two RBMPs which cover the Plan areas: the Anglian RBMP; and the Humber RBMP[494].

[491] The Water Environment (Water Framework Directive) (England and Wales) Regulations 2017. Available at: https://www.legislation.gov.uk/uksi/2017/407/contents Accessed October 2024.
[492] The Water Environment (Water Framework Directive) (England and Wales) Regulations 2017. Available at: https://www.legislation.gov.uk/uksi/2017/407/contents Accessed October 2024.
[493] The WFD divides rivers, lakes, lagoons, estuaries, coastal waters (out to one nautical mile from the low water mark), man-made docks and canals into a series of discrete surface water bodies. It sets ecological as well as chemical targets (objectives) for each surface water body. For a surface water body to be at overall GS, the water body must be achieving good ecological status and good chemical status. Ecological status is measured on a scale of high, good, moderate, poor or bad, while chemical status is measured as good or fail (i.e., failing to achieve good).
[494] Environment Agency. Explore Catchment Data. Available at: https://environment.data.gov.uk/catchment-planning Accessed October 2024

The location of coastal and transitional/estuarine water bodies which fall within the Plan areas, along with their ecological and chemical status as published in 2019, are presented in Figure 46 and Figure 47. There are 15 coastal water bodies and 25 transitional or estuarine water bodies within the Plan areas. The majority of these have a moderate ecological status or potential (87% and 80%, respectively). A small proportion of coastal and transitional/estuarine waterbodies are classified as good ecological status/potential (13% and 8%, respectively), all of which are lagoons or marshland. No coastal waterbodies are classified as poor or bad, whilst one transitional/estuarine water body (4%) is classified as having a poor ecological status/potential and two transitional/estuarine water bodies (8%) have an ecological status/potential of bad. The reason for these classifications is due to the status of phytoplankton (i.e., eutrophication) which is likely related to nutrient and organic enrichment from sewage discharges and/or agricultural run-off.

All waterbodies in the Plan areas are currently failing with respect to chemical status (this is currently the case for all water bodies in England). This is because in 2019, new assessments for ubiquitous, persistent, bioaccumulative, toxic substances (uPBTs) were included, as well as new standards, improved techniques and methods. This resulted in 0% of surface water bodies meeting the criteria for achieving good chemical status in 2019 in England, compared to 97% in 2016[495].

[495] UK Government. 2024. State of the water environment indicator B3: supporting evidence. Available at: https://www.gov.uk/Government/publications/state-of-the-water-environment-indicator-b3-supporting-evidence/state-of-the-water-environment-indicator-b3-supporting-evidence Accessed October 2024

Figure 46: Ecological status of water bodies.

