Marine Management Organisation

FUTURES ANALYSIS FOR THE NORTH EAST, NORTH WEST, SOUTH EAST AND SOUTH WEST MARINE PLAN AREAS

ENVIRONMENT ISO 14001 CERTIFIED
QUALITY ISO 9001 CERTIFIED
INVESTORS IN PEOPLE | Bronze
disability confident EMPLOYER

Marine Management Organisation

MMO1127: Futures analysis for the north east, north west, south east and south west marine plan areas

June 2017

Report prepared by: ABPmer, ICF

Project funded by: Marine Management Organisation

Version	Author	Note
0.1	S F Walmsley	First draft
0.2	S F Walmsley	Amendments
1	S C Hull	Approved

Information about this publication and further copies are available from:

Marine Management Organisation
Lancaster House
Hampshire Court
Newcastle upon Tyne
NE4 7YH

Tel: 0300 123 1032
Email: info@marinemanagement.org.uk
Website: www.gov.uk/mmo

If referencing this document, please cite it as: MMO1127. Futures analysis for the north east, north west, south east and south west marine plan areas, June 2017

This works uses, with thanks, information from the Celtic Seas partnership project. Celtic Seas Partnership is an EC LIFE+ project delivered with the contribution of the LIFE financial instrument of the European Community. Project number: LIFE011 ENV/UK/000392.

Executive Summary

Purpose and scope of study

ABPmer, supported by ICF, was commissioned by the Marine Management Organisation (MMO) to conduct a review of past trends and current drivers and develop future projections for selected industry sectors that are active in the north east, north west, south east and south west marine plan areas.

The MMO is responsible for the development of marine plans in English waters in accordance with the provisions of the Marine & Coastal Access Act (MCAA) 2009. The objective is to contribute to the achievement of sustainable development in the marine area by enabling strategic management of marine activities, achieving integration of different objectives, managing conflicts and complementarities and taking account of how ecosystems function. This will contribute towards the UK vision of clean, healthy, safe, productive and biologically-diverse oceans and seas.

Marine plans are being prepared on a regional basis. The first two marine plans — East Inshore and Offshore Marine Plans — were published in April 2014. The MMO launched a public consultation on the draft South Marine Plan in November 2016. Work to develop marine plans for the north east, north west, south east and south west commenced in July 2016.

This study is will inform iteration two of the marine planning process and feed into the development of draft marine plans and policies.

The scope of the report covers the following sectors which align with Marine Policy Statement (MPS) activities:

- Aquaculture
- Carbon capture and storage (CCS)
- Defence
- Energy production: Nuclear
- Energy production: Offshore electricity networks
- Energy production: Oil and gas
- Energy production: Wave and tidal energy
- Energy production: Wind energy
- Fisheries
- Marine aggregates
- Ports, shipping, dredging and disposal
- Surface water / wastewater management
- Telecommunication cables
- Tourism and recreation.

Methodology

Relevant evidence was collected and collated to inform the analysis. This has involved reviewing existing published information and consulting relevant national and regional sector stakeholders.

Information on the spatial distribution, intensity and economic value of each sector in the north east, north west, south east and south west marine plan areas over the last 10–20 years was summarised. A PESTLE (Political, Economic, Social, Technological, Legal and Environmental) analysis was then undertaken to identify key changes that could affect the sectors in the future.

The information on drivers and trends was used to develop projections of potential future change in the scale and location of each sector in each of the four marine plan regions over the next 6 and 20 years. These projections were constructed under three different scenarios to seek and identify possible alternative outcomes that could occur depending on the importance of particular drivers over time.

Building on the work of the Celtic Seas Partnership Future Trends project (ABPMer, 2016), the three future scenarios considered were:

- Business As Usual (BAU)
- Nature At Work (N@W)
- Local Stewardship (LS).

Business as Usual (BAU) – continuation of current policies

This scenario reflects the anticipated evolution of sectors over the next 20 years, assuming that there will be no significant change in people's attitudes and priorities and no major changes in technology or economics. As such, the scenario describes a continuation of recent trends and current drivers and expectations.

Nature at Work (N@W) – maximising ecosystem services

This is an environmentally-focused future scenario, in which there is an increasing understanding of the importance of ecosystem services, especially in the face of climate change. Society values nature for what it provides or does and accepts the need to create multifunctional landscapes to maintain ecosystem services and quality of life.

Local Stewardship (LS) – local decision-making and differentiation

Under this scenario, society is making a conscious effort to reduce the intensity of economic activity and levels of consumption and people want to manage resources for the future. There are fewer imports but also fewer exports and less consumption generally. Economic growth is slow but the economy is stable. Political power has been devolved and things are increasingly done at a regional or local level.

Projected change across sectors

Projections have been developed for each sector for the period 2017 to 2036 for each of the four marine plan regions for each scenario. These projections are presented as plots of the potential change in activity volume over time with activity volumes expressed in units relevant to that activity. For example, future demand for aggregates is expressed in tonnes of aggregate, future energy production in terms of megawatts (MW) of installed capacity etc.

The plots are accompanied by maps that seek to indicate where projected increases in activity volume might occur. For some sectors, the resource requirements to support the activity are well defined and therefore the maps can be fairly precise in identifying where future activity is likely to occur, for example, areas for future marine aggregate extraction. For other sectors, the resource requirements may be less specific or clear and therefore there is less certainty where future activity might be accommodated, for example, offshore aquaculture.

The plots and maps are supported by narrative that describes the possible changes in activity volume and location over the next 6 and 20 years. Consideration is also given to the potential trade-offs that might need to be made between sectors or between sectors and the natural environment within each region and within the different scenarios.

All three scenarios project growth in the output and economic value of most sectors over the next 20 years. However, some sectors are expected to decline, for example oil and gas production is expected to decline in volume terms as resources become depleted.

Combined projections for the north east, north west, south east and south west marine plan areas

This sub-section summarises the sectoral projections for the north east, north west, south east and south west marine plan areas as a whole. The unweighted average percentage change in activity levels across the four marine plan areas between 2017 and 2036 for each sector under each of the three scenarios (BAU, N@W and LS) is shown in Figure 1. It has not been possible to estimate the percentage change in growth in the surface water management sector given the uncertainties regarding the future trends and qualitative nature of the predictions. It has also not been possible to present the sectoral projections in absolute terms because the information is not available to present activity levels for each sector in one common unit. The percentage changes in activity levels therefore only provide an indication of relative rates of change and do not provide information on the sector’s contribution to overall growth.

Under BAU, the greatest average percentage growth between 2017 and 2036 is predicted to occur in the wave and tidal and aquaculture sectors, although from relatively low starting points. There is also predicted to be significant growth in offshore electricity network distribution cables . Sectors which will show moderate levels of growth in percentage terms under BAU are defence nuclear , wind energy , marine aggregates and the ports, shipping, dredging and disposal sectors. There is anticipated to be little growth in the tourism and recreation sector , although it will remain one of the most valuable sectors economically, and no growth (0%) in the CCS or telecommunications cables sectors under BAU. The fisheries sector is anticipated to see a marginal decline in growth over the 20 year period under BAU and the oil and gas sector will experience a significant decline as oil and gas reserves are depleted .

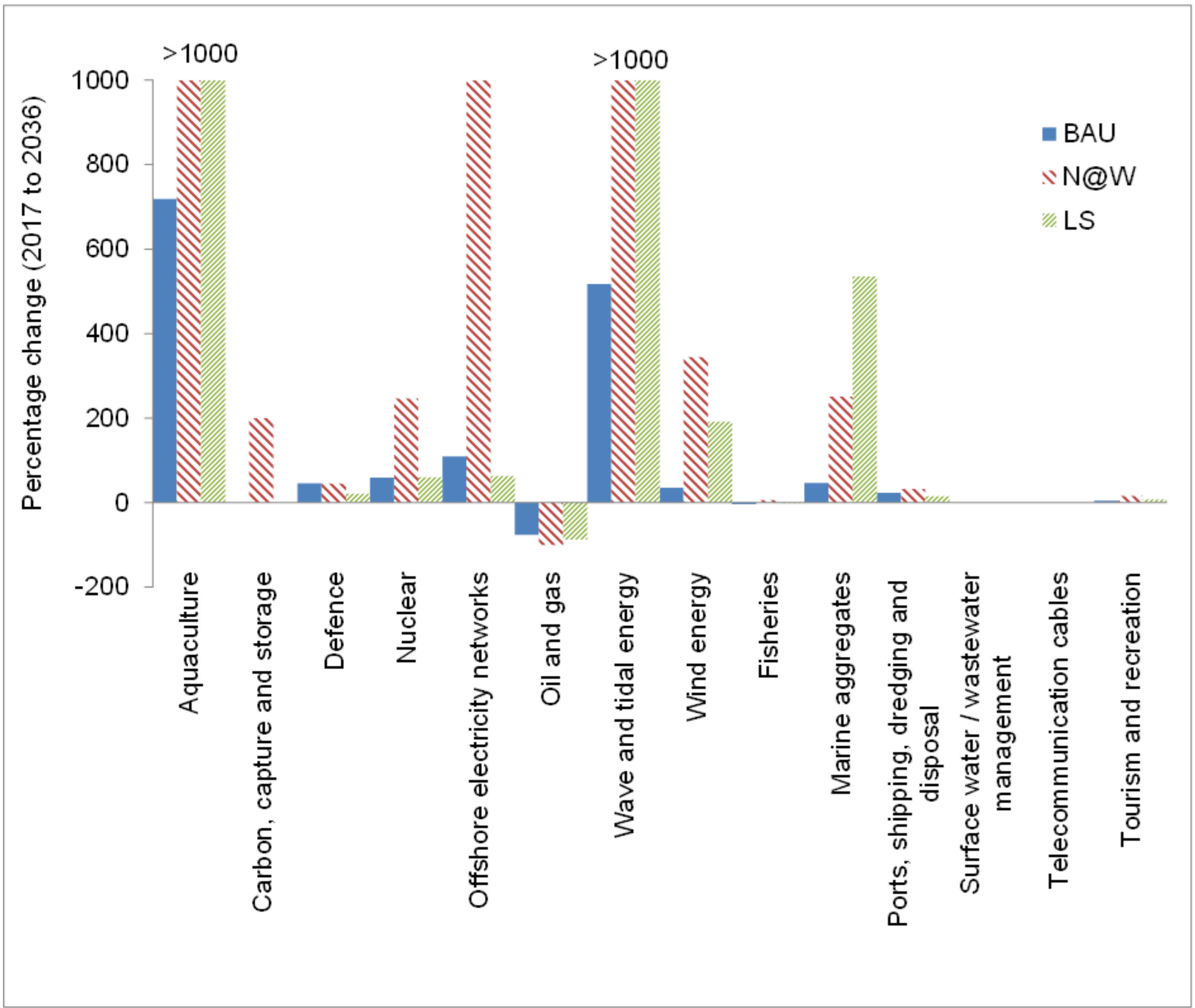


Figure 1: Unweighted average percentage change across sectors between 2017 and 2036 under three scenarios

For N@W, generally higher levels of growth are projected compared to BAU, particularly for aquaculture, CCS, defence, nuclear, offshore electricity networks, wind energy, ports, shipping, dredging and disposal, fisheries and tourism and recreation. The wave and tidal sector is projected to experience very significant growth as a result of investment in tidal lagoons, particularly in the south west region. The offshore electricity networks sector is predicted to grow by a large amount and aquaculture is also projected to grow significantly compared to baseline, reflecting the potential scale of opportunity for these sectors. Marine aggregates is projected to grow , much of which is related to the provision of aggregates for tidal lagoon development. Other sectors that will show relatively strong growth under the N@W scenario are CCS, nuclear energy and wind energy . There is a smaller level of growth predicted in the defence , fisheries , ports, shipping, dredging and disposal and tourism and recreation sectors. No growth is anticipated in the telecommunications sector and oil and gas production is expected to end following depletion of resources.

The LS scenario is anticipated to be particularly beneficial for the wave and tidal (tidal lagoons) sector and also for the marine aggregates sector as a result of increased demand for marine aggregates for lagoon wall construction. Aquaculture is also projected to increase significantly under this scenario. However, for a number of sectors, the LS scenario is projected to result in lower levels of growth, namely defence, offshore electricity networks, fisheries, ports, shipping, dredging and disposal.

Regional projections for each plan area

Levels of current activity and projections for growth vary regionally, reflecting the distribution of the biotic and abiotic resources on which human activities depend. For example, the south west marine plan areas are important for tourism and recreation, fisheries, telecommunication cables, defence and nuclear power generation, but also contain renewable energy resources and marine aggregates that could be suitable for further exploitation in the future. The south west also has potential for future shellfish aquaculture development. The south west is unimportant for oil and gas production and has relatively few major ports.

The north west marine plan areas are also important for tourism and recreation and for fisheries. They also support major offshore wind energy generation, oil and gas production and nuclear power generation. The north west has significant potential for future renewable energy development including tidal lagoons, nuclear and offshore wind energy generation. The development of tidal lagoons could lead to a significant increase in demand for marine aggregates. The north west also has significant potential for shellfish aquaculture development, particularly for mussels. There is also potential for carbon capture and storage.

The north east marine plan areas are important for tourism, ports, nuclear energy and oil and gas production. There is some potential for further offshore wind energy generation, nuclear power generation and carbon capture and storage, but limited potential for marine aggregates, aquaculture or wave and tidal energy development. Oil and gas production is projected to decline significantly over the next 20 years.

The south east marine plan area is important for tourism, ports and offshore wind energy generation. There is potential for growth in the ports sector, nuclear power generation and in shellfish aquaculture.

Potential Trade-offs

The possible future development of sectors identified within the various scenarios may give rise to potential trade-offs between sectors or between sectors and the natural environment. In general, the main trade-offs identified comprise:

- Sectoral development and the natural environment – there may be negative impacts on the natural environment as a result of new or continued activity in the following sectors: aquaculture, CCS, nuclear, offshore electricity networks, wave and tidal, wind energy, fisheries, marine aggregates and port development. Positive benefits to the natural environment may accrue from some of these activities, in particular reduced greenhouse gas emissions. The impacts (both negative and positive) may be greater under higher development scenarios (N@W and LS)

- Sectoral development and tourism/recreation – there may be negative impacts on recreation as a result of aquaculture, nuclear, wave and tidal, offshore wind and port development affecting access to recreational opportunities. Positive recreational benefits may accrue from tidal range developments. The impacts (both negative and positive) may be greater under higher development scenarios (N@W and LS)
- Competition for space between sectoral activities – the presence of existing sectoral activities may preclude alternative uses. This may constrain aquaculture, CCS, offshore electricity, wave and tidal, offshore wind and marine aggregate development opportunities. The impacts will be greater under higher development scenarios (N@W and LS).

Spatial planning techniques can be used to minimise interactions and negative trade-offs.

Conclusion

Overall, there are a number of sectors that have the potential to increase in levels of activity over the next 20 years including offshore renewables (particularly offshore wind, tidal stream and tidal range), aquaculture, carbon capture and storage, nuclear power generation, marine aggregates and offshore electricity networks, with their relative importance varying by marine plan region. Increases in levels of activity may result in trade-offs between marine sectors and with the natural environment, however negative trade-offs can be minimised through careful project design.

Contents

Figures

Tables

1 Introduction

ABPmer, supported by ICF, was commissioned by the Marine Management Organisation (MMO) to conduct a review of past trends and future projections for selected industry sectors that are active in the north east, north west, south east and south west marine plan areas.

The MMO is responsible for the development of marine plans in English waters in accordance with the provisions of the Marine & Coastal Access Act (MCAA) 2009. The goal is to contribute to the achievement of sustainable development in the marine area by enabling strategic management of marine activities, achieving integration of different objectives, managing conflicts and complementarities and taking account of how ecosystems function. This will contribute towards the UK vision of "clean, healthy, safe, productive and biologically-diverse oceans and seas" (HM Government, 2011).

Marine plans are being prepared on a regional basis. The first two marine plans - East Inshore and Offshore Marine Plans were published in April 2014. The MMO launched a public consultation on the draft South Marine Plan in November 2016. Work to develop marine plans for the north east, north west, south east and south west commenced in July 2016.

In developing marine plans, the MMO is required to ensure that all sectors are managed fairly and proportionately to achieve sustainable development. Evidence on the nature and scale of the future development of each sector is required to ensure that sector needs are understood and incorporated appropriately. In addition, to aid monitoring, future trends for the sectors which operate within or have an interest in the marine plan areas will also be required, drawing on previous work where relevant.

The purpose of this study was to conduct a review of the past trends and develop projections for the next 6 and 20 years (aligned with the marine plan second reporting cycle and lifespan of a marine plan) for each selected industry sector which is active in the north east, north west, south east and south west marine plan areas. This will inform the development of draft marine plans and policies.

1.1 Aims and objectives

The aims of the study were to:

- Review trends in the individual marine industry sectors over the last 10-20 years for the north east, north west, south east and south west marine plan areas.
- Review the key changes and/or advances of significance affecting the sectors (including technological advances, changes in ecosystems, management policy, economics etc.).
- Review industry projections (individual sectors) for all plan areas for the next 6 and 20 years and make projections for future changes (and identification of where future development areas may be constrained by protected habitats and species).

- Review the current policy directions of relevance at both national and plan area levels; and the issues raised through the MMO workshops that have recently taken place in the plan areas (MMO, 2017).
- Analyse additional intelligence on potentially significant future changes (both England relevant and global megatrends) that might affect the above going forwards.
- Identify key gaps and limitations of current knowledge for the past and future trends.
- Engage with stakeholders where necessary and relevant to validate and improve the findings.

A confidence assessment in the future projections for 6 and 20 years has been undertaken. The assessment of confidence is qualitative and has been based on the certainty with which plans and projections are likely to materialise within each time period; this in turn is dependent on: the type of development and its stage in the licensing process (e.g. there is higher confidence in a development for which planning permission has been obtained than for a development which is in the planning stages but for which a planning application has not yet been submitted); and other variables such as broader economic factors that may influence demand for marine sector goods and services. In most cases, there is higher confidence in future scenarios in the shorter term (six years) than in the longer term (6 to 20 years).

1.2 Scope of the report

The scope of the report covers the following sectors which align with Marine Policy Statement (MPS) activities:

- Aquaculture
- Carbon capture and storage
- Defence
- Energy production: Nuclear
- Energy production: Offshore electricity networks
- Energy production: Oil and gas
- Energy production: Wave and tidal energy
- Energy production: Wind energy
- Fisheries
- Marine aggregates
- Ports, shipping, dredging and disposal
- Surface water / wastewater management
- Telecommunication cables
- Tourism and recreation.

1.3 Structure of report

This report has been structured as follows:

- **Section 2** presents the methods that have been applied and a description of the scenarios under which the projections are made
- **Section 3** provides a brief overview of each marine plan region
- **Sections 4–17** provide sector-specific information.

The sector-specific sections provide a national baseline review of each sector in English waters, comprising a review of historic trends, key drivers and changes affecting the sector, as well as future trends. A confidence assessment is also included. Details of the sector in each of the north east, north west, south east and south west marine plan areas is then described. The assumptions of future development of the sector under the three future scenarios are set out, and a description of each sector in 6 and 6 to 20 year time frames is provided.

2 Methodology

2.1 Evidence collection

Relevant evidence was collected and collated to inform the futures analysis. This has involved reviewing existing published information and consulting national and regional sector stakeholders.

The following types of evidence have been sought:

- Trends in the levels of activity over the past 10 – 20 years for each sector in the north east, north west, south east and south west marine plan areas
- Information on key political, economic, social, technological, legal and environmental changes and/or advances of significance that could affect the sectors
- Information on possible future trends (including existing sectoral projections) for the next 6 and 20 years for each sector in all plan areas (including east and south)
- Information on current policy directions of relevance at both national and plan area levels including issues raised through recent MMO workshops (MMO, 2017)
- Additional intelligence of potentially significant changes (both England relevant and global megatrends).

In addition to a review of existing literature, the following sector stakeholders (primarily at a national level) were consulted to explore additional information sources and to discuss and agree key assumptions underpinning the analysis:

- British Ports Association
- Carbon Capture Storage Association
- European Subsea Cables Association
- Inshore Fisheries and Conservation Authorities
- Jane Smith Energy UK
- Mineral Products Association
- Ministry of Defence
- National Federation of Fishermen's Organisations
- New Under Ten Fishermens Association
- Oil and Gas UK
- Renewable UK
- Scottish Fishermen's Federation
- Scottish White Fish Producers Association
- Seafish
- Shellfish Association GB
- South West Fish Producer Organisation
- The Crown Estate
- UK Major Ports Group.

2.2 Analysis

Data collected were analysed with the aim of creating projections. Information on the spatial distribution, intensity and economic value of each sector in the north east, north west, south east and south west marine plan areas over the last 10 - 20 years was initially summarised. A confidence assessment was also carried out on these data.

The analysis then considered:

- PESTLE analysis
- Development of scenarios
- Description of scenarios
- Drivers under each scenario
- Application of scenarios
- Trade-offs within and between scenarios.

PESTLE analysis

A PESTLE (Political, Economic, Social, Technological, Legal and Environmental) analysis was then undertaken to identify key changes and/or advances of significance that could affect the sectors in the future. The analysis primarily focused on national-scale changes and advances, but also included a regional dimension where relevant, for example the implications of the Northern Powerhouse initiative for the north west and north east marine plan areas. Changes in policy directions of relevance at both national and plan area level, the issues raised through recent MMO workshops (MMO, 2017) and any additional intelligence on potentially significant future changes were included.

The south marine plan areas have already been subject to futures analysis (MMO, 2013a). The potential impact of global megatrends on these plan areas was commented on in connection with the review of national trends, drivers and changes within the PESTLE analysis.

Development of scenarios

The information on drivers and future trends was used to develop projections of potential future change in the scale and location of each sector in each of the four marine plan regions over the next 6 and 20 years. These projections were based around three different scenarios[1] to seek and identify possible alternative outcomes that could occur depending on the importance of particular drivers over time. The projections and scenarios are not intended as predictions of what will happen, rather what might happen under a particular set of assumptions or conditions.

The three future scenarios considered are based on work completed by the Celtic Seas Partnership ‘Future Trends’ project (Celtic Seas Partnership, 2016):

[1] A scenario is a description of how the future might develop, based on a coherent and internally consistent set of assumptions (‘scenario logic’) about the key relationships and driving forces (e.g. rate of technology change or prices) (Nakicenovic *et al*., 2000).

- Business As Usual (BAU)
- Nature At Work (N@W)
- Local Stewardship (LS).

These scenarios were selected as a continuation of the Celtic Seas work. They are already familiar to stakeholders in the north west and south west marine plan areas and as a result of engagement by the Celtic Seas Partnership project have been developed with stakeholder support. The scenarios have been tried and tested and developed further as part of this project.

The BAU scenario assumes that current policies relating to the use of the marine environment will continue (and thus that existing trends will broadly continue). The N@W and LS scenarios are based on work undertaken by the UK National Ecosystem Assessment Follow-On Project (NEAFO) (Brown *et al*., 2014), and further developed in the Celtic Seas Partnership Future Trends project (Celtic Seas Partnership, 2016).

Description of scenarios

<u>Business as Usual (BAU) — continuation of current policies</u>

This scenario reflects the anticipated evolution of marine sectors over the next twenty years, assuming that there will be no significant change in people's attitudes and priorities and no major changes in technology or economics. This scenario assumes the continuation of recent trends and current expectations and sectoral drivers. Pursuing environmental improvement is less important in this world than economics, and society and industry are reluctant to adopt many global or national environmental policies that would lead to radical change to the status quo.

<u>Nature at Work (N@W) – maximising ecosystem services</u>

This is an environmentally-focused future scenario, in which there is an increasing understanding of the importance of ecosystem services, especially in the face of climate change. Society values nature for what it provides or does and accepts the need to create multifunctional landscapes to maintain ecosystem services and quality of life. Conservation of habitats and species remains desirable, but not at the expense of wider benefits - and the introduction of non-native species to provide food, energy or habitat conversion are accepted if they promote ecosystem-based adaptations that enhance society’s resilience to climate change. Population growth, as a result of an increase in net immigration, and the adoption of new technologies are dominant driving forces. Decision-making is balanced between local and national level, although much economic activity is in private hands. The government plays an important role in managing and regulating economic activity to ensure efficiency in the use of resources and the minimisation of environmental externalities. Renewables cover an increasingly large proportion of energy generation.

<u>Local Stewardship (LS) – local decision-making and differentiation</u>

Under this scenario, society is making a conscious effort to reduce the intensity of economic activity and levels of consumption and people want to manage resources for the future. There are fewer imports but also fewer exports and less consumption generally. Economic growth is slow but the economy is stable. Political power has been devolved and things are increasingly done at a regional or local level; local government is relatively strong, although much activity is conducted by private individuals in small local businesses. People are motivated to live in low carbon economies, and consequently travel less and depend more on their own locality for food and leisure activities. There is great pride in the varied local food products. Increased local specialisation means that the UK is now less homogenised - landscapes are more distinctive and local economies vary considerably. Energy is generated from both local renewable resources and conventional fossil fuels.

Drivers under each scenario

The relative importance of different socio-economic and environmental drivers under each future scenario are shown in Table 1. The relative influence of each driver for the N@W and LS scenarios (in 2030 and 2060) are based on Brown *et al.* (2014), and further developed in the Celtic Seas Partnership Future Trends project (Celtic Seas Partnership, 2016). The influence of each driver in the BAU (in 2036) was based on expert judgement.

Application of scenarios

The scenarios have been applied to each sector in each of the four marine planning regions and are reported in Sections 4 to 7. The projections include:

- Information on the main drivers under each scenario
- Potential future scale and location of the activity at 6 and 20 years.

Trade-offs within and between scenarios

A high-level analysis of the potential trade-offs that might occur within and between the different scenarios has been carried out. Identification of the trade-offs is helpful in engaging stakeholders in marine planning processes as it clarifies the potential impact of plan options and potential plan policies on particular activities and interests.

Table 1: Action of drivers under the scenarios (adapted from Brown *et al*., 2014)

Driver	Scenario/timeline		
	BAU	N@W	LS
	2036	2030	2030
Social			
Population	+	++	0
Social cohesion	0	+	++
Tertiary education	0	+	-
Level of social activism	0	+	++
Respect for the environment	0	+	++
Preference for urban living (compared to rural)	+	0	--
Preference for living at the coast	0	0	-
Demand for provisioning services (consumerism)	+	-	--
Demand for regulating services	+	++	++
Demand for cultural services	0	+	+
Technology			
Innovation (techno-centric)	+	+	--
Innovation (eco-centric)	+	++	++
Innovation (hybrid, appropriate mix of technology)	+	++	0
Level of mechanisation	0	+	-
ICT	+	++	-
Economic			
Magnitude of economic development	+	++	-
Stability of economic development	0	+	++
Equity/distribution of wealth	-	+	++
Energy prices	+	+	+
Food prices	+	+	+
Water prices	+	+	++
Globalisation	+	++	--
Reliance on imports	+	0	--
Environment			
Sustainable resource management	-	++	++
Policy			
Strength of governance	0	++	+
Strength of spatial planning regulations	-	++	+
Strength of international cooperation	0	+	-
Geo-political stability	0	+	--

-- very negative effect.
- slight negative effect.
0 neutral effect.
+ slight positive effect.
++ very positive effect.

Notes: These scores express the relative action of drivers in the changed conditions provided by each scenario. No drivers were presented for BAU in the NEAFO.

2.3 North east

The north east marine plan areas include the area of sea stretching from Flamborough Head to the Scottish border and extends out to the seaward limit of the Exclusive Economic Zone (EEZ). This plan area covers approximately 55,000 km^2 with a coastline of nearly 700 km. The oil and gas sector is prevalent in this area due to the presence of major hydrocarbon fields and well established marine and land infrastructure. Shipping activity is also important in the area and provides links with northern Europe. Fishing has historically constituted a major activity and is still significant commercially, although the level of activity has decreased in recent years.

2.4 North west

The north west marine plan areas cover approximately 7,100 km^2 and the coast line stretches approximately 1,300 km. Oil and gas is a key industry in the north west with a few discrete but productive reserves. The area is also home to strategically important power stations, as well as being important for energy production and fishing.

2.5 South east

The south east marine plan area is the smallest marine plan area. It covers 4,000 km^2 of sea and 1,500 km of coast spanning from Felixstowe to Folkestone, and reaches inland as far as Richmond in London. The naturally sheltered ports in this area are strategically important for container and passenger traffic, with the area being one of the busiest UK freight ports. Well established fisheries also operate from the many of the harbours and the area supports a high proportion of water discharge outlets due to the location of dense population centres.

2.6 South west

The south west marine plan areas comprise the area of sea stretching from the estuary of the River Dart at Dartmouth to the estuary of the River Wye. The area extends out to the seaward limit of the EEZ covering an area of approximately 84,000 km^2 with a coastline of almost 2000 km. This area has a big military presence but also a diverse and strong environmental, tourism and recreation sectors. Marine aggregate extraction is an important industry in the Severn Estuary and Bristol Channel, and provides a well located and economical source of sand for the local construction market. This area is also a key strategic landing point for a large number of telecommunication connections, including from America and Africa.

3 Aquaculture

Sector definition

Shellfish aquaculture relates to the cultivation of shellfish species (molluscs and crustaceans) in coastal/marine based aquaculture installations (i.e. on trestles, ropes, bouchot poles or in nets) or cultivated on the seabed (e.g. on-bottom cultivation).

Finfish aquaculture relates to the cultivation of marine finfish species in marine-based aquaculture installations and excludes land-based marine finfish production and freshwater finfish production.

Data sources

A variety of different information sources have been reviewed to inform this baseline, including published reports and papers and spatial data layers. The main information sources used are provided in the list below:

- Shellfish aquaculture 2015 production statistics and imputed value at first sale (supplied by Cefas);
- Aquaculture Production Businesses (APBs) in 2013 (spatial data layer supplied by the Centre for Environment, Fisheries and Aquaculture Science (Cefas));
- Future Trends in the Celtic Seas (ABPmer & ICF International, 2016);
- Whiteley (2016) Several, Regulating and Hybrid Orders: The Contribution and Value of Orders in Relation to the Sector's Past Development and Future Growth; and
- Hambreys and Evans (2016) Aquaculture in England, Wales and Northern Ireland: An analysis of the economic contribution and value of the major sub-sectors and the most important farmed species.

3.1 National review

Overview of national activity

<u>Production</u>

Although shellfish farming occurs in all areas around England, the highest number of shellfish farming businesses are in the south east and south west, with far fewer APBs in the north east and north west marine plan areas (Figure 2) (based on distribution trends in aquaculture production business distribution across marine plan areas in 2013, which Cefas advised were applicable in 2017; Tim Ellis, Cefas, pers. comm. 21 February 2017).

Mussels are the main species produced by volume and value. The most recent aquaculture production tonnages and indicative value of key shellfish species are shown in Table 2. The number of staff employed in the aquaculture sector in 2014 is shown in Table 3.

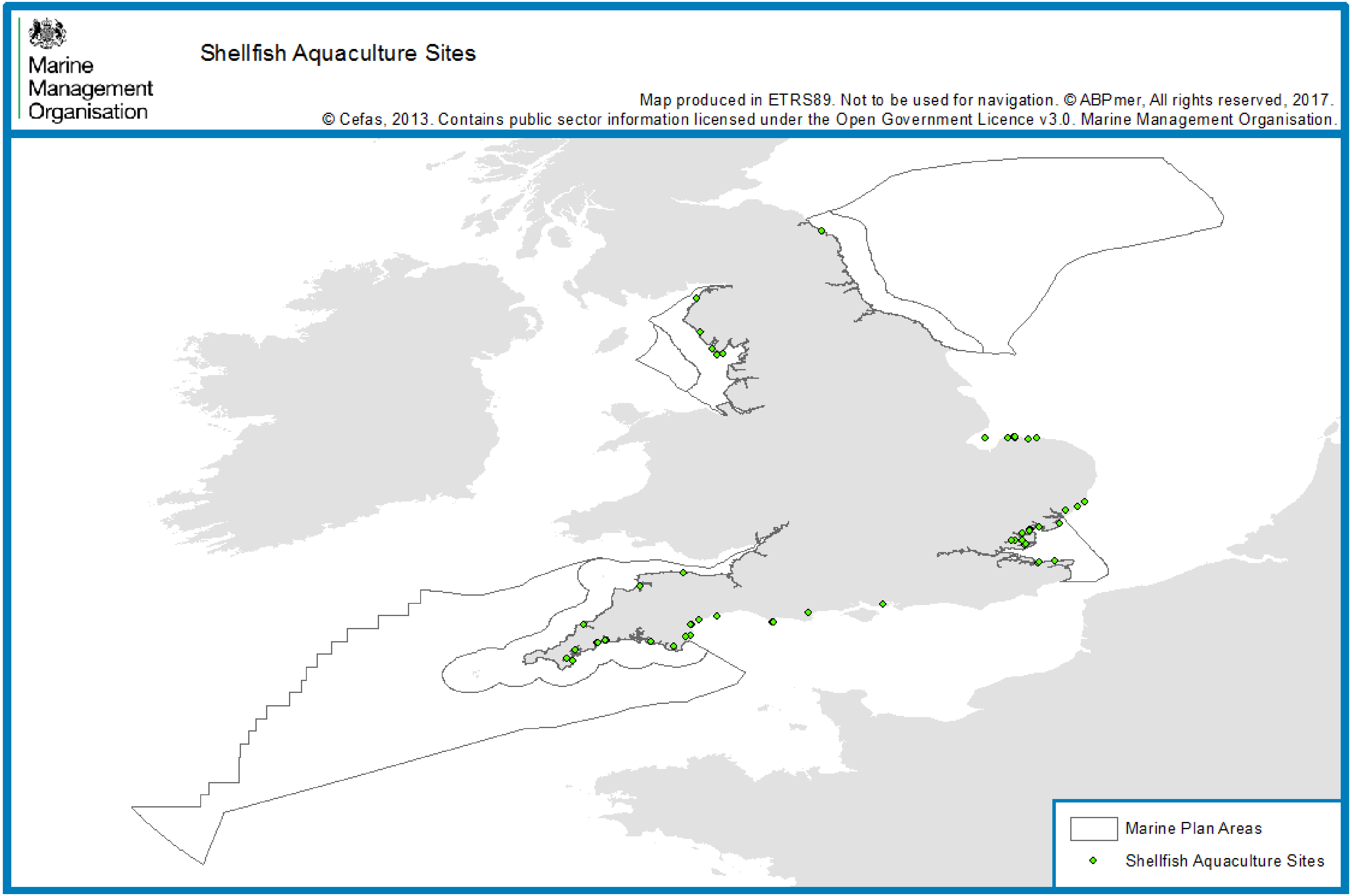


Figure 2: Shellfish aquaculture sites

Crustacean aquaculture within the UK is limited to production of juveniles for release in stock enhancement and conservation schemes, and culture of tropical prawns. There is no marine-based crustacean production and hence this is not considered further.

Finfish aquaculture production in England comprises production of eggs, fry and fingerlings of a range of species for on-growing and grow-out production of larger fish for the table market and restocking of leisure fisheries (Hambrey and Evans, 2016). However, there is currently no marine-based finfish production (on-growing) in England.

Table 2: Production volumes and imputed value of key shellfish aquaculture species in 2015

Species	Production Method	Production Volume (Tonnes)	Estimated Price (£/tonne)	Imputed Value (£)
Mussels	Off bottom	545	1,496	815,320
Mussels	On bottom	1,364	1,496	2,040,544
Native oysters	On bottom	8	3,800	30,400
Pacific oysters	On bottom	1,026	2,000	2,052,000
Manila clams*	On bottom	6	3,500	21,000
Cockles*	On bottom	3,045	2,500	7,612,500
Hard clams	On bottom	2	3,500	7,000
Total		5,996		12,578,764
* Although the tonnages of these species are counted as aquaculture production in the national statistics because they are harvested from a farmed site by an aquaculture business, they are naturally occurring within the farm site and not cultured (Tim Ellis, Cefas, pers. comm. 10 March 2017).				

Source (Cefas supplied data, 21.02.17)

Table 3: Employment in the shellfish aquaculture sector in England in 2014

Male Employees	Female Employees	Total Employees	Male FTE	Female FTE	Total FTE
232	26	258	178	13	191

Source (Cefas, 2017)

In 2016, there were 12 registered Several, Regulating and Hybrid Fishery Orders in England[2]. The location of Fishery Orders which are located within the marine plan areas of interest are shown in Table 4. For the purpose of this study, production from Several Fishery Orders would be classified as 'aquaculture', whilst harvest from Regulating Fishery Orders would be considered to be wild capture. Production from Several Fishery Orders are included in the national APB production statistics presented in Table 2 above (Tim Ellis, Cefas, pers. comm. 10 March 2017).

[2] Several Orders allow legal ownership of certain named shellfish species in a private shellfishery, whilst Regulating Orders create powers of management, usually for a public authority, over natural shellfisheries. Both types of Order can be made anywhere within 6nm of the seashore in England, Wales and Scotland (Whitely, 2016).

Table 4: Registered Fishery Orders in England

Fishery Order Type	Order Name	Marine Plan Area
Several	The River Roach Oyster Fishery Order 2013	South east
Several	The Horsey Island Oyster Fishery Order 1963	South east
Several	The Tollesbury and Mersea (Blackwater Fishery) Order 1999	South east
Several	The River Camel Mussel and Oyster Fishery Order 2013	South west
Several	The River Taw Mussel Fishery Order 1962	South west
Regulating	The Fal Fishery Order 2016	South west

Review of historical trends

At the national level, recent trends in aquaculture production in England have been static or declining (Hambrey and Evans, 2016). Trends in shellfish production in England between 2000 and 2015 are shown in Figure 3 (Cefas supplied data, 10 March 2017). The figure indicates that whilst there has been a relatively large variation in mussel production over this time period, the overall trend is a fall in production levels. Pacific oyster production has slowly increased over the same time period from 297 t in 2000 to 1,026 t in 2015. In contrast, native oyster production has slowly declined from 115 t in 2000 to 8 t in 2015.

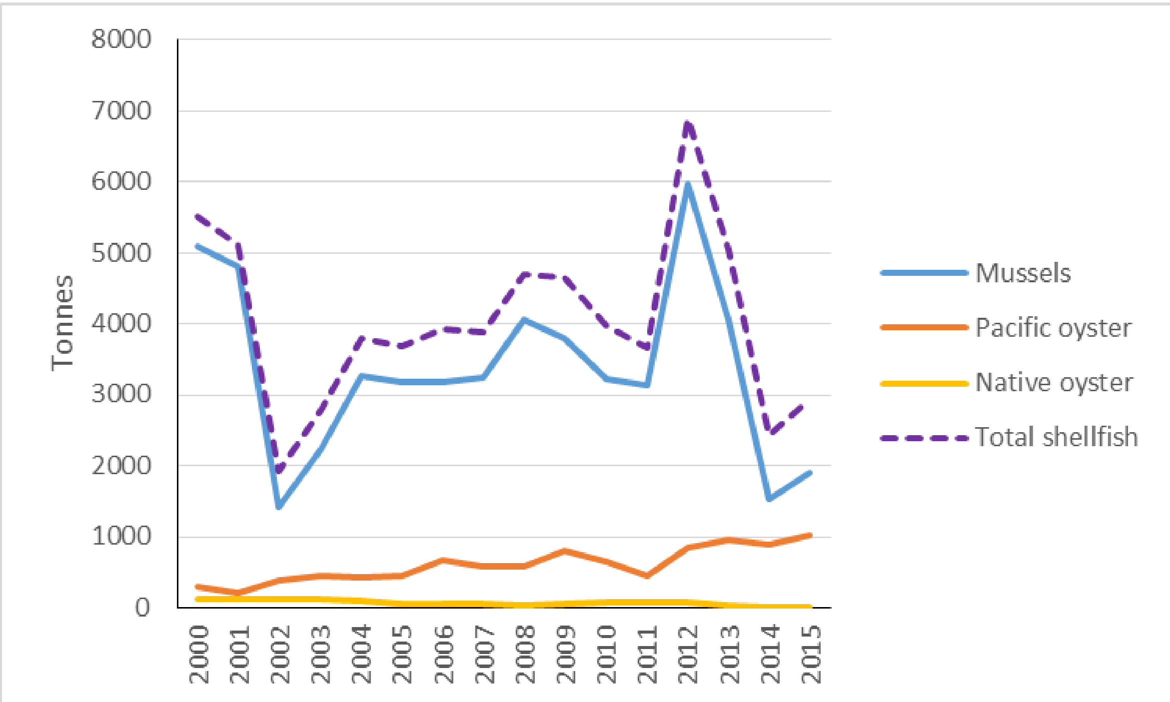


Figure 3: Reported aquaculture production of (a) mussels, (b) Pacific oysters and (c) native oysters in England between 2000 and 2015 (Cefas data)

Review of key changes and/or advances of significance affecting the sector

Key drivers for the aquaculture sector include economic development, particularly for rural communities; food security to help meet the increasing global demand for seafood as wild capture fisheries plateau; market supply and demand, technological developments to enable the industry to move offshore to suitable sites where production can be increased and, for the shellfish sector and the availability and supply of spat/seed. These drivers are described in more detail in Table 5.

Table 5: Key drivers affecting development of the aquaculture sector

Driver	Details	Implications
Political	Blue Growth (sustainable economic growth from marine industries) - numerous EU and national strategy documents currently promote the potential for aquaculture to expand, to provide employment and income, particularly in rural and coastal communities. Examples of national initiatives include: - Establishment of a Seafood Task Force in 2015, and the production of the Seafood Strategy 2040 for England (January 2016), which includes aquaculture. The Seafood Task Force is currently working on an Action Plan to help realise the ambitions set out in Seafood 2040; - The establishment of a UK Aquaculture Network, funded by BBSRC-NERC. The UK network comprises a finfish and shellfish network, the latter of which is being led by Swansea University; - Seafood culture/aquaculture could be included in future strategies for the food and farming sectors Food security - key area for development within all UK devolved administrations and Europe due to its potential to contribute to food security (particularly as wild capture fisheries have plateaued, e.g. FAO, 2016)	EU and national administrations (including England) seeking to sustainably expand sector
Economic	European Maritime and Fisheries Funding (EMFF) - a European funding scheme for use between 2014 and 2020 to support implementation and delivery of the EU's maritime and fisheries policies. There is €92.1m available budget for the EMFF scheme in England.	The budget in England will support investments in aquaculture (production and supply chain) , amongst other activities.

Driver	Details	Implications
	Market supply - fluctuations in supply (i.e. increased or decreased production, for example, in relation to disease, biotoxins, economic climate or export restrictions).	Competition with other producer nations. Decreases in production - potential market opportunities for other producers; increases in production – negative effect on market prices
	Market demand - increasing demand for shellfish in some markets (e.g. Europe, Asia).	Increased demand, although influenced by global socio-economics (i.e. economic cycles, population, incomes, consumer preferences etc.)
	Substitutes - Aquaculture products compete with other fish and shellfish products and other sources of protein	Aquaculture products need to be sold at prices that enable them to compete favourably with substitute products. This can limit profitability of sector and hence attractiveness to investors
Social	Numerous EU and national strategy documents currently promote the potential for aquaculture to expand, to provide employment and income, particularly in rural and coastal communities.	EU and national administrations seeking to sustainably expand sector
	Social licence to operate - the level of approval from the community, that an industry has to operate	Whilst institutions and companies need regulatory permission to conduct their business, there is also now increasingly pressure for 'social permission' from local communities and stakeholders
Technological	Competition for space in inshore waters is high. Technological developments are required to enable industry to move further offshore, including the potential for co-location (e.g. with marine energy installations such as tidal lagoons and offshore wind farms) and potential technological innovations (e.g. deep water cages) which enable the industry to move much further offshore and significantly scale-up production.	Increased available marine space for marine aquaculture.
	Current constraints in shellfish aquaculture include the ability to access a reliable source of seed/spat due to natural variability. Advances in hatchery technology, for example, to enable ‘out of season’ seed production or production of spat for species not currently hatchery produced (e.g. scallop) would help facilitate expansion of the industry.	A more consistent source of seed/spat for shellfish species.
	Additional advances in genetic techniques for example to increase disease resistance, growth rates or in production of triploid/tetraploid specimens (which are theoretically sterile) for biological containment of non-native species.	Potential advances in resistance to disease, growth traits or biosecurity

Driver	Details	Implications
Legal	Achievement of Water Framework Directive (WFD) targets (and improved land management)	For shellfish farming, water quality is a key factor in determining the economic viability of production. Achievement of WFD targets, and improved land management, would likely increase the available marine space for shellfish aquaculture to expand into if improvements occur in areas of good aquaculture potential (i.e. suitable environmental conditions for cultivation)
Environmental	Designation of additional MPAs.	Potential constraints/ restrictions on areas within which aquaculture, or wild seed harvesting can occur (see also seed supply). Considered a key constraint by some stakeholders (e.g. in South coast of England; MMO, 2013a) but not by others (e.g. in Wales; Welsh Government, 2015)
	Achievement of MSFD targets.	Potential reductions / increases in areas available for aquaculture (if suitable environmental conditions for cultivation)
	Ecological carrying capacity (the magnitude of aquaculture production that can be supported without leading to significant changes to ecological processes, species, populations, or communities in the environment)	If the ecological carrying capacity of a waterbody is exceeded the stocking levels or farm densities may cause unacceptable ecological impacts to the wider ecosystem. For example, finfish aquaculture uses ecosystem services for degradation of organic matter and nutrients and the provision of oxygen. However a certain level of fish biomass may exceed the system capacity to process nutrients and provide oxygen therefore generating eutrophication (see Ross *et al*., 2013 for carrying capacity definitions)
	Impacts of climate change (e.g. changes in water temperature, ocean acidification frequency of storms, precipitation levels etc.) on aquaculture	Climate-induced changes in the marine environment have the potential to affect finfish and shellfish sectors in various ways including the species that can be cultured, disease occurrence and susceptibility, mollusc spat fall, frequency of harmful algal blooms and changes in planktonic communities.
	Seed supply - lack of seed supply e.g. due to natural variation in availability	Potential constraint on industry expansion
	Health and disease - Farmed finfish and shellfish may be affected by disease or parasites	Stock losses (mortality) and restriction of movement of aquatic animals into, and out of, the affected area

Sources: ABPmer and ICFI, (2016 and references therein), ABPmer and Stirling University (2015 and references therein), ABPmer and Stirling University (2016 and references therein), Brooks (2016), Gubbins *et al*. (2013), BBSRC and NERC (2015), MMO (2013b), Welsh Government (2015)

Review of future trends

In the BAU scenario, the strategic intention to expand aquaculture (Defra, 2015) and some streamlining of the consenting processes for new/expanded production sites (e.g. Hambrey and Evans, 2016; Nimmo *et al*. 2016; Whiteley, 2016) facilitate sector expansion to a degree. This results in an overall trend of an increase in production through increased productivity from existing sites and potentially establishment of a very low number of offshore sites (for example, suspended rope mussel farms, assumed to be located within 13-30m below Chart Datum (CD), or potentially co-located with offshore wind infrastructure). However, constraints such as water quality issues, seed supply and lack of optimal available sites are not fully resolved and constrain growth to relatively modest levels.

Regional marine plans help to identify suitable areas for new aquaculture sites, although competition for space remains high (resulting in objections to expanded/new sites from other sectors, for example, recreation) and social acceptance of aquaculture remains low (resulting in objections to expanded/new production sites for example on landscape and visual impact issues).

It is not anticipated that marine-based finfish production will occur in any of the four marine plan areas, due to the relatively slim margins for some species (e.g. trout), the substantial investments that would be required, the increased risk associated with offshore production, strong competition from other countries such as Norway, Denmark and Scotland (Hambrey and Evans, 2016) and lack of social licence for finfish farming.

In N@W, blue growth is a key driver for the aquaculture sector and growth is high. Recognition of aquaculture's potential to contribute to food security is also important, as are technological developments that enable greater expansion into offshore areas (assumed to be located within 13-30m below CD), including the potential for co-location with offshore renewable developments or tidal lagoons and innovative technologies such as deep water cages and offshore multi-use platforms. These developments help to scale up production and help reduce the environmental impacts of aquaculture.

Regional marine plans help to identify the most suitable areas for new/expanded aquaculture developments. Streamlined consenting processes facilitate the sector expansion. This is further enhanced by increased societal acceptance of aquaculture as understanding of aquaculture and food security is increased (via awareness programmes). Hence there is reduced opposition to larger/new farms in relation to visual amenity value.

Shellfish aquaculture (including wild seed collection) continues to be considered in MPAs on a case by case basis, due to understanding of the environmental impacts and the ecosystem services (e.g. water purification) and goods and benefits (e.g. health benefits) provided by shellfish aquaculture. It is assumed that expansion of the oyster production sector is facilitated by clarity being provided on the production of Pacific oysters (non-native species) by Government and regulators.

Although there is increased social licence for aquaculture, it is not anticipated that marine-based finfish production will occur due to lack of economic viability (strong market competition), although further to technological developments in energy production, finfish production via land-based recirculation aquaculture systems may become economically viable (note, no land-based production volumes are included in the future projections, as production via this method would be land-based).

In the LS scenario, national aquaculture strategies (promoting the expansion of the sector for the benefit of local communities) and food security are the key drivers. Regional marine plans have identified areas of aquaculture potential and due to the recognition of the importance of the sector to the local economy and job market, these areas are prioritised for aquaculture development. Improvements in shellfish water protected areas provide further potential space for new shellfish production sites.

There is a larger number of smaller, inshore aquaculture sites (where potentially more space is available due to exclusion of some mobile benthic gears within 3nm), oriented towards local food security and provision of high quality, locally-differentiated produce, potentially linked to local tourism initiatives. In addition there is production of shellfish via offshore aquaculture installations (potentially co-located with renewable energy infrastructure) and within tidal lagoons. There is greater social understanding and acceptance of the need for aquaculture leading to reduced objections to new/expanded farms, especially in remote rural areas.

Although EU and UK economic performance is generally poor, there is still a strong market for high quality locally/regionally branded aquaculture products in European and Asian markets. New species/cultivation methods are established locally, where conditions are suitable and a valuable local brand can be promoted (e.g. scallop production). Given the importance of local aquaculture to certain areas there is investment in shellfish hatcheries to ensure adequate seed supply for production of established or new species production.

It has been assumed that no marine-based finfish production occurs due to lack of economic viability (strong market competition) and continued lack of social acceptance.

3.2 North east

In 2013, there was one registered shellfish APB in the north east marine plan area, producing Pacific and native oysters (Cefas, 2017). Hambrey and Evans (2016) estimated direct FTE employment in the shellfish aquaculture sectors in the north of England in 2015 as shown in Table 6, although this included both the north east and north west coasts of England (it was not possible to disaggregate this data)

Table 6: Employment estimates for northern England in 2015

Sector	Estimated direct FTE Employees (Low – High Estimates)
Oysters	6-12
Mussels	2-4
Other Shellfish (species not stated)	2-4

Source Hambrey and Evans (2016)

The assumptions used to develop the BAU, N@W and LS scenarios for aquaculture in the north east marine plan areas are provided in Table 7. Projected production tonnages under each of the three scenarios is shown in Figure 4. Figure 5, Figure 6 and Figure 7 show the spatial application of the scenarios to the sector while the text below provides a brief description of the future trends in 6 years and 6 to 20 years.

Table 7: Assumptions and impacts under the future scenarios for aquaculture production in the north east marine plan areas

Aspect	Scenario		
	Business as Usual	**Nature @ Work**	**Local Stewardship**
Application to the sector	In 2013 there was only one aquaculture production business in this region, producing oysters. As such, growth in this sector is expected to be relatively low compared to the north west, south east and south west marine plan areas, where aquaculture is more established.	Although the industry is facilitated by policy changes, regulatory streamlining and increased social licence in this scenario, due to the relatively low number of aquaculture businesses in this region, growth will be at the same rate as the BAU scenario.	Although the industry is facilitated by regulatory streamlining and increased social licence in this scenario, due to the relatively low number of aquaculture businesses in this region, growth will be at the same rate as the BAU and N@W scenarios.
Assumptions	Growth rate assumptions: The assumed growth in annual oyster production (based on OBR) is: ▪ 1.7% per annum between 2017-2018; ▪ 2.1% between 2019-2020 ▪ 2.0% between 2021-2036 The increase in oyster production occurs through some expansion at the existing site and potentially new site development, subject to availability of suitable sites. It is assumed that there is no development of mussel, scallop or finfish cultivation.	Growth rate assumptions: The assumed growth in annual oyster production is: ▪ 1.7% per annum between 2017-2018; ▪ 2.1% between 2019-2020 ▪ 2.0% between 2021-2036 The increase in oyster production occurs through some expansion at the existing site and potential new site development as per BAU. It is assumed that there is no development of mussel, scallop or finfish cultivation.	Growth rate assumptions: The assumed growth in annual oyster production is: ▪ 1.7% per annum between 2017-2018; ▪ 2.1% between 2019-2020 ▪ 2.0% between 2021-2036 The increase in oyster production occurs through some expansion at the existing site and potential new site development as per BAU. It is assumed that there is no development of mussel, scallop or finfish cultivation.

6-year projection

Based on the relatively low number of aquaculture production businesses in the north east marine plan area, growth in the shellfish (oyster) production sector is assumed to be relatively low (at projected OBR rates) for the next 6 years.

6 to 20 year projection

Although, industry aspirations are supported by policy, regulatory streamlining and increases in societal acceptance of aquaculture, shellfish production over the period 6 to 20 years from present, continues at a modest rate (at projected OBR rates) due to the relatively low starting baseline (i.e. number of farms).

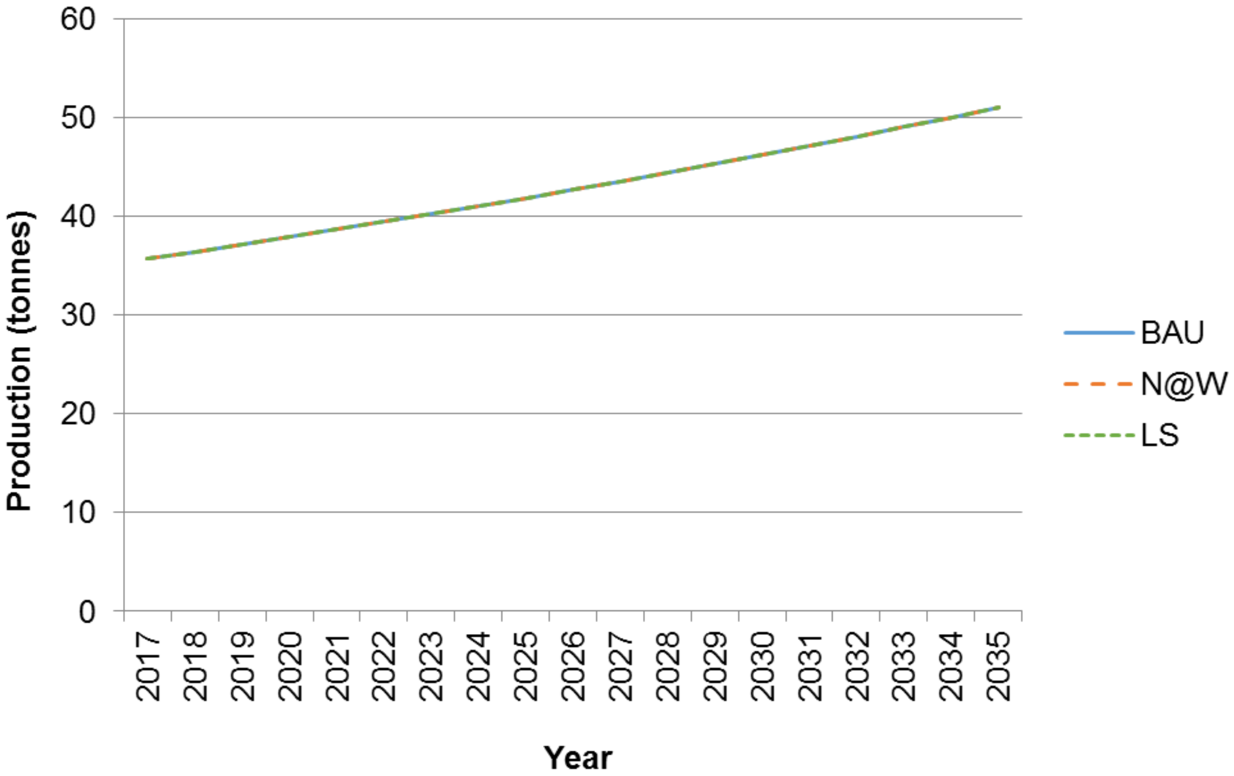


Figure 4: Projections of production tonnages (tonnes) for the oyster production sector (Pacific and native oysters) in the three scenarios for the north east marine plan areas

Potential trade-offs

Aquaculture development is likely to occur inshore. The main potential interactions for aquaculture activity in this area are with the natural environment (habitats) and marine recreation. None of the scenarios project substantial growth in aquaculture within the plan areas over the next 20 years. The scenarios are therefore considered to only entail very minor trade-offs with the natural environment and recreational activity.

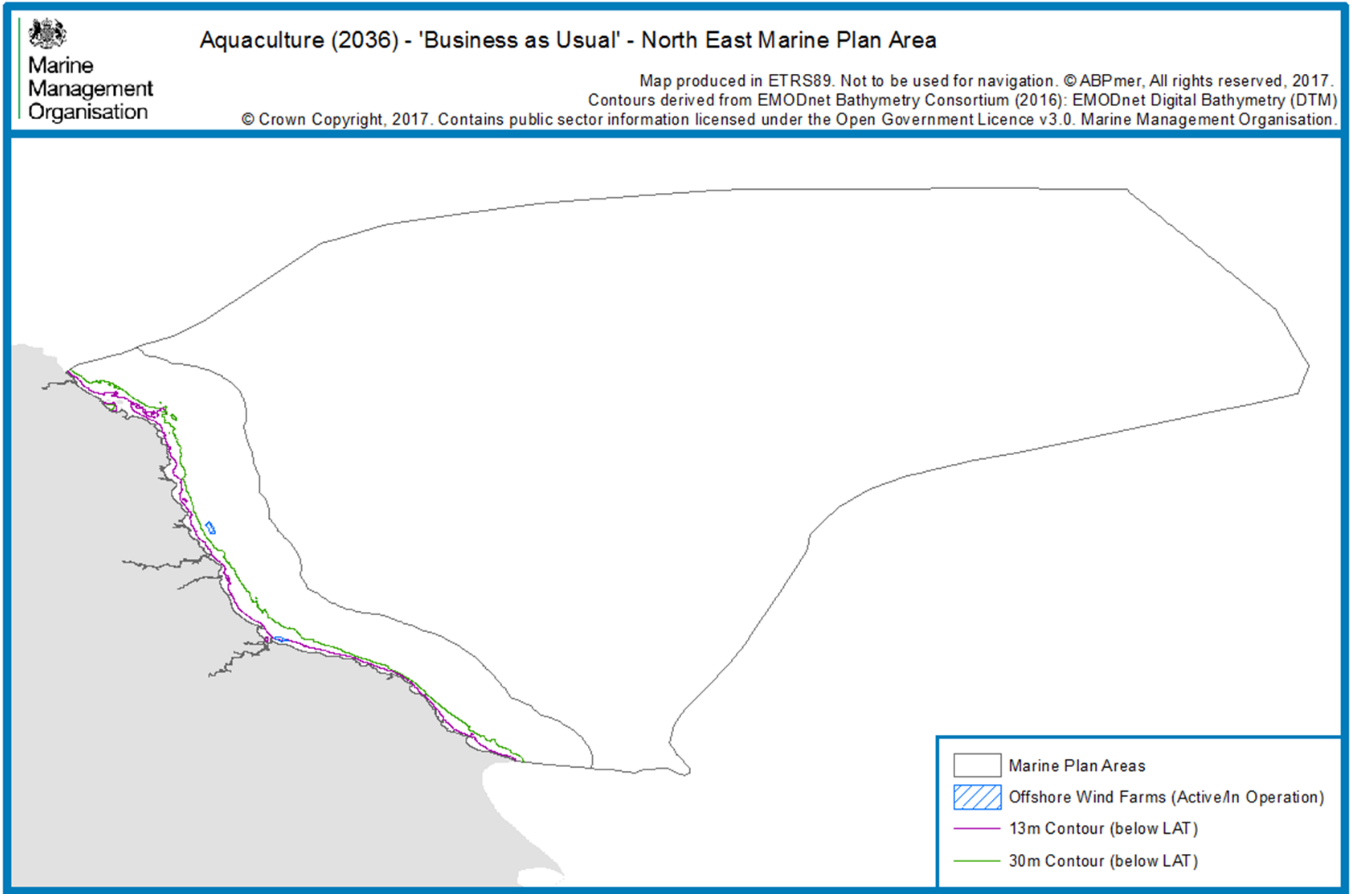


Figure 5: Aquaculture (2036) – BAU – north east marine plan areas

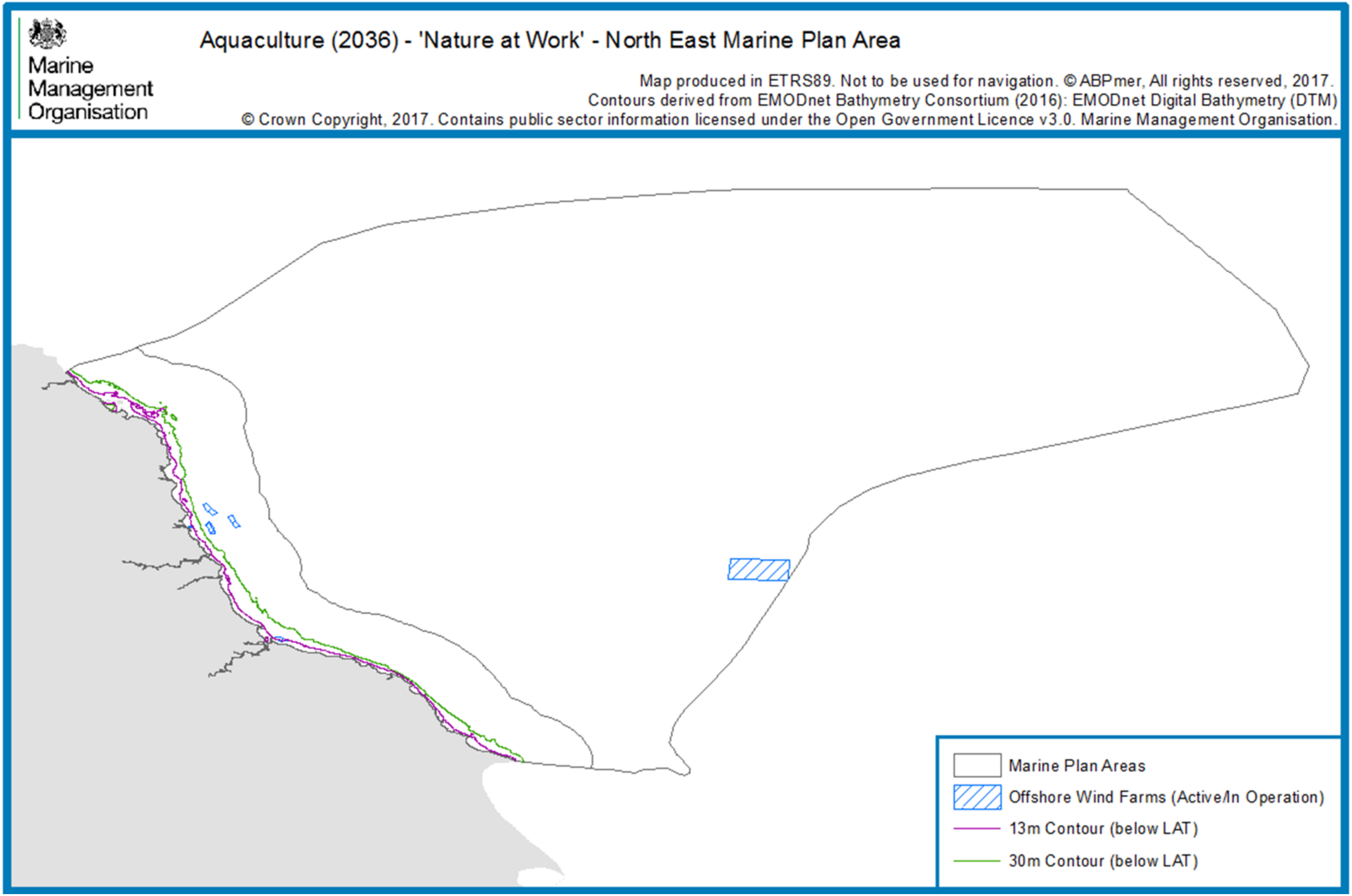


Figure 6: Aquaculture (2036) – N@W – north east marine plan areas

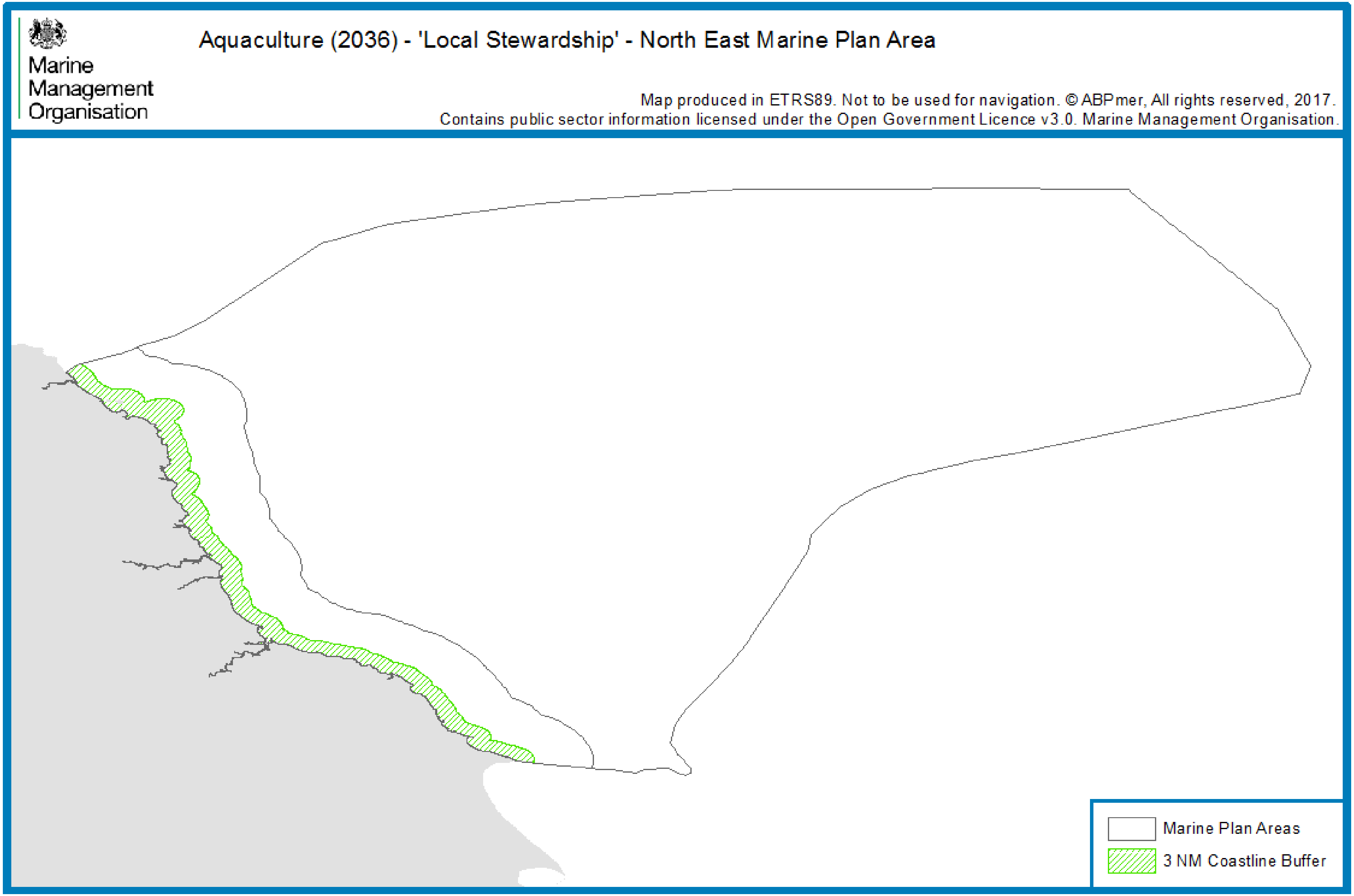


Figure 7: Aquaculture (2036) – LS – north east marine plan areas

3.3 North west

In 2013, there were five registered shellfish APBs in the north west marine plan area, producing mussels (four APBs), Pacific oysters (three APBs), Native oysters (one APB) and Manila clam (one APB) (Cefas, 2017). The estimated direct FTE employment in shellfish aquaculture in the north of England (including both the north east and north west coasts of England) are shown in Table 8.

Table 8: Employment estimates for northern England in 2015

Sector	Estimated direct FTE Employees (Low – High Estimates)
Oysters	6-12
Mussels	2-4
Other Shellfish (species not stated)	2-4

Source Hambrey and Evans (2016)

The assumptions used to develop the BAU, N@W and LS scenarios for aquaculture in the north west marine plan areas are provided in Table 9. Projected production tonnages under each of the three scenarios is shown in Figure 8 and Figure 9. Figure 10, Figure 11 and Figure 12 shows the spatial application of the scenarios to the sector while the text below provides a brief description of the future trends in 6 years and 6 to 20 years.

Table 9: Assumptions and impacts under the future scenarios for aquaculture production in the north west marine plan areas

Aspect	Scenario		
	Business as Usual	**Nature @ Work**	**Local Stewardship**
Application to the sector	There is a relatively low production base (number of shellfish farms) in this area and hence growth in production occurs at a relatively modest rate (OBR projections) for all species produced (mussels and oysters – primarily Pacific oysters but also native) over the initial 6 years. There is high potential for growth in the mussel production sector (Hambrey and Evans, 2016). There is some push towards offshore production for mussels in this scenario, further to demonstration of the viability of such production on the south coast of England.	Facilitated by policy changes, regulatory streamlining and increased social licence in this scenario, three offshore mussel farms are developed, which reach full production capacity in 2028. Although there is potential for growth of the oyster production sector, the shorter grow-out times in the south and east of England (due to higher water temperatures) provide an advantage to the south east and south west marine plan areas for expanding this sector. Hence expansion of this sector remains relatively modest in the north west.	Facilitated by policy changes, regulatory streamlining and the recognised benefits of expanding aquaculture to the local economy, two offshore mussel farms are developed, which reach full production capacity in 2028. Although there is potential for growth of the oyster production sector, the shorter grow-out times in the south and east of England (due to higher water temperatures) provide an advantage to the south east and south west marine plan areas for expanding this sector. Hence expansion of this sector remains relatively modest in the north west.

Aspect	Scenario		
	Business as Usual	**Nature @ Work**	**Local Stewardship**
	There is one offshore mussel farm developed between 2023 and 2027, and full production potential is reached in 2028, which substantially raises production levels of mussels between 2028 and 2036. Although there is potential for growth of the oyster production sector, the shorter grow-out times in the south and east of England (due to higher water temperatures) provide an advantage to the south east and south west marine plan areas for expanding this sector. Hence expansion of this sector remains relatively modest in the north west.		The construction of the West Cumbria Tidal Lagoon, which comes online in 2033, provides an opportunity for shellfish cultivation within the lagoon.
Assumptions	Mussels - growth rate assumptions: ▪ 1.7% per annum between 2017-2018; ▪ 2.1% between 2019-2020 ▪ 2.0% between 2021-2028 Development of one large offshore mussel farm starts in 2023 and reaches full production potential (10,000 tonnes per annum) in 2028. Oysters - growth rate assumptions: ▪ 1.7% per annum between 2017-2018; ▪ 2.1% between 2019-2020 ▪ 2.0% between 2021-2036	Mussels - growth rate assumptions: ▪ 1.7% per annum between 2017-2018; ▪ 2.1% between 2019-2020 ▪ 2.0% between 2021-2028 Development of three large offshore mussel farm starts in 2023 which reach full production potential (10,000 tonnes per annum) in 2028. Oysters - growth rate assumptions: ▪ 1.7% per annum between 2017-2018; ▪ 2.1% between 2019-2020 ▪ 2.0% between 2021-2036	Growth rate assumptions: The assumed growth in annual mussel production is: ▪ 1.7% per annum between 2017-2018; ▪ 2.1% between 2019-2020 ▪ 2.0% between 2021-2028 Development of two large offshore mussel farm starts in 2023 which reach full production potential (10,000 tonnes per annum) in 2028. Oysters - growth rate assumptions: ▪ 1.7% per annum between 2017-2018; ▪ 2.1% between 2019-2020 ▪ 2.0% between 2021-2036

Aspect	Scenario		
	Business as Usual	Nature @ Work	Local Stewardship
	The increase in oyster production occurs through some expansion at the existing site and potentially new site development, subject to availability of site(s) with suitable conditions No marine based finfish production occurs due to strong market competition (lack of economic viability).	The increase in oyster production occurs through some expansion at the existing site and potentially new site development, subject to availability of site(s) with suitable conditions No marine based finfish production occurs due to strong market competition (lack of economic viability).	The increase in oyster production occurs through some expansion at the existing site and potentially new site development, subject to availability of site(s) with suitable conditions. The ability to co-locate aquaculture within the West Cumbria Tidal Lagoon from 2033, results in a relatively small additional yield of oysters (10t) in 2036. No marine based finfish production occurs due to strong market competition (lack of economic viability).

6-year projection

There is a modest increase in production of both mussels and oysters (mainly Pacific oysters but also native oysters) over the next 6 years in all scenarios.

6 to 20 year projection

Facilitated by strategic policy support, regulatory streamlining and lessons learnt from a large scale offshore mussel farm on the south coast of England, industry ambition for more production to move offshore is realised in all three scenarios. Whilst one farm is developed in BAU, three farms are developed in N@W and two farms in LS, as in these scenarios both the ecosystem service and economic benefits, particularly to coastal communities, are recognised. Although there is potential for expansion of the oyster production sector, this primarily occurs in the south east and south west marine plan areas due to the shorter growing times relating to warmer sea temperatures. The development of the marine renewable energy sector in the north west (see the Offshore Wind and Wave and Tidal Sections and figures below) provides potential marine space for co-location with shellfish aquaculture, dependent on environmental conditions, technological developments (particularly for offshore wind) and the level of cross-sector collaboration in all scenarios. This results in a small-scale increase in oyster production from the West Cumbria Tidal Lagoon in the LS scenario in 2036.

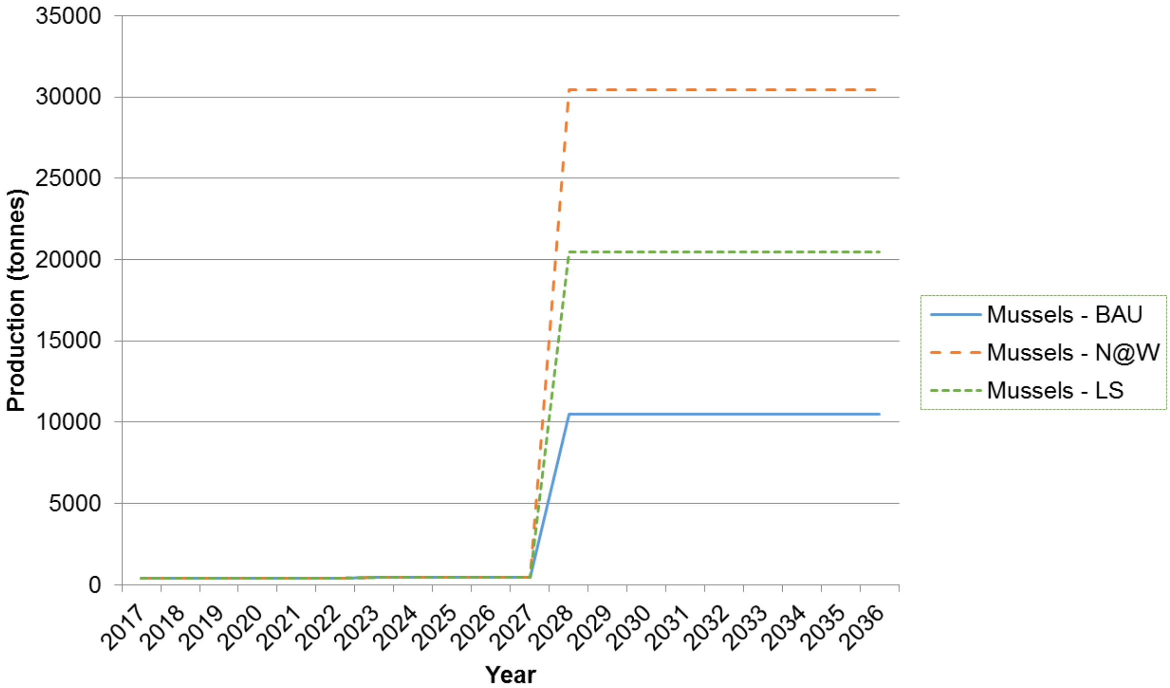


Figure 8: Projections of production tonnages (tonnes) for the mussel production sector in the three scenarios for the north west marine plan areas

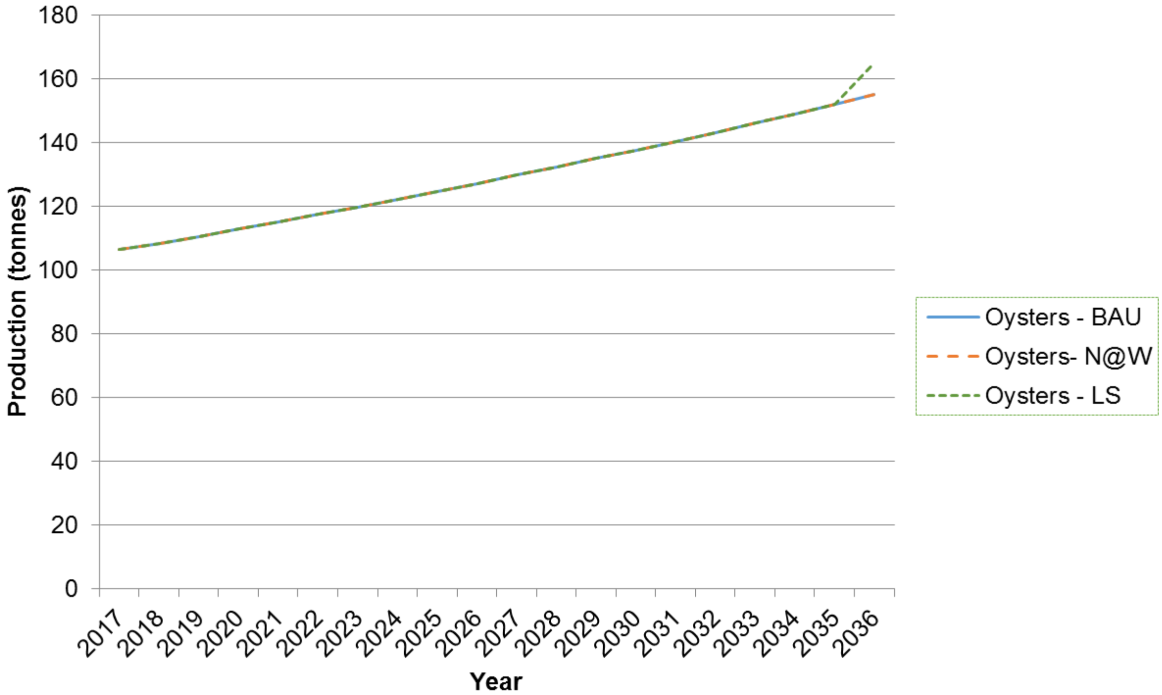


Figure 9: Projections of production tonnages (tonnes) for the oyster production sector in the three scenarios for the north west marine plan areas

Potential trade-offs

Future aquaculture development in the plan areas may occur both inshore and offshore. The main potential interactions are likely to be:

- Natural environment
- Recreation
- Commercial fishing
- Shipping
- Other infrastructure.

Inshore expansion of aquaculture under BAU, N@W and LS scenarios is likely to involve trade-offs with the natural environment and recreation. If offshore expansion under BAU and N@W is located outside of offshore wind farms, such developments could also entail trade-offs with commercial fishing, shipping and other possible future infrastructure projects. Careful siting of developments could help minimise negative trade-offs.

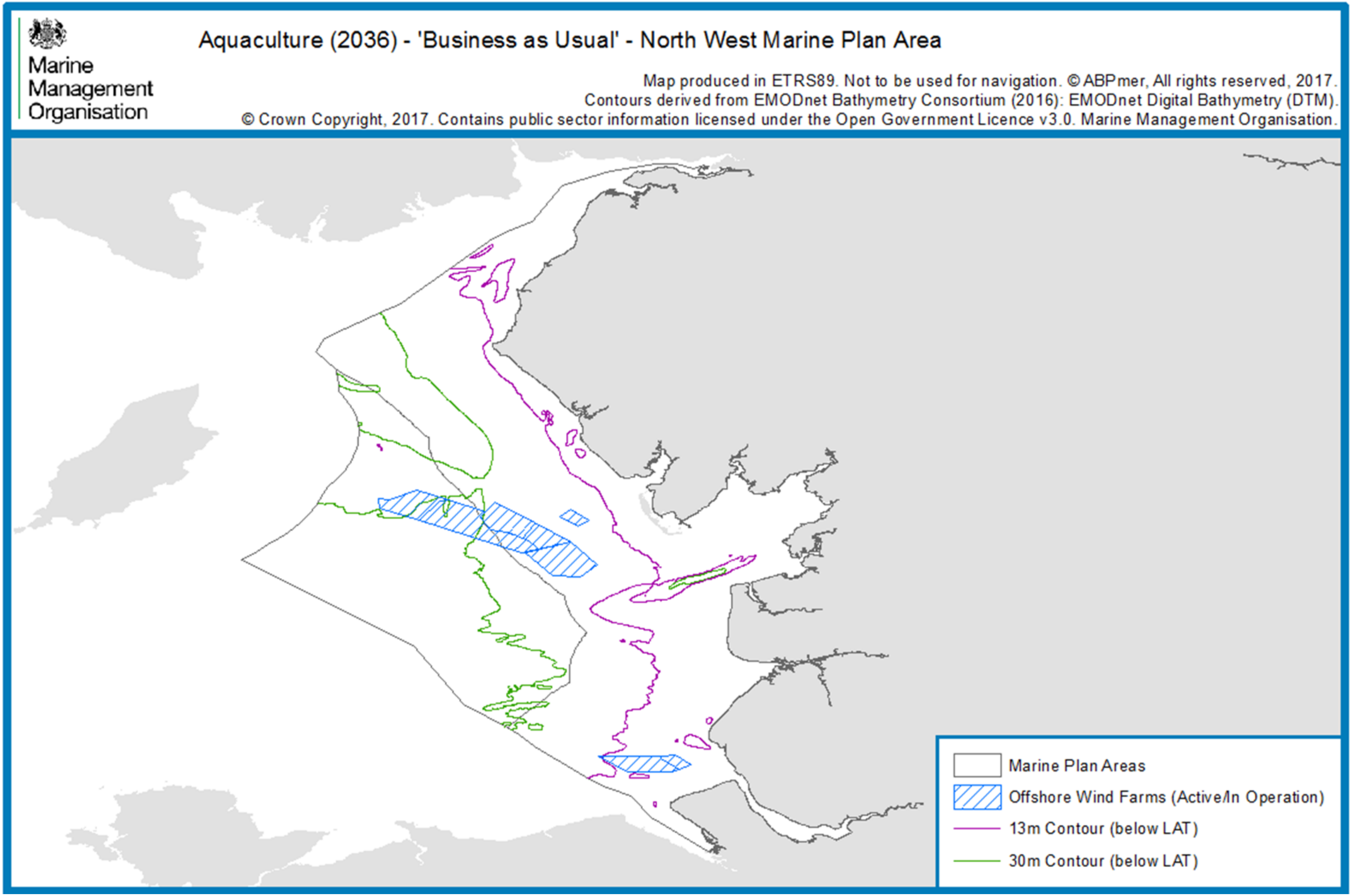


Figure 10: Aquaculture (2036) – BAU – north west marine plan areas

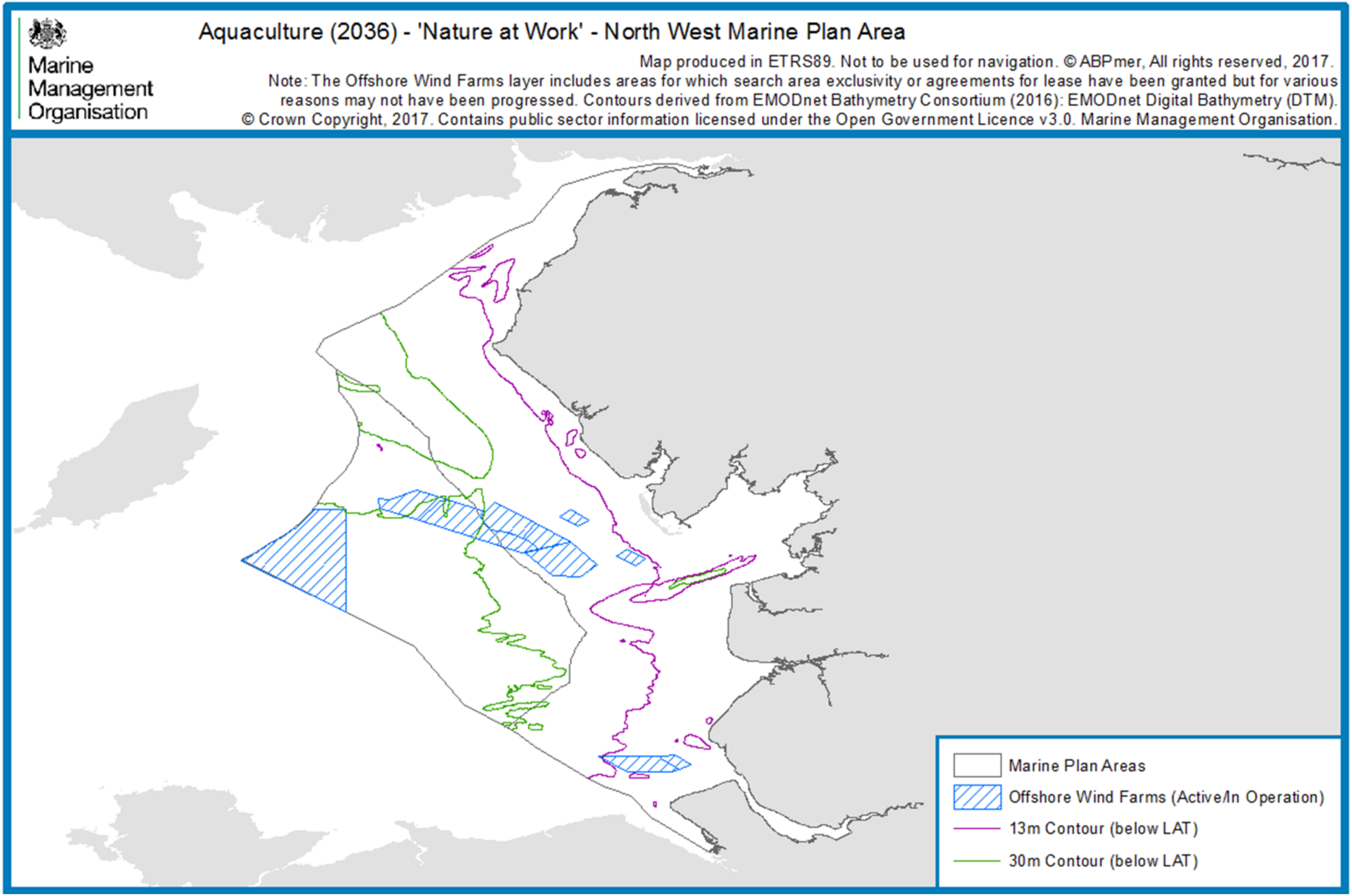


Figure 11: Aquaculture (2036) – N@W – north west marine plan areas

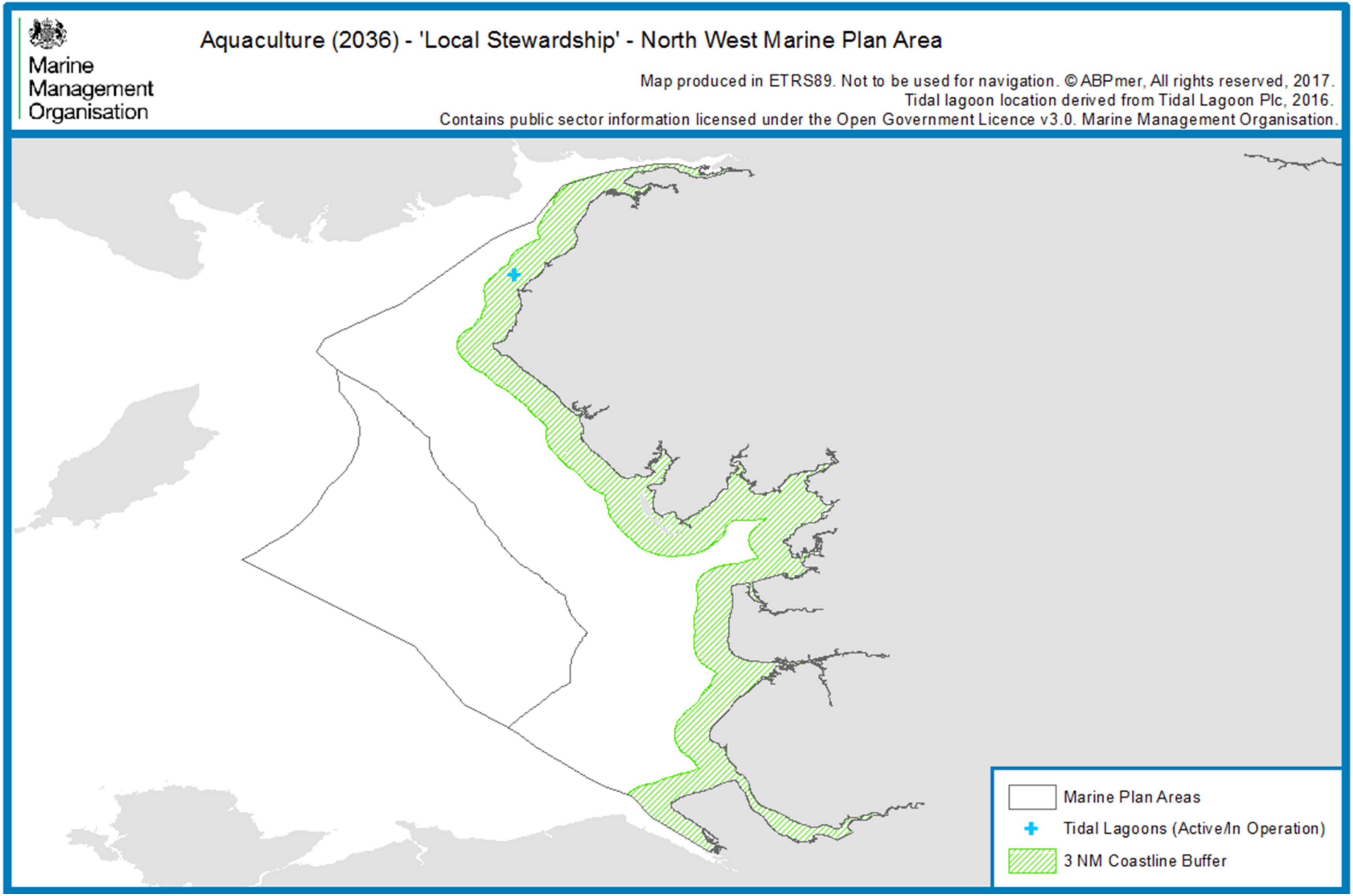


Figure 12: Aquaculture (2036) – LS – north west marine plan areas

3.4 South east

In 2013, there were seventeen registered shellfish APBs in the south east marine plan area, producing mussels (three APBs), Pacific oysters (16 APBs), Native oysters (16 APBs), Manila clam (nine APBs), Parlourde clams (two APBs), hard clam (eight APBs) and cockles (one APB) (Cefas, 2017). The south east inshore area is the dominant oyster production area (36% of English tonnage; Tim Ellis, Cefas, pers. comm. 21 February 2017).

Oyster production occurs on the Essex and north Kent coastlines. Hambrey and Evans (2016) estimated direct FTE employment in the oyster production sector in the south east of England in 2015 to be between 57 and 106, although these statistics include businesses on the Suffolk coastline which are outside of the south east marine plan area.

The assumptions used to develop the BAU, N@W and LS scenarios for aquaculture in the south east marine plan areas are provided in Table 10. Projected production tonnages under each of the three scenarios is shown in Figure 13 and

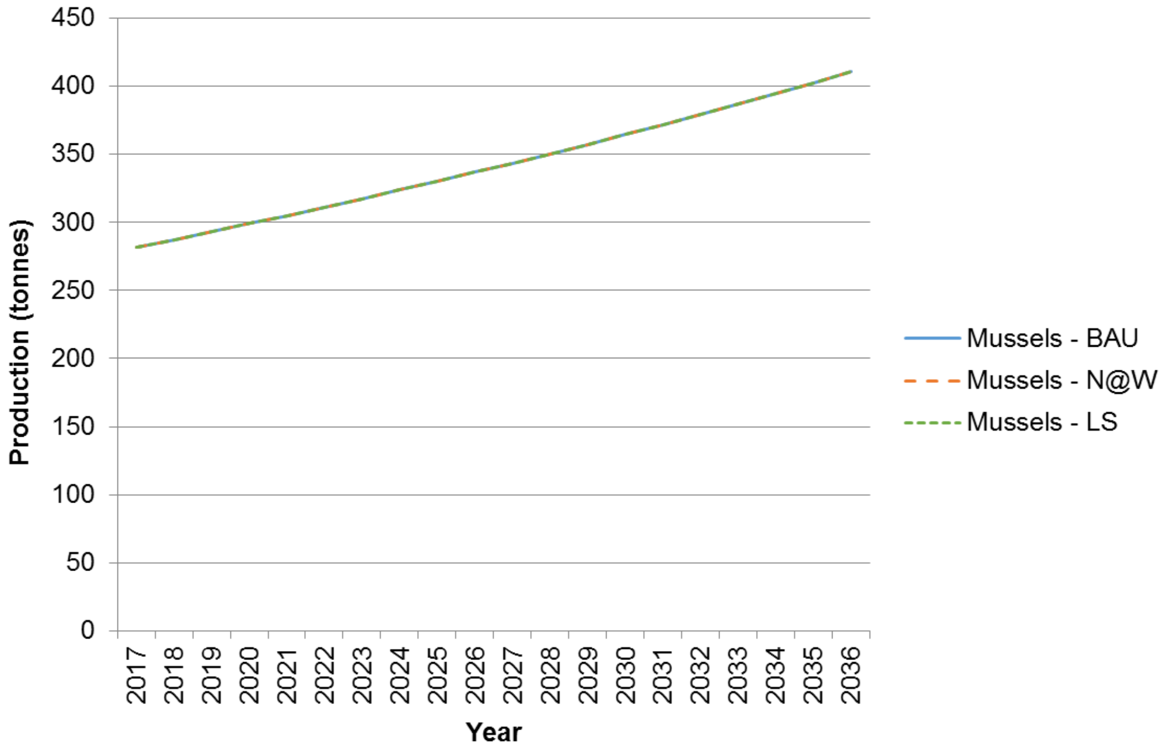


Figure 14. Figure 15, Figure 16 and Figure 17 show the spatial application of the scenarios to the sector while the text below provides a brief description of the future trends in 6 years and 6 to 20 years.

Table 10: Assumptions and impacts under the future scenarios for aquaculture production in the south east marine plan areas

Aspect	Scenario		
	Business as Usual	Nature @ Work	Local Stewardship
Application to the sector	There is potential for growth in the oyster production sector (for Pacific oysters primarily)	The potential for expansion of oyster production is realised in	The potential for expansion of oyster production is realised in

Aspect	Scenario		
	Business as Usual	**Nature @ Work**	**Local Stewardship**
	and over 50% of Pacific oysters and 75% of native oysters were produced in the south east in 2015. As a result, the production of oysters (Pacific and native oysters collectively) does increase progressively over the next 6 and 6-20 years. However, the growth rate is relatively modest as the intention to expand is still tempered slightly by constraints, including in relation to water quality, lack of social licence and the requirement for clarification regarding cultivation of Pacific oyster, in order for investment to occur. Mussels are produced in relatively small volumes in the south east. It has been assumed that there will also only be relatively modest growth via expansion in inshore waters as available space for production further offshore (e.g. between 3-6 nm) is considered unlikely in this marine plan area.	this scenario, supported by the favourable grow-out times in the warmer waters of southern England (compared to the north of England). The increase in production has been projected to occur between 6-20 years from now when technological developments (e.g. enabling more offshore production) and streamlined regulations have taken optimum effect in enabling expansion of the sector. Expansion of Pacific oyster production is facilitated by a strategy and protocol relating to the farming of this non-native species. Mussel production has been assumed to be the same as in the BAU scenario.	this scenario, supported by the favourable grow-out times in the warmer waters of southern England (compared to the north of England). The increase in production has been projected to occur between 6-20 years from now when technological developments (e.g. enabling more offshore production) and streamlined regulations have taken optimum effect in enabling expansion of the sector. Expansion of Pacific oyster production is facilitated by a strategy and protocol relating to the farming of this non-native species and improvements in water quality, resulting in increased availability of suitable sites. Expansion is also facilitated in this scenario through increased social licence for shellfish production. Mussel production has been assumed to be the same as in the BAU scenario

Aspect	Scenario		
	Business as Usual	**Nature @ Work**	**Local Stewardship**
Assumptions	Oyster - growth rate assumptions: ▪ 1.7% per annum between 2017-2018; ▪ 2.1% between 2019-2020 ▪ 2.0% between 2021-2036 The increase in oyster production occurs through some expansion at the existing site and potentially new site development, subject to availability of site(s) with suitable conditions Mussel - growth rate assumptions: ▪ 1.7% per annum between 2017-2018; ▪ 2.1% between 2019-2020 ▪ 2.0% between 2021-2036 The increase in mussel production occurs through some expansion at the existing site and potentially new site development, subject to availability of site(s) with suitable conditions No marine based finfish production occurs due to strong market competition (lack of economic viability).	Oyster - growth rate assumptions: ▪ 1.7% per annum between 2017-2018; ▪ 2.1% between 2019-2020 ▪ 6% between 2021-2036 The increase in oyster production occurs through expansion at the existing sites and new site developments. Mussel - growth rate assumptions: ▪ 1.7% per annum between 2017-2018; ▪ 2.1% between 2019-2020 ▪ 2.0% between 2021-2036 The increase in mussel production occurs through some expansion at the existing site and potentially new site development, subject to availability of site(s) with suitable conditions No marine based finfish production occurs due to strong market competition (lack of economic viability).	Oyster - growth rate assumptions: ▪ 1.7% per annum between 2017-2018; ▪ 2.1% between 2019-2020 ▪ 8% between 2021-2036 The increase in oyster production occurs through expansion at the existing sites and new site developments. Mussel - growth rate assumptions: ▪ 1.7% per annum between 2017-2018; ▪ 2.1% between 2019-2020 ▪ 2.0% between 2021-2036 The increase in mussel production occurs through some expansion at the existing site and potentially new site development, subject to availability of site(s) with suitable conditions No marine based finfish production occurs due to strong market competition (lack of economic viability).