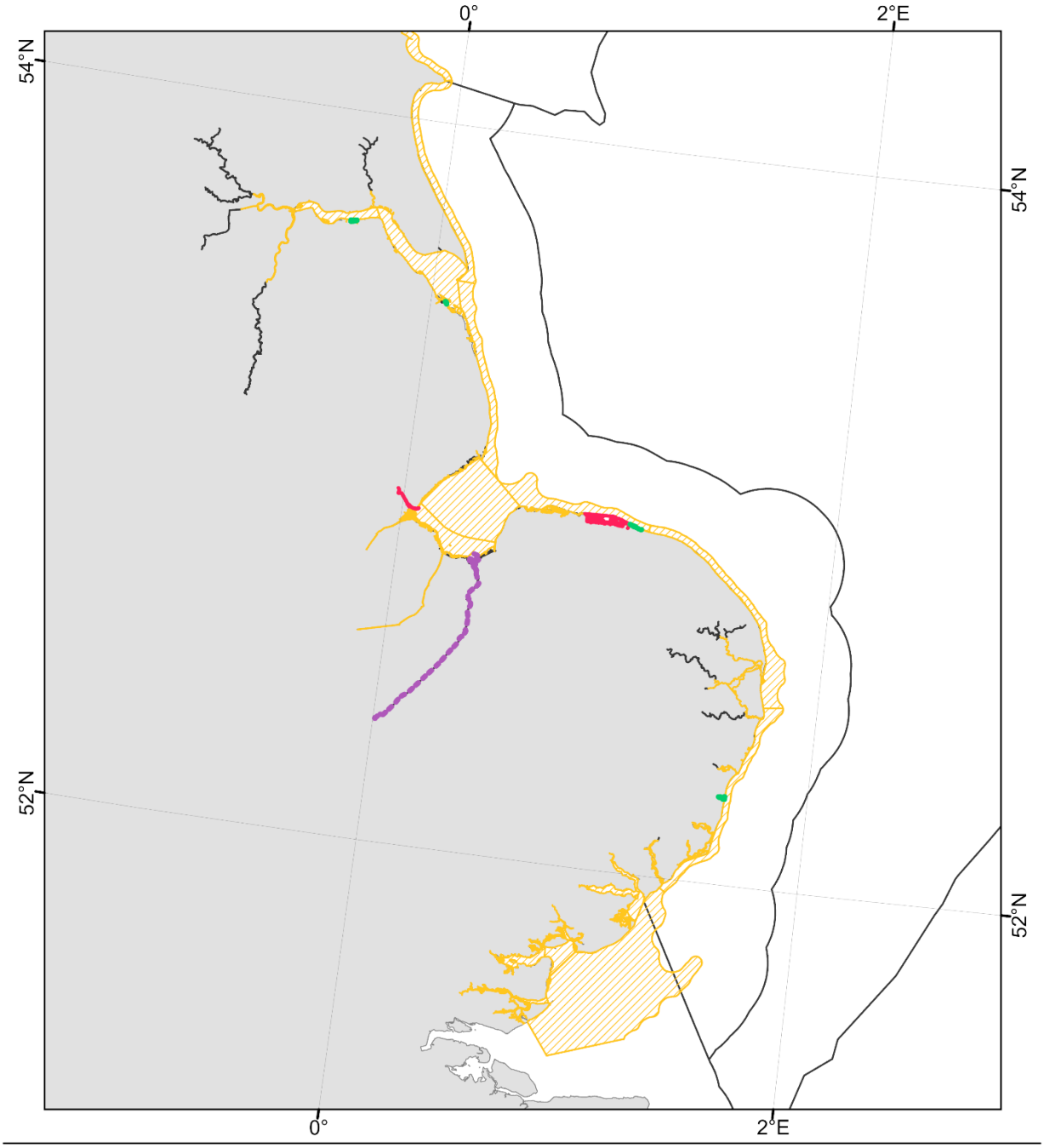

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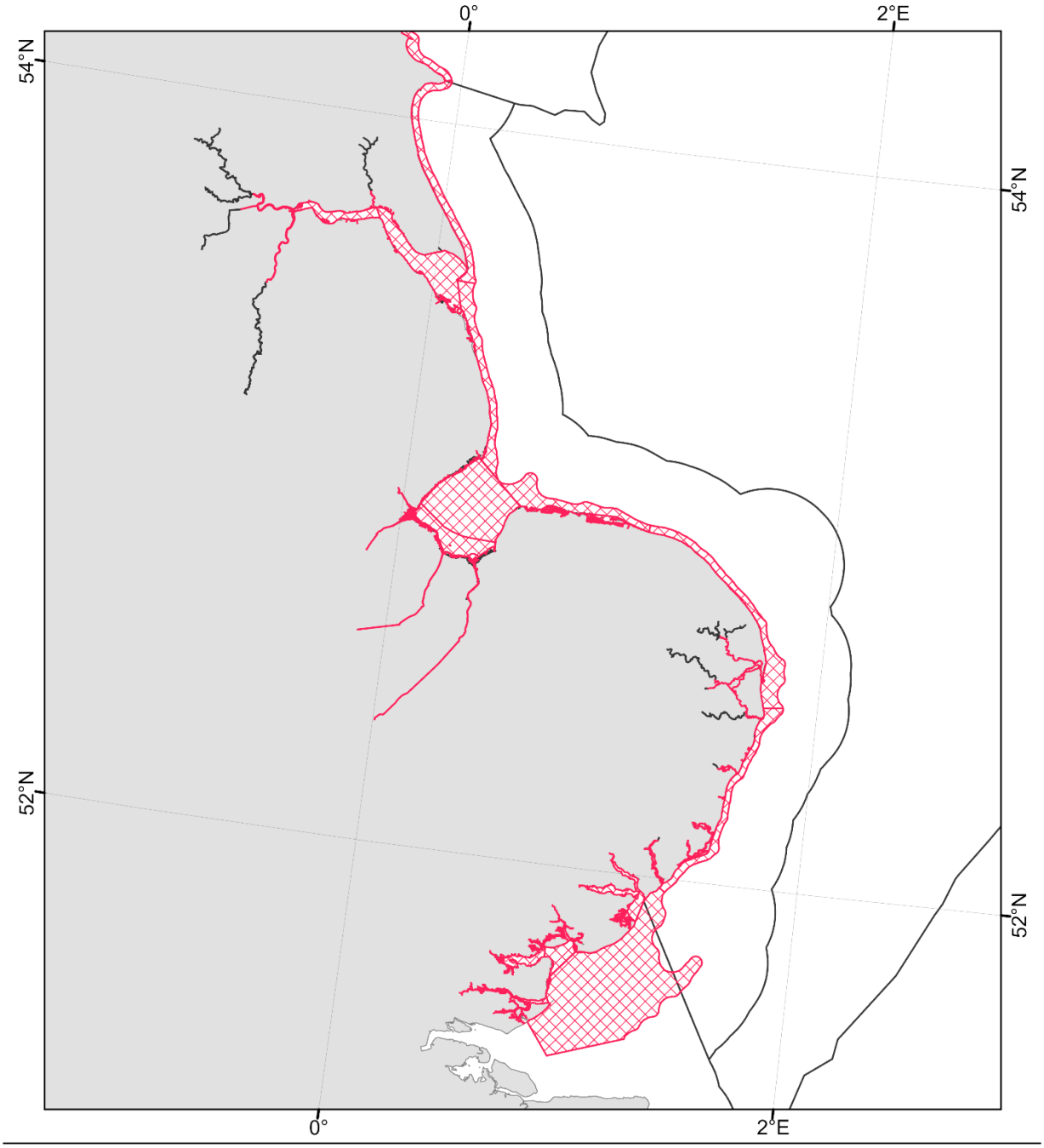
Figure 47: Chemical status of water bodies.



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Bathing waters in the UK are classified as excellent, good, sufficient or poor according to the levels of certain types of bacteria (intestinal enterococci and *Escherichia coli*) in samples obtained during the bathing season (May to September).

In 2023, there were 41 coastal bathing waters designated in the Plan areas, 93% of which complied with the minimum bathing water standard (i.e., sufficient or better)[496]. A total of 24 (59%) were classified as excellent, 12 (29%) were classified as good, 2 (5%) were classified as sufficient (Figure 48). There were 3 coastal bathing waters classified as poor in 2023 (7%), namely Heacham and the River Deben Estuary in East Anglia, and Bridlington South Beach in Yorkshire. Potential reasons for this include faecal pollution from seabirds, agricultural run-off, dogs, and humans (i.e., sewage discharges).

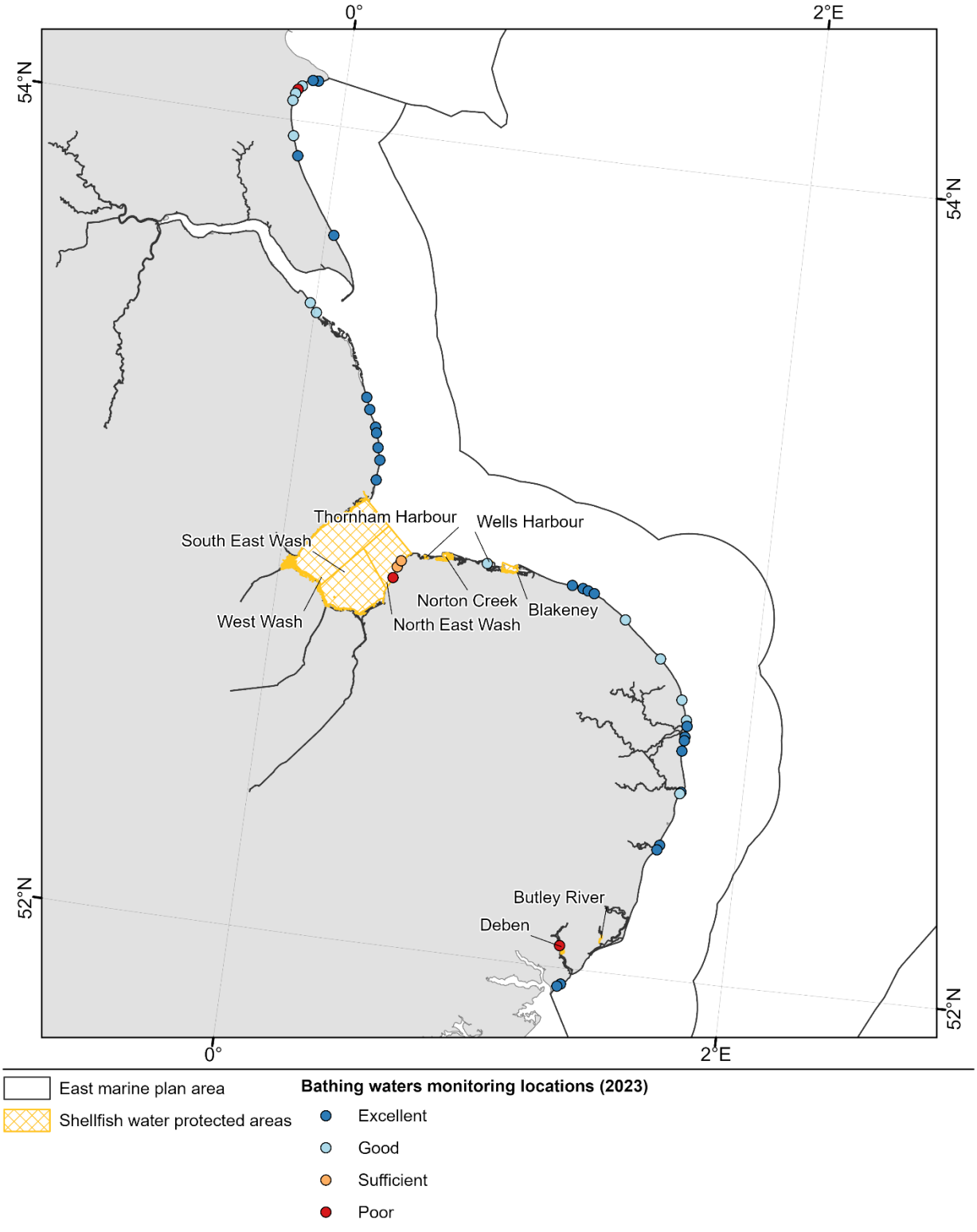
The Shellfish Water Protected Areas (England and Wales) Directions 2016 require the Environment Agency (in England) to endeavour to observe a microbial standard in all 'shellfish water protected areas'. The microbial standard is 300 or fewer colony forming units of *E. coli* per 100 ml of shellfish flesh and intravalvular liquid.

There are nine designated Shellfish Water Protected Areas in the Plan areas (see Figure 48)[497]. These Shellfish Water Protected Areas are concentrated around The Wash. Within these areas are bivalve mollusc (shellfish) classification zones which are classified according to the extent of contamination shown by monitoring of *E. coli* in shellfish flesh according to health standards set out in Annex III of assimilated Regulation (EC) 853/2004 and Articles 53, 54 and 55 of assimilated Regulation (EU) 2019/627. Treatment processes before human consumption are stipulated according to the classification status of the area. Within the Plan areas, there are 29 shellfish classification zones, 97% of which are classified as Class B. This means molluscs can be sold for human consumption after purification in an approved plant, or after re-laying in an approved Class A re-laying area, or after an EC-approved heat treatment process. One area is classified as Class A meaning shellfish can be harvested for direct human consumption.

Phytoplankton and marine biotoxins associated with harmful algal blooms (HABs) are also monitored within Shellfish Water Protected Areas and production areas. Monitoring in 2024 within the Plan areas showed concentrations of biotoxins were either low or not detected[498].