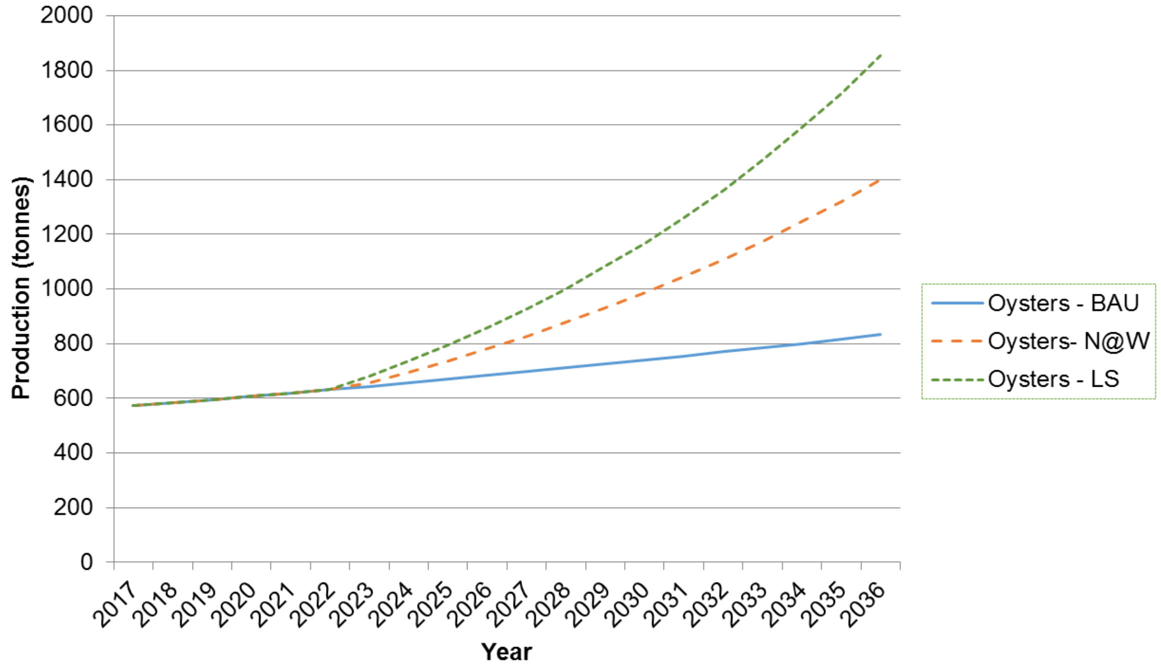


Figure 13: Projections of production tonnages (tonnes) for the oyster production sector in the three scenarios for the south east marine plan areas

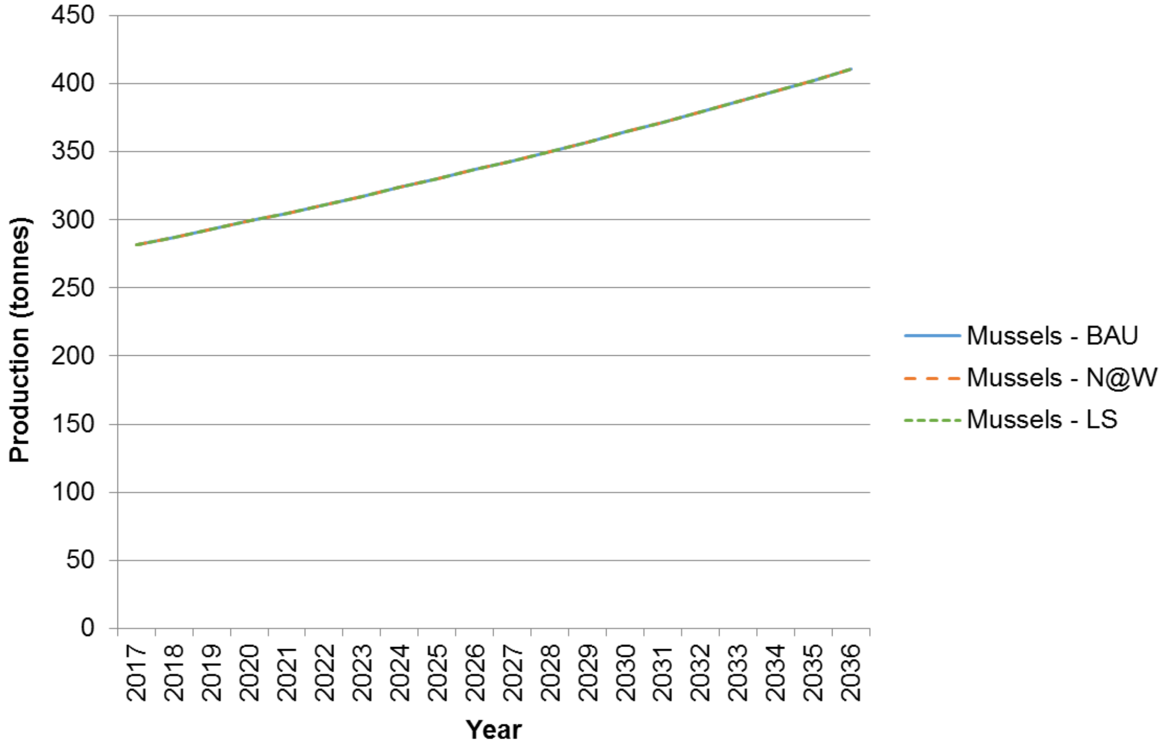


Figure 14: Projections of production tonnages (tonnes) for the mussel production sector in the three scenarios for the south east marine plan areas

6-year projection

There is a modest increase in production of both mussels and oysters (mainly Pacific oysters but also native oysters) over the next 6 years in all scenarios.

6 to 20 year projection

Facilitated by strategic policy support, technological developments, regulatory streamlining and increased social licence, the largest expansion of the oyster production sector occurs in the N@W and LS scenarios. Growth in the LS scenario is greater than in N@W due to improvements in water quality creating additional suitable sites for the industry. The growth in mussel production, which is a relatively minor sector in this area, is more modest in all three scenarios.

Potential trade-offs

The potential trade-offs are similar to the north west marine plan areas.

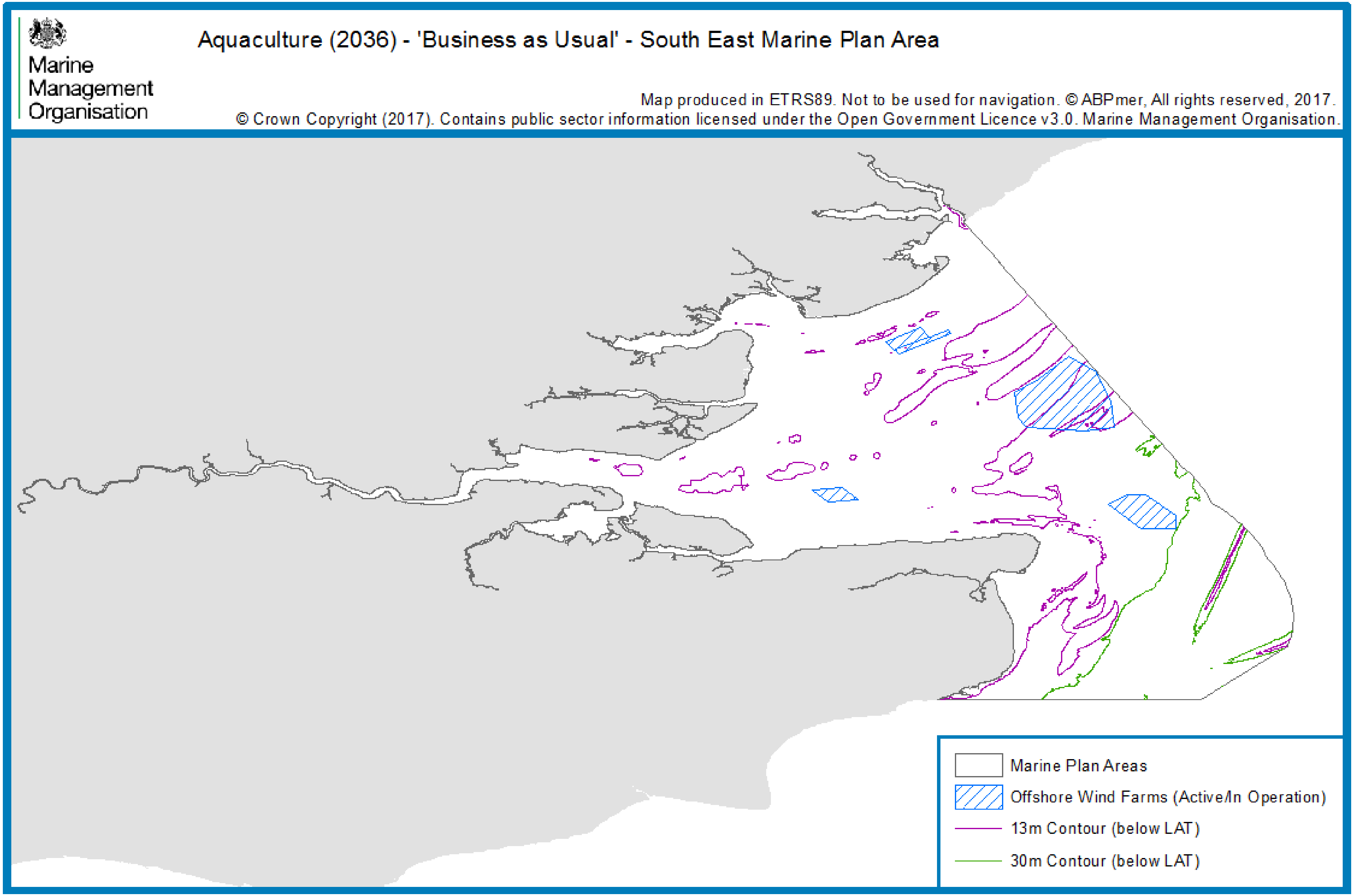


Figure 15: Aquaculture (2036) – BAU – south east marine plan area

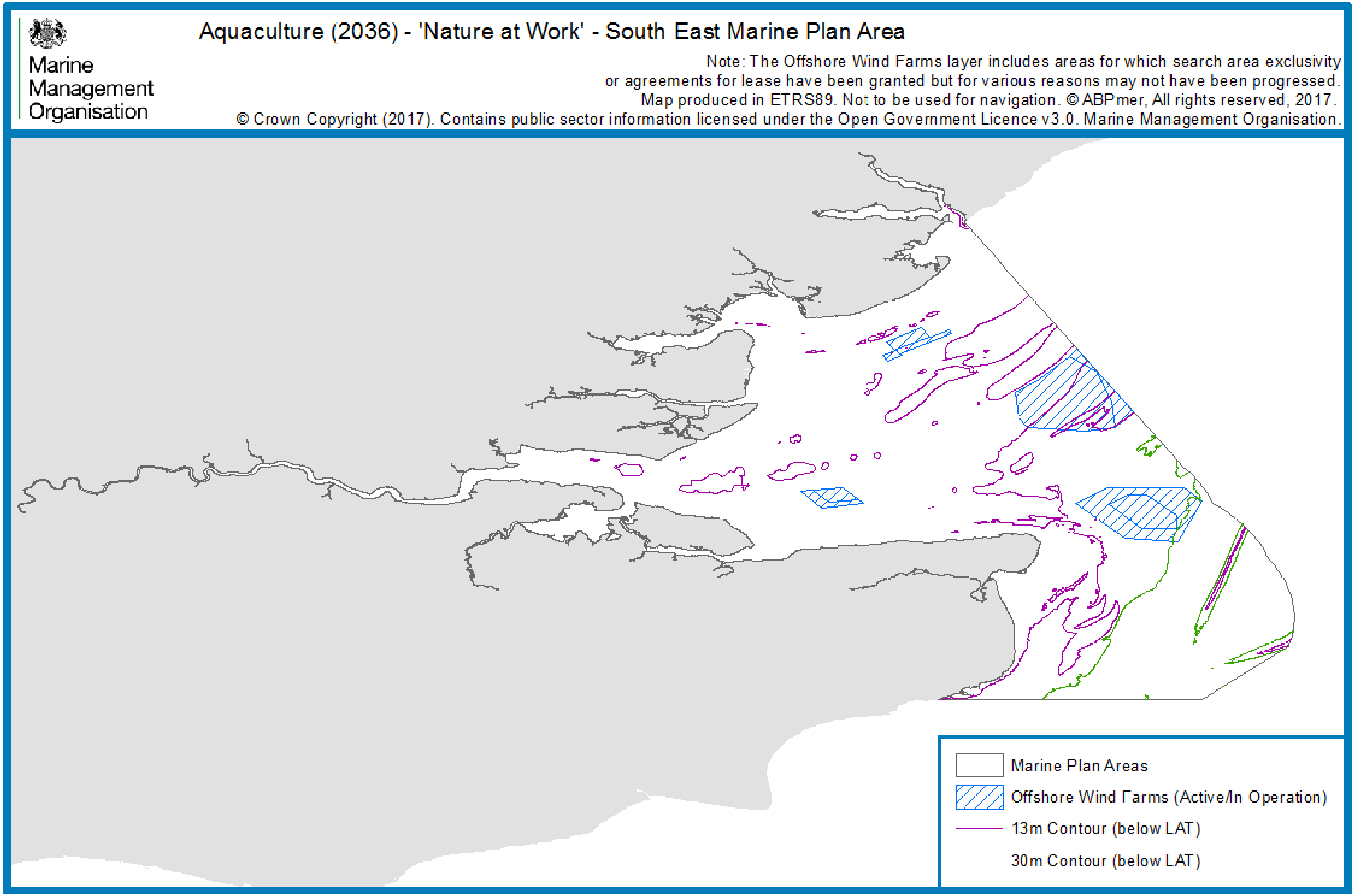


Figure 16: Aquaculture (2036) – N@W – south east marine plan area

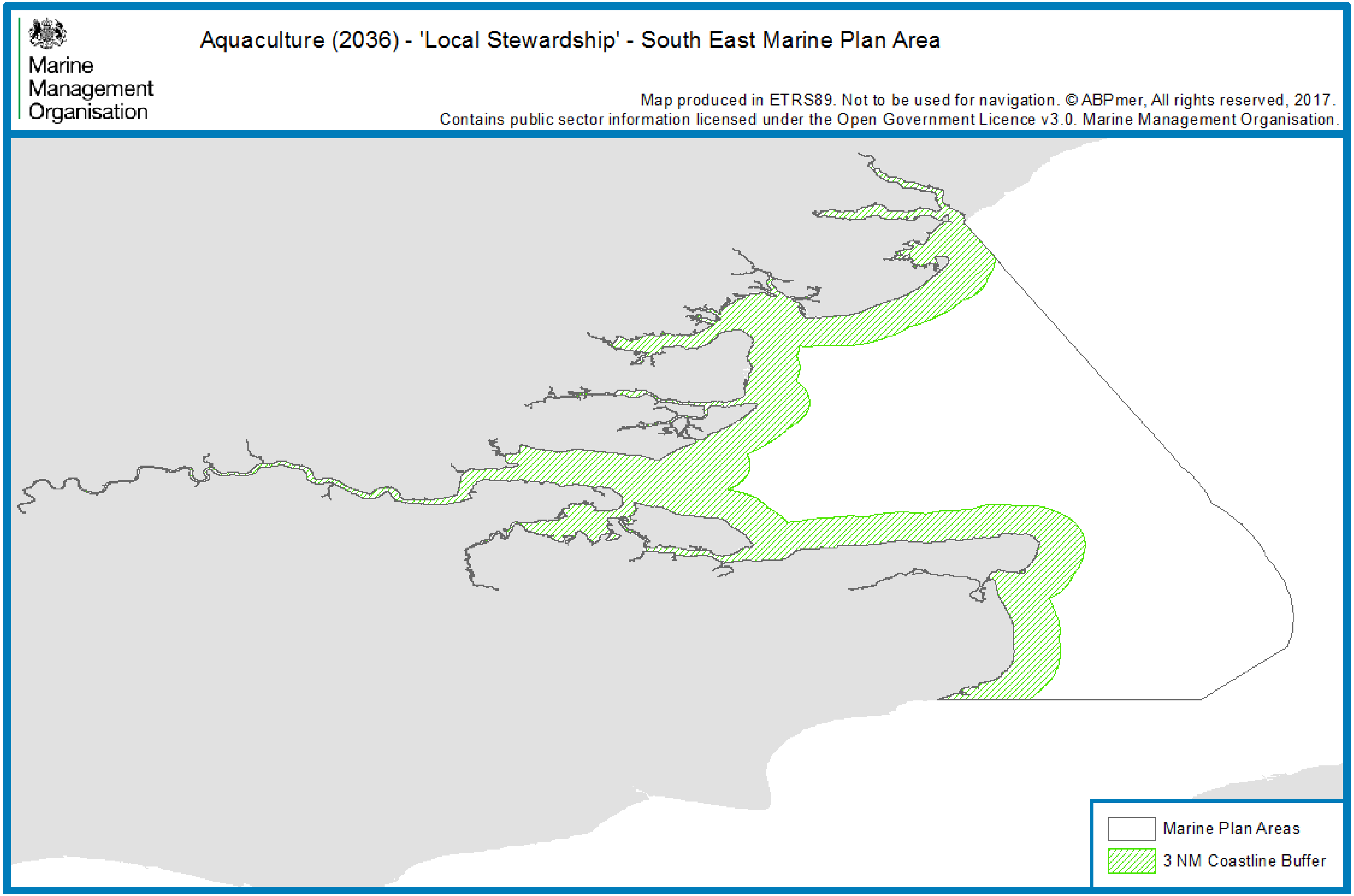


Figure 17: Aquaculture (2036) – LS – south east marine plan area

3.5 South west

In 2013, there were fourteen registered shellfish APBs in the south west marine plan area, producing mussels (14 APBs), Pacific oysters (10 APBs), Native oysters (three APBs) and scallops (one APB) (Cefas, 2017). The south west inshore area is the dominant mussel production area (42% of English tonnage; Tim Ellis, Cefas, pers. comm. 21 February 2017).

Hambrey and Evans (2016) estimated direct FTE employment in different shellfish sectors in the south west of England in 2015 as shown in Table 11.

Table 11: Employment estimates for northern England in 2015

Sector	Estimated direct FTE Employees (Low – High Estimates)
Oysters	20-37
Mussels	29-53
Other Shellfish (species not stated)	3-7
Note, the area classified as the south west in Hambrey and Evans (2016) includes areas outside of the south west marine plan area	

Source Hambrey and Evans (2016)

As noted above, there are no marine-based finfish aquaculture production businesses in England, although there is an APB registered as a finfish farm in the south west that holds native marine fish.

The assumptions used to develop the BAU, N@W and LS scenarios for aquaculture in the south west marine plan areas are provided in Table 12. Projected production tonnages under each of the three scenarios is shown in Figure 18, Figure 19 and Figure 20. Figure 21, Figure 22 and Figure 23 shows the spatial application of the scenarios to the sector while the text below provides a brief description of the future trends in 6 years and 6 to 20 years.

Table 12: Assumptions and impacts under the future scenarios for aquaculture production in the south west marine plan areas

Aspect	Scenario		
	Business as Usual	**Nature @ Work**	**Local Stewardship**
Application to the sector	There is high potential for growth in the mussel production sector (Hambrey and Evans, 2016) and over two thirds of mussel production in England in 2015 came from the south west. There is some push towards offshore production for mussels in this scenario, further to demonstration of the viability of such production on the south coast of England. There is one offshore	Facilitated by policy changes, regulatory streamlining and increased social licence in this scenario, three offshore mussel farms are developed, which reach full production capacity in 2028. This scenario also fosters a higher growth rate in the oyster production sector, compared to BAU, for the same reasons. Technological	Facilitated by policy changes, regulatory streamlining and increased social licence in this scenario, two offshore mussel farms are developed, which reach full production capacity in 2028. This scenario also fosters a higher growth rate in the oyster production sector, compared to BAU, for the same reasons. In addition, growth rates

Aspect	Scenario		
	Business as Usual	**Nature @ Work**	**Local Stewardship**
	mussel farm developed between 2023 and 2027, and full production potential is reached in 2028, which substantially raises production levels of mussels between 2028 and 2036. Although there is potential for growth in the oyster production sector (for Pacific oysters primarily) the growth rate is relatively modest in this scenario as the intention to expand is still tempered slightly by constraints, including in relation to water quality, lack of social licence and the requirement for clarification regarding of cultivation of Pacific oyster, in order for investment to occur. There is potential for growth in the production of scallops and strong interest in doing so in the South West. However, site availability, water quality and seed availability constrain the production to low levels in this scenario.	developments in the hatchery production of scallop spat provide a consistent source of spat for this sector to expand at a greater rate compared to BAU, reaching a production level of 3,000 tonnes per annum between 2028-2036.	are higher than in N@W due to improvements in inshore water quality resulting in increased availability of suitable sites. The development of two tidal lagoons in this scenario (Bridgewater Bay and West Somerset Tidal Lagoons, which come online in 2033) provides an additional opportunity for shellfish cultivation within the lagoons. Technological developments in the hatchery production of scallop spat provide a consistent source of spat for this sector to expand at a greater rate compared to BAU, reaching a production level of 3,000 tonnes per annum between 2028-2036.
Assumptions	Mussels - growth rate assumptions: ▪ 1.7% per annum between 2017-2018; ▪ 2.1% between 2019-2020 ▪ 2.0% between 2021-2028 Development of one large offshore mussel farm starts in 2023 and reaches full production potential (10,000 tonnes per annum) in 2028.	Mussels - growth rate assumptions: ▪ 1.7% per annum between 2017-2018; ▪ 2.1% between 2019-2020 ▪ 2.0% between 2021-2028 Development of three large offshore mussel farms start in 2023 and reaches full production potential (10,000 tonnes per annum) in 2028.	Mussels - growth rate assumptions: ▪ 1.7% per annum between 2017-2018; ▪ 2.1% between 2019-2020 ▪ 2.0% between 2021-2028 Development of two large offshore mussel farm starts in 2023 and reaches full production potential (10,000 tonnes per annum) in 2028.

Aspect	Scenario		
	Business as Usual	**Nature @ Work**	**Local Stewardship**
	Oysters - growth rate assumptions: ▪ 1.7% per annum between 2017-2018; ▪ 2.1% between 2019-2020 ▪ 2.0% between 2021-2036 The increase in oyster production occurs through some expansion at the existing site and potentially new site development, subject to availability of site(s) with suitable conditions Production of 1,000 tonnes per annum of scallop is achieved between 2028-2036.	Oysters - growth rate assumptions: ▪ 1.7% per annum between 2017-2018; ▪ 2.1% between 2019-2020 ▪ 6% between 2021-2036 The increase in oyster production occurs through some expansion at the existing site and new site development. Production of 3,000 tonnes per annum of scallop is achieved between 2028-2036.	Oysters - growth rate assumptions: ▪ 1.7% per annum between 2017-2018; ▪ 2.1% between 2019-2020 ▪ 8% between 2021-2036 The increase in oyster production occurs through some expansion at the existing site and new site development (facilitated by reduced competition with some fisheries excluded from within 3nm, improvements in inshore water quality and greater social licence from local communities). The ability to co-locate aquaculture within the Bridgewater Bay and West Somerset Tidal Lagoons from 2033, results in an additional yield of oysters (10 tonnes) from each lagoon in 2036. Production of 3,000 tonnes per annum of scallop is achieved between 2028-2036, with a potential increase in production levels beyond 2036 (outwith the scope of this study) through production within the Bridgewater Bay and West Somerset Tidal Lagoons.

6-year projection

There is a modest increase in production of both mussels and oysters (mainly Pacific oysters but also native oysters) over the next 6 years in all scenarios.

6 to 20 year projection

Facilitated by strategic policy support, regulatory streamlining and lessons learnt from a large scale offshore mussel farm on the south coast of England, industry ambition for more production to move offshore is realised in all three scenarios. Whilst one farm is developed in BAU, three farms are developed in N@W and two farms in LS, as in these scenarios both the ecosystem service and economic benefits, particularly to coastal communities, are recognised. These changes also benefit the oyster production sector in the N@W and LS scenarios, with the largest increases observed in 6-20 years from the present. Growth in oyster production in the LS scenario is greater than in N@W due to improvements in inshore water quality creating additional suitable sites for the industry combined with the development of the marine renewable energy sector in the south west (the Atlantic Array Offshore Wind Farm, and the Bridgewater Bay and West Somerset Tidal Lagoons) which provides potential marine space for co-location with shellfish aquaculture. This results in an additional small-scale increase in oyster production from the Bridgewater Bay and West Somerset Tidal Lagoons in the LS scenario in 2036. Technological developments provide a reliable source of scallop spat, which enables the development of this production sector in the south west.

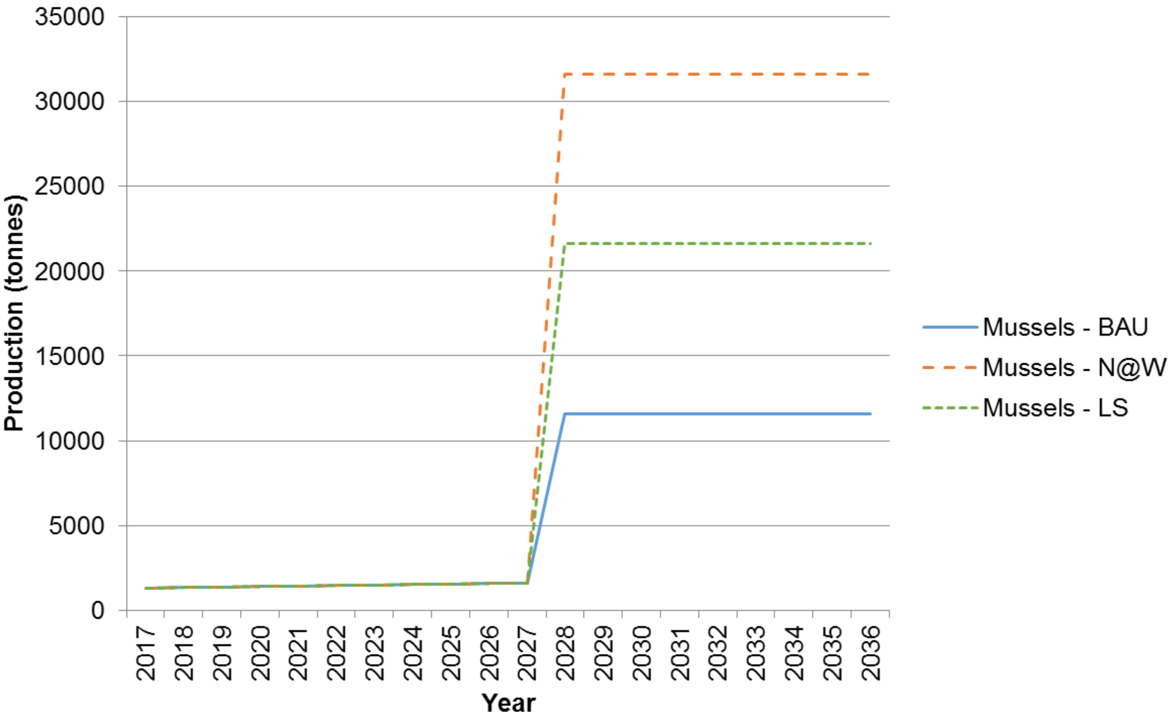


Figure 18: Projections of production tonnages (tonnes) for the mussels production sector in the three scenarios for the south wast marine plan areas

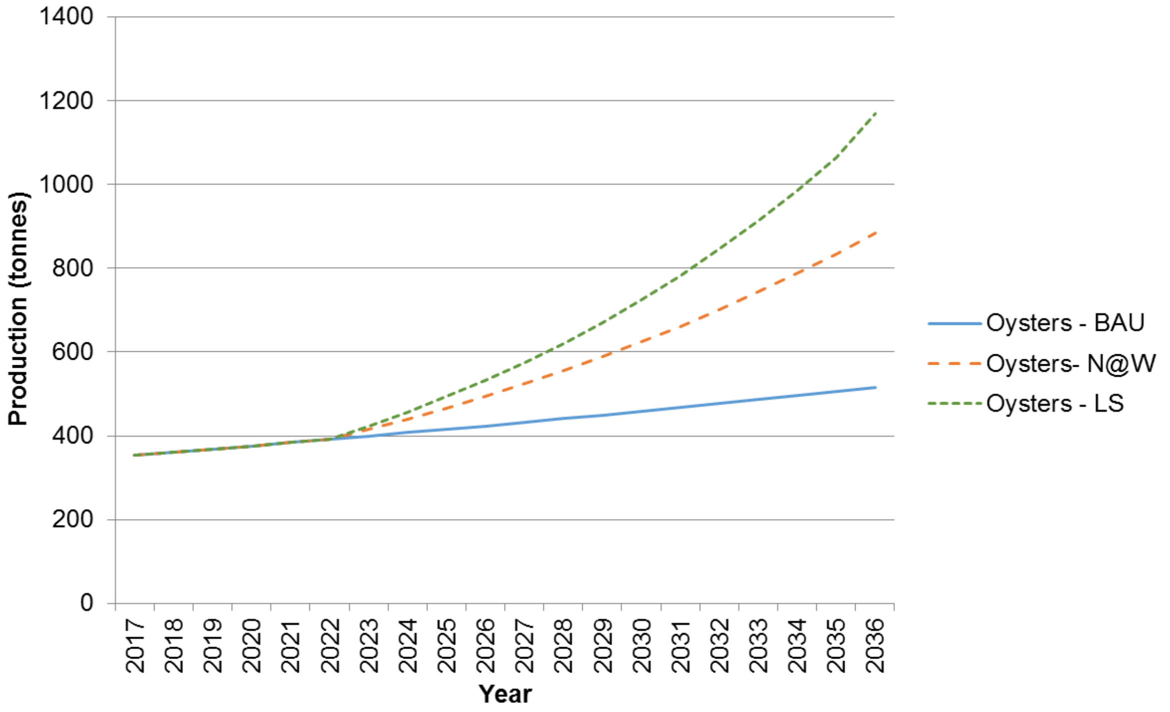


Figure 19: Projections of production tonnages (tonnes) for the oyster production sector in the three scenarios for the south wast marine plan areas

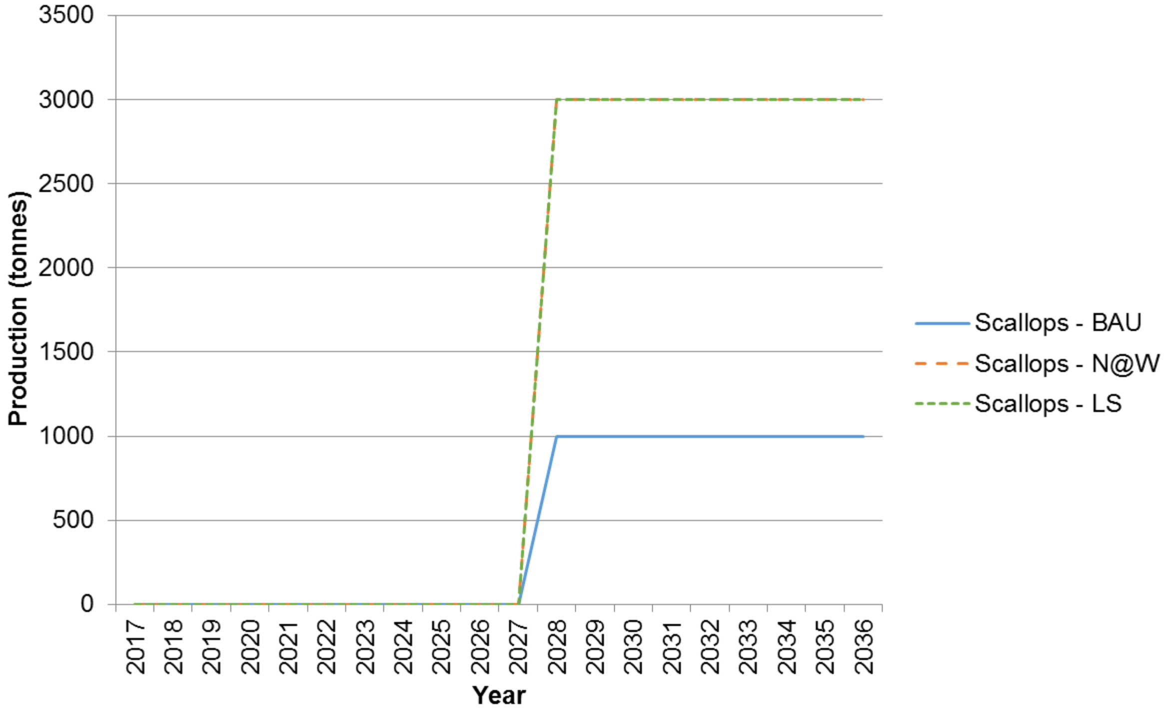


Figure 20: Projections of production tonnages (tonnes) for the scallop production sector in the three scenarios for the south wast marine plan areas

Potential trade-offs

The potential trade-offs are similar to the north west marine plan areas.

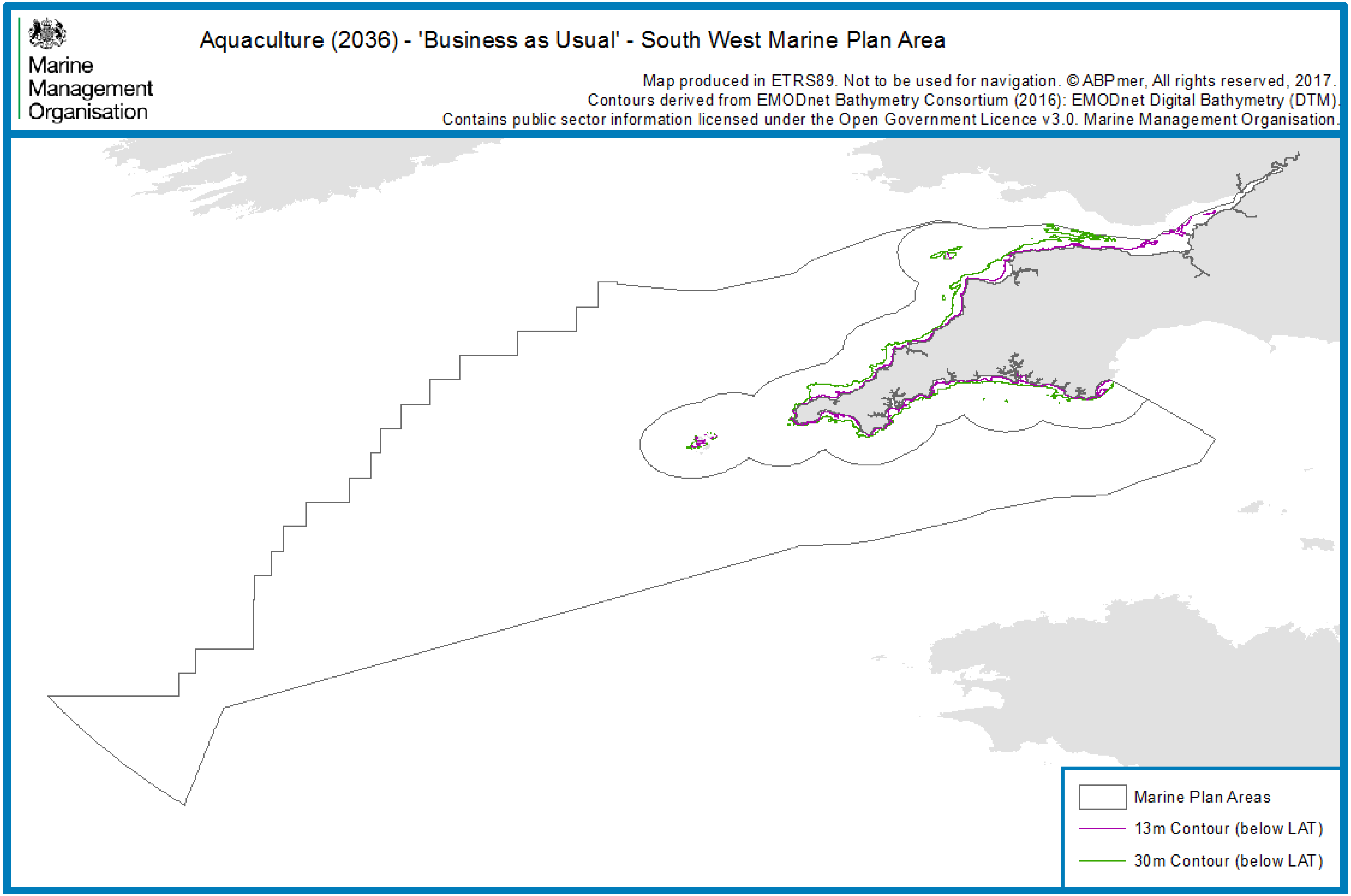


Figure 21: Aquaculture (2036) – BAU – south west marine plan areas

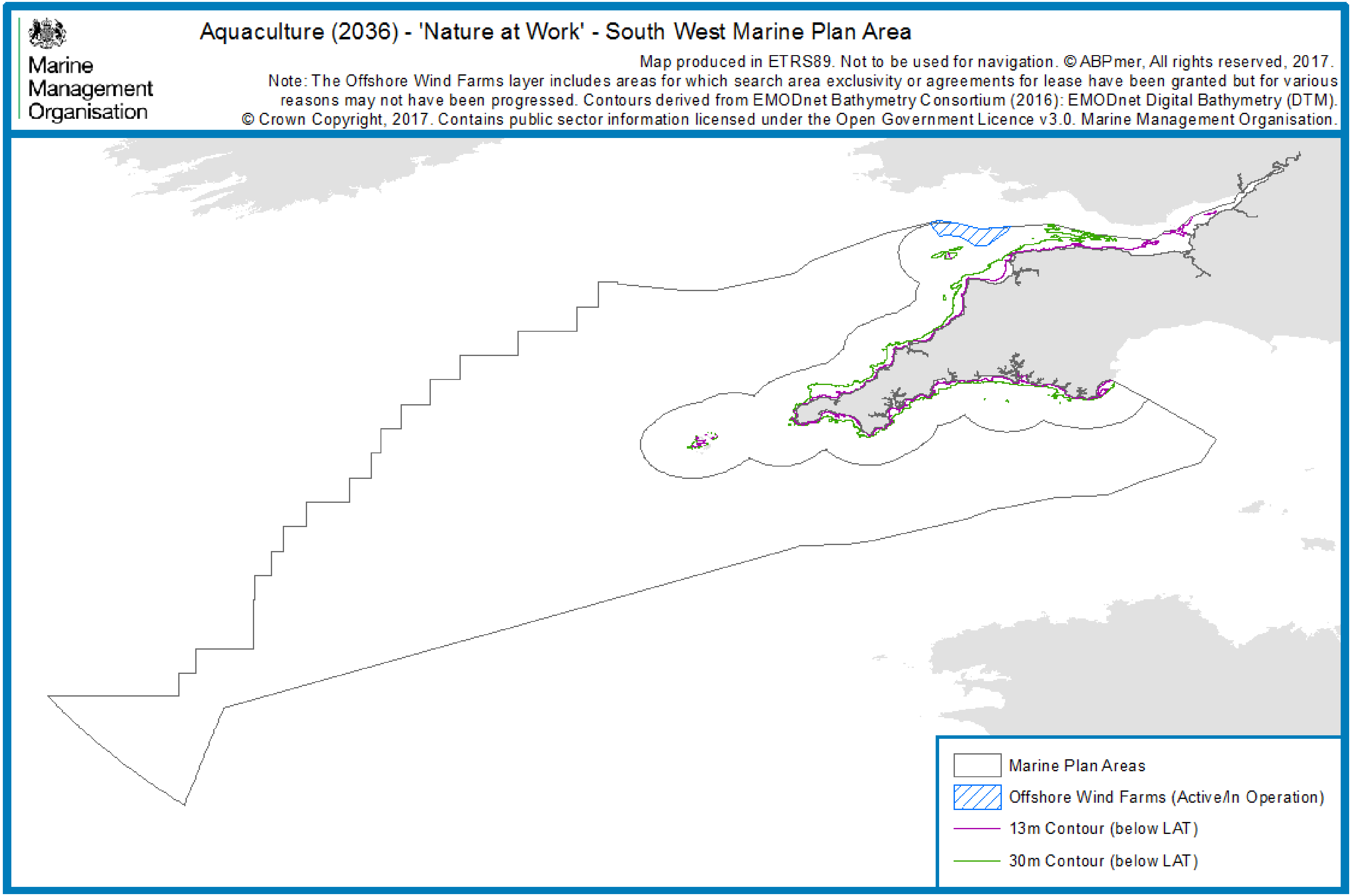


Figure 22: Aquaculture (2036) – N@W – south west marine plan areas

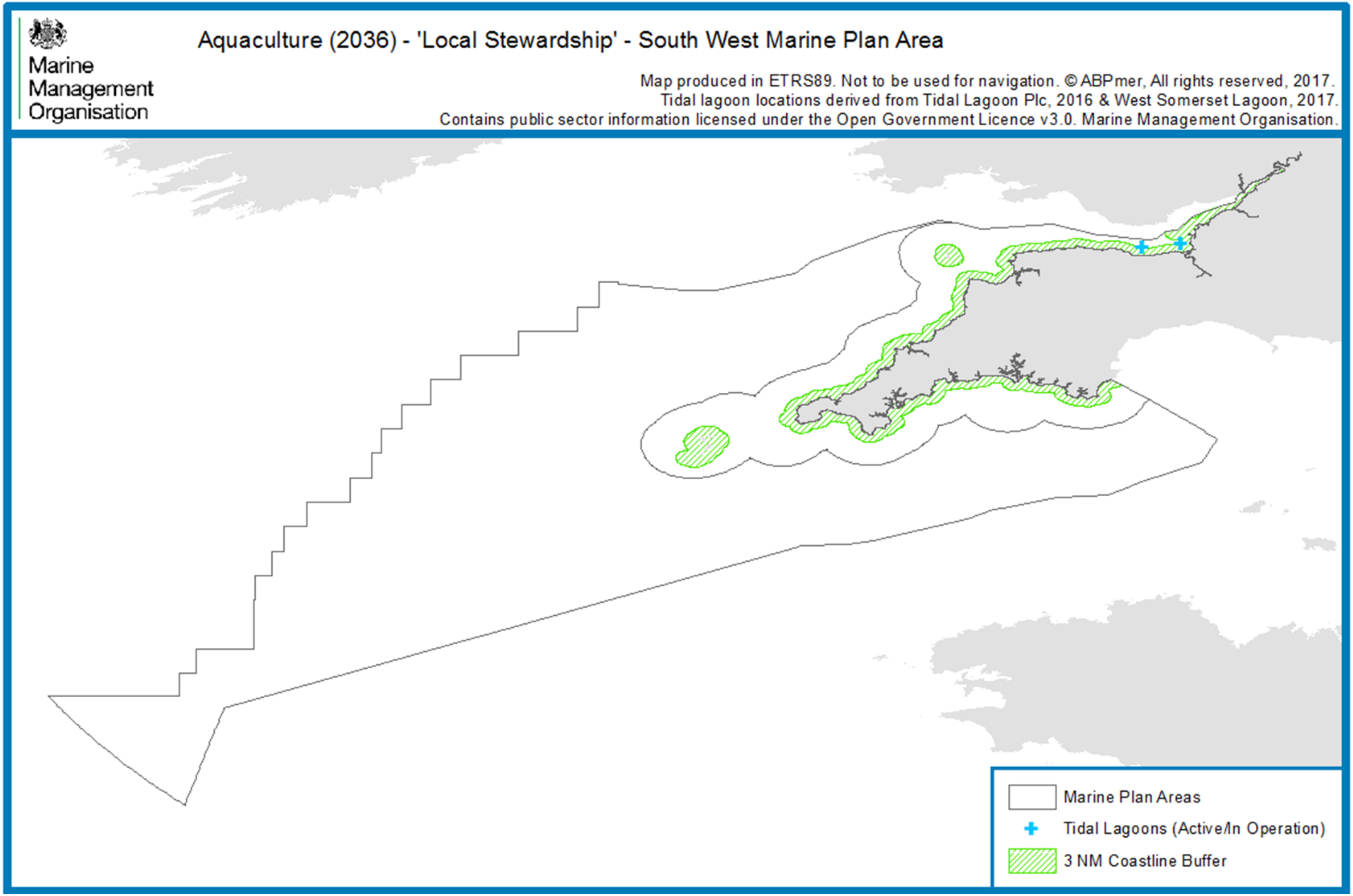


Figure 23: Aquaculture (2036) – LS – south west marine plan areas

4 Carbon, capture and storage

Sector definition

Carbon capture and storage (CCS) is a carbon abatement technology that enables fossil fuels to be used with substantially reduced carbon dioxide (CO_2) emissions. CCS combines three distinct processes: capturing the CO_2 from power stations and other industrial sources, transporting it (usually via pipelines) to storage points, then injection of the CO_2 into deep geological formations (e.g. deep saline aquifers or depleted oil and gas fields) for permanent storage.

Data sources

A variety of different information sources have been reviewed to inform this baseline, including published reports and papers and spatial data layers. The main information sources used were:

- CCS Roadmap (Department of Energy and Climate Change (DECC), 2012);
- Future of CCS in the UK (House of Commons Energy and Climate Change Committee, 2016);
- Economic baseline assessment for the North East, North West, South East and South West Marine Plans (MMO, 2016a); and
- Carbon Capture and Storage Association (CCSA) website[3].

4.1 National review

Overview of national activity

The need to reduce harmful industrial emissions of CO_2 was recognised by the UK Government in the Climate Change Act 2008. This Act sets legally binding targets for the UK to reduce emissions of CO_2 and other greenhouse gases by 80% from 1990 levels, by 2050. The UK Government is committed to making CCS a viable option as part of the UK's low carbon generation mix and to facilitating development of CCS as a key technology for the decarbonisation of the industrial sector. As part of the CCS Roadmap to support the deployment of CCS, the UK Government plans to support the development of a strong and robust supply chain in the UK, creating jobs and markets locally and nationally to serve the early CCS plants and later clusters of CCS activity (DECC, 2012).

CCS is an active field of research and development, and a growing industry. The practice of carbon storage in subsea geological structures has been ongoing globally for more than 30 years. From fewer than 10 large-scale operational projects in 2010, the Global CCS Institute (2016) identified 38 large-scale CCS projects around the world, either in operation, under construction or in various stages of development planning. At the time the Global CCS Institute report was published, there were 15 large-scale CCS projects in operation, with a CO_2 capture capacity of close to 30 million tonnes per annum. As projects in the United States (US), Australia and Canada come on-line, the number of large-scale operational CCS projects is

[3] http://www.ccsassociation.org (Accessed March 2017).

expected to increase to 21 by the end of 2017, with a CO_2 capture capacity of approximately 40 million tonnes per annum.

The commercial viability of CCS is yet to be demonstrated in the UK and the industry has been affected by early setbacks in terms of financing. In 2007, the Department of Business, Enterprise and Regulatory Reform (BERR) launched its first competition for the UK Government to support the development of CCS projects in the UK, but this was cancelled in 2011 before funds were awarded. In 2012, the Department launched a new CCS programme, with an objective to enable developers to invest in CCS in the early 2020s with government support comparable to other low-carbon generating technologies. The second competition was the start of this CCS programme, with the Department hoping it would demonstrate the commercial and technical viability of deploying CCS in the UK. However, as part of the 2015 Spending Review, the UK Government announced the £1 billion capital funding allocated to the second competition was no longer available (National Audit Office, 2017).

There are currently no industrial scale CCS projects in operation in the UK. At the time of the 2015 Spending Review, two preferred bidders that undertook design and engineering stage research and development had been identified for the second CCS Competition: (1) Shell’s Peterhead CCS project; and (2) Capture Power Limited’s White Rose CCS project. The Peterhead CCS project involved capturing around 85% of the CO_2 from an existing combined cycle gas turbine (CCGT) power station at Peterhead (Aberdeenshire, Scotland), before transporting it offshore and storing it in the Goldeneye depleted gas field 2.5 km beneath the North Sea. The White Rose CCS project involved capturing around 90% of the CO_2 from a new super-efficient coal-fired power station at the Drax site in North Yorkshire, before transporting offshore and storing it in a saline rock formation beneath the North Sea. However, both of these projects have since been cancelled due to the withdrawal of UK Government funding, although it should be noted that the proposed Endurance storage site as part of the White Rose CCS project remains under agreement for lease.

While funding from the UK Government is currently not available and there are no UK-based commercial-scale developments in operation, the principles of the CCS Roadmap (DECC, 2012) remain applicable. The CCS Roadmap sets out a vision for a future with widespread deployment of cost-competitive CCS, with tens of gigawatts (GWs) of installed capacity in the power sector and CCS on a variety of industrial applications. Potential CO_2 storage sites include depleted hydrocarbon reservoirs, production fields with the addition of CO_2 enhanced hydrocarbon recovery, and deep saline aquifers. It is envisaged that there would be clusters of power and industrial plants linked together by a pipeline network transporting CO_2 to suitable clusters of storage sites offshore. The potential for such clusters already exists in several regions in the UK, including the east coast of Scotland, Yorkshire and Humber, Teesside, and the eastern Irish Sea, where there are large concentrations of industry close to potential storage capacity. There are also other smaller clusters and other potential storage sites that could be utilised, which would also require supporting infrastructure to be installed (DECC, 2012).

Review of historical trends

CCS is an active field of research and development and a growing industry. However, there are currently no full-scale CCS demonstration projects in operation at coal- or gas-fired power plants within the UK. Plans for a CCS power plant at Longannet in Scotland were cancelled in 2011 due to economic and financial factors, while the Peterhead and White Rose projects have been cancelled following withdrawal of UK Government funding. CCS projects are currently being demonstrated at an industrial scale at a number of locations globally, including in Norway, Canada and the US.

Review of key changes and/or advances of significance affecting the sector

In November 2015, the UK Government announced that funding for CCS projects had been withdrawn for the 'UK CCS Commercialisation Competition'. The decision to remove potential funding for the competition led to the two bidders, namely Shell (Peterhead) and Capture Power Limited (White Rose), cancelling their projects as it is currently inconceivable that CCS will be developed without UK Government support (National Audit Office, 2017). The House of Commons Energy and Climate Change Committee (2016) reported on the future of CCS in the UK, suggesting that a new strategy for CCS (in conjunction with a new gas strategy) should be promptly devised. The challenging infrastructure surrounding the transport and storage of carbon needs to be considered far in advance of it being utilised and investors need the confidence that the UK is committed to a domestic CCS market. The report indicated that if the UK Government does not develop a clear strategy for CCS in the near future, knowledge, investment, assets and expertise in the UK will all be lost.

Deloitte (2016), in a report prepared for The Crown Estate, reviewed the current situation for CCS in the UK since Government funding was withdrawn in late 2015 and made a number of conclusions and recommendations. This included the need to address uncertainty that currently exists within the CCS industry and consider a wider strategic approach to develop a CO_2 transport and industrial network that connects locations (actual or planned) of major power generation plants and industrial facilities with storage sites.

CCS is likely to play a vital role in the move to a low-carbon economy, alongside renewables and nuclear power. CCS is applicable to both the power sector and industrial sectors, many of which may rely on CCS technology to reduce their CO_2 emissions in the future. These CCS technologies will help the advancement of the power and industry sectors, maintaining associated jobs and contributions to the local community. In the future, it is estimated that CCS could create 60,000 jobs across the UK by 2030, contributing up to £40 billion to the UK's economy (AEA, 2008).

There are a number of key policy drivers for the development of the CCS sector in the UK, summarised in Table 13. In particular, the UK has a legally-binding commitment to reduce carbon emissions under the Kyoto Protocol, Paris Agreement and Climate Change Act 2008, and CCS is considered to be a possible technology that will help meet these commitments.

Table 13: Key drivers affecting development of the CCS sector

Driver	Details	Implications
Political	The Carbon Plan sets out the UK Government's plans for achieving the emissions reductions it committed to in the first 4 carbon budgets (2008 – 2027)	Increased investment in CCS
	The CCS Roadmap (DECC, 2012) highlights the UK Government's commitment to helping make CCS a viable option for reducing emissions in the UK	Identified areas most suitable for CCS deployment
	The Carbon Storage Directive (2009/31/EC) establishes a legal framework for the environmentally safe geological storage of CO_2 to contribute to the fight against climate change	Increased investment in CCS
	The UK Marine Policy Statement (HM Government, 2011) highlights the UK's programme to support the development and deployment of CCS and, in particular, the need for suitable locations that provide for the permanent storage of CO_2	Increased investment in CCS
Economic	Funding for the 'UK CCS Commercialisation Competition' was withdrawn in November 2015	Reduced investor confidence in the UK sector
	Requirement for financial support from the Government	Development of CCS in the UK not likely to progress without Government financial support
Social	Lack of public knowledge on CCS	Local support of CCS could be limited
Technological	Developing efficient methods to capture, transport and store carbon emissions on a commercial scale	Lower costs, reducing financial and technological barriers to implementing CCS
Legal	Under the Kyoto Protocol, the EU has set itself targets for reducing its greenhouse gas emissions progressively up to 2050	Increased investment in CCS
	The Paris Agreement provides a framework to strengthen the global response to the threat of climate change through nationally determined contributions	Increased investment in CCS
	The Climate Change Act 2008 sets a legally binding target for reducing UK CO_2 emissions by at least 80% on 1990 levels by 2050	Increased investment in CCS
Environmental	Mitigating the effects of global climate change	Increased investment in renewable and low-carbon energy generation

Review of future trends

There is currently a high level of uncertainty about the future location and scale of CCS activity in UK seas; in particular, commercial viability is still to be demonstrated. Initially, attention is likely to focus on carbon storage in depleted oil and gas fields (e.g. Figure 24), but other structures such as saline aquifers could also be used. It may also be possible to combine permanent storage of CO_2 with the enhanced production of hydrocarbons. Based on these assumptions, there is no or limited potential for CCS to be developed in the south east and south west marine plan areas; current potential CCS areas are likely to be located within the north east and north west (and east) marine plan areas.

A project commissioned by the Energy Technologies Institute (ETI) evaluated five potential offshore, subsurface stores of CO_2 emissions, selected for their potential contribution to mobilising commercial-scale CCS projects in the UK. This included two depleted gas fields (Viking A in the Southern North Sea and Hamilton in the East Irish Sea), one aquifer with structural closures (Bunter Closure 36 in the Southern North Sea) and two open saline aquifers (Captain X and Forties 5 Site 1, both in the Central North Sea). The project confirmed that there are no major technical hurdles to moving industrial scale CO_2 storage forward in the UK. The UK offshore environment could form the basis of a storage resource that could service the needs of many parts of Europe in addition to the UK (Pale Blue Dot Energy, 2016).

The BAU scenario reflects current trends in CCS development, with no activity planned in the UK and investor confidence relatively low. Similarly, it is unlikely that CCS would be a high priority in the LS scenario given the high level of investment required and the global nature of climate change (except where entrepreneurial partnerships develop at a local level, seeking to take a lead, possibly with the revival of government-supported competition).

Under the N@W scenario, for which an environmentally focused future is envisaged, CCS is taken forward as a central component to delivering reduced carbon emissions in the UK. This may involve a willingness of UK Government and industry to take risks in developing CCS technology and taking a global lead in this sector. While the N@W scenario involves increased provision of low-carbon and renewable sources of energy generation (e.g. tidal lagoons and new build nuclear power stations), the industrial sector would look to CCS as a sustainable emissions pathway for the future.

Confidence assessment

Despite global advances over the last three decades, there are still many unknowns about the feasibility of CCS deployment, as well as the impacts of storage. The UK CCS sector therefore remains in its infancy. Future trends are based on proposed schemes rather than approved plans, although limited information has been published since UK Government funding for CCS projects was withdrawn in November 2015. Future projections are therefore highly uncertain. It is assumed that support from the UK Government would be essential to facilitate a successful CCS sector in the UK. However, even with such support, it is feasible that the UK CCS sector may not become well established within the timeframe of this project (i.e. by 2036).

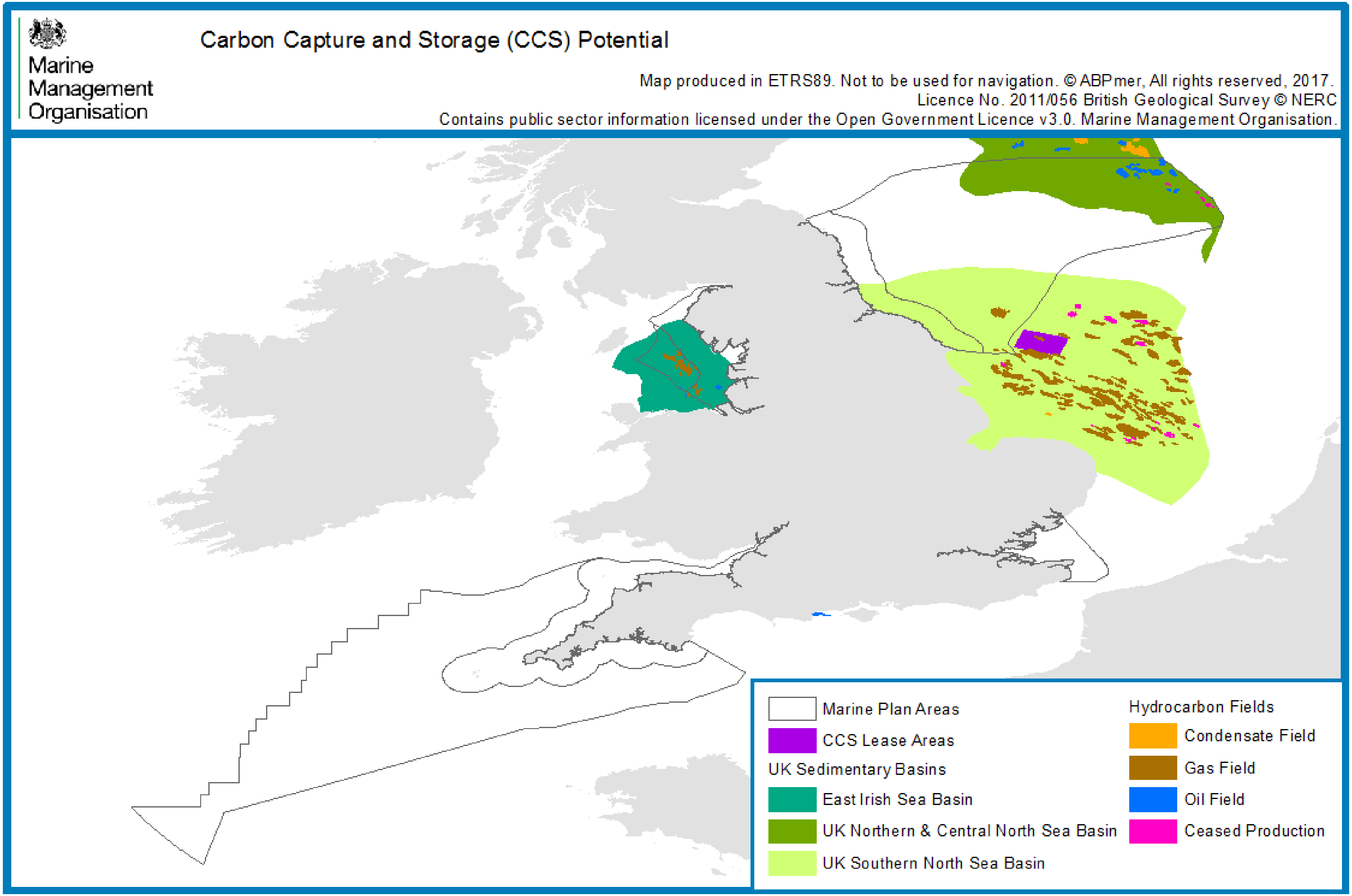


Figure 24: Carbon, capture and storage (CCS) potential

4.2 North east

Middlesbrough, Hartlepool and Newcastle are highlighted as key industrial centres and therefore CO_2 point sources within the north east marine plan areas (DECC, 2012). There is significant potential for CO_2 storage (saline aquifers and depleted hydrocarbon fields) reported at sites located in the Central and Northern North Sea and Humber/Yorkshire region. Energy-intensive industries within the north east marine plan areas could potentially access these storage sites in the future.

Teesside is the conurbation in the northeast of England around the urban centre of Middlesbrough, located on the coast of the north east marine plan areas. Teesside Collective is a cluster of energy-intensive industries (nearly 60% of the UK total) with a shared vision to establish Teesside as the go-to location for future clean industrial development by creating a CCS equipped industrial zone. The concentration of industrial emitters within Teesside and proximity to potential storage sites under the North Sea mean the area is industrially and geographically suited to be the starting place for large-scale industrial decarbonisation in the UK (Teesside Collective, 2017).

Engineering studies have been undertaken to assess CCS design and consider the CO_2 collection network and offshore transport (pipeline) options to two possible storage sites in the north east marine plan areas. These two storage sites discussed in Pale Blue Dot Energy (2016) are ‘Aquifer 5/42 AfL’ (Endurance) associated with the Yorkshire/Humber cluster and the ‘Goldeneye AfL’ depleted gas field that was previously considered for Shell’s Peterhead CCS project. The Endurance open saline aquifer is understood to have a potential capacity of around 520 million tonnes, while the Goldeneye depleted gas field storage capacity was estimated at 37 million tonnes (Pale Blue Dot Energy, 2016). The Teesside project does not include any options for import of CO_2. However, there is an existing CO_2 import/export shipping terminal at Teesport used for food-grade and industrial liquefied CO_2. This could be linked to the proposed network and expanded to handle larger import volumes for onward pipeline transport to storage (Brownsort *et al*. 2015). Nevertheless, it should be noted that these two potential developments within the north east marine plan areas remain at an early concept stage and have not entered the planning system at this time.

The assumptions used to develop the BAU, N@W and LS scenarios for CCS in the north east marine plan areas are provided in Table 14. Projected CO_2 storage under each of the three scenarios is shown in Figure 25. Figure 26 shows the spatial application of the scenarios to the sector while the text below provides a brief description of the future trends in 6 years and 6 to 20 years. However, as the scale and location of CCS development in the north east marine plan areas is currently unknown, Figure 26 is provided for illustrative purposes only.

Table 14: Assumptions and impacts under the future scenarios for CCS in the north east marine plan areas

Aspect	Scenario		
	Business as Usual	**Nature @ Work**	**Local Stewardship**
Application to the sector	There is currently no CCS activity in the north east marine plan areas and there is uncertainty with this sector. It is considered unlikely that significant CCS activity would commence in the north east marine plan areas under this scenario.	The primary drivers for the sector at a national level are related to climate change. It is possible that CCS may be a viable option if industry clusters, such as the Teesside Collective (2017), are progressed. This could be achieved through onshore infrastructure development and storage at suitable subsea locations within the north east marine plan areas (see Figure 26).	There is currently no CCS activity in the north east marine plan areas and there is uncertainty with this sector. It is considered unlikely that significant CCS activity would commence in the north east marine plan areas under this scenario.
Assumptions	No CCS activity anticipated in the north east marine plan areas.	It is assumed that the Teesside Collective cluster is developed within the north east marine plan areas. A pilot project is assumed to capture and store 1 million tonnes of CO_2 per annum between 2025 and 2034 (i.e. 10 years). Once the network is proven, this would subsequently expand to capture and store an additional 10 million tonnes of CO_2 per annum (2035 – 2036) as power stations and more industrial companies join the network.	No CCS activity anticipated in the north east marine plan areas.

6-year projection

There is currently no CCS activity in the north east marine plan areas. Therefore, it is considered unlikely that CCS activity would commence in the north east marine plan areas under the BAU, N@W and LS scenarios over the next 6 years.

6 to 20 year projection

Based on historical trends and future drivers, the development of CCS in the north east marine plan areas is considered unlikely under the BAU and LS scenarios over the period 6 to 20 years. However, the Teesside CCS cluster is assumed to progress under the N@W scenario, initially through a pilot project (1 million tonnes of CO_2 per annum; 2025 – 2034), followed by a larger commercial-scale development (10 million tonnes of CO_2 per annum; 2035 and beyond). By 2036, total CO_2 stored in the north east marine plan areas is estimated to be approximately 30 million tonnes under the N@W scenario (Figure 25).

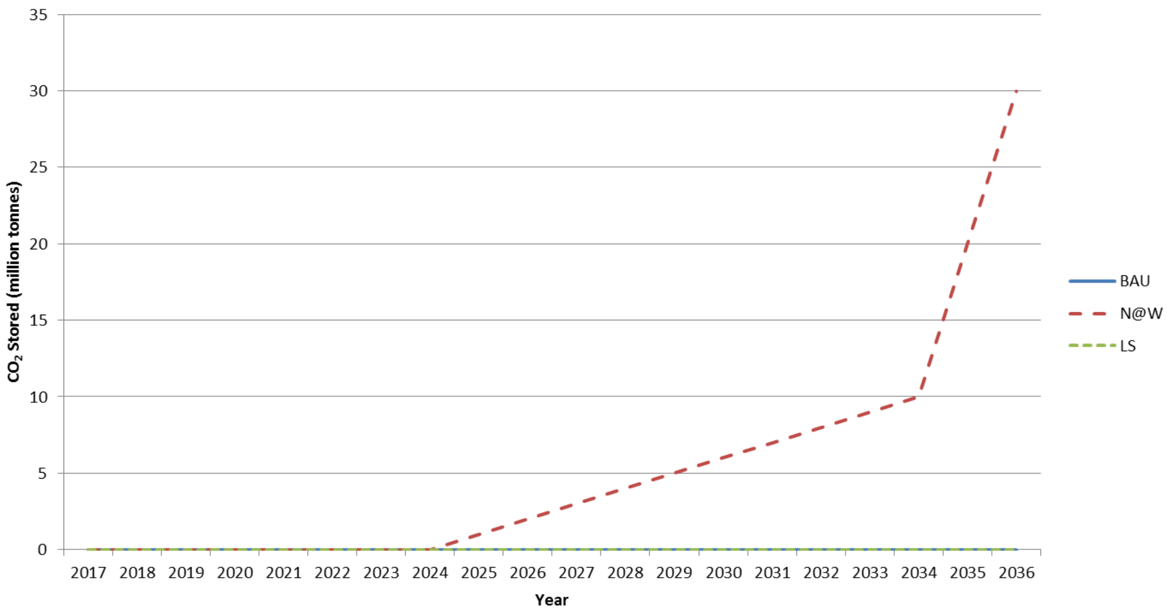


Figure 25: Projections of CO2 storage in the three scenarios for the north east marine plan areas

Potential trade-offs

The main potential interactions for future CCS development are likely to be:

- Natural environment (reduced greenhouse gas emissions)
- Commercial fisheries
- Other infrastructure/extractive industries.

Within the north east marine plan areas, CCS development is only projected under the N@W scenario. The main potential trade-offs are likely to be with the natural environment and commercial fisheries. Negative trade-offs can be minimised through careful route selection and project design.

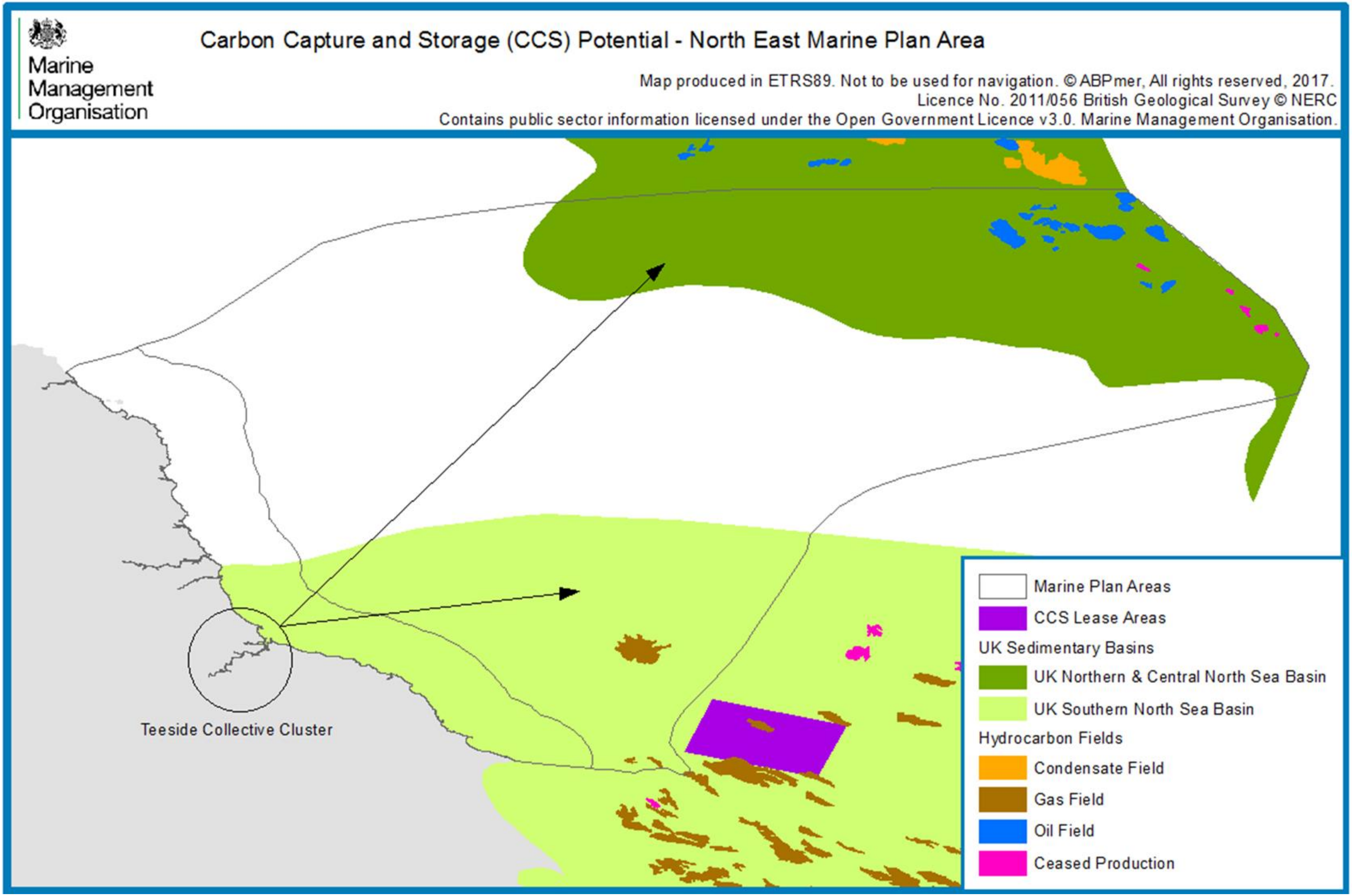


Figure 26: Carbon capture and storage in the north east marine plan areas

4.3 North west

A project carried out by Eunomia Research and Consulting Limited on behalf of Hydrocarbon Resources and Peel Energy considered a phased development of CCS for six emission clusters around the Irish Sea, including north west England, with storage in gas fields in Liverpool Bay and Morecambe Bay in the eastern Irish Sea. The project was conceived to provide a regional storage plan, building on the proposed Ayrshire Power Limited new-build power station CCS demonstration at Hunterston; however, this has not been followed-up since cancellation of the Hunterston CCS demonstration project (Brownsort *et al*. 2015).

The CCS Roadmap (DECC, 2012) highlighted numerous industrial centres/CO_2 point sources which are located within the north west marine plan areas, generally in the Merseyside region, and indicated that there are several potential storage sites in the eastern Irish Sea, including very large (depleted) gas fields. The Hamilton depleted gas field, which is located in Liverpool Bay, could accommodate the injection of 125 million tonnes of CO_2. In addition, the North and South Morecambe gas fields, strategically important natural gas production assets in the region, represent prime CO_2 storage targets once natural gas production has been completed. Any development is likely to be deployed with new infrastructure since the platforms will have exceeded their design life at the end of the gas production phase. South Morecambe has an ultimate potential capacity of around 850 million tonnes, with North Morecambe providing an additional 180 million tonnes. Key development challenges are likely to include CO_2 phase management when injecting into a strongly depleted reservoir and also assurance of effective containment in legacy and gas production wells through careful abandonment programmes (Pale Blue Dot Energy, 2016).

The assumptions used to develop the BAU, N@W and LS scenarios for CCS in the north west marine plan areas are provided in Table 15. Projected CO_2 storage under each of the three scenarios is shown in Figure 27. The text below provides a brief description of the future trends in 6 years and 6 to 20 years. However, as the scale and location of CCS development in the north east marine plan areas is currently unknown, Figure 28 is provided for illustrative purposes only.

6-year projection

There is currently no CCS activity in the north west marine plan areas. Therefore, it is considered unlikely that CCS activity would commence in the north west marine plan areas under the BAU, N@W and LS scenarios over the next 6 years.

Table 15: Assumptions and impacts under the future scenarios for CCS in the north west marine plan areas

Aspect	Scenario		
	Business as Usual	**Nature @ Work**	**Local Stewardship**
Application to the sector	There is currently no CCS activity in the north west marine plan areas and there is uncertainty with this sector. It is considered unlikely that significant CCS activity would commence in the north west marine plan areas under this scenario.	The primary drivers for the sector at a national level are related to climate change. It is possible that CCS may be a viable option if industry clusters, such as the eastern Irish Sea CCS cluster (Eunomia Research and Consulting Limited, 2011), are progressed. This could be achieved through onshore infrastructure development and storage at suitable subsea locations within the north west marine plan areas.	There is currently no CCS activity in the north west marine plan areas and there is uncertainty with this sector. It is considered unlikely that significant CCS activity would commence in the north west marine plan areas under this scenario.
Assumptions	No CCS activity anticipated in the north west marine plan areas.	It is assumed that the East Irish Sea CCS cluster is developed within the north west marine plan areas. This includes storage of CO_2 captured from six regions, namely north west England, north Wales, south Wales, eastern Ireland, Northern Ireland and western Scotland. A development scheme is assumed to capture and store 1 million tonnes of CO_2 between 2030 and 2037.	No CCS activity anticipated in the north west marine plan areas.

6 to 20 year projection

Based on historical trends, the development of CCS in the north west marine plan areas is considered unlikely under the BAU and LS scenarios over the period 6 to 20 years from present. However, the East Irish Sea CCS cluster is assumed to progress under the N@W scenario, initially through a pilot project (1 million tonnes of CO_2 per annum; 2030 – 2036). By 2036, total CO_2 stored in the north west marine plan areas is estimated to be approximately 6 million tonnes under the N@W scenario (Figure 27). In the years to follow, it is assumed larger commercial scale storage will be progressed (post-2036).

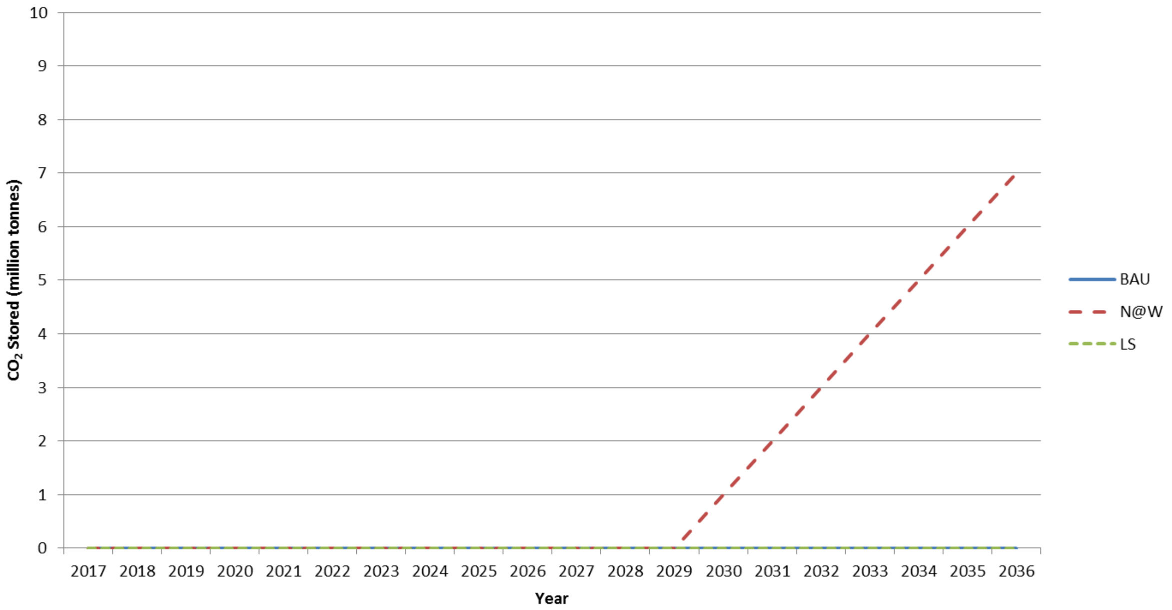


Figure 27: Projections of CO2 storage in the three scenarios for the north west marine plan areas

Potential trade-offs

The main potential interactions for future CCS development are likely to be:

- Natural environment (reduced greenhouse gas emissions)
- Commercial fishing
- Other infrastructure/extractive industries.

Within the north west marine plan areas, CCS development is only projected under the N@W scenario. the main potential trade-offs are likely to be with the natural environment and other infrastructure and extractive industries. Negative trade-offs can be minimised through careful route selection.

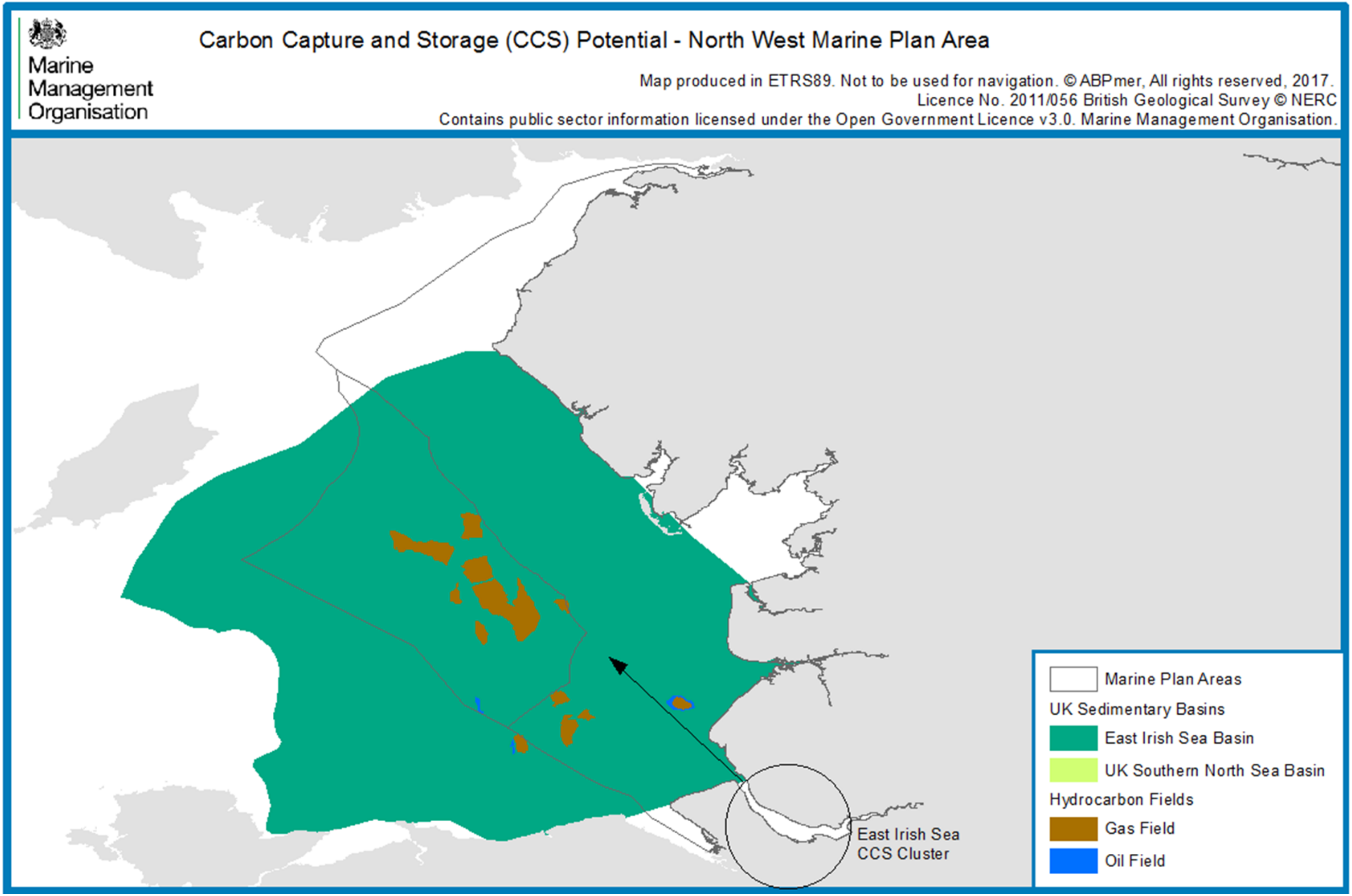


Figure 28: Carbon capture and storage in the north west marine plan areas

4.4 South east

In 2009, two potential CCS demonstration projects were being considered for new power stations at Kingsnorth and Tilbury on the Thames estuary. To support these projects, E.ON carried out a study of CO_2 collection, transport and offshore storage for a proposed Thames CCS cluster comprising eight existing large emitters and the two new power stations, with potential for capture of up to 44 million tonnes of CO_2 per year. Collection and transport of CO_2 by pipeline was proposed with storage offshore in depleted gas fields in the Southern North Sea. In 2010, the two CCS demonstration projects were cancelled and there has been no progress on the Thames CCS cluster proposal since (Brownsort *et al*. 2015).

While there are several major industrial centres/CO_2 point sources located in the London area, there are currently no recognised CO_2 storage sites (e.g. saline aquifers, depleted hydrocarbon fields) available in the south east marine plan area (DECC, 2012). It may be possible to connect storage sites in the Southern North Sea, such as Bunter Closure 36 (saline aquifer), Hewett and Viking (depleted gas fields), via pipelines from a beachhead at Medway located within in the south east marine plan area. Approximately 610 million tonnes of CO_2 could be stored at these three sites combined (Pale Blue Dot Energy, 2016).

6-year projection

There is currently no CCS activity in the south east marine plan area. Therefore, it is considered unlikely that CCS activity would commence in the south east marine plan area under the BAU, N@W and LS scenarios over the next 6 years.

6 to 20 year projection

While current research indicates there is no suitable CO_2 storage within the south east marine plan area, it is feasible that an industry cluster in the Thames region could be connected to suitable storage sites in the southern and/or central North Sea. This could incorporate existing networks linked to depleted oil and gas fields or the provision of a new, purpose built pipeline.

Potential trade-offs

No activity is anticipated under any scenario in the south east marine plan area, therefore there are no potential trade-offs.

4.5 South west

Industrial centres/CO_2 point sources such as Bristol, Cardiff and Swansea are located in the Bristol Channel and Severn Estuary; however, there are currently no recognised CO_2 storage sites (e.g. saline aquifers, depleted hydrocarbon fields) available in the south west marine plan areas (DECC, 2012).

6-year projection

There is currently no CCS activity in the south west marine plan areas and no suitable storage areas have been identified. Therefore, it is considered unlikely that CCS activity would commence in the south west marine plan areas under the BAU, N@W and LS scenarios over the next 6 years.

6 to 20 year projection

There is currently no CCS activity in the south west marine plan areas and no suitable storage areas have been identified. Therefore, it is considered unlikely that CCS activity would commence in the south west marine plan areas under the BAU, N@W and LS scenarios over the next 20 years.

Potential trade-offs

No activity is anticipated under any scenario in the south west marine plan area, therefore there are no potential trade-offs.

5 Defence

Sector definition

The Ministry of Defence (MOD) has the primary role of providing military defence and security to the people and assets of the UK and overseas territories. Within UK waters, in peacetime, military activities comprise practice and training activities, routine patrolling, transporting equipment and personnel in and out of the country, search and rescue operations (in conjunction with HM Coastguard) and communications including using radar.

The marine environment is used predominantly by the Royal Navy (submarine bases, jetties and exercise areas), but is also used by the Army (training camps and firing ranges), Royal Air Force (bases, coastal Air Weapon Ranges and Danger Areas) and Ministry of Defence (MOD) (Defence Test and Evaluation Ranges to trial weapon systems).

Defence activities that use the marine environment, directly or indirectly, in support of operational capability are diverse but include operational vessels and aircraft, HM naval bases, surface and sub-surface navigational interests, underwater acoustic ranges, maritime and amphibious exercises, coastal training and test and evaluation ranges (HM Government, 2011).

Data sources

A variety of different information sources have been reviewed to inform this baseline, including published reports and papers and spatial layers. The main information sources used are provided in the list below:

- UK Government’s National Security Strategy and Strategic Defence and Security Review 2015 (SDSR, 2015)
- UK Defence Statistics
- Military spatial data including MOD ports, practice and exercise areas, munitions dumps and low flying zones
- Autumn Statement 2015 (HM Treasury, 2015)
- Spring Budget 2017 (HM Treasury, 2017)
- UK military expenditure (The World Bank, 2017).

5.1 National review

Overview of national activity

Military activities occur in both inshore and offshore waters. All coastal military locations and the full area available for military training and other defence activities are shown in Figure 29, Figure 30 and Figure 31.

Principal marine-related defence activities include sea transport by naval vessels and sea training. Activities relating to maritime transport are mainly associated with naval bases. The only Her Majesty’s Naval Base (HMNB) is located in the south west marine plan areas and is HMNB (Figure 29). There is also a submarine shipyard at Barrow-in-Furness in the north west inshore marine plan area.

Sea training is carried out within defined military practice and exercise areas (PEXAs) (Figure 30). These are areas available to the MOD for military practice and exercises, though any area of UK waters may be used for military activities. The PEXAs do not constitute closed areas and in general are not restricted for other use except at such times that special exercises are underway that preclude other users for safety reasons. A large proportion (60%) of the north east, north west, south east and south west marine plan areas comprise PEXAs, the most extensive of which occurs in the south west marine plan areas(Figure 30).

There are also naval training establishments which may have associated marine activities (Figure 30). These are HMS Calliope in the north east inshore marine plan area, HMS Eaglet in the north west inshore marine plan area, and Britannia Royal Naval College Dartmouth and HMS Raleigh in the south west inshore marine plan area.

The UK has a military low flying system which supports training below 2000 feet throughout UK airspace except in controlled airspace dedicated to civil aviation traffic and over major built up areas. Military low flying activities are conducted close to the coast in the north east, north west, south east and south west marine plan areas, the majority of which is low priority and less likely to raise concerns (Figure 31).

In addition to the military low flying system, Areas of Intense Aerial Activity (AIAA) are areas of airspace within which military or civil aircraft, singly or in combination with others, regularly participate in unusual manoeuvres. An AIAA is associated with Royal Navy Air Station (RNAS) in Culdrose which overlaps with the south west marine plan areas. The only other AIAA is associated with the Warton Aerodrome in the north west inshore marine plan area.

The MOD also has a number of air bases located in coastal areas with associated air traffic radars. In addition the MOD operates a number of air defence radars at coastal locations to survey UK airspace. The only munitions disposal site that has a licence to handle a limited amount of explosive material is at Whitesand Bay (Plymouth) within the south west inshore marine plan area (Figure 29).

Some onshore coastal defences such as aerodromes, transmitter sites and explosive stores have safeguarding zones extending over the marine area.

The Royal Fleet Auxiliary (RFA) is a civilian-manned fleet delivering logistical and operational support for the wide range of tasks the Royal Navy undertakes. RFA ships regularly operate within the English marine area.

The Royal Navy is also involved with fishery protection operations in the English marine area. The mission of the Fishery Protection Squadron is to patrol the fishery limits of England, Wales and Northern Ireland. With a small headquarters staff based in Portsmouth Naval Base, the Squadron comprises 3 River Class Offshore Patrol Vessels in UK waters. The ships in the Fishery Protection Squadron are able to operate with helicopters, and can be utilised in the maritime counter terrorism, counter-drug surveillance or pollution control role in addition to their core tasking of fishery protection (Royal Navy, 2017).

The UK defence industry is a key employer and contributor to the national economy, employing around 142,000 people directly with a turnover of £24 billion (ADS, 2016). The MOD has a £35 billion budget for 2016/17 and a longer term commitment to meet NATO's target of spending 2% of national income on defence every year up to 2020 (HM Treasury, 2015; MOD, 2016a). The increased budget has allowed the MOD to invest in stronger defence with more ships and more troops in the Royal Navy. From 2016/17 all savings from efficiencies and reprioritisation are also being reinvested in the defence budget.

The MOD employs people throughout the UK in support of its operations in the marine environment, including HM naval bases, MOD ranges and coastal estates. Gross Value Added (GVA) of UK military activity in the sea was estimated to be approximately £400 million in 2012 (MSCC, 2014). Marine activities and hence the location of the value to the economy are mainly related to the location of the naval bases and exercise areas. The Royal Navy employs 38,140 military staff (as of 1 January 2016) and 4,450 civilian staff (as of 1 October 2015) (MOD, 2015; 2016b).

Identifying defence activities is relatively straightforward from national statistics. However, establishing whether defence activities are connected to marine activities is not possible. Based on a review of the activities that are linked to the defence industry, it is estimated that in 2014 the industry employed around 47,000 people in the north east, north west, south east and south west marine plan areas (MMO, 2016a).

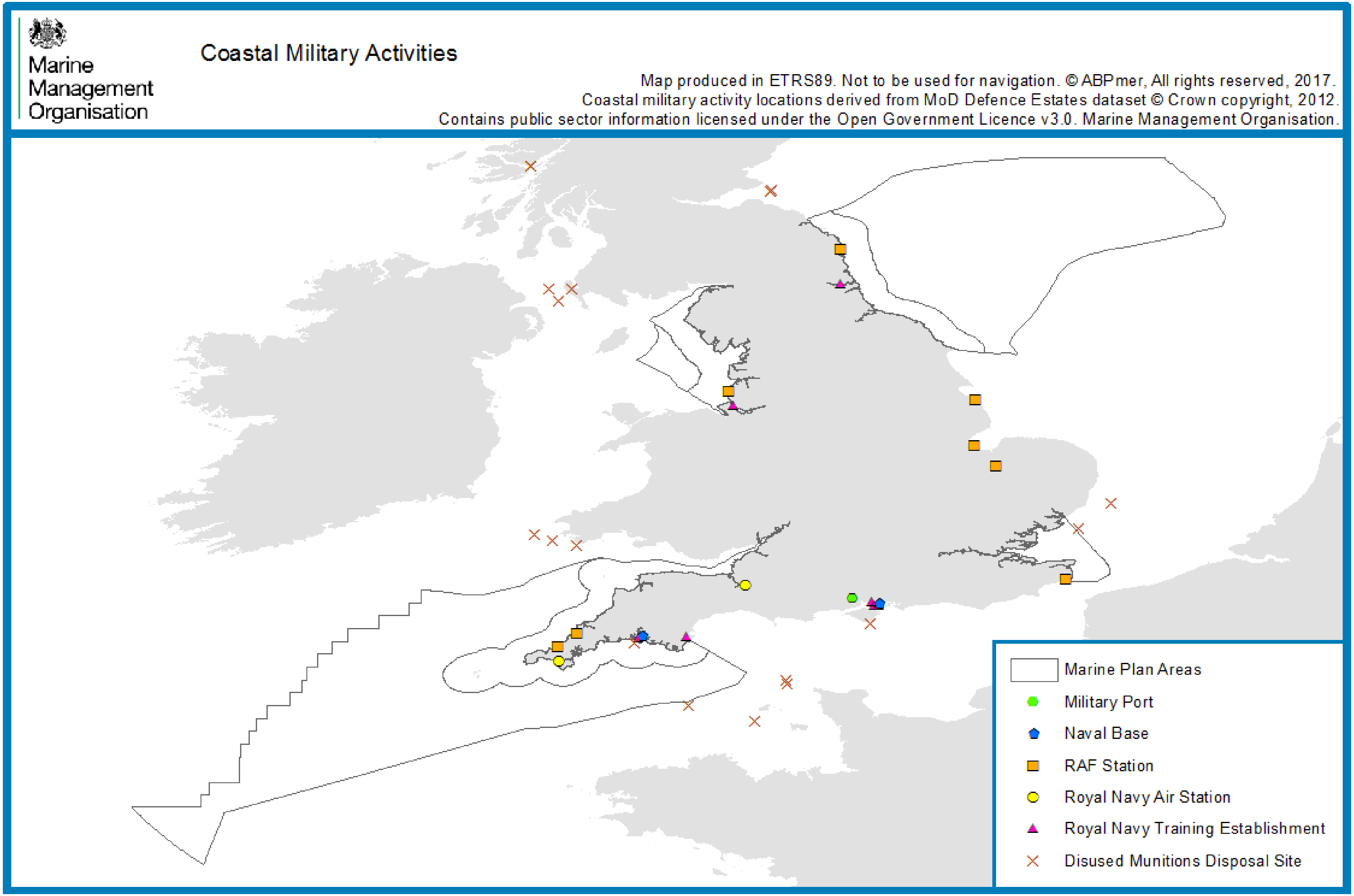


Figure 29: Coastal military activities

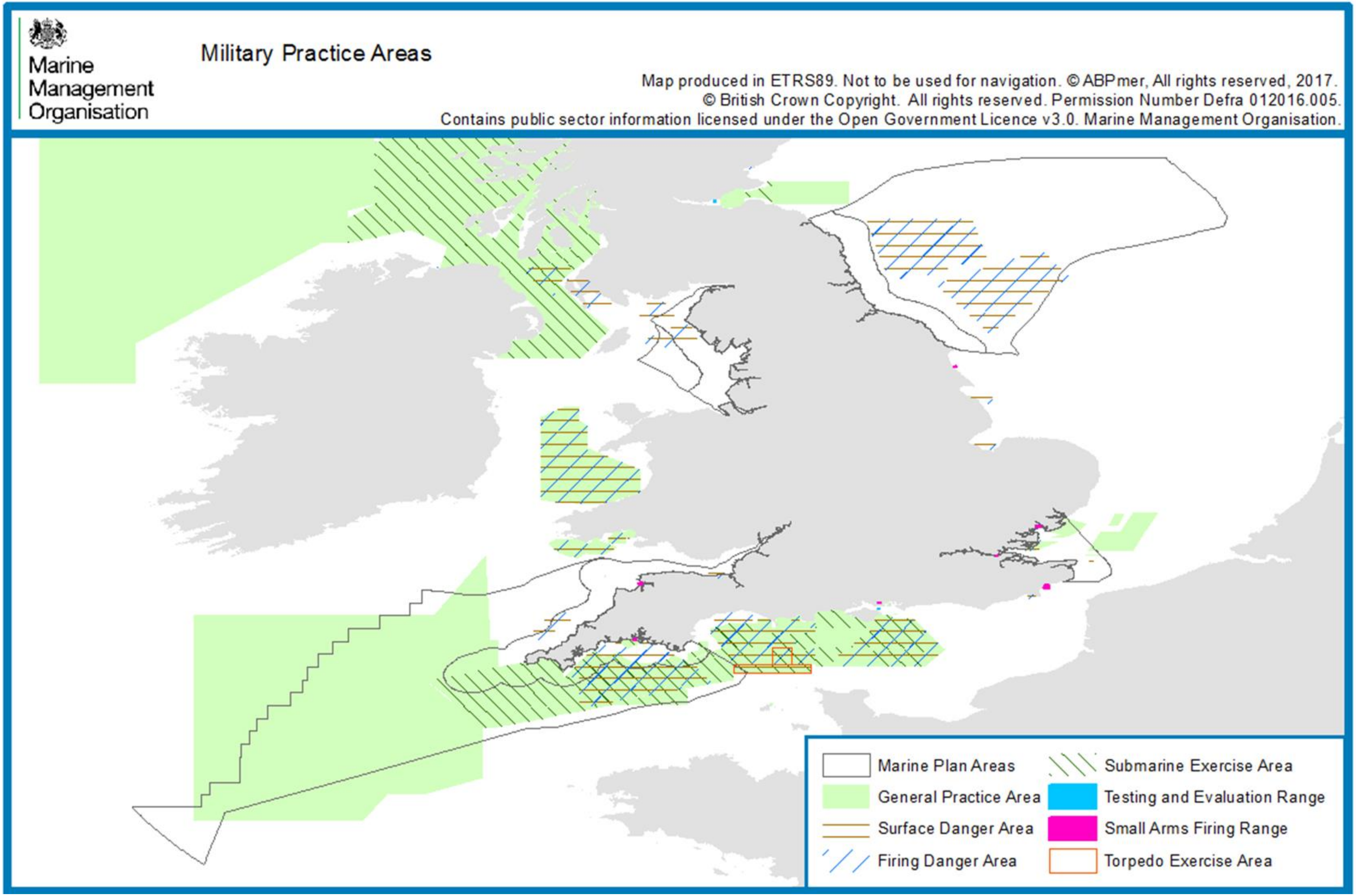


Figure 30: Military practice areas

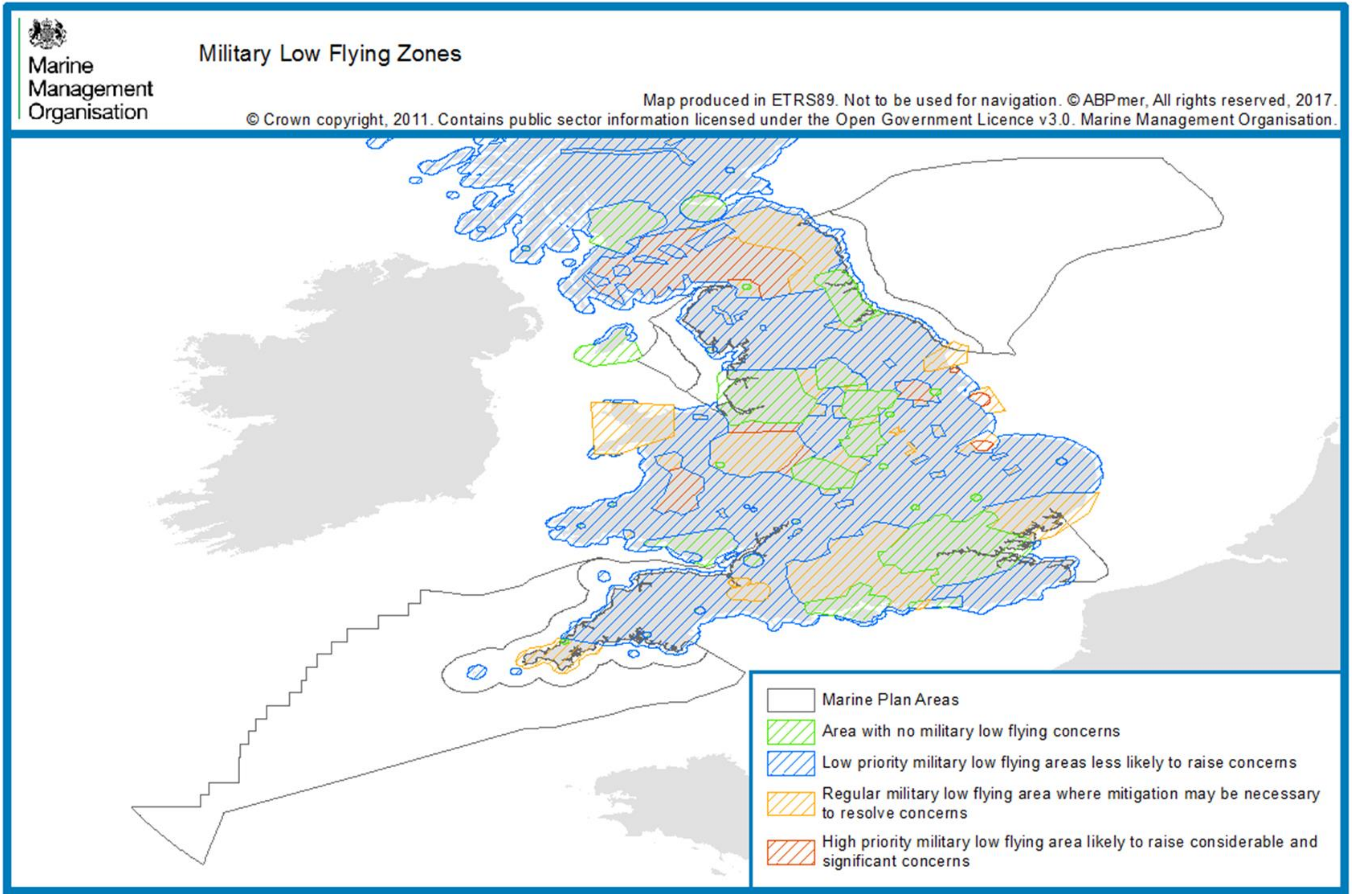


Figure 31: Military low flying zones

Review of historical trends

Figure 32 shows that the UK defence expenditure has declined in recent years from a high in 2009. The UK government has committed to spending 2% of GDP on defence until 2020 and as such the future of defence spending for the UK will be linked to changes in the economy.