[496] Environment Agency. Swimfo: Find a bathing water. Available at: https://environment.data.gov.uk/bwq/profiles/ Accessed October 2024.
[497] UK Government. 2022. List of shellfish water protected areas in England. Available at: https://www.gov.uk/Government/publications/water-framework-directive-shellfish-protected-areas/list-of-shellfish-water-protected-areas-in-england Accessed October 2024.
[498] Cefas. Harmful Algal Blooms (Habs) Surveillance Programmes and Monitoring. Available at: https://www.cefas.co.uk/data-and-publications/habs/ Accessed October 2024.

Figure 48: Bathing and shellfish water classifications in 2023.



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30.3 PESTLE analysis

The key drivers expected to influence water quality in the Plan areas are legal drivers as they dictate that activities that should be undertaken to achieve the required water quality standards. These are listed in Table 34 below.

Table 34: PESTLE analysis for the water quality sector.

Driver	Details	Implications	Impact (+ / - / Variable)
Political	High-level vision for clean, healthy, safe, productive and biologically diverse oceans and seas as set out in the UK MPS[499] (HM Government, 2011).	Improved/maintained water quality and improvement in management practices.	+
	Following the UK's General Election in July 2024, the new UK Government has pledged to put failing water companies under special measures to clean up riverine and coastal waters. It plans to give regulators new powers to block the payment of bonuses to executives of water companies that pollute waterways and bring criminal charges against persistent law breakers. The UK Government also plans to impose automatic and severe fines for wrongdoing and ensure independent monitoring of sewage discharges to the rivers and seas. See section 17.	Improved/maintained water quality and improvement in management practices. Some uncertainty given policies are yet to be set out in full.	Variable
Economic	High cost and lack of resources to upgrade sewerage system, reduce discharges from CSOs, and improve wastewater treatment systems (see Section 17).	Increased pressure on sewage and treatment works and reduced water quality.	-
Social	Population growth and thus increase in housing developments.	Increased pressure on sewage and treatment works and reduced water quality.	-
	Use of coastal waters for recreation and wider social demand to improve environmental standards. Environmental charities and activist groups campaigning for cleaner waters and reduced sewage discharges.	Increased demand for clean bathing waters.	+

[499] Her Majesty Government. UK Marine Policy Statement. 2011. Available at: https://assets.publishing.service.gov.uk/media/5a795700ed915d042206795b/pb3654-marine-policy-statement-110316.pdf Accessed October 2024

Driver	Details	Implications	Impact (+ / - / Variable)
Technological	Development of technology to meet new and revised standards of wastewater treatment and measures to reduce nutrient load from diffuse sources.	Improved/maintained water quality and improvement in management practices.	+
	Practical difficulties associated with improving the UK's antiquated sewerage system and wastewater treatment which will involve increasing storage capacity at sewage treatment works, replacing and repairing very old pipes and outfalls, and upgrading above ground flood water transport.	Increased pressure on sewage and treatment works and reduced water quality.	-
Legal	The Water Framework Regulations set out a requirement in the medium term to achieve good ecological and chemical status in surface and groundwater water bodies by (at least) 2027.	Improved/maintained water quality and improvement in management practices.	+
	The Bathing Water Regulations set out water quality standards to protect water quality at bathing waters throughout the bathing season (May to September).	Improved/maintained water quality and improvement in management practices.	+
	The Shellfish Water Protected Areas Directions requires microbial standards to be observed.	Improved/maintained water quality and improvement in management practices.	+
Environmental	Industry and agricultural growth resulting in increased discharges to the marine environment.	Increased pressure on sewage and treatment works and reduced water quality.	-
	Climate change could lead to increased storm frequency and rainfall, which in turn could lead to increased agricultural run-off containing pollutants such as pesticides and organic waste, eutrophication (which could be exacerbated by increased sea temperatures) and CSO discharges to the marine environment. Sea level rise could also influence wastewater discharge points.	Increased pressure on sewage and treatment works and reduced water quality.	-

30.4 Future scenarios

6 year projection

Over the next six years, it is assumed that political, legal and social drivers will act to increase efforts **to improve, or at least maintain, water quality**. This may improve water quality within the Plan areas, particularly microbiological concentrations within bathing waters (moderate confidence). However, at this stage, there is **uncertainty as to how these policies and plans will be implemented, whether funding and resources are available** to implement them, and how effective they will be in improving water quality.

Efforts to improve water quality and limit discharges of sewage to coastal waters in the short term **may be undermined by existing inadequacies in the sewerage system** (moderate confidence). It is considered that the high cost and practical challenges associated with upgrading the UK's antiquated sewerage system will offset any progress to improve water quality. The frequency of extreme weather and heavy rainfall events associated with climate change is also likely to increase. This **may cause temporary reductions in water quality through increased rates of run-off and CSO discharges.**

Overall, it is considered likely that **water quality within the Plan areas will be maintained** over the next six years based on the existing trend observed in recent years (moderate confidence).

6 to 20 year projection

Over the next 20 years**, water quality will continue to be influenced by natural and human-induced variability, ongoing cyclical patterns, and trends**. This includes changes in prevalence of chemicals in marine sediments in response to legislative controls, degradation of some contaminants, ongoing human activities such as maintenance dredging and disposal, and existing discharge licences in the area. **The future baseline will also be influenced by climate change**, such as changes in sea pH and temperature and increased rates of rainfall surface water run-off, which in turn can have an impact on water quality (e.g. reductions in dissolved oxygen and concentrations of contaminants). **Population, industrial and agricultural growth** are also likely to **increase pressure on the water environment**.

31 Summary

There has been a significant increase in the amount of industrial activity occurring within the Plan areas over the last ten years, with further development and expansion projected in the future. Industries which currently have a large spatial footprint within the east inshore marine plan area include fisheries, tourism and recreation, and ports and shipping sectors. Industries which currently have a large spatial footprint across the east offshore marine plan area include the oil and gas, offshore wind, and the port and shipping sectors.

In regard to ecological features, an extremely high diversity of species and habitat types exist across the Plan areas. Areas of particularly high importance, where MPAs are designated include The Wash and the Humber estuary as globally important areas for migrating birds, extensive areas of saltmarsh, mudflats, and seagrass and oyster beds along The Wash and north Norfolk coast, and Dogger Bank as the largest sandbank in the UK.

Significant growth across the Plan areas is likely to include the development of the renewable energy sector and its associated cabling, and the developing CCUS and hydrogen sectors. This will likely lead to competition between industries for space and ultimately spatial squeeze within the Plan areas.

Given that large parts of the Plan areas are designated nature conservation areas, increasing numbers of byelaws are likely to be introduced in order to implement management measures. This is expected to improve environmental status and aid recovery of feature condition, but also contributes further to spatial squeeze on other sectors (for example the fisheries sector). This may also result in restrictions on certain activities including recreational and tourism activities in coastal areas, dredging, and cabling in offshore areas.

Future industrial and environmental trends in the Plan areas are influenced by several drivers, including political, economic, social, technological, legal, and environmental drivers, many of which are interlinked between industries. For example, the legal obligation under the Climate Change Act[500] to achieve net zero emissions by 2050 to mitigate against the impacts of climate change, is driving both development of some sectors, and mitigation actions which may transform existing sectors.

In addition to these drivers, the activities and trends of sectors, of which seascape is a key sector, will also impact marine planning. Seascape, particularly in regard to protected landscapes, is a key driver and can enable or restrict development of other sector, therefore informing the nature of the marine planning policies that ensure activities occur in the most appropriate location.

[500] UK Government. 2019. Climate Change Act 2008. Available at: https://www.legislation.gov.uk/ukpga/2008/27/section/1/2019-06-27 Accessed October 2024.

Climate pressures will likely result in, but not be limited to, sea level rise, increased storminess, and increased runoff which will have environmental consequences on features such as water quality and coastal erosion, as well as impacts on industries such as weather downtime and the need to build in contingency for these conditions. Climate change policies will influence the development of industries and technologies including the renewable energy sectors, those which can help to decarbonise existing industries (CCUS and hydrogen) and the associated requirements of the means of powering vessels and vehicles sustainably.