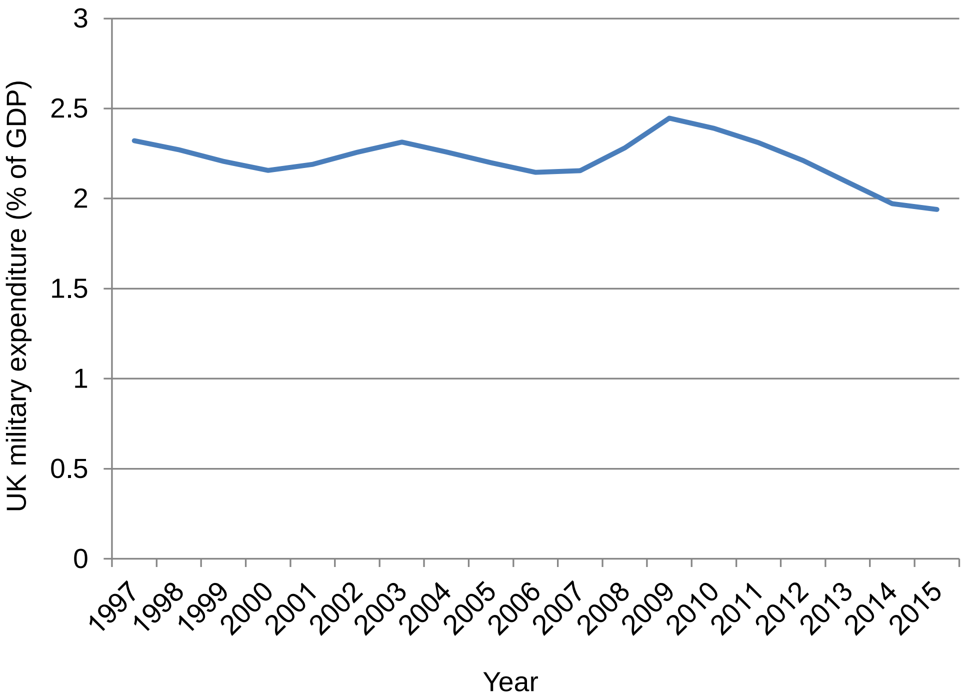


Figure 32: Historic trend of UK military budget

Data source: The World Bank (2017)

Review of key changes and/or advances of significance affecting the sector

The key drivers which are expected to strongly influence the military activity sector are shown in Table 16.

One of the key drivers is political and related to policy. On 23 November 2015, the UK Government published the National Security Strategy and Strategic Defence and Security Review 2015 (SDSR 2015), which set out the United Kingdom's National Security Strategy for the next five years and how it would be implemented. The first annual report on the implementation of this strategy presented the progress that had been made in delivering key commitments, and explained how major developments with national security implications are being responded to.

The commitments in SDSR 2015 set out the key policy and capability developments required as a consequence of the UK's National Security Strategy. The commitments vary in scale and in the time needed for them to be implemented. Some, such as establishing the Armed Forces' Joint Force 2025, will take a decade, while others, such as the Parliamentary vote on the nuclear deterrent, have already been delivered.

A further important political driver is the Government's commitment to maintain UK defence spending at 2% of GDP until 2020.

Technological advances may also reduce defence activities in the marine environment through the use of autonomous vehicles, artificial intelligence and lower training needs (MMO, 2011a). However, developments in military technology are classified and are therefore difficult to judge.

Table 16: Key drivers affecting development of the defence sector

Driver	Details	Implications
Political	National defence policies determine the state of military operations and influence the defence budget	Possible changes in activity level or location
Economic	UK defence budget linked to country's GDP	Funding changes linked to economic cycles
Social	Possible social resistance to renewal of Trident	Possible changes in submarine exercise activity level or location
Technological	Technological advances	Advances in technology could lead to a need for fewer personnel, lower training activity and increased spending on development contracts
Legal	New regulations being brought in to reduce pollution from shipping	Low sulphur fuels with higher costs required for use
	Ballast water management convention	New systems of ballast water management and reporting procedures, leading to difficulties for smaller ports without reception/treatment facilities and for existing naval vessels needing to retro-fit filtration systems
Environmental	Potential restrictions to access or undertake testing in designated sites	Potential for reduced marine area for military activities

Review of future trends

The primary drivers for the defence sector are political. The UK Government is implementing the recommendations of its strategic review in the period to 2025. It has committed to spending 2% of GDP on defence until 2020. Assuming growth in the UK economy over time, there will be increased expenditure on the defence sector with possible changes in military activity levels.

National defence policies and global politics influence the nature of military operations and also the defence budget and these are unlikely to change under the BAU, N@W and LS scenarios. However, economic growth is slower under the LS scenario and therefore the rates of change in military expenditure are anticipated to be the less under this scenario compared to BAU and N@W.

Confidence assessment

Owing to the confidential nature of military defence activities it is difficult to assess the extent and frequency of activity and future trends within the marine environment of the marine plan areas (UKMMAS, 2010). There are uncertainties concerning the exact location of training activities within designated exercise areas and the frequency of use of those areas given the need for a certain amount of security in the information provided. In some instances the exact nature of Government spending changes is also uncertain and thus it is difficult to predict the future intensity of military activity within each of the marine plan areas.

5.2 North east

PEXAs cover 34% of the north east marine plan areas and include extensive surface and firing danger areas used for military aviation training (Figure 30).

The majority of the military low flying activities are conducted close to the coast and are categorised as low priority and less likely to raise concerns. There is a small regular military low flying area in the southwestern part of the north east marine plan areas where mitigation may be necessary to resolve concerns.

Identifying defence activities is relatively straightforward from national statistics. However, there are challenges in identifying whether defence activities connect to marine activities and assessing the scale of the Government funded activities. Due to the sensitivity of the data and data suppression requirements, it is not possible to identify how much employment or business activity is connected to marine activities or the true size of activity. Based on a review of the activities that are linked to the defence industry, it is estimated that in 2014 the industry employed around 1,150 people in the north east marine plan areas (MMO, 2016a). The estimated indirect and induced employment numbers are 1,760. The numbers directly and indirectly employed are lower than for the north west, south east and south west marine plan areas.

The assumptions used to develop the BAU, N@W and LS scenarios for defence in the north east marine plan areas are provided in Table 17. Projected MOD expenditure under each of the three scenarios is shown in Figure 33. Figure 34 shows the spatial extent of the sector in the north east marine plan areas while the text below provides a brief description of the future trends in 6 years and 6 to 20 years under the scenarios.

Table 17: Assumptions and impacts under the future scenarios for defence in the north east marine plan areas

Aspect	Scenario		
	Business as Usual	Nature @ Work	Local Stewardship

Aspect	Scenario		
	Business as Usual	**Nature @ Work**	**Local Stewardship**
Application to the sector	The primary driver of expenditure for this sector is the political commitment to spend 2% of GDP on defence. It is therefore assumed that defence sector expenditure will grow in line with economic growth. The sector growth predictions for the scenario have been based on the UK economic and fiscal forecast of GDP until 2021 (OBR, 2016) and then GDP growth of 2% until 2036.	Similar to the BAU scenario with the primary driver being economic growth, and same growth rates as BAU.	There will be slower growth in this scenario due to lower levels of economic growth.
Assumptions	Sector growth (spending budget) has been assumed to increase at: • 1.7% between 2017 and 2018 • 2.1% between 2018 and 2020 • 2.0% between 2020 and 2036. These levels of economic growth are based on the November 2016 UK economic and fiscal forecast (OBR, 2016). Employment numbers have been assumed to be stable. It is assumed that employment will not increase at the same rate as sector growth due to efficiencies and technological advances. Footprint of PEXAs will remain the same as current – activity within these areas may increase due to growth in military spending. There would be no new naval bases developed.	Sector growth (spending budget) has been assumed to increase at: • 1.7% between 2017 and 2018 • 2.1% between 2018 and 2020 • 2.0% between 2020 and 2036. These levels of economic growth are based on the November 2016 UK economic and fiscal forecast (OBR, 2016). Employment numbers have been assumed to be stable. It is assumed that employment will not increase at the same rate as sector growth due to efficiencies and technological advances. Footprint of PEXAs will remain the same as current – activity within these areas may increase due to growth in military spending. There would be no new naval bases developed.	Slower growth, lower than BAU, more local emphasis. Half the rate of growth as BAU i.e. assumed to be 0.85% between 2017 and 2018 etc. Employment numbers have been assumed to be stable. It is assumed that employment will not increase at the same rate as sector growth due to efficiencies and technological advances. Footprint and activity within PEXAs will remain the same as current. There would be no new naval bases developed.

6-year projection

Between 2017 and 2022, defence expenditure in the north east marine plan areas is predicted to grow at the same rate and in line with economic growth under the BAU and N@W scenarios. The growth in defence expenditure under the LS scenario is more gradual due to the anticipated lower levels of economic growth. By 2022, expenditure by the sector is predicted to be just over £32 million under the BAU and N@W compared to just below £31 million under the LS scenario.

6 to 20 year projection

Between 2023 and 2036, the continued higher economic growth rate of the BAU and N@W scenarios will result in a difference in expenditure by this sector compared to the LS scenario increasing over time. By 2036, expenditure by the defence sector in the north east marine plan areas is predicted to be just over £42 million compared to just over £35 million under the LS scenario.

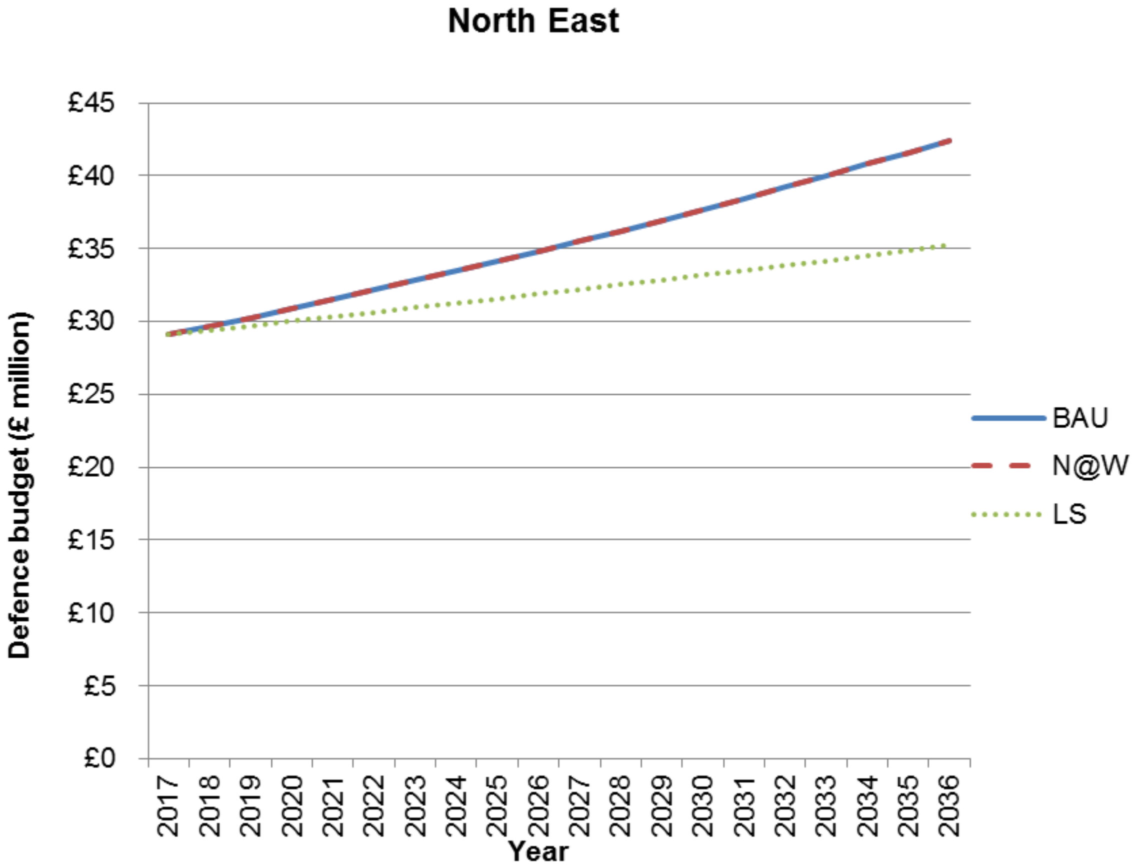


Figure 33: Projected defence expenditure in the north east marine plan areas between 2017 and 2036 under three scenarios

Potential trade-offs

No significant increase in activity is anticipated under any scenario.

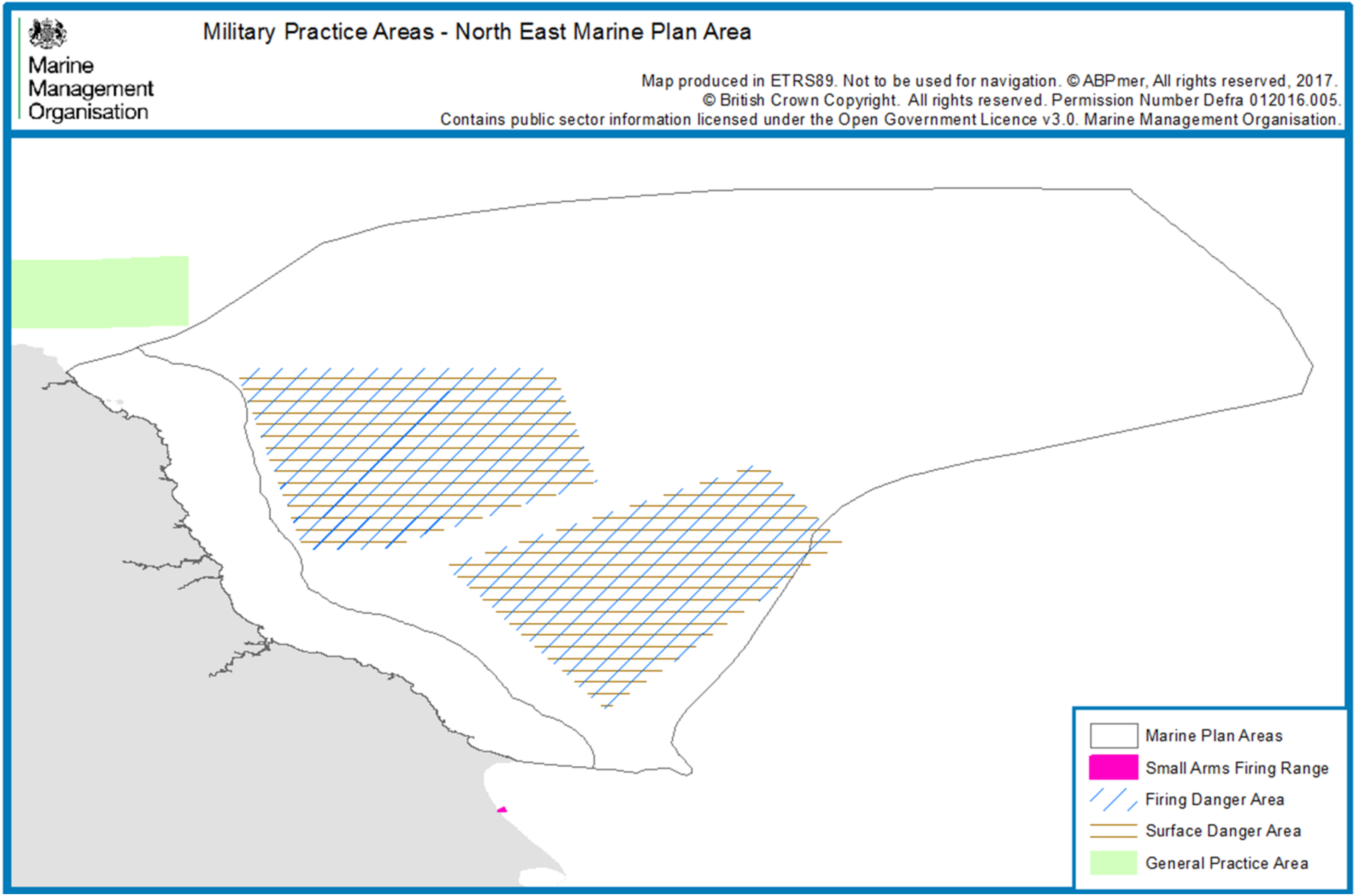


Figure 34: Military practice areas – north east marine plan area

5.3 North west

There are two large shipyards within the north west inshore marine plan area: BAE Systems Maritime Submarines at Barrow-in-Furness and Cammell Laird at Birkenhead, Merseyside (KOFAC, 2017). Barrow shipyard has a long standing track record of design and construction of first of class naval surface ships and submarines. It employs over 5,000 people at its 169 acre site where the facilities can be used to build large warships and submarines. Cammell Laird at Birkenhead delivers RFA ship and commercial ship repair as well as shipbuilding. It is currently delivering future aircraft carrier flight deck sections.

PEXAs cover 14% of the north west marine plan areas and include surface and firing danger areas used for weapon test and evaluation activities (Figure 30).

Identifying defence activities is relatively straightforward from national statistics, although a limiting factor is that it is unknown where defence activities are connected to marine activities. Based on a review of the activities that are linked to the defence industry, it is estimated that in 2014 the industry employed around 10,130 people in the north west marine plan areas (MMO, 2016a). The estimate for indirect employment in the north west is 15,561 jobs. The numbers directly and indirectly employed are higher than for the north east and south east but lower than for the south west marine plan areas.

The assumptions used to develop the BAU, N@W and LS scenarios for defence in the north west marine plan areas are provided in Table 18. Projected MOD expenditure under each of the three scenarios is shown in Figure 35. Figure 36 shows the spatial application of the sector in the north west marine plan areas while the text below provides a brief description of the future trends in 6 years and 6 to 20 years.

Table 18: Assumptions and impacts under the future scenarios for defence in the north west marine plan areas

Aspect	Scenario		
	Business as Usual	**Nature @ Work**	**Local Stewardship**
Application to the sector	As for the north east marine plan area (see Table 17).	As for the north east marine plan area (see Table 17).	As for the north east marine plan area (see Table 17).
Assumptions	Sector growth (spending budget) has been assumed to increase at: • 1.7% between 2017 and 2018 • 2.1% between 2018 and 2020 • 2.0% between 2021 and 2036. These levels of economic growth are based on the November 2016 UK economic and fiscal forecast (OBR, 2016).	Sector growth (spending budget) has been assumed to increase at: • 1.7% between 2017 and 2018 • 2.1% between 2018 and 2020 • 2.0% between 2021 and 2036. These levels of economic growth are based on the November 2016 UK economic and fiscal forecast (OBR, 2016).	Slower growth, lower than BAU, more local emphasis. Half the rate of growth as BAU i.e. assumed to be 0.85% between 2017 and 2018 etc. Employment numbers have been assumed to be stable. It is assumed that employment will not increase at the same rate as sector growth due to efficiencies and technological advances.

Aspect	Scenario		
	Business as Usual	Nature @ Work	Local Stewardship
	Employment numbers have been assumed to be stable. It is assumed that employment will not increase at the same rate as sector growth due to efficiencies and technological advances. Footprint of PEXAs will remain the same as current – activity within these areas may increase due to growth in military spending. There would be no new naval bases developed.	Employment numbers have been assumed to be stable. It is assumed that employment will not increase at the same rate as sector growth due to efficiencies and technological advances. Footprint of PEXAs will remain the same as current – activity within these areas may increase due to growth in military spending. There would be no new naval bases developed.	Footprint and activity within PEXAs will remain the same as current. There would be no new naval bases developed.

6-year projection

Between 2017 and 2022, defence expenditure in the north west marine plan areas is predicted to grow at the same rate and in line with economic growth under the BAU and N@W scenarios. The growth in defence expenditure under the LS scenario is more gradual due to the anticipated lower levels of economic growth. By 2022, the expenditure by the sector is predicted to be just over £283 million under the BAU and N@W compared to just below £270 million under the LS scenario.

6 to 20 year projection

Between 2023 and 2036, the continued higher economic growth rate of the BAU and N@W scenarios will result in a difference in expenditure for this sector compared to the LS scenario increasing over time. By 2036, expenditure by the defence sector in the north west marine plan areas is predicted to be just under £374 million compared to just over £310 million under the LS scenario.

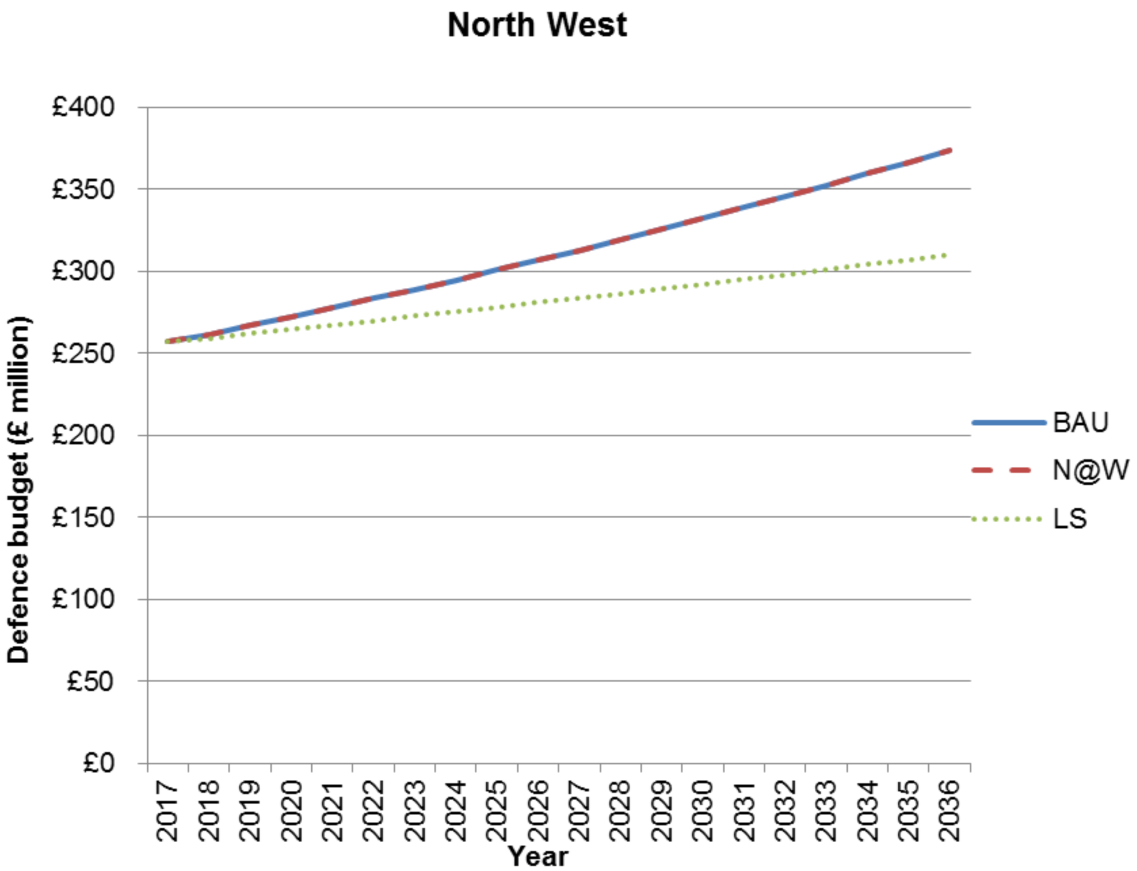


Figure 35: Projected defence expenditure in the north west marine plan areas between 2017 and 2036 under three scenarios

Potential trade-offs

No significant increase in activity is anticipated under any scenario.

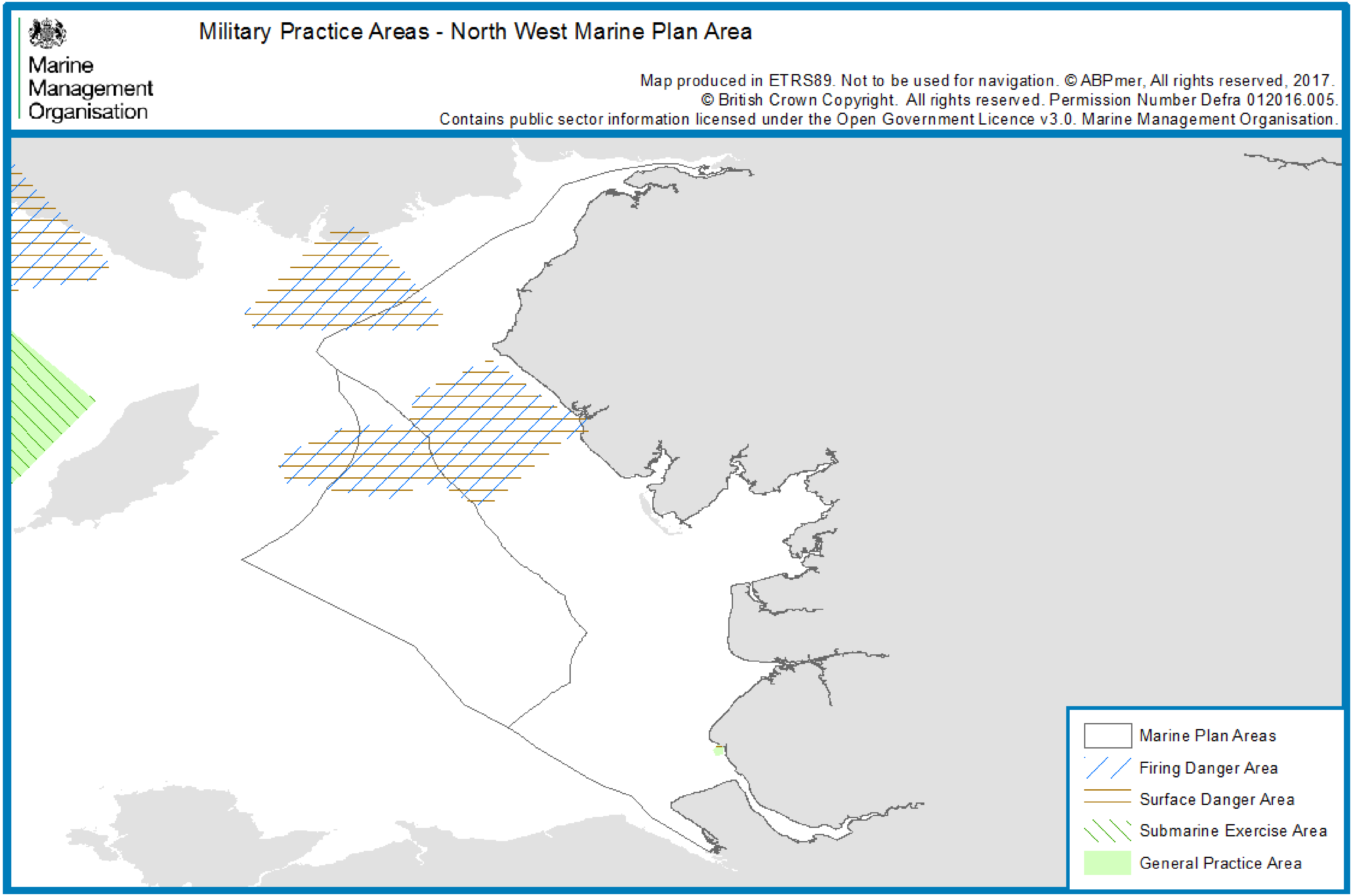


Figure 36**: Military practice areas – north west marine plan area**

5.4 South east

PEXAs cover 17% of the south east marine plan area and include general practice, firing danger and surface danger areas used for weapon test and evaluation activities (Figure 30). There is also a small arms firing range located at East Mersea (Colchester).

Identifying defence activities is relatively straightforward from national statistics, although a limiting factor is that it is unknown where defence activities are connected to marine activities.

Based on a review of the activities that are linked to the defence industry, it is estimated that in 2014 the industry employed around 8,310 people in the south east marine plan area (MMO, 2016a). The estimate for indirect and induced employment is 12,760 jobs. The numbers directly and indirectly employed are higher than for the north east marine plan areas but lower than for the north west and south west marine plan areas.

The assumptions used to develop the BAU, N@W and LS scenarios for defence in the south east marine plan area are provided in Table 19. Projected MOD expenditure under each of the three scenarios is shown in Figure 37. Figure 38 shows the spatial application of the scenarios to the sector while the text below provides a brief description of the future trends in 6 years and 6 to 20 years.

Table 19: Assumptions and impacts under the future scenarios for defence in the south east marine plan area

Aspect	Scenario		
	Business as Usual	**Nature @ Work**	**Local Stewardship**
Application to the sector	As for the north east marine plan area (see Table 17).	As for the north east marine plan area (see Table 17).	As for the north east marine plan area (see Table 17).
Assumptions	Sector growth (spending budget) has been assumed to increase at: • 1.7% between 2017 and 2018 • 2.1% between 2018 and 2020 • 2.0% between 2021 and 2036. These levels of economic growth are based on the November 2016 UK economic and fiscal forecast (OBR, 2016).	Sector growth (spending budget) has been assumed to increase at: • 1.7% between 2017 and 2018 • 2.1% between 2018 and 2020 • 2.0% between 2021 and 2036. These levels of economic growth are based on the November 2016 UK economic and fiscal forecast (OBR, 2016).	Slower growth, lower than BAU, more local emphasis. Half the rate of growth as BAU i.e. assumed to be 0.85% between 2017 and 2018 etc. Employment numbers have been assumed to be stable. It is assumed that employment will not increase at the same rate as sector growth due to efficiencies and technological advances.

Aspect	Scenario		
	Business as Usual	Nature @ Work	Local Stewardship
	Employment numbers have been assumed to be stable. It is assumed that employment will not increase at the same rate as sector growth due to efficiencies and technological advances. Footprint of PEXAs will remain the same as current – activity within these areas may increase due to growth in military spending. There would be no new naval bases developed.	Employment numbers have been assumed to be stable. It is assumed that employment will not increase at the same rate as sector growth due to efficiencies and technological advances. Footprint of PEXAs will remain the same as current – activity within these areas may increase due to growth in military spending. There would be no new naval bases developed.	Footprint and activity within PEXAs will remain the same as current. There would be no new naval bases developed.

6-year projection

Between 2017 and 2022, defence expenditure in the south east marine plan area is predicted to grow at the same rate and in line with economic growth under the BAU and N@W scenarios. The growth in defence expenditure under the LS scenario is more gradual due to the anticipated lower levels of economic growth. By 2022, expenditure by the sector is predicted to be just over £232 million under the BAU and N@W compared to just over £221 million under the LS scenario.

6 to 20 year projection

Between 2023 and 2036, the continued higher economic growth rate of the BAU and N@W scenarios will result in a difference in expenditure by this sector compared to the LS scenario increasing over time. By 2036, expenditure by the defence sector in the south east marine plan area is predicted to be just under £307 million compared to just over £254 million under the LS scenario.

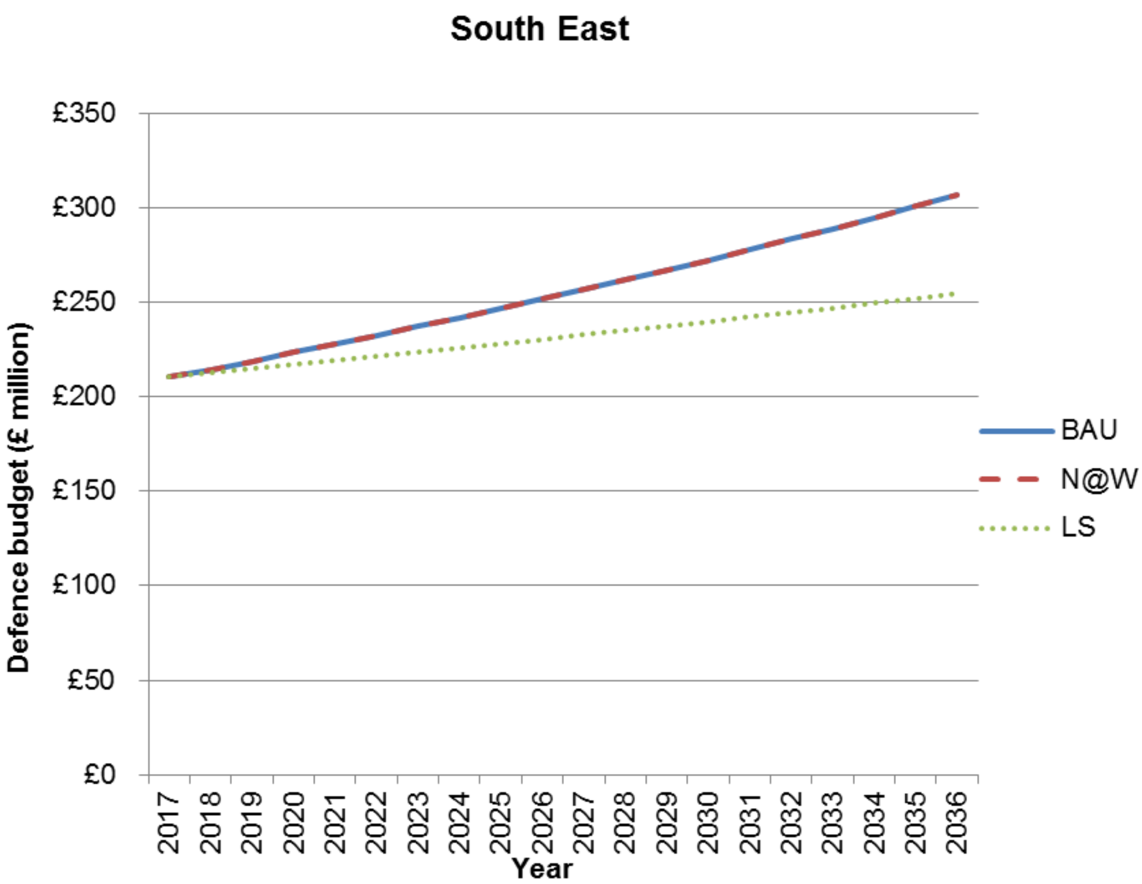


Figure 37: Projected defence expenditure in the south east marine plan area between 2017 and 2036 under three scenarios

Potential trade-offs

No significant increase in activity is anticipated under any scenario.

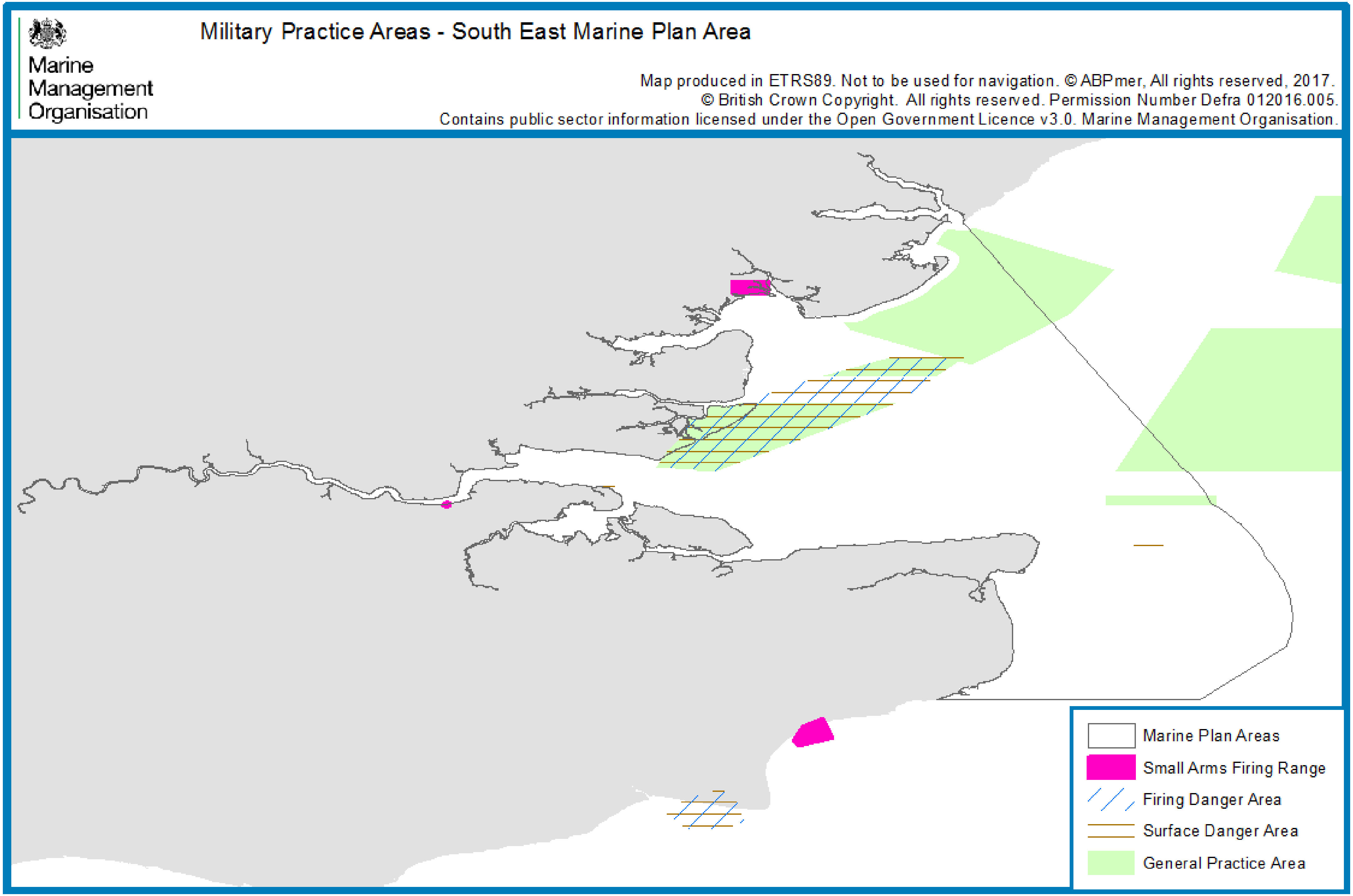


Figure 38: Military practice areas – south east marine plan area

5.5 South west

HMNB Devonport, located in the south west marine plan areas is the largest naval base in western Europe and has been supporting the Royal Navy since 1691. The vast site covers more than 650 acres and has 15 dry docks, four miles of waterfront, 25 tidal berths and five basins.

Devonport is home to Britain's amphibious ships and half her frigates, plus the training hub of the front-line Fleet, Flag Officer Sea Training (FOST). Devonport is also the sole nuclear repair and refuelling facility for the Royal Navy (NDA, 2013).

HMNB Devonport has a number of assault ships associated with it including HMS Albion, HMS Bulwark and HMS Ocean. Devonport offers support to its base ships in the areas of personnel, engineering and supplies.

PEXAs cover 83% of the south west marine plan areas and comprise an extensive complex of general, surface danger, firing danger and submarine exercise areas (Figure 30). The majority of these sites are covered by MOD byelaws and are used for Naval training involving shipping and aircraft engaged in firing activities where access is prohibited when firing or other activities are taking place (HM Government, 2012).

Britannia Royal Naval College (BRNC) in Dartmouth has been training and educating Royal Navy Officers, both onshore and at sea, since 1863. The College's contribution to defence today remains the training and development of Officers from over 20 Navies (Royal Navy, 2013).

Identifying defence activities is relatively straightforward from national statistics. However, establishing whether defence activities are connected to marine activities is not possible. Based on a review of the activities that are linked to the defence industry, it is estimated that in 2014 the industry employed around 27,840 people in the south west marine plan areas (MMO, 2016a). The estimate for indirect and induced employment is 42,770 people. The numbers directly and indirectly employed are the highest of the 4 plan areas.

The assumptions used to develop the BAU, N@W and LS scenarios for defence in the south west marine plan areas are provided in Table 20. Projected MOD expenditure under each of the three scenarios is shown in Figure 39. Figure 40 shows the spatial application of the scenarios to the sector while the text below provides a brief description of the future trends in 6 years and 6 to 20 years.

Table 20: Assumptions and impacts under the future scenarios for defence in the south west marine plan area

Aspect	Scenario		
	Business as Usual	**Nature @ Work**	**Local Stewardship**
Application to the sector	As for the north east marine plan area (see Table 17).	As for the north east marine plan area (see Table 17).	As for the north east marine plan area (see Table 17).
Assumptions	Sector growth (spending budget) has been assumed to increase at: • 1.7% between 2017 and 2018 • 2.1% between 2018 and 2020 • 2.0% between 2021 and 2036. These levels of economic growth are based on the November 2016 UK economic and fiscal forecast (OBR, 2016). Employment numbers have been assumed to be stable. It is assumed that employment will not increase at the same rate as sector growth due to efficiencies and technological advances. Footprint of PEXAs will remain the same as current – activity within these areas may increase due to growth in military spending. There would be no new naval bases developed.	Sector growth (spending budget) has been assumed to increase at: • 1.7% between 2017 and 2018 • 2.1% between 2018 and 2020 • 2.0% between 2021 and 2036. These levels of economic growth are based on the November 2016 UK economic and fiscal forecast (OBR, 2016). Employment numbers have been assumed to be stable. It is assumed that employment will not increase at the same rate as sector growth due to efficiencies and technological advances. Footprint of PEXAs will remain the same as current – activity within these areas may increase due to growth in military spending. There would be no new naval bases developed.	Slower growth, lower than BAU, more local emphasis. Half the rate of growth as BAU e.g. assumed to be 0.85% between 2017 and 2018. Employment numbers have been assumed to be stable. It is assumed that employment will not increase at the same rate as sector growth due to efficiencies and technological advances. Footprint and activity within PEXAs will remain the same as current. There would be no new naval bases developed.

6-year projection

Between 2017 and 2022, defence expenditure in the south west marine plan areas is predicted to grow at the same rate and in line with economic growth under the BAU and N@W scenarios. The growth in defence expenditure under the LS scenario is more gradual due to the anticipated lower levels of economic growth. By 2022, expenditure by the sector is predicted to be just over £778 million under the BAU and N@W compared to just over £741 million under the LS scenario.

6 to 20 year projection

Between 2023 and 2036, the continued higher economic growth rate of the BAU and N@W scenarios will result in a difference in expenditure by this sector compared to the LS scenario increasing over time. By 2036, expenditure by the defence sector in the south west marine plan areas is predicted to be just over £1 billion compared to just over £852 million under the LS scenario.

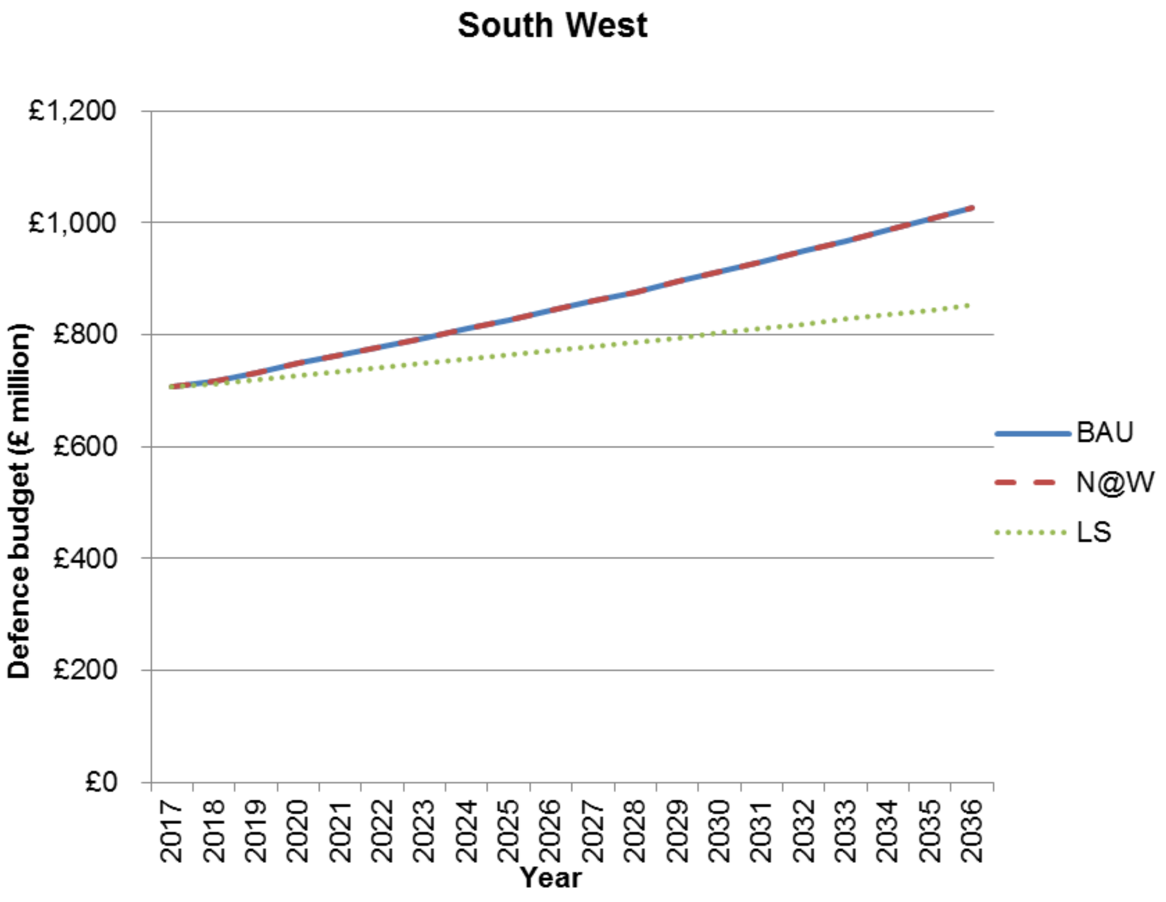


Figure 39: Projected defence expenditure in the south west marine plan areas between 2017 and 2036 under three scenarios

Potential trade-offs

No significant increase in activity is anticipated under any scenario.

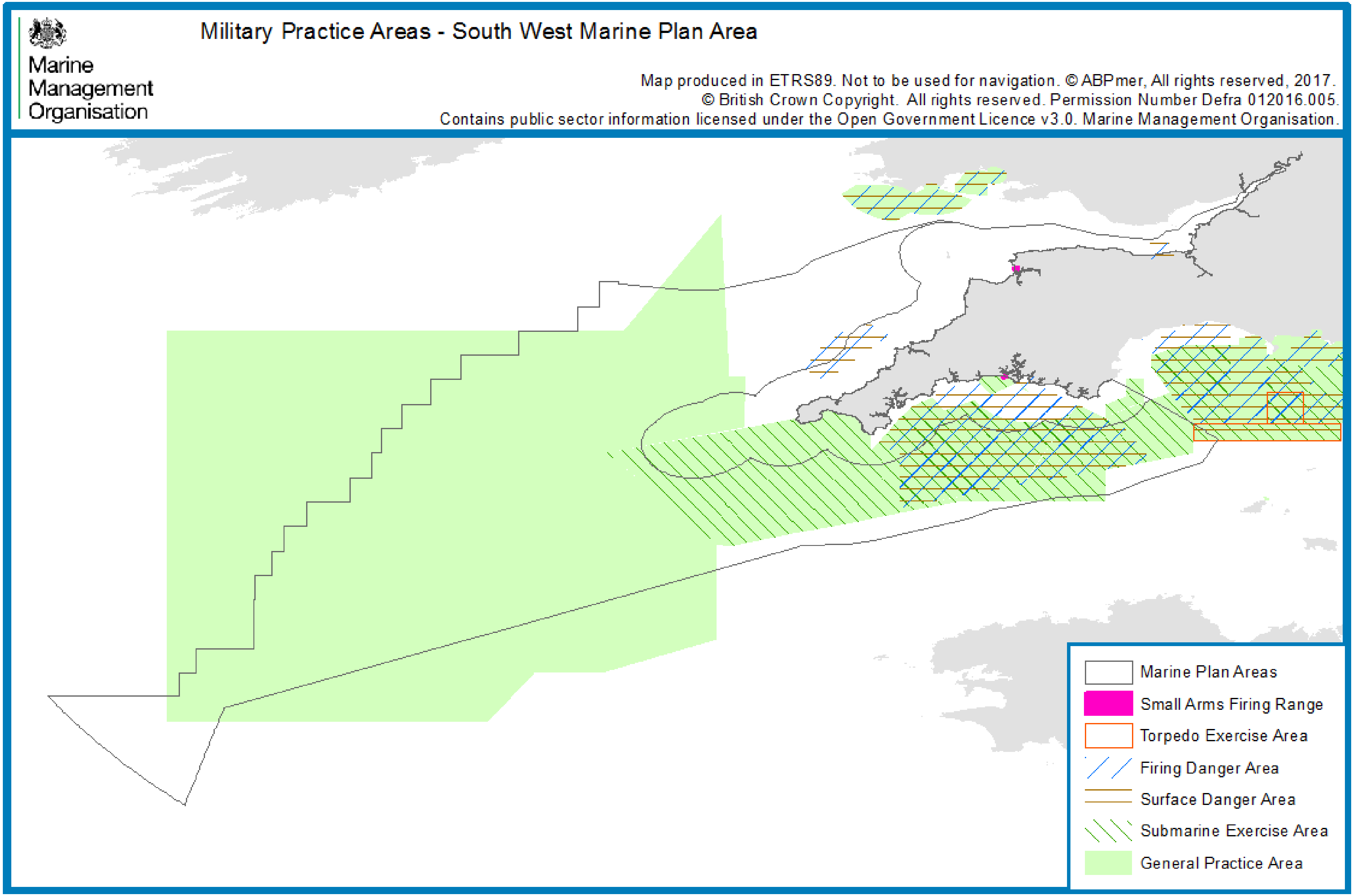


Figure 40: Military practice areas – south west marine plan area

6 Energy production: Nuclear

Sector definition

The nuclear energy sector refers to the production of electricity from nuclear power, including the disposal of spent fuel. The abstraction of seawater for cooling and the subsequent discharge of cooling water associated with the operation of nuclear power stations are discussed in Section 14

Data sources

A variety of different information sources have been reviewed to inform this baseline, including published reports and papers and spatial data layers. The main information sources used are provided in the list below:

- Economic baseline assessment for the North East, North West, South East and South West marine plans (MMO, 2016a)
- Nuclear Power in the UK (National Audit Office, 2016)
- Future Trends in the Celtic Seas (ABPmer & ICF International, 2016).

6.1 National review

Overview of national activity

The electricity generating sector of the UK is undergoing a major transition from old, polluting technologies, to cleaner low-carbon sources. Much of the UK's existing electricity generation plant is set to close over the next two decades. At the same time, the government expects electricity demand will increase due to take-up of electricity-based technologies, particularly for transport and heating homes and buildings. New infrastructure will be required to secure a stable supply of energy for the UK but these new developments must support greenhouse-gas emissions targets as well as being affordable for bill payers (National Audit Office, 2016).

Some low carbon sources of energy, such as wind, are intermittent in nature and can be more expensive than traditional fossil-fuel power sources. Nuclear energy provides a reliable, non-intermittent source of low-carbon power generation and is therefore central to the UK Government's energy policy, forming an important part of a "balanced mix" of generating technologies (National Audit Office, 2016).

New nuclear investment faces particular challenges, including high upfront costs, which can make financing projects difficult. Aware of the financial issue, the UK Government has developed the Contracts for Difference (CfD) scheme aimed at boosting investor confidence in low carbon energy generation by providing a fixed energy price for a pre-determined number of years (National Audit Office, 2016).

There are currently 14 operational nuclear power stations in the UK with a combined capacity of 7,978MW (see Figure 41). All of these, apart from Sizewell B, are gas cooled reactors. In addition to the currently active nuclear power stations, a further seven are currently proposed or under construction. All nuclear power stations, existing and proposed, are located on the coast and are distributed throughout the UK. The sector as a whole in 2014 supported 15,500 jobs (full time equivalent) with an annual turnover of approximately £3.5 billion.

Review of historical trends

Historically, the UK has met most of its energy needs from domestic sources — coal was the predominant source until the middle of the 20th century, and since the 1970s, oil and gas from the North Sea have also been important. Since the 1970's nuclear power, fuelled by imported uranium, has generated a significant proportion of the UK's electricity, reaching a peak of 30% of electricity output in the 1990s. Annual electricity generation from nuclear power in the UK has gradually declined from the late 1990s as old plants have been shut down and age-related problems affect plant availability (WNA, 2013).

Review of key changes and/or advances of significance affecting the sector

The key drivers affecting the Nuclear Energy sector are presented in Table 21. The National Policy Statement (NPS) for Nuclear Power Generation (EN-6) (DECC, 2011) sets out the UK Government's view that to contribute to the delivery of the Government's objectives of energy security and decarbonisation, nuclear energy should be free to contribute as much as possible towards meeting the future need for non-renewable capacity, up to the end of 2025 and beyond. This NPS, together with the Overarching National Policy Statement for Energy (EN-1), is the primary decision-making document for the Infrastructure Planning Commission (IPC) when considering development consent applications for the construction of new nuclear power stations on sites in England and Wales that are listed in this NPS and that the Government has assessed to be potentially suitable for such development before the end of 2025 (DECC, 2011). Government policies on energy and climate change, in particular, the EU Renewable Energy Directive, the Climate Change Act, the UK Renewable Energy Strategy (2009) and the new Industrial Strategy (2017) are also key drivers for encouraging decarbonisation of energy production.

The CfD scheme aims to increase investment in low carbon power generation. A number of new nuclear power stations, including Hinkley C, have been proposed under this scheme which has attracted significant external investment (see National Overview). It is likely that this scheme will continue to incentivise low carbon energy generation and attract international investment into the UK.

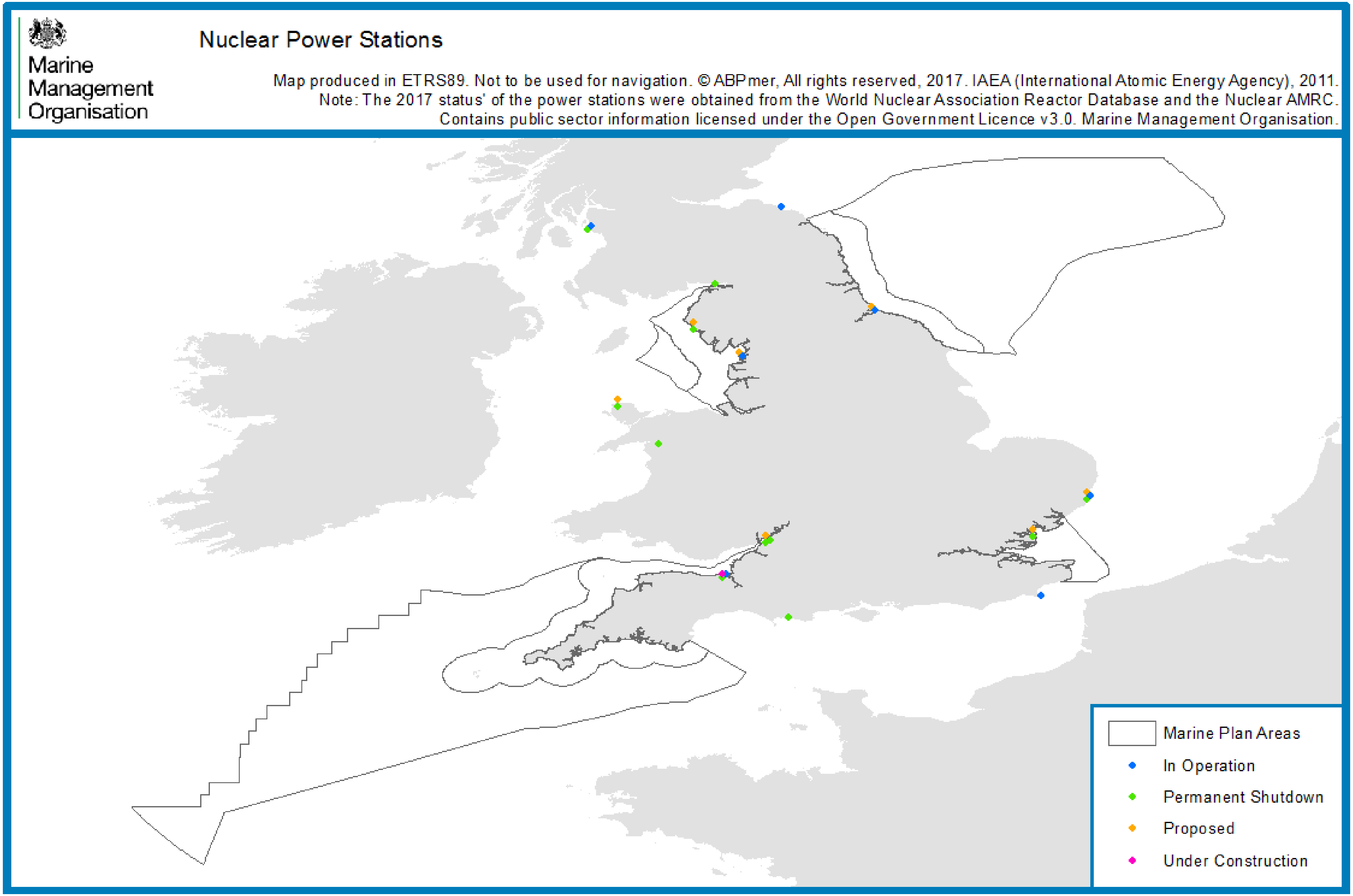


Figure 41: Nuclear power stations

Table 21: Key drivers affecting development of the nuclear energy sector

Driver	Details	Implications
Political	National Policy Statement (NPS) for Nuclear Power Generation (EN-6) sets out the Government's view that nuclear should be free to contribute towards meeting the UK's future needs for non-renewable capacity contributing to a balanced energy mix	Supports nuclear development at identified sites
	Climate Change Committee advice (2011) recommends that the electricity sector needs to be largely decarbonised by 2030	Driver for investment in nuclear energy
Economic	Price of fossil fuel and electricity	Increased costs may make nuclear power more competitive, partially mitigating high start-up costs
	High costs of electricity generation and reliance on CfD	Future investment will be dependent on availability of CfD and overall costs of electricity generation
Social	Current UK public opinion generally supports nuclear power generation although there is a small minority that is likely to strongly oppose (Poortinga *et al*., 2013; DECC, 2016). New sites are most likely to be built adjacent to or near to existing sites within broadly accepting communities benefiting from employment	No public barrier for new nuclear energy builds
Technological	Development of nuclear technologies	Driving down the cost of nuclear power generation
Legal	Climate Change Act (2008) puts a cap on the total quantity of greenhouse gas emissions emitted in the UK to achieve an emissions cut of 80% on 1990 levels by 2050	Driver for investment in nuclear energy
Environmental	Lower carbon emissions	Driver for investment in nuclear energy
	Management of nuclear waste and the potential for contamination	Demand for adequate long-term safe storage minimisation of risk and radioactive contamination

Review of future trends

The increase in global energy demand is expected to keep growing and will need to be met through a number of sources, with an increasing contribution of low carbon generation. The UK Government expect that nuclear energy will provide a significant proportion of the UK's future energy demand. High upfront cost will be mitigated by encouraging foreign investment and building larger power stations to reduce the unit price of electricity. All new nuclear power stations currently in the planning system have a rated capacity of around 3GW which is generated from Pressurised Water Reactors (PWR). Several construction issues have faced the build-out of similar nuclear power stations in other countries over recent years, resulting in schedule and budget exceedances. Construction of these power stations is therefore considered to take 10 years under all scenarios.

Under each of the three scenarios, the development of nuclear power projects is driven by central government policy with the lowest rate of development under the LS scenario as a preference for local energy generation disincentivises new nuclear developments. Under the BAU scenario current emission targets drive the construction of several currently planned nuclear power stations but no further developments are made. Alternatively, under the N@W scenario, climate change mitigation becomes a stronger policy priority and nuclear power is the main form of low carbon energy generation due to the consistently large supply of energy it can generate. This leads to all potential nuclear power stations currently in the planning stage proceeding through construction and into the generation phase before 2036.

Confidence assessment

Currently, nuclear power forms an important part of the UK Governments plan to meet future energy demand. However, the large upfront costs of nuclear power mean that external investment is required for new power stations to be built. Consequently, the amount of nuclear power in the UK is uncertain and reliant upon foreign investment.

6.2 North east

The nuclear developments in the north east marine plan areas are shown in Table 22. Hartlepool is the only nuclear power station in the north east marine plan areas. It is composed of two gas-cooled reactors with capacities of 595 and 585MW capable of supplying electricity to over 2 million UK homes (EDF Hartlepool website). At present, the site employs approximately 530 full time employees and over 200 full time contract partners (MMO, 2016a). The Hartlepool site will see operation to 2024 after which time decommissioning or new stations could provide different employment and economic opportunities. There is a proposal for a new nuclear power station at the Hartlepool site.

Estimates suggest that the nuclear industry employs 1,670 people across 130 businesses in the North East. Indirect and induced employment in the nuclear sector is estimated at 5,840 (MMO, 2016a).

Table 22: Nuclear power developments in the north east marine plan areas

Name	Total number of reactors	Status	Capacity (MW)	Reactor Type
Hartlepool 1	2	In Operation	1,185	Gas-Cooled Reactor
Hartlepool		Proposed	1,800	

The assumptions used to develop the BAU, N@W and LS scenarios for nuclear energy in the north east marine plan areas are provided in Table 23. Projected nuclear capacity under each of the three scenarios is shown in Figure 42. Figure 43 and Figure 44 shows the spatial application of the scenarios to the sector while the text below provides a brief description of the future trends in 6 years and 6 to 20 years.

Table 23: Assumptions and impacts under the future scenarios for nuclear energy in the north east marine plan areas

Aspect	Scenario		
	Business as Usual	**Nature @ Work**	**Local Stewardship**
Application to the sector	All nuclear power stations currently operating continue to do so until they enter the decommissioning stage. Under this scenario new build nuclear power stations that are in the latter stages of the planning process go ahead. Those that are currently in earlier stages of planning do not go ahead. However none of these are present in the north east marine plan areas..	Climate change mitigation becomes a stronger policy priority, leading to increased development of low carbon energy generation with nuclear power making a significant contribution to national demand. Increased development of nuclear power is highly dependent on the CfD scheme and therefore determined by central government and external investment.	All nuclear power stations currently operating continue to do so until they enter the decommissioned stage. There is significant competition from renewables and public perceptions of suitable energy resources resulting in new build nuclear power stations that are not in the latest stage of planning do not go ahead.
Assumptions	The Hartlepool nuclear power station continues operating until 2024 when decommissioning of the site begins. No further reactors are built on the site or at any other site in the north east.	The Hartlepool power station ends generation in 2024 after 41 years. The new Hartlepool station is built on the same site and begins to export electricity to the grid in 2031.	This scenario results in the same outcomes as BAU.

6-year projection

Between 2017 and 2022, the Hartlepool nuclear power station continues to operate resulting in all three scenarios having a total capacity of 1,180MW.

6 to 20 year projection

Between 2023 and 2036, the Hartlepool nuclear power station comes to the end of its operational life after 41 years of operation. Power generation ceases in 2024 causing total capacity under all scenarios to drop to zero. As no additional nuclear power is predicted to occur in the north east between 2022 and 2036 under BAU and LS, capacity is maintained at zero throughout the remainder of the time period for these two scenarios. Under N@W, the significant contribution of nuclear power to meeting national energy demand and decarbonisation targets results in a new nuclear power station being constructed at Hartlepool with a capacity of 1,800MW. Under this scenario the new Hartlepool power station begins exporting electricity to the grid in 2031 and capacity is maintained at 1,800MW for the remainder of the time period.

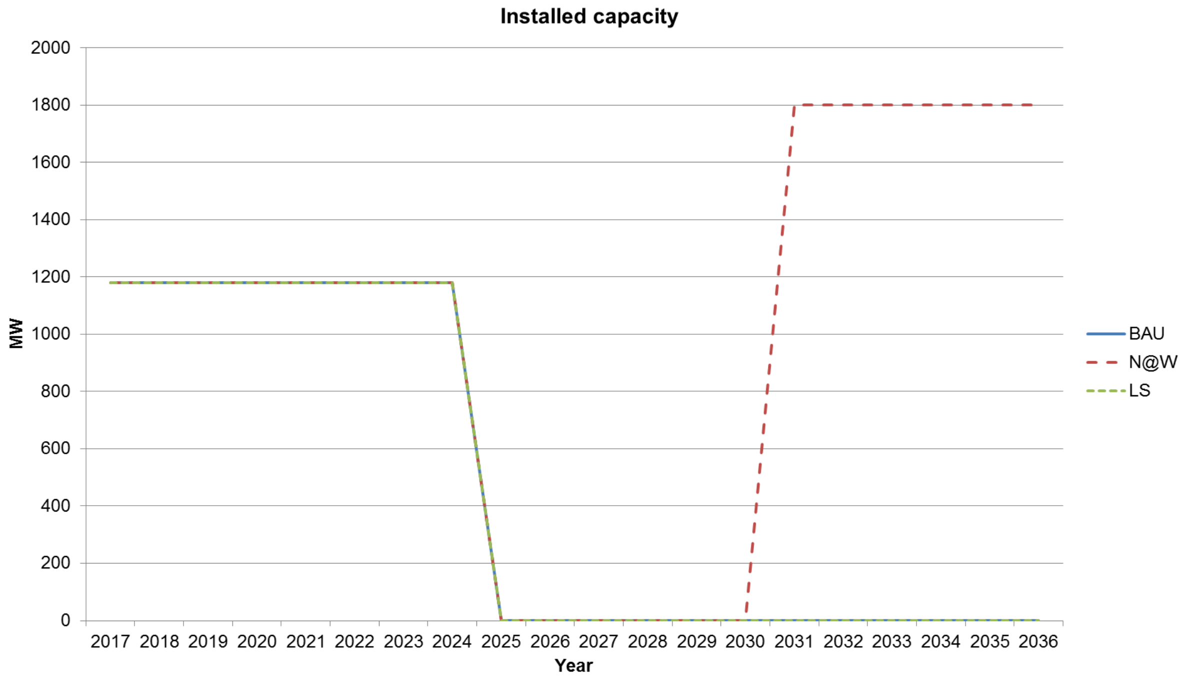


Figure 42: Nuclear capacity in the north east marine plan areas between 2017 and 2036 under three scenarios

Potential trade-offs

The main potential interactions for future nuclear development are likely to be:

- Natural environment (habitat damage, fish impingement/entrainment, reduced greenhouse gas emissions)
- Recreation (access restriction).

Within the north east marine plan areas, new nuclear development is only projected under the N@W scenario. The main potential trade-offs are likely to be with the natural environment and recreation. Negative trade-offs can be minimised through careful project design.

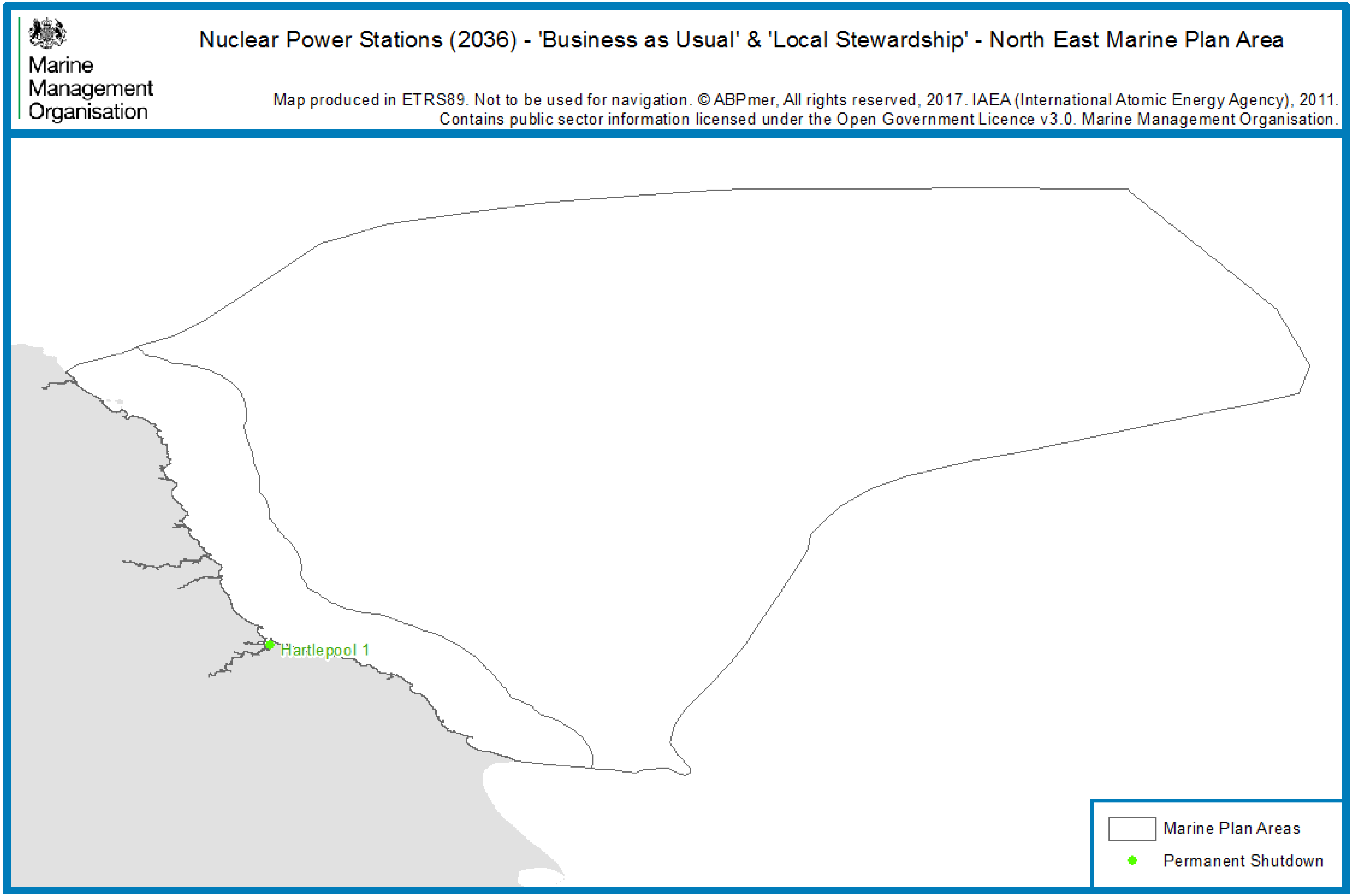


Figure 43: Nuclear power stations (2036) – BAU and LS – north east marine plan areas

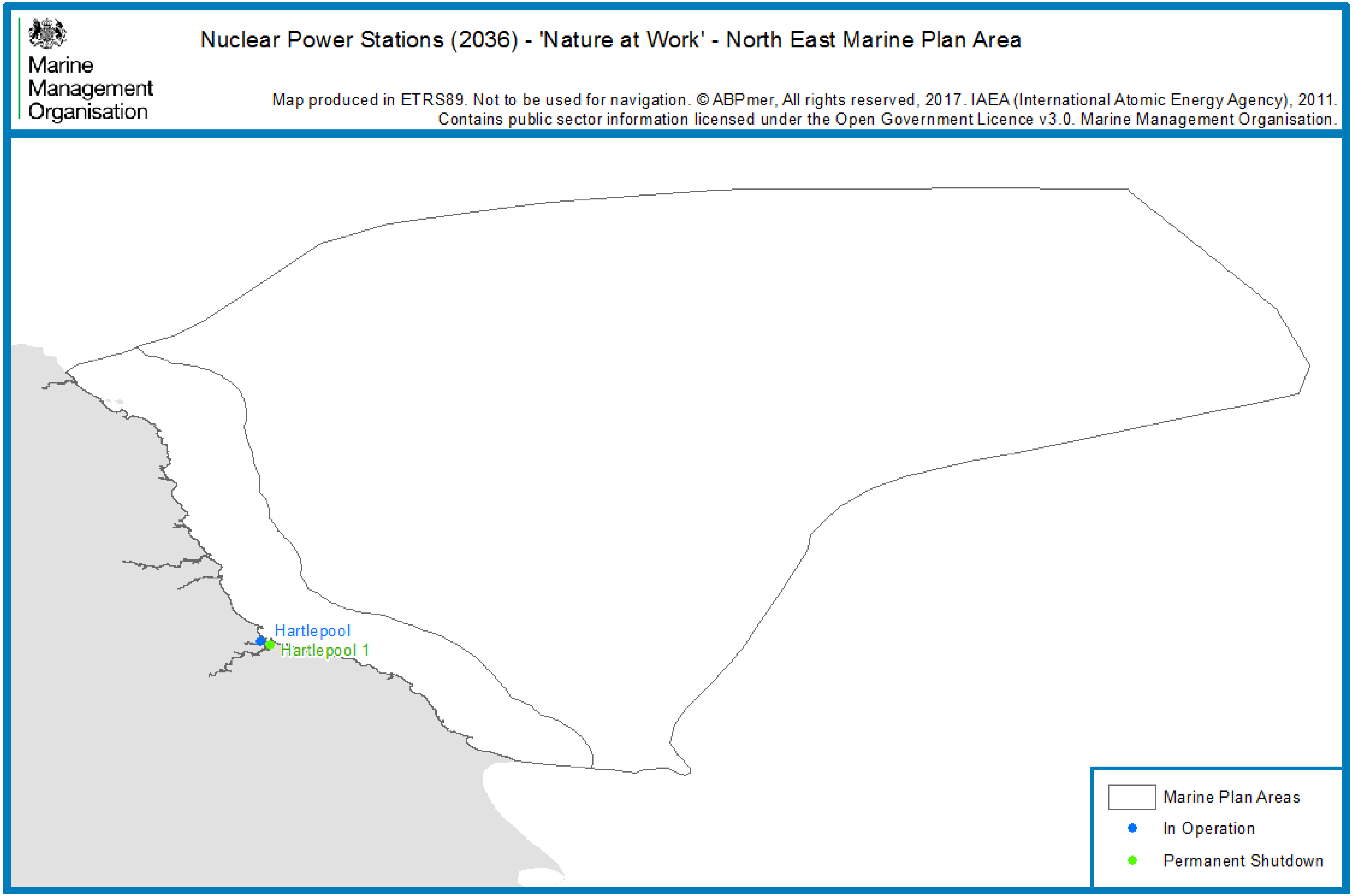


Figure 44: Nuclear power stations (2036) – N@W – north east marine plan areas

6.3 North west

The nuclear developments in the north west marine plan areas are shown in Table 24. Heysham is the only operational nuclear power station in the north west marine plan areas. This site hosts four gas-cooled reactors with a combined capacity of 2,385MW. Sellafield is also located in the north west region, consisting of five permanently shut down reactors. The site contains two currently active fuel reprocessing facilities which handle spent fuel from across the UK and overseas. A further two sites have been proposed for the construction of new nuclear power stations in the region, one near Sellafield (Moorside) and an additional one at Heysham. There are further nuclear industry assets in the area including Capenhurst and Springfields fuel processing plants, as well as activities connected to the decommissioning of the existing Sellafield site.

Heysham 1 and 2 each employ approximately 520 full time staff and approximately 250 contract partners. Sellafield employs approximately 10,000 staff in the decommissioning effort (Sellafield website) whilst Moorside is expected to create 1,000 jobs and an additional 8,500 jobs during construction.

The range of different activities within the nuclear industry is complex. Power stations account for much of the employment in this sector. However, there are wider energy related economic activities (e.g. safety) which are also relevant.

The MMO economic baseline states that in 2014, 15,396 people were employed across 345 businesses in the north west nuclear sector, a value that represents just under half of all energy employment (31,480 people across 4,590 businesses). Using the employment multiplier for electricity generation (3.5) indirect employment in the north west is estimated at 53,950 (Scottish Government, 2016; MMO, 2016a). It should be noted that the multiplier could be even larger given that the industry has several safety and technical requirements which distinguish it from other energy sectors.

Table 24: Nuclear power developments in the north west marine plan areas

Name	Total number of reactors	Status	Capacity (MW)	Reactor Type
Heysham 1	2	In Operation	1,155	Gas-Cooled Reactor
Heysham 2	2	In Operation	1,230	Gas-Cooled Reactor
Sellafield (Calder Hall 1,2,3,4)	4	Permanent Shutdown	49	Gas-Cooled Reactor
Sellafield (Windscale AGR)	1	Permanent Shutdown	24	Gas-Cooled Reactor
Heysham 3		Proposed	3,000 (assumed)	Pressurised Water Reactor
Moorside		Proposed	3,400	Pressurised Water Reactor

The assumptions used to develop the BAU, N@W and LS scenarios for nuclear energy in the north west marine plan areas are provided in Table 25. Projected nuclear capacity under each of the three scenarios is shown in Figure 45. Figure 46 and Figure 47 show the spatial application of the scenarios to the sector while the text below provides a brief description of the future trends in 6 years and 6 to 20 years.

Table 25: Assumptions and impacts under the future scenarios for nuclear energy in the north west marine plan areas

Aspect	Scenario		
	Business as Usual	**Nature @ Work**	**Local Stewardship**
Application to the sector	As for the north east marine plan areas (see Table 23).	As for the north east marine plan areas (see Table 23).	As for the north east marine plan areas (see Table 23).
Assumptions	Heysham 1 and 2 continue to operating until 2025 and 2030 respectively. The Moorside nuclear power station is currently progressing though the planning process and therefore considered to go ahead under this scenario, beginning generation in 2030.	Heysham 1 and 2 continue to operating until 2025 and 2030 respectively. The Moorside and Heysham 3 power stations both go ahead and begin generating power in 2030 and 2035 respectively. Heysham 3 has an assumed capacity of 3,000MW.	This scenario results in the same outcome as BAU

6-year projection

Between 2017 and 2022, the two Heysham nuclear power stations continue to operate under all scenarios. No additional nuclear capacity is added in this time period under any scenario. Capacity therefore remains at 2,385MW.

6 to 20 year projection

Between 2023 and 2036, both currently operating nuclear power stations in the north west reach the end of their operational life. In 2025 Heysham 1 ceases generation causing total capacity under all scenarios to drop to 1,230MW. In 2030, capacity increases to 4,630MW under all scenarios as the Moorside power station becomes operational. However this capacity is only maintained for a single year as Heysham 2 ceases operation in 2031 resulting in capacity declining to 3,400MW under all scenarios. Capacity remains at this level under BAU and LS for the remainder of the time period. Under N@W an additional power station, Heysham 3, becomes operational in 2035. With larger capacity than Heysham 2, the operation of Heysham 3 (3,000MW) results in total capacity increasing to 6,400MW in 2035 and remaining at this level for the remainder of the time period.

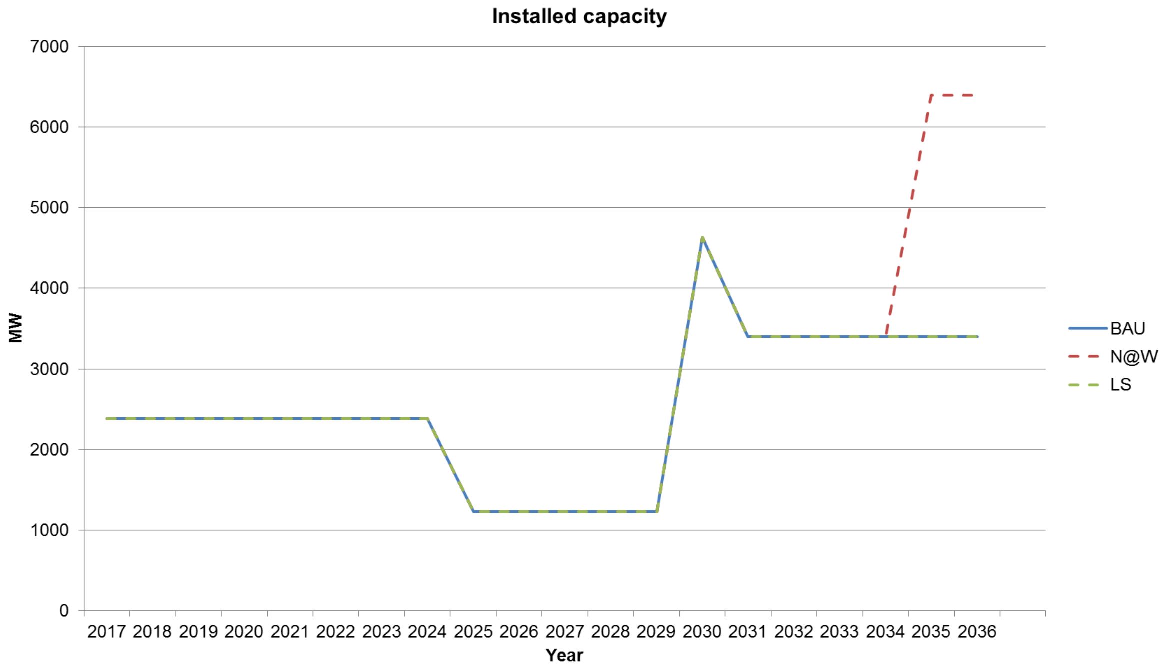


Figure 45: Nuclear capacity in the north west marine plan areas between 2017 and 2036 under three scenarios

Potential trade-offs

The main potential interactions for future nuclear development are likely to be:

- Natural environment (habitat damage, fish impingement/entrainment, reduced greenhouse gas emissions)
- Recreation (access restriction).

Within the north west marine plan areas, new nuclear development is projected under all three scenarios with greater levels of development under the N@W scenario. The main potential trade-offs are likely to be with the natural environment and recreation. Negative trade-offs can be minimised through careful project design.

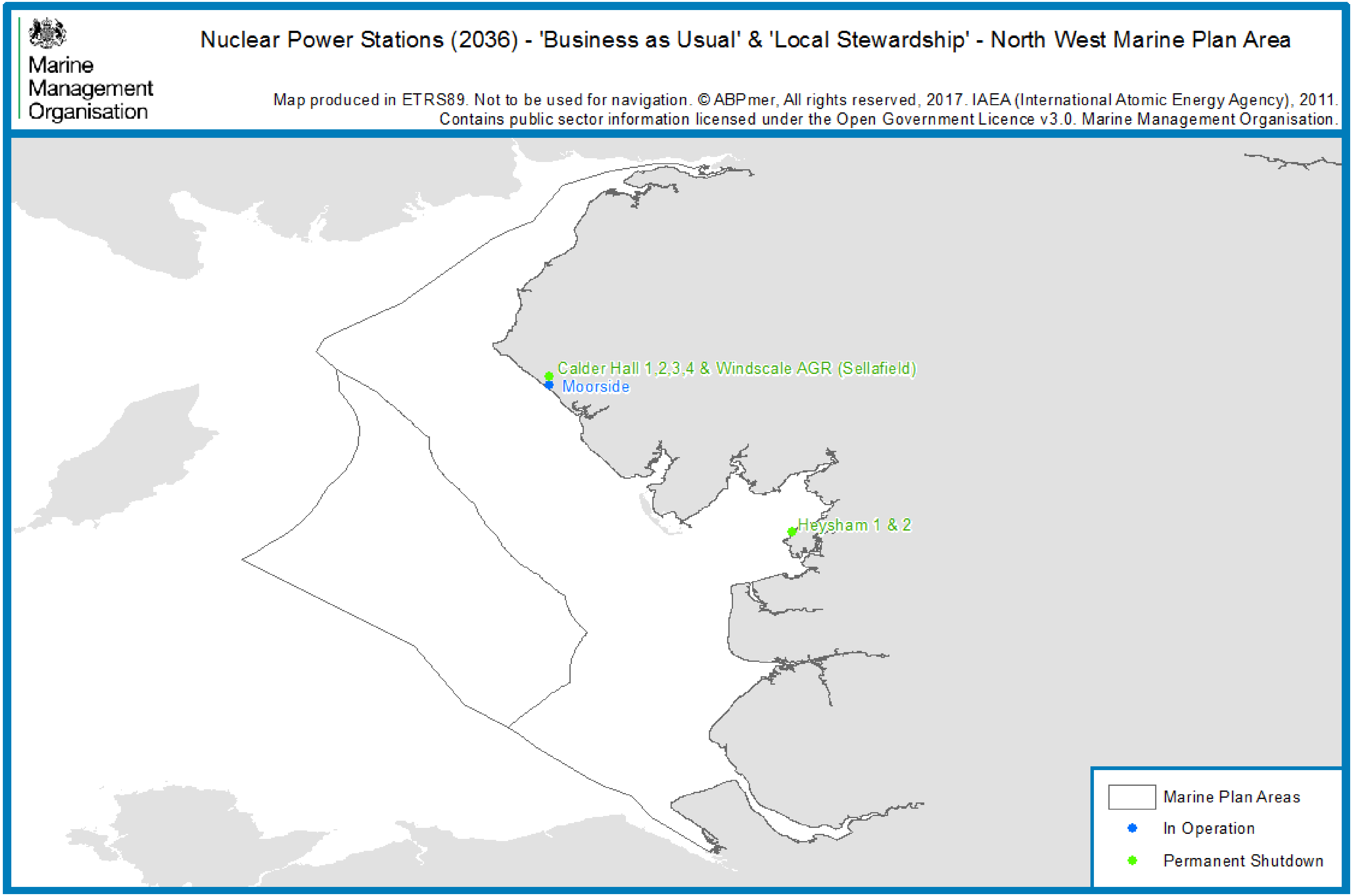


Figure 46: Nuclear power stations (2036) – BAU and LS - north west marine plan areas

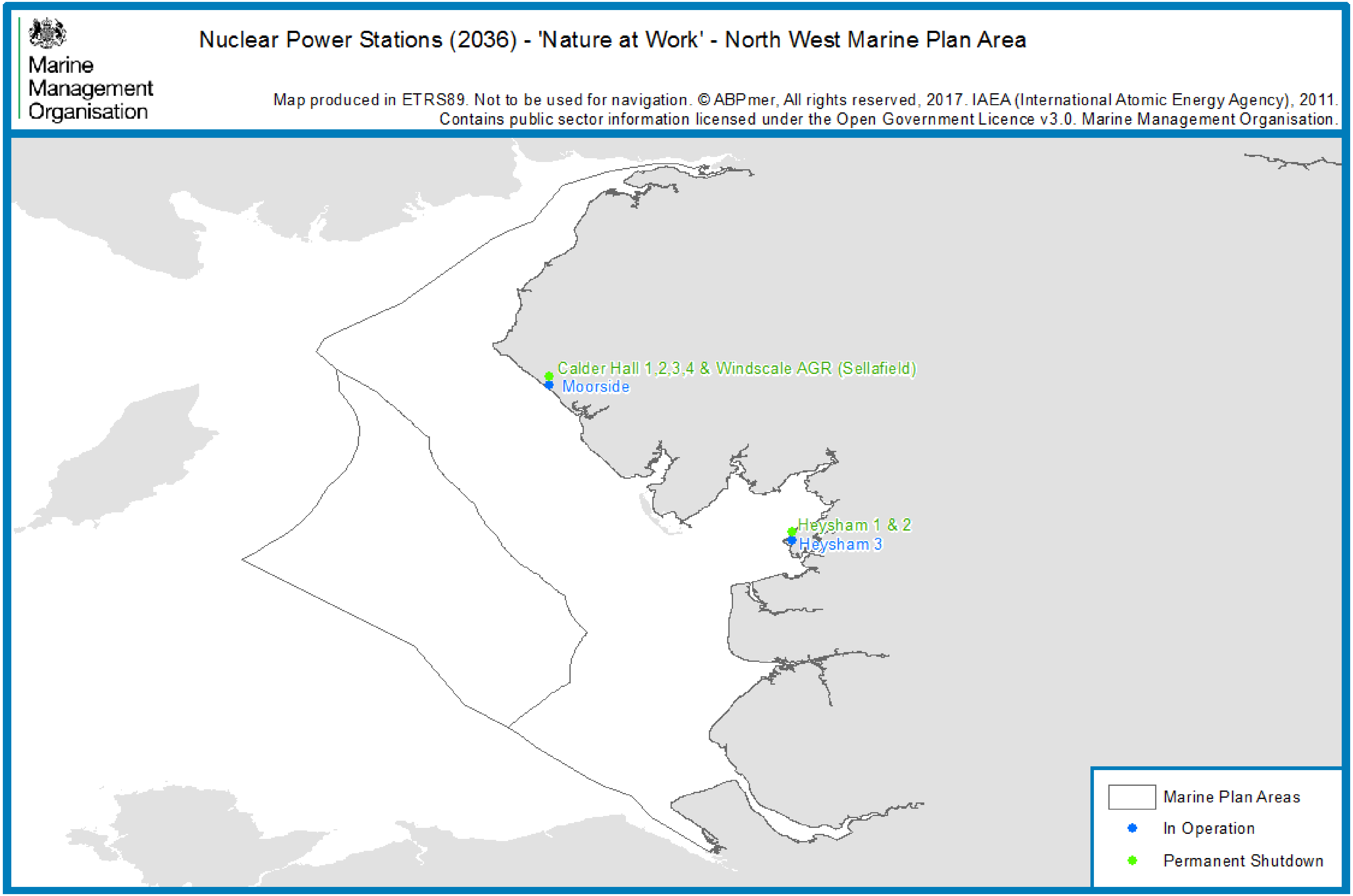


Figure 47: Nuclear power stations (2036) – N@W - north west marine plan areas

6.4 South east

The nuclear developments in the south east marine plan area are shown in Table 26. Bradwell is the only nuclear power station in the south east marine plan area and is currently undergoing decommissioning. There is a proposal to build a new reactor on the site, however a recent news release suggests that a decision as to whether the site will go ahead will not be made until 2020 (Ruddick and Phillips, 2016).

Despite the lack of operational nuclear power stations, national statistics for employment suggest that the nuclear industry in the south east region supports 275 businesses and 6,820 jobs. This is a larger amount of employment than some regions with operational nuclear power stations and is attributed to a large proportion of the employment being accounted for by head office activities and activities of businesses not near any nuclear power stations. An employment multiplier (3.5) suggests that indirect and induced employment by the nuclear sector in the region is around 23,900 jobs (MMO, 2016a).

Table 26: Nuclear power developments in the south east marine plan area

Name	Total number of reactors	Status	Capacity (MW)	Reactor Type
Bradwell 1 and 2	2	Permanent Shutdown	123	Gas-Cooled Reactor
Bradwell 3		Proposed	3,000	Pressurised Water Reactor

The assumptions used to develop the BAU, N@W and LS scenarios for nuclear energy in the south east marine plan area are provided in Table 27. Projected nuclear capacity under each of the three scenarios is shown in Figure 48. Figure 49 shows the spatial application of the scenarios to the sector while the text below provides a brief description of the future trends in 6 years and 6 to 20 years.

Table 27: Assumptions and impacts under the future scenarios for nuclear energy in the south east marine plan area

Aspect	Scenario		
	Business as Usual	Nature @ Work	Local Stewardship
Application to the sector	As for the north east marine plan areas (see Table 23) but no nuclear power stations are currently operating in the south east marine plan area.	As for the north east marine plan areas (see Table 23).	As for the north east marine plan areas (see Table 23) but no nuclear power is currently operating in the south east marine plan area.
Assumptions	No activity under this scenario	No nuclear activity occurs until 2035 when the Bradwell 3 nuclear power station begins to export electricity to the grid. This power station has an assumed capacity of 3,000MW.	No activity under this scenario

6-year projection

Between 2017 and 2022, none of the scenarios result in any nuclear capacity being added to the south east.

6 to 20 year projection

Between 2023 and 2036, BAU and LS follow the same trend, both resulting in no nuclear capacity being added in areas adjacent to the south east marine plan area. Under N@W, the 3,000MW Bradwell 3 power station comes online in 2035 and is operational throughout the remainder of the time period.

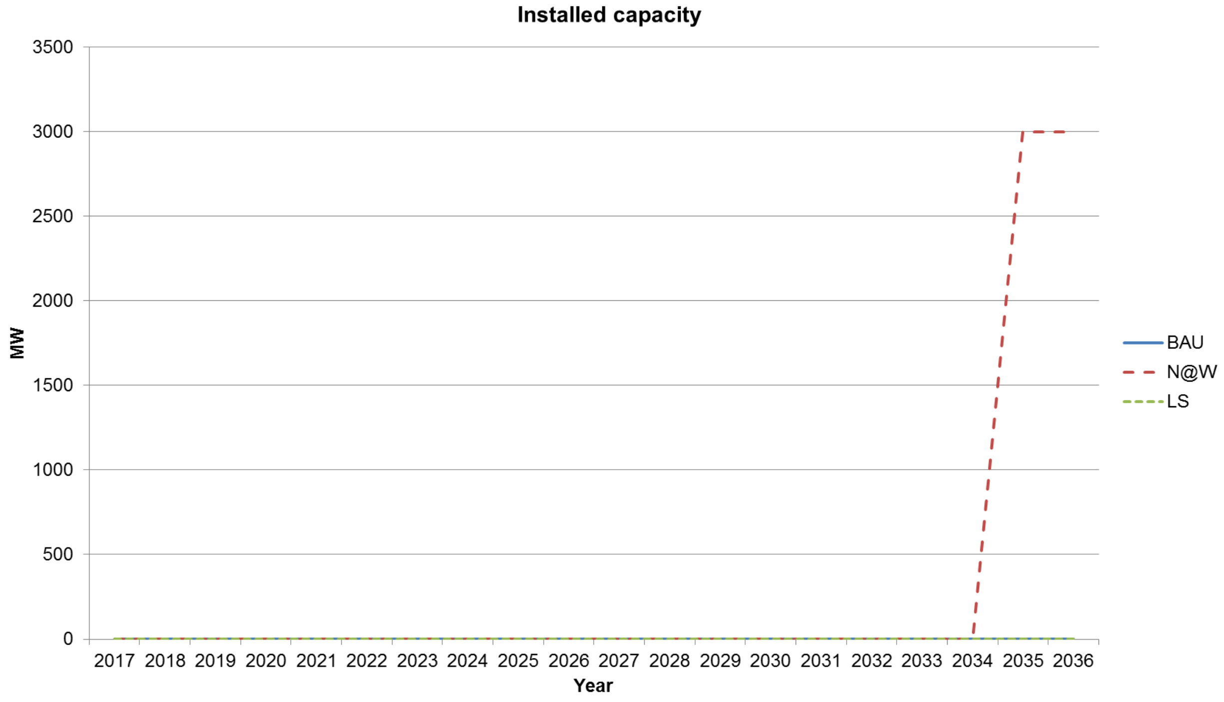


Figure 48: Nuclear capacity in the south east marine plan area between 2017 and 2036 under three scenarios

Potential trade-offs

The potential trade-offs are similar to the north east marine plan areas.