Overall, the Plan areas are a particularly busy part of English waters, both in regard to industrial activity and ecological importance. It is therefore essential that marine planning supports appropriate management to ensure that both the environment and industrial sectors have sufficient space to maintain their viability and adapt to the pressing impacts of climate change. This can be supported by identifying key areas for particular sectors, supporting co-location (for both environmental and industrial sectors), and ensuring effective evidence gathering and review through marine planning processes.

Abbreviations

ABP	Associated British Ports
AIS	Automatic identification system
AONB	Area of Outstanding Natural Beauty
BMAPA	British Marine Aggregate Producers Association
BNG	Biodiversity Net Gain
CCC	Climate Change Committee
CCMA	Coastal Change Management Areas
CCUS	Carbon Capture Usage and Storage
Cefas	Centre for Environment, Fisheries and Aquaculture
CO	Carbon monoxide
CO_2	Carbon dioxide
CSO	Combined Sewer Overflow
DAS	Disposal at Sea
DCO	Development Consent Order
DESNZ	Department for Energy Security and Net Zero
DfT	Department of Transport
EA	Environment Agency
EGL	Eastern Green Link
ELC	European Landscape Convention
ENORI	Essex Native Oyster Restoration Initiative
EPA	Environmental Performance Assessment
EPS	European Protected Species
EU	European Union
FMP	Fisheries Management Plan
FTE	Full time equivalent
GBN	Great British Energy
GDP	Gross domestic product
GES	Good Environmental Status
GHG	Greenhouse Gas
GVA	Gross Value Added
GW	Gigawatt
HM	Her Majesty
HND	Holistic Network Design
HPMA	Highly Protected Marine Area
HVDC	High Voltage Direct Current
ICES	International Council for the Exploration of the Sea
IERRT	Immingham Eastern Roll-on/Roll-off (Ro-Ro) Terminal
IFCA	Inshore Fisheries and Conservation Authority
IGET	Immingham Green Energy Terminal
IMMA	Important Marine Mammal Areas
IMO	International Maritime Organisation
INNS	Invasive Non-native Species
JNCC	Joint Nature Conservation Committee
MCA	Maritime and Coastguard Agency
MCAA	Marine and Coastal Access Act
MCCA	Marine and Coastal Access Act
MCMS	Marine Case Management System
MCZ	Marine Conservation Zone

MLWS	Mean low water springs
MMO	Marine Management Organisation
MNG	Marine Net Gain
MNR	Marine Noise Registry
MOD	Ministry of Defence
MPA	Marine Protected Area
MPS	Marine Policy Statement
MW	Megawatt
NATO	North Atlantic Treaty Authority
NM	Nautical Miles
NNR	National Nature Reserve
NSTA	North Sea Transition Authority
ORPRED	Offshore Petroleum Regulator for Environment and Decommissioning
PESTLE	Political, Economic, Social, Technological, Legal, Environmental
PSS	Protected Site Strategies
RAF	Royal Air Force
RBMP	River Basin Management Plans
RGI	Revenue growth index
RSPB	Royal Society for the Protection of Birds
SAC	Special Area of Conservation
SHORE	Shipping Office for Reducing Emissions
SMART	Science Monitoring and Reliable Telecommunications
SMP	Shoreline Management Plans
SPA	Special Protected Area
SRU	Strategic Renewables Unit
SSEP	Strategic Spatial Energy Plan
TAC	Total allowable catch
TCA	UK-EU Trade and Cooperation Agreement
TCE	The Crown Estate
TSS	Traffic Separation Scheme
UK	United Kingdon
UKSF	UK Seafood Fund
UN	United Nations
UNESCO	United Nations Educational, Scientific and Cultural Organisation
uPBTs	Ubiquitous, persistent, bioaccumulative, toxic substances
VMS	Vessel Monitoring System
WFD	Water Framework Directive
WHO	World Health Organisation
WINEP	Water Industry National Environment Programme
WRMP	Water Resources Management Plan
WWT	Wildfowl and Wetlands Trust
ZSL	Zoological Society of London