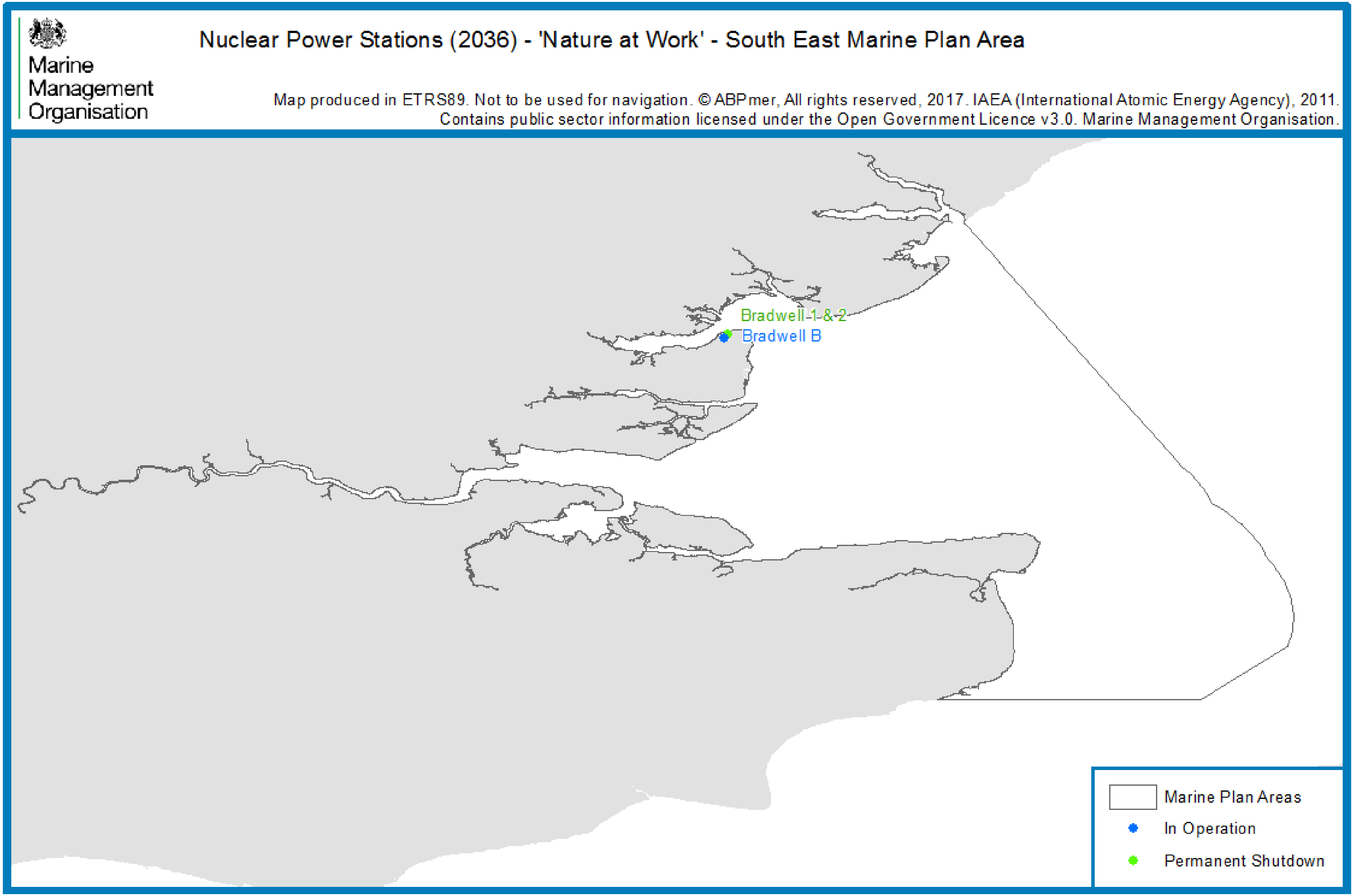


Figure 49: Nuclear power stations (2036) – N@W – south east marine plan area

6.5 South west

The nuclear developments in the south west marine plan areas are shown in Table 28. Hinkley Point B is the only operational nuclear power station in the south west marine plan areas. The station contains two gas-cooled reactors with a combined capacity of 945MW, capable of supplying electricity to over 2 million UK homes. Hinkley Point B is run by EDF Energy and has been exporting electricity to the grid since 1976; the estimated decommissioning date is 2023.

Two nuclear power stations are currently undergoing decommissioning in the south west. Hinkley Point A ceased generation in 2000 after 35 years of operation producing 103 TWh. Oldbury ceased generation in 2012 after 44 years of operation producing 137.5 TWh (Magnox website). Both of these sites have confirmed plans for new nuclear power stations. Construction of Hinkley Point C is currently underway and is a venture undertaken by Nuclear New Build Generation Company (NNBG) and China General Nuclear Power (CGN) facilitated by the UK Government's CfD scheme. A timeline for the new Oldbury nuclear power station has not yet been published. The developer, Horizon, states that lessons learnt from the Wylfa site in North Wales is a fundamental principle for the Oldbury development. It can therefore be assumed that planning for Oldbury will not begin until consent has been granted for Wylfa.

Hinkley Point B power station employs approximately 535 full time employees plus over 220 full time contract partners. Whilst power stations account for much of the employment in this sector, there are also wider energy related economic activities of relevance. ONS data shows that the nuclear industry in the south west employs 5,520 people across 420 businesses. Using an employment multiplier the indirect and induced employment in the nuclear sector in south west is estimated to be 19,330. It should be noted that the multiplier could be even larger given that the industry has several safety and technical requirements which distinguish it from other energy sectors.

Table 28: Nuclear power developments in the south west marine plan areas

Name	Total number of reactors	Status	Capacity (MW)	Reactor Type
Hinkley Point C	2	Under Construction	3,200	Pressurised Water Reactor
Hinkley Point B	2	In Operation	955	Gas-Cooled Reactor
Berkeley 1 and 2	2	Permanent Shutdown	138	Gas-Cooled Reactor
Hinkley Point A1 and A2	2	Permanent Shutdown	235	Gas-Cooled Reactor
Oldbury A1 and A2	2	Permanent Shutdown	217	Gas-Cooled Reactor
Oldbury		Proposed	2,700	Pressurised Water Reactor

The assumptions used to develop the BAU, N@W and LS scenarios for nuclear energy in the south west marine plan areas are provided in Table 29. Projected nuclear capacity under each of the three scenarios is shown in Figure 50. Figure 51 and Figure 52 shows the spatial application of the scenarios to the sector while the text below provides a brief description of the future trends in 6 years and 6 to 20 years.

Table 29: Assumptions and impacts under the future scenarios for nuclear energy in the south west marine plan areas

Aspect	Scenario		
	Business as Usual	**Nature @ Work**	**Local Stewardship**
Application to the sector	All nuclear power stations currently operating continue to do so until they enter the decommissioning stage. New build nuclear power stations that are in construction (Hinkley C) and in the planning process (Oldbury) proceed. However the Oldbury power station does not begin generation before 2036.	As for the north east marine plan areas (see Table 23).	As for the north east marine plan areas (see Table 23).
Assumptions	Hinkley Point B continues to operate until 2023. Hinkley Point C begins generation in 2030. Planning for the Oldbury power station proceeds but it does not generate power before 2036.	Hinkley Point B continues to operate until 2023. Hinkley Point C begins generation in 2030 and Oldbury begins generation in 2035.	Hinkley Point B continues to operate until 2023 and Hinkley Point C begins operation in 2030. The Oldbury nuclear power station is not constructed under this scenario.

6-year projection

Between 2017 and 2022, Hinkley Point B continues to operate under all scenarios, producing 955MW of capacity.

6 to 20 year projection

In 2023 Hinkley Point B ceases generation. Hinkley Point C commences generation in 2030 with a capacity of 3,200MW under all scenarios. No further nuclear developments occur under LS, therefore this scenario remains at 3,200MW between 2024 and 2036. The same trend is observed in BAU, however the Oldbury power station is assumed to be under construction but does not begin operation during this time period.

Under N@W, capacity increases to 5,900MW in 2035 when the Oldbury power station becomes operational, adding 2,700MW of nuclear capacity. Total capacity for BAU and N@W therefore reaches a peak of 5,900MW in 2035 which is maintained for the remainder of the time period.

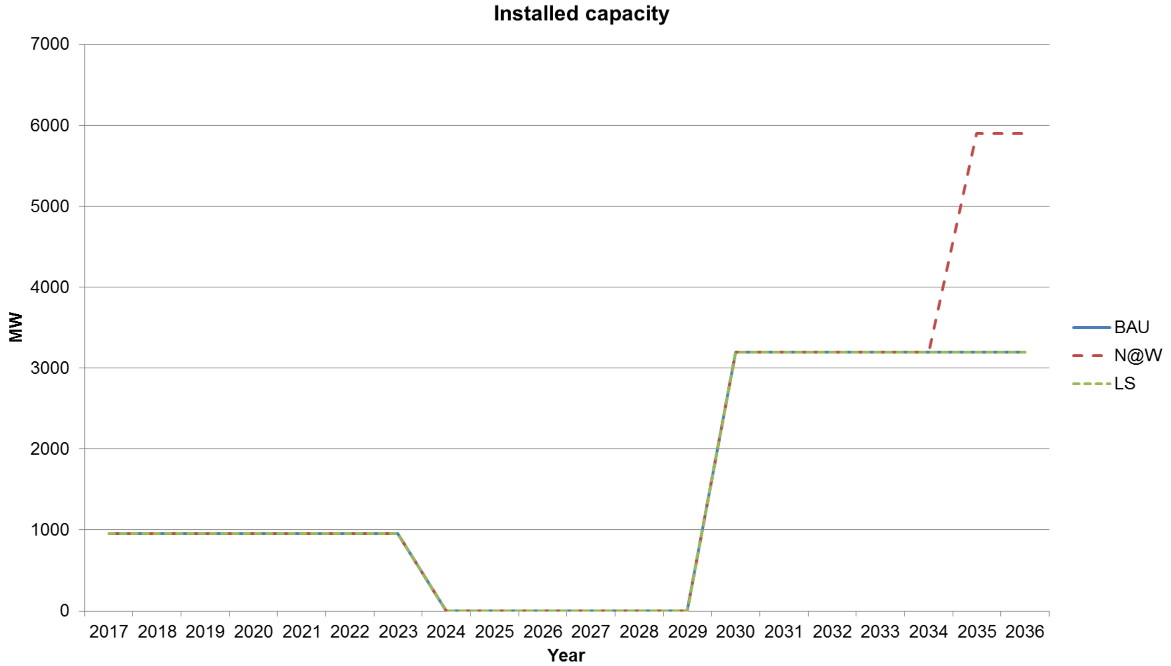


Figure 50: Nuclear capacity in the south west marine plan areas between 2017 and 2036 under three scenarios

Potential trade-offs

The potential trade-offs are similar to the north west marine plan areas.

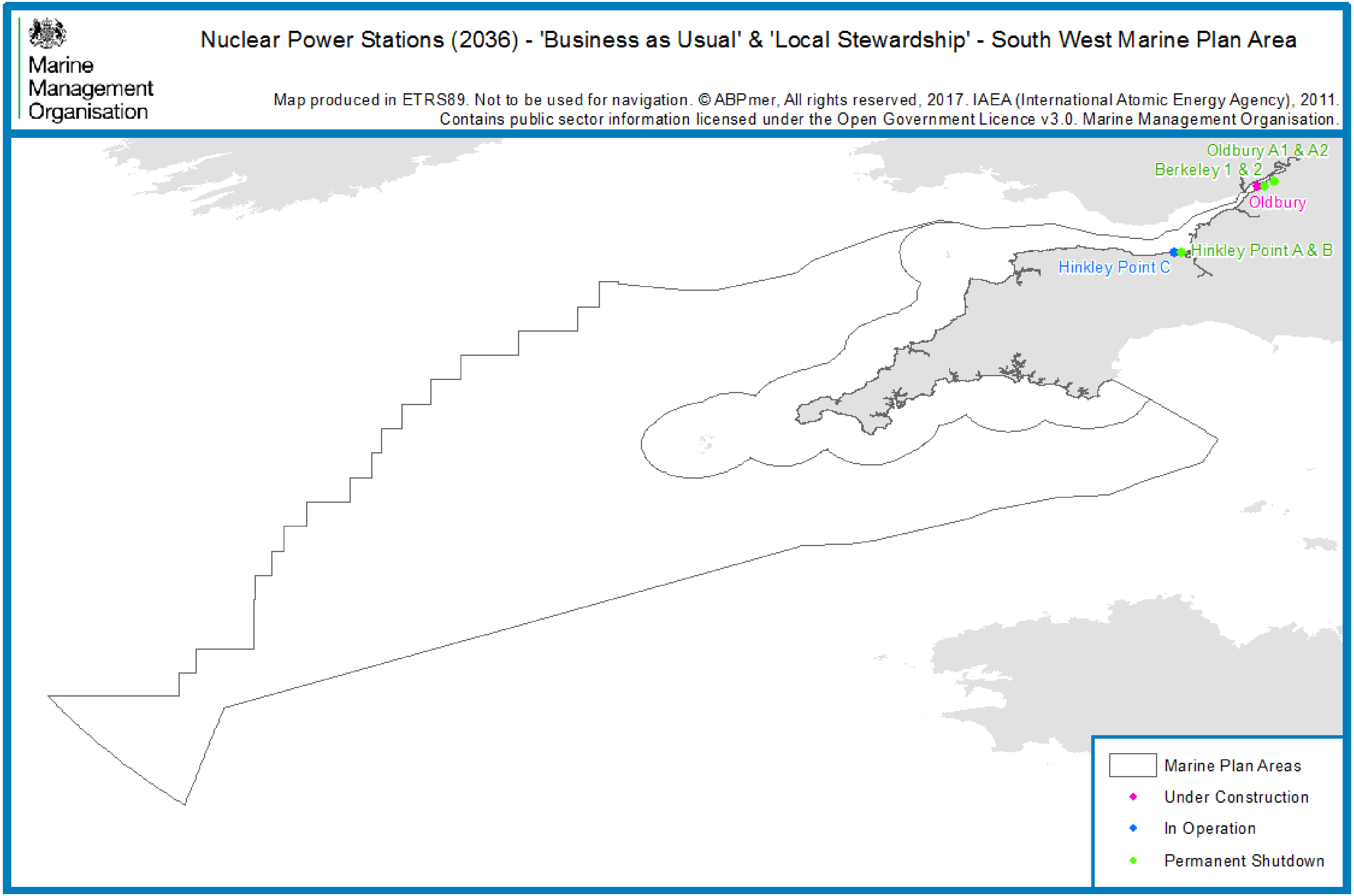


Figure 51: Nuclear power stations (2036) – BAU and LS – south west marine plan areas

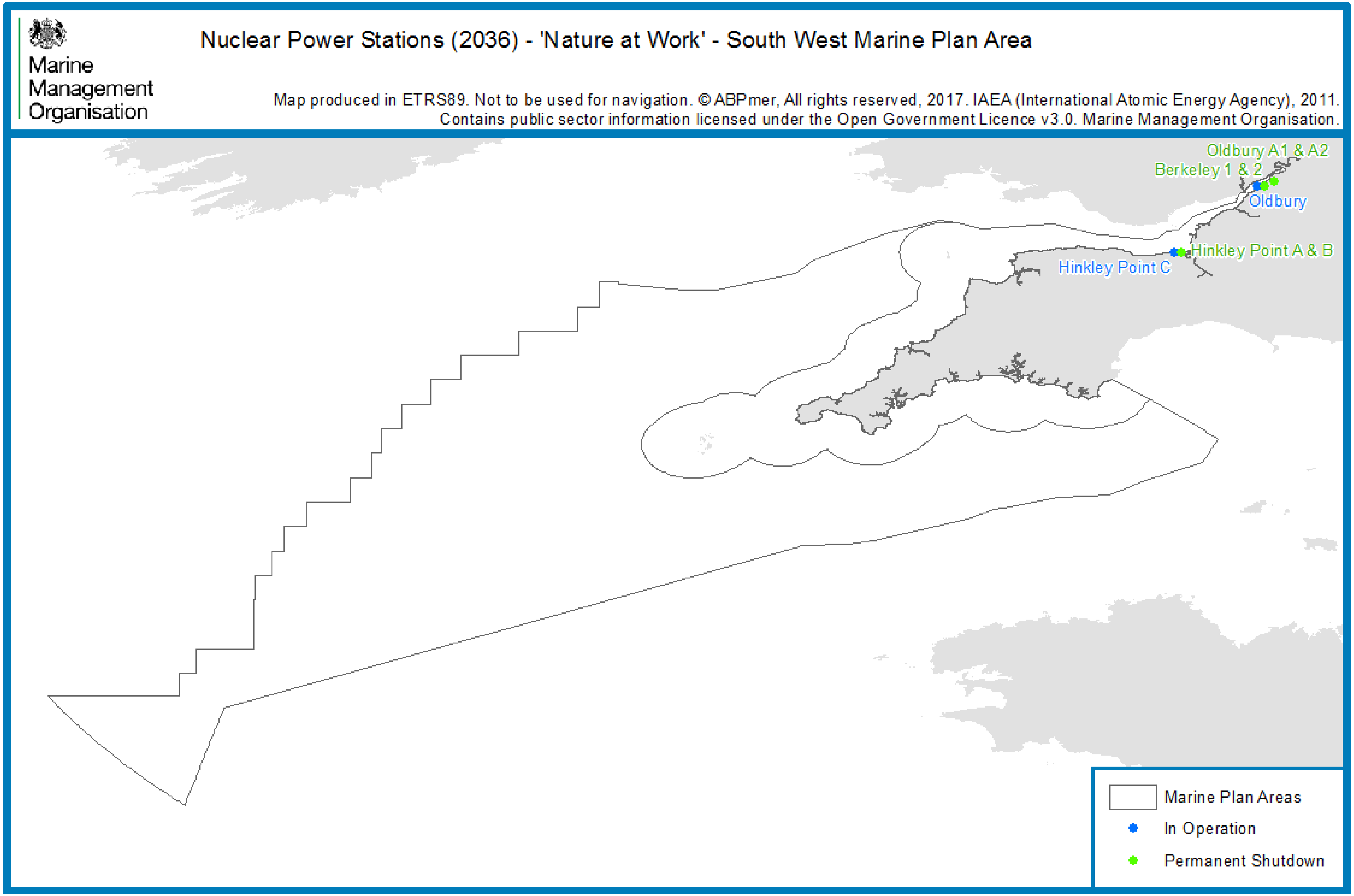


Figure 52: Nuclear power stations (2036) – N@W – south west marine plan areas

7 Energy production: Offshore electricity distribution networks

Sector definition

The offshore electricity networks sector is concerned with the transmission of power through submarine cables. These include international and national links among the islands of the UK and with Europe (termed here as interconnectors).

Data sources

A variety of different information sources have been reviewed to inform this baseline, including published reports and papers and spatial data layers. The main information sources used are provided in the list below:

- Economic baseline assessment for the North East, North West, South East and South West Marine Plans (MMO, 2016a);
- The Crown Estate submarine cable spatial data;
- Future Trends in the Celtic Seas (ABPmer & ICF International, 2016); and
- Ofgem reports and website (Ofgem, 2014; 2016; 2017).

7.1 National review

Overview of national activity

Electrical interconnection with other nations contributes to UK energy security, affordability and decarbonisation objectives. The UK currently has 3.5GW of interconnection with other nations, 2GW with France, 1GW with the Netherlands and 500MW with the Republic of Ireland (Ofgem, 2017). In 2015 this represented approximately 4.4% of domestic generation capacity, well short of the European Commission's target of 10% (Pöyry, 2016).

Over the past few years the UK has seen an increase in the commercial interest in interconnection. A number of projects are currently under consideration to increase the UK's interconnection capacity, which could provide billions of pounds of additional investment in electricity networks. If all of these projects were to go ahead, approximately 10GW of new interconnection would be achieved by 2025 (Pöyry, 2016).

In early 2015 the Nemo (1GW to Belgium) and North Sea Link (NSN) (1.4GW to Norway) interconnectors both reached a final investment decision, which marks a major milestone towards seeing these interconnectors become operational. A further seven proposals have been put forward to provide connections between France, Norway, Ireland, Denmark and Iceland. If approved, these are suggested to be commissioned in the early 2020s, contributing towards the UK's 10% interconnection target (National Grid, n.d.[4]; Pöyry, 2016).

[4] http://www2.nationalgrid.com/About-us/European-business-development/Interconnectors/Iceland/

Considering domestic power cables as well as interconnectors, a total of 63 subsea power cables are present in UK waters (see Figure 53). Two interconnectors run through the north west marine plan areas. These are the Isle of Man interconnector and the first part of the Western HVDC Link. In the south east marine plan area, Nemo Link provides a connection between the UK and Belgium. No interconnectors are currently present in the south west or north east marine plan areas. The presence of power cables on the seabed can be affected by the activities of other business sectors. For example, there is risk to and from the fishing industry as trawls and anchors may become caught on submarine cables, which can prove costly to both fishing and cabling operations in terms of repairs and maintenance (MMO, 2016a).

Review of historical trends

The very first submarine power cable was installed in the early 19th century. Early cables were very restricted in length and capacity, limited to river and estuary crossings. Technological and design developments over the past two centuries have increased the operating capacity and the length of submarine power cables meaning that submarine power cables are now capable of stretching for hundreds of kilometres (European Subsea Cables Association, 2017; UKMMAS, 2010).

Recently, the importance of these cables has increased with the advent of offshore renewable energy developments requiring electrical export from offshore sites to the onshore grid. The Generating Energy & Prosperity report published in 2014 by the Offshore Renewable Catapult suggests that submarine power cables are crucial to unlocking the significant economic gains from offshore renewables and interconnection with mainland Europe (European Subsea Cables Association, 2017).

Review of key changes and/or advances of significance affecting the sector

Table 30 highlights the key changes affecting the sector. The offshore electricity network is driven ultimately by demand and the desire for energy security at a national level and, to some extent, the commercial opportunity to selling surplus electricity. In addition policy drivers such as the Energy White Paper (DTI, 2003) include goals to maintain the reliability of energy supplies so that people and businesses can rely on secure energy. However, previous regulatory frameworks have failed to incentivise the construction of new interconnectors despite the potentially significant benefits they provide (Ofgem, 2014).

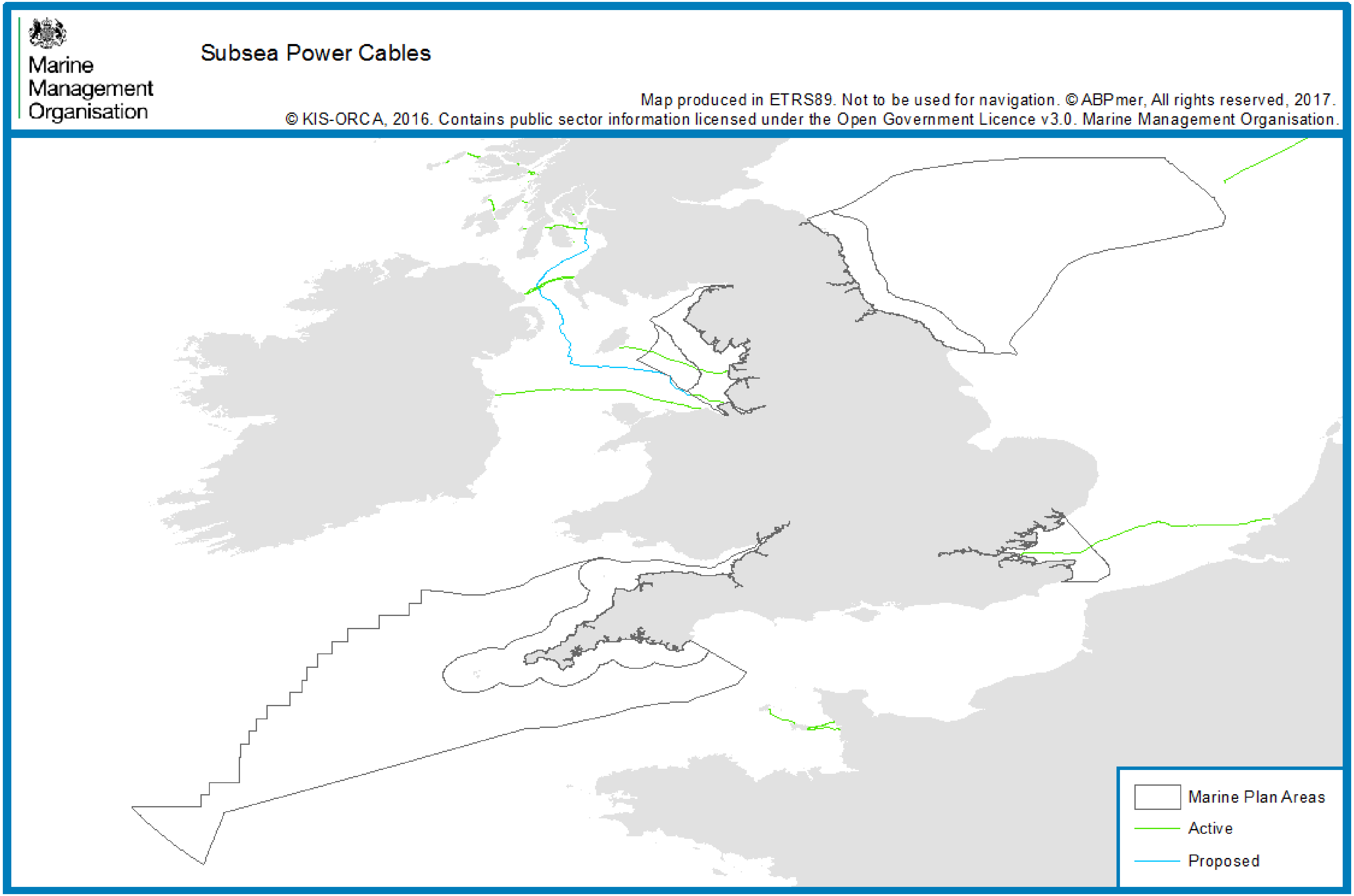


Figure 53: Subsea power cables

Table 30: Key drivers affecting development of the offshore electricity distributions networks sector

Driver	Details	Implications
Political	Maintain the reliability and security of energy supplies (national level). Goals to create a single integrated electricity market (at EU level)	Potential further development of offshore electricity networks
	North Seas Countries Offshore Grid Initiative (covering North and Irish Seas) and UK-Irish Memorandum of Understanding (MoU) on energy cooperation and association with offshore wind energy industry.	Potential to develop offshore supergrids in the North and Irish Seas
	UK to have a good energy mix and maintain energy security	Acts as an incentive and a constraint on renewable sources
Economic	Funding for Projects of Common Interest (PCIs) leading to investment in interconnectors (such as FAB project interconnection between Cotentit (France) and Exeter (UK)	More stable electricity price
	Cap and Floor regulatory regime	Increased investment in electricity interconnectors
Social	No significant drivers identified	N/A
Technological	Increases in the capacity of cables and the use of larger capacity cables over longer distances	Potential further development of offshore electricity networks
	Development of HVDC technology	Increase the efficiency of electrical transfer allowing larger interconnection distance
	Increased offshore network capacity requirements	Potential further development of offshore electricity networks
Legal	No significant drivers identified	N/A
Environmental	No significant drivers identified	N/A

In 2014 the UK Government rolled out the ‘Cap and Floor’ regulatory regime to encourage investment in electricity interconnectors. This regime aims to balance between commercial incentives and appropriate risk mitigation for project developers by providing a ‘floor’ which ensures a minimum amount of revenue that an electricity interconnector can earn. This means that, if an interconnector does not receive enough revenue from its operations, its revenue will be ‘topped up’ to the floor level. Simultaneously, the amount a developer can earn from a ‘cap and floor’ project is limited. Should the cap level be exceeded, the excess revenue will be transferred to the UK system operator (Ofgem, 2016). As an alternative, developers can still seek exemptions from regulatory requirements. However this route means that developers face the full upside and downside of the investment meaning other measures to safeguard their investment are usually required (Ofgem, 2016). The majority of the currently proposed interconnection projects have applied for the Cap and Floor regime.

To incentivise and help create an integrated EU energy market, the European Commission began identifying PCIs in 2013. PCIs are identified as projects that are essential for completing the European internal energy market and for reaching the EU's energy policy objectives of affordable, secure and sustainable energy supply.

Designated PCIs may benefit from accelerated planning and permit granting, a single national authority for obtaining permits, improved regulatory conditions, lower administrative costs due to streamlined environmental assessment processes, increased public participation via consultations, increased visibility to investors, and access to financial support totalling €5.35 billion from the Connecting Europe Facility (CEF) from 2014-2020. The funding is intended to speed up the projects and attract private investors. To become a PCI, a project must have a significant impact on the energy markets and market integration of at least two EU countries, boost competition on energy markets and boost the EU's energy security by diversifying sources, and contribute to the EU's climate and energy goals by integrating renewables. The list of PCIs is updated every two years to incorporate new projects and removes obsolete ones. Currently there are 10 PCI projects occurring in the UK which include the Nemo and NSN interconnectors. The next update to the PCI list is due in in 2017.

A key advance of significance affecting the sector is likely to be related to technological advances which could increase the capacity of cables and enable larger capacity cables to be used.

Review of future trends

The power cable industry is experiencing significant growth, with several new projects currently in the installation and planning phases. It is likely that investment in the activities described in this section will be affected by the recent downturn in the economy in the short term, but long-term drivers for competitive electricity markets and international energy cooperation are likely to maintain the impetus towards increasing the level of interconnector capacity.

National Grid's Electricity Ten Year Statement sets out three future energy scenarios which provide a range of potential reinforcements and outcomes for the development of the transmission network. On a UK-wide level, interconnector capacity is forecast to increase in all scenarios, with total capacity in 2030 ranging from 6,600 to 11,600MW. These scenarios suggest that the growth in renewable generation and increase in interconnection capacity could result in the UK becoming a net exporter of electricity by the end of this decade with significant increases in exports and reductions in imports by 2030 (National Grid, 2012).

In the north east, north west and south east marine plan areas, all scenarios considered in this analysis result in interconnection projects currently under construction or in late stages of planning being built out over the next 10 years (no projects are currently planned for the south west marine plan areas). Between 2025 and 2036 it is assumed that all planned interconnection infrastructure will be added to current capacity under BAU and N@W. Those projects currently considered speculative or in the very early stages of planning will go ahead under N@W, providing additional capacity due to a national push in renewable energy generation and the development of offshore grids. LS will not result in any additional interconnection capacity as this scenario favours local production of energy.

Confidence assessment

The exact number and routes of any future interconnectors is difficult to predict. Enabling access for the UK to Europe's electricity markets is expected to drive forward the development of offshore electricity networks, especially within the north west and south east marine plan areas.

7.2 North east

There are no interconnecting power cables currently running through the north east marine plan areas. There are, however, two interconnectors planned in the north east marine plan areas (Table 31). The North Sea Link (NSN) will connect the UK to Norway, making landfall at Blyth. The cable will have a capacity of 1,400MW and is predicted to be operational in 2021. The second, Eastern HVDC Link, is a 2,000MW cable which will run between Peterhead in Scotland to either Hawthorn Pit or Lackenby in the north east of England. Scottish and Southern Electricity Networks have not given a date for when this project is likely to go ahead but have stated it would be post 2021 (Scottish and Southern Electricity Networks, n.d.[5]).

More speculative plans have been made in the north east marine plan areas with regard to the North Sea Offshore Grid. This is an initiative that is considered essential to fully exploiting the offshore renewable energy potential of the North Sea and meeting Europe's decarbonisation targets over the coming decades. The offshore grid infrastructure would involve interconnection between the countries of the North Sea and the connection and integration of significant levels of offshore and onshore renewables (E3G, 2017).

Table 31: Offshore interconnecting cables in the north east marine plan areas

Name	Owner	Capacity (MW)	Status	Route
North Sea Link (NSN)	Statnett and National Grid NSL Limited	1,400	Consents granted	Blyth, UK to Kvilldal, Norway
Eastern HVDC Link	Scottish and Southern Electricity Networks	2,000	In planning	Peterhead, Scotland to Hawthorn Pit or Lackenby in the north east of England

The assumptions used to develop the BAU, N@W and LS scenarios for the offshore electricity distribution networks sector in the north east marine plan areas are provided in Table 32. Projected installed capacity under each of the three scenarios is shown in Figure 54. No spatial data were available for the planned cables in the north east marine plan areas therefore no figures have been produced to show the spatial distribution of power cables under the three scenarios.

Table 32: Assumptions and impacts under the future scenarios for offshore electricity distribution networks in the north east marine plan areas

Aspect	Scenario		

[5] https://www.ssepd.co.uk/EasternHVDClink

	Business as Usual	Nature @ Work	Local Stewardship
Application to the sector	All operational interconnectors continue to operate and those in the construction or planning stage progress through to operation.	All operational interconnectors continue to operate and those in the construction or planning stage progress through to operation. Additional capacity is added between 2025 and 2036 as part of the North Sea Offshore Grid.	All operational interconnectors continue to operate and those in the construction or the late stages of planning stage progress through to operation. No additional capacity is added.
Assumptions	The NSN interconnector comes on line in 2021. The Eastern HVDC Link is also constructed and comes online in 2025. The maximum capacity of this scenario is 3,400MW.	The NSN interconnector comes online in 2021. The Eastern HVDC Link is also constructed and comes online in 2025. An additional 2,000MW interconnector travelling through and making landfall in the north east marine plan areas is installed under this scenario as part of the North Sea Offshore Grid. This comes online in 2030. The maximum capacity of this scenario is 5,400MW.	The only operational cable under this scenario is NSN which comes on line in 2021. No further interconnectors are installed. Maximum capacity under this scenario is 1,400MW.

6-year projection

No interconnectors are currently installed in the north east marine plan areas, therefore in 2017 all scenarios begin at a capacity of 0MW. The NSN interconnector is currently being constructed and is due to come on line in 2021. This cable adds 1,400MW of capacity under all scenarios, connecting the UK with Norway. Capacity remains at this level for all scenarios in 2022.

6 to 20 year projection

Under LS, no additional capacity is added beyond 2023 as local energy generation is preferred to importing from Europe. Thus, the Eastern HVDC Link is not developed and capacity remains at 1,400MW through to 2036.

Between 2023 and 2036 additional capacity is added under BAU and N@W. Under both of these scenarios, the Eastern HVDC Link comes online in 2025, providing a 2,000MW link between the north east of England and Scotland. Capacity therefore increases to 3,400MW in 2025. Under BAU capacity is maintained at this level for the remainder of the time period. However, under N@W, the large amount of renewable energy generation results in the development of a North Sea Offshore Grid. This requires an additional 2,000MW interconnector travelling through and making landfall in the north east marine plan areas which is assumed to begin operation in 2025. Capacity therefore increases to 5,400MW in 2025 and is maintained at this level for the remainder of the time period under N@W.

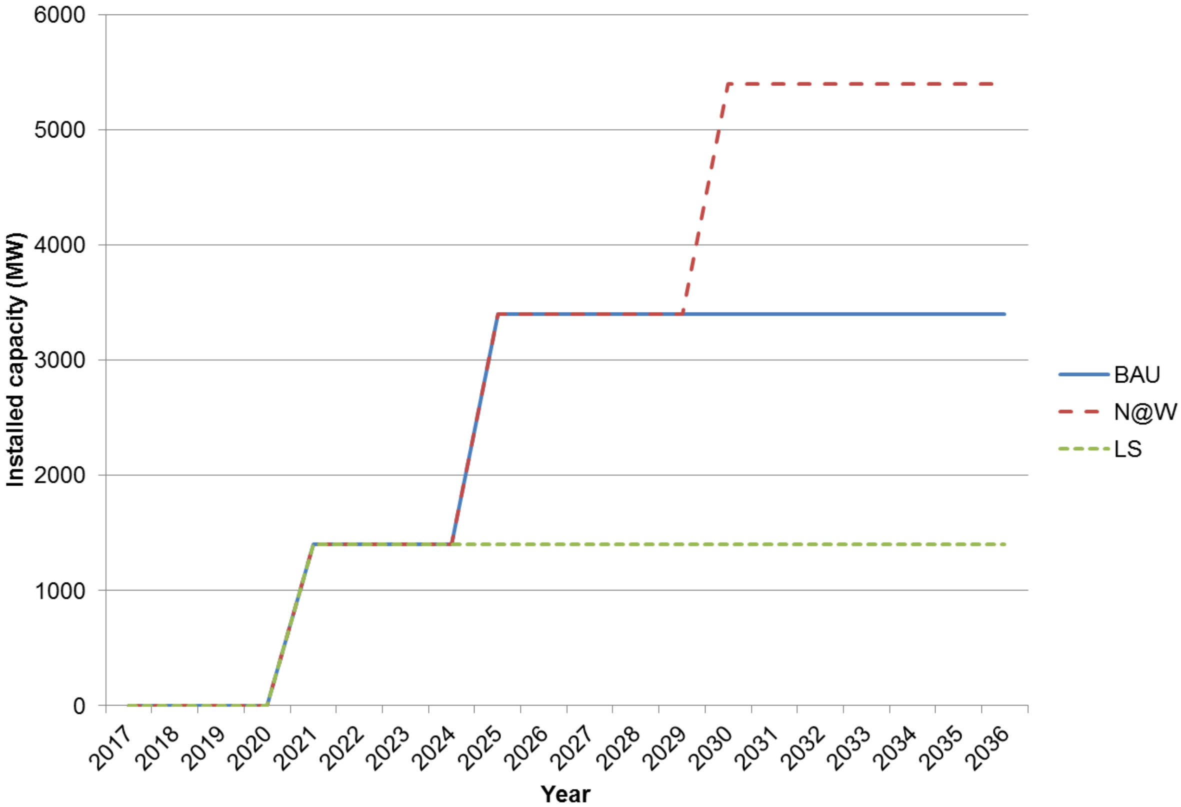


Figure 54: Installed capacity in the north east marine plan areas between 2017 and 2036 under three scenarios

Potential trade-offs

The main potential interactions for future offshore electricity network development are likely to be:

- Commercial fisheries
- Other infrastructure/extractive industries.

Within the north east marine plan areas, new offshore electricity network development is projected under all three scenarios with greater levels of development under the N@W scenario. The main potential trade-offs are likely to be with commercial fisheries and other infrastructure. Negative trade-offs can be minimised through careful route selection and project design.

7.3 North west

Two interconnector cables run through the north west marine plan areas (Table 33). The Isle of Man Interconnector is owned by the Manx Electricity Authority and became active in 2011. It links the Isle of Man to the UK, transferring energy to and from the two locations. The Western HVDC Link is owned by National Grid and Scottish Power and runs between Ardneill on the west coast of Scotland to the Wirral. The project is in the final stages of construction and is due to become operational later in 2017.

Only one other power cable, running across the River Mersey, is present in the north west marine plan areas. An additional cable is currently in planning and will connect the proposed Moorside nuclear power station to grid infrastructure in Lancashire as part of the North West Coast Connections (NWCC) project. The cable will have a capacity of 2GW and will run through a tunnel under Morecambe Bay and cross a number of estuaries including the Esk and the Duddon. Current projections suggest that this cable will be active by 2024.

Table 33: Offshore interconnecting cables in the north west marine plan areas

Name	Owner	Capacity (MW)	Status	Route
IOM/UK Interconnector	Manx Electricity Authority	60	Active	Douglas, IOM to Cleveleys, UK
Western HVDC Link	National Grid and Scottish Power	2,200	Under construction	Ardneill, UK to Wirral, UK
North West Coast Connections	National Grid	2,000	In planning	Across Morecambe Bay and Esk and Duddon Estuaries
Link to the Irish Sea Offshore Grid	Irish-Scottish Links on Energy Study (ISLES)	2,000	N/A	N/A

The assumptions used to develop the BAU, N@W and LS scenarios for the offshore electricity distribution networks sector in the north west marine plan areas are provided in Table 34. Projected installed capacity under each of the three scenarios is shown in Figure 55. Figure 56 shows the spatial distribution of interconnectors in the north west marine plan areas. Figures have not been produced for different scenarios due to the lack of spatial data for planned or predicted cables.

Table 34: Assumptions and impacts under the future scenarios for offshore electricity distribution networks in the north west marine plan areas

Aspect	Scenario		
	Business as Usual	**Nature @ Work**	**Local Stewardship**
Application to the sector	As for the north east marine plan areas (see Table 32).	As for the north east marine plan areas (see Table 32). However the additional capacity added between 2025 and 2036 is part of the Irish Sea Offshore Grid.	As for the north east marine plan areas (see Table 32).
Assumptions	The IOM/UK interconnector continues to operate and the Western HVDC Link interconnector begins operation in 2017. In 2026 the NWCC cable becomes operational, as part of the electricity transmission network. The maximum capacity of this scenario is 4,260MW.	As with BAU, the IOM/UK interconnector is operational and the Western HVDC Link and NWCC cables begin operation in 2017 and 2026 respectively. In addition, due to the large amount of renewable activity an additional 2,000MW interconnector is installed running between the north west of England and Ireland. This cable begins operation in 2030. The maximum capacity of this scenario is 6,260MW.	This scenario is the same as BAU with a maximum capacity of 4,260MW. This scenario assumes that the Moorside Development goes ahead and the NWCC cables becomes operational.

6-year projection

All scenarios begin in 2017 with a capacity of 2,260MW as a result of the interconnector running between the UK and the Isle of Man and the Western HVDC Link which comes online in 2017. No further capacity is added under any scenario between 2017 and 2022.

6 to 20 year projection

In 2026 an additional 2,000MW of capacity is added under all scenarios as a result of the NWCC cable becoming operational. As no additional infrastructure is currently in planning, the BAU and LS scenarios remain at a capacity of 4260MW through to 2036.

N@W assumes that the Isles project is carried through to the implementation stage, resulting in the development of an Irish Sea Offshore Grid. This results in a 2,000MW cable running between Ireland and the north west of England. Installed capacity under N@W therefore increases to 6,260MW in 2030 and is maintained at this level for the remainder of the time period.

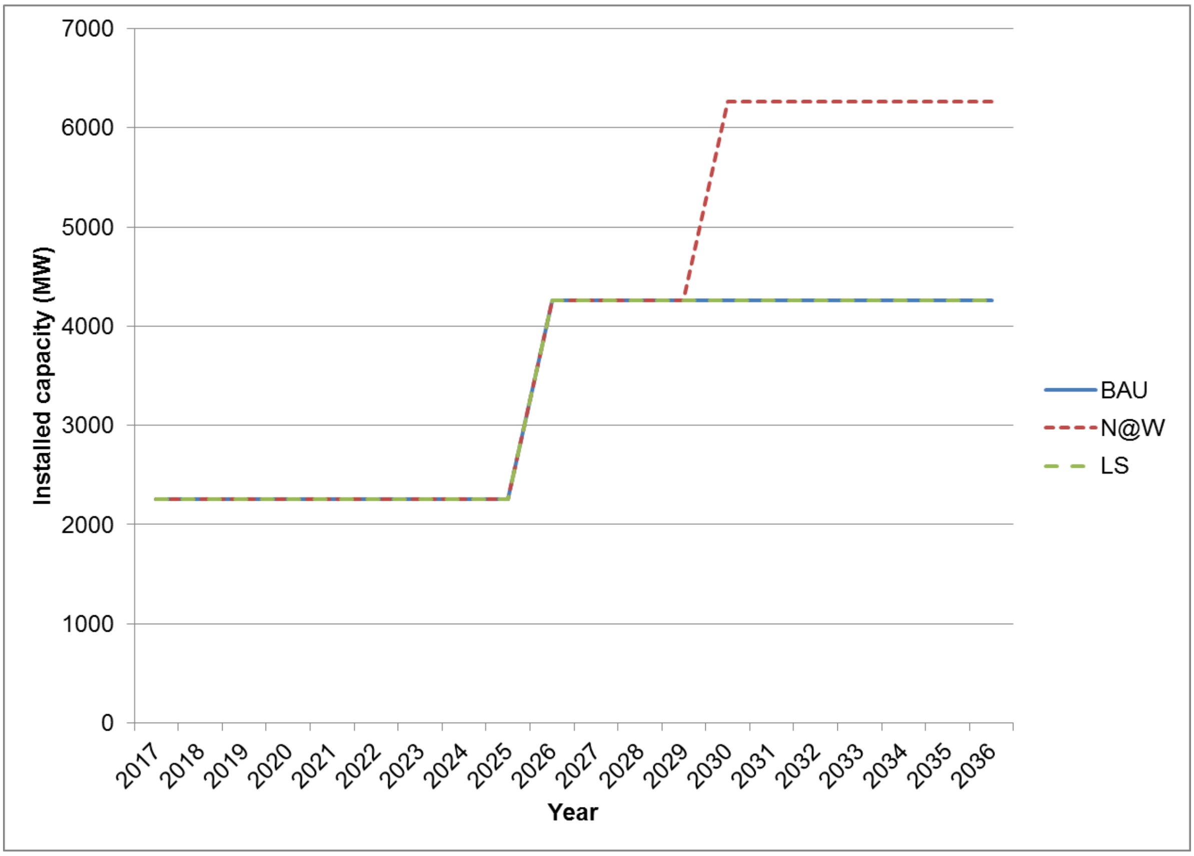


Figure 55: Installed capacity in the north west marine plan areas between 2017 and 2036 under three scenarios

Potential trade-offs

The potential trade-offs are similar to the north east marine plan areas.

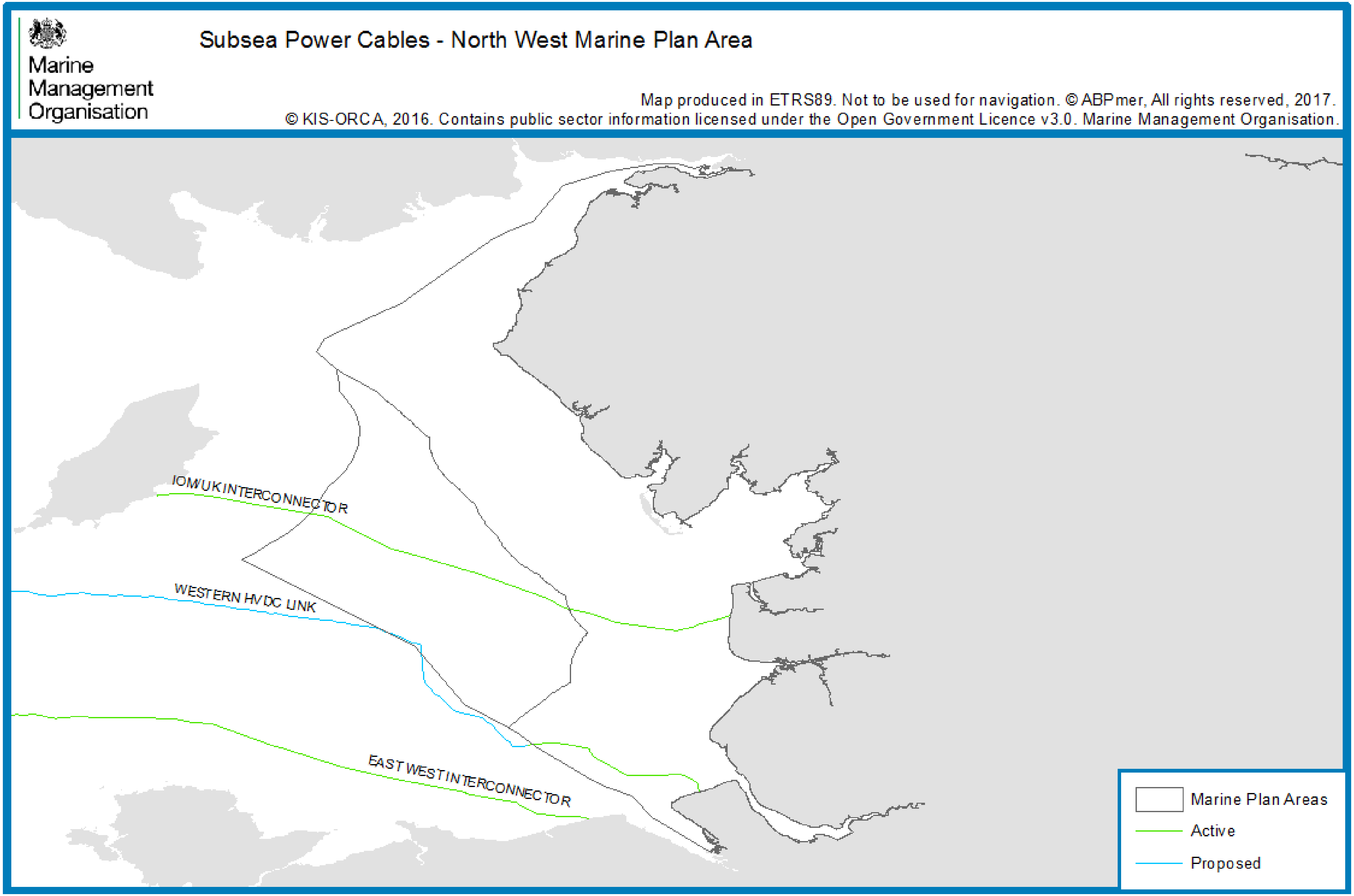


Figure 56: Offshore electricity distribution networks sector in the north west marine plan areas

7.4 South east

There is one active interconnecting power cable running through the south east marine plan area (Table 35). BritNed HVDC is owned by BritNed and runs between Grain in the UK and Maarslahte in the Netherlands. The cable has been active since 2010.

The Nemo Link interconnector is also present in the south east marine plan area. It is currently under construction, and due to be operating in 2019. It connects the UK to Belgium, making landfall near Ramsgate. A further interconnector, Grid Link, is in the planning process. This cable will provide a 1,400MW link between England and France, running through the Medway Estuary, UK, and making landfall in Dunkirk, France. This project was granted an electricity interconnector licence in December 2016 but no indication of a predicted operation date has been published to date.

In addition to these interconnectors, a single power cable runs across the Medway while three power cables cross the Thames.

Table 35: Offshore interconnecting cables in the south east marine plan area

Name	Owner	Capacity (MW)	Status	Route
BritNed HVDC	BritNed	1,000	Active	Grain, UK - Maasvlakte, Holland
Nemo Link	Nemo Link	1,000	Under construction	Pegwell Bay, UK to Zeebrugge Belgium
GridLink	GridLink Interconnector Limited	1,400	In planning	Kingsnorth via the Medway, UK to Durkerque, France

The assumptions used to develop the BAU, N@W and LS scenarios for the offshore electricity distribution networks sector in the south east marine plan area are provided in Table 36. Projected installed capacity under each of the three scenarios is shown in Figure 57. Figure 58 shows the spatial distribution of power cables in the south east marine plan area. Figures have not been produced for different scenarios due to the lack of spatial data for planned or predicted cables.

Table 36: Assumptions and impacts under the future scenarios for offshore electricity distribution networks in the south east marine plan area

Aspect	Scenario		
	Business as Usual	**Nature @ Work**	**Local Stewardship**
Application to the sector	As for the north east marine plan areas (see Table 32).	As for the north east marine plan areas (see Table 32). However the additional capacity added between 2025 and 2036 is to allow for the export of renewable energy generated in the UK.	As for the north east marine plan areas (see Table 32).
Assumptions	The BritNed HVDC interconnector continues to operate and the Nemo Link interconnector begins operation in 2019. The Grid Link interconnector progresses through planning and begins operation in 2025. The maximum capacity of this scenario is 3,400MW.	As with BAU, BritNed HVDC, Nemo Link and Grid Link all feature in this scenario. An additional 2,000MW interconnector landfalls in the region forming part of the North Sea Offshore Grid. The maximum capacity of this scenario is 5,400MW.	The BritNed HVDC interconnector continues to operate and the Nemo Link interconnector begins operation in 2019. The Grid Link interconnector does not progress through The maximum capacity of this scenario is 2,000MW.

6-year projection

In 2017, all scenarios begin at 1,000MW as a result of the operational BritNed interconnector. In 2019, Nemo Link becomes operational, increasing capacity under all scenarios to 2,000MW. No further capacity is added between 2019 and 2022.

6 to 20 year projection

Under LS, no additional capacity is added beyond 2023 as local energy generation is preferred. Thus, the Grid Link interconnector is not developed and capacity is maintained at 2,000MW for the remained of the time period.

Under BAU and N@W additional capacity is added between 2023 and 2036. In 2025 the Grid Link interconnector becomes operational, adding 1,400MW of capacity. Capacity therefore increases to 3,400MW in 2025 for both scenarios. Under BAU capacity remains at this level through to 2036. Under N@W the North Sea Offshore Grid is developed to exploit the renewable energy potential of the North Sea. As a result of this an interconnector is installed in the south east marine plan area, coming online in 2030 and increasing capacity by 2,000MW to 5,400MW. Capacity remains at this level through to 2036.

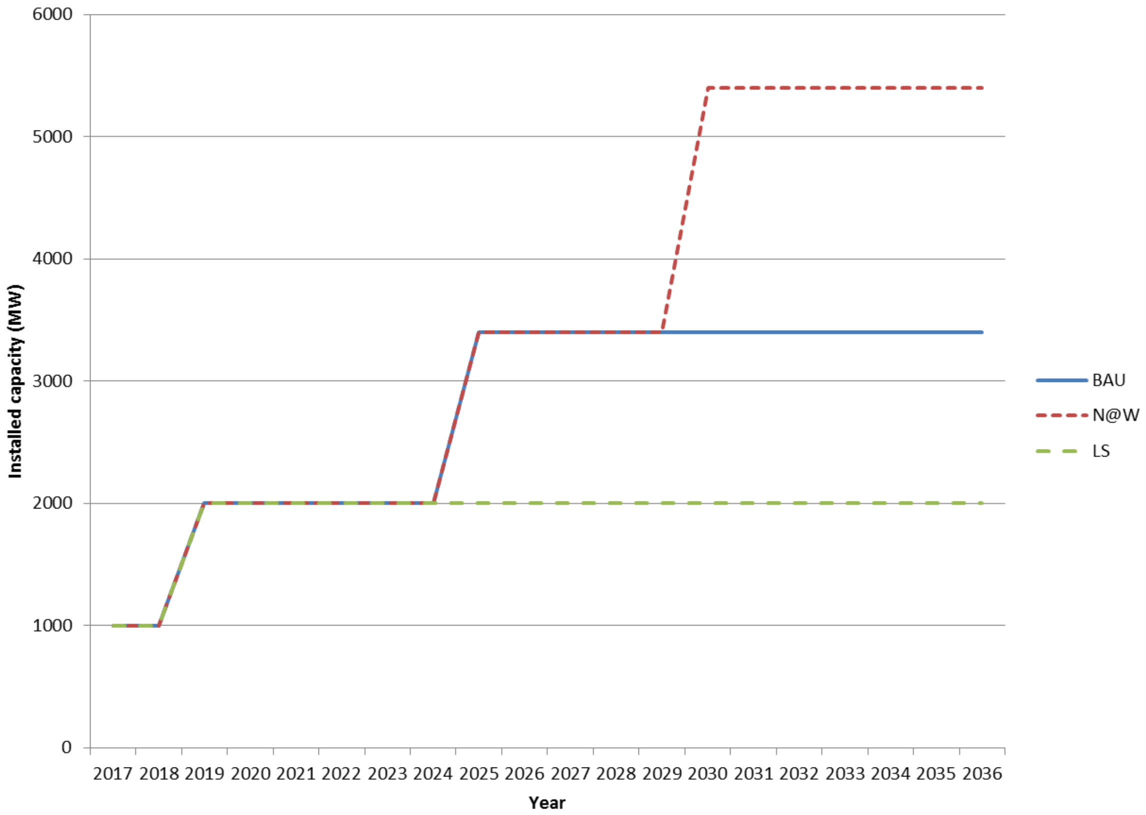


Figure 57: Installed capacity in the south east marine plan area between 2017 and 2036 under three scenarios

Potential trade-offs

The potential trade-offs are similar to the north east marine plan areas.

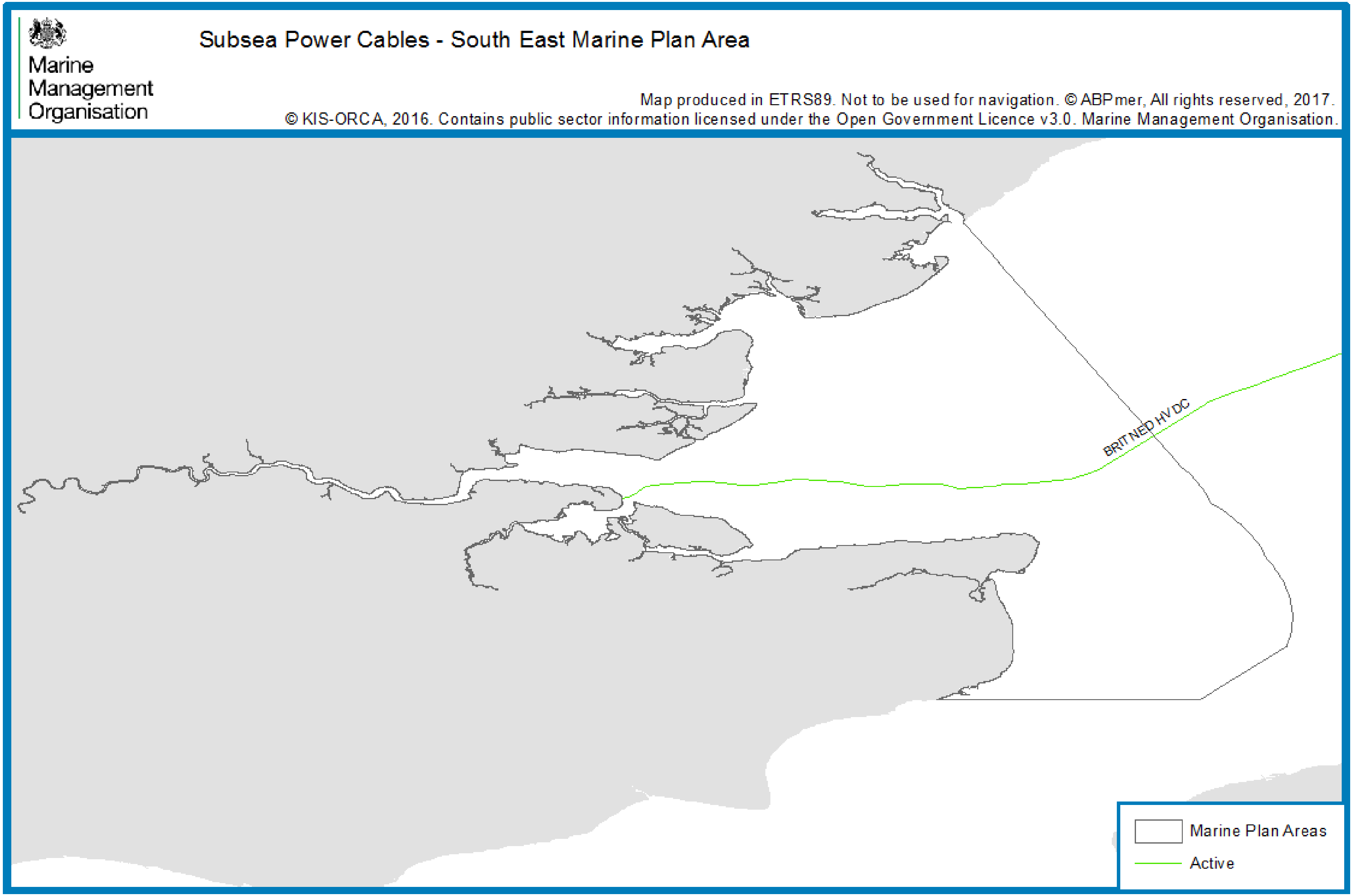


Figure 58: Offshore electricity distribution networks sector in the south east marine plan area under the BAU scenario

7.5 South west

There is only one operational interconnecting power cables in the south west marine plan areas which runs from Whitesands Bay in Cornwall to St. Marys in the Isles of Scilly. This cable is operated by Wester Power Distribution and has a capacity of 7.5MW (Three Dragons, 2014). One additional cable connecting Ireland to France has been proposed and is currently undergoing a feasibility study (Table 37).

Table 37: Offshore interconnecting cables in the south east marine plan area

Name	Owner	Capacity (MW)	Status	Route
Celtic Interconnector	EirGrid	700	Undergoing a feasibility study	Ireland to France
Isle of Scilly connector	Western Power Distribution	7.5	Operational	England to Scilly Isles

The assumptions used to develop the BAU, N@W and LS scenarios for the offshore electricity distribution networks sector in the south west marine plan areas are provided in Table 38. Projected installed capacity under each of the three scenarios is shown in Figure 59. The text below provides a brief description of the future trends in 6 years and 6 to 20 years. No interconnectors are currently present in the south west marine plan areas and spatial data for planned or predicted cables was not available. Scenario figures have therefore not been produced.

Table 38: Assumptions and impacts under the future scenarios for offshore electricity distribution networks in the south west marine plan areas

Aspect	Scenario		
	Business as Usual	Nature @ Work	Local Stewardship
Application to the sector	As for the north east marine plan areas (see Table 32).	The only operational cable in the south west marine plan areas is the Isle of Scilly connector. No further interconnectors are under construction or in the planning stage in the south west marine plan areas. However interconnectors currently in the concept stage progress through to development.	As for the north east marine plan areas (see Table 32).
Assumptions	The Isle of Scilly connector continues to operate. No further capacity is added.	This scenario assumes that the 700MW Celtic interconnector is installed between France and Ireland which runs through the south west offshore marine plan areas.	The Isle of Scilly connector continues to operate. No further capacity is added.

6-year projection

The Isle of Scilly connector continues to operate at a 7.5MW capacity under all scenarios between 2017 and 2022.

6 to 20 year projection

N@W is the only scenario in which any additional activity occurs in the south west marine plan areas. In 2025, the Celtic interconnector running from Ireland to north west France becomes operational. The cable route travels through the south west offshore marine plan area but does not make land fall in the south west. The Celtic interconnector adds an additional 700MW of capacity to the N@W scenario. Given its very early stage of development it has not been included in the BAU or the LS scenarios.

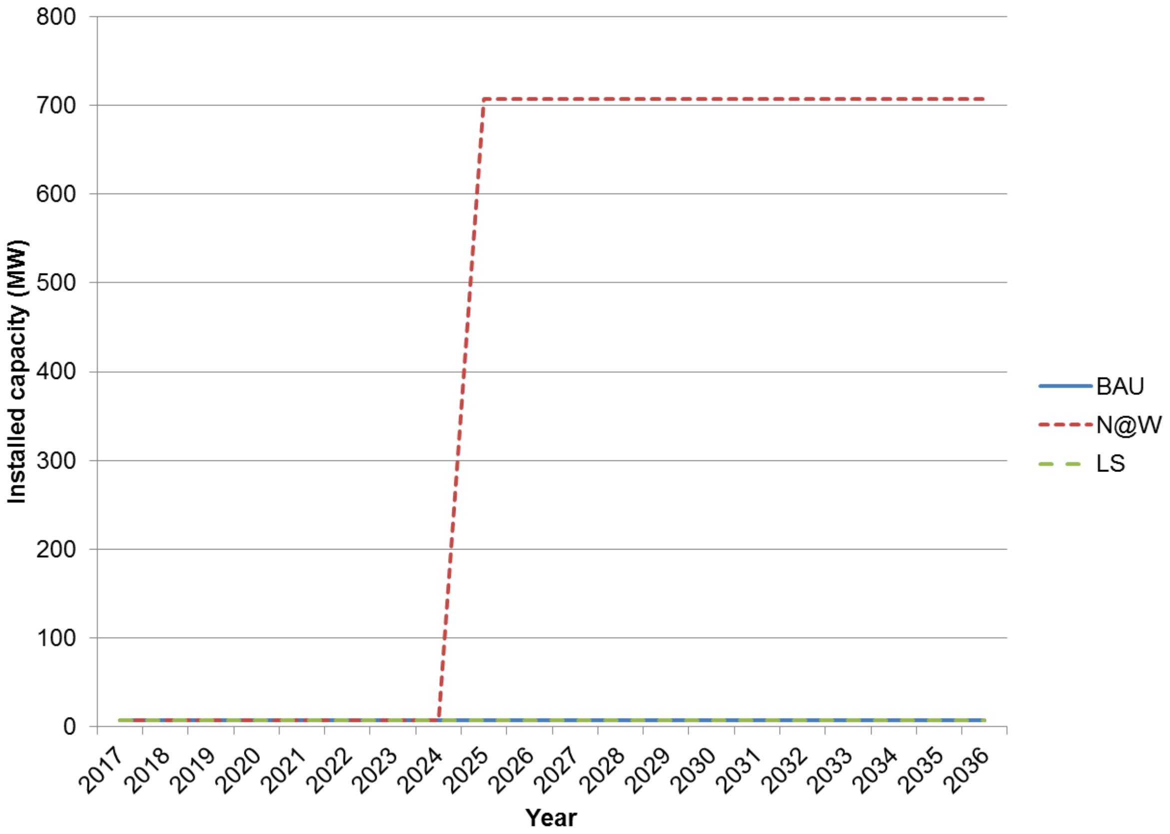


Figure 59: Installed capacity in the south west marine plan areas between 2017 and 2036 under three scenarios

Potential trade-offs

The potential trade-offs are similar to the north east marine plan areas, but are only projected to occur under the N@W scenario.

8 Energy production: Oil and gas

Sector Definition

The upstream oil and gas industry in the UK relates to the exploration and extraction of oil and gas from the environment, largely from offshore reserves. The term 'oil reserve' refers to oil, the condensate gas liquids obtained from gas fields and from the associated gas in oil fields. A 'gas reserve' refers to the quantity of gas expected to be available for sale from dry gas fields, gas-condensate fields and oil fields with associated gas.

Data sources

A variety of different information sources have been reviewed to inform this baseline, including published reports and papers and spatial data layers. The main information sources used are provided in the list below:

- Economic baseline assessment for the North East, North West, South East and South West Marine Plans (MMO, 2016a);
- Strategic Scoping Report for Marine Planning in England (MMO, 2013c);
- The Crown Estate spatial data; and
- UK Oil and Gas Economic Review 2016 (Oil and Gas UK, 2016).

8.1 National review

Overview of national activity

In 2015 gas produced 30% of the power generated in the UK, while less than 1% was produced from oil which is more commonly used for producing petroleum and other products (BEIS, 2016). Aberdeen is regarded as the UK centre for the oil and gas industry due to its proximity to significant oil deposits in the North Sea. However, several other areas, including the north west and the Teesside area, are also of importance to the industry and include areas supporting infrastructure dealing with the processing of oil, petroleum and chemicals in several clusters across England. In terms of employment, the majority of employment lies in Scotland (45% of jobs) whilst just over 21% of jobs are located in London and south east England (MMO, 2016a).

Following the incorporation of the Department of Energy and Climate Change (DECC) into the Department for Business, Energy and Industrial Strategy (BEIS) in July 2016, licences for the exploration for oil and gas reserves off the coast of the UK are now granted by the Oil and Gas Authority (OGA) as Petroleum Exploration and Development Licences. Licences are granted for blocks in coastal or marine areas and are issued in licensing rounds. Licences are valid for a sequence of 'terms', usually comprising the exploration, appraisal and production phases of an oil or gas field. At the end of the exploration term, usually six years, licences automatically expire unless the licensee has completed a work programme agreed upon with the OGA as part of the licensing application. If work continues, the appraisal and development term is usually set at five years and licences will expire at the end of this term unless a development plan has been approved by the Secretary of State. The final term is intended solely for production, and is usually set at 20 years, although this may be extended if production is continuing, at the discretion of the Secretary of State (DECC, 2013).

To date, 29 oil and gas licencing rounds have occurred in the UK. The majority of these are located off the north east coast of England and the east and west coast of Scotland. The indicative areas for the 30th licencing round are located off the east and north west coasts of England.

At present, a total of 451 offshore fields are located in UK waters, the majority of which are off the east coast of England, the east coast of Scotland and the north west of England. 340 offshore fields are currently producing with construction and development occurring in a further 2 and 39 fields respectively. Production has ceased at 50 of the UK offshore fields, and been suspended at a further 18 fields. In total, 3,598 active wells are present in UK waters, the majority of which are in the North Sea (see Figure 60). A further 171 wells are currently being drilled around the UK, while two new wells are being planned.

Offshore extraction of oil and gas is a substantial industry that makes a significant contribution to the UK economy. It is the most highly-taxed industry in the UK; however the taxation rate has varied vastly in the past, ranging from 30% to 81% over the last 20 years. Since production on the UK Continental Shelf (UKCS) began in the mid 1960s the industry has paid over £330 billion in upstream production corporate taxes (Oil and Gas UK, 2016).

In 2016 the UKCS was expected to generate a free cash-flow deficit of around £2.7 billion, an improvement on the £4.2 billion deficit seen in both 2015 and 2014. The reduction in the deficit is a direct result of a reduction in expenditure achieved by companies postponing discretionary spending. A continued decline in expenditure was predicted to occur throughout 2016 and into 2017 due to further reductions in operating costs and capital investment (Oil and Gas UK, 2016).

Employment within the oil and gas industry is highly diverse and includes financial and legal services, administration, design, engineering, environmental and geo-sciences, health and safety, information technologies, management, operations and sales and marketing (UKMMAS, 2010). Across the UK in 2016, the oil and gas industry directly employed 34,000 people while a further 151,500 and 144,900 were employed as indirect or induced employees respectively . Thus, in 2016, the industry supported an approximate total of 330,000 people, a 27% reduction relative to 2014 levels (UK Oil and Gas, 2016).

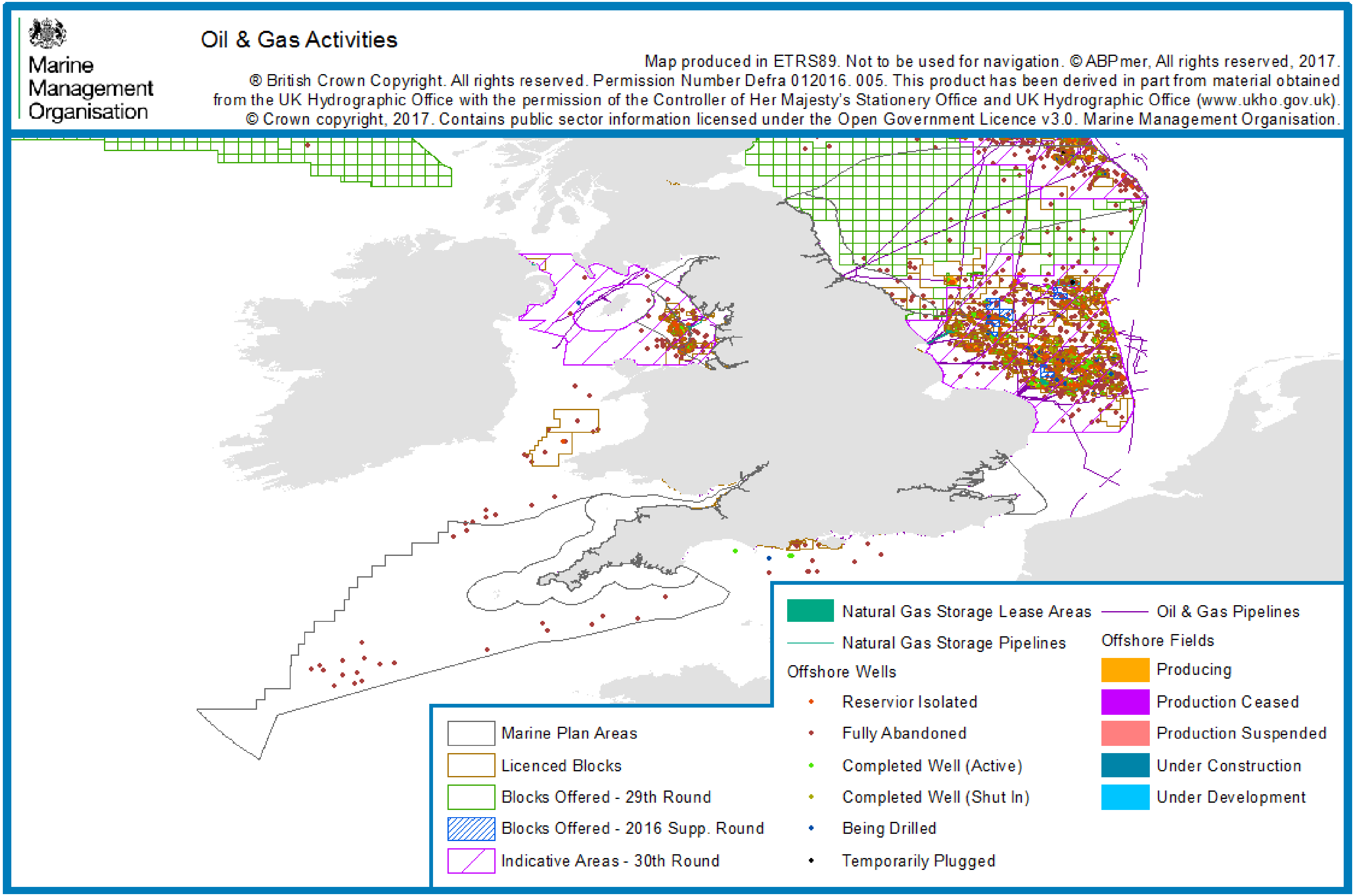


Figure 60: Oil and gas activity in the UK

Review of historical trends

Production of oil and gas from the UKCS first began in 1967 and increased steadily from the 1970s to June 1980 when Britain became a net exporter of oil. Production peaked in the mid-1980s and then experienced a dramatic decline in the late 1980s following the Piper Alpha disaster. In the 1990s crude oil recovered, peaking again in 1999. Gas production steadily increased from the 1980s peaking in 2000 due to increasing demand for gas for power generation. Production of crude oil and gas has since declined due to decreasing levels of reserves. Around 2004, the UK again became a net importer of oil and gas (UKMMAS, 2010).

In 2011 oil production in the UK was down by 18% from the previous year, and gas by 21%, due to declining reserves on the UKCS. These figures represented an increased rate of decline compared to previous years. Production continued to decrease until 2015 when production levels began to recover slightly, showing an increase of 10.4% (equivalent to an additional 602 million barrels of oil equivalent (boe) on 2014 production. This made the UK the world’s 21st largest oil and gas producer in 2015, accounting for 1.1% of global production. The upward trend continued into 2016 with liquid production in the first half of 2016 increasing by 9.4% and net gas by 1.2% relative to the levels of production in the first half of 2015 (Oil and Gas UK, 2016).

In the last four decades an estimated £400 billion has been spent on exploration, development and continued investment in the oil and gas industry’s operations in the UKCS (UKMMAS, 2010). However, exploration continues to show a decreasing trend with only six exploration and three appraisal wells spudded (initial drilling) over the first six months of 2016 (UK Oil and Gas, 2016). Oil and Gas UK state that 43 billion boe have been recovered from the UKCS since 1967 with the remaining recoverable resource potential ranging from 10 to 20 billion boe.

Investment and effort going into decommissioning will increase over the next 20 years. As fields reach the end of their production life, field operators will begin to publish decommissioning plans for currently active fields within the marine plan areas of interest, setting out measures to decommission disused installations and/or pipelines and describing in detail the methods to undertake the work. The most recent decommissioning plan within the marine plan areas of interest was published by Maersk Oil UK Limited for the Janice, James and Affleck fields in the north east marine plan areas. The plan was approved by BEIS in 2016 and states that the fields will be fully decommissioned by 2022 with a close out report published within four months of the completion of the offshore works to detail any variation from the decommissioning plan.

Review of key changes and/or advances of significance affecting the sector

Total UK oil and gas production peaked in 1999 and, despite a recent upward trend, has shown a general decline due to decreasing reserves (UKMMAS, 2010). The UKs current energy policy is set out in The Energy White Paper (DTI, 2007) and outlines the government’s international and domestic energy strategy, which includes supporting and maximising economic production of fossil fuels in the UK. Key policy drivers for oil and gas are described in Table 39.

The technical feasibility and economic viability to extract oil and gas from particular reserves can change in response to developments in technology and changes in economics. A high oil price can make reserves profitable to extract that were previously considered uneconomic and *vice versa*. The development of Enhanced Oil Recovery techniques can also make it possible to increase the amount of oil extracted from a reserve (MMO, 2013c).

The Energy Act 2008 aimed to develop the appropriate legislative framework to ensure secure supplies of energy for the UK. The report specifically identified a need to maximise economic recovery of oil and gas reserves from the UKCS (DTI, 2007). The recovery of these remaining UKCS reserves will require additional industry investment both in monetary terms and with the investment of expertise (UKMMAS, 2010). In recent years investment and research within the industry has focussed on the supply chain as the UK has become increasingly reliant on oil and gas imports. A dedicated international marketing strategy covering the entire UK energy sector has been developed by UK Trade and Investment (UKMMAS, 2010). However, the 2016 economic report published by Oil and Gas UK indicated that capital investment in the sector is falling rapidly to approximately £9 billion in 2016 from a record of £14.8 billion in 2014 (MMO, 2016a), reflecting the collapse of oil prices from 2014.

Table 39: Key policy drivers affecting development of the Oil and Gas Sector

Driver	Details	Implications
Political	Licences for the exploration for oil and gas reserves are granted by OGA off the coast of the UK	Future licensing rounds will determine areas of exploration/production
	The push for the UK to have a competitive and secure energy market and to move towards a low carbon economy. Government investment also focused on maximising oil/gas recovery	Decrease in government investment. Marginal reserves more economic to exploit
	UK to have a good energy mix and maintain energy security	Acts as an incentive and a constraint on renewable sources
	Combatting energy poverty	Government favouring cheaper sources of energy, limiting the extent of support for more expensive forms of energy generation (e.g. offshore wind)
Economic	Declining reserves on UKCS mean it is increasingly technically demanding and costly to extract remaining reserves.	The UK is becoming increasingly dependent on imported energy, which is anticipated to supply about half of the UK's total annual gas demand by 2020, decommissioning to become a priority

Driver	Details	Implications
	Oil/gas price	Economically viable to extract oil/gas if price high (i.e. reserves profitable to extract that were previously considered uneconomic.); The converse applies when oil and gas prices are low
	Investors finding environmental constraints and technological developments hinder potential development sites	Reduced investment in new oil/gas fields
Social	No significant drivers identified	
Technological	Development of Enhanced Oil Recovery techniques to make it possible to increase the amount of oil extracted from a reserve and expand fields in deeper water further offshore	Economically viable to continue to extract oil at lower oil price or from more marginal fields
	Development of extraction technology for offshore shale gas extraction	Extraction of shale gas from offshore fields
Legal	No significant drivers identified	
Environmental	Designation of additional MPAs	Potential constraints/ restriction on areas within which oil and gas can be exploited
	Offshore shale gas extraction	Environmental challenges involving the public and NGOs

Review of future trends

In general the recovery of the UK's remaining oil and gas reserves will require additional investment, both in money and expertise. As reserves throughout the UK mature, the UK will become increasingly dependent on imported oil and gas. Estimates suggest that by 2020, imports will supply approximately half of the UK's total annual gas demand. The long term reduction in activity will result in around 500 individual structures (including platforms) being decommissioned around the UK over the next three decades (UKMMAS, 2010).

Currently, no oil or gas activity occurs in the south east or south west marine plan areas. None of the 29th round or 30th round indicative licence blocks fall within these plan areas (see Figure 60) and therefore no oil and gas activity is likely to occur in these areas over the next 20 years. Future leasing round blocks are present in the north east and north west marine plan areas. Future exploration and extraction in these areas will be highly dependent upon oil price and investment in the sector.

Oil and gas extraction from the UKCS has been decreasing since the 1980s and, despite the slight production increase seen in 2015 and 2016, is likely to continue to fall over the next 20 years due to a move towards low carbon energy production and declining amounts of economically viable reserves (Oil and Gas UK, 2016; Kemp and Stephan, 2017).

A total of 21 fields on the UKCS ceased production in 2015 and a further 20 fields are predicted to close per annum for the remainder of the decade (Oil and Gas UK, 2016). The decommissioning of oil and gas infrastructure will therefore become a major industry over the next 20 years. In 2015 alone, £1 billion was spent on decommissioning, a value expected to double by the end of 2017 (Oil and Gas UK, 2016).

Decommissioning plans for several fields have been published by field operators. These documents provide a detailed plan and an approximate schedule for the decommissioning of the infrastructure. However, as these are only available for a small number of fields within the marine plan areas, the three scenarios have been based on predictions made by Kemp and Stephan (2017) (see Table 41).

Oil and gas continues to be produced at the highest rate under the BAU scenario, where energy security is maintained by maximising the recovery of oil and gas from existing sites. The lowest rates of production occur under the Nature at Work scenario where renewable sources of energy are favoured and government incentives for investment and exploration of oil and gas are lower. Therefore, there is a sharper rate in the decline of production at existing fields and no new discoveries come on stream. Under LS, the recovery of oil and gas is required to meet energy demand but increased levels of community-led green energy result in a sharper decline than the BAU scenario.

Confidence assessment

Only a small proportion of the oil and gas production licences awarded under the licensing rounds actually develop into sites of oil and gas extraction. It is not known if the licences awarded under the 29th Round will be developed into production sites. Data on the economic value of the oil and gas industry within the north east, north west, south east and south west are limited.

8.2 North east

The north east is a key location for the provision of products and services relating to the oil and gas industry due to its access points to UKCS oil and gas areas, process industry, infrastructure and skills base (Oil & gas infrastructure maps from the DECC and OGA).

In terms of oil and gas resource, the north east marine plan areas hosts 35 licenced blocks and 24 offshore fields. A further 167 blocks have been offered in the 29th licensing round, 102 of which have been previously licenced. A total of 15 fields are currently producing in the north east marine plan areas from 111 active wells. An additional four oil fields are currently being developed resulting in the drilling of 11 new wells (see Table 40). Pipeline infrastructure is also present, with 520 pipelines on the seabed within the north east marine plan areas. 452 of these are active and the remaining 68 are either abandoned or not in use. A further 49 are either proposed or at a pre-commission stage.

The north east, and specifically Tees Valley (Teesside), is home to an integrated chemical complex which, in terms of manufacturing capacity, is the largest in the UK and second largest in western Europe. The area is home to a range of key clusters in the chemical sector including refining, petrochemicals, speciality and fine chemicals, plastics, biotechnology and pharmaceuticals (MMO, 2016a). As well as these economic assets, a key asset in the north east is the Teesside Gas Processing Facility, which has the capability to process up to 6% of UK demand for natural gas. The plant processes gas from the UK Central North Sea (MMO, 2016a).

Research by the North East of England Process Industry Cluster (NEPIC) in 2013 highlights how the oil and gas process industries in the north east made up between 22-26% of GVA (around £26 billion) and employed 29,500 people. Indirect employment is estimated to be much greater, with over 1,400 firms in the supply chain. However NEPIC's sector definition focused on the manufacturing and processing of chemicals and is not specific to the oil and gas industry. The Office for National Statistics (ONS) values are therefore more likely to be representative of direct oil and gas employment. ONS values suggest that in 2014, the oil and gas industry in the north east employed 3,550 people in 720 businesses. Indirect employment can be calculated using the employment multiplier for gas (1.4) which estimates that indirect employment is 5,030 (MMO, 2016a).

Table 40: Producing oil and gas fields present in the north east marine plan areas

Field name	Field type	Status	2016 Production (m^3 for oil and Ksm^3 for gas)
Fulmar	Oil	Producing	66,416
Leven	Oil	Producing	896
Medwin	Oil	Producing	1,814
Innes	Oil	Production ceased	-
Angus	Oil	Production ceased	-
Flora	Oil	Production ceased	-
Fergus	Oil	Production ceased	-
Nethan	Oil	Producing	83
Auk	Oil	Producing	87,427
Orion	Oil	Producing	94,873
Affleck	Oil	Producing	69,651
Alma	Oil	Producing	458,844
Galia	Oil	Producing	124,629
Auk North	Oil	Producing	59,803
James	Oil	Producing	18,357
Halley	Oil	Producing	5,356
Flyndre	Oil	Under development	-
Cawdor	Oil	Under development	-
Clyde	Oil	Producing	18,785
Fife	Oil	Production ceased	-
Janice	Oil	Producing	83,630
Wollaston	Gas	Producing	-
Whittle	Gas	Producing	119,445
Cleeton	Gas	Producing	286
Breagh	Gas	Producing	777,875

The assumptions used to develop the BAU, N@W and LS scenarios for oil and gas in the north east marine plan areas are provided in Table 41. Projected oil and gas production under each of the three scenarios is shown in Figure 61 and Figure 62 respectively. Figure 63 shows the spatial distribution of the oil and gas activity in the north east marine plan areas.

Table 41: Assumptions and impacts under the future scenarios for oil and gas production in the north east marine plan areas

Aspect	Scenario		
	Business as Usual	**Nature @ Work**	**Local Stewardship**
Application to the sector	This scenario results in the largest amount of oil and gas activity, assuming that current trends continue over the next 20 years. However, due to a decreasing supply of economically viable resource the amount of oil and gas production decreases over time but some small amount of activity still occurs.	Oil and gas activity is at its lowest level under this scenario due to climate change mitigation becoming a stronger policy priority, leading to increased development of low carbon energy generation. Investment in UKCS oil and gas decreases to such an extent that, by 2036, no oil and gas production occurs in the marine plan areas.	Despite a national move toward a decarbonised energy generation and local interest in renewable energy, some fossil fuel power generation is required to meet energy demand. Small amount of investment therefore occurs allowing small amounts of oil and gas production from the marine plan areas but extraction values are smaller than those of BAU.
Assumptions	Production values for the active fields in the north east marine plan areas are estimated from 2016 production values published by the OGA. Production values for 2036 are estimated by averaging the outcome of all modelled scenarios in Kemp and Stephan (2017) for the Central North Sea. The rate of decline between the 2017 and 2036 values is assumed to be constant.	2017 production values for active fields in the north east are estimated from 2016 production values published by the OGA. Given the government's strong incentive to decarbonise energy production, this scenario assumes oil and gas activity in the north east marine plan areas will decrease to zero in 15 years' time for oil and 10 years' time for gas owing to the larger amount of current oil production relative to gas in the north east marine plan areas. The rate of decline from 2017 to the point where production reaches zero is assumed to be constant.	2017 production values for active fields in the north east marine plan areas are estimated from 2016 production values published by the OGA. 2036 production levels are assumed to be half of those in the BAU scenario reflecting the decreased use of fossil fuels in energy production and transport. The decrease between 2017 and 2036 is assumed to be constant.

6-year projection

Between 2017 and 2022, all three scenarios in the north east marine plan areas show a decrease in the amount of oil production from the UKCS. In 2017, production levels for all three scenarios begin at the same value, 1.09 million m^3 per year. N@W shows the largest rate of reduction resulting in oil production decreasing to 0.73 million m^3 per year in 2022. The BAU and LS scenarios show a shallower rate of decline, resulting in production values of 0.84 and 0.82 million m^3 per year respectively in 2022.

All scenarios for gas production in the north east marine plan areas begin at 0.9 million ksm^3 per year in 2017. A very similar trend to oil production is evident, with all three scenarios resulting in a decreasing production level over time. Again, N@W shows the sharpest rate of decline, with values decreasing to 0.45 ksm^3 per year in 2022. BAU and LS provide a shallower rate of decline, both decreasing to 0.67 ksm^3 per year in 2022.

6 to 20 year projection

The rate of decline under all scenarios for oil and gas production remains constant to 2036 until zero production is reached. Oil production reaches zero under N@W in 2032 and remains at that level throughout the rest of the time period. Oil production under BAU and LS do not reach zero before 2036, but decline constantly to 0.14 and 0.07 million m^3/ year respectively in 2036.

Gas production under N@W reaches zero in 2027, six years before oil production reaches zero, due to the lower amount of gas activity currently occurring in the north east marine plan areas relative to oil. BAU and LS continue a rate of decline very similar to one another, reaching values of 0.05 and 0.02 ksm^3/ year respectively in 2036.

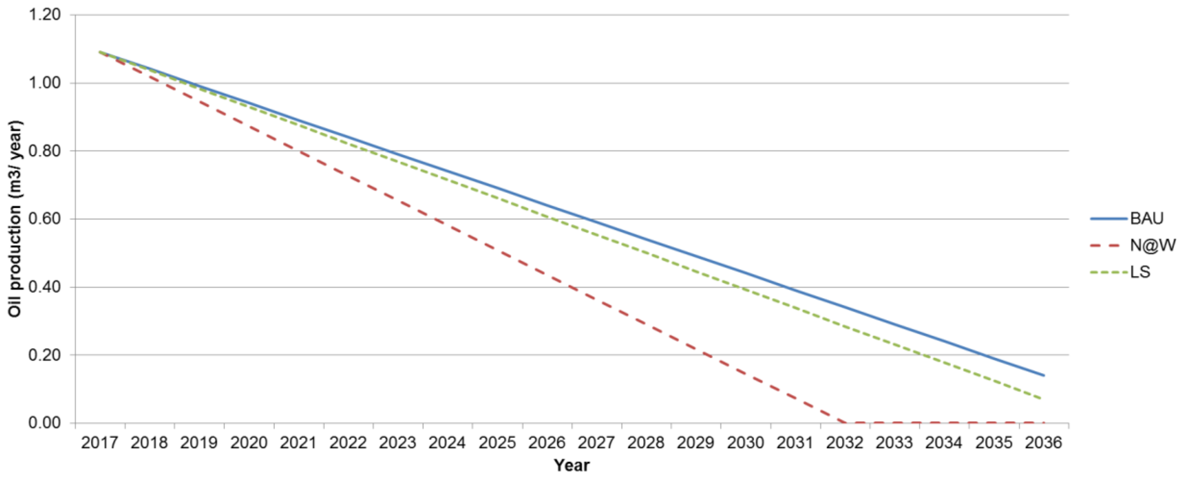


Figure 61: Oil production in the north east marine plan areas between 2017 and 2036 under three scenarios

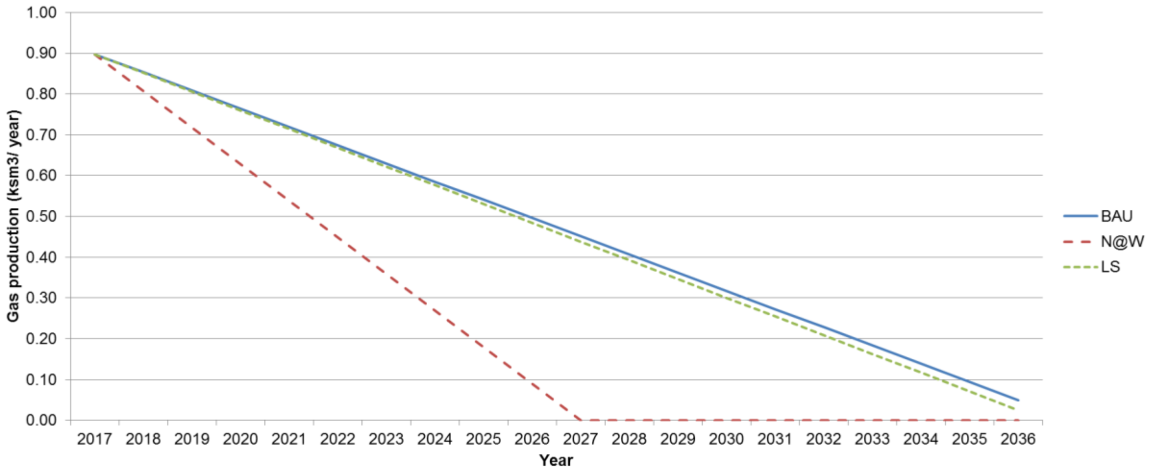


Figure 62: Gas production in the north east marine plan areas between 2017 and 2036 under three scenarios

Potential trade-offs

The oil and gas sector is projected to decline under all scenarios as a result of reducing reserves. Decommissioning may create new space for other sectors.

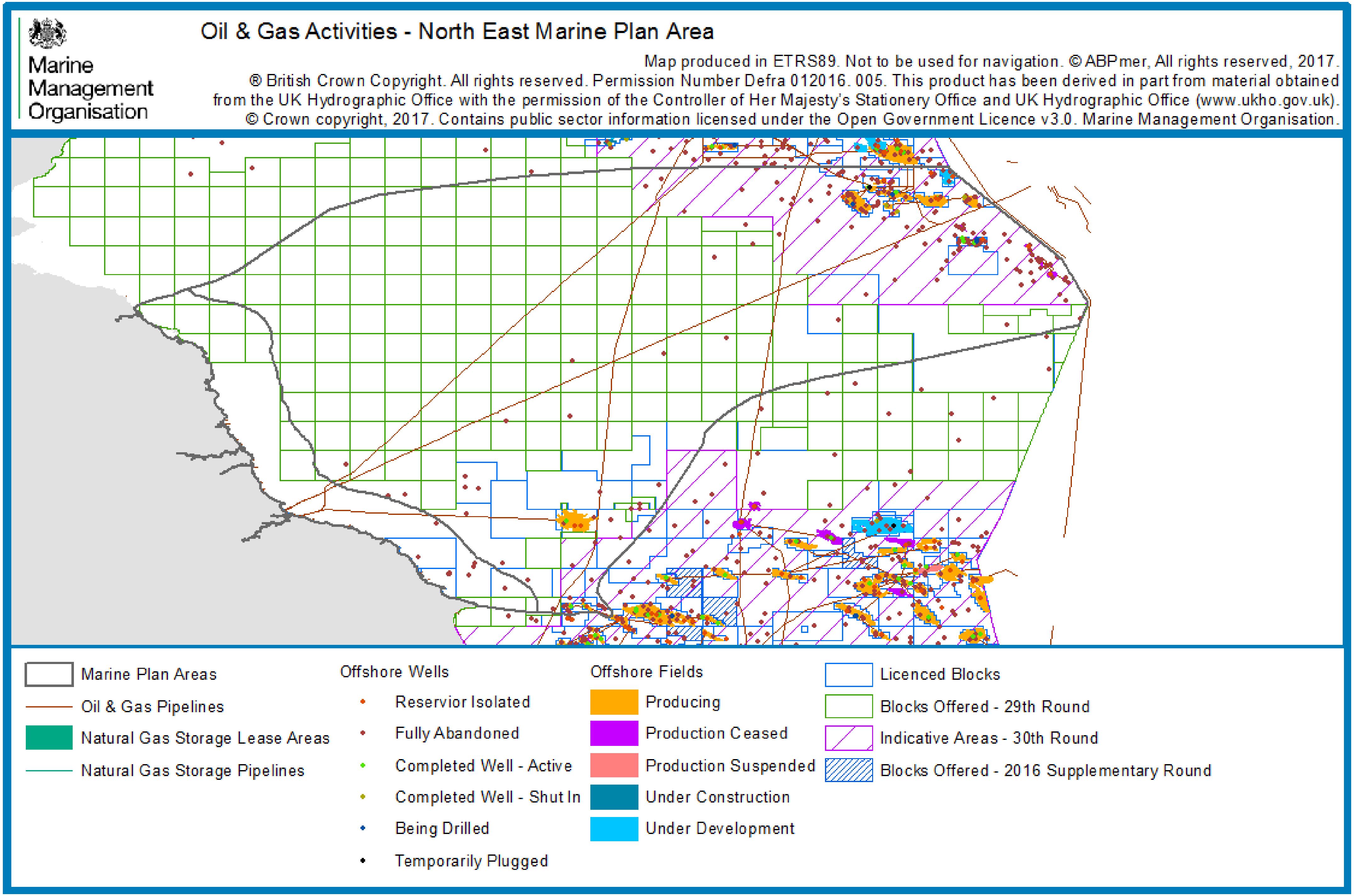


Figure 63: Oil & gas activities – north east marine plan areas

8.3 North west

Despite the oil and gas industry having a heavy focus in the North Sea, the north west marine plan areas contain a cluster of activity. Within this area of the Northern Irish Sea there are 17 licenced blocks and a total of 14 offshore fields, 13 of which are currently producing and support 90 active wells. The remaining oil field is currently under development (see Table 42). In addition 67 pipelines are present on the seabed in the north west marine plan areas, 64 of which are in use and 3 are not active. None of the licence blocks offered in the 29th licencing round were located in the north west marine plan areas. However, a large area in the northern Irish Sea that overlaps with the north west marine plan areas has been identified as an indicative area for the 30th oil and gas licencing round.

The offshore oil and gas activity in the north west marine plan areas is supported by several onshore processing facilities. The area around Runcorn is of specific importance for the sector, hosting what is described as the largest chemical cluster in the UK, supporting a range of key businesses in the chemical sector including refining, petrochemicals, chemicals, plastics, biotechnology and pharmaceuticals.

According to Chemicals Northwest, an industry-led chemical cluster support organisation, the chemical processing industry supports 650 businesses that employ 50,000 people and make an annual contribution of £3 billion to the regional economy. These values take account of all the chemical processing that occurs in the region, not just those originating from the oil and gas sector. Thus, it is considered that the ONS values provide a more accurate representation of the direct employment from the oil and gas industry within the north west. ONS suggest that the sector directly supports 1,510 businesses that provide employment for 8,940 people. Using an employment multiplier (1.4), indirect employment is estimated at 12,680 (MMO, 2016a).

Table 42: Producing oil and gas fields present in the north west marine plan areas

Field name	Field type	Status	2016 Production (m3 for oil and Ksm3 for gas)
Douglas	Oil	Producing	178,707
Conwy	Oil	Under Development	160,913
Lennox (Oil)	Oil	Producing	11,226
Lennox (Gas)	Gas	Producing	-
Hamilton East	Gas	Producing	-
Hamilton	Gas	Producing	44,492
Millom	Gas	Producing	69,489
South Morecambe	Gas	Producing	319,503
Dalton	Gas	Producing	2,154
Bains	Gas	Producing	-
Calder	Gas	Producing	340,320
Hamilton North	Gas	Producing	9,507
Rhyl	Gas	Producing	212,365
North Morecambe	Gas	Producing	441,475

The assumptions used to develop the BAU, N@W and LS scenarios for oil and gas in the north west marine plan areas are provided in Table 43. Projected oil and gas production under each of the three scenarios is shown in Figure 64 and Figure 65 respectively. Figure 66 shows the spatial distribution of current oil and gas activity in the north west marine plan areas.