Annex A

Type of MPA	Name of MPA
SAC with a marine component	Margate and Long Sands
	Orfordness - Shingle Street
	Alde, Ore and Butley Estuaries
	North Norfolk Coast
	Humber Estuary
	The Wash and North Norfolk Coast
	Dogger Bank
	Haisborough, Hammond and Winterton
	Inner Dowsing, Race Bank and North Ridge
	North Norfolk Sandbanks and Saturn Reef
	Southern North Sea
	Flamborough Head
Special Area of Conservation	Greater Wash
	Outer Thames Estuary
	Benacre to Easton Bavents
	Gibraltar Point
	Hornsea Mere
	Humber Estuary
	N Norfolk Coast
	Alde-Ore Estuary
	Deben Estuary
	Sandlings
	Flamborough and Filey Coast
	Breydon Water
	Great Yarmouth North Denes
	Ouse Washes
	Nene Washes
	Minsmere-Walberswick
	Broadland
Site of Special of Scientific Interest	Church Ings
	River Derwent
	Deben Estuary
	Hornsea Mere
	Dimlington Cliff
	Leven Canal
	Eskamhorn Meadows
	Kirkby Wharfe
	Acaster South Ings
	Tophill Low
	Withow Gap, Skipsea
	Bolton Percy Ings
	Pulfin Bog
	Flamborough Head
	Humber Estuary
	The Lagoons
	North Killingholme Haven Pits
	Saltfleetby-Theddlethorpe Dunes
	Nene Washes (Whittlesey)
	Ouse Washes
	Berry Fen
	Adventurers' Land
	Bassenhally Pit
	Rockhall Wood Pit, Sutton

	Aldeburgh Hall Pit
	Gedgrave Hall Pit
	Round Hill Pit, Aldeburgh
	Richmond Farm Pit, Gedgrave
	Bawdsey Cliff
	Minsmere-Walberswick Heaths & Marshes
	Crag Pit, Aldeburgh
	Ferry Cliff, Sutton
	Aldeburgh Brick Pit
	Pakefield to Easton Bavents
	Chillesford Church Pit
	Snape Warren
	Leiston-Aldeburgh
	Sandlings Forest
	Corton Cliffs
	Iken Wood
	Sizewell Marshes
	Ramsholt Cliff
	Buckanay Farm Pit, Alderton
	Landguard Common
	Alde-Ore Estuary
	North Norfolk Coast
	Morston Cliff
	Upton Broad & Marshes
	Hunstanton Cliffs
	Ant Broads & Marshes
	Sidestrand & Trimingham Cliffs
	Sprat's Water & Marshes, Carlton Colville
	Barnby Broad & Marshes
	River Nar
	Stiffkey Valley
	Mundesley Cliffs
	Geldeston Meadows
	Weybourne Cliffs
	Cantley Marshes
	Cockthorpe Common, Stiffkey
	Yare Broads & Marshes
	Happisburgh Cliffs
	Sheringham & Beeston Regis Commons
	Upper Thurne Broads & Marshes
	Bure Broads & Marshes
	Decoy Carr, Acle
	Beeston Cliffs
	Wells Chalk Pit
	Wiggenhall St Germans
	Wiveton Downs
	Great Yarmouth North Denes
	Limpenhoe Meadows
	Shallam Dyke Marshes, Thurne
	Winterton-Horsey Dunes
	Hardley Flood
	Damgate Marshes, Acle
	Breydon Water
	Stanley & Alder Carrs, Aldeby
	Halvergate Marshes
	East Runton Cliffs
	Ludham-Potter Heigham Marshes
	Overstrand Cliffs

	St James' Pit
	Weybourne Town Pit
	Poplar Farm Meadows, Langley
	Mother Drain, Misterton
	Chapel Point to Wolla Bank
	Sea Bank Clay Pits
	Gibraltar Point
	Tuetoes Hills
	The Wash
	Spalford Warren
	Besthorpe Meadows
Marine Conservation Zone	Gibraltar Point
	North Norfolk Coast
	Humber Estuary
	Deben Estuary
	Minsmere-Walberswick
	Broadland
	Breydon Water
	Ouse Washes
	The Wash
	Nene Washes
	Alde-Ore Estuary
	Orford Inshore
	Holderness Inshore
	Cromer Shoal Chalk Beds
	Foreland
	Markham's Triangle
	Holderness Offshore
	Kentish Knock East