Table 43: Assumptions and impacts under the future scenarios for oil and gas production in the north west marine plan areas

Aspect	Scenario		
	Business as Usual	**Nature @ Work**	**Local Stewardship**
Application to the sector	As for the north east marine plan areas (see Table 41).	As for the north east marine plan areas (see Table 41).	As for the north east marine plan areas (see Table 41).
Assumptions	Production values for the active fields in the north west marine plan areas are estimated from 2016 production values published by the OGA. Production values of 2037 are estimated by averaging the outcome of all modelled scenarios in Kemp and Stephan (2017) for the central north sea. The rate of decline between the 2017 and 2036 values is assumed to be constant.	2017 production values for active fields in the north west marine plan areas are estimated from 2016 production values published by the OGA. Given the Governments strong incentive to decarbonise energy production, this scenario assumes oils and gas activity in the north west marine plan areas will decrease to zero in 15 years' time for gas and 10 years for oil owing to the larger amount of current gas production relative to oil in the north west marine plan areas. The rate of decline from 2017 to the point where production reaches zero is assumed to be constant.	2017 production values for active fields in the north west marine plan areas are estimated from 2016 production values published by the OGA. 2036 production levels are assumed to be half of those in the BAU scenario reflecting the decreased use of fossil fuels in energy production and transport. The decrease between 2017 and 2036 is assumed to be constant.

6-year projection

Between 2017 and 2022, all three scenarios in the north west marine plan areas show a decrease in the amount of oil production from the UKCS. In 2017, production levels for all three scenarios begin at the same value, 0.35 million m^3 per year. N@W shows the largest rate of reduction resulting in oil production decreasing to 0.18 million m^3 per year in 2022. The BAU and LS scenarios show a shallower rate of decline, resulting in production values of 0.29 and 0.27 million m^3 per year respectively in 2022.

All scenarios for gas production begin at 1.44 million ksm^3/ year in 2017. A very similar trend to oil production is evident, with all three scenarios resulting in a decreasing production level over time. Again, N@W shows the sharpest rate of decline, with values decreasing to 0.96 ksm^3 per year in 2022. BAU and LS provide a shallower rate of decline, declining to 1.11 and 1.09 ksm^3 per year respectively in 2022.

6 to 20 year projection

The rate of decline under all scenarios for oil and gas production remains constant to 2036 until zero production is reached. Oil production reaches zero under N@W in 2027 and remains at that level throughout the rest of the time period. Oil production under BAU and LS do not reach zero before 2036, but decline to 0.12 and 0.06 million m^3/ year respectively in 2036.

Gas production under N@W reaches zero in 2032, six years after oil production reaches zero, due to the larger amount of gas activity currently occurring in the north west marine plan areas. BAU and LS decline at a rate very similar to one another, reaching values of 0.19 and 0.09 ksm^3/ year respectively in 2036.

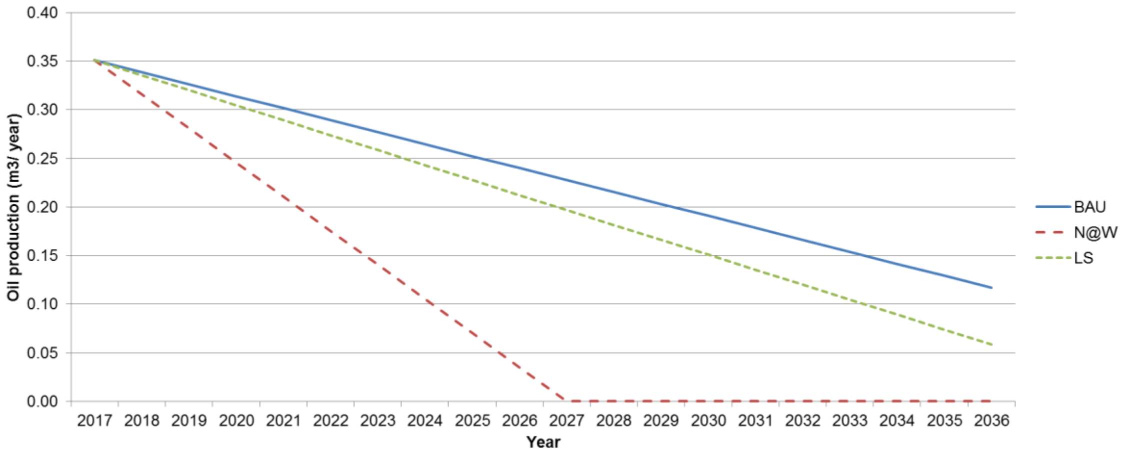


Figure 64: Oil production in the north west marine plan areas between 2017 and 2036 under three scenarios

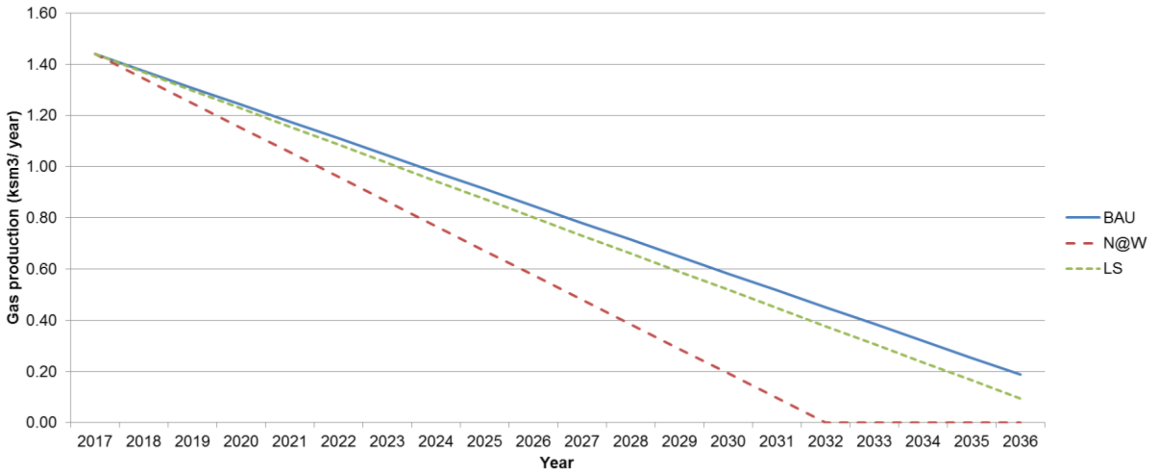


Figure 65: Gas production in the north west marine plan areas between 2017 and 2036 under three scenarios

Potential trade-offs

The oil and gas sector is projected to decline under all scenarios as a result of reducing reserves. Decommissioning may create new space for other sectors.

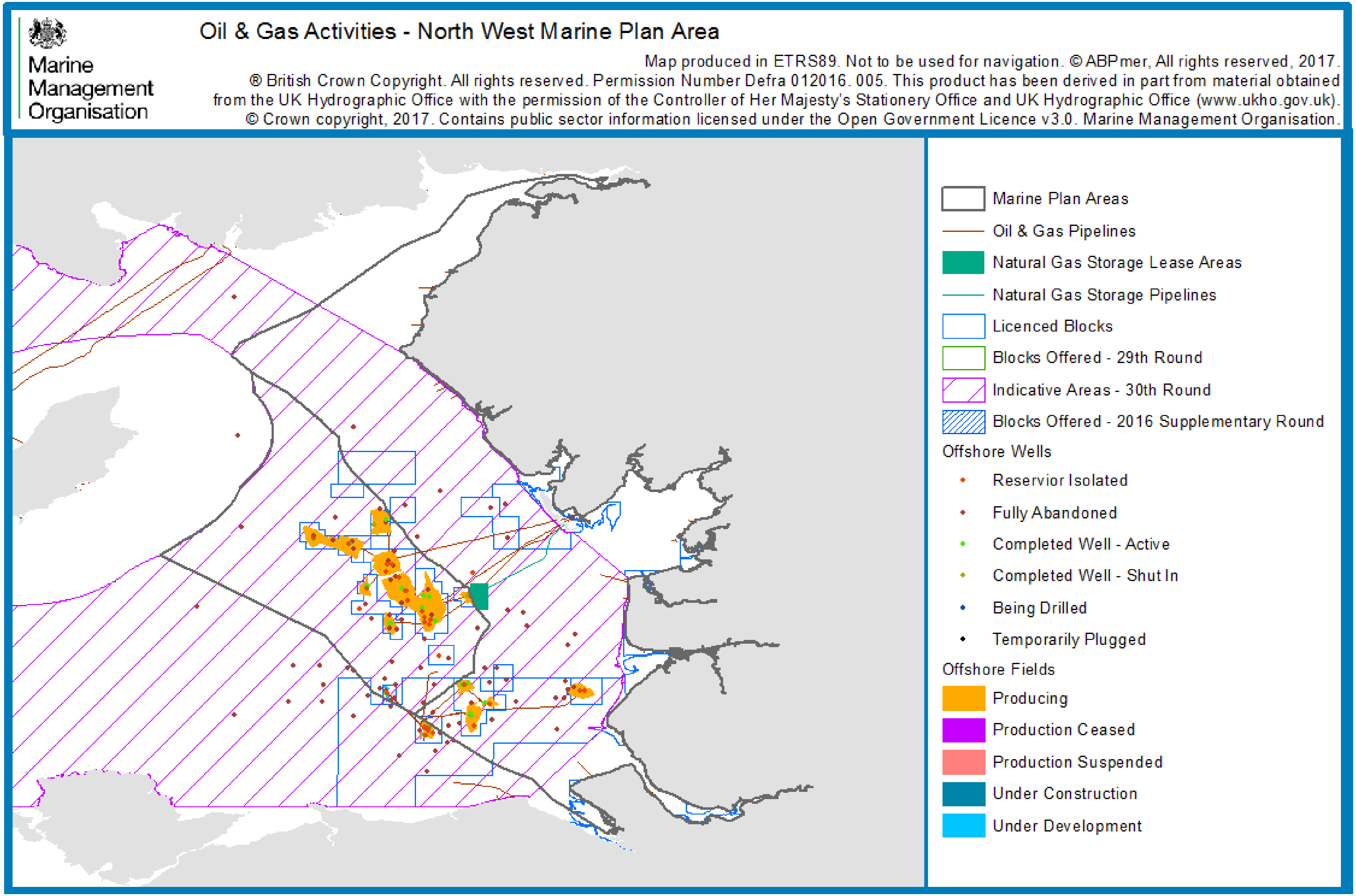


Figure 66: Oil and gas activities - north west marine plan areas

8.4 South east

The south east marine plan area does not contain any licensed blocks for oil and gas exploration or extraction. None of the blocks offered in the 29th licensing round are present in this marine plan area therefore no activity is predicted to occur over the next 20 years.

8.5 South west

The south west marine plan areas do not contain any licensed blocks for oil and gas exploration or extraction. None of the blocks offered in the 29th licensing round are present in this marine plan area therefore no activity is predicted to occur over the next 20 years.

9 Energy production: Wave and tidal energy

Sector definition

This sector is concerned with the generation of energy through wave and tidal devices. The UK Marine Policy Statement (HM Government, 2011) recognises that the marine environment will make an increasingly major contribution to the provision of the UK’s energy supply and distribution, with up to 20% of the UK’s current energy demand potentially supplied by wave and tidal energy.

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. The oscillating low-frequency energy created by wave movement can be converted into electricity and then added to the national grid. Energy output is determined by wave height, wave speed, wavelength 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).

Data sources

A variety of different information sources have been reviewed to inform this baseline, including published reports and papers and spatial data layers. The main information sources used are provided in the list below:

- Economic baseline assessment for the North East, North West, South East and South West Marine Plans (MMO, 2016a)
- Marine Plan Areas Sustainability Appraisal (MMO, 2016b)
- Strategic Scoping Report for Marine Planning in England (MMO, 2013c)
- Information on wave and tidal energy leases provided by The Crown Estate (The Crown Estate 2017[6])
- South West Marine Energy Park (South West MEP, 2012)

9.1 National review

Overview of national 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. Wave and tidal technologies are still at a pre-commercial stage and there are many designs being

[6] https://www.thecrownestate.co.uk/energy-minerals-and-infrastructure/wave-and-tidal/

pursued by developers to harness the power of waves and tides. To date, there are two commercial tidal developments operating in UK waters, MeyGen and Bluemill Sound. MeyGen is the largest, with four 1.5MW turbines being deployed in its first phase of development. This development is still under construction with more turbines to be added to the array in subsequent phases. A DCO was granted to Tidal Lagoon Power in June 2015 for the Swansea Tidal Lagoon in Welsh waters.

Theoretical estimates suggest that wave and tidal stream energy sources have the potential to meet up to 20% of the UK's current electricity demand (RenewableUK, n.d.[7]). This would require the installed capacity of approximately 30–50GW of wave and tidal stream devices. In addition, studies have estimated that the UK's total theoretical tidal range resource lies between 25 and 30GWs, enough to supply around 12% of current UK electricity demand (RenewableUK, n.d.[7]).

Although the resource is abundant around the UK, it is not evenly distributed. The majority of the UK's wave resource is found in waters around Scotland, the south west coast of England and Wales, Northern Ireland and the Isle of Wight. The tidal range resource is mainly concentrated in the Bristol Channel and Severn Estuary (between 8 and 12GW). However, bays and estuaries located in north west England as well as a few locations in the south east, east and north east England also have significant tidal range potential (UK Government, 2013; The Crown Estate, 2012). Tidal stream resources are located at various locations around the UK coastline but generally in confined areas where the tidal flow is funnelled and concentrated, such as around headlands and islands.

Despite the potential, wave and tidal energy remain in a pre-commercial state. Only two commercial projects (MeyGen and Bluemull Sound) are currently under construction, both of which are in Scottish waters. Although the MeyGen tidal array in the Pentland Firth is technically still under construction, Phase 1A of the build out has been completed and has resulted in four turbines exporting electricity to the grid. Phase 1B is expected to begin in 2017 (Atlantis Resource Ltd, 2017). In addition, several dedicated test areas, such as EMEC in Orkney, WaveHub off the north Cornish coast and FaB Test in Falmouth Bay (south Cornwall), have been established and have hosted a range of devices that have exported energy into the national grid. Deployments are now generally shifting away from device development and towards the testing and development of commercial arrays. Tidal range projects have not yet been tested in the UK, although the Swansea tidal lagoon has been granted a Development Consent Order. Several environmental concerns are present regarding the environmental impact of tidal lagoons during operation (Hendry, 2016). These have already lead to delays in the development of the Swansea Bay lagoon and could result in delays or even abandonment of forthcoming projects if the issues are not resolved.

The development of wave and tidal infrastructure is spatially restricted to areas with an appropriate water depth, geology, met ocean conditions and resource availability. Consequently, the deployment of wave and tidal developments will be concentrated in specific areas around the UK (MMO, 2016b). As shown in Figure 67, all current and planned wave and tidal developments in England are located along the west

[7] http://www.renewableuk.com/page/WaveTidalEnergy

coast, with the north west and south west marine plan areas each hosting a number of planned developments. WaveHub in the south west inshore marine plan area is the only currently active development in England. No developments are currently planned in the north east or south east marine plan areas. Wave and tidal developments are connected to onshore gird infrastructure through export cables. The presence of these is therefore associated with the amount of wave and tidal activity in a particular marine plan area.

Over the coming decade, more commercial scale tidal stream and tidal range projects may enter construction and/or operational phases. Wave energy technologies are currently lagging behind tidal developments; thus, there are currently no current plans for any commercial wave arrays in UK waters.

The establishment of a wave and tidal energy industry could bring economic benefits for the UK. The Carbon Trust has estimated that the global market for marine renewables (wind, wave and tide) could be worth £340 billion (in 2050) and that the UK's share of this could be worth £76 billion (SOEC, 2007).

The industry estimates that marine renewables (wave and tidal) could support 10,000 direct jobs in 2020 and the Carbon Trust has estimated that there could be as many as 68,000 UK-based jobs by 2050 (DECC, 2012). Wave and tidal energy could also benefit energy security by reducing the UK's reliance on imported fuels. Tidal stream has the additional benefit of providing a predictable output that is not dependent on the weather (MMO, 2013c).

.

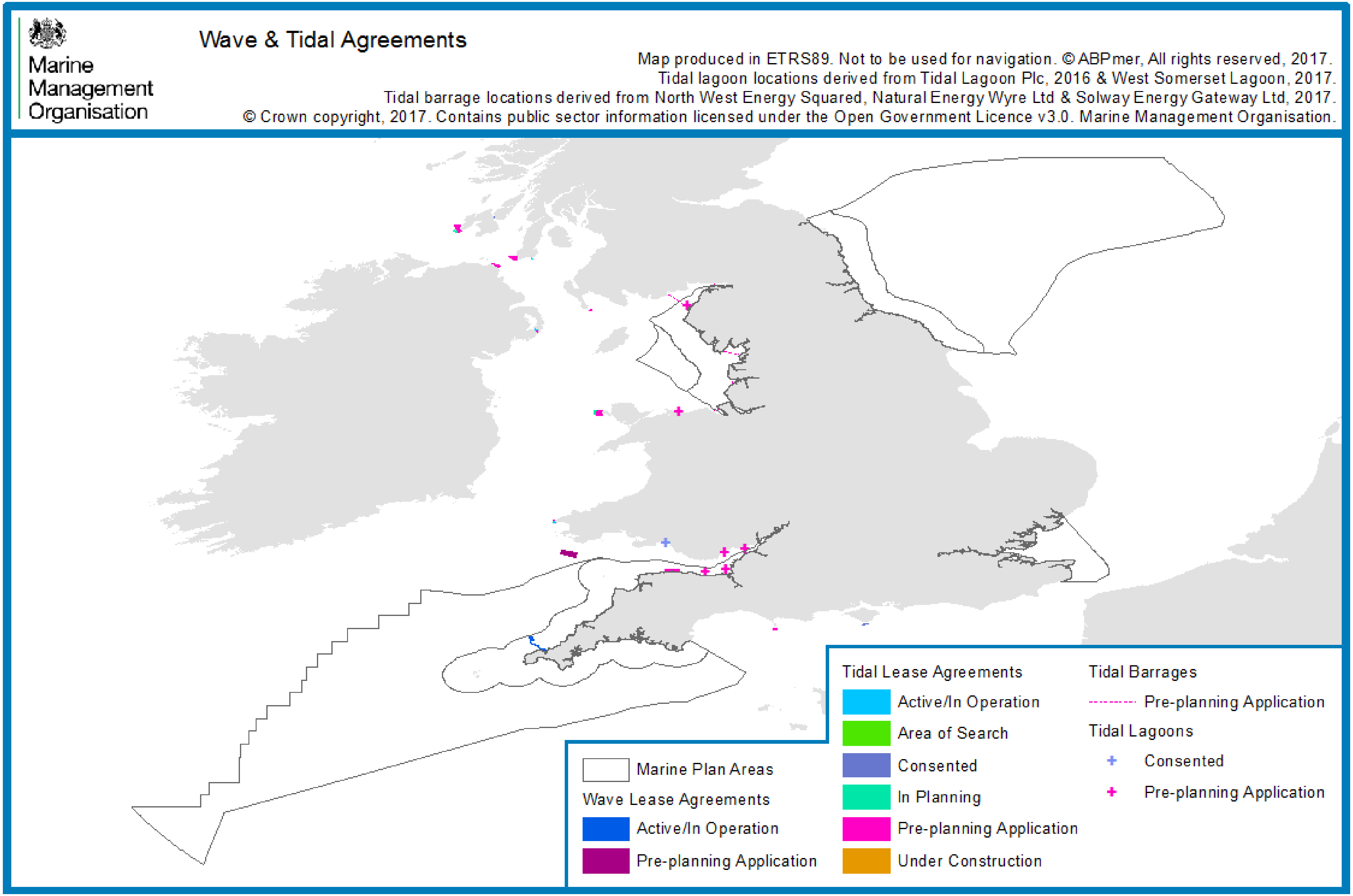


Figure 67: Location of wave and tidal agreements in the UK

Review of historical trends

The concept of using coastal waters as an energy source in England has been around since 1849 when the first proposal for a Severn Barrage was made (Hendry, 2016). However, the technology required to exploit wave and tide resources is relatively new and the sector is considered to be an emerging industry.

Between 2011 and 2015, DECC committed £200 million of funding for low-carbon technologies (including bioenergy, nuclear, wind, wave and tidal). Specifically in relation to wave and tidal investment, DECC launched its Marine Energy Array Demonstrator (MEAD) scheme (DECC, 2013). BEIS is investing up to £20 million in the MEAD scheme to support two pre-commercial projects to demonstrate the operation of wave and/or tidal devices in array formation for an extended period of time (RenewableUK, 2012). In February 2013 DECC announced that two British companies had been awarded a share of the £20 million: MeyGen Ltd (based in Pentland Firth, Scotland); and Sea Generation Wales Ltd (based in Anglesey, Wales), to test and develop tidal turbine arrays. In 2014, The Crown Estate committed to investing almost £10 million in the MeyGen Ltd tidal power development and is undertaking enabling actions (research and technical studies) to support the project development process of wave and tidal energy. In addition, The Crown Estate has also leased over 40 sites for tidal stream and wave projects (The Crown Estate, 2017). The tidal stream projects will support the development and testing of pre-commercial marine tidal devices in array formations, potentially driving down costs and testing their ability to produce economically viable amounts of energy out at sea (DECC, 2013).

No commercial deployments have occurred in England to date, however three test sites have been established in the south west inshore marine plan area, namely FaB Test (a nursery site for small scale devices), WaveHub and the North Devon Demonstration Zone. Several devices have been tested at these sites, however they are yet to be used to their full potential. Tidal range developments have not yet been tested in English waters however plans for two tidal lagoons off the Somerset coast are being developed.

Review of key changes and/or advances of significance affecting the sector

Table 44 provides a summary of the key drivers likely to affect the development of the wave and tidal sector over the next 20 years. Government policies on energy and climate change, in particular, the EU Renewable Energy Directive, the Climate Change Act, the UK Renewable Energy Strategy (2009) and the new Industrial Strategy (2017) are all key drivers for encouraging and increasing the use of renewables including wave and tidal energy. These legally-binding targets, coupled with the expectation that energy demand is predicted to increase throughout the UK will help to drive the wave and tidal sectors forward.

Wave and tidal technologies are currently in a pre-commercial state and are far less-developed and widely-deployed than wind technologies. The advancement of the wave and tidal sector is underpinned by technological advances to make wave and tidal devices more commercially viable. These technological advancements are reliant on significant government funding and/or subsidies and private sector investment. Security of funding will be a key driver affecting advances in wave and tidal technologies.

To boost investment in the renewable energy industry, the UK Government is implementing the Electricity Market Reform (EMR), through the Energy Act (2013), to make sure the UK remains a leading destination for investment in low-carbon electricity. The EMR has superseded the Renewable Obligation Certificates (ROCs) and put in place measures to attract £110 billion investment needed to replace current generating capacity and upgrade the grid by 2020. One of the main elements of EMR is Contracts for Difference (CfDs) which are long-term contracts aimed at providing stable and predictable incentives for companies to invest in low-carbon generation. The CfD regime came into force in 2014. In 2015, DECC (now BEIS) announced an increase in the budget for pot 2 developments (less established technologies such as offshore wind, wave and tidal) of £25 million, meaning a total of £260 million will be made available for projects commissioning from 2017/18 onwards (UK Government, 2017). Towards the end of 2016, the government announced the next round of CfD auctions would have a budget of £290 million across two delivery periods and outlined support for offshore wind, wave and tidal technologies. The £290 million round will open in April 2017 for projects to be delivered in either 2021/22 or 2022/23 (UK Government, 2016a).

Horizon 2020 Energy is a European funding stream aimed at research and innovation in the energy sector with a budget of around €6 billion for the period 2014 – 2020. The 2016 Calls for Proposals had a total budget of over €500 million, covering a range of technology areas including renewable energy technologies. The budget for Low Carbon energy technology development was set at €120 million with budgets per project ranging from €0.6 million to €10 million. Additional funding was aimed at Low Carbon energy technology demonstration with a total budget of €85 million, ranging from €3 to €10 million per project (UK Government, 2016b).

When distributing subsidies to renewable technologies, the government must make informed decisions. For this reason, an Independent Review of Tidal Lagoons (The Hendry Review) was commissioned to assess the strategic case for tidal lagoons and whether they could play a cost effective role as part of the UK energy mix (Hendry, 2016). The report concluded that large scale tidal lagoons have potential to be competitive with low carbon projects and provide attractive prospects for customer bills particularly when compared to nuclear projects over a long time period (Hendry, 2016).

Table 44: Key drivers affecting development of the wave and tidal sector

Driver	Details	Implications
Political	Reduce imports of energy to increase energy security through securing a diverse energy mix	Increased investment in renewable technologies but also constrains the growth of one particular sector
	Closure of power stations – reduce reliance on fossil fuels	Demand for alternative sources of energy
	Reduce imports of energy	Increased investment in renewable technologies

Driver	Details	Implications
	Renewable energy developments require leasing of the seabed. Custodians of the seabed play 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
	Combatting energy poverty	Government favouring cheaper sources of energy, limiting the extent of support for more expensive forms of energy generation (e.g. offshore wind)
	Policy toward unabated coal fired power stations and clean air regulations	Development driven away from these technologies and into cleaner forms of energy production such as wind
Economic	Increasing or decreasing coal, 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
	Availability of CfD	Increasing investment in wave and tidal developments
Social	Increased population resulting in increased demand for energy	Potential for greater investment in renewable technologies
	Interactions with fisheries/shipping/recreation/seascape	Constraints/ restriction on areas within which renewables can be developed
	Public perception of suitable energy sources	Increased drive for renewable energy generation
Technological	Developments in technology used to generate clean energy	Expansion of renewable energy generation devices to offshore areas
	Reduction in manufacturing/ installation costs	Increased competitiveness of renewables against alternative technologies
	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	The development of future renewable energy sites will be linked to growth in grid capacity
Legal	EU Renewable Energy Directive (2009/28/EC) and associated targets: • UK - 15% of all of its energy from renewable sources by 2020.	Increased investment in renewable technologies
	The Climate Change Act commits the UK to a legally-binding target for reducing CO2 emissions by at least 80% on 1990 levels by 2050	Increased investment in renewable technologies
Environmental	Assessments of proposed developments against a wider range of environmental receptors, increased survey/monitoring effort	Increased costs for developers
	Designation of additional MPAs	Potential constraints/ restriction on areas within which renewable devices can be developed
	Concerns over the preservation of countryside environments	Favours the development of offshore wind energy

Review of future trends

The increase in global energy demand is expected to continue and this will be met from a combination of production sources. Demand for electricity is also likely to increase with increasing use of electric vehicles. In the long term, despite the current uncertainty regarding the commercial viability of these technologies, especially wave, increased investment in marine renewable technologies is predicted to lead to increased efficiency and a decrease in costs associated with wave and tidal technologies.

Under each of the three scenarios, the development of wave and tidal projects is driven by central government policy, with the lowest rate of development under the Business as Usual (BAU) scenario. Under the Nature at Work (N@W) scenario, climate change mitigation becomes a stronger policy priority leading to the development of an increasingly larger number of wave and tidal projects. Under the Local Stewardship (LS) scenario, local interest in marine renewables, especially tidal lagoons, drive the development of further local wave and tidal projects so that this scenario results in the largest amount of wave and tidal power generation.

Confidence assessment

The wave and tidal industry is currently in a pre-commercial state with many unknowns about the scale, location and layout of potential future commercial deployments. The viability of wave and tidal technologies has been proven however further testing is required at a commercial level (MMO, 2013c).

To date, no commercial developments have been deployed in the north east, north west, south east or south west marine plan areas. Although Fab Test, WaveHub and the North Devon Demonstration Zone in the south west inshore marine plan area have been granted an Agreement for Lease, very little capacity has been deployed at these sites. Similarly, despite the presence of tidal range resource, tidal range developments are yet to be built in the UK. The uncertainty over the commercial viability of wave and tidal technologies and their associated environmental effect highlights the need to further development and testing. In turn, this leads to uncertainty over the scale of wave and tidal deployment activity within the north east, north west, south east or south west marine plan areas over the next 20 years.

9.2 North east

To date, no wave or tidal activity has occurred or has been planned in the north east marine plan areas due to a lack of exploitable wave or tidal resource (The Crown Estate, 2012). It is therefore assumed that over the next 20 years, no wave or tidal developments will occur in the north east marine plan areas.

9.3 North west

No agreements for lease have been granted for wave or tidal energy development in the north west marine plan areas. However there are plans for a tidal lagoon in Cumbria that is currently at the pre-planning application stage (MMO, 2016a). In addition, seven potential barrage schemes are currently in the pre-planning application stage in the north west (see Table 45).

Table 45: Offshore wind developments in the north west marine plan areas

Wave or tidal development	Development type	Status	Project Capacity (MW)	Lease status
West Cumbria	Tidal lagoon	Pre-planning Application	1,377	N/A
Solway Tidal Gateway	Tidal barrage	Pre-planning Application	11	N/A
Duddon Tidal Gateway	Tidal barrage	Pre-planning Application	740	N/A
Morecambe Bay Tidal Gateway	Tidal barrage	Pre-planning Application	11	N/A
Ribble Tidal Gateway	Tidal barrage	Pre-planning Application	180	N/A
Mersey Tidal Gateway	Tidal barrage	Pre-planning Application	171	N/A
Dee Tidal Gateway	Tidal barrage	Pre-planning Application	11	N/A
Wyre	Tidal barrage	Pre-planning Application	1,377	N/A

The assumptions used to develop the BAU, N@W and LS scenarios for wave and tidal energy in the north west marine plan areas are provided in Table 46. Projected installed capacity under each of the three scenarios is shown in Figure 68. Figure 69 shows the spatial application of the scenarios to the sector while the text below provides a brief description of the future trends in 6 years and 6 to 20 years.

Table 46: Assumptions and impacts under the future scenarios for wave and tidal energy in the north west marine plan areas

Aspect	Scenario		
	Business as Usual	**Nature @ Work**	**Local Stewardship**
Application to the sector	There is currently no wave or tidal energy developments in the north west marine plan areas. It is therefore considered unlikely that any activity will occur within the next 20 years.	No activity under this scenario as offshore wind is preferred in the region.	Local interest in marine renewables technologies. Lack of significant tidal stream and wave resource results in tidal range being the only potential resource in the north west marine plan area.
Assumptions	No activity under this scenario.	No activity under this scenario.	West Cumbria tidal lagoon, the Solway Tidal Gateway and Wyre tidal barrage all go ahead. Given the current early stage of these developments it is assumed that construction and operation will occur sometime between 2030 and 2036. Thus the final capacity of these projects is spread between 2030 and 2036, with all projects reaching full capacity in 2036.

6-year projection

Between 2017 and 2022, none of the scenarios result in any marine renewable activity in the north west marine plan areas. This is a result of the lack of significant tidal stream and wave resource and the embryonic stage of tidal lagoon and barrage projects in the region.

6 to 20 year projection

Between 6 and 20 years, LS is the only scenario that results in any wave or tidal power generation activity. Under this scenario the West Cumbria Tidal Lagoon, the Solway Tidal Gateway and the Wyre Barrage are constructed. These are not included in the BAU or the N@W scenarios as they are currently in a very early stage of planning and are considered to be speculative. Given this uncertainty, these projects were not given a specific operational start date. Instead, it was assumed that all three developments would begin generating power sometime between 2030 and 2036. Cumulative capacity of the LS scenario therefore increases uniformly between these dates reaching a total capacity of 1,450MW in 2036 (Figure 68).

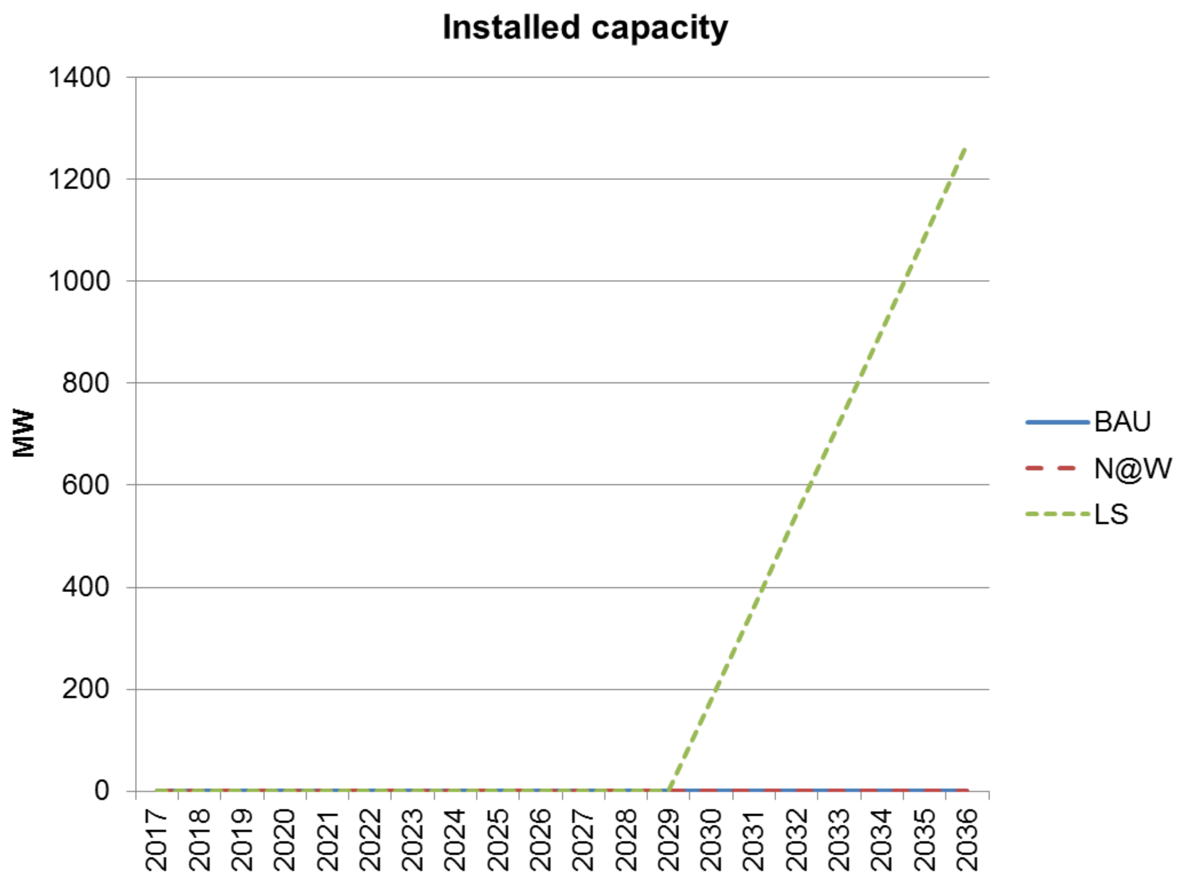


Figure 68: Installed wave and tidal capacity in the north west marine plan areas between 2017 and 2036 under three scenarios

Potential trade-offs

The main potential interactions for future wave and tidal development are likely to be:

- Natural environment (habitat loss/damage, damage to mobile features, reduced greenhouse gas emissions)
- Recreation (changes to access)

- Commercial fishing
- Other infrastructure/extractive industries
- Shipping.

Within the north west marine plan areas, the only form of development anticipated is tidal range development under the LS scenario. The main potential trade-offs are likely to be with the natural environment and recreation. Negative trade-offs can be minimised through careful project design.

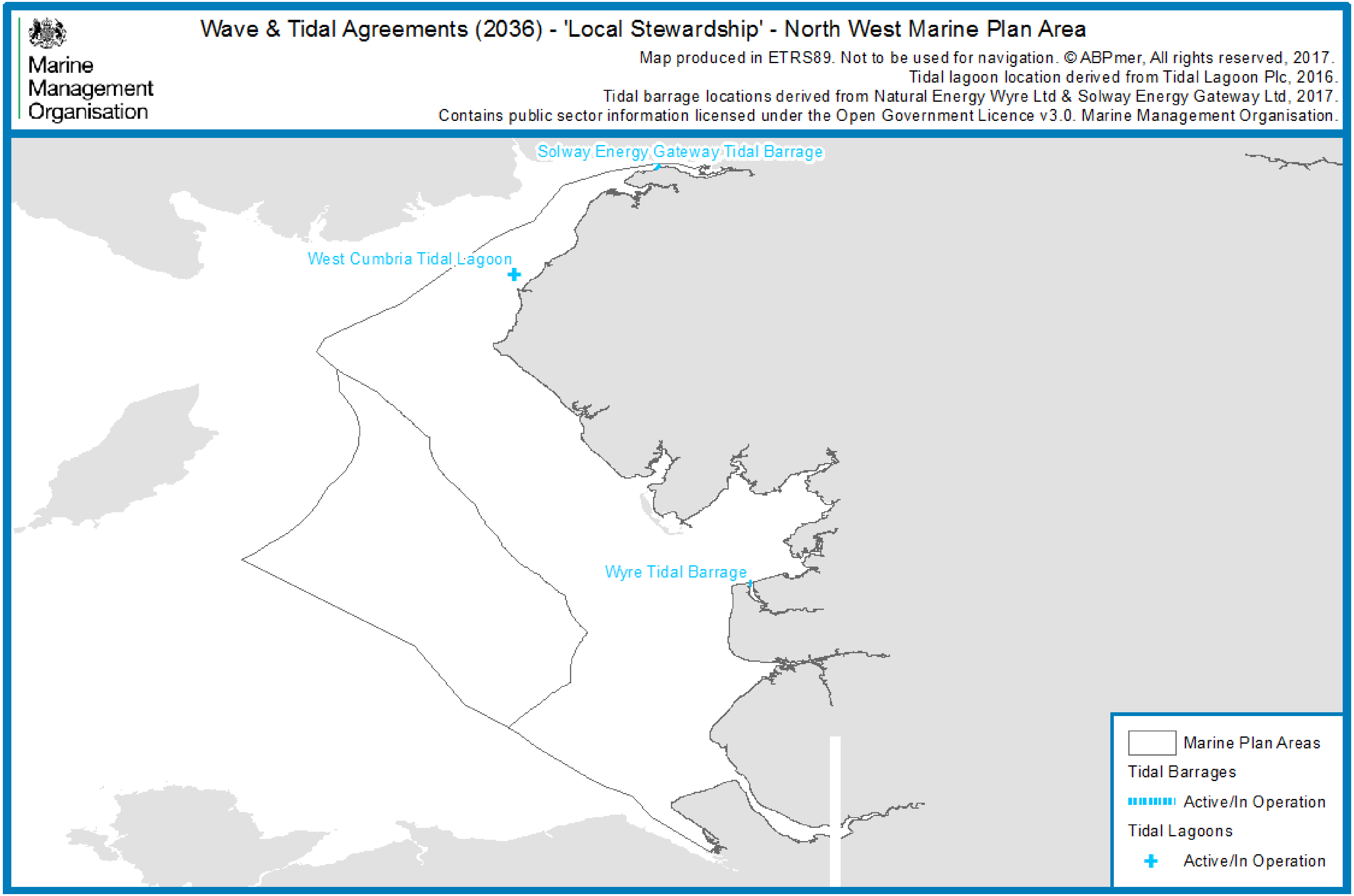


Figure 69: Wave and tidal agreements (2036) – LS - north west marine plan areas

9.4 South east

To date, no wave or tidal activity has occurred or has been planned in the south east marine plan area due to a lack of exploitable wave or tidal resource. It is therefore assumed that over the next 20 years, no wave or tidal developments will occur in the south east marine plan area.

9.5 South west

The renewables focus in the south west is upon wave and tidal developments. This is a direct result of resource abundance and the proximity to good port, grid and supply chain infrastructure. Several key economic assets including the South West Marine Energy Park (MEP), Wave Hub, The North Devon Demonstration Zone (NDDZ), Falmouth Bay Test Site (FaB Test) and Plymouth University support the renewable energy economy in the south west of England.

The South West MEP is a collaborative partnership between local and national government, Local Enterprise Partnerships, technology developers, academia and industry. It provides a physical and geographic zone with priority focus for marine energy technology development, energy generation projects and industry growth. The geographic scope of the South West MEP extends from Bristol to Cornwall and the Isles of Scilly, with a focus around the ports, research facilities and industrial clusters found in Cornwall, Plymouth and Bristol. The core objective is to create a positive business environment that will foster business collaboration, attract investment and accelerate the commercial development of the marine energy sector (South West MEP, 2012).

Currently, Wave Hub, FaB Test and the NDDZ are the only sites in the region to have been granted a seabed lease from The Crown Estate. Wave Hub is a site aimed at testing and developing offshore wave energy technologies and is located 16km north west of Hayle, Cornwall. The site offers four cable connections to pre-installed grid connected infrastructure, each with a 48MW maximum export capacity. To date only one developer has deployed a wave device at WaveHub. Seatricity currently has its Oceanus 2 device deployed at the site and are planning to deploy a 10MW array in the near future. Carnegie Clean Energy Ltd. and GWave also have plans to deploy devices at the site with estimate commission dates of 2018 and 2020 respectively (Wavehub, 2017a).

FaB test is a one quarter scale, fully consented, wave energy test site developed in response to industry requests for an area to test scale models of wave energy devices in real and dynamic environments (WaveHub, 2017b). It allows for up to three devices to be deployed concurrently and while not grid connected it does provide an extremely accessible and cost effective nursery facility as a stepping stone from proof of concept to full scale deployment at Wave Hub (South West MEP, 2012). Two devices have been deployed at FaB Test, namely the Fred Olsen Bolt Lifesaver and the Polygen Ltd. Volta. Currently only the Volta is present at the site.

The NDDZ is located in the Bristol Channel between Foreland Point and Hangman Point approximately 3.5 to 10 km offshore. Marine Current Turbines (MCT) deployed a device at the site between 2003 and 2007 (South West MEP, 2012) however this lease has since expired and the new NDDZ lease began in 2014. The site has the potential to support the demonstration of tidal stream arrays with a generating capacity of up to 30MW. The project is currently in the pre-planning application stage and has not seen the deployment of any tidal stream devices. The site will be managed by Wave Hub Limited working in partnership with District and County local authorities and the Exmoor National Park.

The south west region includes the Severn Estuary and Bristol Channel where a number of tidal range developments have been proposed including both lagoons and barrages. Most of the lagoon developments are located in Welsh waters, apart from Bridgwater Bay lagoon and the West Somerset Tidal Lagoon. It should be noted that tidal lagoon schemes in the south west marine plan areas are favoured over tidal barrages, therefore those barrage schemes detailed in Table 1 are not considered in the following scenarios.

Table 47: Offshore wave and tidal developments in the south west marine plan areas

Wave or tidal development Name	Development type	Status	Project Capacity (MW)	Lease status
Wave Hub	Wave	Active/In Operation	4 x 30MW grid connections	Leased
North Devon Demonstration Zone	Wave	Pre-planning Application	Up to 30MW per project	Leased
FaB Test	Wave	Active/In Operation	N/A	Leased
Bridgewater Bay	Tidal lagoon	Pre-planning Application	6,500	N/A
West Somerset Tidal Lagoon	Tidal lagoon	Pre-planning Application	3,000	N/A
Beachley Barrage	Tidal barrage	Pre-planning Application	183	N/A
Shoots Barrage	Tidal barrage	Pre-planning Application	308	N/A
Brean Down to Lavernock Point Barrage	Tidal barrage	Pre-planning Application	1,918	N/A

The assumptions used to develop the BAU, N@W and LS scenarios for wave and tidal energy in the south west marine plan areas are provided in Table 48. Projected installed capacity under each of the three scenarios is shown in Figure 70 and Figure 71. Figure 72, Figure 73 and Figure 74 shows the spatial application of the scenarios to the sector while the text below provides a brief description of the future trends in 6 years and 6 to 20 years.

Table 48: Assumptions and impacts under the future scenarios for wave and tidal energy production in the south west marine plan areas

Aspect	Scenario		
	Business as Usual	**Nature @ Work**	**Local Stewardship**
Application to the sector	Lowest level of development of marine renewables, with only two developments occurring at WaveHub (the only site currently active with a Development Consent Order). It is assumed that these developments do not proceed past stage 1 of their testing. FaB Test would be active in this scenario but the activity is not considered to be large enough to have a significant impact. Limited availability of Contracts for Difference (CfD) and strong competition for available CfDs from wind and nuclear mean no commercial developments are pushed forward.	Climate change mitigation becomes a stronger policy priority, leading to increased development of renewable energy sources, covering an increasingly large proportion of energy generation. Increased development of wave and tidal technologies determined from central government.	Local interest in marine renewables, with the development of additional marine renewable projects compared to N@W and BAU. Tidal lagoons are being developed for multiple local benefits including flood protection, aquaculture and recreation/tourism. This scenario assumes WaveHub and the NDDZ will be operating at full capacity and the two tidal lagoons are developed.
Assumptions	Only WaveHub active with currently planned deployments taking place. Currently planned deployments include: ▪ Seatricity Oceanus 2 (1 x 162kW): 2017–2018 ▪ Carnegie Wave Energy (1x 1MW): 2018–2019 ▪ GWave (1x 9MW) 2020–2027 Under this scenario it is assumed that new developers will continually replace the lost capacity resulting in WaveHub maintaining an installed capacity of 1MW between 2019 and 2036.	WaveHub becomes more active with currently planned deployments being developed through to stage two. Other developers also deploy devices at the site. The NDDZ becomes active. WaveHub deployments: ▪ Seatricity Oceanus 2 Stage 1 (1 x 162kW): 2017–2018 ▪ Seatricity Oceanus 2 Stage 2 (10MW array) 2019–2025 ▪ Carnegie Wave Energy (1x 1MW): 2018–2019 ▪ Carnegie Wave Energy (15MW array) 2020–2026 ▪ GWave (1x 9MW) 2020–2027 ▪ GWave (4 x 9MW) 2021–2028	WaveHub and the NDDZ begin to move towards full capacity and two tidal Lagoons are built. WaveHub deployments: ▪ Seatricity, Carnegie and GWave operate as in N@W ▪ An additional 10MW of capacity is added each year beyond 2027 due to the deployment of new arrays, until capacity is needed. NDDZ deployments: ▪ Site is used more than in N@W. 1MW of capacity added each from 2018 to 2022. From 2022 onwards 5MW of capacity added until 30MW is reach. Site remains at 30MW for remained of time period.

Aspect	Scenario		
	Business as Usual	Nature @ Work	Local Stewardship
		Capacity peaks at 71MW in between 2023 and 2025, new developments at the site maintain a capacity of 70MW for the remainder of the time period. NDDZ deployments:Assuming that, beginning in 2018, several devices are always operational at the site resulting in a combined capacity of 1MW for the remainder of the time period.	Tidal Lagoons: ▪ Bridgwater Bay (6,500MW) becomes operational in 2033. ▪ West Somerset Tidal Lagoon (3,000MW) becomes operational in 2033

6-year projection

Over the first six years, between 2017 and 2022, developments at WaveHub and the NDDZ contribute to wave and tidal power generation. Under the BAU scenario, WaveHub is the only operating site. All currently planned projects go ahead, with Seatricity and Carnegie deployments producing a peak capacity of 1.2MW in 2018. As these projects are not commercial deployments it is assumed they have a short life span of two years. As these go offline, GWave deploy their large 9MW device in 2019. This device, being much larger than the previous two deployments, continues operation until 2022.

The N@W scenario assumes more capacity is deployed at WaveHub through currently planned projects moving into their second stage of deployment. It also assumes developers begin to use the NDDZ, with constant 1MW capacity installed at the site between 2019 and 2022. This results in a total installed capacity of 62MW in 2022 under the N@W scenario (see Figure 71).

Between 2017 and 2022, the LS scenario sees the same amount of capacity installed at WaveHub as N@W. LS however assumes that more capacity will be installed at the NDDZ, with 1MW of capacity being added each year between 2018 and 2022 resulting in 5MW of capacity being installed at the NDDZ in 2022 and a total capacity of 66MW in the south west marine plan areas (see Figure 71).

6 to 20 year projection

Post 2022, BAU sees the continued operation of the GWave device until 2027 when it is decommissioned. Post 2027 it is assumed that new developers will move into WaveHub resulting in the site maintaining a capacity of 1MW between 2027 and 2036. The N@W scenario continues to increase in capacity due to growth at WaveHub until a peak of 79MW is achieved in 2023. After 2025 some of the stage two developments begin to be decommissioned. However, it is assumed that the removed capacity is replaced by new projects. WaveHub therefore maintains a capacity of 79MW for the remainder of the time period. The NDDZ remains at 1MW throughout resulting the N@W maintaining 80MW between 2023 and 2036 (see Figure 70).

Until 2034, the LS scenario follows a similar trend to N@W; the major differences between the two being that an additional 10MW of capacity is added to WaveHub every year after 2027 until its maximum capacity of 120MW is reached to reflect increasing interest and development of wave energy technology. Additionally, from 2022 onwards, an additional 5MW of capacity is added to the NDDZ until it reaches a maximum capacity of 30MW in 2027. Therefore, in 2033 the operational capacity under the LS scenario is 150MW. In 2034 the Bridgwater Bay and West Somerset tidal lagoons begin to generate electricity with a combined capacity operational capacity of 9,500MW (6,500MW from Bridgewater Bay (Hendry, 2016) and 3,000 from West Somerset Tidal Lagoon (West Somerset Tidal Lagoon, n.d.)[8]). The final installed capacity of the LS scenario is therefore 9,650MW (see Figure 70).

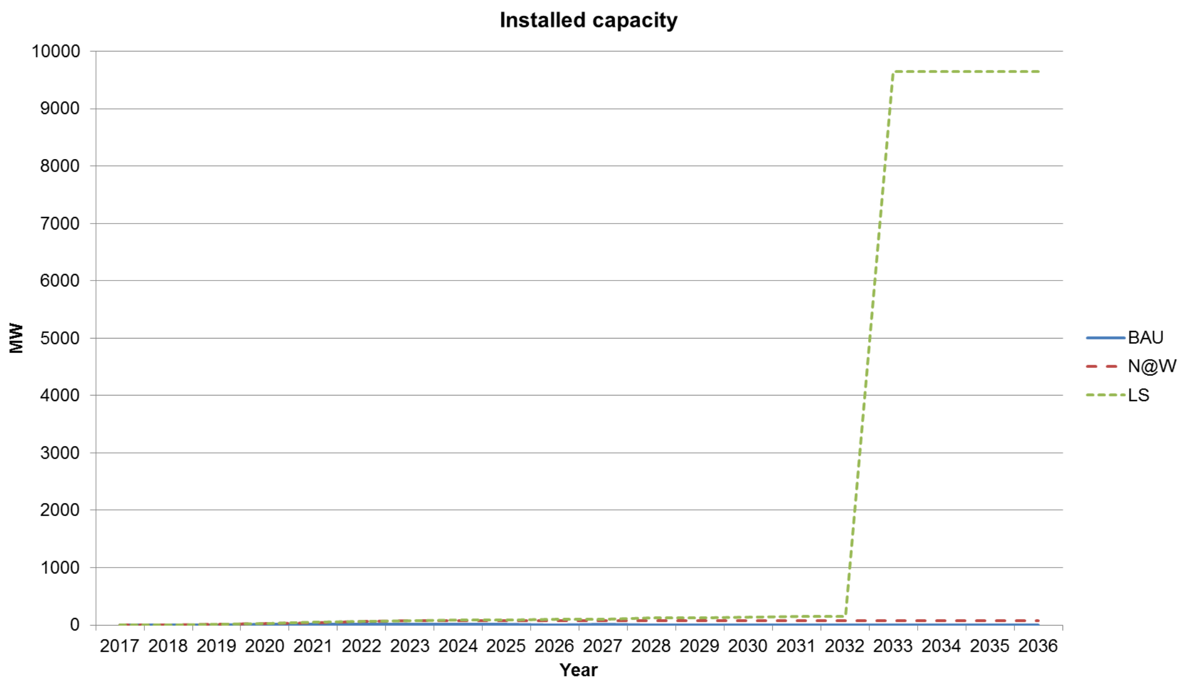


Figure 70: Installed wave and tidal capacity in the south west marine plan areas between 2017 and 2036 under three scenarios

[8] https://www.westsomersetlagoon.com/project-4

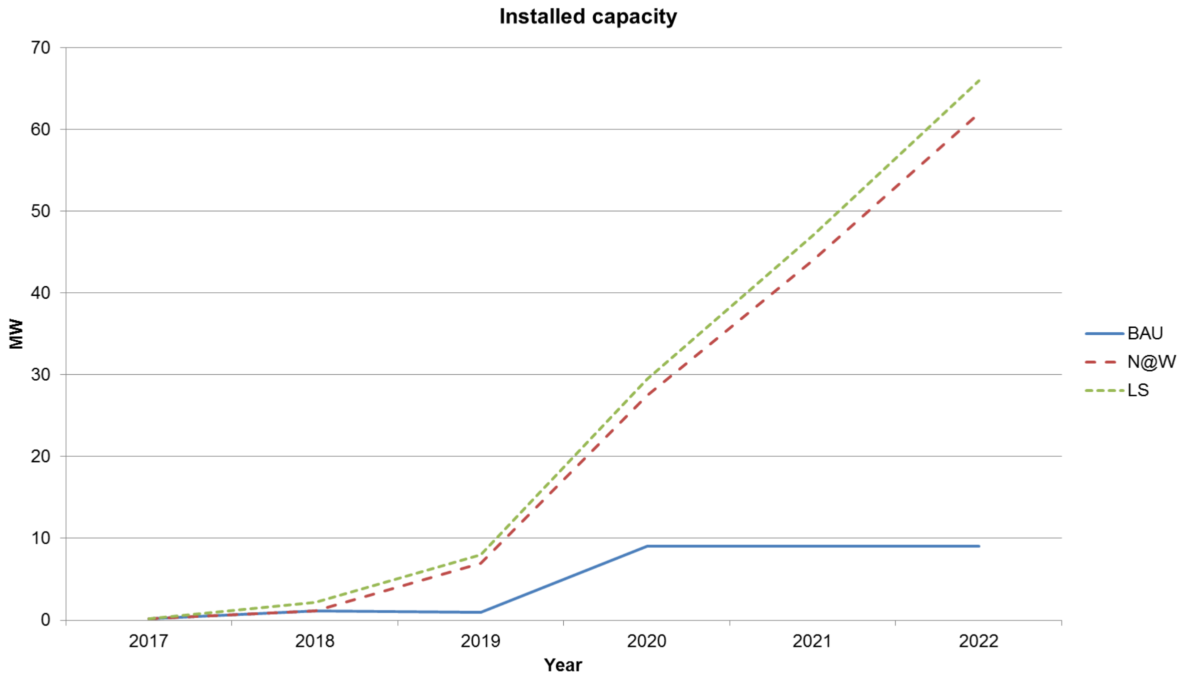


Figure 71: Installed wave and tidal capacity in the south west marine plan areas between 2017 and 2022 under three scenarios

Potential trade-offs

The main potential interactions for future wave and tidal development are likely to be:

- Natural environment (habitat loss/damage, mobile features, reduced greenhouse gas emissions)
- Recreation (changes to access)
- Commercial fishing
- Other infrastructure/extractive industries
- Shipping.

Within the south west marine plan areas, development is anticipated under all scenarios with the greatest levels of development under the LS scenario as a result of tidal lagoon development. The main potential trade-offs are likely to be with the natural environment and recreation. Negative trade-offs can be minimised through careful project design.

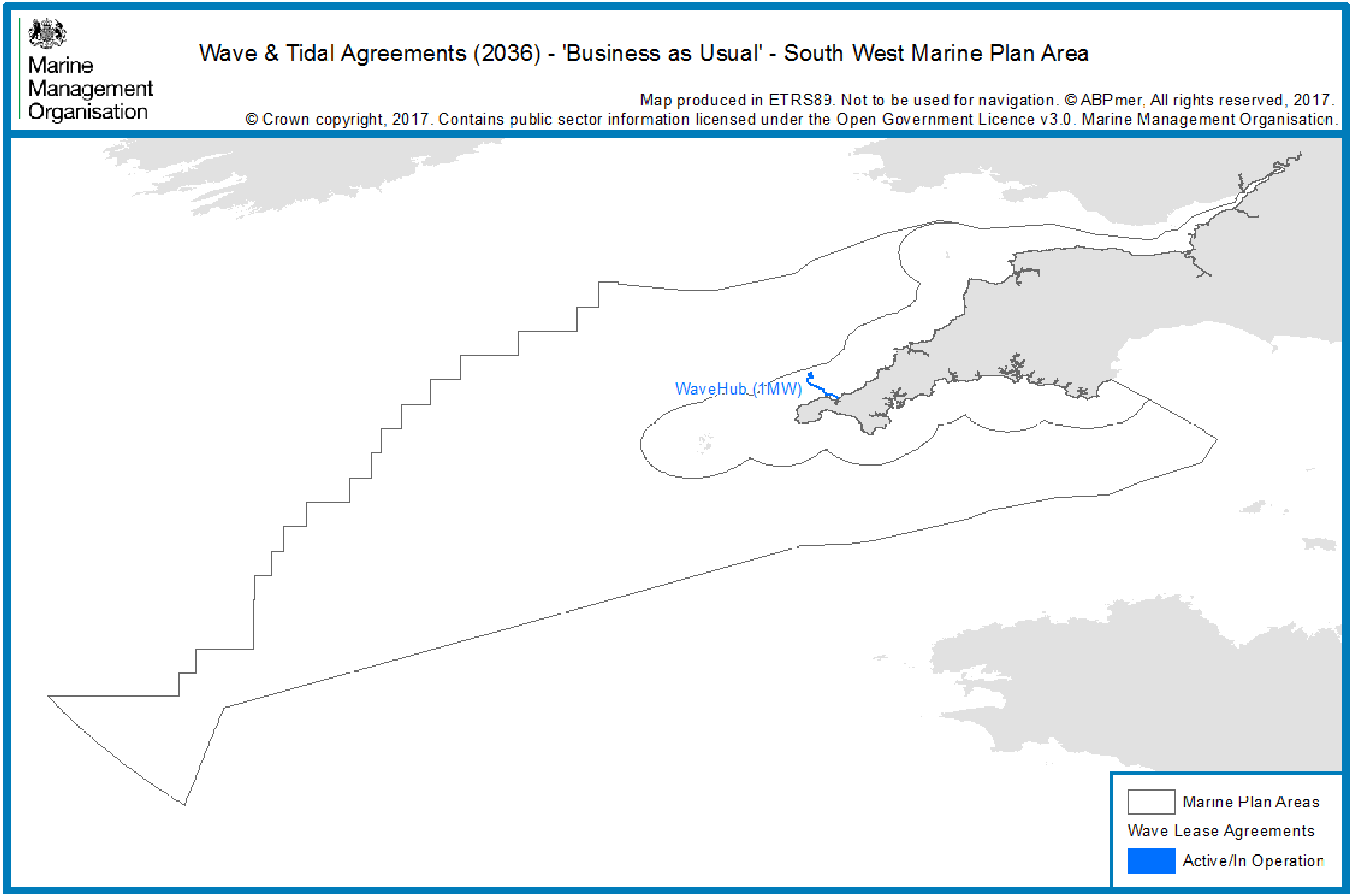


Figure 72: Wave and tidal agreements (2036) – BAU – south west marine plan areas

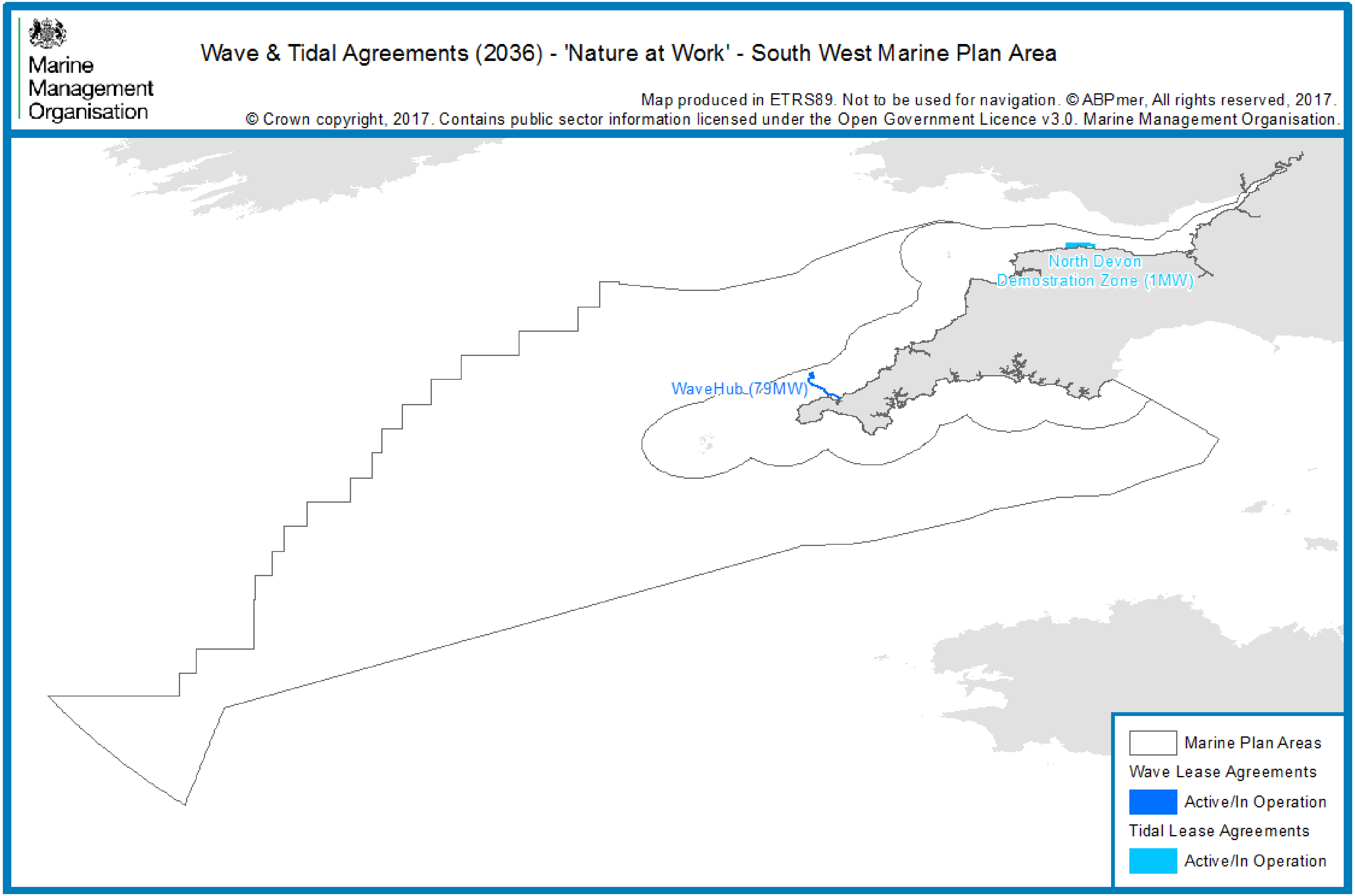


Figure 73: Wave and tidal agreements (2036) – N@W – south west marine plan areas

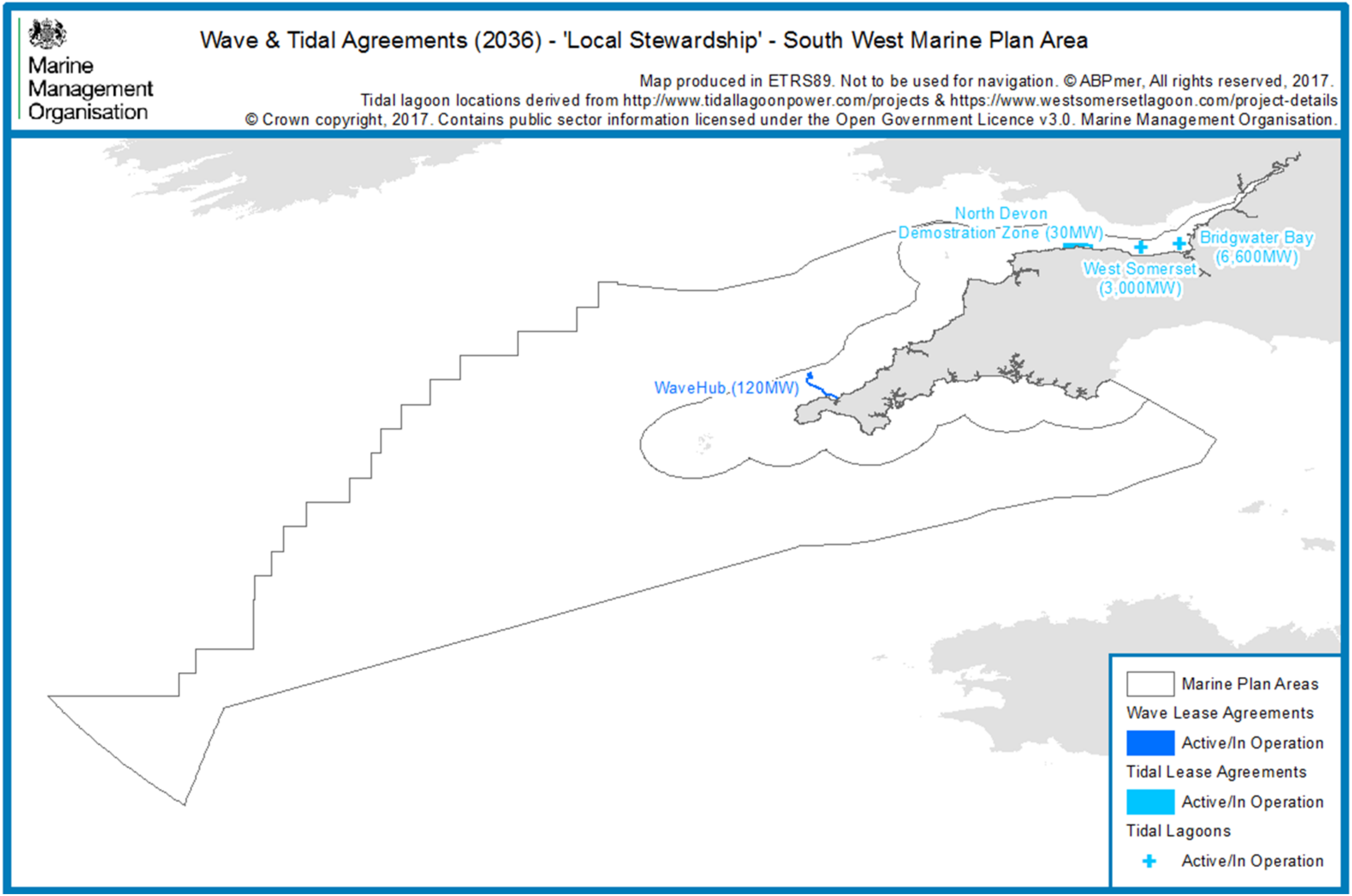


Figure 74: Wave and tidal agreements (2036) – LS – south west marine plan areas

10 Energy production: Wind energy

Sector definition

The wind energy sector is concerned with the generation of energy through harvesting the power of wind, in this context, in the offshore environment. Wind turbines are used to convert kinetic energy in the wind into electrical energy. To feed this energy into the National Grid, offshore wind farms have power export cables linking them to onshore grid connections.

Data sources

A variety of different information sources have been reviewed to inform this baseline, including published reports and papers and spatial data layers. The main information sources used are provided in the list below:

- Economic baseline assessment for the North East, North West, South East and South West Marine Plans (MMO, 2016a);
- Future Trends in the Celtic Seas (ABPmer, 2016);
- Marine Plan Areas Sustainability Appraisal (MMO, 2016b);
- Strategic Scoping Report for Marine Planning in England (MMO, 2013c);
- Crown Estate spatial leasing data (The Crown Estate, 2017[9]);
- 4C Offshore[10] website; and
- Renewable UK timelines.

10.1 National review

Overview of national activity

In the UK, wind power has been a key focus of the renewable energy effort, with a large amount of capacity being installed offshore and connected to onshore grid infrastructure via export cables. As a result, the UK has been at the forefront of in the offshore wind industry since 2008 (RenewableUK, n.d.[11]). The development of offshore wind farms is spatially restricted to areas with an appropriate water depth and plentiful resource. Consequently, offshore wind developments are not distributed evenly through the UK but tend to be concentrated in the east and north west marine plan areas (MMO, 2016b). Figure 75 provides the location of offshore wind developments in the north east, north west, south east and south west marine plan areas.

The current national capacity of offshore wind exceeds 5.1GW which accounts for approximately 5% of the annual national energy consumption. This power is generated from 29 operational farms. A further 4.5GW of capacity is currently under construction (The Crown Estate, 2017).

---

[9] https://www.thecrownestate.co.uk/energy-minerals-and-infrastructure/offshore-wind-energy /
[10] http://www.4coffshore.com/
[11] http://www.renewableuk.com/page/WindEnergy

Since the announcement of third consenting round for offshore wind in 2008, a number of developments have been scaled back or cancelled, reducing the potential capacity by 7.37GW from initial Round 3 plans. Numerous reasons for this have been cited including consenting issues, lack of subsidies and challenging seabed conditions (Pers. comms. F. Locatelli RenewableUK 27/03/17; WindPowerOffshore, 2014). This has resulted in 18 Round 3 developments being developed with a combined capacity of 19,486MW. Three of these projects, Hornsea Project One, East Anglia One (in the east marine plan areas) and Rampion (in the south marine plan areas) are currently under construction. These developments have a capacity of 1,218, 714 and 400MW respectively and are all estimated to be completed before 2022 (Dong energy, n.d.; E.ON, 2017; Scottish Power Renewables, 2017). Of the remaining 15 Round 3 developments, six are currently consented (a combined capacity of 6,704MW), eight are at the pre-application stage (combined capacity of 9,250MW) and one is in planning (1,200MW).

Review of historical trends

Offshore wind energy in the UK has been subject to three main rounds of leasing from The Crown Estate who own the rights to the majority of the UK seabed. The first leasing round was announced in 2000 and was aimed at demonstration scale projects of up to 30 turbines. Eighteen sites were awarded, totalling a combined potential capacity of 1.5GW. Round 2 (2003) was aimed at commercial scale projects within three strategic areas (the Greater Wash, the Thames Estuary and Liverpool Bay) previously identified in the ‘Future Offshore’ report (a framework document for offshore wind development in the UK). Round 2 resulted in 15 successful applications amounting to a total potential capacity of 7.2GW. Round 3 was announced in 2008 and aimed to install 25GW of offshore wind energy in the UK Renewable Energy Zones and the territorial waters of England and Wales (Barclay, 2012).

A further two leasing rounds have taken place. The first involved the geographic extension of development rights to four Round 1 and Round 2 sites. The second has involved leasing the seabed for demonstration projects aimed at testing new technologies, installation methods and supply chains (The Crown Estate, 2017).

All Round 1 sites taken forward have been built and are currently operational with a generating capacity of 1,062MW. Of a total of 14 Round 2 developments 11 of these are currently operational giving a combined capacity of 3,783MW. Two sites, Dudgeon (402MW) and Race Bank (573MW), both located in the east marine plan areas, are under construction and are due to be completed in 2017 (Dudgeon offshore, n.d.) and 2018 (Dong Energy, 2016) respectively. The final Round 2 site, Triton Knoll (750MW), also in the east marine plan areas, is fully consented; a start date for construction has not yet been released.

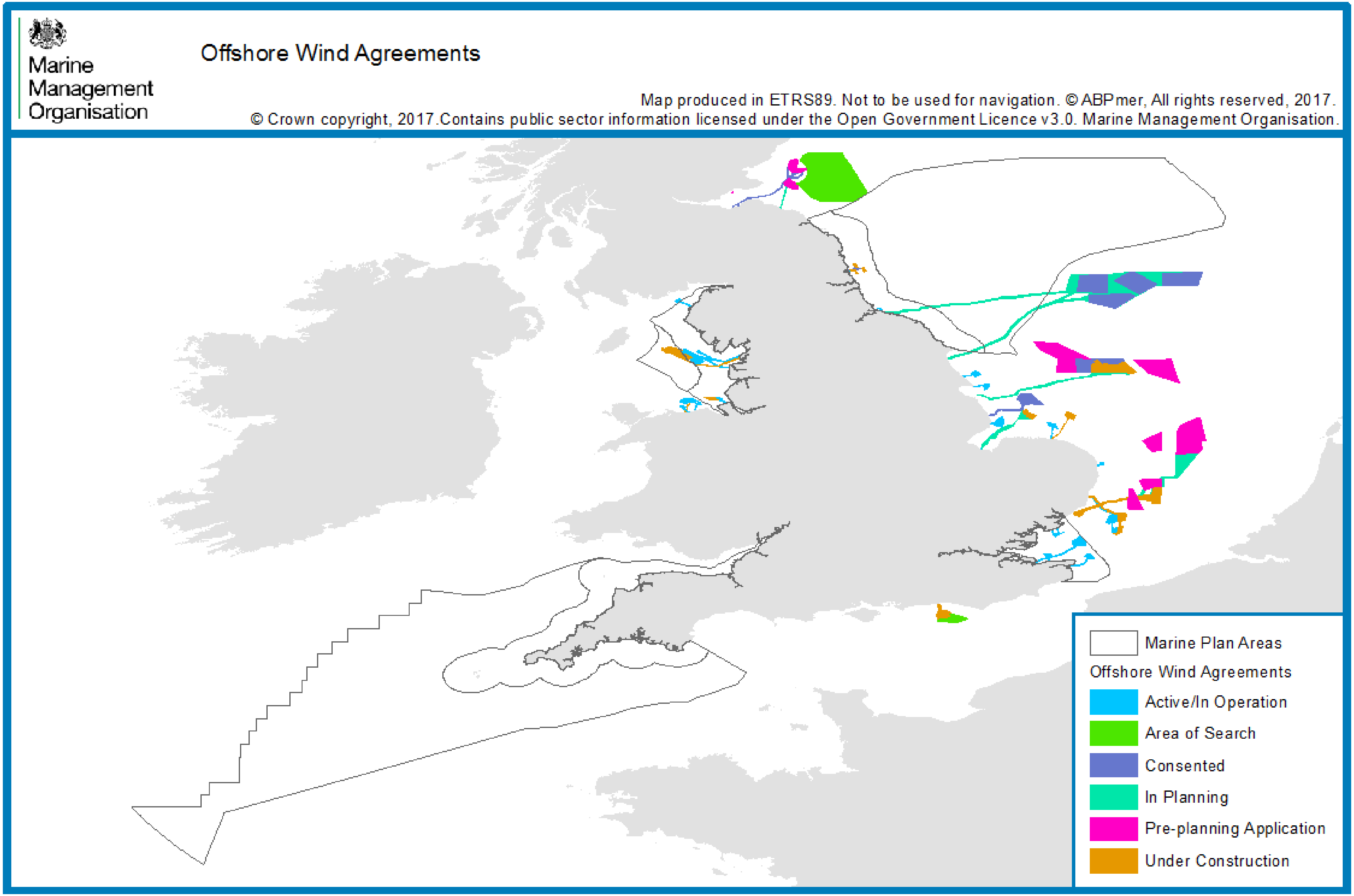


Figure 75: Offshore wind agreement

Review of key changes and/or advances of significance affecting the sector

The development of renewable energy is driven by international, European and national policy drivers and legal obligations as well as technological advances in harnessing the power of the wind.

Table 49 highlights the key policy drivers which will affect offshore wind development in the future. In particular, the EU Renewable Energy Directive commits the EU as a whole to generating 20% of total energy consumed by 2020 from renewable sources. Member States have individual targets to help meet this 20% overall target. As a result, the UK has a legally-binding target to generate 15% of all of its energy (including heat, electricity and transport) from renewable sources by 2020. Parallel to this, the Climate Change Act also sets a legally-binding target for reducing UK CO_2 emissions by at least 80% on 1990 levels by 2050. Other key Government policies on energy and climate change, include the UK Renewable Energy Strategy (2009) and the new Industrial Strategy (2017) are also key drivers for encouraging decarbonisation of energy production.

In addition to policy drivers, advances in technology will also affect the wind sector. It is predicted that new technology developments will make the harnessing of wind power more economically viable in the future. The development of new technologies and the subsequent reduction of costs will be highly dependent on the funding and level of investment that the industry receives. Additionally, the development of larger more efficient turbines is leading to higher outputs per km^2.

To boost investment in the renewable energy industry the UK Government implemented the Electricity Market Reform (EMR), under the Energy Act, in 2013 to make sure the UK remains a leading destination for investment in low-carbon electricity. The EMR superseded the Renewable Obligation Certificates (ROCs) and put in place measures to attract £110 billion investment needed to replace current generating capacity and upgrade the grid by 2020. One of the main elements of EMR is Contracts for Difference (CfDs) which are long-term contracts aimed at providing stable and predictable incentives for companies to invest in low-carbon generation. The CfD regime came into force in 2014. In 2015 DECC announced an increase to the budget for ‘pot 2 developments’ (less established technologies such as offshore wind, wave and tidal) of £25 million, meaning a total of £260 million will be made available for projects commissioning from 2017/18 onwards. Towards the end of 2016, the government announced the next round of CfD auctions would have a budget of £290 million across two delivery periods and outlined support for offshore wind, wave and tidal technologies. The £290 million round opened in April 2017 for projects to be delivered in either 2021/22 or 2022/23 (UK Government, 2016a).

Horizon 2020 Energy is a European funding stream aimed at research and innovation in the energy sector with a budget of around €6 billion for the period 2014 – 2020. The 2016 Calls for Proposals have a total budget of over €500 million, covering a range of technology areas including renewable energy technologies. The budget for Low Carbon energy technology development (including offshore wind developments) was set at €120 million with budgets per project ranging from €0.6 million to €10 million. Additional funding was aimed at Low Carbon energy technology demonstration (including offshore wind developments) with a total budget of €85 million, ranging from €3 to €10 million per project (UK Government, 2016b).

The Crown Estate is currently in its third round of leasing (see overview of national activity) Any future leasing round will determine where future wind farm developments are likely to be constructed. Large-scale offshore wind farms also rely on associated port infrastructure to construct, service and maintain the wind turbines. Therefore the development of future wind farm sites within the north east, north west, south east and south west could be linked to future port developments.

Table 49: Key drivers affecting development of the offshore wind sector

Driver	Details	Implications
Political	Closure of power stations – reduce reliance on fossil fuels	Demand for alternative sources of energy
	Reduce imports of energy	Increased investment in renewable technologies
	Government subsidies for energy produced	Incentive for developers
	Renewable energy developments require leasing of the seabed. Custodians of the seabed play 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
	Reduce imports of energy to increase energy security through securing a diverse energy mix	Increased investment in renewable technologies but also constrains the growth one particular sector
	Combatting energy poverty	Government favouring cheaper sources of energy, limiting the extent of support for more expensive forms of energy generation (e.g. offshore wind)
Economic	Availability of CfD	Increasing investment in offshore wind developments
	Cost of construction	This heavily influences the ultimate price of power from offshore wind
	Coal, oil and gas prices	Increasing oil price increases the attractiveness of renewable energy and may increase investment in the sector
Social	Increased population resulting in increased demand for energy.	Potential for greater investment in renewable technologies.
	Fisheries/shipping/recreation/ seascape	Constraints/ restriction on areas within which renewables can be developed.
	Public perception of suitable energy sources	Increased drive for renewable energy generation

Driver	Details	Implications
Technological	Developments in the technology used to generate clean energy and the infrastructure used to connect this 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. Expansion of renewable energy generation devices to offshore areas. Increased area in which renewable devices can be deployed (i.e. floating turbines)
	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.	The development of future renewable energy sites will be linked to growth in grid capacity.
	Development of an offshore supergrid	Promote transnational cooperation in the production of offshore wind energy and the distribution of generated power, especially between nations bordering the North Sea.
Legal	EU Renewable Energy Directive (2009/28/EC) and associated targets: • UK - 15% of all of its energy from renewable sources by 2020	Increased investment in renewable technologies
	The Climate Change Act commits the UK to a legally-binding target for reducing CO_2 emissions by at least 80% on 1990 levels by 2050.	Increased investment in renewable technologies
Environmental	Assessments of proposed developments against a wide range of environmental receptors, increased survey/monitoring effort	Increased costs for developers
	Designation of additional MPAs	Potential constraints/ restriction on areas within which renewable devices can be developed
	Concerns over the preservation of countryside environments	Favours the development of offshore wind energy

Review of future trends

The increase in global energy demand is expected to continue and this will be met from a combination of production sources. Demand for electricity is also likely to increase with increasing use of electric vehicles. In the long term, increased investment in wind technologies will ultimately result in a reduction in the cost of offshore wind power generation through improvements in operational and construction efficiency. Technological development may also allow for the expansion of offshore wind developments into sites previously considered unsuitable.

In small, localised areas, wind farms have little interaction with other sectors as they are located to minimise impacts with, for example, the fishing and shipping sectors. However, as the number and size of offshore windfarm sites grows there is the potential for increased interaction with other users of the sea including seascape, recreation and tourism. Conversely, these windfarm sites provide opportunities for co-existence, for example with aquaculture, and may provide benefits to biodiversity, through the restriction of areas in which mobile towed fishing gears can operate.

The future rate of expansion in the offshore wind industry varies under the different scenarios. The most growth occurs under N@W where cost reductions and technology efficiencies are achieved to allow development within previously disregarded sites. BAU results in the least growth, owing to climate change and reductions in CO_2 emissions not being considered a policy priority. LS falls in between these two scenarios, with local decisions resulting in smaller, local offshore windfarm sites being developed to provide jobs and energy security for local communities.

Confidence assessment

As a result of the distribution of wind resources and environmental conditions, some areas have more scope for offshore wind activity than others. The operating life of wind farms that are currently in existence is uncertain, as is future investment and leasing rounds which also affect technology development. The confidence in the trajectory of future development of this sector is therefore considered to be low.

10.2 North east

The north east marine plan areas currently possess one operational offshore wind farm. The Teesside development formed part of the Round 1 developments with a capacity of 62MW (see Table 50). Currently, the export cable serving the Teeside development is the only operational export cable contained wholly within the north east marine plan areas The Creyke cable passes through the north east marine plan areas but serves a wind farm outwith the north east marine plan area.

Two further demonstration developments are planned in the region, both of which are offshore of Blyth and are aimed at testing foundation technologies. Construction of one of these, Blyth Demo (Array 2), is currently underway. This development will consist of 5 turbines with an overall capacity of 42MW. The Blyth Demo (Array 3A and 4) is larger, consented for 58MW and made up of 10 turbines. Construction of this site will only begin once the build out and commissioning of the Blyth Demo (Array 2) is complete. To support the Blyth demonstration development two export cables have been consented, one of which is currently under construction. A further four export cables that would run through the north east marine plan areas connecting the Dogger Bank development to the onshore grid infrastructure are currently in planning. Two of these, Z3 Teeside A Offshore Transmission (OFTO) and Z3 Teeside B OFTO, make landfall within the north east marine plan areas while the other two just pass through, making landfall in the east marine plan areas.

Economic activity in the north east connected to offshore wind is concentrated on ports. There are a number of key economic assets including Siemen’s offshore training centre, enterprise zones at the Port of Blyth, Port of Tyne and Teesport, and industry groups and universities supporting the development of the north east’s renewables industry. Transport for the North reports that firms in the renewables industry are making £150 million worth of investment in the marine and offshore sector in the north east, which contributes to the Northern Powerhouse agenda (MMO, 2016a; Transport for the North, 2017).

Table 50: Offshore wind developments in the north east marine plan areas

Windfarm Name	Development Round	Status	Project Capacity (MW)	Number of turbines	Lifespan (years)
Teesside	1	Active/In Operation	62	27	20 (assumed)
Blyth	1	Decommissioned	4	2	-
Blyth Demo (Array 3A and 4)	Demo	Consented	58	10	20 (assumed)
Blyth Demo (Array 2)	Demo	Under Construction	42	5	22

Table 51: Export cables serving offshore wind developments in the north east marine plan areas

Cable Name	Status
Teesside	Active/In Operation
Blyth	Present but not active
Z3 Teesside A OFTO	In Planning
Z3 Creyke Beck A OFTO	In Planning
Z3 Creyke Beck B OFTO	In Planning
Z3 Teesside B OFTO	In Planning
Blyth Demo	Consented
Blyth Demo Phase 1	Under Construction

The assumptions used to develop the BAU, N@W and LS scenarios for wind energy in the north east marine plan areas are provided in Table 52. Projected installed capacity under each of the three scenarios is shown in Table 73. Figure 77, Figure 78, and Figure 79 show the spatial application of the scenarios to the sector while the text below provides a brief description of the future trends in 6 years and 6 to 20 years.

Table 52: Assumptions and impacts under the future scenarios for wind energy in the north east marine plan areas

Aspect	Scenario		
	Business as Usual	**Nature @ Work**	**Local Stewardship**
Application to the sector	All operational wind developments continue to operate to the end of their life and those currently under construction come online. Some of the larger developments are repowered like for like (i.e. with the same amount of capacity)and continue to operate. No further developments, such as those currently in planning, progress through to the operational stage.	Climate change mitigation becomes a stronger policy priority, leading to increased development of renewable energy sources, covering an increasingly large proportion of energy generation. Cost reduction of development of offshore wind energy is achieved, making previously uneconomic projects viable. All sites in any stage of planning are developed, as are those that have previously been abandoned (i.e. abandoned Round 3 sites). As some sites previously considered unsuitable become accessible with the development of floating technologies. It is assumed that a fourth licencing round will take place, resulting in additional capacity being added in some locations. Some of this capacity will be made up of floating technologies.	Local decisions (made by local partnerships or city regions) about renewables mean that more, smaller, local sites are developed to promote jobs in construction at local ports and provide energy sources for local communities. Alternative forms of community-based renewable energy sources are also promoted. This scenario generates more power from offshore wind than BAU, but generates less than N@W. Some of the capacity added under this scenario will be made up of floating technologies.
Assumptions	All operational sites included in this scenario. These are: ▪ Teesside; and ▪ Blyth Demo (Array 2). The Teeside development is repowered in 2023 and continues to operate at the same capacity. Blyth Demo (Array 2) will continue to operate throughout the remained of the time period.	Developments present in BAU are operational as well as the Blyth Demo (Array 3A and 4). Plans to redevelop the original Blyth site are carried out, resulting in a 40MW development. A large Round 4 site is also assumed to be developed off the coast of Teesside, with a total capacity of 400MW which is installed over two years.	The same developments occur as N@W, with the exception of the large Round 4 development which does not occur under this scenario. Instead, two smaller 100MW developments are built which aim to help meet local energy demand in the absence of other renewable or nuclear power generation.

Aspect	Scenario		
	Business as Usual	Nature @ Work	Local Stewardship
	Maximum capacity under this scenario is 104MW	Operational sites under this scenario are: ▪ Teesside; ▪ Blyth; ▪ Blyth Demo (Array 3A and 4); ▪ Blyth Demo (Array 2); and ▪ Round 4 Teesside. The original Teesside development is the only array to reach the end of its original operational life between 2017 and 2036. Under this scenario, the development is repowered to its previous capacity. Maximum capacity under this scenario is 602MW.	Operational sites under this scenario are: ▪ Teesside; ▪ Blyth; ▪ Blyth Demo (Array 3A and 4); ▪ Blyth Demo (Array 2); ▪ Small Round 4 development 1; and ▪ Small Round 4 development 2. The original Teesside development is the only array to reach the end of its original operational life between 2017 and 2036. Under this scenario, the development is repowered to its previous capacity as no other significant source of renewable energy is present in the region. Maximum capacity under this scenario is 402MW.

6-year projection

In 2017 all scenarios begin at 62MW as a result of the operational Teesside development. Installed capacity increases to 103MW in 2018 as a result of the Blyth Demo (Array 2) coming online. Under BAU, installed capacity remains at this level until 2022. Under N@W and LS, capacity increases further in 2020 as a new development at Blyth comes online at the same time as the Blyth Demo (Array 3A and 4) begins operation. Capacity reaches 202MW in 2020 and remains at this level to 2022.

6 to 20 year projection

No additional offshore wind developments occur in the north east marine plan areas under BAU. However, the Teesside development is repowered in 2023 to maintain capacity at 104MW throughout the remaining time period.

Additional developments occur under the N@W and LS scenarios. Under N@W, a large 400MW Round 4 development is built, with half capacity reached in 2023 and full capacity reached in 2024. A maximum capacity of 602MW is therefore achieved in 2024 and maintained for the remainder of the time period. Under LS, additional capacity is also added in 2023 due to Round 4 developments. This scenario promotes smaller, local developments. The new developments therefore consist of two 100MW offshore wind farms, both of which come online in 2023. Maximum capacity of 402MW is achieved in 2023 and maintained for the remainder of the time period under LS.

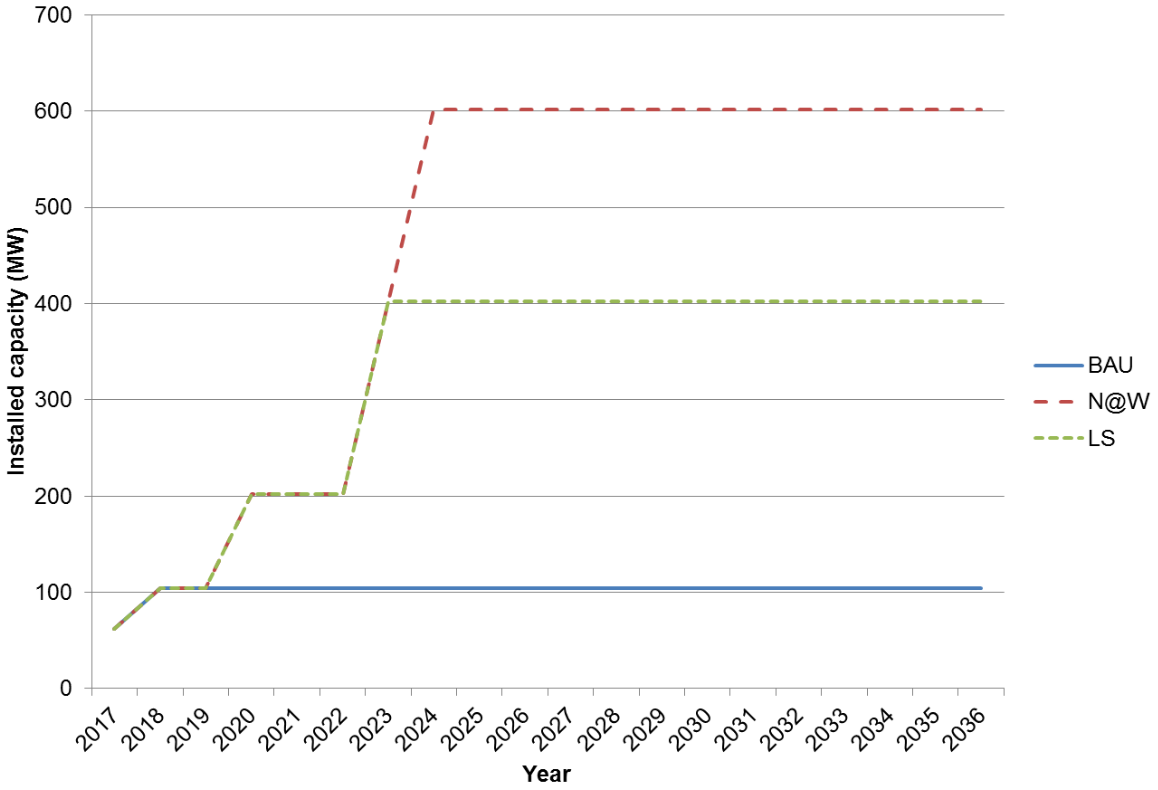


Figure 76: Installed capacity in the north east marine plan areas between 2017 and 2036 under three scenarios

Potential trade-offs

The main potential interactions for future offshore wind development are likely to be:

- Natural environment (habitat loss/damage, mobile features, reduced greenhouse gas emissions)
- Recreation (changes to access)
- Commercial fisheries
- Other infrastructure/extractive industries
- Shipping.

Within the north east marine plan areas, greater levels of development are anticipated under the N@W and LS scenarios. The main potential trade-offs are likely to be with the natural environment, recreation and commercial shipping. Negative trade-offs can be minimised through careful project design.

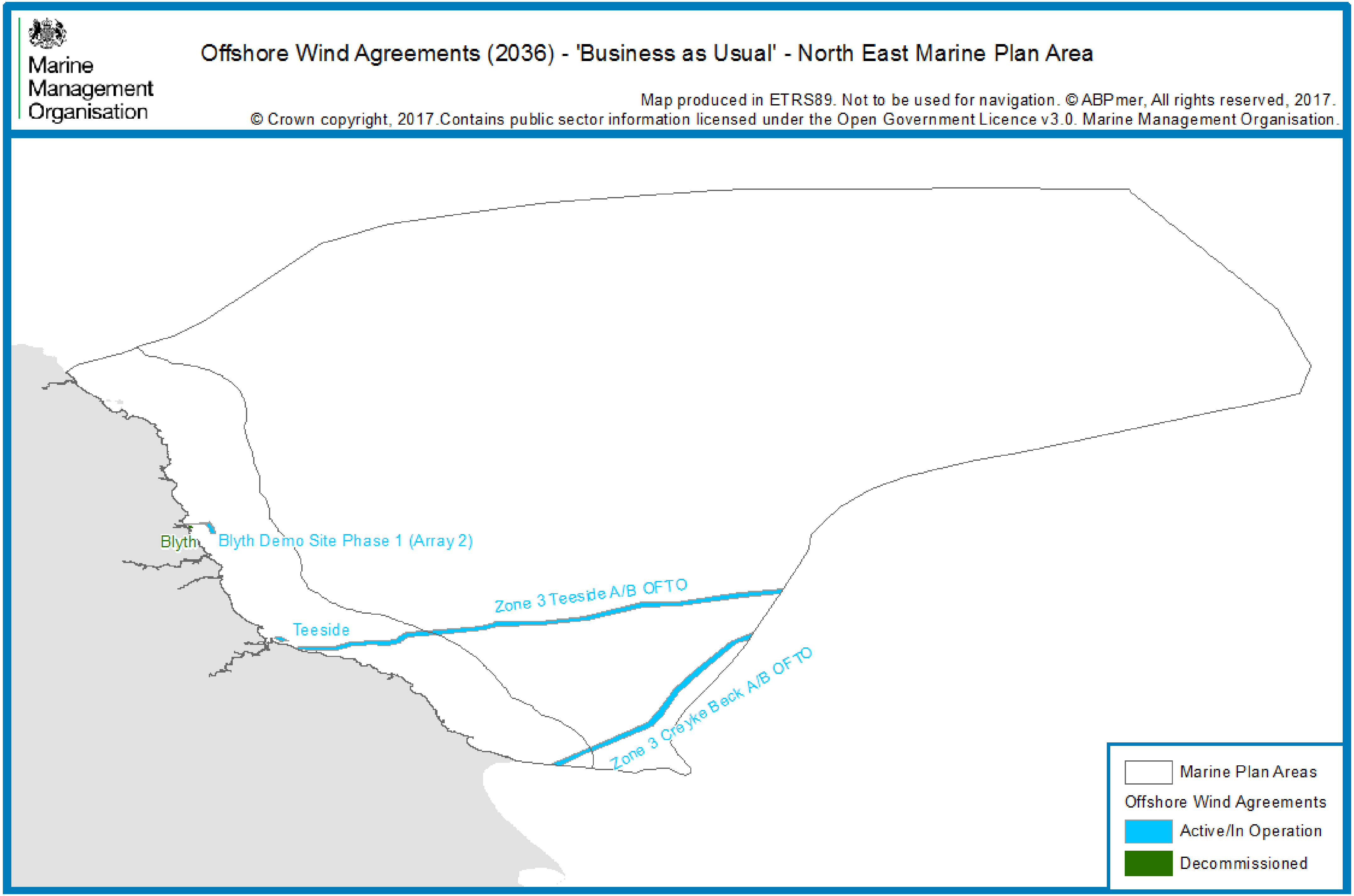


Figure 77: Offshore wind agreements (2036) - BAU – north east marine plan areas

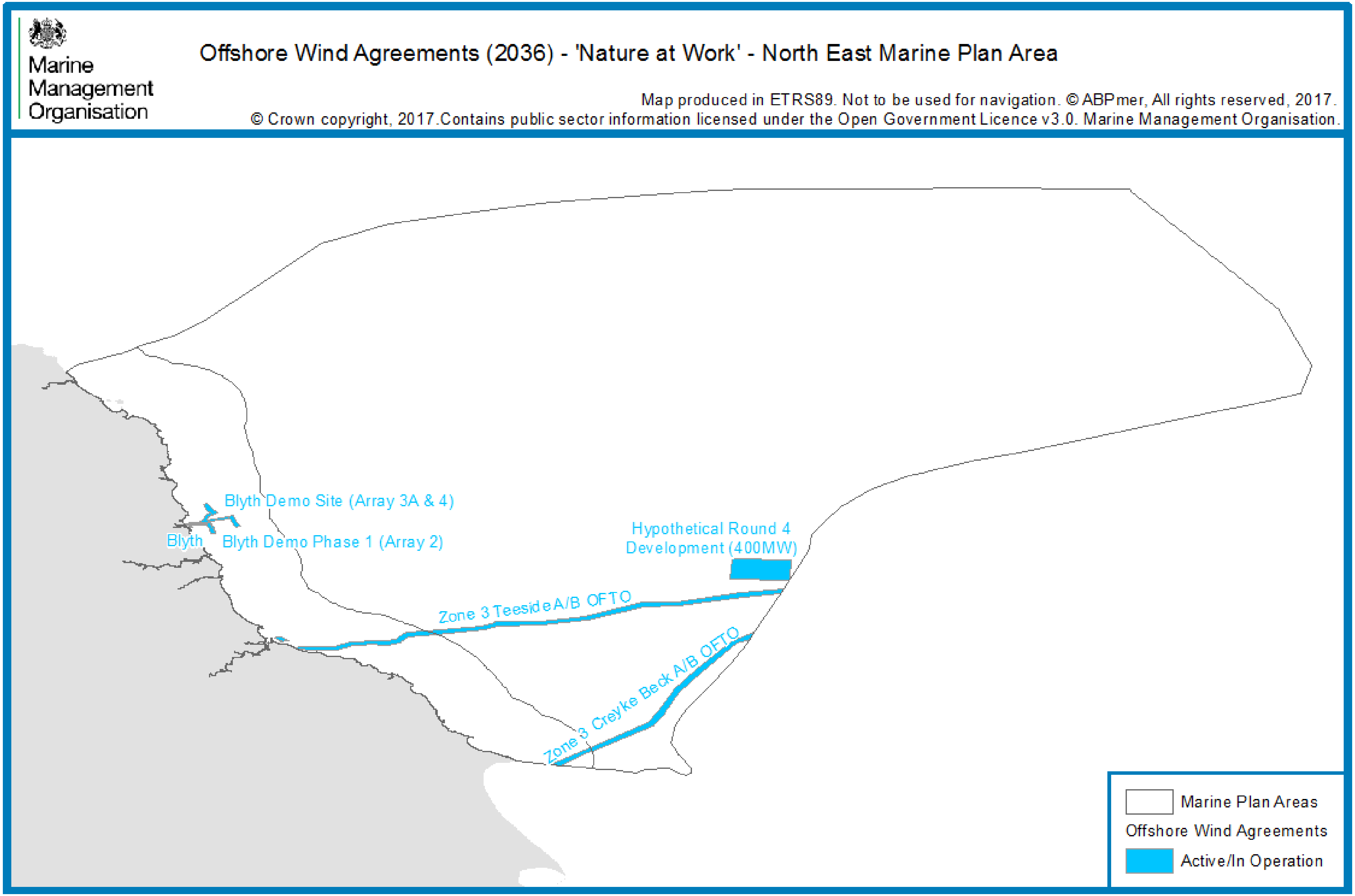


Figure 78: Offshore wind agreements (2036) – N@W - north east marine plan areas

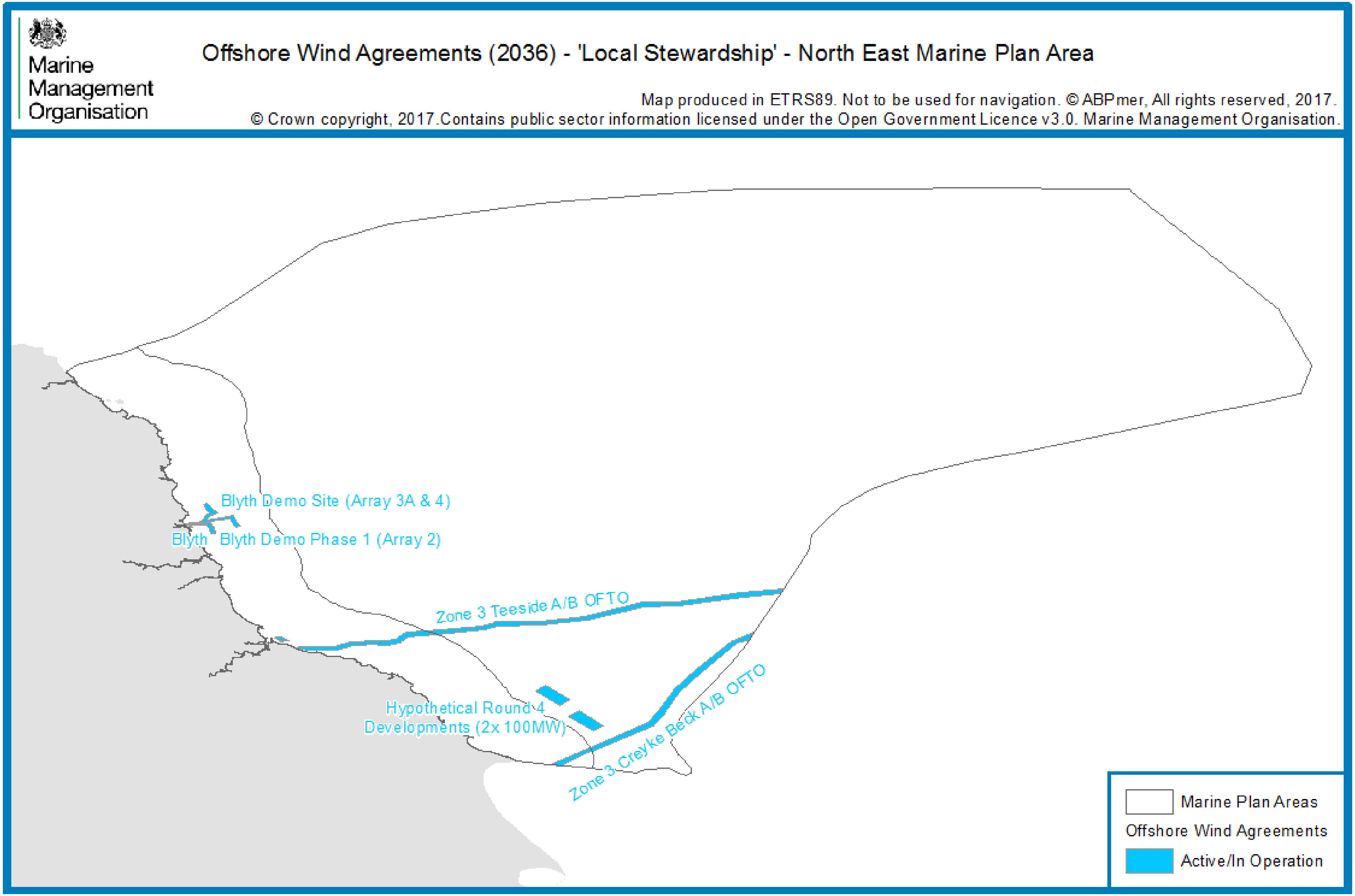


Figure 79: Offshore wind agreements (2036) - LS – north east marine plan areas

10.3 North west

The north west marine plan area currently supports six operational offshore wind farms, three Round 1 developments and three Round 2 developments. These developments have a combined capacity of 1,087MW which is generated from 295 turbines (see Table 53). Each of these wind farms is connected to the onshore grid infrastructure via its own export cable.

Table 53: Offshore wind developments in the north west marine plan areas

Windfarm Name	Development Round	Status	Project Capacity (MW)	Number of turbines	Lifespan (years)
Walney 1	2	Active/In Operation	184	51	20
Walney 2	2	Active/In Operation	184	51	25
West of Duddon Sands	2	Active/In Operation	389	108	20 (assumed)
Barrow	1	Active/In Operation	90	30	20
Ormonde	1	Active/In Operation	150	30	25
Burbo Bank	1	Active/In Operation	90	25	20
Burbo Bank Extension	Extension	Under Construction	254	25	20
Walney Extension (3 and 4)	Extension	Under Construction	659	87	25

An additional two developments are currently under construction (Burbo Bank Extension and Walney Extension (3 and 4)). These new developments are larger than those currently in operation in the marine plan areas, with capacities of 254 and 659 MW respectively (combined capacity of 913MW). Burbo Bank Extension is due to be completed in 2017 (Burbo Bank Extension, n.d.) while Walney Extension has an estimated completion date of late 2019 (Walney Extension, n.d.). Once completed, the overall capacity of the north west marine plan areas will be 2000 MW. The Burbo Bank Extension export cable is in place and classed as active/operational. The Walney Extension export cable is currently under construction, therefore the north west marine plan areas contain seven active/operating export cables and one export cable that is being constructed.

In the north west, economic activity connected to the renewables industry is concentrated around the ports. There are a number of key economic assets in the north west related to the renewables industry, including enterprise zones and business assets such as Cammell Laird's shipyard, the Port of Liverpool, Port Wirral, Port Ince, the 3MG/Stobart facility at Halton and the Former Bridgewater Paper Mill at Ellesmere Port (MMO, 2016a). Ports at Barrow and Heysham also provide important operational and maintenance facilities for wind farms in the north west marine plan areas.

Table 54: Export cables serving offshore wind developments in the north west marine plan areas

Cable Name	Status
Robin Rigg OFTO	Active/In Operation
Walney 2 OFTO	Active/In Operation
Walney 1 OFTO	Active/In Operation
Barrow OFTO	Active/In Operation
West of Duddon Sands OFTO	Active/In Operation
Burbo Bank Extension OFTO	Active/In Operation
Ormonde OFTO	Active/In Operation
Walney Extension OFTO	Under Construction

The assumptions used to develop the BAU, N@W and LS scenarios for wind energy in the north west marine plan areas are provided in Table 55. Projected installed capacity under each of the three scenarios is shown in Figure 80. Figure 81, Figure 82 and Figure 83 show the spatial application of the scenarios to the sector while the text below provides a brief description of the future trends in 6 years and 6 to 20 years.

Table 55: Assumptions and impacts under the future scenarios for wind energy in the north west marine plan areas

Aspect	Scenario		
	Business as Usual	**Nature @ Work**	**Local Stewardship**
Application to the sector	As for the north east marine plan areas (see Table 52).	As for the north east marine plan areas (see Table 52).	As for the north east marine plan areas (see Table 52) however tidal range developments will be favoured over wind therefore this scenario results in two relatively large wind developments not being repowered. By 2036, this scenario therefore results in the lowest amount of wind capacity.

Aspect	Scenario		
	Business as Usual	**Nature @ Work**	**Local Stewardship**
Assumptions	All operational sites included in this scenario. These are: ▪ Walney 1; ▪ Walney 2; ▪ West of Duddon Sands; ▪ Barrow; ▪ Ormonde; ▪ Burbo Bank; and ▪ Burbo Bank Extension. The lifetime of some of these developments end before 2036. Decommissioning dates are: ▪ Walney 1: 2031; ▪ West of Duddon Sands: 2034; ▪ Barrow: 2026; ▪ Ormonde: 2036; and ▪ Burbo Bank: 2027. However, it is assumed that the larger developments are repowered. Small developments are not assumed to be repowered, therefore Barrow ceases generation in 2026. Maximum capacity under this scenario is 2,000 but reduces to 1,910 in 2026	All developments in BAU take place as well as planned and previously abandoned schemes. Developments operating under this scenario are: ▪ Walney 1; ▪ Walney 2; ▪ West of Duddon Sands; ▪ Barrow; ▪ Ormonde; ▪ Burbo Bank; ▪ Burbo Bank Extension; ▪ Walney Extension (3 and 4); and ▪ Zone 9 Celtic Array. Under this scenario, all developments reaching the end of their lives are repowered to the same capacity. Maximum capacity under this scenario is 3,000MW	All developments present in BAU are operational and those developments in the planning system move into the operational phase. Active developments under this scenario are: ▪ Walney 1; ▪ Walney 2; ▪ West of Duddon Sands; ▪ Barrow; ▪ Ormonde; ▪ Burbo Bank; ▪ Burbo Bank Extension; and ▪ Walney Extension (3 and 4). Smaller developments are repowered when they reach the end of their operational lives. Large developments however are not repowered. Walney 1 and West of Duddon Sands cease operation in 2031 and 3034 respectively due to local preference of smaller schemes and tidal range developments. Maximum capacity under this scenario is 2,000MW

6-year projection

In 2017 all scenarios begin at 1,341MW. Walney Extension (3 and 4) begins generating power in 2019, adding an additional 659MW of capacity under all scenarios. All scenarios therefore reach 2,000MW in 2019 and remain at this level until 2022.

6 to 20 year projection

Under BAU, no additional capacity is added in the north west marine plan areas. Five of the operational developments reach the end of their current operating life between 2023 and 2036. All of these are assumed to be repowered apart from the smallest development, Barrow, which permanently ceases operation as larger developments are favoured. BAU capacity therefore decreases from 2,000MW in 2025 to 1,910MW in 2026 where it remains through until 2036.

Under N@W, the large Zone 9 Celtic Array begins operation in 2028 and reaches full capacity in 2029. N@W capacity therefore increases from 2,000MW in 2027 to 3,000MW in 2029 and is maintained at this level for the reminder of the time period as developments reaching the end of their operational life are all repowered to their previous capacity.

LS in the north west marine plan areas does not see any additional capacity installed between 2023 and 2036, but instead results in two relatively large developments, Walney 1 and West of Duddon Sands, permanently ceasing generation in 2031 and 2034 respectively. This is a result of tidal range power being preferred in the region due to its potential for multiple benefits (including flood protection, aquaculture and tourism/recreation). Smaller developments, including Barrow, are repowered to their previous capacity once they reach the end of their original operational life. Consequently, installed capacity under LS in 2036 is 1,427MW, a value lower than that of the BAU and N@W scenarios.

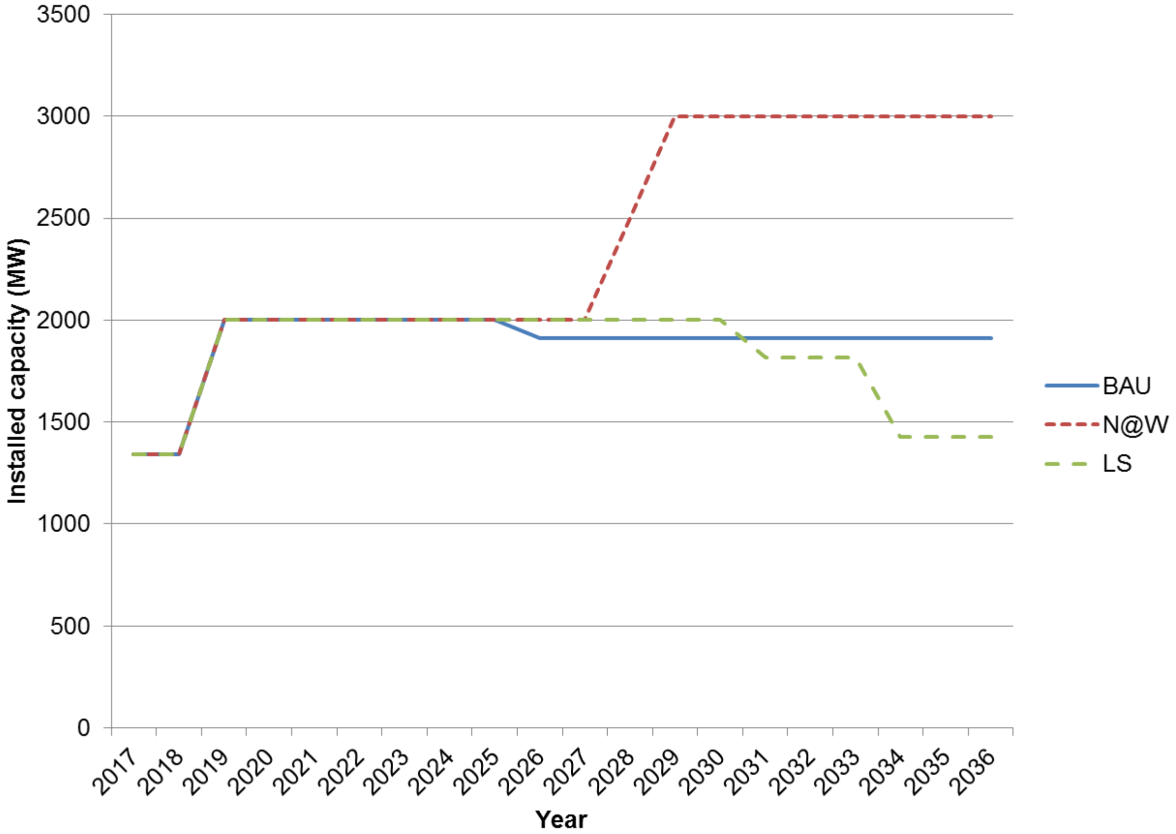


Figure 80: Installed capacity in the north west marine plan areas between 2017 and 2036 under three scenarios

Potential trade-offs

The potential trade-offs are similar to the north east marine plan areas although higher levels of development are only projected under the N@W scenario. .

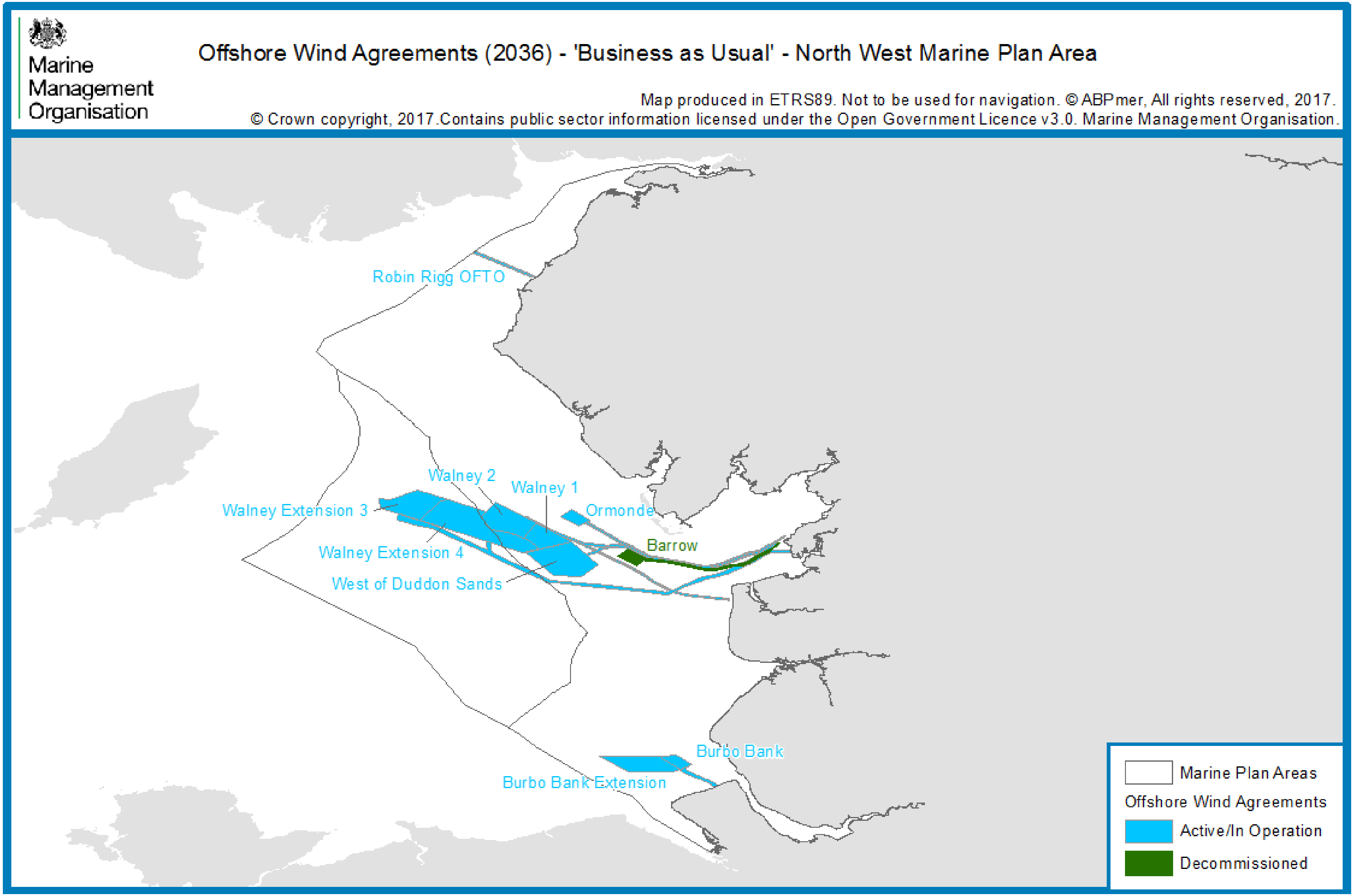


Figure 81: Offshore wind agreements (2036) – BAU - north west marine plan areas

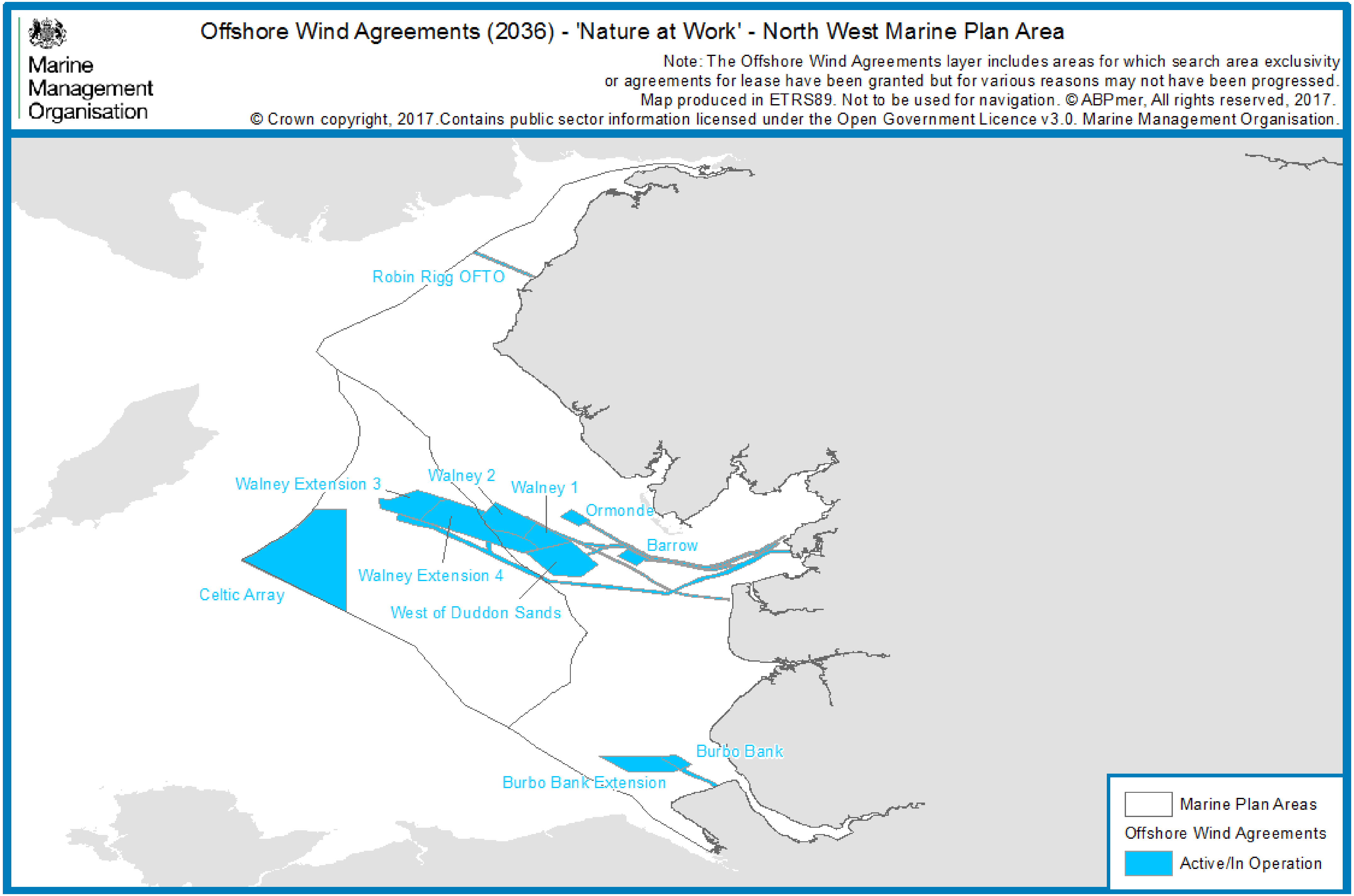


Figure 82: Offshore wind agreements (2036) – N@W - north west marine plan areas

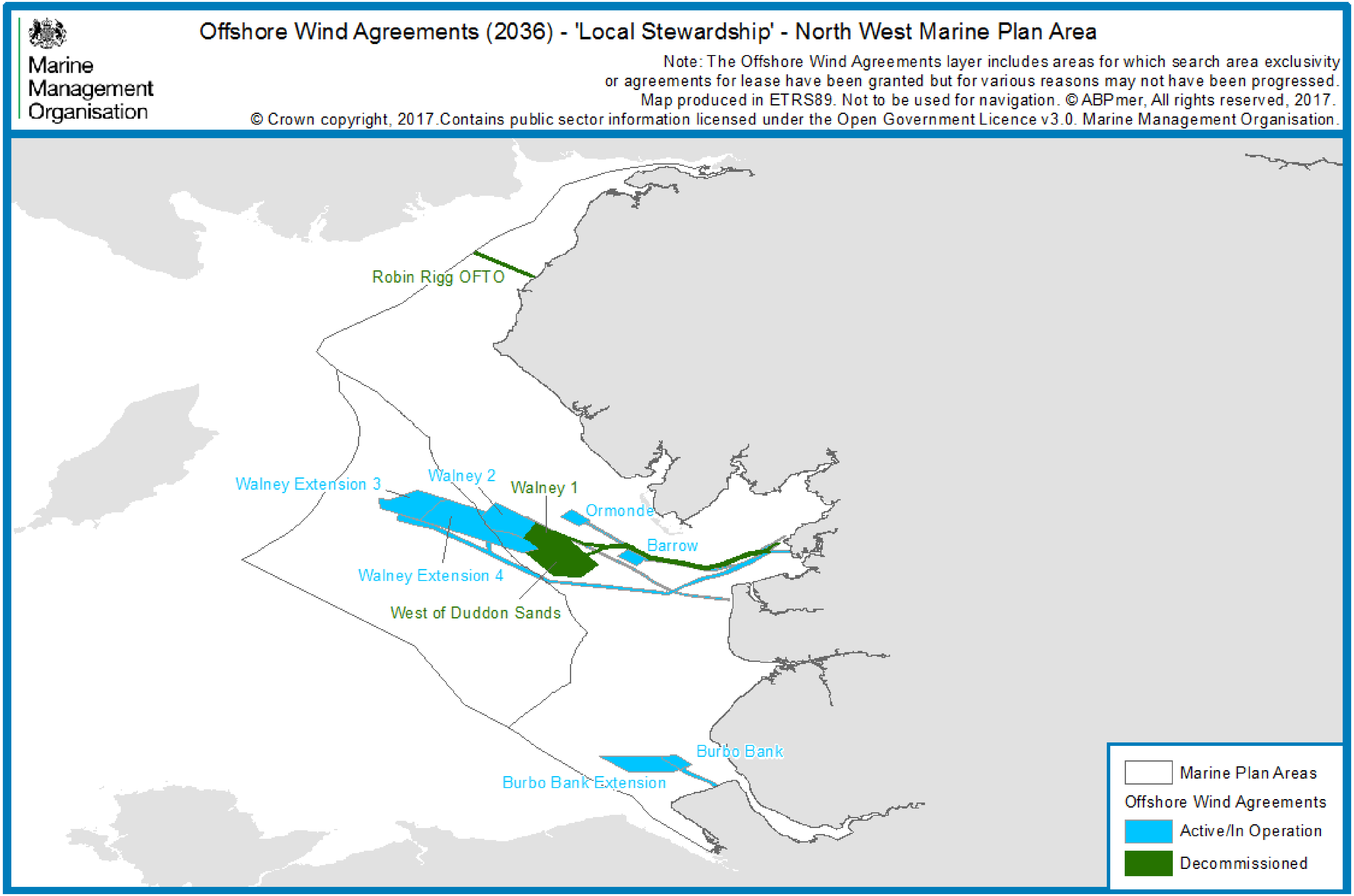


Figure 83: Offshore wind agreements (2036) – LS - north west marine plan areas

10.4 South east

Offshore wind is the focus of renewable energy activity in the south east marine plan area. Central to this is the south east Centre for Renewable Offshore Engineering (CORE), one of the six areas in England designated by Government as most suitable to meet the needs of the offshore renewable energy industry. This region has been identified as such due to shallow waters and strong wind resources, local strengths in infrastructure and port logistics, local supply chains, land availability, offshore access and skilled workforces (MMO, 2016a). The south east CORE covers the Thames Estuary and extends from Ramsgate to Harwich and Brightlingsea.

Seven offshore wind farms are currently operational in the south east marine plan area, giving a combined capacity of 1,254MW from 370 turbines (see Table 56). Electricity from these developments is transferred into the onshore grid infrastructure via five export cables. Each wind farm possesses its own export cable, with the exception of Kentish Flats 1 and 2 which share the same export cable and Gunfleet Sands 1, 2 and Demo. There are no further developments under construction in this marine plan area. However, an extension to the current Thanet development is in the early stages of planning.

Port infrastructure in Kent and Essex provides services for many of the developments in the south east marine plan area (MMO, 2016a; Kent Partnership, 2017). In particular, ports such as Ramsgate, Harwich Navyard, Brightlingsea and Whitstable have become important centres for operation and maintenance bases and related services, and further locations like Sittingbourne (the Swales Skills Centre for engineering and renewable technologies training) and Medway are the home to supply chain businesses, R&D and training facilities (MMO, 2016a).

Table 56: Offshore wind developments in the south east marine plan area

Windfarm Name	Development Round	Status	Project Capacity (MW)	Number of turbines	Lifespan (years)
Gunfleet Sands 1 and 2	1 and 2	Active/ In Operation	172	48	25
Gunfleet Sands Demo	Demo	Active/ In Operation	12	2	-
Kentish Flats 1	1	Active/ In Operation	90	30	20
Kentish Flats 2	Extension	Active/ In Operation	50	15	20
London Array	2	Active/ In Operation	630	175	-
Thanet	2	Active/ In Operation	300	100	40
Thanet extension	2.5	In planning	340	34	N/A

Table 57: Export cables serving offshore wind developments in the south east marine plan area

Cable Name	Status
Gunfleet Sands OFTO	Active/In Operation
London Array OFTO	Active/In Operation
Kentish Flats 1	Active/In Operation
Thanet	Active/In Operation
Gunfleet Sands Demo	Active/In Operation

The assumptions used to develop the BAU, N@W and LS scenarios for wind energy in the south east marine plan area are provided in Table 58. Projected installed capacity under each of the three scenarios is shown in Figure 84. Figure 85, Figure 86, and Figure 87 shows the spatial application of the scenarios to the sector while the text below provides a brief description of the future trends in 6 years and 6 to 20 years.

Table 58: Assumptions and impacts under the future scenarios for wind energy in the south east marine plan area

Aspect	Scenario		
	Business as Usual	**Nature @ Work**	**Local Stewardship**
Application to the sector	As for the north east marine plan areas (see Table 52).	As for the north east marine plan areas (see Table 52).	As for the north east marine plan areas (see Table 52).
Assumptions	All operational and developments under construction are included in this scenario. These are: ▪ Gunfleet Sands 1 and 2; ▪ Gunfleet Sands Demo; ▪ Kentish Flats 1; ▪ Kentish Flats 2; ▪ London Array; and ▪ Thanet. A number of these sites will reach the end of their current operational life by 2036. Decommissioning dates are: ▪ Gunfleet Sands 1 and 2: 2036; ▪ Gunfleet Sands Demo: 2032; ▪ Kentish Flats 1: 2025; ▪ Kentish Flats 2: 2036; and ▪ London Array: 2033. However, it is assumed that the majority of these	All developments in BAU take place as well as planned and previously abandoned schemes. These are: ▪ Gunfleet Sands 1 and 2; ▪ Gunfleet Sands Demo; ▪ Kentish Flats 1; ▪ Kentish Flats 2; ▪ London Array; ▪ London Array Extension; ▪ Thanet; and ▪ Thanet extension. Maximum capacity under this scenario is 1,748MW.	All developments present in BAU are operational and those developments in the planning system move into the operational phase. Active developments under this scenario are: ▪ Gunfleet Sands 1 and 2; ▪ Gunfleet Sands Demo; ▪ Kentish Flats 1; ▪ Kentish Flats 2; ▪ London Array; ▪ Thanet; and ▪ Thanet extension. Given the lack of alternative renewable sources of power, all developments are repowered when they come to the end of their currently operational life. Maximum capacity under this scenario is 1,508MW.

Aspect	Scenario		
	Business as Usual	Nature @ Work	Local Stewardship
	sites will be repowered. The smallest developments however (Gunfleet Sands Demo and Kentish Flats 2) are assumed to be decommissioned and cease generation completely. Maximum capacity under this scenario is 1,254MW.		

6-year projection

In 2017 all scenarios begin at 1,254MW as a result of six operational developments. Under BAU, installed capacity remains at this level through until 2022. Under N@W and LS, capacity increases in 2020 as Thanet extension begins operation. Both scenarios reach 1,508MW in 2020 and maintain this capacity until 2022.

6 to 20 year projection

BAU maintains a capacity of 1,254MW until the two smallest developments, Gunfleet Sands Demo and Kentish Flats 2, come to the end of their operational life in 2033 and 2035 respectively and are not repowered. All other developments are repowered to their previous capacity under BAU. Capacity under this scenario ends in 2036 at 1,192MW.

N@W sees all developments repowered and an additional development, the previously abandoned extension to the London Array, coming online. Given the advanced stages of planning this development reached before being abandoned, this scenario assumes the development will be able to come online in 2023. This increases capacity to 1,748MW which is maintained until 2036.

Under LS, all developments are repowered to their previous capacity as the region does not possess any alternative sources of renewable energy generation. However, no additional developments are predicted to come online. Capacity is therefore maintained at 1,508MW for the remainder of the time period.

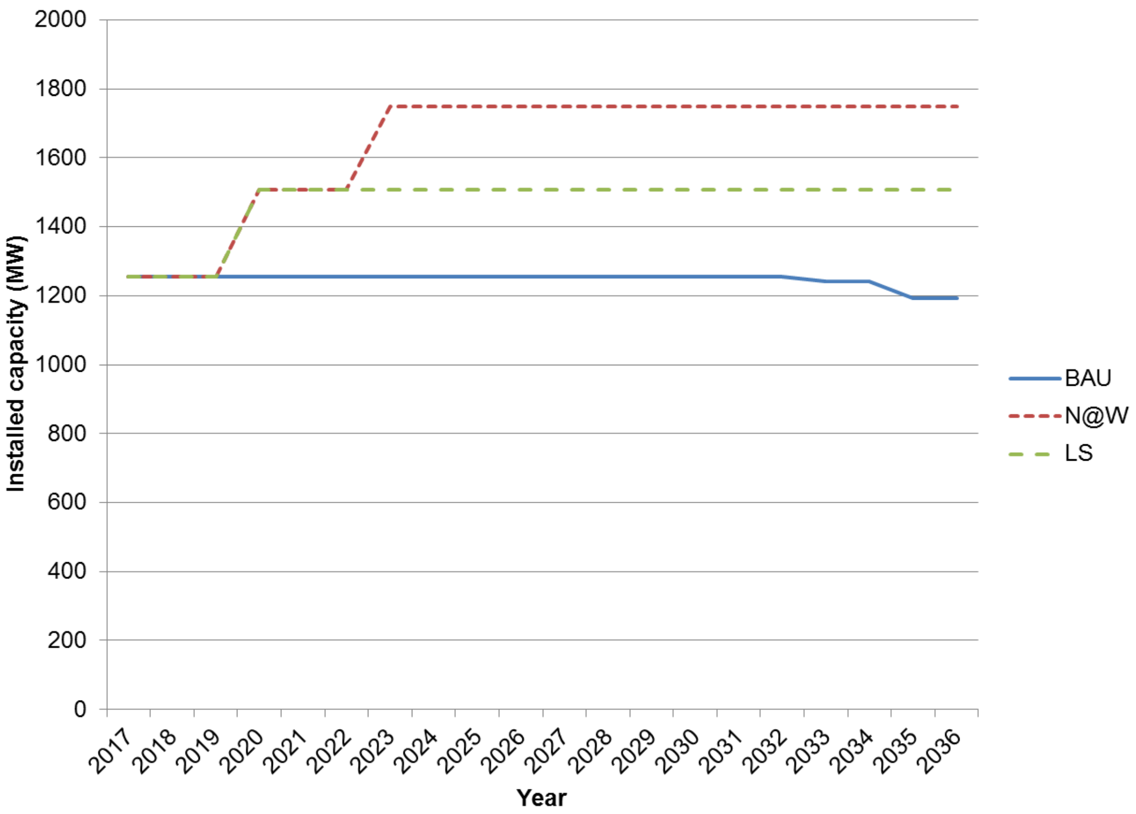


Figure 84: Installed capacity in the south east marine plan area between 2017 and 2036 under three scenarios

Potential trade-offs

The potential trade-offs are similar to the north east marine plan areas.

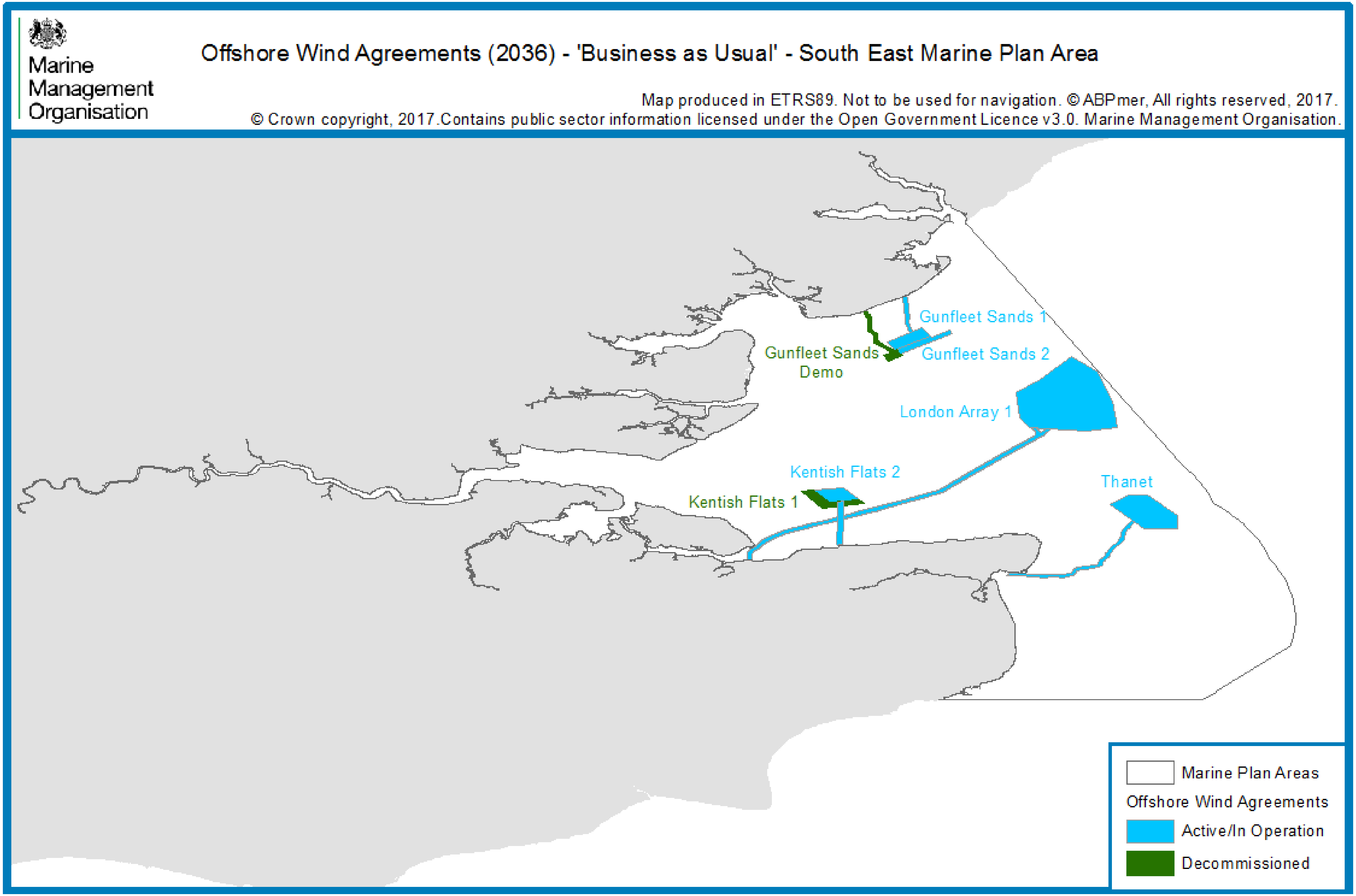


Figure 85: Offshore wind agreements (2036) – BAU – south east marine plan area

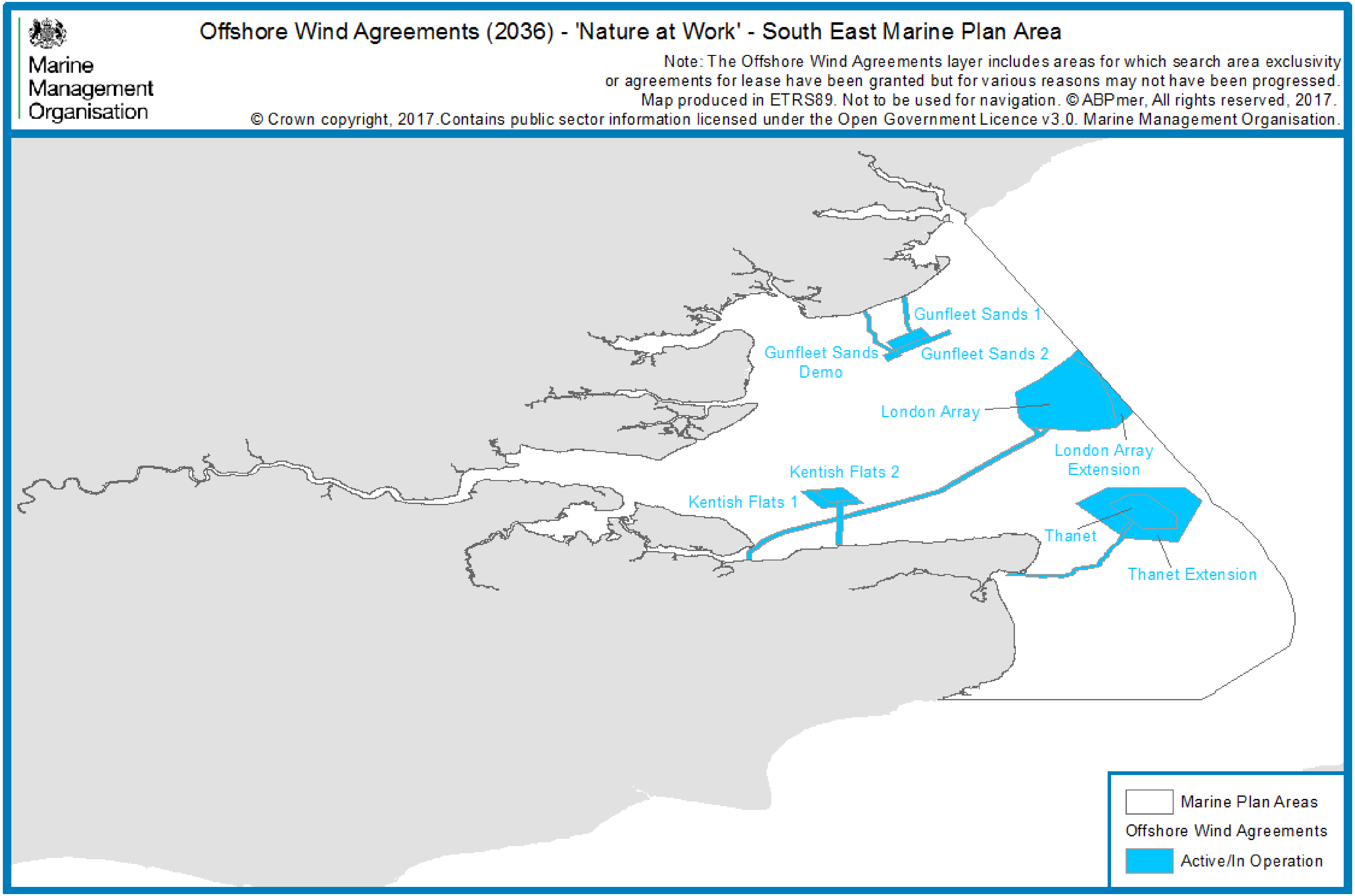


Figure 86: Offshore wind agreements (2036) – N@W – south east marine plan area

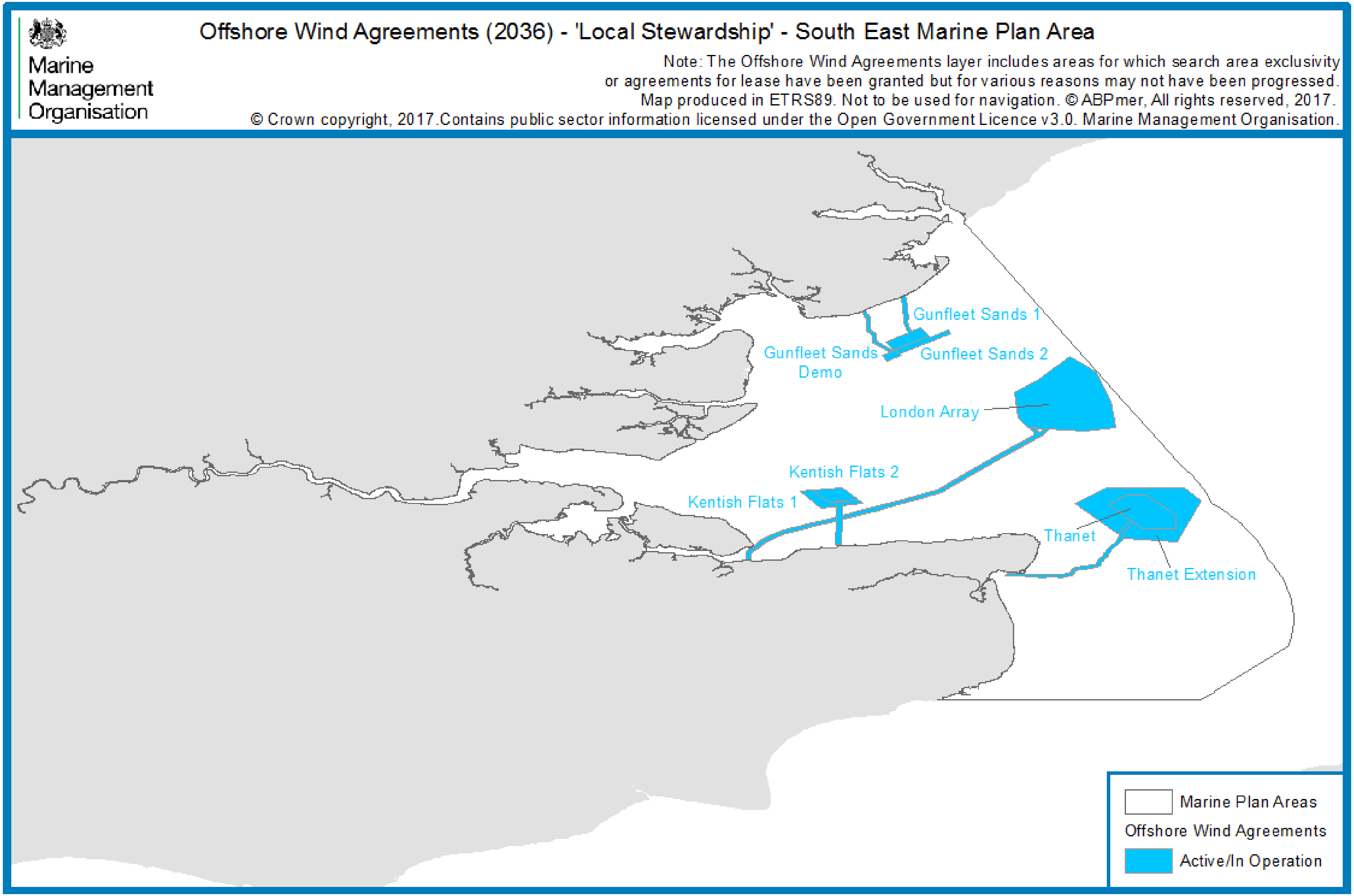


Figure 87: Offshore wind agreements (2036) – LS – south east marine plan area

10.5 South west

Although there is a significant amount of onshore wind activity in the south west, there have been no offshore wind developments in the region to date. No future plans for offshore wind in the south west have been made since the Round 3 Atlantic Array development in the Bristol Channel was abandoned in 2013.

The assumptions used to develop the BAU, N@W and LS scenarios for wind energy in the south west marine plan areas are provided in Table 59. Projected installed capacity under each of the three scenarios is shown in Figure 88. Figure 89 shows the spatial application of the scenarios to the sector while the text below provides a brief description of the future trends in 6 years and 6 to 20 years.

Table 59: Assumptions and impacts under the future scenarios for wind energy in the south west marine plan areas

Aspect	Scenario		
	Business as Usual	**Nature @ Work**	**Local Stewardship**
Application to the sector	No offshore wind developments are currently in operation, under construction or in the planning stage in south west marine plan areas.	As for the north east marine plan areas (see Table 52).	No offshore wind developments are currently in operation, under construction or in the planning stage in south west marine plan areas. Alternative forms of community-based renewable energy sources are promoted. Tidal range power is the renewable energy of choice in the region given the multiple potential benefits it presents and the significant tidal rage resource. Offshore wind is therefore not a local priority.
Assumptions	No offshore wind activity under this scenario	This scenario assumes that the previously abandoned Atlantic Array goes ahead. Maximum capacity under this scenario is therefore 1,200MW.	No offshore wind activity under this scenario due to the large amounts of tidal range developments in the region.

6-year projection

No activity for any of the scenarios in this time period.

6 to 20 year projection

Only N@W results in any offshore wind activity in the south west marine plan areas. Capacity from the previously abandoned Atlantic Array begins to come online in 2028, with the development reaching its full operational capacity of 1,200MW in 2030. Capacity is maintained at this level for the remainder of the time period as no other developments occur in the region.

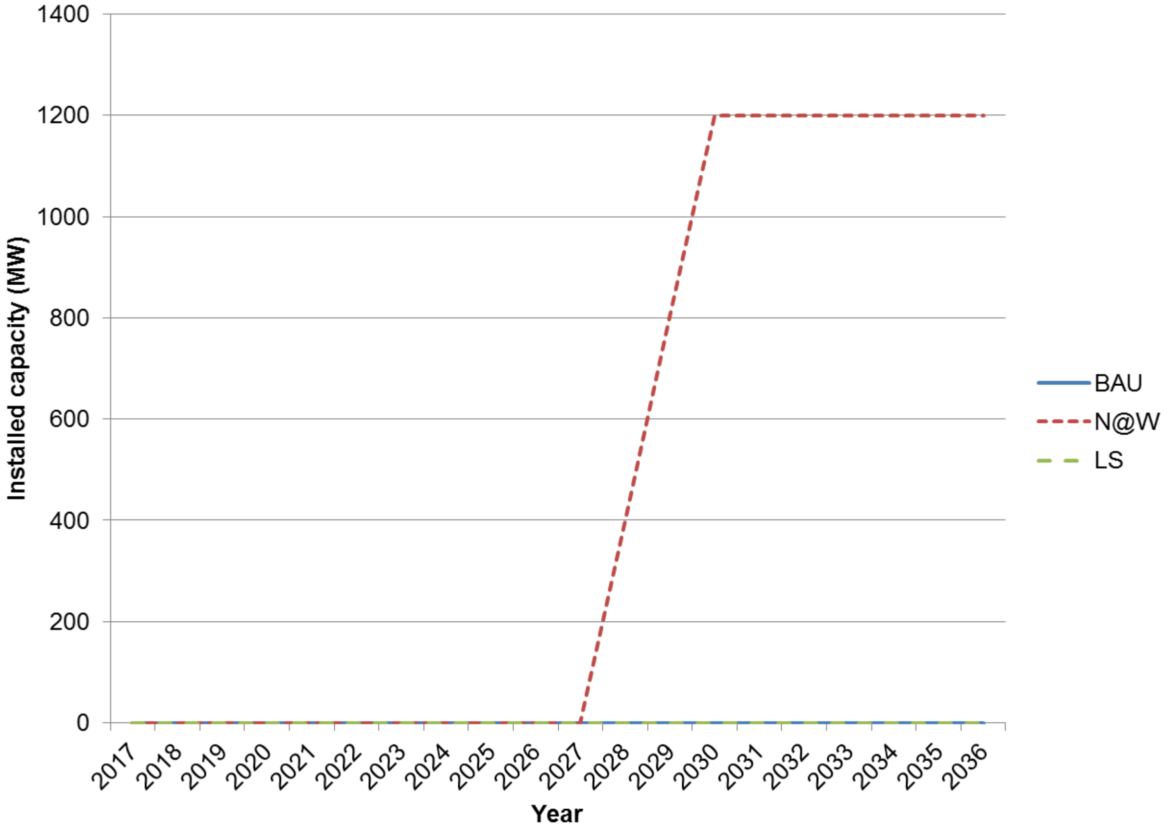


Figure 88: Installed capacity in the south west marine plan areas between 2017 and 2036 under three scenarios

Potential trade-offs

The potential trade-offs are similar to the north west marine plan areas.

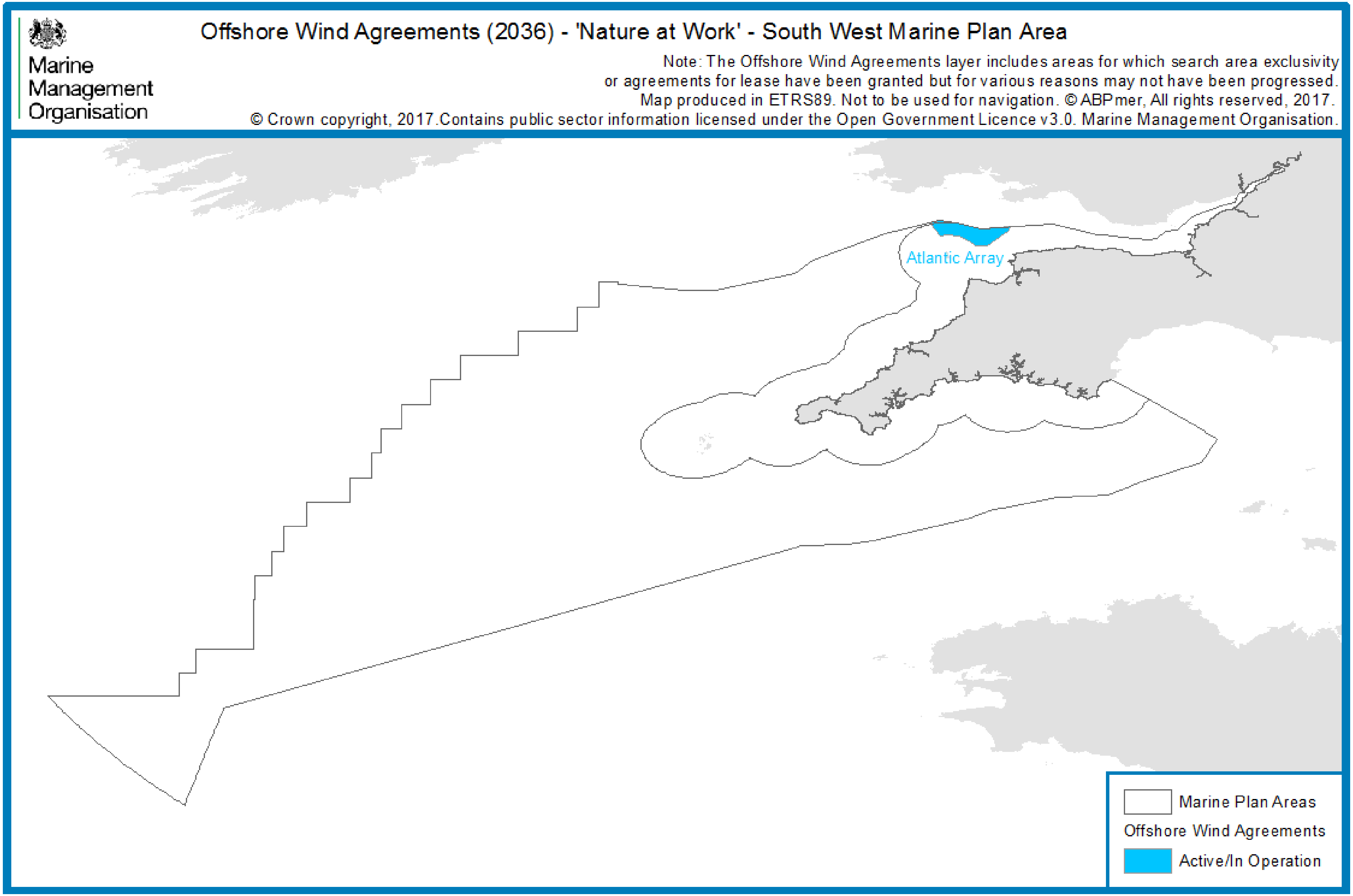


Figure 89: Offshore wind agreements (2036) – N@W – south west marine plan areas

11 Fisheries

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).

Data sources

A variety of different information sources have been reviewed to inform this baseline, including published reports and papers and spatial data layers. The main information sources used are provided in the list below:

- UK sea fisheries annual statistics (MMO, 2016c);
- ICES official nominal catches (2014);
- UK fishing activity for >15m vessels (MMO VMS data, 2015);
- UK landings by ICES rectangle for <15m vessels (MMO, 2015);
- Stakmap data (<15m vessels) (Natural England data, 2012);
- Project Inshore reports;
- IFCA reports; and
- Stakeholder consultation.

11.1 National review

Overview of national activity

The following overview describes the landings, fleet structure and gears used within the UK, by devolved administration. This is due to the fact that the marine plan areas may be fished by vessels registered to different UK administrations as well as European vessels beyond the 6nm limit. The information is summarised from MMO (2016c) unless otherwise stated.

<u>Landings by the UK fleet</u>

In 2015, UK vessels landed 708,000 tonnes (t) of seafish and shellfish into the UK and abroad, with a total value of £775 million. Demersal fish accounted for 38% of the total value, while shellfish and pelagic fish accounted for 36% and 27% respectively. Of this, over 400,000 t, worth nearly £437 million, was landed into the UK, predominantly into Scotland (see Table 60). The largest component of landings by the Scottish and Northern Irish fleets were pelagic fish, whilst the largest component of landings by the English and Welsh fleets were demersal fish and shellfish respectively.

Cod, haddock and plaice are the three main demersal species landed by the UK fleet in terms of weight, accounting for almost half the quantity of all demersal species landed in 2015. Mackerel and herring are the two main pelagic species landed by the UK fleet, accounting for 88% by weight and 93% by value of total pelagic landings in

2015, and almost half of all landings by the UK fleet. Scallops, crabs and *Nephrops* (langoustines) are the three main species of shellfish landed by UK vessels into the UK and abroad, accounting for around two thirds of the quantity and value landed in 2015 (MMO, 2016c).

Table 60: Landings into the UK and abroad by UK vessels in 2015

Region	Fishery Type	Landings ('000 tonnes)	Value (£ million)
England	Demersal	74.2	144.6
	Pelagic	68.5	30.3
	Shellfish	60.4	95.9
	Total	203	270.8
Wales	Demersal	1.3	2.9
	Pelagic	-	-
	Shellfish	9.7	10.2
	Total	11.0	13.0
Scotland	Demersal	90.8	142.8
	Pelagic	291.5	160.1
	Shellfish	57.7	133.9
	Total	439.9	436.9
Northern Ireland	Demersal	2.3	2.5
	Pelagic	29.8	16.1
	Shellfish	15.6	27.2
	Total	47.7	45.8

Source (MMO, 2016c)

Landings by the UK fleet by vessel length

In 2015, vessels over 24m in length caught 73% of the volume of landings by the UK fleet. These vessels comprised just 4% of the UK fleet by number, yet their landings of pelagic species formed 97% of the annual total for the UK fleet.

The majority of landings (91%) of demersal species by the UK fleet were by vessels over 18 metres in length. In contrast, landings of shellfish are much more evenly distributed across the fleet, with vessels 10 metres and under in length accounting for 23% of the volume of landings.

Landings by the UK fleet by gear used

In 2015, 88% of fish landed by UK vessels was captured using mobile gears, such as beam trawls, demersal trawls and seines, pelagic seines and dredges. Almost all landings of pelagic fish and 89% of all demersal fish were caught using mobile gears, the large majority of which were caught using demersal trawls and seines[12]. A total of 149,500 tonnes of shellfish was landed by the UK fleet in 2015, 40% (59,600 t) of which was caught using passive gear[13] (mainly pots and traps) and 60%

[12] This category includes otter, *Nephrops*, shrimp and pair trawls, and all demersal seines.
[13] Passive gear means any fishing gear or catch operation which does not require an active movement of the gear. Examples include: gillnets, longlines, traps, pots and creels.

(89,900 t) of which was caught using mobile gear (mainly dredges, demersal trawls and demersal seines) (MMO, 2016c).

Important areas for UK over-15m vessels using mobile gears include (Figure 90): the western English Channel (in the south west marine plan area), where there are important beam trawl and scalloping areas; the Irish Sea, where *Nephrops* grounds are found within the north west marine plan area; and along the north east coast of England, within the north east marine plan areas (predominantly inshore). The data indicate that there is limited activity by UK over-15m vessels in the south east marine plan area. Activity of UK over-15m vessels using passive gears (Figure 91) is distributed around the UK, with higher values deriving from specific areas offshore from the Humber Estuary, in the English Channel, off Lands End, and in Cardigan Bay.

Figure 92 provides an indication of the spatial distribution of effort of smaller vessels (under-15m) by gear type in English waters. Bottom gear (trawls) are used extensively, particularly on the eastern coast, including in areas quite far offshore although the highest levels of intensity (in terms of number of vessels per grid cell) are in the inshore areas due to the more limited operating range of smaller vessels. Particularly important areas of activity include The Wash, the Thames estuary and surrounding areas, the north-east coast, areas off south Devon and Cornwall, and Morecambe Bay. Levels of dredging are lower, although with a large number of vessels dredging in The Wash (cockles and mussels). Lining is concentrated off the Suffolk coast, with important areas for netting off East Anglia, the Holderness coast, south Devon and Cornwall, and north west England. The most important area for potting is the Holderness coast, just outside the north east marine plan area, with other important areas along the north east coast, Norfolk, south Devon, and the Bristol Channel.

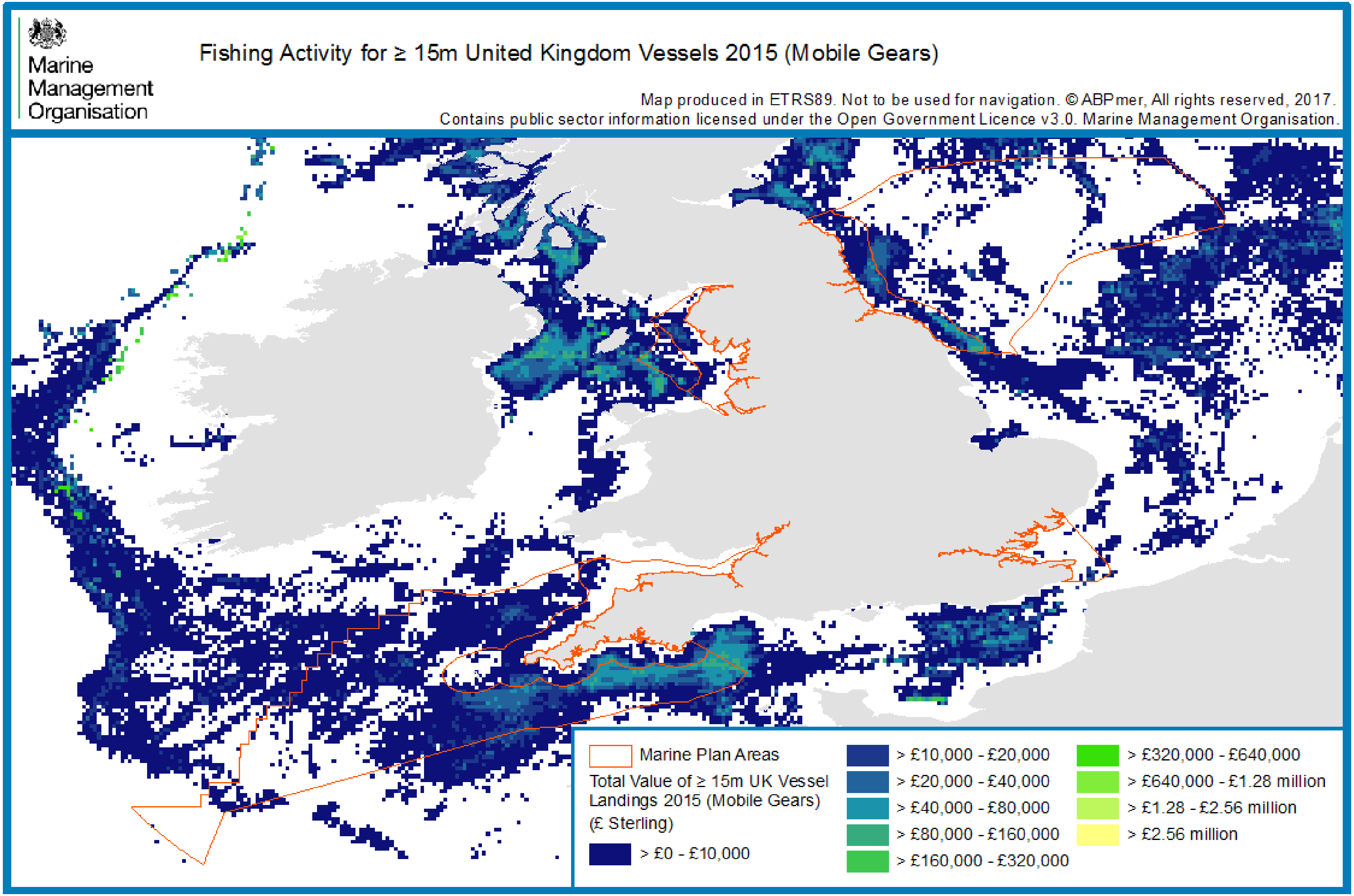


Figure 90: Landing values for vessels 15m and over using mobile gears (Source: MMO 2017b)

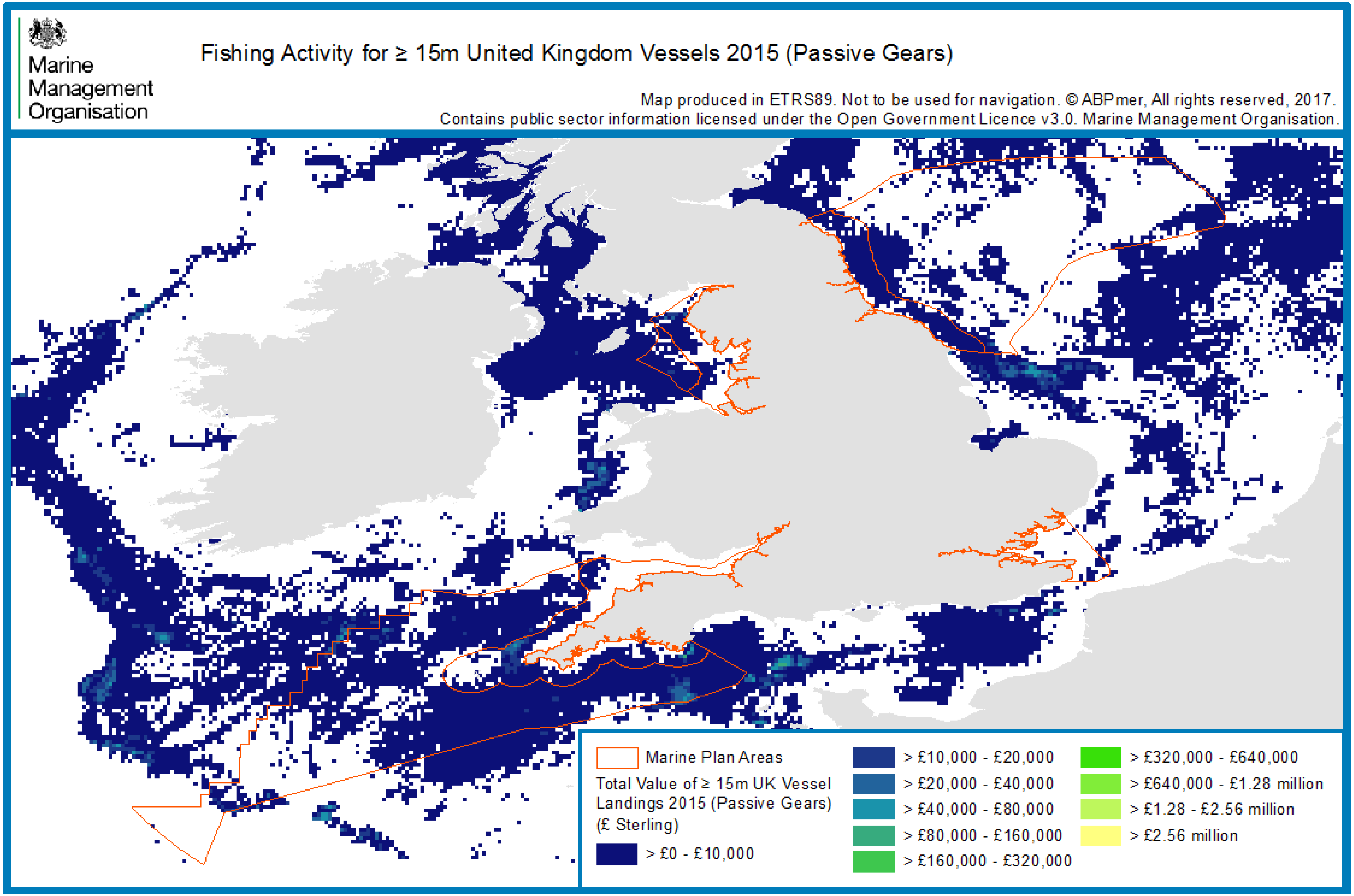


Figure 91: Landing values for vessels 15m and over using passive gears (Source: MMO 2017b)

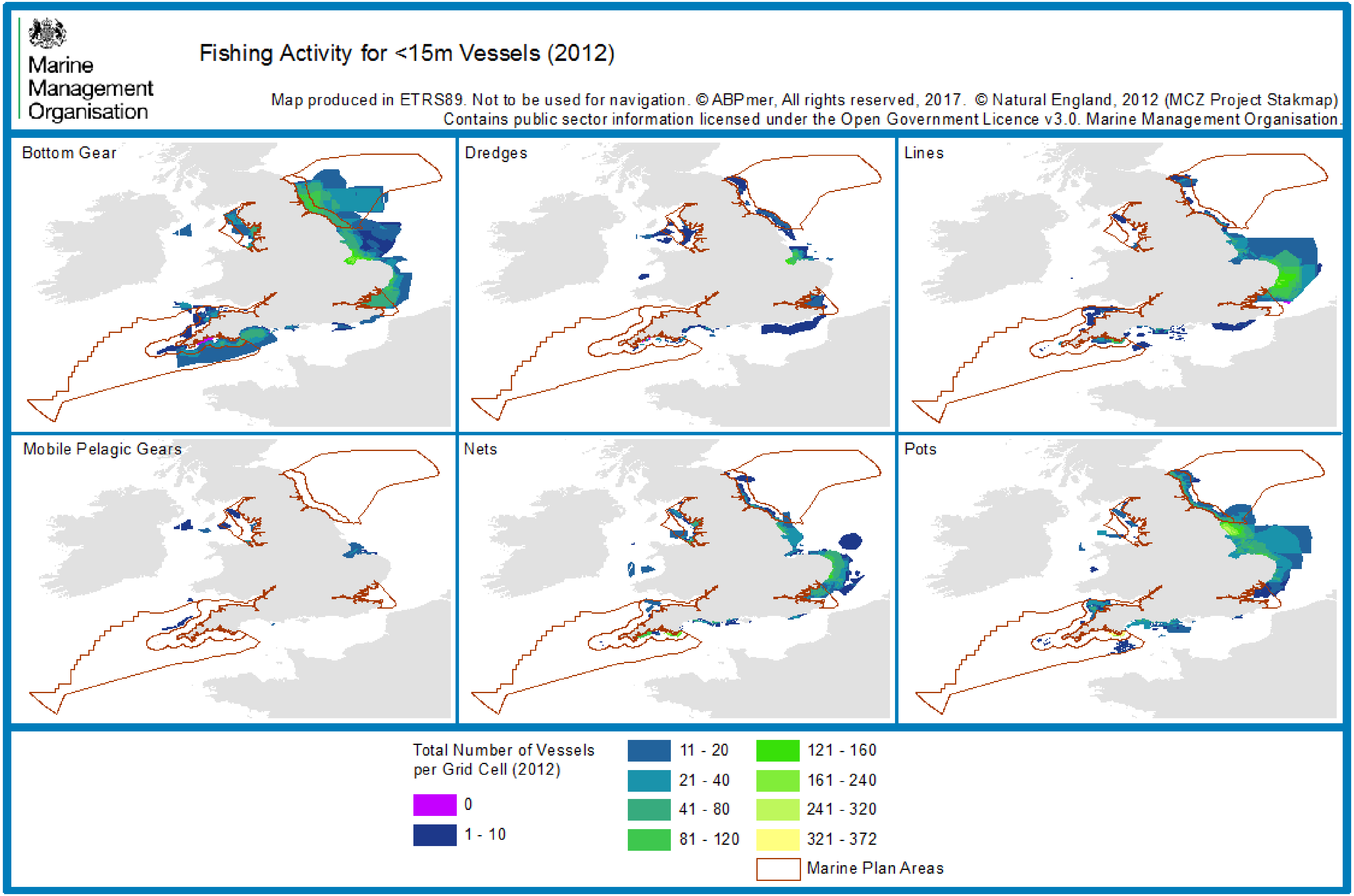


Figure 92: Fishing intensity by gear type for vessels under 15m (Source: Stakmap data)

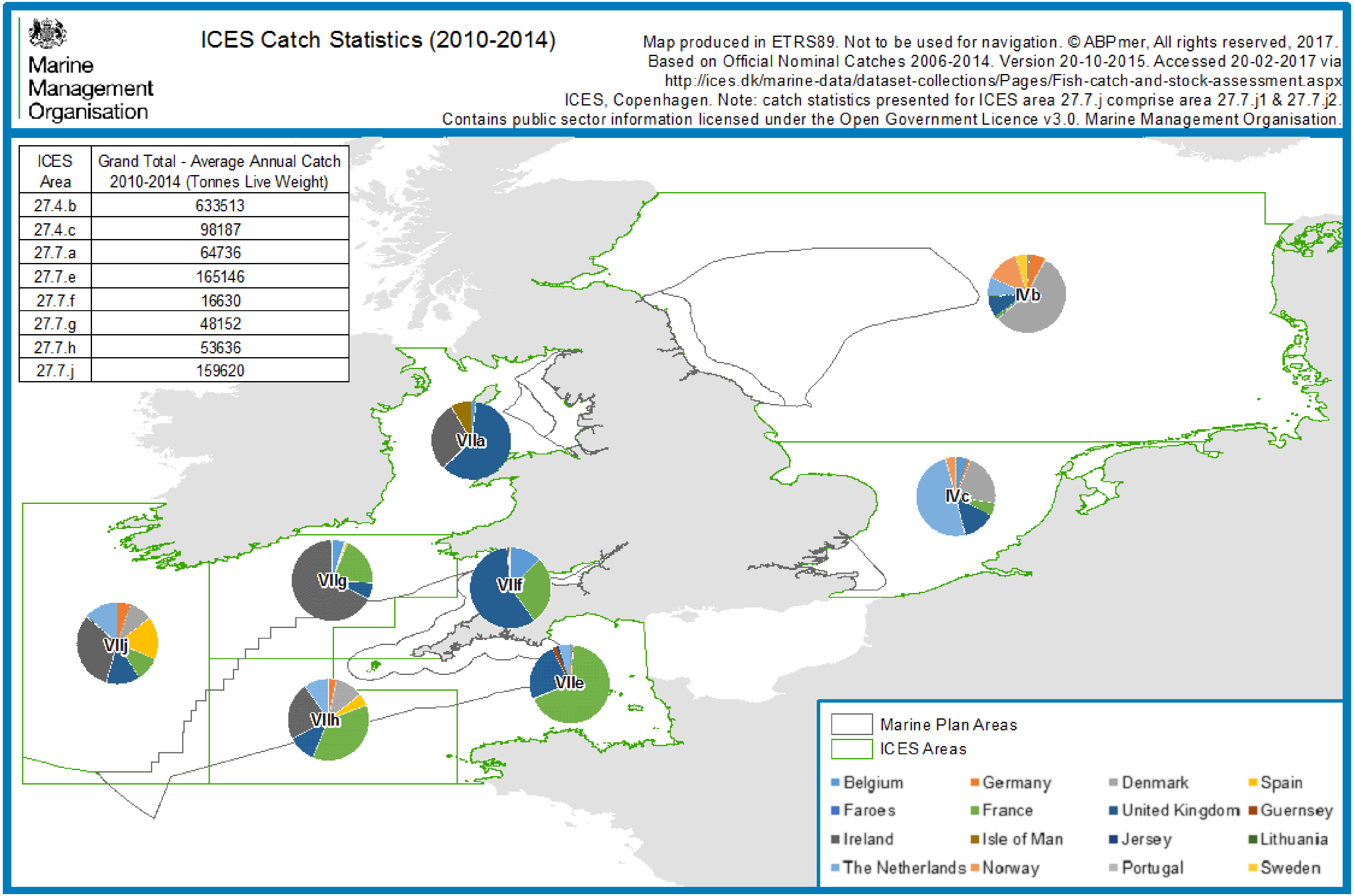


Figure 93: Landings by ICES Division, by country (annual average, 2010-2014) (Source: ICES nominal catches, 2014)

Landings by non-UK vessels

In 2015, 46,000 t of fish were landed into the UK by non-UK vessels. French and Irish registered vessels landed the largest quantity of fish into the UK (17,000 t and 7,000 t respectively). The majority of fish landed into the UK by non-UK registered vessels were demersal (69%) (MMO, 2016c).

The distribution of catches from the ICES divisions[14] that overlap the marine plan areas, by country, is shown in Figure 93. Landings are predominantly derived from ICES Division IVb (Central North Sea) (51% of total catches from the ICES divisions which overlap with marine plan areas). The highest average annual catches (across all ICES divisions shown between 2010 and 2014) are by Danish, French, Dutch, Irish and Norwegian vessels. Catches from UK waters by non-UK vessels are often landed into non-UK ports.

UK Fleet Structure

In 2015, the UK fishing industry comprised 6,187 fishing vessels, of which 4,863 were under 10m in length (targeting inshore stocks) and 1,324 were over 10m in length (targeting inshore and/or offshore stocks, depending on vessel size). There were an estimated 12,107 fishermen, of which 5,569 were based in England, 851 in Wales, 4,828 in Scotland and 859 in Northern Ireland. Part-time fishermen accounted for 16% of the total number of fishermen in 2015.

England has the largest number of vessels in the UK fleet (51% of the total UK fleet, of which over 80% are under 10m in length), while Scotland has the highest share of gross tonnage capacity (56%) and engine power (46%). This difference can partly be explained by the higher proportion of vessels of 10 metres and under in length in the English fleet (83% in England compared with 71% in Scotland) compared to the larger pelagic trawl vessels in the Scottish fleet. Furthermore, the English fleet is involved in several key fisheries that are typically lower volume but higher value (e.g. the Channel fisheries for sole and plaice, lobster and scallop fisheries) with smaller vessels targeting a variety of stocks throughout the year. In contrast, in Scotland, larger vessels are engaged in several fisheries that are high volume but lower value (e.g. herring and mackerel) (MMO, 2016c).

Review of historical trends

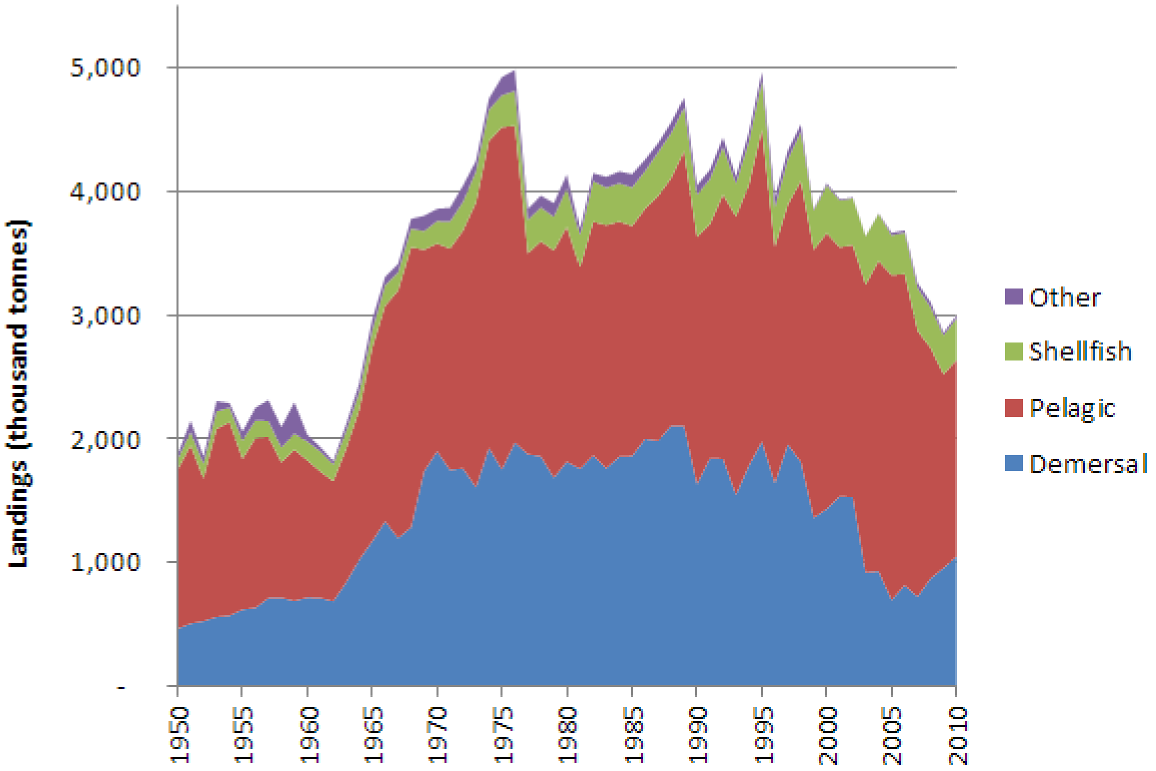
Fishing has been an important part of the maritime history of countries around the North-East Atlantic for centuries, with coastal communities developing around emerging fishing opportunities such as the herring fisheries and the distant-water fisheries for cod and other species (UKMMAS, 2010a). Following the Second World War, there was a steady uncontrolled growth of fishing and progressive advances in the design and construction of vessels, deck machinery, fishing gears and electronics (Engelhard, 2008). This resulted in increasing numbers of stocks being subjected to non-sustainable rates of fishing.

[14] The ICES Statistical Areas delineate the divisions and subdivisions of FAO Major Fishing area 27 (North-East Atlantic). They are used as bounding areas for calculation of fish statistics, e.g. catch per unit effort (CPUE) and stock estimates.

Figure 94 shows the historical reported landings (from all countries) from ICES areas IV (North Sea), VI (west of Scotland) and VII (Channel and approaches, and west of Ireland), representing the main fishing areas surrounding the UK.

Landings were around 1.5 million tonnes until the mid-1960s, and increased rapidly in the 1970s to over 4 million tonnes, from increased landings from both demersal and pelagic stocks. Landings fluctuated around this level, peaking at around 5 million tonnes in 1976 and again in 1995. From around 2000, landings began to decline as a result of reduced Total Allowable Catches (TACs) and reduced levels of fishing effort to rebuild stocks.

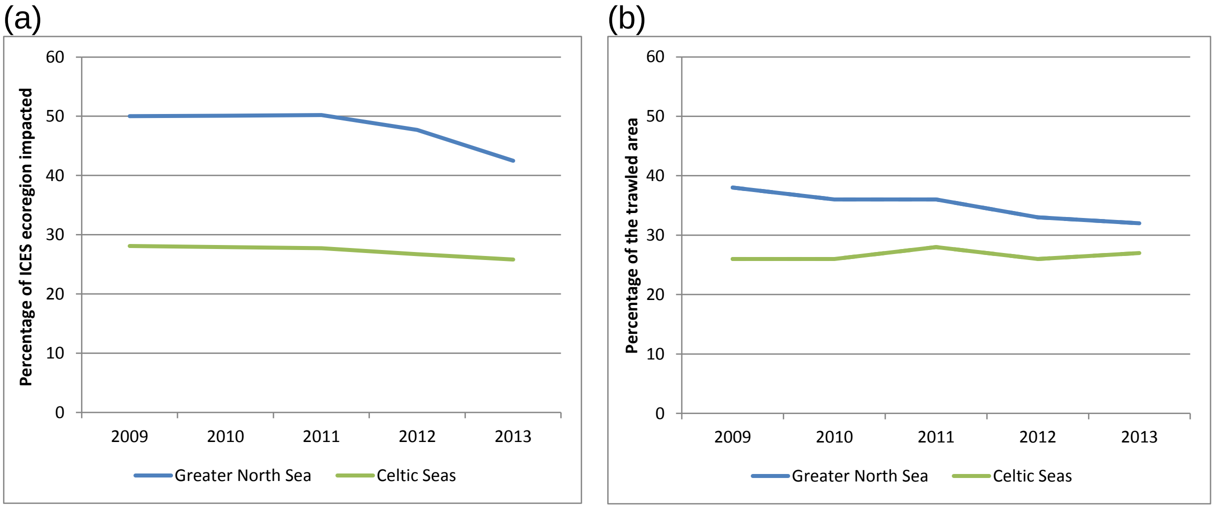
Fishing mortality has reduced since the late 1990s, generally progressing towards fishing at or below Maximum Sustainable Yield (MSY) in all areas of the North Sea and North-East Atlantic, since 2006 (STECF, 2015).



Source: ICES, 2011.

Figure 94: Historical reported landings from ICES areas IV, VI and VII, all countries (1950–2010)

Fishing is concentrated in particular areas, with an area of 527,000 km² affected by mobile bottom gears in the Celtic Seas and Greater North Sea in 2013, which equates to 33% of the area of the two ecoregions (ICES, 2015). The spatial footprint of mobile bottom gears has decreased: in the Greater North Sea ecoregion it has declined from 50% of the area in 2009 to 42.5% of the area in 2013; and in the Celtic Seas it has declined from 28% to 26% (Figure 95a). There has also been an aggregation of effort within the trawled area of the Greater North Sea, with 90% of fishing effort being concentrated in 32% of the trawled area (Figure 95b) (ICES, 2015a).



Note: Spain is not included in the data. Source: ICES, 2015b.

Figure 95: Spatial extent and concentration of mobile demersal fishing activity in the Celtic Seas and Greater North Sea (a) percentage of ICES ecoregion impacted by mobile bottom-contacting gears; (b) percentage of trawled area containing 90% of the fishing activity.

Mobile demersal fishing is the most widespread cause of seabed abrasion, with the potential to affect good environmental status (GES) for the marine environment. Patterns of seabed abrasion also highlight important fishing grounds for these gear types. Future changes to the locations where fishing can or cannot take place have the potential to influence the distribution of seabed abrasion from mobile demersal fishing. Figure 96 shows the intensity of seabed disturbance from mobile bottom gears (causing surface and subsurface abrasion). There are extensive demersal fishing grounds in the North Sea, southern Irish Sea, western Channel and south and south west of Ireland. Within the Irish Sea there are grounds for scallops and *Nephrops*.

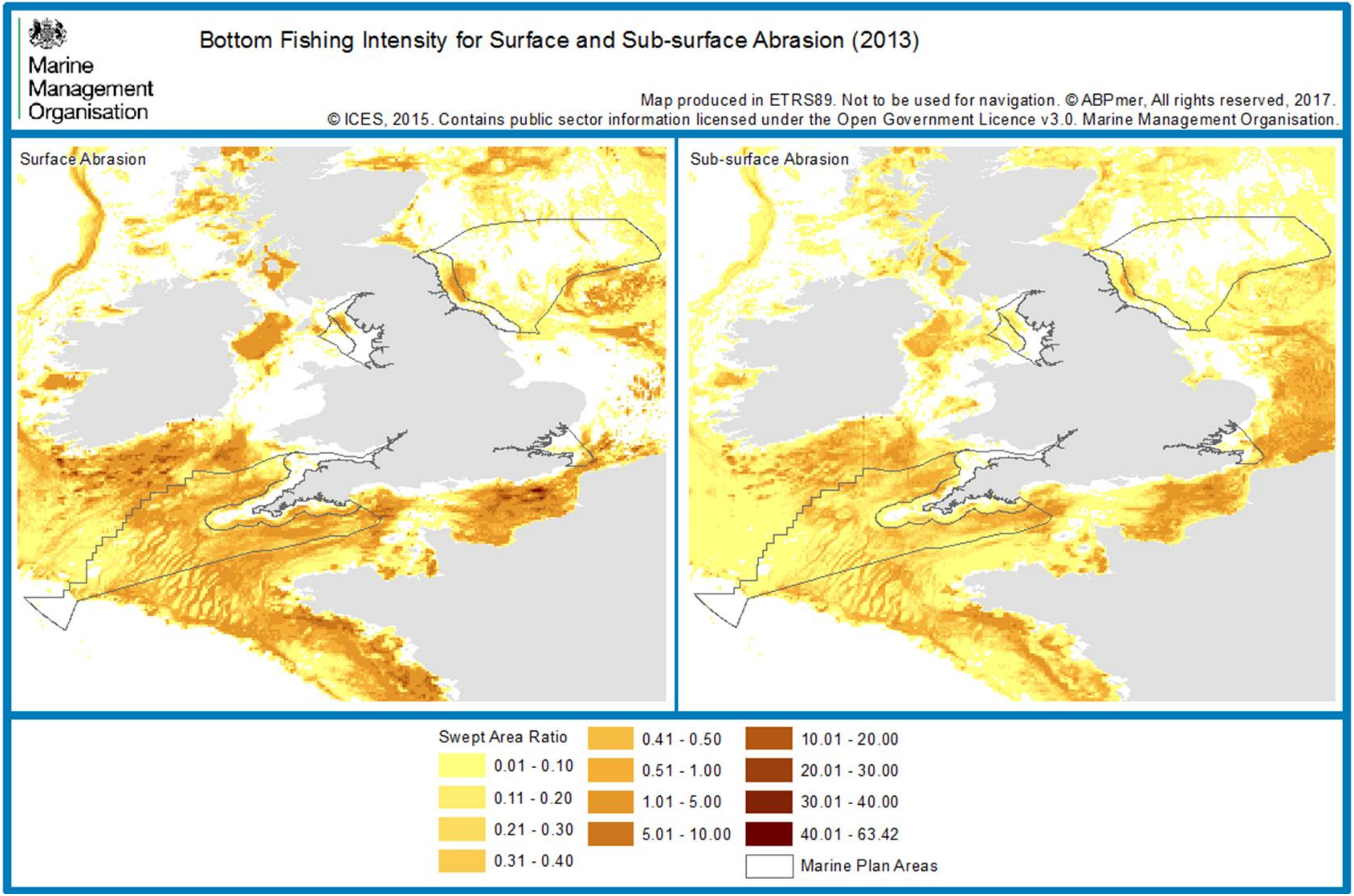


Figure 96: Bottom fishing intensity for surface and sub-surface abrasion

Review of key changes and/or advances of significance affecting the sector

The main drivers affecting the fishing sector are related to balancing both the long-term productivity of the industry and the sustainability of the fishery resources (UKMMAS, 2010a). Key drivers include policy developments under the Common Fisheries Policy (CFP), in particular the drive to bring levels of exploitation down to levels consistent with achieving MSY (Maximum Sustainable Yield), which has been reducing levels of fishing, and the Landings Obligation which has already been introduced for pelagic species and is being phased in for demersal stocks with all species included by 2019. The Landings Obligation only applies to species managed under TACs (Total Allowable Catches) and Quotas. This may result in the premature closure of mixed fisheries when quota for 'choke' species[15] runs out. Policy developments in other areas, such as development of offshore renewable energy generation, and implementation of MPAs that restrict fishing activity, will also impact on the sector. Table 61 summarises the key changes affecting the fisheries sector.

Table 61: Key drivers affecting development of the fisheries sector

Driver	Details	Implications
Political	Expansion of other marine industries e.g. renewable energy, oil and gas	Restrictions on fishing areas due to infrastructure and other marine activities
Economic	Availability and price of imported fish and shellfish (from fisheries and aquaculture)	World market prices and exchange rates may influence profitability of certain fisheries, and influence fishing behaviour.
	Future trade relationships	Influence on potential markets and demand for catches, which may influence fishing behaviour
	Oil price affects profitability, especially for mobile demersal fleet segment	High oil price increases costs but may drive technological innovation to adapt gear to increase fuel efficiency. Over the period 2008-2014 fleets have shown a declining energy consumption per landed tonne (e.g. in Ireland, fuel consumption has declined from 363 l/tonne to 221 l/tonne). In some cases this may imply a lower level of seabed impact
Social	Population growth	Increasing human population may increase demand
	Local priorities	Local needs/priorities to foster local fishing industry and communities
	Consumer preferences	Consumer demands for certain types of fish and shellfish drive fishing behaviour
Technological	Developments in technology and power	Fishing can expand into deeper waters, although this is limited by quota availability and other environmental restrictions. Technological innovation may also

[15] A species with a low quota that, under the Landings Obligation, could cause a vessel to have to stop fishing even if it still has quota for other species.

Driver	Details	Implications
		reduce seabed impact and improve selectivity.
Environmental	Status of fish stocks and TACs	Recovery of stocks towards MSY could result in increases in the level of TACs and quotas. This would increase the volume and value of landings, but may also result in higher levels of fishing effort resulting in greater seabed impacts
	Designation of additional Marine Protected Areas (MPAs) (Tranche 3 rMCZs) and management measures within existing MPAs (MCZs, SACs, SPAs)	Constraints/restrictions on areas within which fishing can take place, especially with mobile demersal gears. Potential contribution to supporting population replenishment of target species outside MPAs
	Retailer and consumer pressure for environmentally responsible seafood	More fisheries likely to seek ecolabel certification, likely to drive technological adaptations to reduce seabed impact and bycatch levels

Source: ABPmer and ICF (2016) and references therein

Review of future trends

Commercial fisheries are expected to be influenced by requirements to achieve fishing mortality at MSY levels and the Landing Obligation, which will reduce landings for UK fleets in the short term. This will be more pronounced under N@W and LS, as these scenarios support environmental objectives more strongly. After 2020, stock biomass starts to recover and landings increase. Commercial fisheries are also influenced by nature conservation — the designation of MPAs and implementation of management measures within them. The effects are most pronounced under N@W, where all MPAs (inshore and offshore) have a high level of environmental management implemented, restricting mobile demersal gears in particular. Under LS, only the inshore sites are subject to high levels of management, and the 3 nm zone may exclude mobile demersal gears from some areas. The absolute values will depend on levels of stock recovery which are uncertain, but the relative differences between the scenarios reflect the differing levels of environmental designation under the scenarios.

The impacts on commercial fisheries will be felt very differently between different fleets and in different areas. The larger offshore fleets that target pelagic species will be largely unaffected. Vessels targeting demersal species and some shellfish species (predominantly scallops and *Nephrops*) with mobile demersal gears will be most affected by MSY targets, Landing Obligation and MPA management measures. Inshore or small-scale vessels with a limited operating range could be significantly affected by MPAs, and would have limited ability to adjust through moving to alternative fishing grounds.

Under N@W, the spatial restrictions on mobile demersal gears are most intense, with limitations as a result of MPAs and also windfarms. The cumulative effect of such spatial restrictions limits the potential for displacement of fishing activity to alternative areas and some fleet segments could be significantly affected, resulting in a loss of landings. MPAs may contribute to rebuilding stock biomass and 'spillover' effects, but the significance of this is uncertain and most increases in stock biomass are likely to be achieved through fisheries management measures reducing the level of fishing effort on stocks.

Under LS, mobile demersal gears may be restricted from some inshore areas, but for those areas with important inshore fleets and a strong local fishing tradition, local decisions may result in the prioritisation of fishing activity in the 3 nm zone, strengthening local fishing communities and local harbours as tourism destinations renowned for their seafood.

Where mobile demersal gears are restricted, this may create new opportunities for static gears such as pots and nets, and some fleet segments are likely to adapt to spatial restrictions and policy changes by changing gear types and adapting fishing techniques.

The implementation of restrictions on mobile demersal gears through MPAs and windfarms, as well as the likely reduction in fishing activity as a result of the Landings Obligation, will reduce the spatial footprint of the seabed abrasion from mobile demersal gears. This will potentially result in improvements in the status of seabed benthic habitats previously impacted by trawling, potentially contributing to regulating ecosystem services (nutrient cycling, productivity), and biodiversity. However, such restriction on fishing activity in some areas may result in an increased intensity of fishing in the remaining available areas through displacement. Furthermore, as stocks recover to MSY, TACs could be increased accordingly, which may lead to in increased fishing effort and hence seabed impact (unless other drivers result in some fishermen switching to less impacting gear types).

Confidence assessment

Information on the spatial distribution of effort of smaller vessels, which do not have vessel monitoring systems (VMS) fitted (under-15m, and under-12m since 2013), is limited. This was addressed, as far as possible, through datasets based on interviews with inshore fishermen in 2012 (Stakmap), Project Inshore reports and stakeholder consultation. The Stakmap data provide number of vessels per area and are indicative only of the distribution of smaller vessel activity as not all fishermen gave permission for their data to be made publicly available.

Landings by ICES rectangle were used for scenario projections for under-10m and 10m and over vessels. These were calculated for ICES rectangles which intersect with the north east, north west, south east and south west marine plan areas (those ICES rectangles where the centroid is within each marine plan area). As the landings volume and values have been calculated for the whole of any ICES rectangle which intersect with the marine plan areas, the values presented are indicative only. Additionally, vessels are only required to report one ICES rectangle per day of fishing, therefore landings from a particular ICES rectangle may over- or under-estimate the true level of landings from an area. There is no statutory requirement for fishermen from under-10m vessels to declare their catches, therefore the data are likely to underestimate the volume and value of landings from this fleet sector.

Data for non-UK vessels are only available at a broad spatial scale (ICES divisions) and therefore do not reflect actual landings from the individual marine plan areas.

11.2 North east

In this region, a total of 13,500 t of fish and shellfish worth £24.5 million were taken annually by UK vessels between 2010 and 2014 (Table 62) (based on landings volumes and values from ICES rectangles that overlap with the north east marine plan area). The trend in the volume of landings is shown in Figure 97. The majority of landings are taken by 10m and over vessels, landing a mixture of shellfish, demersal and pelagic species. Under-10m vessels' landings are dominated by shellfish, with some demersal species.

Table 62: Average volume and value of demersal, pelagic and shellfish landings (2010-2014) reported for under-10m and 10m and over vessels, from ICES rectangles overlapping[16] the north east marine plan areas

Fishing sector	Average volume 2010-2014 (tonnes)	Average value 2010-2014 (£)
10m and Under		
Demersal (10m and under vessels)	888	943,808
Pelagic (10m and under vessels)	28	31,263
Shellfish (10m and under vessels)	2,199	7,338,305
Over 10m		
Demersal (over-10m vessels)	3,509	3,770,162
Pelagic (over-10m vessels)	2,971	1,030,413
Shellfish (over-10m vessels)	3,968	11,339,557
Total	13,563	24,453,508

[16] ICES rectangles whose centroid is within the north east marine plan area: 37E9, 37F0, 38E8, 38E9, 38F0, 39E8, 39E9, 39F0, 40E8, 40E9, 40F0, 40F1, 40F2, 41E9, 41F0, 41F1, 41F2.

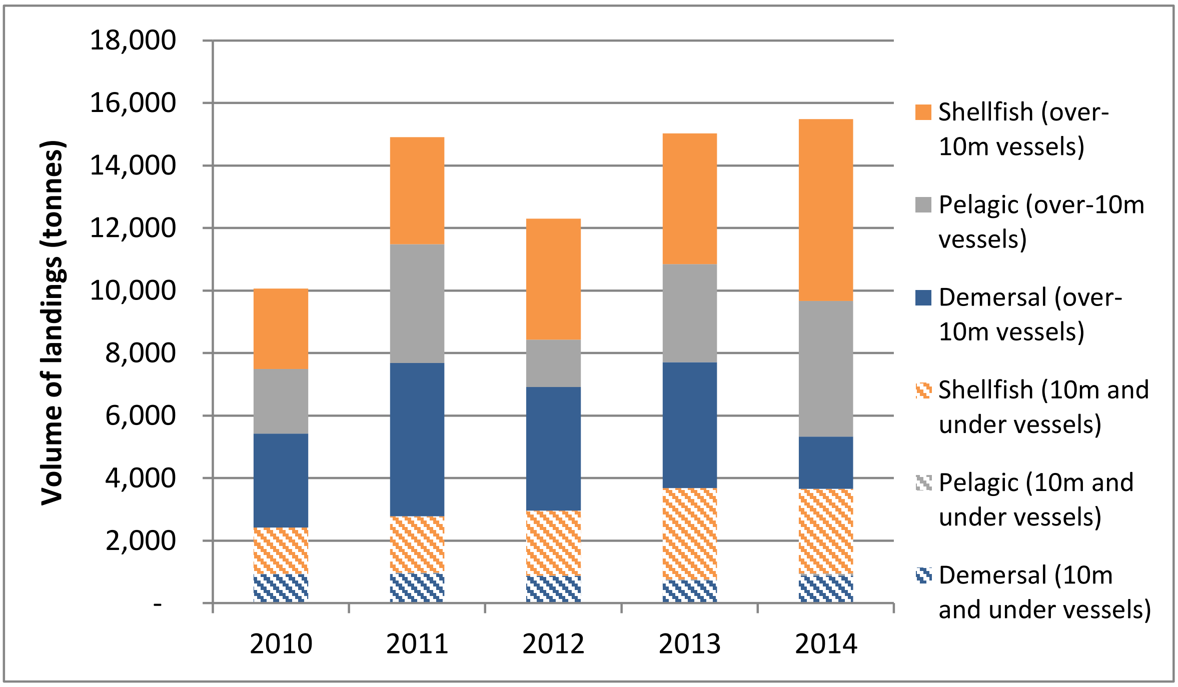


Figure 97: Trends in volume of landings by UK under-10m and 10m and over vessels, from ICES rectangles overlapping the north east marine plan areas, 2010-2014

UK over-15m vessels landed a total of 4,664 t (all gears), worth £8.1 million in 2015 (MMO, 2017b). The vast majority of landings from these vessels were caught using mobile gear (98% of volume, worth £7.9 million), with passive gear accounting for 2% of landing volume (worth £160,000). Figure 90 indicates that the highest fishing effort using mobile gears (based on areas showing the highest value of landings), occurs within the inshore marine plan area (particularly in the south east of this area), although mobile gears are also used in an area beyond 6nm further north along the coast. Figure 91 indicates that there is relatively little fishing effort using passive gears by vessels 12m and over in these marine plan areas.

The north east marine plan areas lie within ICES Division IVb, in which shellfish make up the majority of the UK vessel landings by value (into the UK and abroad), dominated by cockles, crabs, cuttlefish and lobsters, with some mussels, *Nephrops* and oysters. Herring and mackerel are taken as pelagics and the main demersal species are plaice, haddock, sole, turbot, lemon sole and cod (MMO, 2016c). The over-15m fleet within the North Eastern IFCA District[17] predominantly use demersal otter trawls to target *Nephrops*, cod, whiting and haddock (Acoura, 2015a).

Non-UK vessels with historical access rights in the 6-12nm zone include Dutch, German, Belgian and French vessels targeting herring. Other non-UK vessels fishing beyond 12nm in ICES Division IVb include Danish and Norwegian registered vessels (see Figure 93; note, it is not known from the data shown what proportion of landings come from waters within the offshore marine plan area).

---

[17] This District extends from the River Tyne to Haile Sand Fort, close to Humberston, on the South Bank of the Humber Estuary. The District also includes the estuaries and all waters out to 6 nm (Acoura, 2015a).

Stakmap data (see Figure 92) indicate that the most commonly-used gears by under-15m vessels in the north east marine plan area are demersal trawls followed by pots. Demersal trawl effort occurs within most of the inshore marine plan area, concentrated mainly within and beyond 6nm off the North Yorkshire and Northumberland coastline. Pots are also used along the entire coastline in this region with decreasing intensity with distance offshore. There are relatively few vessels using nets, lines and dredges.

Further information on the fisheries targeted using these gears is provided by Project Inshore (Acoura, 2015a). Information is summarised for each of the Inshore Fisheries Conservation Authority (IFCA) districts which intersect with the north east marine plan areas.

The fishing fleet in the North Eastern IFCA district is made up mainly of under 10m boats, fishing single day trips (largely within the IFCA district although many do fish beyond). Under 15m vessels target *Nephrops*, whiting, cod and lobster. A range of static and mobile gears are used. Typically trawlers and netters land a range of fish and shellfish such as sole, whiting, haddock, cod, *Nephrops* and plaice. A significant number of inshore vessels use pots to target lobster and brown crab and, to a lesser extent, whelks (the whelk fishery is predominantly between 12-18 miles off the coast, outside of 6nm jurisdiction). Dredging is prohibited throughout the district out to 3nm, and out to 6nm in some areas (Acoura, 2015a).

The main fishing centres in the Northumberland IFCA (NIFCA) district[18] are North Shields, Blyth, Amble and Seahouses, interspersed with a range of small traditional fishing settlements. Relative to its size, the area covered by the NIFCA is subject to low levels of fishing effort (although there is substantially greater fishing effort applied in the 6 to 12nm zone, focused particularly on *Nephrops* trawling and used by both local and mainly Scottish vessels) (Acoura, 2015b).

The major species targeted are lobster and brown crab via pots and *Nephrops* via pots and trawls (the latter beyond 6nm as noted above). Minor species targeted include salmon (via gill nets), velvet crab (via pots) and various finfish (via set nets and trawl by-catch). Economically, the two most significant fisheries are the creel fishery for lobster and crab and the trawl fishery for *Nephrops*. In 2012, the value of lobster landings to local ports in the district was estimated at £2.4 million and crab landings at just under £0.8 million (ascribed mainly to catches within the district). *Nephrops* landings to local ports (mainly caught outside the IFCA District) were valued at £8.4 million in 2012, of which £1.2 million was from vessels under 10m in length (Acoura, 2015b).

The assumptions used to develop the BAU, N@W and LS scenarios for fisheries in the north east marine plan areas are provided in Table 63. The projected volume of landings under each of the three scenarios is shown in Figure 98. Figure 99, Figure 100 and Figure 101 show the spatial application of the scenarios to the sector which the text below provides a brief description of the future trends in 6 years and 6 to 20 years.

[18] This District extends from the Scottish / English border (just north of the mouth of the River Tweed) south to the mouth of the River Tyne and includes all waters out to 6 nm.

Table 63: Assumptions and impacts under the future scenarios for commercial fisheries in the north east marine plan areas

Aspect	Scenario		
	Business as Usual	Nature @ Work	Local Stewardship
Application to the sector	The target of F_{MSY}[19] is not achieved for all stocks by 2020. Demersal stocks are rebuilding. Pelagic stocks are already fished sustainably and landings are stable. Shellfish stocks are currently unsustainably exploited and have potential to increase landings if stocks are allowed to rebuild. The implementation of the Landings Obligation affects demersal and shellfish sectors due to lack of quota for 'choke species' from 2019. However, over time the fleet adjusts, either through selectivity measures, gear switching, and/or specific targeting of areas to avoid choke species, and together with recovery of stocks and increasing quotas as a result, landings values increase. The spatial footprint of seabed abrasion pressure remains similar to current, with some additional reductions in area from offshore wind farms and MPAs, contributing to improvements in GES for Descriptor 6 (seabed integrity). However, effort would likely be redistributed to fishing grounds outside of the affected areas where intensity would increase.	F_{MSY} is achieved for all fish stocks by 2020 and stocks continue to rebuild beyond this date. Efforts to achieve F_{MSY} quicker mean a reduction in landings from demersal and shellfish stocks in the short-term, resulting in impacts on some fleet segments in the short term, but with longer-term gains. The implementation of the Landings Obligation is as for BAU. The reduction in spatial footprint of seabed abrasion pressure is slightly greater than under BAU, from the increase in implementation of offshore wind farms, contributing to improvements in GES for Descriptor 6 (seabed integrity). However, some level of coexistence is likely to be possible within offshore wind farms (Gray *et al.*, 2016), and effort would likely be redistributed to fishing grounds outside of the affected areas where intensity would increase.	F_{MSY} is not achieved for all stocks by 2020. The implementation of the Landings Obligation is as for BAU. Local decisions may result in exclusion of mobile demersal gears from some inshore areas (<3 nm), but may also promote more exclusive access for inshore and local vessels. This may result in displacement of some mobile demersal effort to areas beyond 3 nm. The spatial footprint of seabed abrasion pressure remains similar to current, with some additional reductions from offshore wind farms and MPAs contributing to improvements in GES for Descriptor 6 (seabed integrity). However, effort would likely be redistributed to fishing grounds outside of the affected areas where intensity would increase.

[19] The fishing mortality level consistent with achieving MSY.

Aspect	Scenario		
	Business as Usual	Nature @ Work	Local Stewardship
Assumptions	Implementation of the landings obligation results in a 5% reduction in demersal and shellfish landings in 2019. Demersal landings then grow 2% p.a. from 2022 to 2026, followed by stable landings. Shellfish landings decline 2% p.a. from 2020 due to overexploitation and are then stable from 2027. Pelagic landings are stable. Mobile demersal gears may be displaced from some (or parts of) existing MPAs, under existing management measures (no new management measures are implemented).	There is a 5% reduction in demersal landings and a 20% reduction in shellfish landings in 2018 to support rebuilding of stocks, and a further 5% reduction in 2019 due to the landings obligation. Demersal and shellfish stocks increase 5% p.a. from 2021 to 2026. Pelagic landings are stable. Mobile demersal gears may be displaced from some (or parts of) existing MPAs, under existing management measures (no new management measures are implemented).	As for BAU, except local management measures within 3nm (which may prioritise smaller, local boats) result in 25% of the 10m and over vessels' shellfish landings being caught by the under 10m sector, and there is a voluntary 10% reduction in shellfish landings from this sector in 2018 to support rebuilding of stocks, and landings increase 2%p.a. from 2022–2026. Pelagic landings are stable. Mobile demersal gears may be displaced from some (or parts of) existing MPAs, under existing management measures (no new management measures are implemented).

6-year projection

Declining stocks and the implementation of the landings obligation result in a reduction in landings volumes from the north east marine plan area under BAU and LS. There is a larger reduction in landings volume under N@W due to restrictions on catches to help rebuild stocks, and some recovery starts to be seen within the 6 years. The implementation of MPAs affects where mobile demersal fishing can take place.

6 to 20 year projection

Under BAU, stocks stabilise but landings are below 2017 levels, due to declining shellfish stocks. Efforts to manage local stocks and prioritise the inshore fleet under LS result in some increases in landings, from both demersal and shellfish stocks, however this has a negative impact on nomadic fleets and larger vessels. Strong stock recovery under N@W results in the highest level of landings of the three scenarios. The implementation of MPAs and windfarms affects where mobile demersal fishing can take place, reducing the spatial footprint of seabed abrasion pressure and contributing to the achievement of GES for Descriptor 6 (seabed integrity). This is most pronounced under N@W, however, effort would be redistributed to fishing grounds outside of the affected areas where intensity would increase. Under LS, the increasingly local focus of economic activity and decline in international markets potentially has the greatest impact on the fisheries sector under this scenario, resulting in reduced exports for fish and shellfish. However, this is offset to some extent by increasing local consumption of fish and shellfish, particularly in combination with increased tourism, and development of local markets.

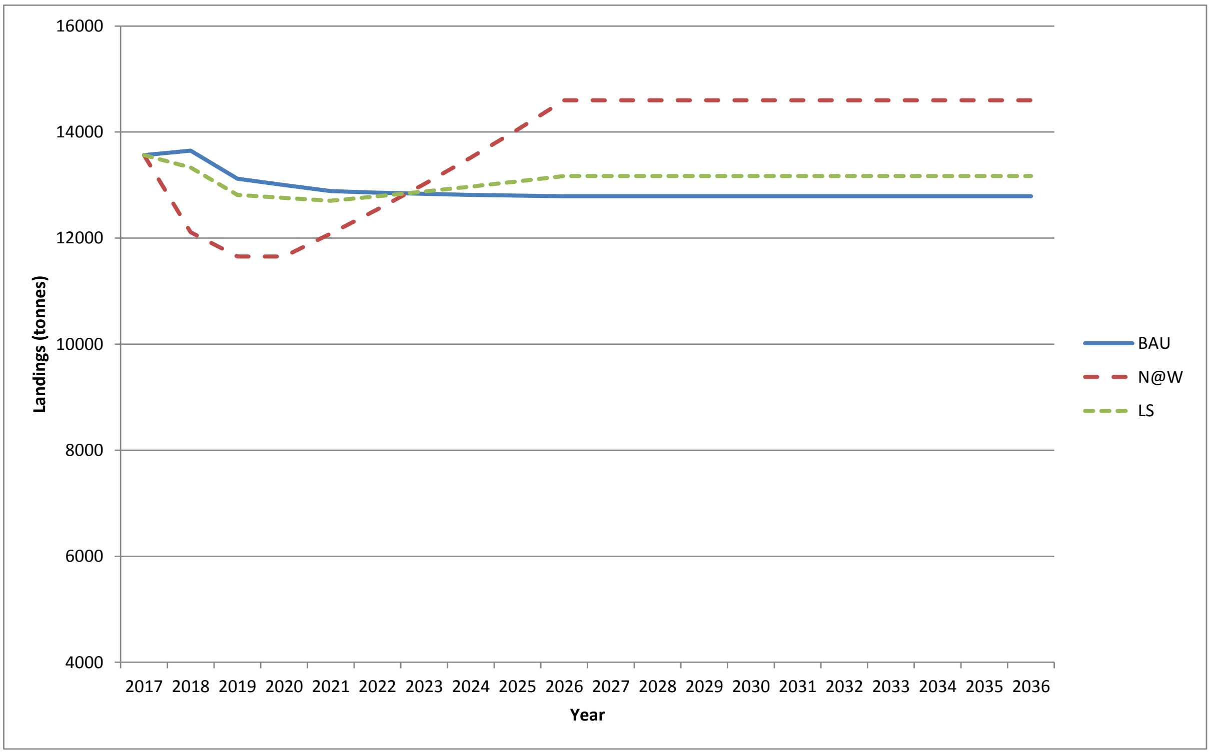


Figure 98: Volume of landings from the north east marine plan areas between 2017 and 2036 under the three scenarios

Potential trade-offs

The main potential interactions for commercial fisheries are likely to be:

- Natural environment (impacts on fish stocks, damage to benthic habitats and protection areas)
- Interactions between different fishing gears (mobile vs static gears)
- Other infrastructure.

The footprint of fishing activity in the north east marine plan areas is projected to decrease over time as a result of management measures within marine protected areas and exclusion due the presence of new infrastructure. Displacement of fisheries activity may result in new interactions (and associated trade-offs) elsewhere. Displacement effects may be greater under the LS scenario if bottom towed gears are displaced further offshore.

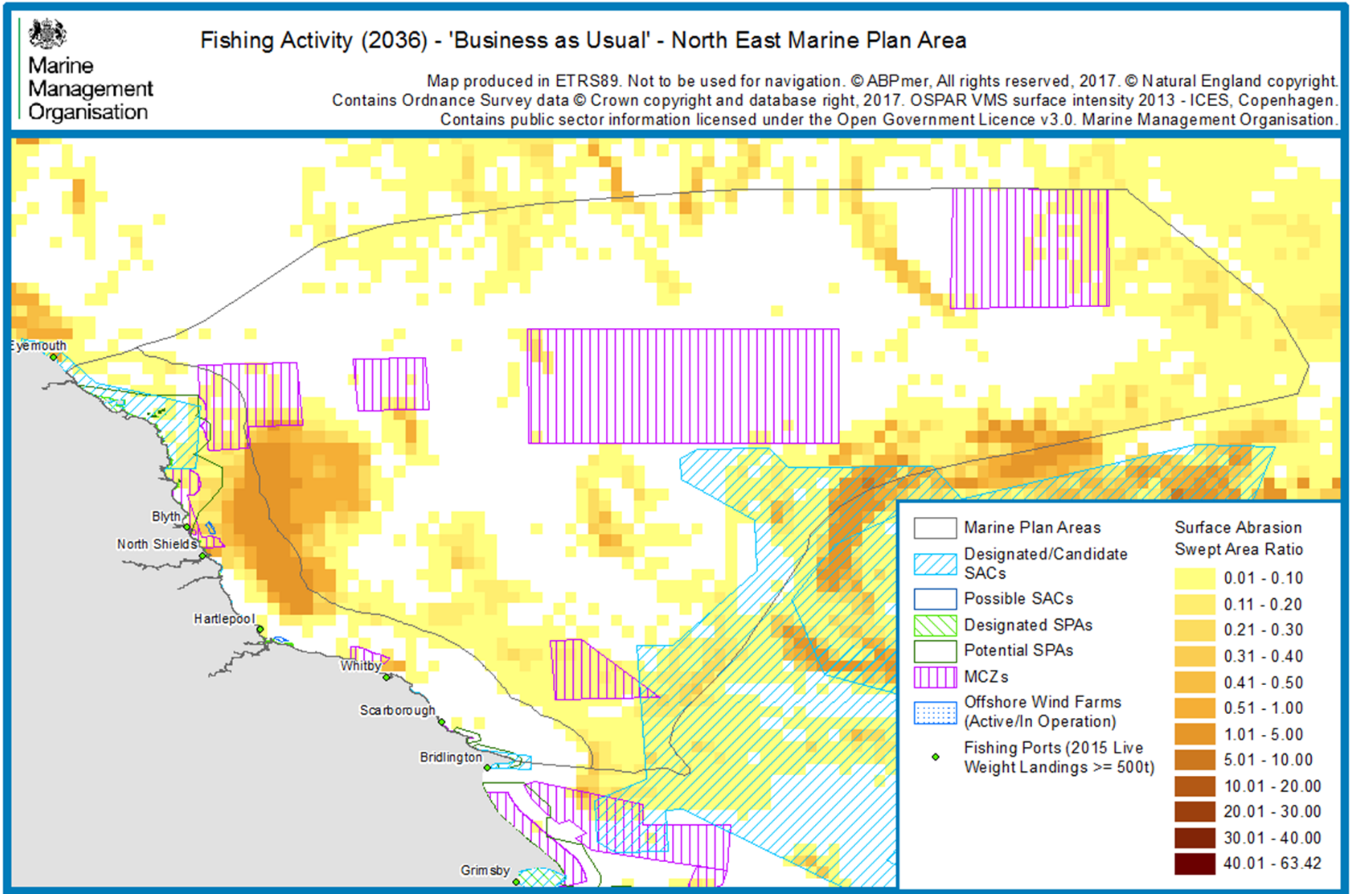


Figure 99: Fisheries (2036) – BAU – north east marine plan areas

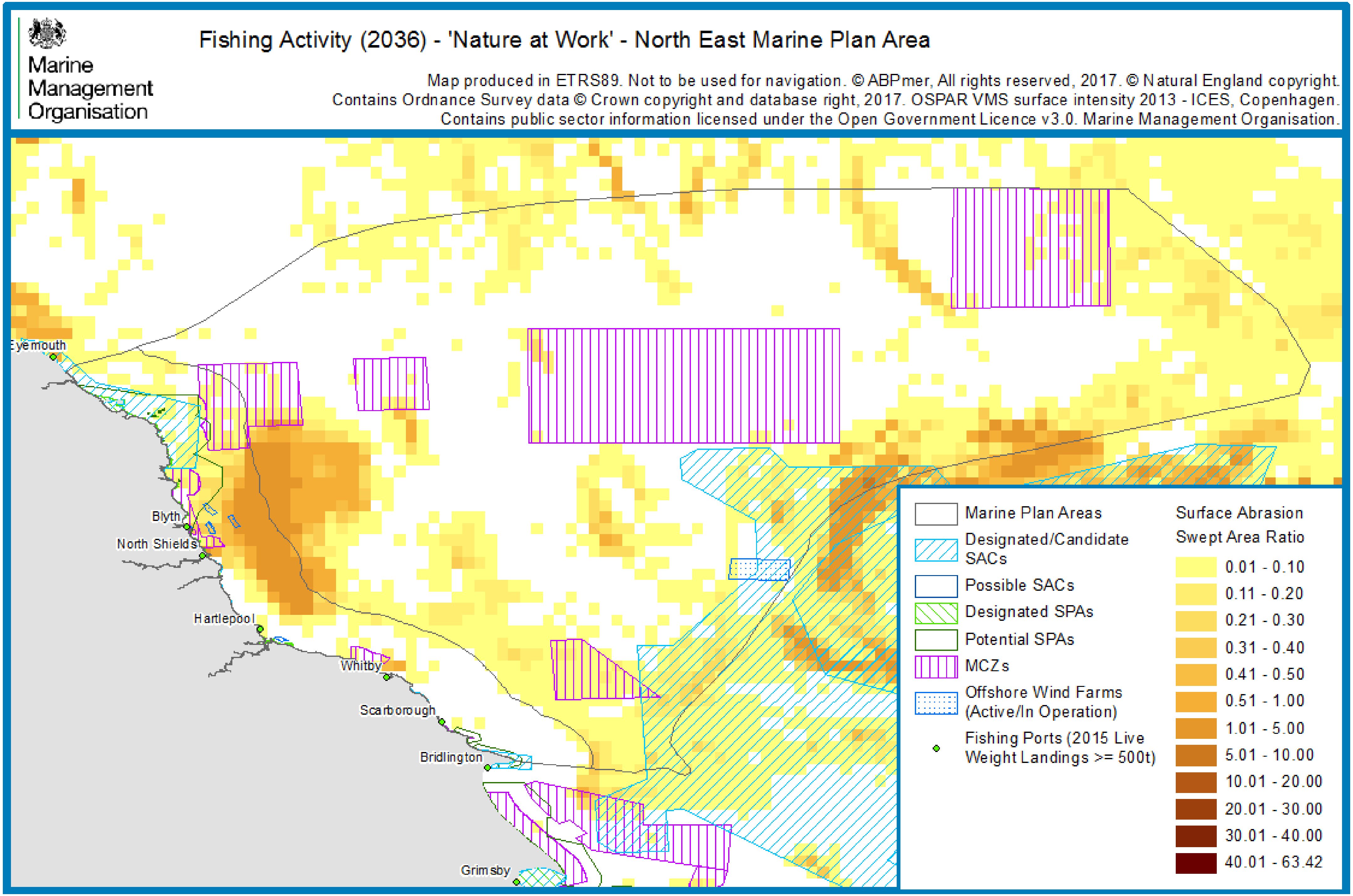


Figure 100: Fisheries (2036) – N@W – north east marine plan areas

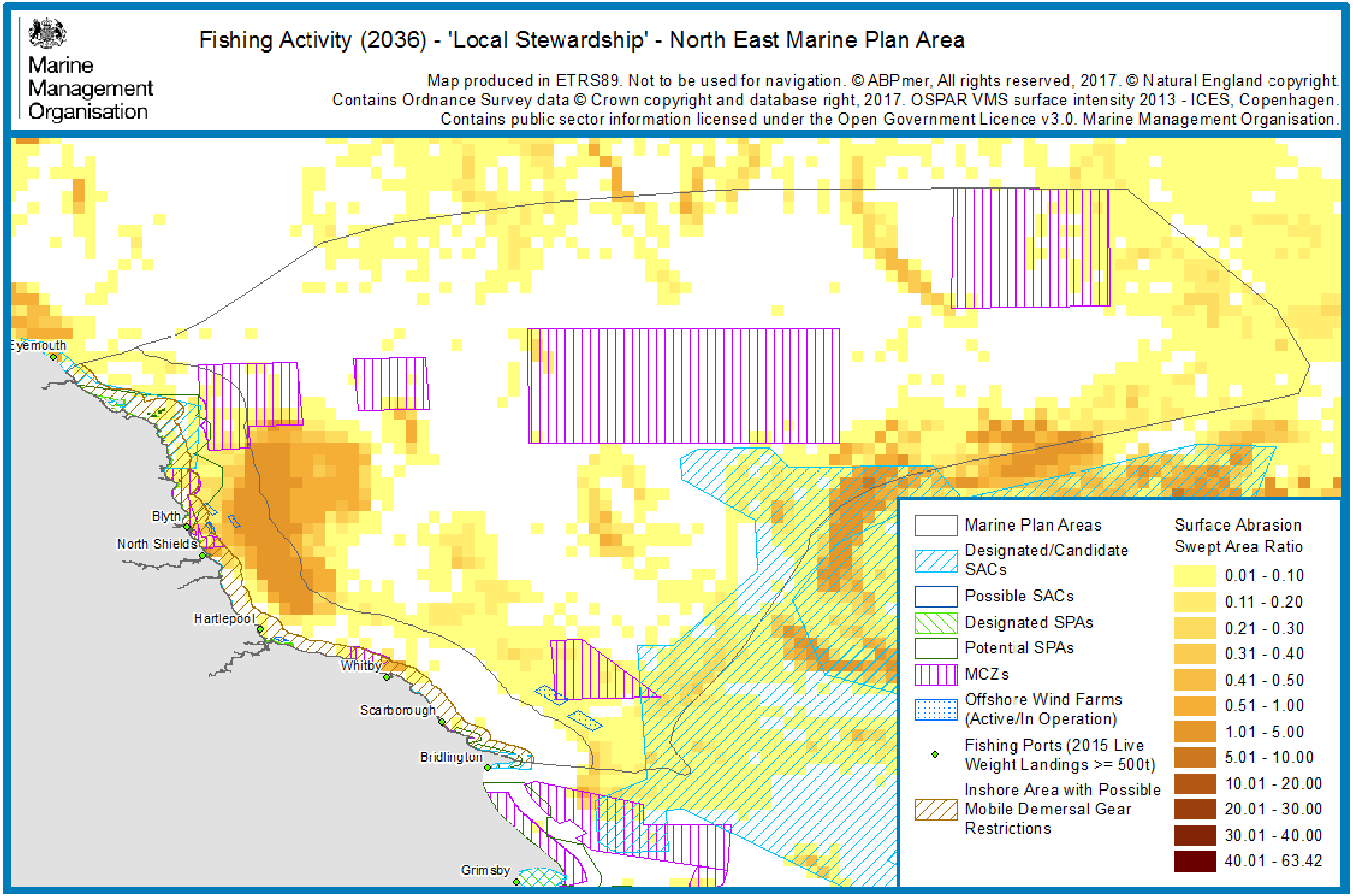


Figure 101: Fisheries (2036) – LS – north east marine plan areas

11.3 North west

In this region, a total of 3,740 t of fish and shellfish worth £3.3 million were taken annually by UK vessels between 2010 and 2014 (Table 64) (based on landings volumes and values from ICES rectangles that overlap[20] with the north west marine plan area). The trend in the volume of landings is shown in Figure 102. The majority of landings are taken by 10m and over vessels, and are dominated by shellfish. Landings of demersal and pelagic fish species are minimal.

Table 64: Average volume and value of demersal, pelagic and shellfish landings (2010-2014) for under-10m and 10m and over vessels, from ICES rectangles overlappingthe north west marine plan areas

Fishing sector	Average volume 2010-2014 (tonnes)	Average value 2010-2014 (£)
10m and Under		
Demersal (10m and under vessels)	61	105,892
Pelagic (10m and under vessels)	0	43
Shellfish (10m and under vessels)	69	215,206
Over 10m		
Demersal (over-10m vessels)	207	261,453
Pelagic (over-10m vessels)	0	16
Shellfish (over-10m vessels)	3,403	2,692,735
Total	3,740	3,275,346

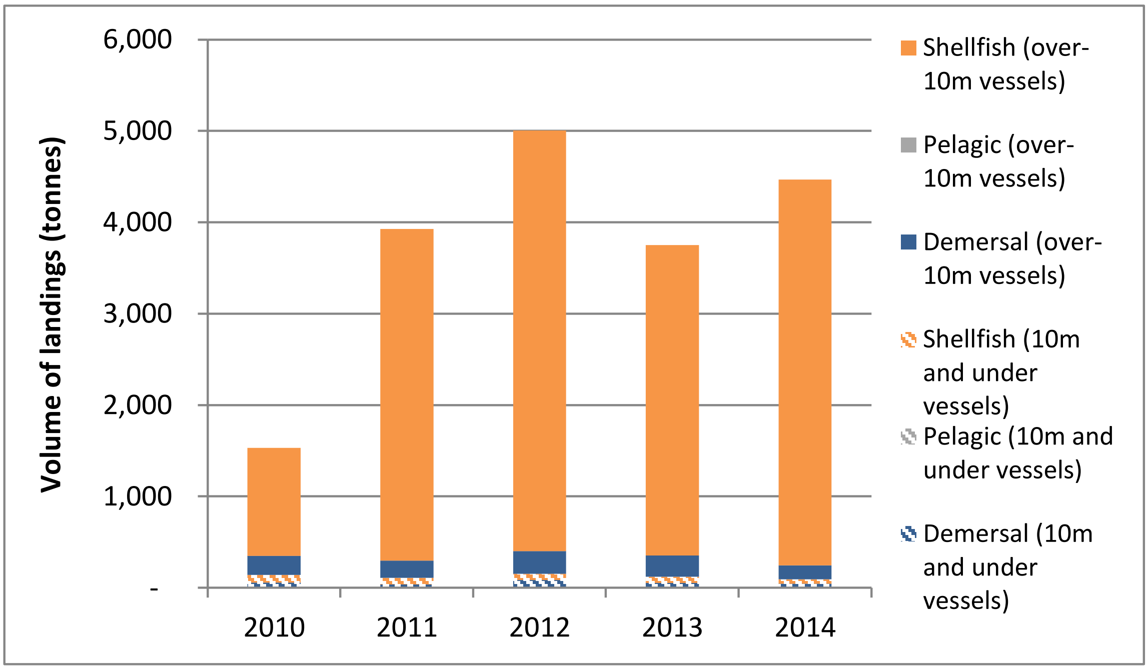


Figure 102: Trends in volume of landings by under-10m and 10m and over vessels, from ICES rectangles overlapping the north west marine plan areas, 2010-2014

[20] ICES rectangles whose centroid is within the north west marine plan area: 35E7, 36E6, 36E7, 37E6, 37E7, 38E6.

UK over-15m vessels landed a total of 3,688 tonnes (all gears), worth £3 million in 2015 (MMO, 2017b). The vast majority of landings were caught using mobile gear (86% of volume, worth £2.5 million), with passive gear accounting for 15% of landing volume (worth £451,000). The highest fishing effort using mobile gears (based on areas showing the highest value of landings), occurs along the seaward boundary of the north west offshore marine plan area (see Figure 90), and there is relatively low levels of fishing effort using passive gears by vessels 15m and over in these marine plan areas.

The north west marine plan areas lie within ICES Division VIIa, in which shellfish make up the majority of the UK vessel landings into the UK and abroad by value, being dominated by scallops and *Nephrops*, with some whelks, lobsters, crabs and mussels. Herring are taken as pelagics and the main demersal species are haddock, monkfish, skates and rays and hake (MMO, 2016c).

Non-UK vessels with historical access rights in the 6-12nm zone include Ireland, targeting *Nephrops*, and France, targeting multiple species. Other non-UK vessels fishing beyond 12nm in ICES Division VIIa include Irish, Isle of Man and Belgian registered vessels (see Figure 93; note, it is not known from the data shown what proportion of landings come from waters within the offshore marine plan area).

The most commonly used gears by under-15m vessels are demersal trawls followed by nets. Demersal trawl effort occurs within most of the inshore marine plan area, concentrated particularly around Morecambe Bay and the River Dee. The number of vessels using nets is also highest around Morecambe Bay and the River Dee. Lower numbers of vessels use pots, lines, mobile pelagic gear and dredges within the marine plan area.

The North Western IFCA Annual Report (NWIFCA, 2016)[21], indicates that species targeted in the district in 2015/16 included crab and lobster (via potting; 39,284 pot sets between April 2015 and March 2016, returning 4,539 kg of brown crab and 10,940 kg lobster), *Nephrops*, whelks, mussels and cockles. Gears used include nets and pots (NWIFCA, 2016). It was not specified whether these landings related specifically to under 15m vessels.

The assumptions used to develop the BAU, N@W and LS scenarios for fisheries in the north west marine plan areas are provided in Table 65. The projected volume of landings under each of the three scenarios is shown in Figure 103. Figure 104, Figure 105, and Figure 106 show the spatial application of the scenarios to the sector which the text below provides a brief description of the future trends in 6 years and 6 to 20 years.

[21] The North Western IFCA district extends from the Welsh Border in the Dee Estuary to the Scottish Border in the Solway Firth and includes coastal Council landward areas and all sea areas up to 6 nm offshore.

Table 65: Assumptions and impacts under the future scenarios for commercial fisheries in the north west marine plan areas

Aspect	Scenario		
	Business as Usual	Nature @ Work	Local Stewardship
Application to the sector	As for the north east marine plan area (see Table 63).	As for the north east marine plan area (see Table 63).	As for the north east marine plan area (see Table 63).
Assumptions	Landings from demersal stocks decline 2%p.a. to 2020, and shellfish landings are stable, except implementation of the landings obligation results in a 5% reduction in demersal and shellfish landings in 2019. Demersal landings then grow 2% p.a. from 2022 to 2026, followed by stable landings, and shellfish landings grow 2% p.a. from 2023–2025 as fleets adjust. Pelagic landings are stable. Mobile demersal gears may be displaced from some (or parts of) existing MPAs, under existing management measures (no new management measures are implemented).	There is a 5% reduction in demersal landings and a 20% reduction in shellfish landings in 2018 to support rebuilding of stocks, and a further 5% reduction in 2019 due to the landings obligation. Demersal and shellfish stocks increase 5% p.a. from 2021 to 2026. Pelagic landings are stable. Mobile demersal gears may be displaced from some (or parts of) existing MPAs, under existing management measures (no new management measures are implemented).	As for BAU, except local management measures within 3nm (which may prioritise smaller, local boats) result in 25% of the 10m and over vessels' shellfish landings being caught by the under 10m sector, and there is a voluntary 10% reduction in shellfish landings from this sector in 2018 to support rebuilding of stocks. Pelagic landings are stable. Mobile demersal gears may be displaced from some (or parts of) existing MPAs, under existing management measures (no new management measures are implemented).

6-year projection

The implementation of the Landings Obligation results in a reduction in landings volumes from the north west marine plan area under BAU and LS. There is a larger reduction in landings volume under N@W due to restrictions on catches to help rebuild stocks, and some recovery starts to be seen within the 6 years. The implementation of MPAs and windfarms affects where mobile demersal fishing can take place, particularly the various Walney areas, (all scenarios).

6 to 20 year projection

Under BAU, stocks are stable but landings are below 2017 levels. Efforts to manage local stocks and prioritise the inshore fleet under LS result in the redistribution of catches from larger to smaller vessels, but this does not have a significant effect on landings. Stock recovery under N@W results in the highest level of landings of the three scenarios. The implementation of MPAs and windfarms affects where mobile demersal fishing can take place, reducing the spatial footprint of seabed abrasion pressure. This is most pronounced under N@W, with the operation of all Walney sites and also the Celtic array windfarm, as well as MCZs, affecting *Nephrops* and scallop grounds. Some effort would likely be redistributed to fishing grounds outside of the affected areas where intensity would increase. Under LS, the increasingly local focus of economic activity and decline in international markets potentially has the greatest impact on the fisheries sector under this scenario, resulting in reduced exports for fish and shellfish. However, this is offset to some extent by increasing local consumption of fish and shellfish, particularly in combination with increased tourism, and development of local markets.

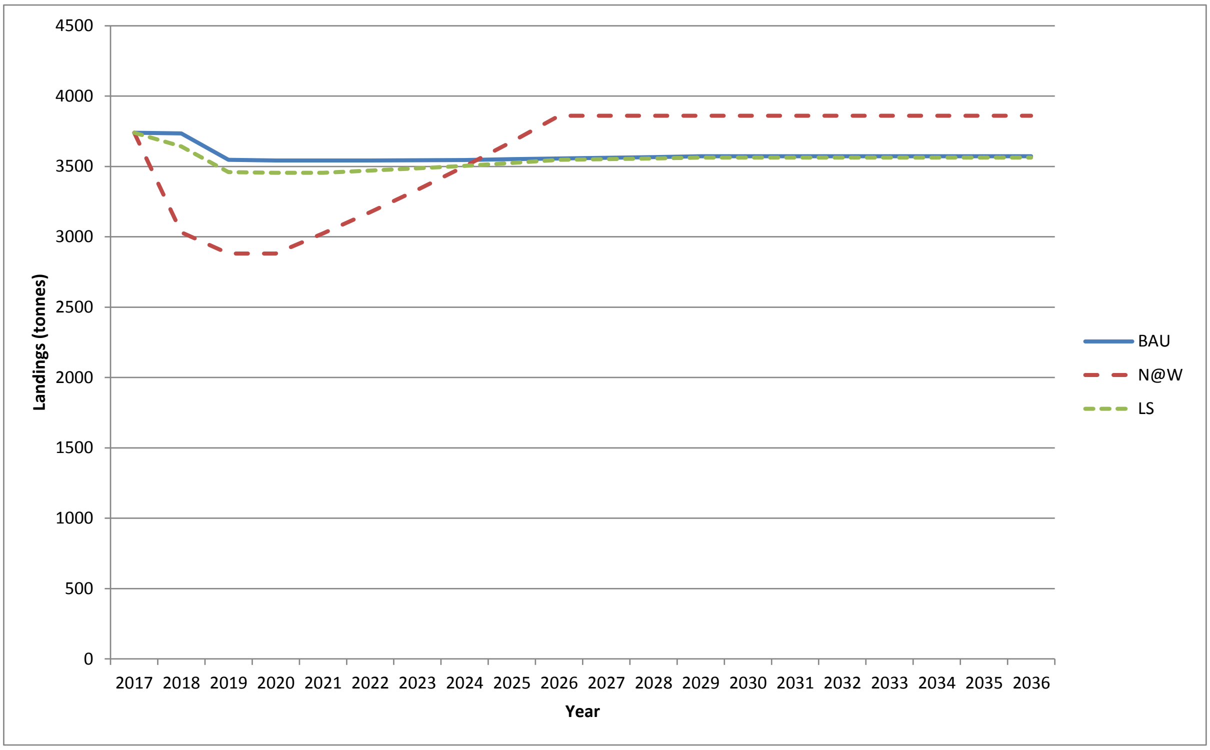


Figure 103: Volume of landings from the north west marine plan areas between 2017 and 2036 under the three scenarios

Potential trade-offs

The potential trade-offs are similar to the north east marine plan areas.

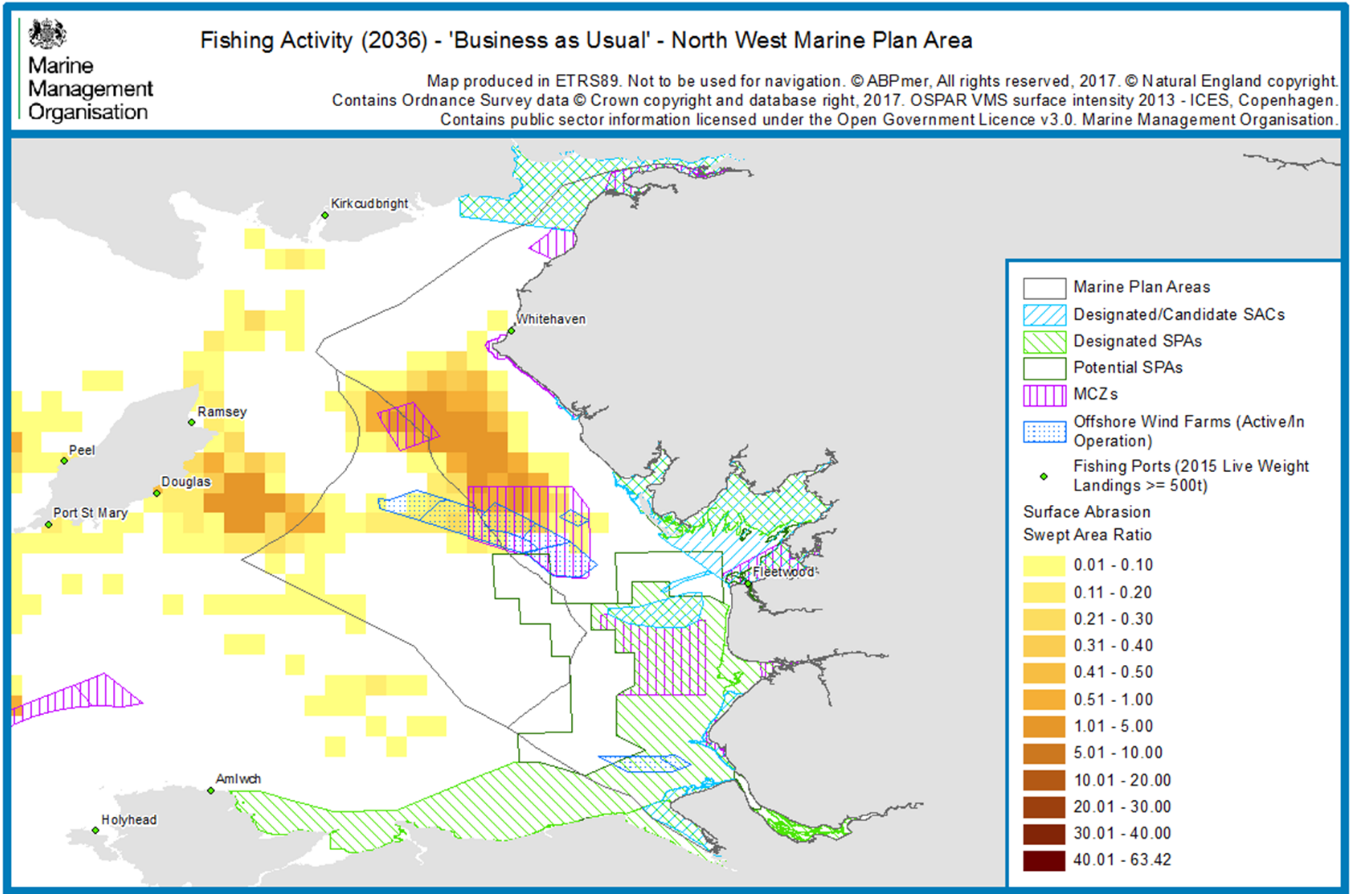


Figure 104: Fisheries (2036) – BAU – north west marine plan areas

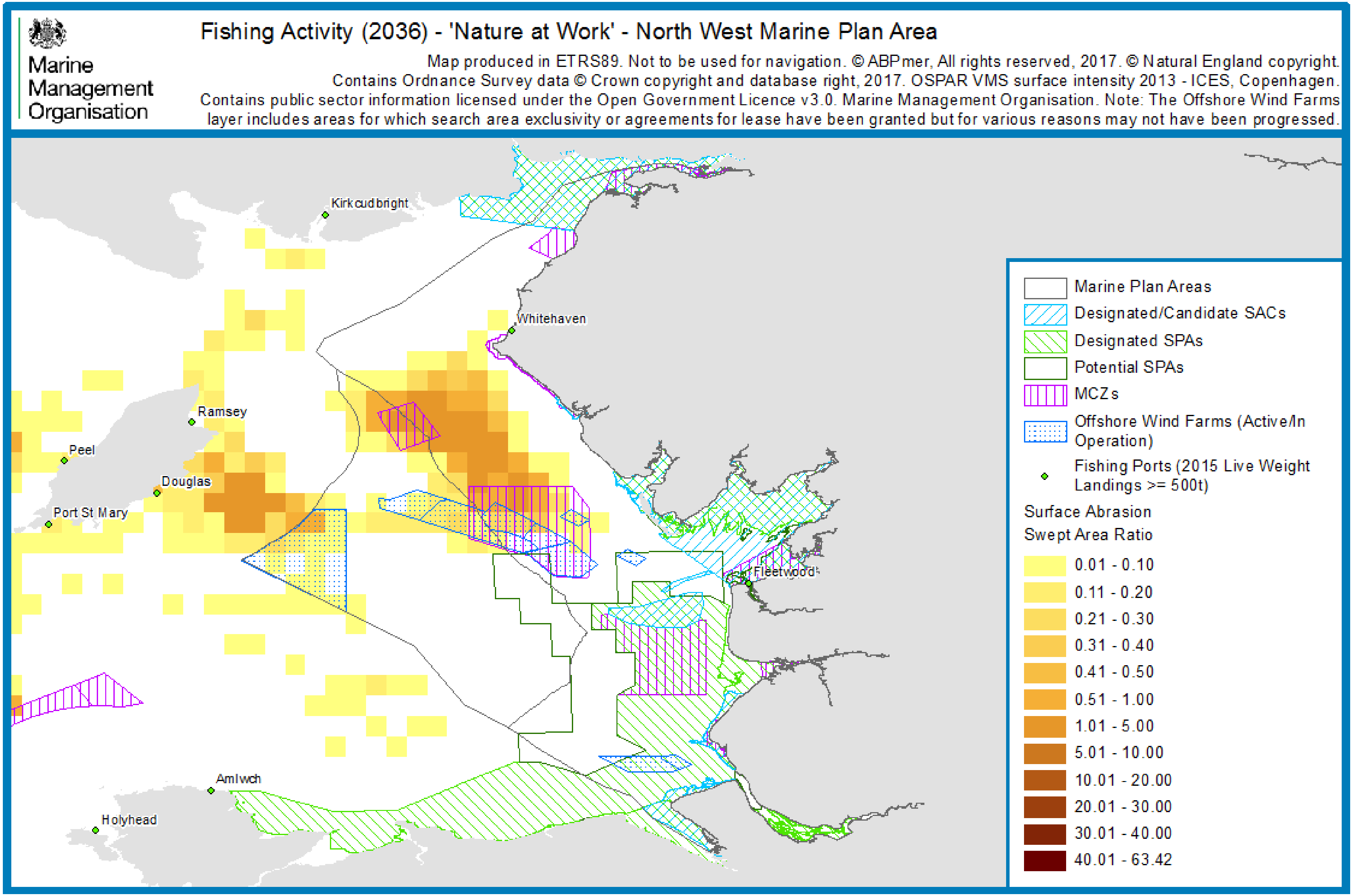


Figure 105: Fisheries (2036) – N@W – north west marine plan areas

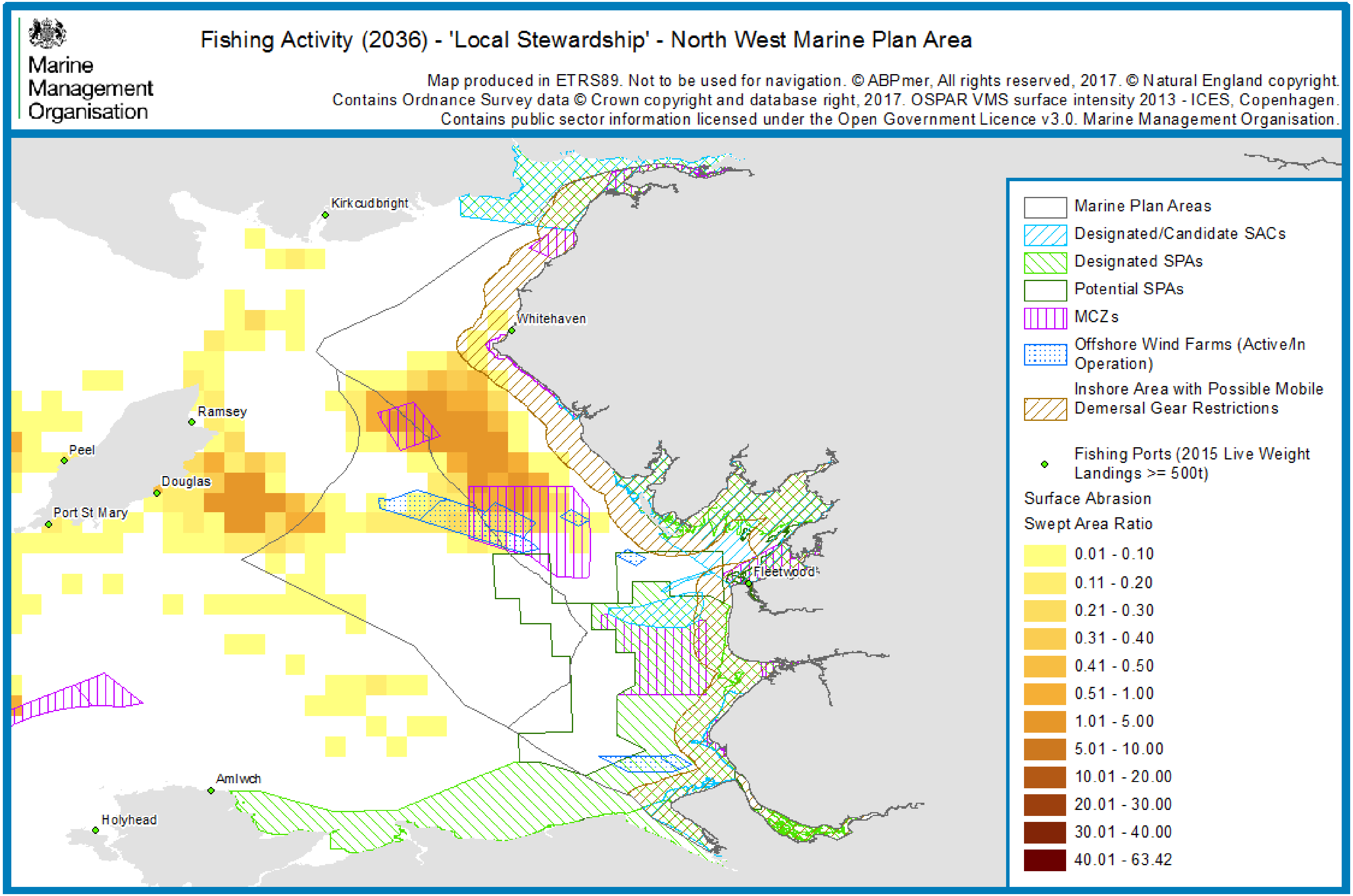


Figure 106: Fisheries (2036) – LS – north west marine plan areas

11.4 South east

In this region, a total of 3,500 t of fish and shellfish worth £3.9 million were taken annually by UK vessels between 2010 and 2014 (Table 66) (based on landings volumes and values from ICES rectangles that overlap[22] with the south east marine plan area). The trend in the volume of landings is shown in Figure 107. Landings have been dominated by under-10m vessels, but in 2013 and 2014 landings by 10m and over vessels increased significantly, particularly for shellfish, but also for pelagics in 2014.

Table 66: Average volume and value of demersal, pelagic and shellfish landings (2010-2014) for under-10m and 10m and over vessels, from ICES rectangles overlapping the south east marine plan areas

Fishing sector	Average volume 2010-2014 (tonnes)	Average value 2010-2014 (£)
10m and Under		
Demersal (10m and under vessels)	549	1,397,509
Pelagic (10m and under vessels)	220	37,102
Shellfish (10m and under vessels)	793	798,945
Over 10m		
Demersal (over-10m vessels)	114	209,831
Pelagic (over-10m vessels)	427	130,789
Shellfish (over-10m vessels)	1,446	1,280,486
Total	3,549	3,854,662

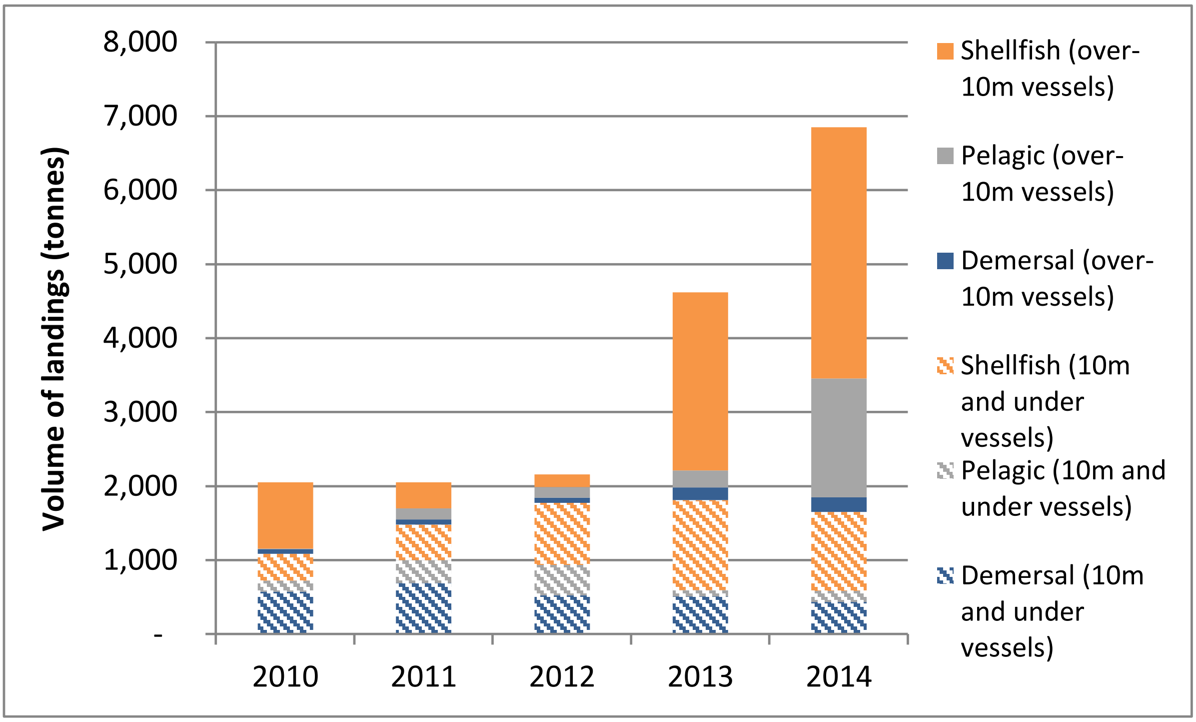


Figure 107: Trends in volume of landings by under-10m and 10m and over vessels, from ICES rectangles overlapping the south east marine plan areas, 2010-2014

[22] ICES rectangles whose centroid is within the south east marine plan area: 31F0, 31F1, 32F0.

UK over-15m vessels landed a total of 345 t (all gears), worth £208,000 in 2015 (MMO, 2017b). All of the landings from these over 15m vessels were caught using mobile gear. Figure 90 and Figure 91 indicate that there is very little fishing effort by vessels 15m and over in length (using either mobile or passive gears) in this marine plan area.

The south east marine plan area lies within ICES Division IVc, in which shellfish make up the majority of the UK vessel landings into the UK and abroad by value, being dominated by cockles, whelks, lobster, shrimps and prawns and crabs, with some scallops, squid, mussels, cuttlefish and oysters. Horse mackerel and herring are taken as pelagics and the main demersal species are sole, bass, cod and plaice (MMO, 2016c).

Non-UK vessels with historical access rights in the 6-12nm zone include Belgian vessels, targeting demersal species, and French vessels, targeting multiple species. Other non-UK vessels fishing beyond 12nm in ICES Division IVc include Dutch, Danish, French and Belgian registered vessels (see Figure 93; note, it is not known from the data shown what proportion of landings come from waters within the south east marine plan area).

The figures indicate that the most commonly used gears by under-15m vessels are demersal trawls, followed by nets and lines. Demersal trawl effort is evenly distributed throughout the marine plan area. Fishing effort using nets and lines is highest in the north of the marine plan area adjacent to the Essex coast. There are relatively few vessels using pots and no vessels using mobile pelagic gear or dredges.

The assumptions used to develop the BAU, N@W and LS scenarios for fisheries in the south east marine plan areas are provided in Table 67. The projected volume of landings under each of the three scenarios is shown in Figure 108. Figure 109, Figure 110 and Figure 111 show the spatial application of the scenarios to the sector which the text below provides a brief description of the future trends in 6 years and 6 to 20 years.

Table 67: Assumptions and impacts under the future scenarios for commercial fisheries in the south east marine plan areas

Aspect	Scenario		
	Business as Usual	Nature @ Work	Local Stewardship
Application to the sector	As for the north east marine plan area (see Table 63).	As for the north east marine plan area (see Table 63).	As for the north east marine plan area (see Table 63).
Assumptions	Demersal stocks continue to rebuild. However, implementation of the landings obligation results in a 5% reduction in demersal and shellfish landings in 2019. Demersal landings then grow 2% p.a. from 2022 to 2026, followed by stable landings.	Demersal stocks continue to rebuild. However, there is a 5% reduction in demersal landings and a 20% reduction in shellfish landings in 2018 to support rebuilding of stocks, and a further 5% reduction in 2019 due to the landings obligation.	As for BAU, except local management measures within 3nm (which may prioritise smaller, local boats) result in 25% of the 10m and over vessels' shellfish landings being caught by the under 10m sector, and there is a voluntary 10% reduction in shellfish landings from this sector in 2018 to support

Aspect	Scenario		
	Business as Usual	Nature @ Work	Local Stewardship
	Shellfish landings decline 2% p.a. from 2020 due to overexploitation and are then stable from 2027. Pelagic landings are stable. Mobile demersal gears may be displaced from some (or parts of) existing MPAs, under existing management measures (no new management measures are implemented).	Demersal and shellfish stocks increase 5% p.a. from 2021 to 2026. Pelagic landings are stable. Mobile demersal gears may be displaced from some (or parts of) existing MPAs, under existing management measures (no new management measures are implemented).	rebuilding of stocks, and landings increase 2% p.a. from 2022–2026. Pelagic landings are stable. Mobile demersal gears may be displaced from some (or parts of) existing MPAs, under existing management measures (no new management measures are implemented).

6-year projection

The implementation of the landings obligation results in a reduction in landings volumes from the south east marine plan area under BAU and LS. There is a larger reduction in landings volume under N@W due to restrictions on catches to help rebuild stocks, and some recovery starts to be seen within the 6 years. The implementation of MPAs and windfarms affects where mobile demersal fishing can take place, as the Thanet extension is constructed during this period.

6 to 20 year projection

Under BAU, stocks are stable but landings are below 2017 levels, due to declines in shellfish stocks. Efforts to manage local stocks and prioritise the inshore fleet under LS result in the redistribution of catches from larger to smaller vessels, and reduction of shellfish landings by under-10m vessels results in rebuilding of the stocks and higher levels of landings overall compared to BAU. Stock recovery under N@W results in the highest level of landings of the three scenarios. The implementation of MPAs and windfarms affects where mobile demersal fishing can take place, reducing the spatial footprint of seabed abrasion pressure. This is most pronounced under N@W, with the operation of the London Array and Thanet extension areas, as well as MPAs. Some effort would likely be redistributed to fishing grounds outside of the affected areas where intensity would increase. Under LS, the increasingly local focus of economic activity and decline in international markets potentially has the greatest impact on the fisheries sector under this scenario, resulting in reduced exports for fish and shellfish. However, this is offset to some extent by increasing local consumption of fish and shellfish, particularly in combination with increased tourism, and development of local markets.

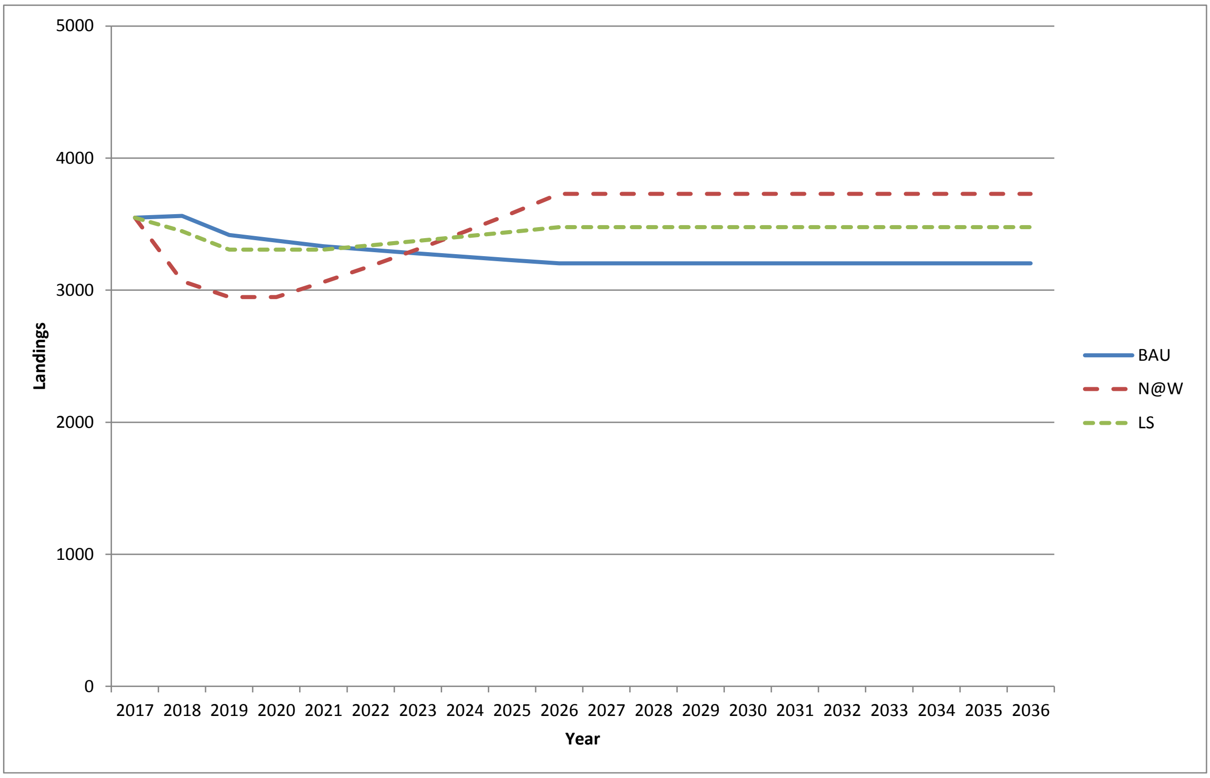


Figure 108: Volume of landings from the south east marine plan areas between 2017 and 2036 under the three scenarios

Potential trade-offs

The potential trade-offs are similar to the north east marine plan areas.

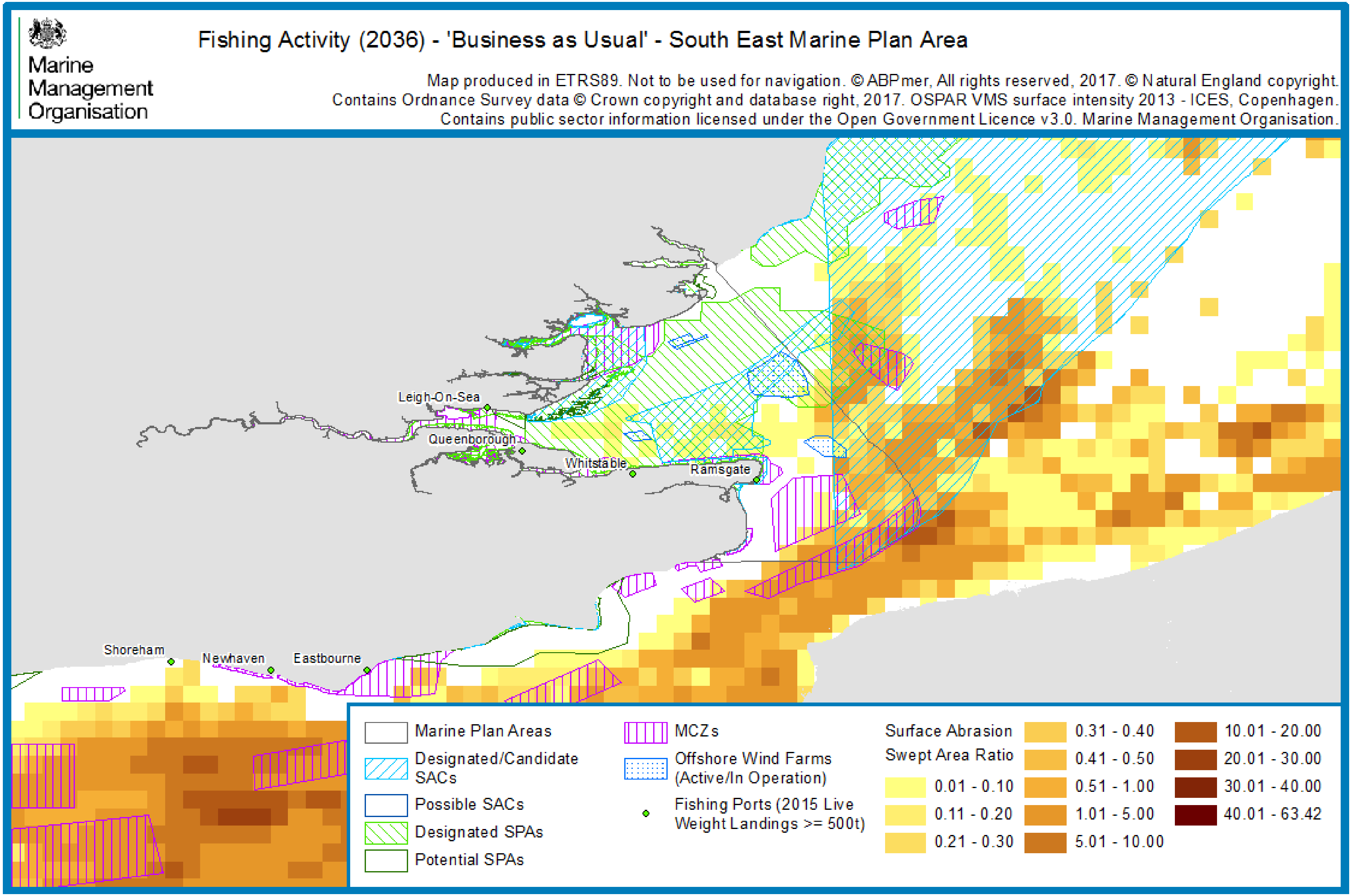


Figure 109: Fisheries (2036) – BAU – south east marine plan area

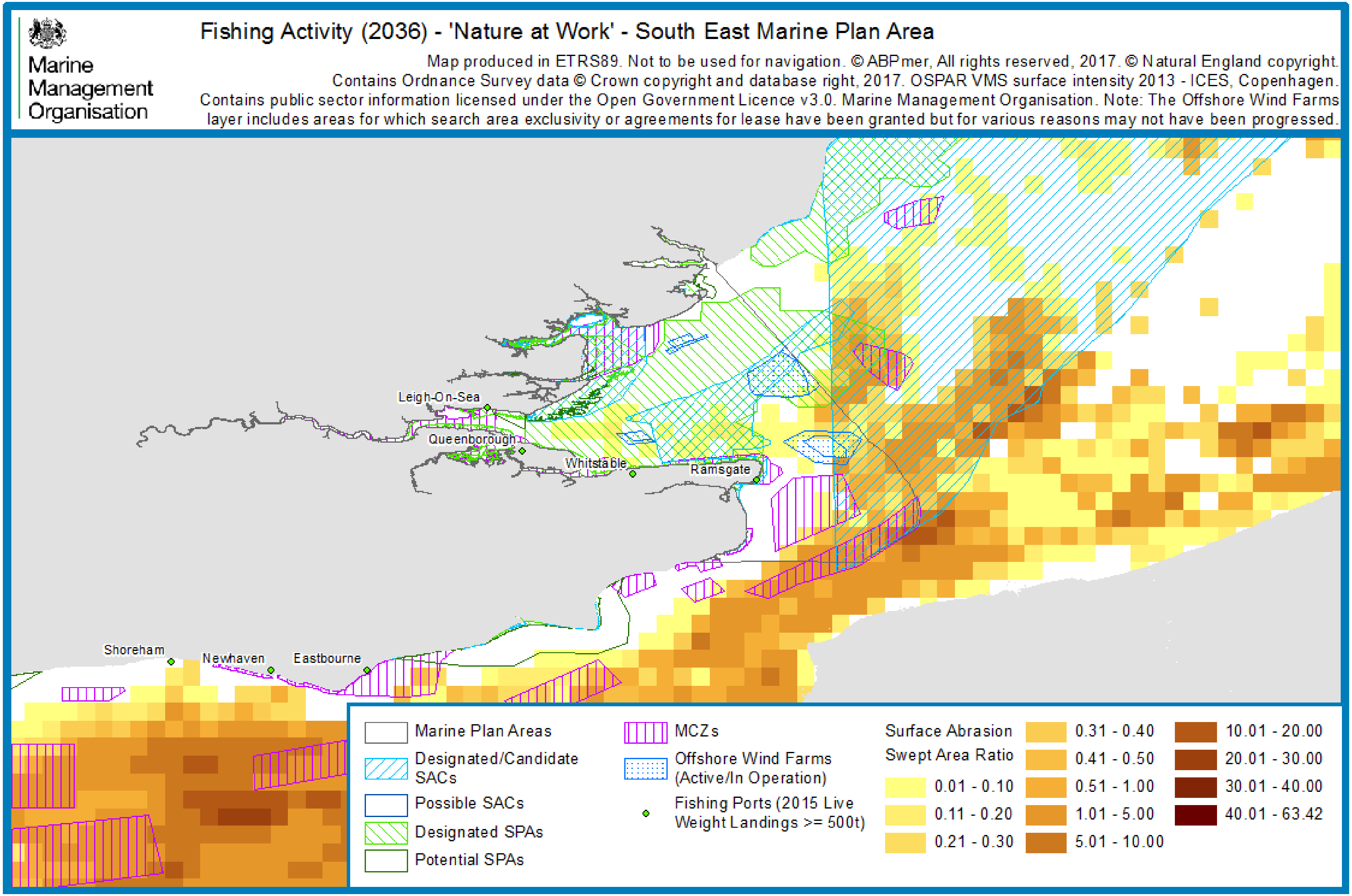


Figure 110: Fisheries (2036) – N@W – south east marine plan area

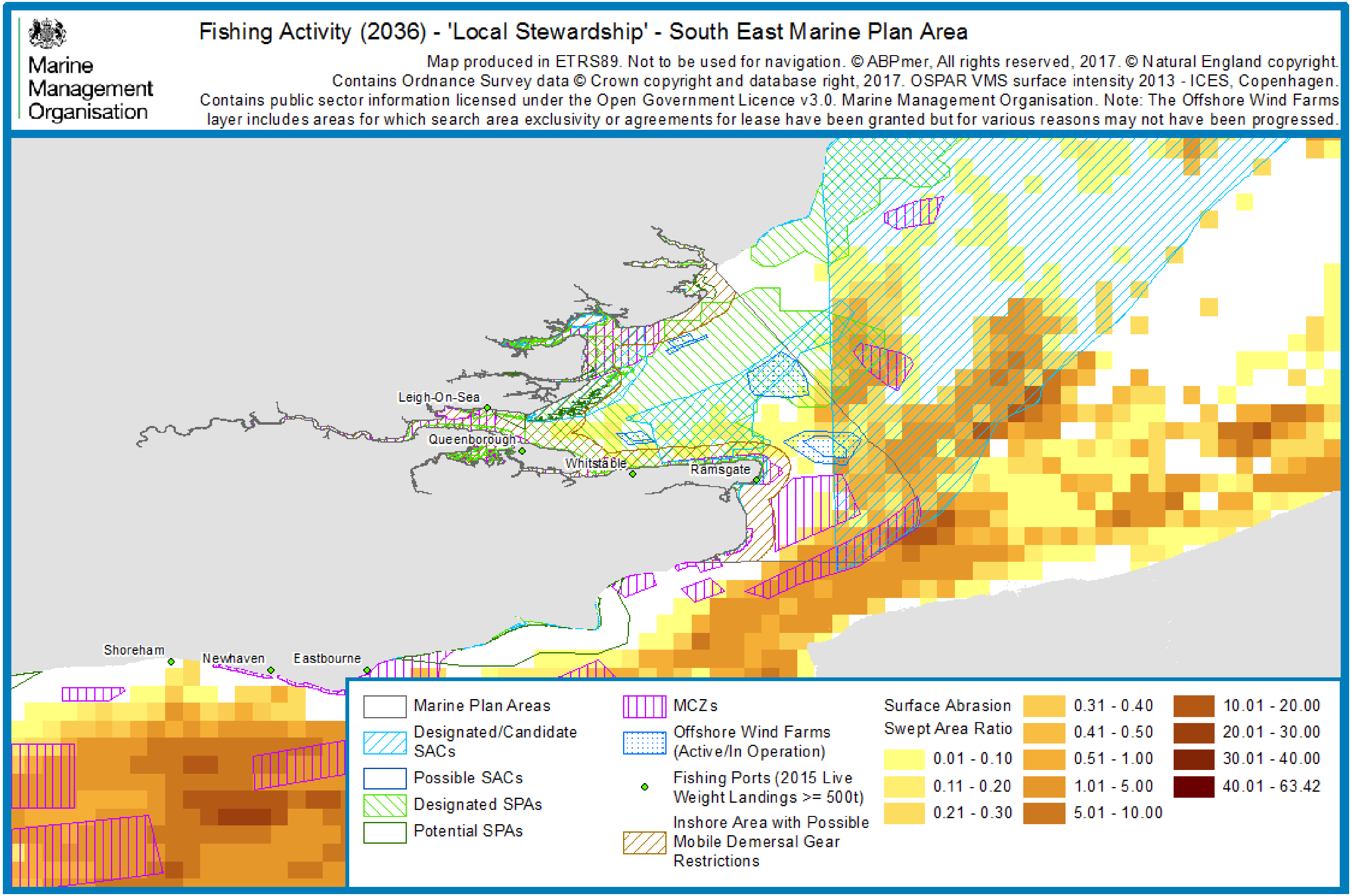


Figure 111: Fisheries (2036) – LS – south east marine plan area

11.5 South west

In this region, a total of 13,500 t of fish and shellfish worth £24.5 million were taken annually by UK vessels between 2010 and 2014 (Table 68) (based on landings volumes and values from ICES rectangles that overlap[23] with the south west marine plan area). The trend in the volume of landings is shown in Figure 112. The majority of landings are taken by 10m and over vessels, but under-10m vessels also land significant volumes and values of fish and shellfish. Landings by 10m and over vessels are dominated by demersal fish, but shellfish are also significant and there are sizeable landings of pelagics. The under-10m landings include demersal, pelagic and shellfish species.

The south west is an important area for fisheries, with the second highest volume and value of landings in the UK (by UK vessels) after Scotland. The three main landing ports in England are in this region — in 2015, Plymouth had the largest quantity of landings in England (13,000 t), followed by Brixham and Newlyn with 12,000 t. However, the value of landings in Brixham (£23 million) and Newlyn (£22 million) were higher than in Plymouth (£15 million), largely due to receiving larger volumes of higher-value demersal fish and shellfish than Plymouth (MMO, 2016c).

UK over-15m vessels landed a total of 14,310 t (all gears), worth £30.6 million in 2015 (MMO, 2017b). The vast majority were caught using mobile gear (80% of volume, worth £25.7 million), with passive gear accounting for 20% of landing volume (worth £4.9 million). Figure 90 indicates that the highest fishing effort using mobile gears (based on areas showing the highest value of landings), occurs within the offshore marine plan area off the south Devon coastline. The figure indicates that fishing effort using passive gears is relatively concentrated in a few areas in the inshore marine plan area (off the north Cornwall coast between Lands End and St Ives and around the south Devon coastline near Brixham) and in the adjacent offshore marine plan area (between 6 and 12nm) off the south Devon coast.

Additional information provided by the Cornwall IFCA indicates that pots and nets are used throughout the 6nm area in this District. There is also fairly extensive fishing effort using mobile gear from Lizard Point to Plymouth within 12nm (predominately under-15m vessels within 6nm, most of which are vessels under 12m targeting scallops). There is a relatively limited amount of fishing effort for scallop on the north coast of Cornwall within 6–12nm (Sam Davies, Cornwall IFCA, pers. comm. 04.04.17).

The south west marine plan areas lie within ICES Subarea VII (Irish Sea, West of Ireland, Porcupine Bank, Eastern and Western English Channel). Shellfish make up the majority of the UK vessel landings into the UK and abroad by value from ICES Divisions VIId and VIIe (English Channel), being dominated by scallops, crabs, cuttlefish and whelks, with some squid, lobsters, oysters and other shellfish. Horse

[23] ICES rectangles whose centroid is within the south west marine plan area: 25E0, 26E1, 26E2, 27E1, 27E2, 27E3, 27E4, 28E1, 28E2, 28E3, 28E4, 28E5, 28E6, 29E2, 29E3, 29E4, 29E5, 29E6, 30E3, 30E4, 30E5, 31E5, 31E6, 32E7.

mackerel, herring and sardines are taken as pelagics and the main demersal species are sole, monkfish, lemon sole, bass and other flatfish (MMO, 2016c).

Table 68: Average volume and value of demersal, pelagic and shellfish landings (2010-2014) for under-10m and 10m and over vessels, from ICES rectangles overlapping the south west marine plan areas

Fleet sector	Average volume 2010-2014 (tonnes)	Average value 2010-2014 (£)
10m and Under		
Demersal (10m and under vessels)	2,304	5,852,361
Pelagic (10m and under vessels)	1,958	1,431,637
Shellfish (10m and under vessels)	4,058	6,730,563
Over 10m		
Demersal (over-10m vessels)	14,082	31,970,005
Pelagic (over-10m vessels)	7,818	2,171,678
Shellfish (over-10m vessels)	12,787	21,504,492
Total	43,006	69,660,735

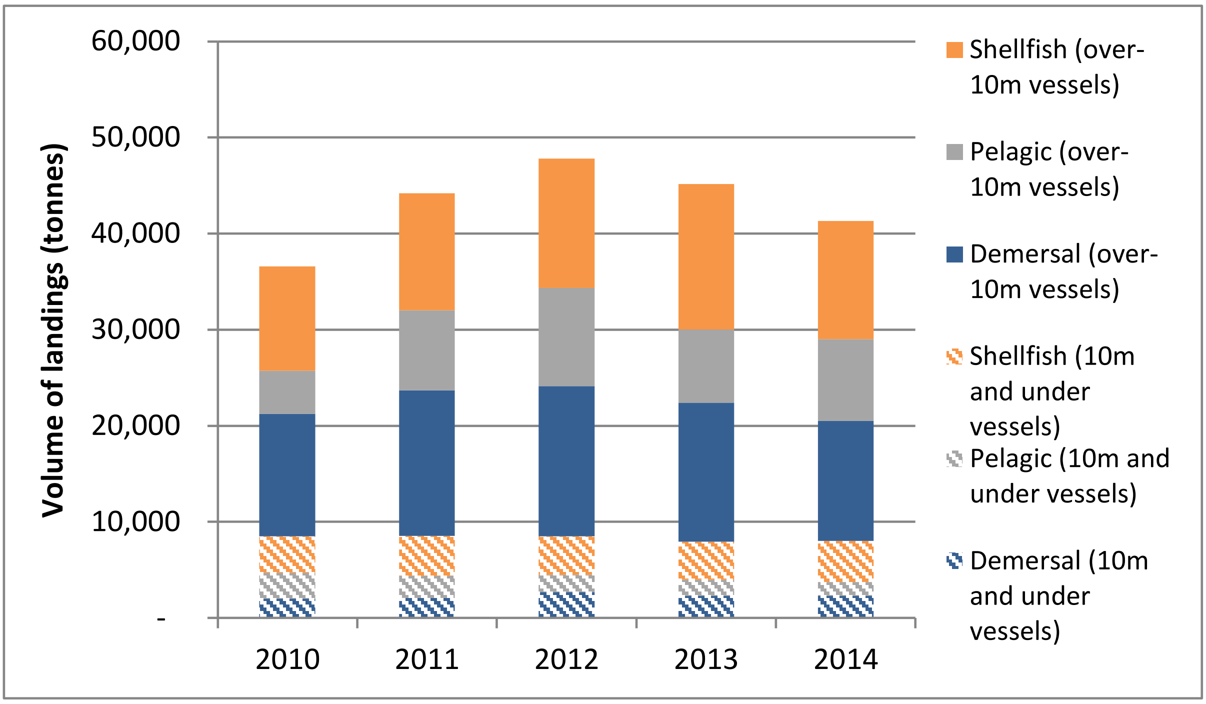


Figure 112:Trends in volume of landings by under-10m and 10m and over vessels, from ICES rectangles overlapping the south west marine plan areas, 2010-2014

In the south west portion of the offshore marine plan area, demersal fish make up the vast majority of the UK vessel landings into the UK and abroad by value (from ICES Division VIIh and VIIj), being dominated by monkfish, megrim and hake (MMO, 2016c). The hake fishery (certified by the Marine Stewardship Council) has developed recently (targeted with bottom-set nets outside 12nm), with landings at Newlyn often dominated by hake (Sam Davies, Cornwall IFCA, pers. comm. 04.04.17). Mackerel and horse mackerel are taken as pelagics and the main shellfish species are cuttlefish, squid and *Nephrops* (MMO, 2016c).

In the Bristol Channel area and off the north Cornwall coast, the majority of UK landings by value are shellfish (from ICES Divisions VIIf and VIIg), being dominated by lobsters, whelk and crabs, with some *Nephrops* and scallops. Demersal species also comprise a substantial component of landings value from these areas; the main species are hake, monkfish, turbot, sole, bass, pollack, skates and rays, and megrim (MMO, 2016c). Pelagic landings are dominated by sardines and mackerel (MMO, 2016c).

Non-UK vessels with historical access rights in the 6-12nm zone include Belgian vessels targeting demersal species, and French vessels targeting lobster, crawfish, scallops and demersal species. Other non-UK vessels fishing beyond 12nm in ICES Subdivisions VIIe, VIIf, VIIg, VIIh and VIIj2 include French, Dutch, Belgian and Irish registered vessels (see Figure 93; note, it is not known from the data shown what proportion of landings come from waters within the south west marine plan areas).

The most commonly-used gears by under-15m vessels are pots, nets and lines. Potting effort is highest along the south Devon coastline with lower numbers of vessels potting off the north Devon coast. Vessels using nets and lines are also concentrated along the south Devon coast, with fewer vessels operating off the north coast. Demersal trawling is the most widespread activity by under-15m vessels in the inshore marine plan area, albeit by fewer vessels compared to those using pots, nets and lines. There are relatively few under-15m vessels using mobile pelagic gears and dredges.

The south west marine plan areas encompass both Cornwall and Devon and Severn IFCA districts. The fleet in the Cornwall IFCA district[24] is made up mainly of under 10m boats, fishing single day trips (largely within 6nm although many do fish beyond). A significant number of inshore vessels use pots to target brown crab, lobster and spider crab, while towed dredges are used to target scallops and oysters (within a Fishery Regulating Order) (Acoura, 2015c). Pot and net fisheries occur all around the coast in this IFCA District and there are 54 ports and landing stations in Cornwall. There is extensive netting along both coasts, but predominantly the southern coast, for a range of species including turbot, sole, plaice, haddock, cod and monkfish. Some vessels are involved in a seasonal net fishery for pilchards; there are 14 ring netters targeting sardines on the south coast, between Mounts Bay and Plymouth (an emerging fishery). There are small inshore under-10m trawling vessels based in Mevagissey, Loe and Plymouth, however the predominant fishing effort within 6nm using towed gear is off the north Devon coast; most of the beam trawlers in the south of the district operate offshore (Sam Davies, Cornwall IFCA, pers. comm. 04.04.17).

Between 2006 and 2010, the highest volume of landings by weight were taken by demersal trawls (lemon sole, cuttlefish, haddock, monkfish and whiting comprised the majority of the catch), beam trawls (monkfish, cuttlefish and sole dominating the catch), pots (80% brown crab) and dredges (97% scallops) (FCI, 2012).

[24] The Cornwall IFCA district extends from Marsland Mouth on the north coast of Cornwall to the western end of the Plymouth Breakwater in Plymouth Sound on the south coast. The district also includes the estuaries and all waters out to 6 nm (Acoura, 2015a).

In 2012, approximately 38,000 t of fish and shellfish were landed into ports in the Devon and Severn IFCA district[25]. The main species landed by volume were horse mackerel (20% of total landings), scallops (19%), cuttlefish (10%) and crabs (8%). The total value of landings was £53 million, with scallops (22% of total value), cuttlefish (15%), sole (9%) and crab (9%) being the top four species by value (Acoura, 2015d).

Between 2006 and 2010, the highest proportion of landings by weight (27%) was taken by pelagic trawls (where sprat dominated the catch), demersal trawl (20% of total landings; including cuttlefish, lemon sole, whiting, skates and rays, monkfish and squid), pots (19% of total landings; mainly comprising brown crab and whelks) and dredge (17% of total landings, dominated by scallops) (FCI, 2012).

The assumptions used to develop the BAU, N@W and LS scenarios for fisheries in the south west marine plan areas are provided in Table 69. The projected volume of landings under each of the three scenarios is shown in Figure 113. Figure 114, Figure 115 and Figure 116 show the spatial application of the scenarios to the sector which the text below provides a brief description of the future trends in 6 years and 6 to 20 years.

Table 69: Assumptions and impacts under the future scenarios for commercial fisheries in the south west marine plan areas

Aspect	Scenario		
	Business as Usual	Nature @ Work	Local Stewardship
Application to the sector	As for the north east marine plan area (see Table 63).	As for the north east marine plan area (see Table 63).	As for the north east marine plan area (see Table 63).
Assumptions	Demersal stocks continue to rebuild and shellfish landings are stable. However, implementation of the landings obligation results in a 5% reduction in demersal and shellfish landings in 2019. Demersal landings then grow 2% p.a. from 2022 to 2026, followed by stable landings, and shellfish landings grow 2% p.a. from 2023–2025 as fleets adjust. Pelagic landings are stable.	There is a 5% reduction in demersal landings and a 20% reduction in shellfish landings in 2018 to support rebuilding of stocks, and a further 5% reduction in 2019 due to the landings obligation. Demersal and shellfish stocks increase 5% p.a. from 2021 to 2026. Pelagic landings are stable.	As for BAU, except local management measures within 3nm (which may prioritise smaller, local boats) result in 25% of the 10m and over vessels' shellfish landings being caught by the under 10m sector, and there is a voluntary 10% reduction in shellfish landings from this sector in 2018 to support rebuilding of stocks, and landings increase 2% p.a. from 2022–2026. Pelagic landings are stable.

[25] The Devon IFCA district covers the south Devon coast from Lyme Regis in the east to Plymouth in the west and the north coast, including the Severn Estuary (from Countisbury Cove as far as Maisemore Weir to Chepstow) and Lundy Island. The district also includes the River Avon through Bristol and all other rivers entering the sea within the district which extends seawards to 6 nm (or the boundary with Welsh Territorial Waters in the north of the area) (Acoura, 2015b).

Aspect	Scenario		
	Business as Usual	Nature @ Work	Local Stewardship
	Mobile demersal gears may be displaced from some (or parts of) existing MPAs, under existing management measures (no new management measures are implemented).	Mobile demersal gears may be displaced from some (or parts of) existing MPAs, under existing management measures (no new management measures are implemented).	Mobile demersal gears may be displaced from some (or parts of) existing MPAs, under existing management measures (no new management measures are implemented).

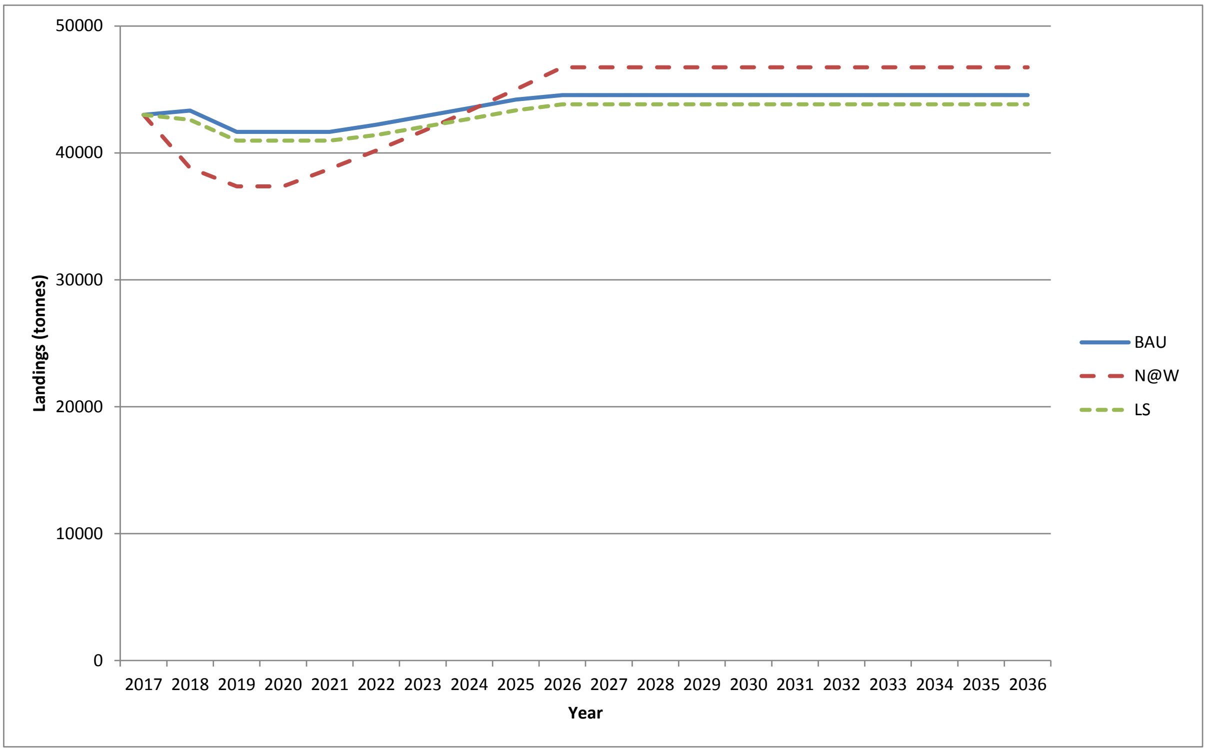


Figure 113: Volume of landings from the south west marine plan areas between 2017 and 2036 under the three scenarios

6-year projection

The implementation of the landings obligation results in a reduction in landings volumes from the south west marine plan area under BAU and LS. There is a larger reduction in landings volume under N@W due to restrictions on catches to help rebuild stocks, and some recovery starts to be seen within the 6 years. There are no windfarms anticipated in the area under the scenarios, but the implementation of MPAs is likely to affect where mobile demersal fishing can take place.

6 to 20 year projection

Under BAU, demersal stock recovery continues and results in landings rising above 2017 levels. Efforts to manage local stocks and prioritise the inshore fleet under LS result in the redistribution of catches from larger to smaller vessels, and reduction of shellfish landings by under-10m vessels results in rebuilding of the stocks and overall landings are similar to BAU. Stock recovery under N@W results in the highest level of landings of the three scenarios. The implementation of MPAs affects where mobile demersal fishing can take place, reducing the spatial footprint of seabed abrasion pressure. Some effort would likely be redistributed to fishing grounds outside of the affected areas where intensity would increase. Under LS, the increasingly local focus of economic activity and decline in international markets potentially has the greatest impact on the fisheries sector under this scenario, resulting in reduced exports for fish and shellfish. However, this is offset to some extent by increasing local consumption of fish and shellfish, particularly in combination with increased tourism, and development of local markets.

Potential trade-offs

The potential trade-offs are similar to the north east marine plan areas.

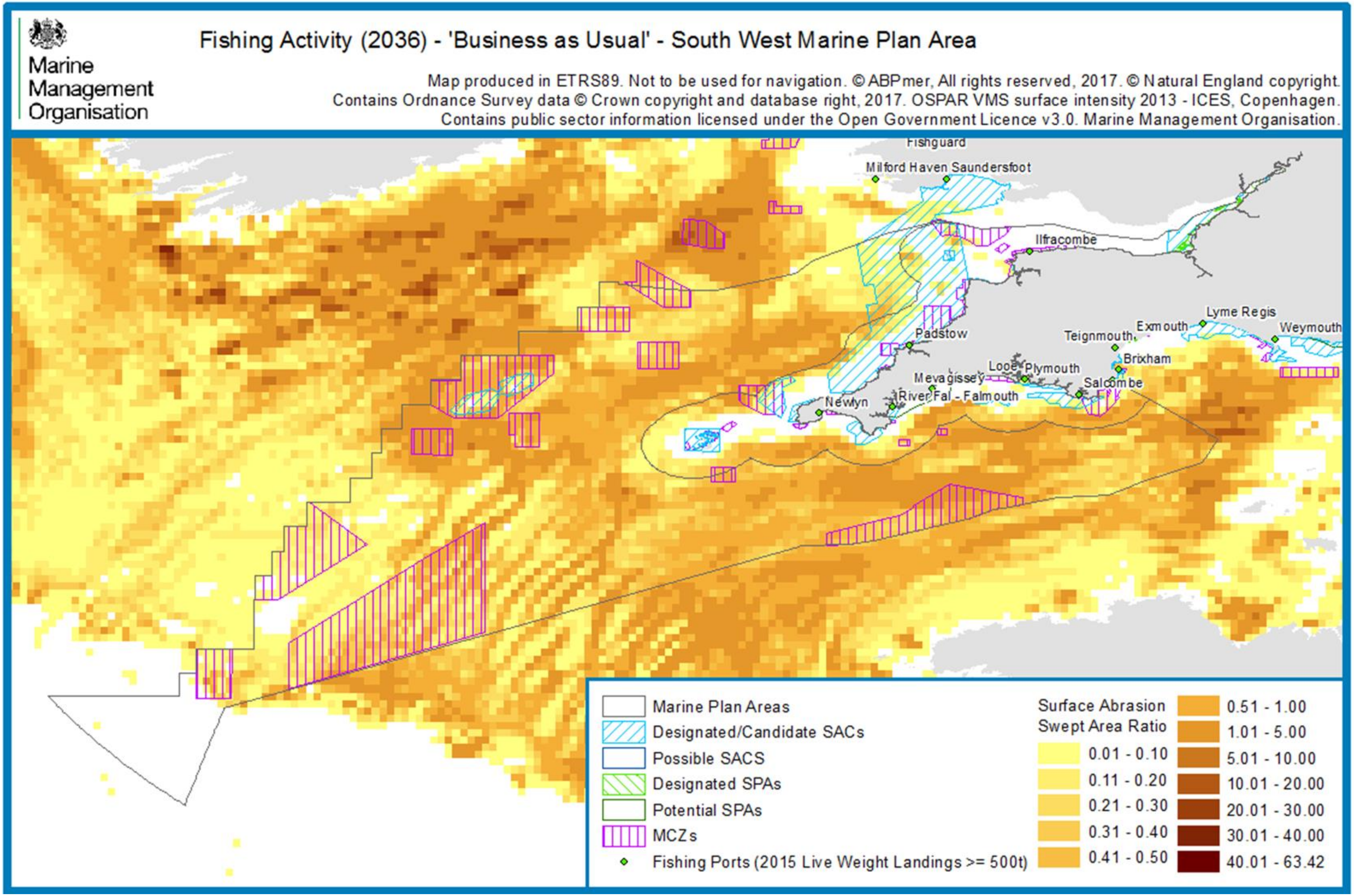


Figure 114: Fisheries (2036) – BAU – south west marine plan areas

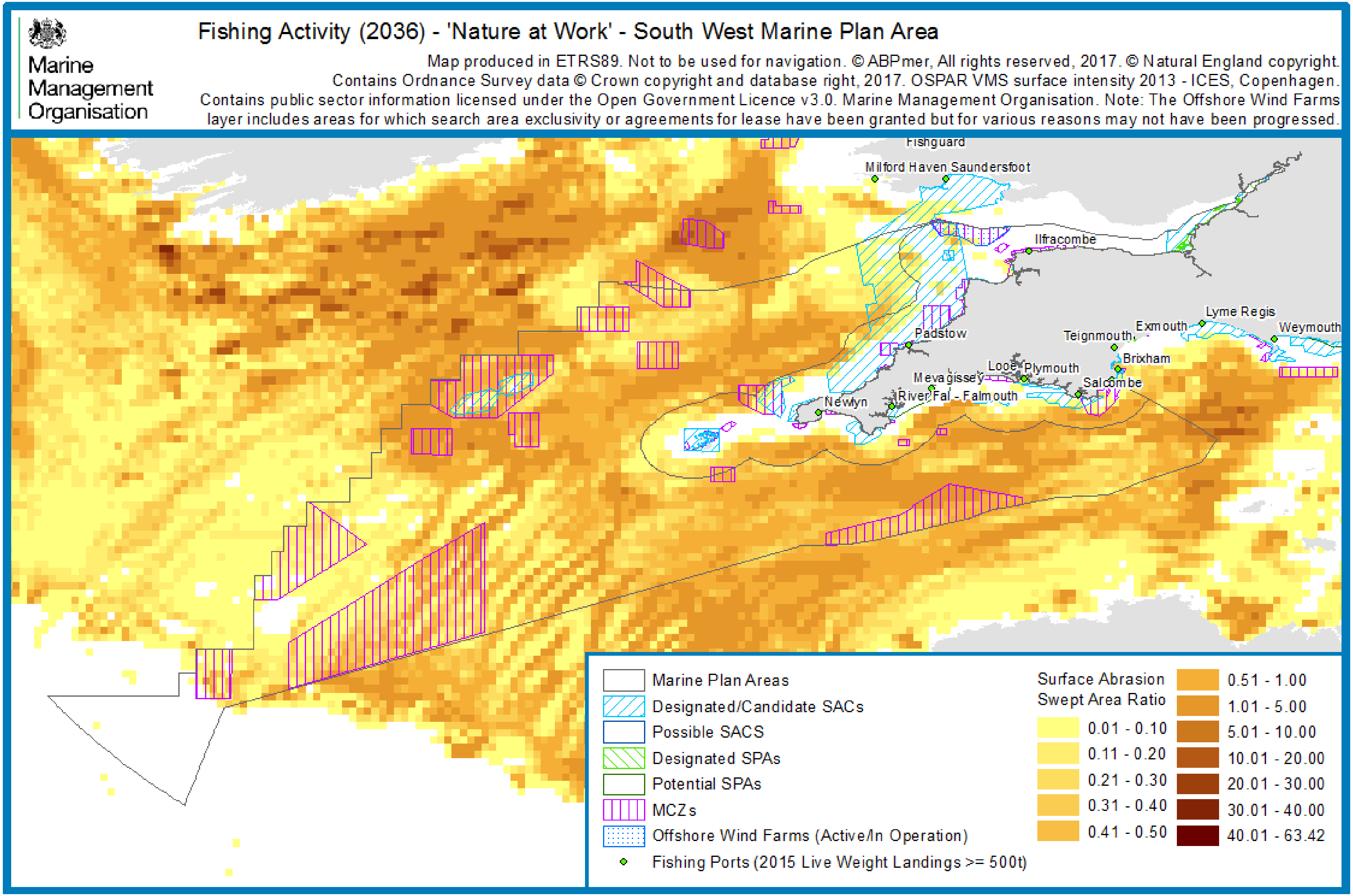


Figure 115: Fisheries (2036) – N@W – south west marine plan areas

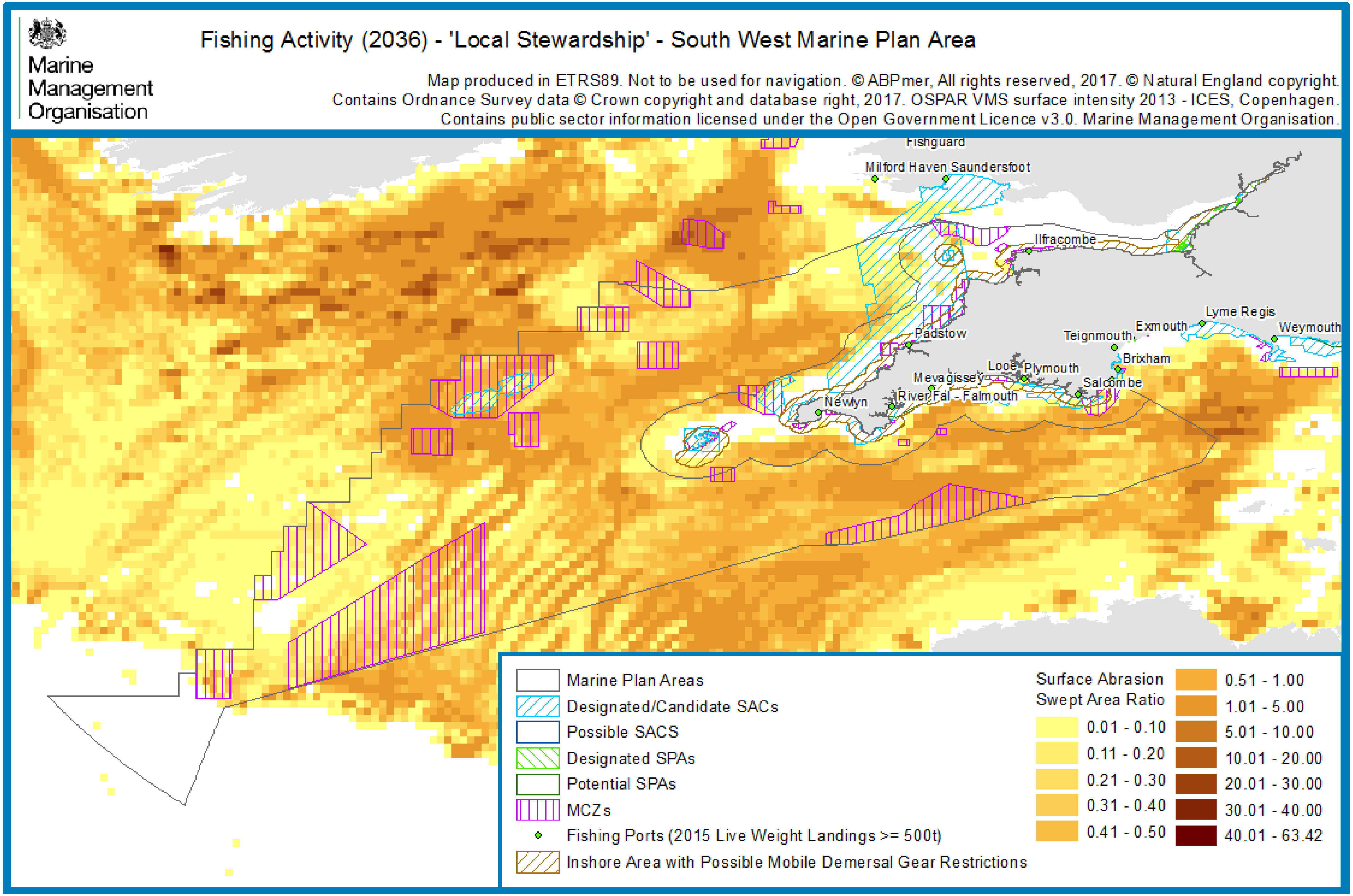


Figure 116: Fisheries (2036) – LS – south west marine plan areas

12 Marine aggregates

Sector definition

Marine aggregates are a mixture of natural sands and gravels used in construction and civil engineering, derived from marine sources (The Crown Estate and British Marine Aggregate Producers Association (BMAPA), 2010). Once dredged from the seabed, the marine aggregates are typically supplied to discharge wharves in markets close to the dredging licence area (The Crown Estate and BMAPA, 2013), although they can also be delivered to wharfs further afield and exported to mainland European markets (The Crown Estate, 2016a). Additionally, marine aggregate resource is used for beach replenishment purposes that play an important role in coastal defence management and protection and as construction fill for large infrastructure projects.

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 (EMU Limited, 2012).

Data sources

A variety of different information sources have been reviewed to inform this baseline, including published reports and papers and spatial data layers. The main information sources used are provided in the list below:

- Spatial data from The Crown Estate showing the location of marine aggregate extraction areas (licence, application and option/prospecting)[26];
- The Crown Estate dredging/landing tonnage statistics[27];
- Future Trends in the Celtic Seas (ABPmer, 2016);
- Economic baseline assessment for the North East, North West, South East and South West Marine Plans (MMO, 2016a);
- Mineral Products Association (MPA) long-term aggregates supply and demand scenarios (2016-30) (MPA, 2016a); and
- Marine Aggregate Regional Environmental Assessments (MAREAs) have been commissioned and prepared by dredging associations for the Anglian, Humber, East Channel, South Coast and Thames Estuary regions[28].

[26] https://www.thecrownestate.co.uk/energy-minerals-and-infrastructure/aggregates
[27] https://www.thecrownestate.co.uk/energy-minerals-and-infrastructure/downloads/marine-aggregate-downloads
[28] The locations of current licenced areas within these regions do not overlap with the north east, north west, south east or south west marine plan areas. The Thames Estuary marine aggregate region includes consideration of the south east marine plan area, but all licenced areas are located within the east marine plan areas.

12.1 National review

Overview of national activity

Britain has one of the world's most developed marine aggregate industries, extracting 15 to 20 million tonnes from the seabed annually. Onshore sand and gravel resources are becoming increasingly constrained, particularly in the South East of England and London. Therefore, the marine aggregate industry now provides around 25% of the sand and gravel demand for England and Wales.

In 2015, 15.4 million tonnes of primary aggregates were extracted from The Crown Estate licensed areas in England and Wales, of which 2.2 million tonnes (~14%) was exported to international markets (Belgium, France and the Netherlands). A further 4.1 million tonnes of secondary aggregates, used for beach nourishment and reclamation fill, was extracted from licensed areas in 2015 (The Crown Estate, 2016a). This equates to a 12.9% increase in annual marine (primary and secondary) production from 2014 (BMAPA, 2016). The total area of seabed in English and Welsh waters that was licenced for marine aggregate extraction in 2015 by The Crown Estate was 932 km^2, with a total active dredge area of 337 km^2 (The Crown Estate and BMAPA, 2016). The actual area dredged in 2015 was 83 km^2, which equates to approximately 9% of the total licenced areas.

Aggregate extraction takes place within most of the English marine plan areas apart from the north east (Figure 117), although it should be noted that the area of seabed dredged in English and Welsh waters has decreased between 2011 (114 km^2) and 2015 (83 km^2) (The Crown Estate and BMAPA, 2016). Around 47% (7.3 million tonnes) of the total production by tonnage in England came from the east marine plan areas (East Coast, Humber and Thames Estuary marine aggregate regions) in 2015. A further 44% (6.7 million tonnes) was produced in the south marine plan areas (East English Channel and South Coast regions), with smaller contributions from the south west and north west marine plan areas (The Crown Estate, 2016a) (see Figure 118 for aggregate resource map for the UK Continental Shelf).

The aggregate industry minimises its transport costs and environmental impacts by landing the extracted minerals at specialised wharves strategically located close to the point of demand. As well as supplying marine sand and gravel for ongoing general construction activity, there is also a requirement for larger volumes of material to be supplied on a contract basis in support of major infrastructure projects, such as nuclear new builds, port development, road bridge construction and offshore wind farms. The industry has to respond to changes in demand as aggregates are not usually stored for later sale due to physical constraints in wharf space.

The construction sector in Great Britain is worth around £144 billion (MPA, 2016b), with around one third of all construction activity concentrated in London and the South East of England. Marine sources provide one third of primary construction aggregate used in London and the South East of England, and contribute approximately 13% of all concrete aggregate used in Great Britain. The concrete aggregate industry employs over 30,000 people with a turnover of £4.3 billion and GVA of £1.7 billion (Tarmac Aggregates, 2013 pers. comm.). In addition to the companies involved in the production of marine aggregates and the concrete aggregate industry in the UK, there are a number of other companies indirectly involved through joint ventures. In the UK, it has been estimated that the industry directly employs approximately 640 staff on ships and shore-based support, with an additional 600 staff on wharves which receive aggregates and 550 staff related to the primary delivery of aggregates (Highley *et al*. 2007). The latest BMAPA sustainable development report indicates that associated member companies, for which total reported production represents approximately two thirds of The Crown Estate figures, employed 54.5 office staff and 347 sea staff in 2015 (BMAPA, 2016).

Eleven companies are generally involved in the production of marine aggregates in the UK. In 2008, these companies landed 19.3 million tonnes of primary aggregate for construction in the UK and abroad representing an estimated landed value (turnover) (before processing and on land sorting) of £116 million and a gross value added (GVA) of £54 million. A further 2 million tonnes were extracted for beach replenishment. Those secondary market values for the marine aggregate dredging industry that could be identified included £80 million GVA from processing and £303 million GVA from sales of concrete products in 2005. Ancillary market values from exploration and transport were more difficult to define in total but indicators include a dredging fleet replacement value of £1 billion (UK Marine Monitoring and Assessment Strategy (UKMMAS), 2010). Similarly, a more recent review estimated the GVA of the marine aggregates sector in the UK (related to primary activities) in 2012 to be £0.1 billion, calculated by uprating the 2008 value using gross domestic product (GDP) deflators (Marine Science Co-ordination Committee (MCSS), 2014). Nevertheless, it should be noted that these figures potentially undervalue the contribution the marine aggregates sector makes given it is at the start of the construction supply chain and the wider enabling value the sector provides.

The Crown Estate has the strategic objective to "actively manage our assets to drive sustainable outperformance against our commercial targets"[29]. Royalties from mineral extraction benefit the taxpayer by contributing revenue from national assets directly to the Treasury (The Crown Estate and BMAPA, 2013).

[29] https://www.thecrownestate.co.uk/our-business/strategy-and-performance/a-strategy-to-maximise-value

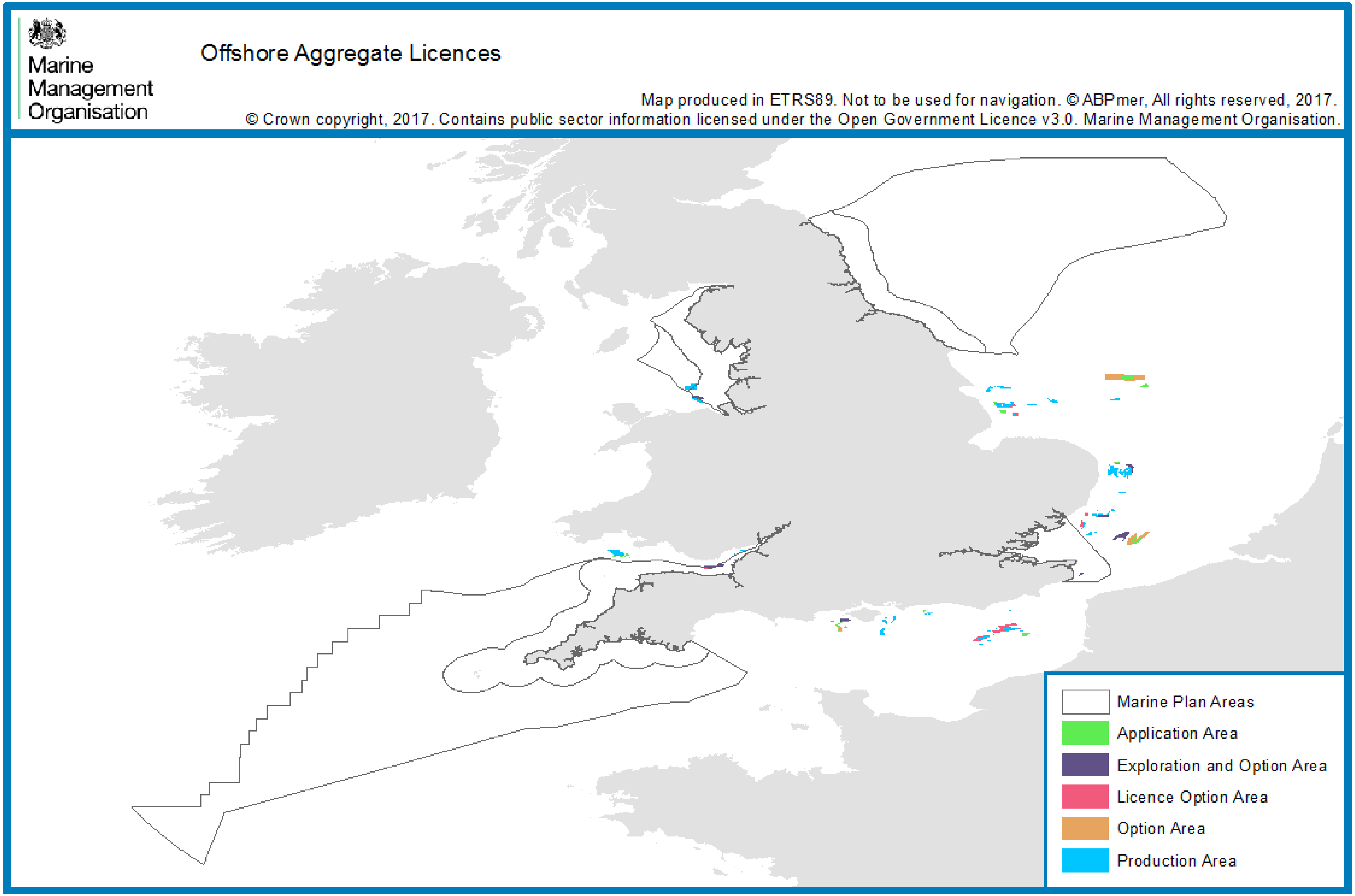


Figure 117: Location of marine aggregate extraction sites in the UK

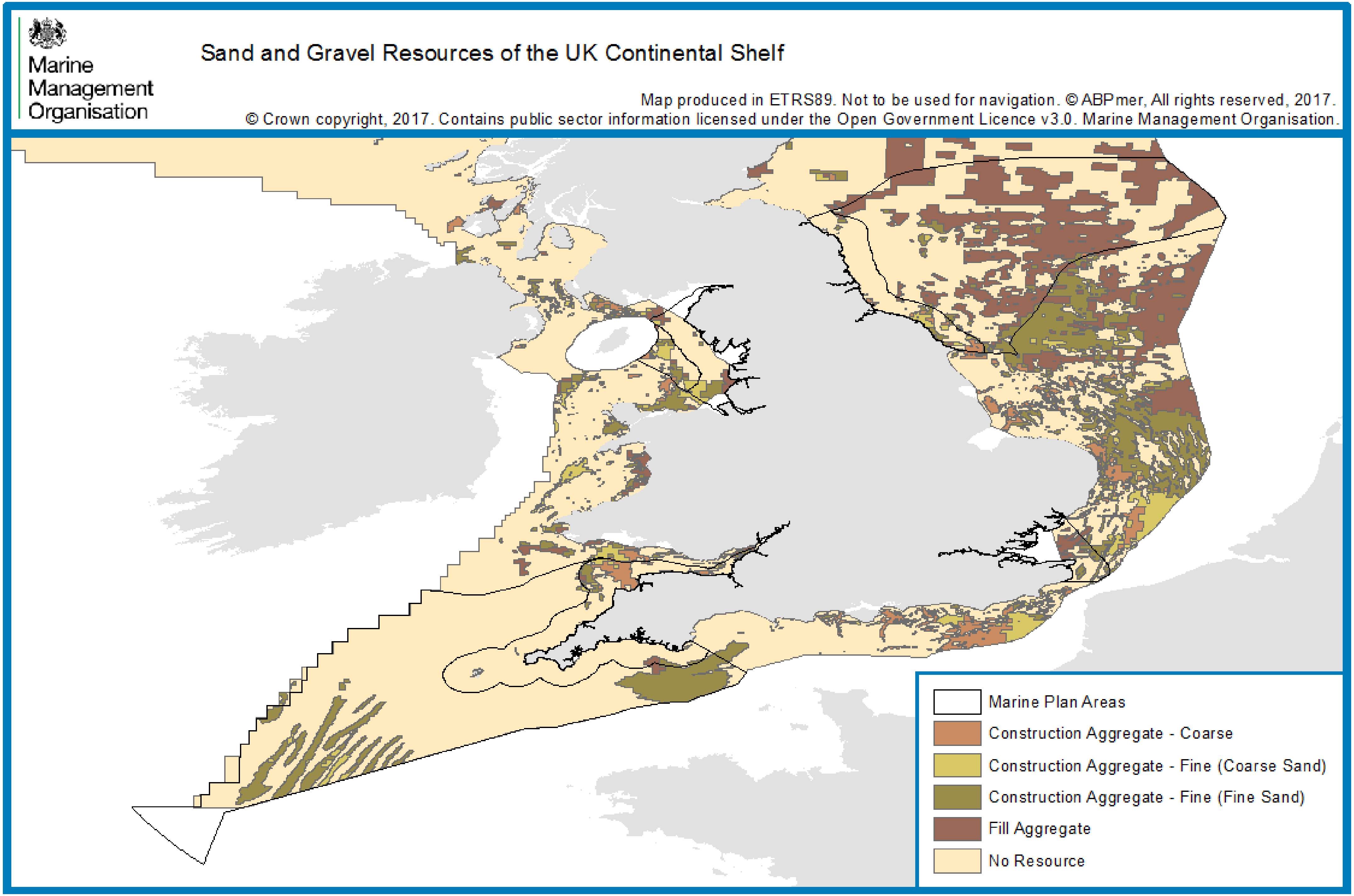


Figure 118: Marine aggregate resources on the UK Continental Shelf

Review of historical trends

At the turn of the millennium, total aggregate demand in the UK was approximately 270 million tonnes per year, with a regular annual contribution from marine-won sources of around 20 million tonnes. However, demand for aggregates decreased to around 200 million tonnes per year in 2007 due to the economic downturn and associated uncertainty in the construction industry. This was reflected by a slight decline in aggregates extracted from the marine environment (The Crown Estate and BMAPA, 2014). Over the last few years, there have been signs that the aggregate industry is recovering towards pre-recession levels, with total demand at 226.3 million tonnes in 2015 (MPA, 2016). Marine aggregate extraction between 2011 and 2015 ranged from 16.0 to 19.5 million tonnes per year (Table 70).

Table 70: Marine aggregate extraction and landing statistics (tonnes) per region between 2011 and 2015

Marine Aggregate Region	Year (Tonnes)				
	2011	2012	2013	2014	2015
Extraction					
Humber[1]	2,905,879	2,309,833	2,140,186	2,187,272	2,144,030
East Coast[1]	5,275,569	3,564,464	4,249,110	4,720,088	4,474,629
Thames Estuary[1,2]	806,735	1,090,559	782,986	1,690,834	2,663,512
East English Channel[3]	4,344,081	3,764,185	3,402,686	3,862,818	3,674,197
South Coast[3]	4,236,566	4,360,518	3,567,564	3,179,612	3,332,257
South West[4]	1,232,087	1,067,526	1,024,357	1,087,277	1,131,751
North West[5]	314,098	635,268	858,813	520,383	2,046,899
Total	19,115,015	16,792,353	16,025,702	17,248,284	19,467,275
Landing					
Humber[1]	541,726	537,975	502,595	514,302	595,891
East Coast[1]	148,483	83,865	27,931	57,085	119,421
Thames Estuary[1,2]	6,902,148	5,638,506	6,063,530	7,325,856	8,306,772
East English Channel[3]	130,586	178,729	94,216	-	-
South Coast[3]	2,529,549	2,301,746	2,537,503	2,573,259	2,824,536
South West[4]	965,685	1,075,174	1,033,969	1,097,123	1,137,567
North West[5]	304,515	277,720	369,201	241,578	252,856
Export	6,098,020	4,548,675	4,089,687	2,994,538	2,153,146
Beach nourishment/ reclamation fill	1,494,303	1,665,930	1,307,070	2,444,543	4,077,086
Total	19,115,015	16,308,320	16,025,702	17,248,284	19,467,275

[1] East marine plan areas; [2] South east marine plan area; [3] South marine plan areas; [4] South west marine plan areas; [5] North west marine plan areas.

Source: The Crown Estate

Over the last two decades, the location and intensity of marine aggregate dredging areas around the UK have changed. Some dredging areas have reduced in size, several new marine licences have been granted and some licensed areas have been surrendered. This reduction in the area of seabed dredged was partly instigated by the 'area involved' initiative between BMAPA and TCE. In March 1999, BMAPA and TCE agreed to review all dredging licences over a five year period. A commitment was made to surrender areas no longer containing commercially viable aggregate resources and to publish annual reports detailing the extent of dredging within areas (The Crown Estate and BMAPA, 2016).

The contribution from the East Coast marine aggregate region has significantly decreased from approximately 10 million tonnes per year in 2000, thus equating to around 50% of total marine-won aggregate extraction in the UK, to approximately 4.5 million tonnes in 2015. In contrast, the East English Channel is a relatively new marine aggregate region, with extraction increasing to over 3.5 million tonnes in 2015. Onshore sand and gravel resources are becoming increasingly constrained, particularly in the South East of England and London. In terms of landings, these two regions receive the majority of marine-won primary aggregates (Table 70).

The "replenishment rate" provides information on long-term availability of aggregate supplies based on new areas being licensed to replace those that are at the end of their licence period. If the amount of aggregates receiving planning permission equals the level of production, the replenishment rate is 100%. Whilst the average replenishment rate for crushed rock has been close to and above parity in the past 10 years, land-won sand and gravel is being replaced at a much slower pace: for every 100 tonnes of sand and gravel used, only 61 tonnes is being replaced through new planning permissions. In addition, the crushed rock replenishment rates of over 100% reflects mostly new permissions granted at a small number of sites, and therefore these reserves are not evenly distributed across the country. The implication of long-term replenishment rates below 100% is that shortages of supply may become apparent. Evidence from Local Aggregates Assessments and Local Plan formulation suggests that this is beginning to appear in parts of Yorkshire, the South West, the South East, the North West and the West Midlands aggregate regions. A major challenge will be tackling the decline in land-won sand and gravel permitted reserves, and the potential for compensating this decline through an increase in the supply of alternative sources of aggregates, such as marine sand and gravel amongst others (MPA, 2016).

Throughout the UK, beach replenishment is a well-established market for marine aggregates dating back to the 1960s. It peaked in the mid-1990s and since then there has been a continuous programme of replenishment to sustain both work previously carried out and any new schemes. The tonnages used for beach replenishment vary from year to year reflecting the funding that is available to support individual schemes, which are likely to be sourced locally and pumped directly from dredger to beach.

Review of key changes and/or advances of significance affecting the sector

Demand for aggregates is driven by activity in the construction industry and the economy as a whole. The ability of the marine industry to deliver more aggregates relates to the capacity of the dredging fleet and wharf facilities to allow production, landing, processing and distribution. The technology of the current aggregate dredging fleet means that the maximum depth that resources can be practically worked is approximately 60 m, with most dredging taking place in water depths between 18 to 30 m within coastal waters less than 25 km offshore (Highley *et al*. 2007). Wherever possible, sources near to the demand will continue to be used (i.e. those closest to the landing wharves) to reduce transport costs. However, a combination of technological advances of fleets, such as the ability to exceed the current maximum depth, market demand and resource suitability may result in a change to the sector in the future with areas of the seabed further offshore and/or in deeper waters becoming suitable for aggregate dredging. In addition, vessel sizes have increased and will become more efficient over time, thus delivering more aggregates to wharves for the same time/effort.

Land-based sources of sands and gravels along the south coast of England and London area are relatively scarce and large-scale resources do not exist. Offshore, the sands and gravels are of particularly high quality and, as a result, supply of marine aggregates forms an important contribution to fulfilling local demand (Highley *et al*. 2007). Unlike terrestrial sources of aggregates, marine supplies are not constrained by the availability of the resource, a key driver of the potential of the industry to expand in the medium to long term (subject to being able to demonstrate that the activity can be undertaken in an environmentally acceptable way).

Like all forms of mineral extraction, marine dredging has environmental impacts and the industry is strictly controlled. Marine licences for sand and gravel extraction will only be issued if the impacts associated with the application are ultimately considered to be environmentally acceptable. This will include consideration of potential effects on designated sites, fisheries, heritage, coastal processes and the wider environment amongst others. The impact on the aggregates sector will depend on the features for which sites are designated, whether aggregate extraction may have a detrimental effect on those features and the conservation objective for each feature (e.g. if the conservation objective is ‘maintain’, existing activities may be allowed to continue).

The future of aggregates also relates to government policies on infrastructure, energy security and climate change such as Crossrail, Thames Tideway, High Speed 2 (HS2), nuclear new builds, tidal power developments and offshore wind farms. House-building may also represent a significant demand and thus the marine aggregate sector is largely dependent on broader economic activity, as supported by sectoral policy. The Marine Policy Statement (HM Government, 2011) acknowledges the need to safeguard reserves for future extraction and requires marine planning authorities to make provision for marine aggregate supplies to contribute to the overarching Government objective of ‘securing an adequate and continuing supply [of marine aggregates] to the UK for various uses’. This policy also considers marine aggregates to have reduced impacts on local communities compared to the extraction of land-won aggregates, in particular with regard to the extraction process and transportation (HM Government, 2011). One of the main benefits of using marine sources is that vessels can deliver aggregates directly to wharves in urban areas, which reduces pollution and road congestion. Additionally, it is recognised there are often no practicable alternative sources to marine aggregate for the maintenance of coastal defences required for climate change adaptation.

The UK Government wishes to see continued use of marine aggregates for construction and beach replenishment work in keeping with the principles of sustainable development, as described in the UK Marine Policy Statement (HM Government, 2011). To achieve this, the dredging industry requires access to suitable long-term aggregate resources to meet its varied and fluctuating markets and to provide it with sufficient confidence to invest in new ships and wharves. Table 71 highlights the key changes affecting the marine aggregate sector.

Table 71: Key drivers affecting development of the marine aggregate sector

Driver	Details	Implications
Political	Housing White Paper (Department for Communities and Local Government, 2017) and National Infrastructure Delivery Plan 2016–2021 (Infrastructure and Projects Authority, 2016) outlining the UK Government's plans to build new homes.	Continued demand for aggregates to support growth
	The National Planning Policy Framework (Department for Communities and Local Government (DCLG), 2012) sets out the Government's planning policies for England and how these are expected to be applied, including: • Building a strong, competitive economy • 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	Continued demand for aggregates to support growth
	The UK Marine Policy Statement (HM Government, 2011) 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 aggregates from construction industry linked to economic cycle and public/private investment	Demand for marine aggregates will fluctuate in response to economic cycles
	Large scale infrastructure project demand (e.g. port development, nuclear new build, renewable energy developments and export markets)	Demand linked to other sector policy drivers and economic climate

Driver	Details	Implications
Social	Demand for sustainable transport (e.g. fewer lorries on roads) and thus reducing carbon emissions cost per tonne delivered (The Crown Estate, 2010)[30]	Increased demand from alternative sources, including marine resources
Technological	Increased efficiency and economies of scale 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	N/A
Environmental	Targets of the MSFD	Potential constraints/ restriction on areas within which aggregates can be dredged
	Increased pressure on coastal areas from rising sea levels	Growth in activities such as dredging, beach nourishment, and sand reclamation
	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 dredging and disposal activities	Increased regulation of dredging and disposal activities (e.g. additional licence conditions)
	Designation of additional MPAs	Potential constraints/ restriction on areas where aggregate extraction can take place

Review of future trends

The primary drivers of marine aggregate extraction in all three scenarios 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.

In the Nature at Work (N@W) scenario, increased demand (compared to the Business as Usual (BAU) scenario) relates to marine aggregate required for the construction of new nuclear builds and tidal lagoon walls (where material cannot be provided from the lagoon itself), in addition to projected future demand for general construction and soft coastal defences. In the Local Stewardship (LS) scenario,

[30] Emissions from a lorry are up to 25 times more than those from a large sea vessel, whilst those from rail are approximately four times more than shipping (The Crown Estate, 2010).

although it has been assumed that overall economic development and hence demand for marine aggregate is lower compared to the BAU and the N@W scenarios, there is a further increase in demand for tidal lagoons (although with a reduced focus on nuclear power) and hence this scenario projects the greatest volume of marine aggregate extraction to provide the construction material.

The increased demand for marine aggregate in the N@W and LS scenarios are predominantly met through extraction at Licensed, Application, Option and Exploration Areas (as of 2017), thus assuming there is little change in the footprint of the sector between the three scenarios. Where suitable resources exist, extraction of material from sand and gravel resources in local inshore waters may also occur for use in beach replenishment and sandscaping in the N@W (resources within 12 nautical miles (nm)) and LS (resources within 6 nm) scenarios.

Confidence assessment

Assessing the precise contribution that marine aggregates make to overall aggregate supply on a regional basis is complicated by a variation in statistics from different sources, primarily due to incomplete coverage of landings at wharves and the different conversion factors used (Highley *et al*. 2007). In addition, annual summary statistics reported by The Crown Estate do not incorporate aggregate extraction sites outside of their ownership.

Competition between operators results in a level of confidentiality, making it difficult to fully assess aspects such as tonnages, the economic value and employment associated with the marine aggregate sector. There is uncertainty surrounding which Application Areas may be licensed and which Option/Exploration Areas may become Licence Areas. It is also uncertain which parts of existing Licence Areas may be surrendered over time. There is uncertainty concerning the level of future demand for marine aggregates which depends on the availability of land-won or recycled aggregate supplies, overall demand linked to the state of the economy, and future requirements for major construction projects (such as new build nuclear power stations and tidal lagoons) and for beach replenishment. While specific considerations have been made for new build nuclear power stations and tidal lagoons, it is important to stress that these are by no means the only types of infrastructure project that marine materials may be required to support.

12.2 North east

There are currently no licensed, application or option marine aggregate extraction areas located within the north east marine plan areas. The nearest marine aggregate extraction areas are located within the Humber region to the south. However, 570,330 tonnes of marine dredged primary aggregates were landed to Blyth, River Tees and River Tyne wharves, all located within the north east marine plan areas, in 2015. The majority of this landed material was dredged from the Humber region (approximately 460,000 tonnes; The Crown Estate, 2016a).

The assumptions used to develop the BAU, N@W and LS scenarios for marine aggregates in the north east marine plan areas are provided in Table 72. As there is no current or planned extraction from the north east marine plan areas no scenarios figures have been produced. The text below provides a brief description of the future trends in 6 years and 6 to 20 years.

Table 72: Assumptions under the future scenarios for marine aggregates in the north east marine plan areas

Aspect	Scenario		
	Business as Usual	**Nature @ Work**	**Local Stewardship**
Application to the sector	There is currently no production of marine aggregates in the North East marine aggregate region, and thus the north east marine plan areas. It is considered unlikely that significant marine aggregate extraction would commence in the north east marine plan areas under this scenario.	While the primary drivers for the sector at a national level are related to construction demand and climate change, there is currently no production of marine aggregates in the North East marine aggregates region and thus unlikely to be required in this capacity within the north east marine plan areas. However, it is anticipated that marine aggregates may be a viable option to support the potential Hartlepool new build nuclear power station development. This could be achieved through a one-off licence application for a suitable site within the north east marine plan areas.	There is currently no production of marine aggregates in the North East marine aggregate region, and thus the north east marine plan areas. It is considered unlikely that significant marine aggregate extraction would commence in the north east marine plan areas under this scenario.
Assumptions	No aggregate extraction anticipated in the north east marine plan areas.	It is assumed that the Hartlepool nuclear power station is constructed, using aggregate from a one-off licence application within the north east marine plan areas. The requirement for marine aggregate was calculated as follows: • One new nuclear power station (Hartlepool). Development requires approximately 1.5 million tonnes of aggregates (BMAPA website). To be constructed between 2025 and 2030, thus 0.25 million tonnes of aggregate per annum required from the North East marine aggregate region during this period.	No aggregate extraction anticipated in the north east marine plan areas.

6-year projection

There is currently no production of marine aggregates in the North East marine aggregate region, and thus the north east marine plan areas. Therefore, it is considered unlikely that marine aggregate extraction would commence in the north east marine plan areas under the BAU, N@W and LS scenarios over the next 6 years.

6 to 20 year projection

Based on historical trends, the extraction of marine aggregates in the north east marine plan areas is considered unlikely under the BAU and LS scenarios over the period 6 to 20 years from present. However, to support construction of the potential Hartlepool nuclear power station new build under the N@W scenario, it is assumed that nearby marine-won aggregate supplies would be sought. Given the distance between Hartlepool and current licence, application and option areas within the Humber marine aggregate region, it is feasible that a one-off (capital) licence would be obtained within the north east marine plan areas. During the construction period, assumed between 2025 and 2030, approximately 2.5 million tonnes of aggregates would be required per annum (Figure 119; see Table 72 for further detailed assumptions). After this period, it is assumed that the production of marine aggregates from the north east marine plan areas under the N@W scenario would cease. A spatial figure has not been provided as it is not possible to identify where the potential licence area would be situated.

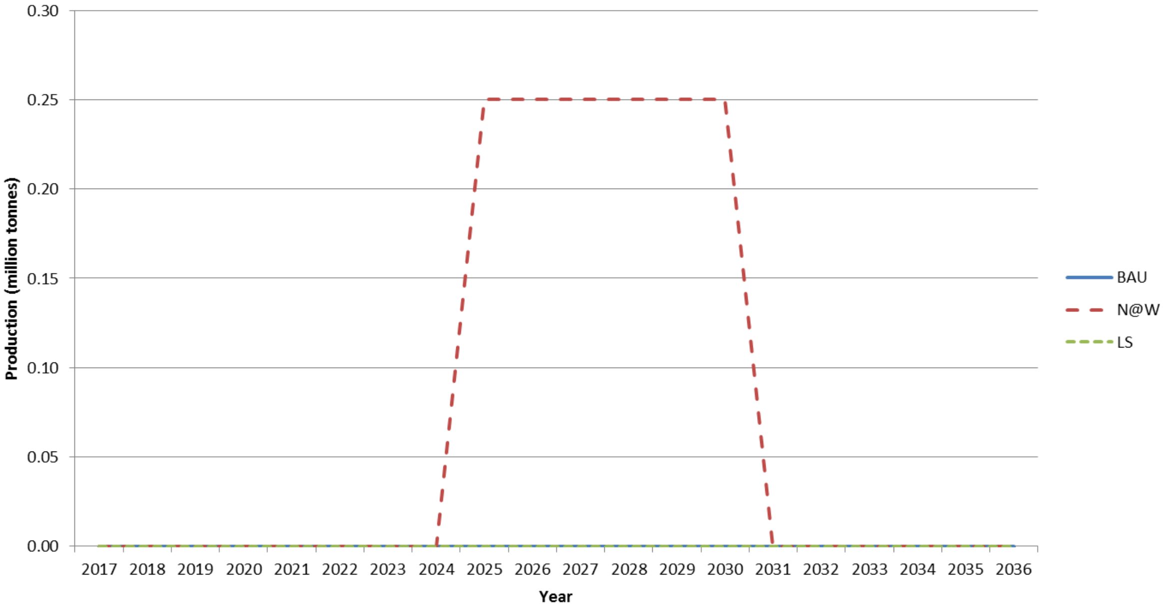


Figure 119: Projections of production tonnages (million tonnes) for the marine aggregate sector in the three scenarios for the north east marine plan areas

Potential trade-offs

The main potential interactions for future marine aggregate development are likely to be:

- Natural environment (habitat damage)
- Other infrastructure.

Within the north east marine plan areas, future marine aggregate development is only projected under the N@W scenario. The main potential trade-offs are likely to be with the natural environment and future infrastructure. Negative trade-offs can be minimised through careful site selection.

12.3 North west

There is one marine aggregate licence area located within the north west marine plan areas, namely Liverpool Bay (Area 457). In addition, one option/prospecting area for marine aggregate extraction overlaps the boundary of English/Welsh territorial waters (Area 518) and thus is partially located within the north west marine plan area. The Hilbre Swash (Areas 392/393) marine aggregate licence area is located in Welsh waters immediately adjacent to the north west marine plan areas, beyond the Dee Estuary along the England/Wales border.

In 2015, 260,649 tonnes of primary aggregates were extracted from licenced areas in the North West marine aggregate region, with around 215,844 tonnes landed within the north west marine plan areas (Barrow and Liverpool wharves). A further 1.79 million tonnes was extracted from the region as secondary aggregates, predominantly for reclamation use as part of the 'Liverpool2 Container Terminal' project (sourced from Area 457). Consequently, marine aggregates extracted from the North West marine aggregate region were notably increased in 2015 compared to annual extraction rates between 2006 and 2014 (The Crown Estate, 2016a).

The assumptions used to develop the BAU, N@W and LS scenarios for marine aggregates in the north west marine plan areas are provided in Table 73. Projected extraction under each of the three scenarios is shown in Figure 120. Figure 121, Figure 122 and Figure 123 shows the spatial application of the scenarios to the sector while the text below provides a brief description of the future trends in 6 years and 6 to 20 years.

Table 73: Assumptions under the future scenarios for marine aggregates in the north west marine plan areas

Aspect	Scenario		
	Business as Usual	Nature @ Work	Local Stewardship
Application to the sector	The primary driver for the sector in this scenario is construction demand (related to economic growth) which will require increased provision of aggregate from alternative sources (including marine sources) as the availability of land-won sand and gravel reduces, largely through exhaustion.	The primary drivers are construction demand and climate change with increased demand to provide material for tidal lagoon projects, new nuclear builds, sandscaping and beach replenishment. Increased demand for marine aggregate will be	Lower levels of overall economic development mean lower demand for aggregate for general construction projects. However, this reduction is offset through increased development of tidal lagoons which require aggregate for the building of the tidal lagoons, and sandscaping and beach

Aspect	Scenario		
	Business as Usual	**Nature @ Work**	**Local Stewardship**
	Demand for marine aggregate will be met through extraction at current Licensed, Application and Option Areas. Climate change will also continue to be a driver, resulting in an increase in activities such as dredging, beach nourishment and sand reclamation (EEA, 2015).	met through an increased intensity of extraction at the Licensed, Application and Option Areas, as well as potential extraction of sand/gravel from areas where there are suitable natural resources (<12 nm), for use in sandscaping and beach replenishment. There is potential to increase the maximum depth from which aggregate resources could be extracted as a result of economies of scale (e.g. larger vessels).	replenishment. Public perceptions of suitable energy resources mean less emphasis on nuclear power generation. The increased demand for marine aggregate will be met through an increased intensity of extraction from the Licensed, Application, Option and Exploration Areas, as well as potential extraction of sand/gravel from more local inshore areas (<6 nm), where there are suitable natural resources, for use in sandscaping and beach replenishment.
Assumptions	Based on the November 2016 UK economic and fiscal forecast (Office for Budget Responsibility (OBR), 2016), sector growth (extraction tonnages) have been assumed to increase at: • 1.7% (2017 – 2018) • 2.1% (2018 – 2020) • 2.0% (2020 – 2036) Annual extraction rate in 2017 based on five-year (2011 – 2015) average for North West marine aggregate region. It is assumed that 50% of extraction from the North West marine aggregate region is from Licenced Areas within the north west marine plan areas (remainder sourced from Licenced Areas within Welsh waters). The following infrastructure projects are assumed to be constructed (requiring aggregate from the marine environment) and come on-line:	The spatial assumptions are the same as for the BAU scenario, except that Heysham 3 nuclear power station is also constructed, in addition to Moorside nuclear power station. Additional extraction is also required (compared to the BAU scenario) for sandscaping and beach replenishment, which is seen as preferable to the construction of hard sea defences. The requirement for marine aggregate was calculated as follows: • As per the BAU scenario for the Moorside nuclear power station, plus Heysham 3 nuclear power station which is assumed to be constructed between 2025 and 2034 (0.15 million tonnes of aggregate per annum required per development from the north west marine plan areas). • An extra 1 million tonnes per annum (from 2022 to 2036) is extracted for sandscaping from the	The spatial assumptions are the same as for the BAU and N@W scenarios, except that while Moorside nuclear power station will be constructed, it is assumed Heysham 3 nuclear power station does not proceed. In addition, four tidal lagoon projects are assumed to be developed in the North West of England and North Wales (Colwyn Bay, West Cumbria, Wyre and Solway). Additional extraction is also required (compared to the BAU scenario) for sandscaping and beach replenishment, which is seen as preferable to the construction of hard sea defences. The requirement for marine aggregate was calculated as follows: • As per the BAU scenario for the Moorside nuclear power station (assumed Heysham 3 nuclear power station does not proceed). • Four new tidal lagoon projects (Colwyn Bay, West Cumbria, Wyre and

Aspect	Scenario		
	Business as Usual	Nature @ Work	Local Stewardship
	One new build nuclear power station (Moorside). Development requires approximately 1.5 million tonnes of aggregates (BMAPA website). Moorside to be constructed between 2020 and 2029, thus 0.15 million tonnes of aggregate per annum required from the north west marine plan areas during this period.	north west marine plan areas.	Solway), approximately 15 million m³ of aggregate required per tidal lagoon development (unpublished data), 30% met from Licence Areas (i.e. in addition to sediment dredged from within the footprint development), thus 4.5 million m³ of sediment is required per development. Using a conversion of 1,600 kg/m³ for fresh sand, it has been assumed that each development would require 7.2 million tonnes of marine aggregates, thus 28.8 million tonnes between the four tidal lagoon developments. However, given the range in scale of these proposed tidal developments (i.e. order of magnitude differences in output from faciliites) and that some aggregate material would likely be obtained from Licenced Areas in Welsh waters (i.e. the Colwyn Bay tidal lagoon is in Wales), it is assumed that a total of 20 million tonnes of aggregate would be required from licensed aggregate areas in the north west marine plan areas. If construction of the four tidal lagoon developments is assumed to occur between 2029 and 2036, this equates to an average requirement of 2.5 million tonnes of marine aggregate per annum. • An extra 1 million tonnes per annum (from 2022 to 2036) is extracted for sandscaping from the north west marine plan areas.

6-year projection

The current level of aggregate production (averaged from 2011 to 2015) for the north west marine plan areas is approximately 2.5% of the UK total (437,546 tonnes per annum), assuming 50% of material from the North West marine aggregate region is extracted in English waters (remainder from Welsh waters). Over the next 6 years, it is assumed that this production rate would steadily increase to approximately 509,041 tonnes per annum under all three scenarios for use in the general construction industry.

Construction of the Moorside nuclear power station would commence in 2020, with a requirement for 150,000 tonnes of marine aggregates per annum from Licence Areas within the north west marine plan areas. From 2022, it is also assumed that 1 million tonnes of marine aggregates would be required per annum to support sandscaping projects under the N@W and LS scenarios.

Peak production rates in the north west marine plan areas over the next 6 years (realised in 2022) would be 632,610 tonnes per annum under the BAU scenario and 1.63 million tonnes per annum under the N@W and LS scenarios (Figure 120; see Table 73 for further detailed assumptions).

6 to 20 year projection

Construction of the Moorside nuclear power station is assumed to be completed in 2029 under all three scenarios, requiring approximately 150,000 tonnes of marine aggregates per annum from Licence Areas within the north west marine plan areas. This requirement would overlap the construction requirements of Heysham 3 nuclear power station (a further 150,000 tonnes per annum; 2025 – 2034), assumed to progress under the N@W scenario only. Four tidal lagoon projects are anticipated for construction under the LS scenario (Colwyn Bay, West Cumbria, Wyre and Solway). As all of these developments are currently at the early planning stage, it is difficult to estimate their construction programme. Therefore, the associated marine aggregate requirement from the north west marine plan areas (around 20 million tonnes in total; see Table 73 for further detailed assumptions) is assumed to be equally distributed during the period 2029 to 2036 (i.e. 2.5 million tonnes per annum). This may be sourced from areas identified as potential construction aggregate resource within 6 or 12 nm, or possibly beyond 12 nm.

Peak production rates in the north west marine plan areas are predicted to occur in 2029 under the BAU (704,367 tonnes per annum) and N@W (1.85 million tonnes per annum) scenarios. This relates to the final year of Moorside nuclear power station construction and the overlap between Moorside and Heysham 3 nuclear power station construction, respectively. Under the LS scenario, the assumption that Heysham 3 nuclear power station would not proceed would lead to a slight decrease in requirement compared to N@W during the period 2025 to 2029. However, the total requirement for marine aggregates within the north west marine plan areas would increase to over 4 million tonnes post-2030 (see Table 73), largely to support the development of tidal lagoons. This indicates an increase of approximately 3.5 million tonnes per annum compared to the BAU scenario (Figure 120).

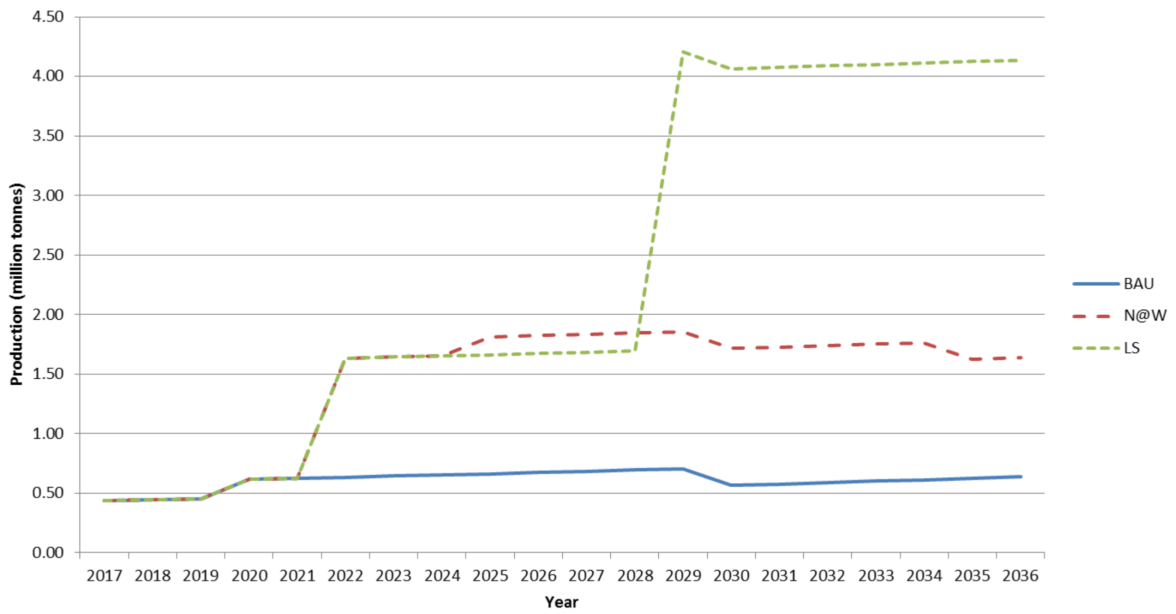


Figure 120: Projections of production tonnages (million tonnes) for the marine aggregate sector in the three scenarios for the north west marine plan areas

Potential trade-offs

The main potential interactions for future marine aggregate development are likely to be:

- Natural environment (habitat damage)
- Other infrastructure.

In the north west marine plan areas, the main potential trade-offs are likely to be with the natural environment and future infrastructure under all scenarios, but particularly N@W and LS. Negative trade-offs can be minimised through careful site selection.

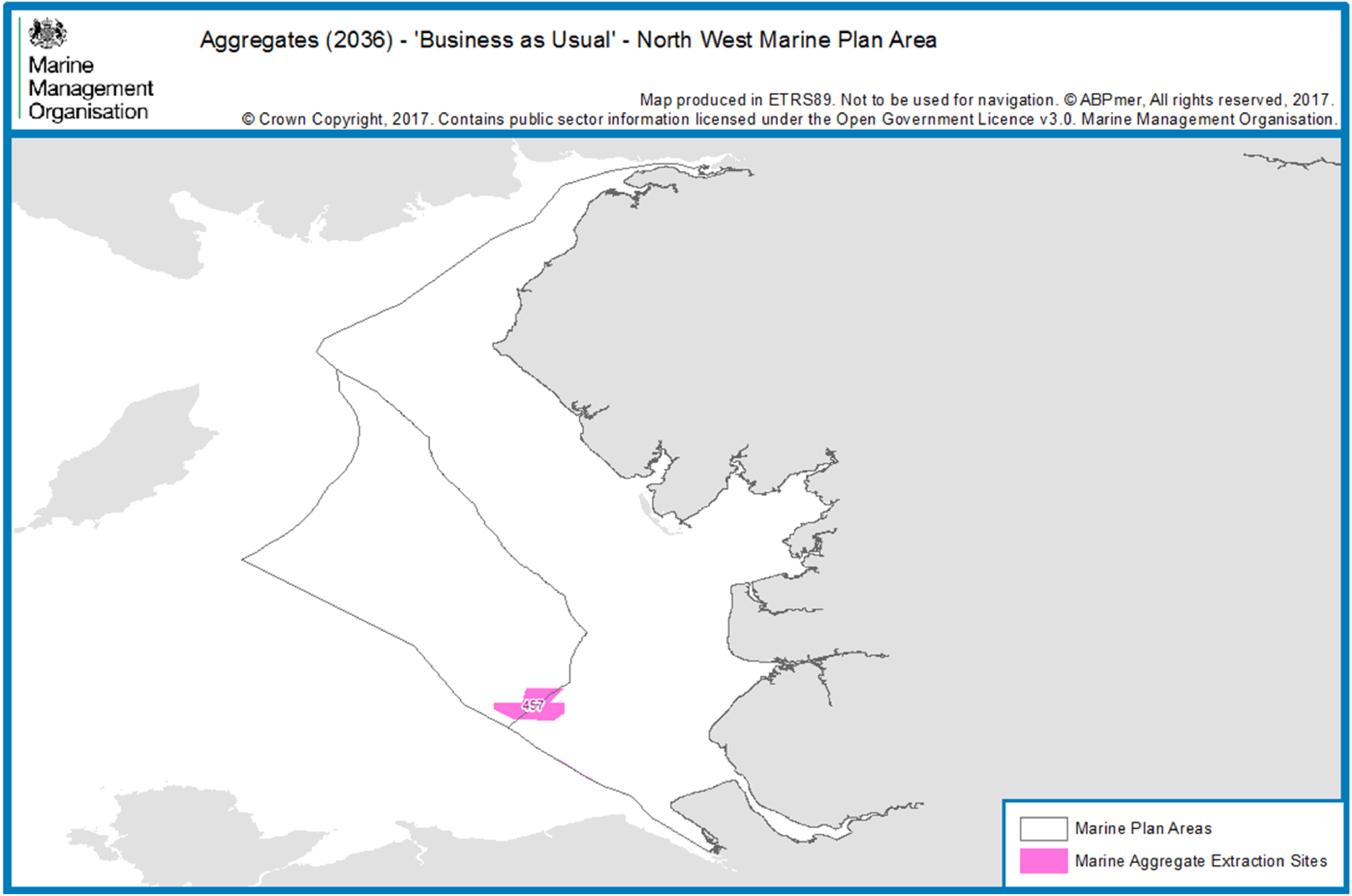


Figure 121: Aggregates (2036) – BAU - north west marine plan areas

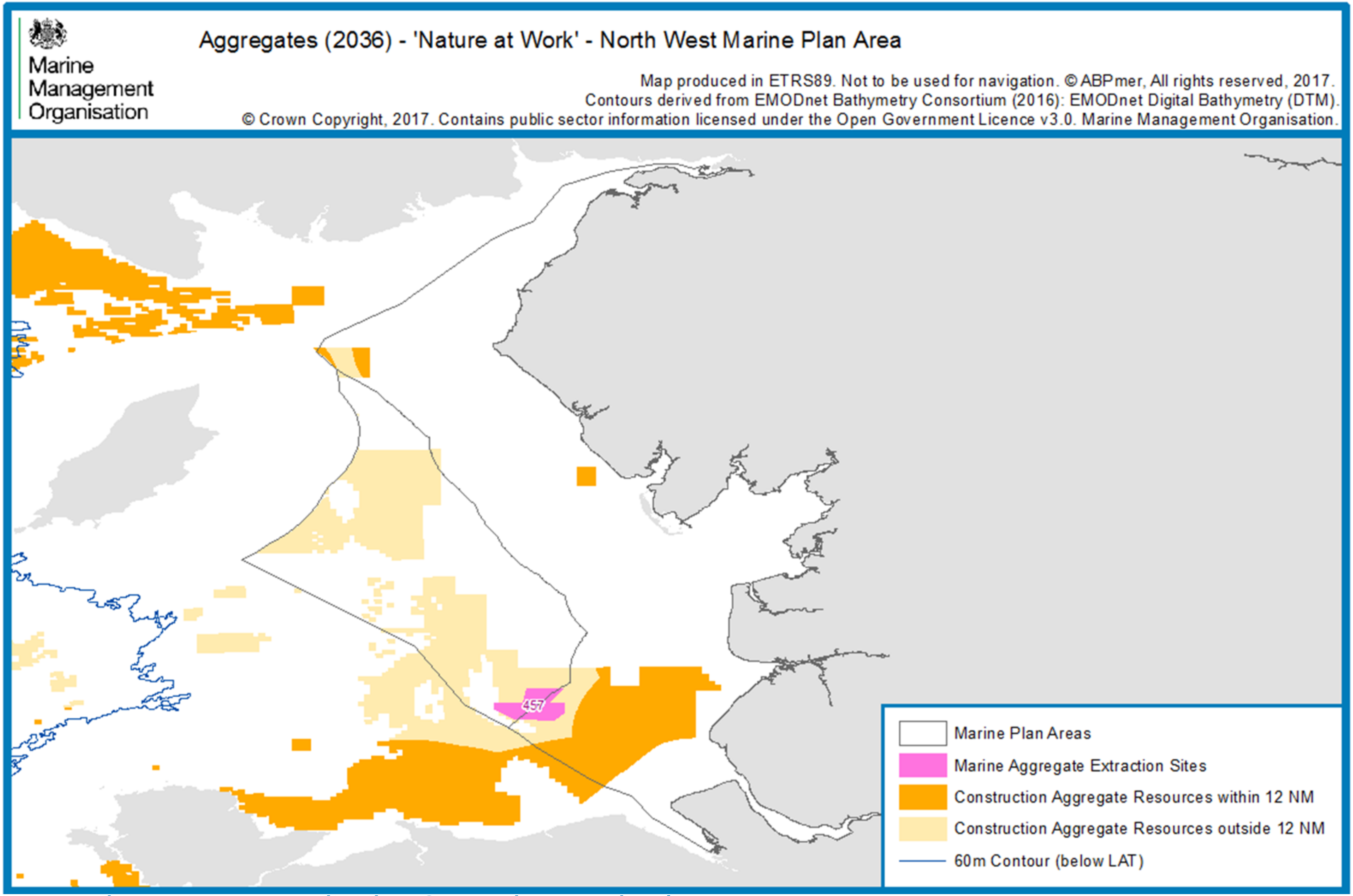


Figure 122: Aggregates (2036) – N@W - north west marine plan areas

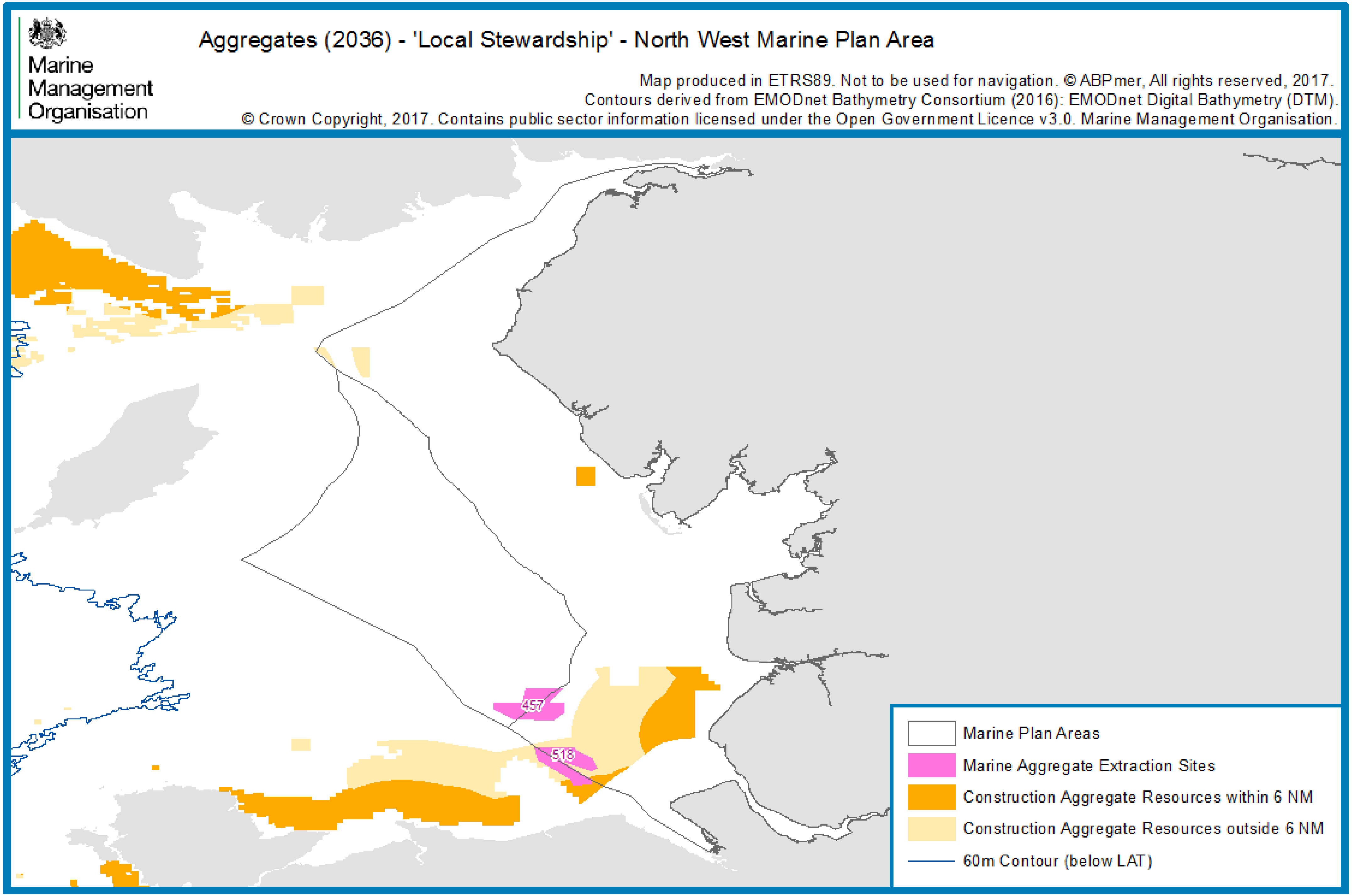


Figure 123: Aggregates (2036) – LS - north west marine plan areas

12.4 South east

There are no marine aggregate licenced areas located within the south east marine plan area; however, there is one exploration/option area, namely Goodwin Sands (Area 521). Despite minimal dredging activity in the south east marine plan area, high tonnages (on a national scale) are landed to wharves in the Thames Estuary. In 2015, 8.3 million tonnes of primary aggregates were landed to Cliffe, Dagenham, Denton, Erith, Greenhithe, Greenwich wharves, Northfleet, River Medway and Swale wharves and Thurrock, equating to 66% of the total annual landings of primary marine aggregate in England. In addition, 1.1 million tonnes of secondary aggregates were landed at Clacton-on-Sea within the south east marine plan area for use in coastal adaptation. The project was undertaken to provide around 5 km of coastal protection, including 3,000 homes at risk of flooding and erosion (The Crown Estate, 2016a).

The assumptions used to develop the BAU, N@W and LS scenarios for marine aggregates in the south east marine plan area are provided in Table 74. Projected tonnages under each of the three scenarios is shown in Figure 124. Figure 125 shows the spatial application of the scenarios to the sector while the text below provides a brief description of the future trends in 6 years and 6 to 20 years.

6-year projection

While nationally-significant landings of marine aggregate are made to the south east marine plan area, particularly London, all current Licence, Application and Option Areas within the Thames Estuary marine aggregate region are located in the east marine plan areas, with the exception of the Goodwin Sands exploration/option area. Under the BAU and N@W scenarios, it is assumed that marine aggregate extraction is permitted from Goodwin Sands at a production rate of 1.25 million tonnes per annum between 2018 and 2020 (Figure 124). No production is considered to occur within the south east marine plan area under the LS scenario (i.e. proposed extraction at Goodwin Sands does not proceed).

6 to 20 year projection

Following completion of dredging activities at Goodwin Sands in 2020 (under the BAU and N@W scenarios only), it is assumed there will be no further marine aggregate extraction within the south east marine plan area (Figure 124).

Table 74: Assumptions under the future scenarios for marine aggregates in the south east marine plan area

Aspect	Scenario		
	Business as Usual	**Nature @ Work**	**Local Stewardship**
Application to the sector	While the primary driver for the sector in this scenario is construction demand (related to economic growth) which will require increased provision of aggregate from alternative sources (including marine sources) as the availability of land-won sand and gravel reduces, there is currently no production of marine aggregates in the South East marine aggregates region. It is anticipated that marine aggregate extraction will be permitted from Goodwin Sands to support proposed development at the Port of Dover.	While the primary drivers for the sector at a national level are related to construction demand and climate change, there is currently no production of marine aggregates in the South East marine aggregates region. As under the BAU scenario, it is anticipated that marine aggregates extraction will be permitted from Goodwin Sands to support proposed development at the Port of Dover.	There is currently no production of marine aggregates in the South East marine aggregate region, and thus the south east marine plan area. It is considered unlikely that significant marine aggregate extraction would commence in the south east marine plan area under this scenario, including the proposed dredging activity at Goodwin Sands.
Assumptions	It is assumed the licence application to extract up to 3.75 million tonnes of marine aggregate from Goodwin Sands, located within the south east marine plan area, is approved. Extraction to take place between 2018 and 2020; therefore, 1.25 million tonnes per annum during this period.	The spatial assumptions are the same as for the BAU scenario.	No aggregate extraction anticipated in the south east marine plan area.

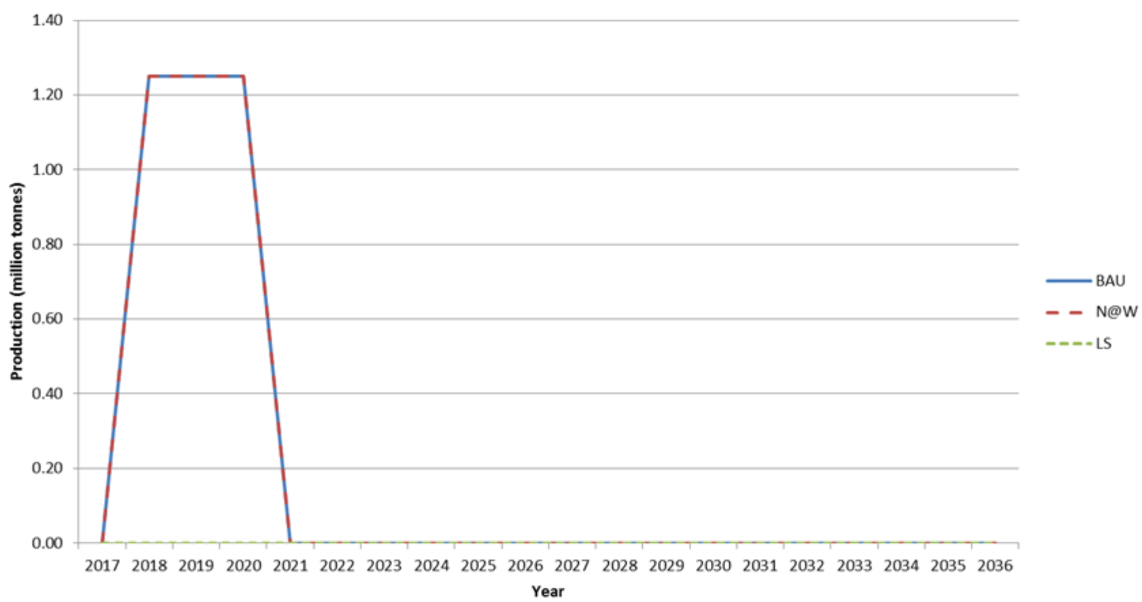


Figure 124: Projections of production tonnages (million tonnes) for the marine aggregate sector in the three scenarios for the south east marine plan area

Potential trade-offs

The main potential interactions for future marine aggregate development are likely to be:

- Natural environment (habitat damage);
- Other infrastructure.

In the south east marine plan area, the main potential trade-offs are likely to be with the natural environment and future infrastructure under all scenarios. Negative trade-offs can be minimised through careful site selection.

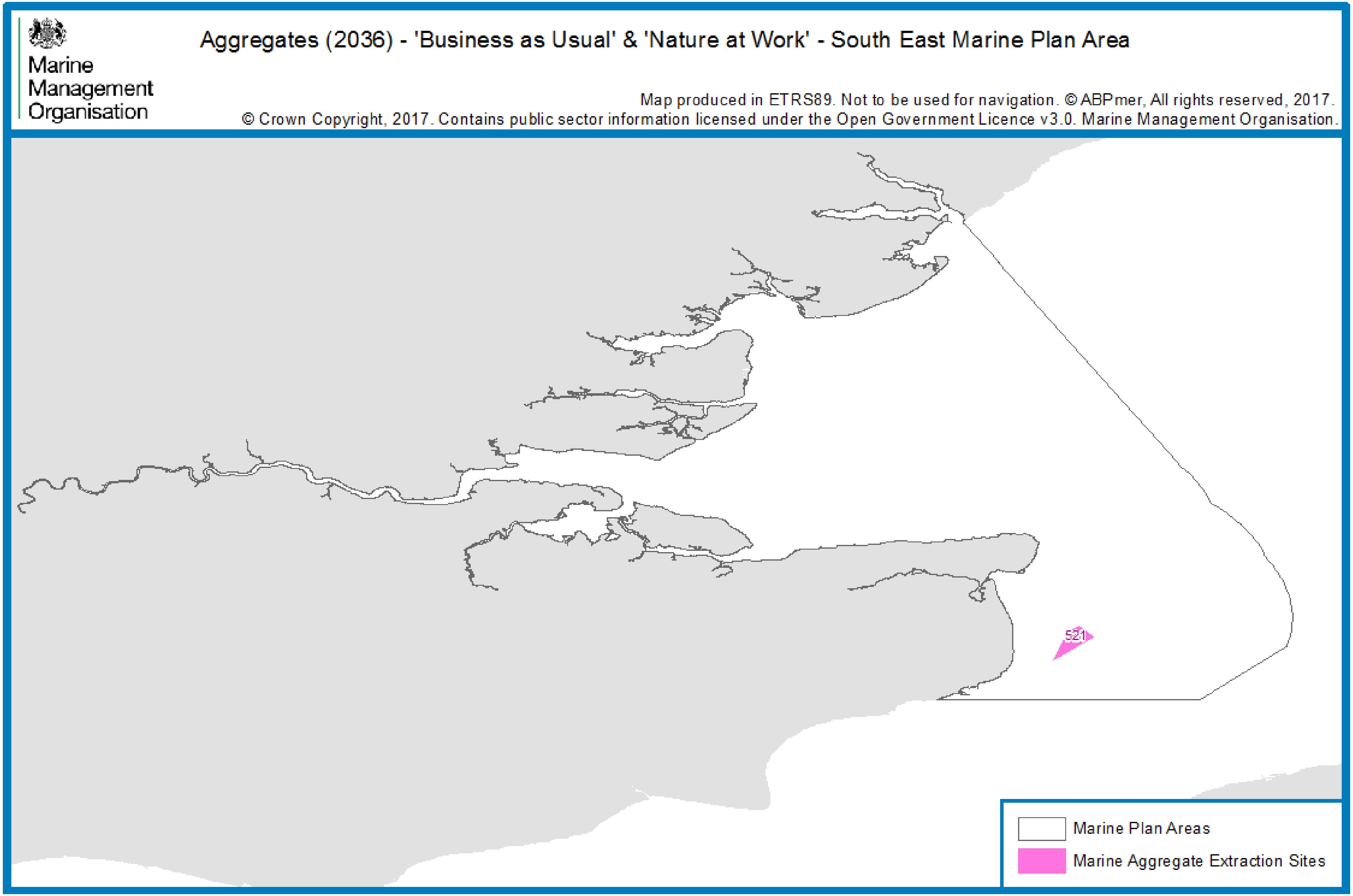


Figure 125: Aggregates (2036) – BAU and N@W– south east marine plan area

12.5 South west

The Crown Estate's South West marine aggregate region encompasses the South West of England and South Wales, specifically the Bristol Channel and Severn Estuary. The Culver Sands (Area 472) marine aggregate licence area is located within the south west marine plan areas. In addition, the Culver Extension (Area 526) application area and Bedwyn Sands licence renewal area partially overlap the English/Welsh border and thus are located within the south west marine plan areas. The North Bristol Deep (Areas 470/1-2) and North Middle Ground (Areas 455/459) licence areas are located immediately adjacent to the south west marine plan areas in Welsh waters.

In 2015, 1.1 million tonnes of primary aggregates were dredged within the South West marine aggregate region. However, it should be noted that this includes aggregates sourced from Licence Areas outside of the south west marine plan areas (i.e. Welsh waters). Roughly the same tonnage of primary aggregates was landed in the South West marine aggregate region, with 483,811 tonnes to wharves within the south west marine plan areas (Appledore, Avonmouth, Bridgwater and Yelland wharves; The Crown Estate, 2016a). It should be noted that removals from Bedwyn Sands (Severn Sands Limited) which is located partially in English and Welsh waters (not under The Crown Estate ownership) are not included in these statistics. Therefore, based on the maximum production licence condition for Bedwyn Sands (250,000 tonnes per annum), it is possible that The Crown Estate figures underestimate total production in the South West marine aggregate region by up to 25%.

The assumptions used to develop the BAU, N@W and LS scenarios for marine aggregates in the south west marine plan areas are provided in Table 75. Projected installed capacity under each of the three scenarios is shown in Figure 126. Figure 127, Figure 128 and Figure 129 shows the spatial application of the scenarios to the sector while the text below provides a brief description of the future trends in 6 years and 6 to 20 years.

Table 75: Assumptions under the future scenarios for marine aggregates in the south west marine plan areas

Aspect	Scenario		
	Business as Usual	Nature @ Work	Local Stewardship
Application to the sector	The primary driver for the sector in this scenario is construction demand (related to economic growth) which will require increased provision of aggregate from alternative sources (including marine sources) as the availability of land-won sand and gravel reduces, largely through exhaustion. Demand for marine aggregate will be met through extraction at	The primary drivers are construction demand and climate change with increased demand to provide material for tidal lagoon projects, new nuclear builds, sandscaping and beach replenishment. Increased demand for marine aggregate will be met through an increased intensity of extraction at the Licence, Application	Lower levels of overall economic development mean lower demand for aggregate for general construction projects. However, this reduction is offset through increased development of tidal lagoons which require aggregate for the building of the tidal lagoons, and sandscaping and beach replenishment. Public perceptions of suitable energy resources mean

Aspect	Scenario		
	Business as Usual	**Nature @ Work**	**Local Stewardship**
	current Licence, Application and Option Areas. Climate change will also continue to be a driver, resulting in an increase in activities such as dredging, beach nourishment and sand reclamation (EEA, 2015).	and Option Areas, as well as potential extraction of sand/gravel from areas where there are suitable natural resources (<12 nm), for use in sandscaping and beach replenishment. There is potential to increase the maximum depth from which aggregate resources could be extracted as a result of economies of scale (e.g. larger vessels).	less emphasis on nuclear power generation. The increased demand for marine aggregate will be met through an increased intensity of extraction from the Licence, Application, Option and Exploration Areas, as well as potential extraction of sand/gravel from more local inshore areas (<6 nm), where there are suitable natural resources, for use in sandscaping and beach replenishment.
Assumptions	Based on the November 2016 UK economic and fiscal forecast (OBR, 2016), sector growth (extraction tonnages) have been assumed to increase at: • 1.7% (2017 – 2018) • 2.1% (2018 – 2020) • 2.0% (2020 – 2036) Annual extraction rate in 2017 based on five-year (2011 – 2015) average for South West marine aggregate region. It is assumed that 50% of extraction from the South West marine aggregate region is from Licence Areas within the south west marine plan areas (remainder sourced from Licenced Areas within Welsh waters). The following infrastructure projects are assumed to be constructed (requiring aggregate from the marine environment) and come on-line: • Swansea tidal lagoon (no aggregate requirement as	The spatial assumptions are the same as for the BAU scenario, except that Cardiff tidal lagoon and Newport tidal lagoon are also constructed. Additional extraction is also required (compared to the BAU scenario) for sandscaping and beach replenishment, which is seen as preferable to the construction of hard sea defences. The requirement for marine aggregate was calculated as follows: • As per the BAU scenario for Swansea tidal lagoon and two new build nuclear power stations (Hinkley Point C and Oldbury). • Two new tidal lagoon projects (Cardiff and Newport). Assumptions: approximately 15 million m³ of aggregate required per tidal lagoon to build the lagoon wall (unpublished data); 30% met from Licence Areas in the South West marine aggregate region (i.e. in addition to sediment dredged from within the footprint	The spatial assumptions are the same as for the BAU and N@W scenarios, except that in addition to the Swansea, Cardiff and Newport tidal lagoons and Hinkley Point C nuclear power station, additional tidal lagoon projects are developed in Bridgwater Bay and West Somerset, while the Oldbury nuclear power station does not proceed. Additional extraction is also required (compared to the BAU scenario) for sandscaping and beach replenishment, which is seen as preferable to the construction of hard sea defences. The requirement for marine aggregate was calculated as follows: • As per the BAU scenario for the Hinkley Point C nuclear power station (assumed Oldbury nuclear power station does not proceed). • As per the N@W scenario for tidal lagoons (Cardiff and Newport), plus construction of the Bridgwater Bay and West Somerset tidal

Aspect	Scenario		
	Business as Usual	Nature @ Work	Local Stewardship
	material for lagoon walls is provided from within the footprint of the lagoon development). • Two new build nuclear power stations (Hinkley Point C and Oldbury). Each development requires approximately 1.5 million tonnes of aggregates (BMAPA website). Hinkley Point C to be constructed between 2018 and 2027 licenced Areas within Welsh waters). • Oldbury to be constructed between 2025 and 2034, hence an additional 0.15 million tonnes of aggregate per annum required from the South West marine aggregate region for both developments during these periods. It is assumed that 50% of marine aggregates (0.075 million tonnes per development) will be sourced from licensed aggregate areas in the south west marine plan areas (remainder to be sourced from Licensed Areas within Welsh waters).	development), and 50% of this marine-won material sourced from Licence Areas within the south west marine plan areas (remainder from Licensed Areas within Welsh waters); 2.25 million m³ of sediment required per development. Using a conversion of 1,600 kg/m³ for fresh sand, each development would require 3.6 million tonnes of marine aggregates from the south west marine plan areas. If construction is assumed to occur over four years (2023 – 2026 for Cardiff tidal lagoon; 2025 – 2028 for Newport tidal lagoon), each development requires 0.9 million tonnes per annum of marine aggregate over the construction period • An extra 1 million tonnes per annum (from 2022 to 2036) is extracted for sandscaping from the south west marine plan areas.	lagoon between 2029 and 2032. • An extra 1 million tonnes per annum (from 2022 to 2036) is extracted for sandscaping from the south west marine plan areas.

6-year projection

The current level of aggregate production (averaged from 2011 to 2015) for the south west marine plan areas is approximately 3.1% of the UK total (554,300 tonnes per annum), assuming 50% of material from the South West marine aggregate region is extracted in English waters (remainder from Welsh waters). Over the next 6 years, it is assumed that this production rate would steadily increase to approximately 611,389 tonnes per annum under all three scenarios for use in the general construction industry. While the Swansea tidal lagoon project is anticipated for construction during this period (2019 – 2020), no additional marine aggregate is required beyond material available within the development footprint.

Construction of Hinkley Point C nuclear power station would commence in 2018 under all three scenarios, with a requirement for 75,000 tonnes of marine aggregates per annum from Licence Areas within the south west marine plan areas (see Table 75 for further detailed assumptions). From 2022, it is also assumed that 1 million tonnes of marine aggregates would be required per annum to support sandscaping projects under the N@W and LS scenarios.

Peak production rates in the south west marine plan areas over the next 6 years (realised in 2022) would be 686,389 tonnes per annum under the BAU scenario and 1.69 million tonnes per annum under the N@W and LS scenarios (Figure 126).

6 to 20 year projection

Construction of Hinkley Point C (under all three scenarios) and Oldbury (BAU and N@W scenarios only) new build nuclear power stations are assumed to be completed in 2027 and 2034, respectively. Each development would require approximately 75,000 tonnes of marine aggregates per annum from Licence Areas within the south west marine plan areas. Post 2022, two tidal lagoon projects are anticipated for construction under the N@W scenario, with Cardiff tidal lagoon assumed to be constructed between 2023 and 2026 and Newport tidal lagoon assumed to be constructed between 2025 and 2028. Under the LS scenario, in addition to these two tidal developments, it is assumed two further tidal lagoons will be constructed in Bridgwater Bay and West Somerset between 2029 and 2032. With approximately 7.2 million tonnes of marine aggregate required per tidal development, it is likely that significant demand will be sought from the south west marine plan areas.

Peak production rates in the south west marine plan areas are predicted to occur in 2034 under the BAU scenario (850,389 tonnes per annum), in 2026 under the N@W (3.61 million tonnes per annum) and in 2032 under the LS (3.55 million tonnes per annum) scenarios. This relates to continued growth of the sector over the next 20 years under BAU and the overlap in construction programme between Cardiff and Newport tidal lagoon developments for the N@W and LS scenarios, as well as Oldbury nuclear power station under the N@W scenario. Under the LS scenario, the assumption that Oldbury nuclear power station would not proceed would lead to a slight decrease in requirement compared to N@W. However, the total requirement for marine aggregates within the south west marine plan areas would increase to approximately 3.5 million tonnes under both N@W and LS between 2025 and 2026, with continued elevated production until 2032 under the LS scena, largely to support the development of tidal lagoons. This indicates a discrepancy of approximately 2.5 million tonnes per annum compared to the BAU scenario during periods of peak demand (Figure 126).

Other than current Licence, Application and Option Areas, there are a number of locations within the south west marine plan areas which could provide additional resource under the N@W and LS scenarios. In particular, additional construction aggregate could be sourced from the Outer Bristol Channel from locations within 12 nm under N@W and within 6 nm under LS to support proposed new build nuclear power station and tidal lagoon developments, in addition to the general construction industry.

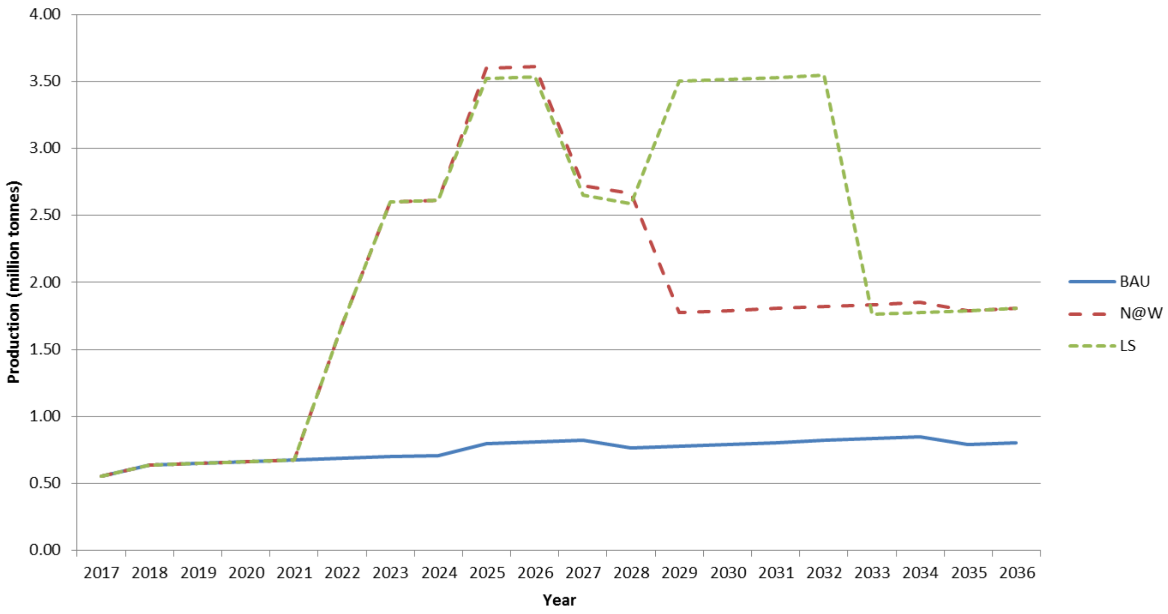


Figure 126: Projections of production tonnages (million tonnes) for the marine aggregate sector in the three scenarios for the south west marine plan areas

Potential trade-offs

The main potential interactions for future marine aggregate development are likely to be:

- Natural environment (habitat damage)
- Other infrastructure.

In the south west marine plan areas, the main potential trade-offs are likely to be with the natural environment, telecommunication cables and future infrastructure under all scenarios, but particularly N@W and LS. Negative trade-offs can be minimised through careful site selection.

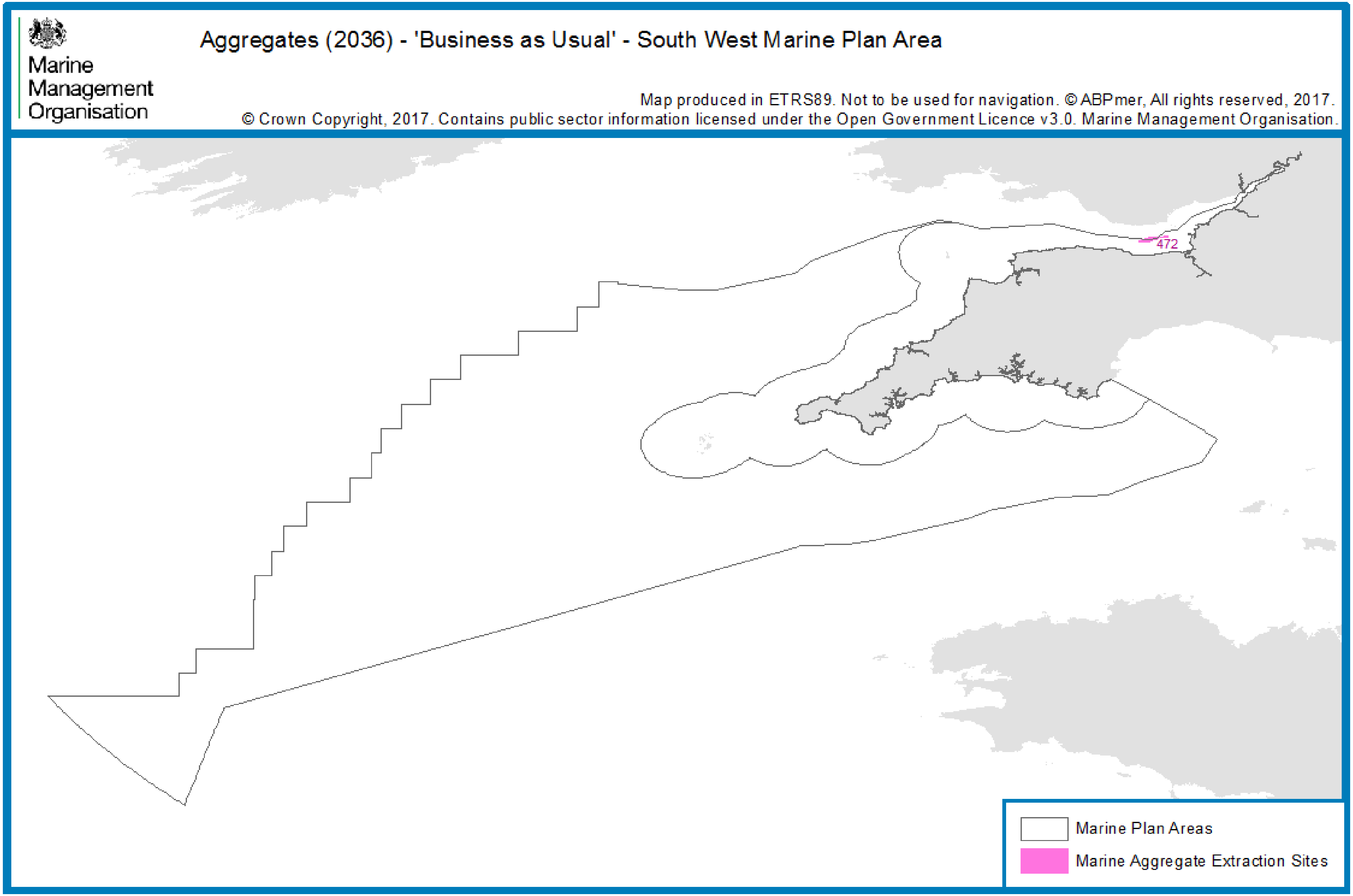


Figure 127: Aggregates (2036) – BAU – south west marine plan areas

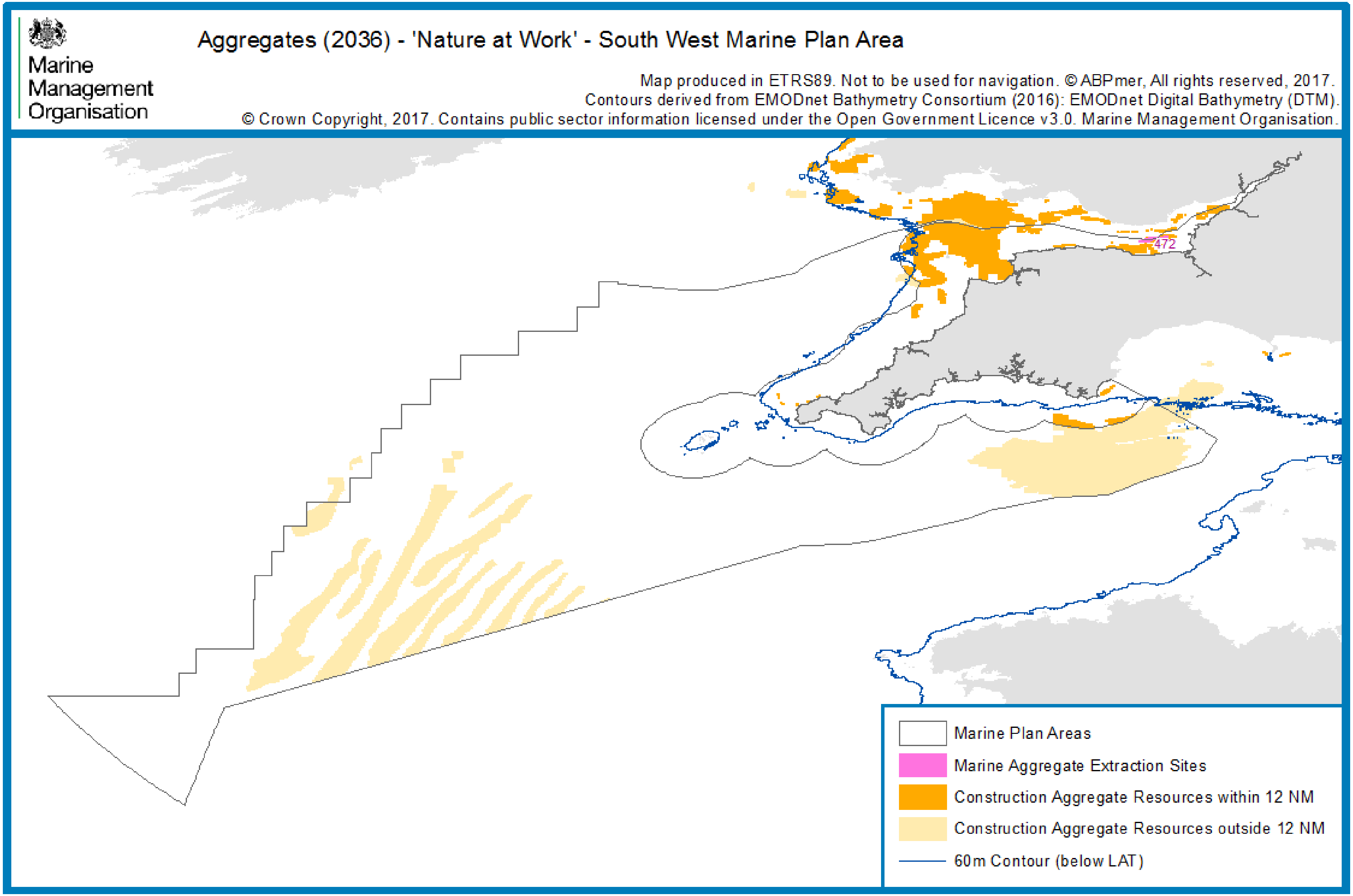


Figure 128: Aggregates (2036) – N@W – south west marine plan areas

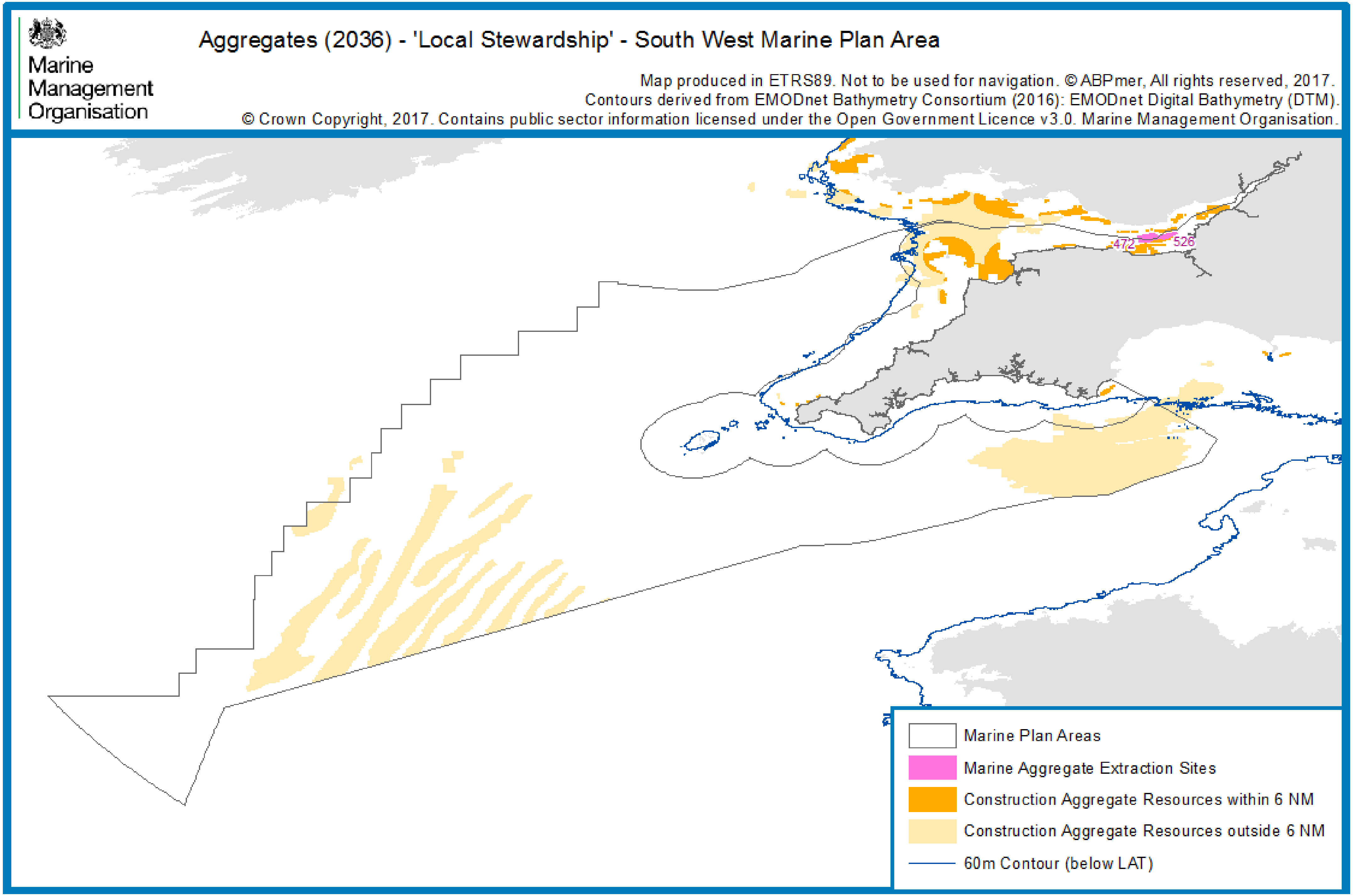


Figure 129: Aggregates (2036) – LS – south west marine plan areas

13 Ports, shipping, dredging and disposal

Sector definition

Ports provide the modal interchange points by which goods and people are transported from land to sea. Within England, there are three types of port ownership: Trust, Municipal and Private. All ports operate on a commercial basis, independently from Government. Duties and responsibilities are conferred by legislation tailored to each port, with port operations administered by the Statutory Harbour Authorities (SHA).

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 movement of vessels is monitored and recorded by the Maritime and Coastguard Agency (MCA) and by individual port authorities whilst vessels are within their area of jurisdiction.

The operation of ports and marinas requires dredging and the disposal of the marine sediment. Applications for dredge licences are overseen by the MMO who also licence specific disposal sites using scientific advice provided by the Cefas. In relation to port and harbour activities, there are two types of (non-aggregate) dredging licensed by the MMO. These are capital dredging and maintenance dredging.

Capital dredging is the removal of material to create a greater water depth than had previously existed. 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. Dredging of marine aggregates is covered in Section 3.10.

Data sources

A variety of different information sources have been reviewed to inform this baseline, including published reports and papers and spatial data layers. The main information sources used are provided in the list below:

- Department for Transport UK port and shipping statistics (DfT, 2016a; b)
- Economic information on GVA and employment from Oxford Economics (2015a; b; c) and MMO (2016a)
- AIS data.

13.1 National review

Overview of national activity

Ports and shipping

As an island nation, the UK is particularly dependent upon trade that utilises ports and shipping. Throughout the last century, the shipping industry has seen a general increase in total trade volume as industrialisation and liberation of national economies have fuelled free-trade and a growing demand for consumer products. These changes in trade and the shipping that services it, drive port development that responds to market need (MMO, 2013c).

The DfT classifies ports into major and minor categories with major ports handling more than 1 million tonnes of cargo annually (Figure 130). In 2013 the UK had a total of 52 major ports and a further 108 minor ports. The latest port freight statistics indicate that in 2015 total tonnage of freight moving through major UK ports was 496.7 million tonnes, a 1% drop relative to 2014 (DfT, 2016a). Whilst tonnage fell marginally, reflecting reduced demand for coal and ores, changes in steel production, and lower dependency on food imports, unitised traffic experienced a third consecutive year of growth rising 4% from 2014 levels to 23.6 million units. 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. In 2015 liquid bulk was the largest of the main cargo types with 194.4 million tonnes being handled at UK major ports, the majority of which was made up of crude oil (DfT, 2016a).

The large amount of trade coming through ports inherently results in UK waters being heavily used by commercial shipping vessels. The most heavily used areas around the UK are off the south and south east coasts in the east English Channel (Figure 131). The north east and north west coasts also have areas of heavy vessel traffic. To minimise collision risk, some heavily used areas have developed Traffic Separation Schemes (TSS) which divides opposing traffic into lanes.

It is estimated that the maritime services sector, defined as ports, shipping and maritime business excluding oil and gas, defence and manufacturing, directly employed 239,000 people in the UK in 2013 (Oxford Economics, 2015a). The sector's direct gross contribution to the UK's GDP in 2013 totalled £9.9 billion, generating a tax revenue of £2.5 billion for the Exchequer. Including indirect and induced employment, these values increase to 489,000 jobs, a £22 billion contribution to the UK's GDP and £6.5 billion in tax revenue (Oxford Economics, 2015a). In addition, naval bases and military ports also make significant contributions (see Defence, Section 3.3).

Dredge and disposal

To facilitate continuous trade into and out of ports, dredging is often required. This involves the removal of sediment and the subsequent disposal of spoil. A total of 591 disposal sites are present in UK waters, the majority of which are within inshore areas. At present, 227 disposal sites are open and the remaining are either closed or disused (MMO, 2013c).

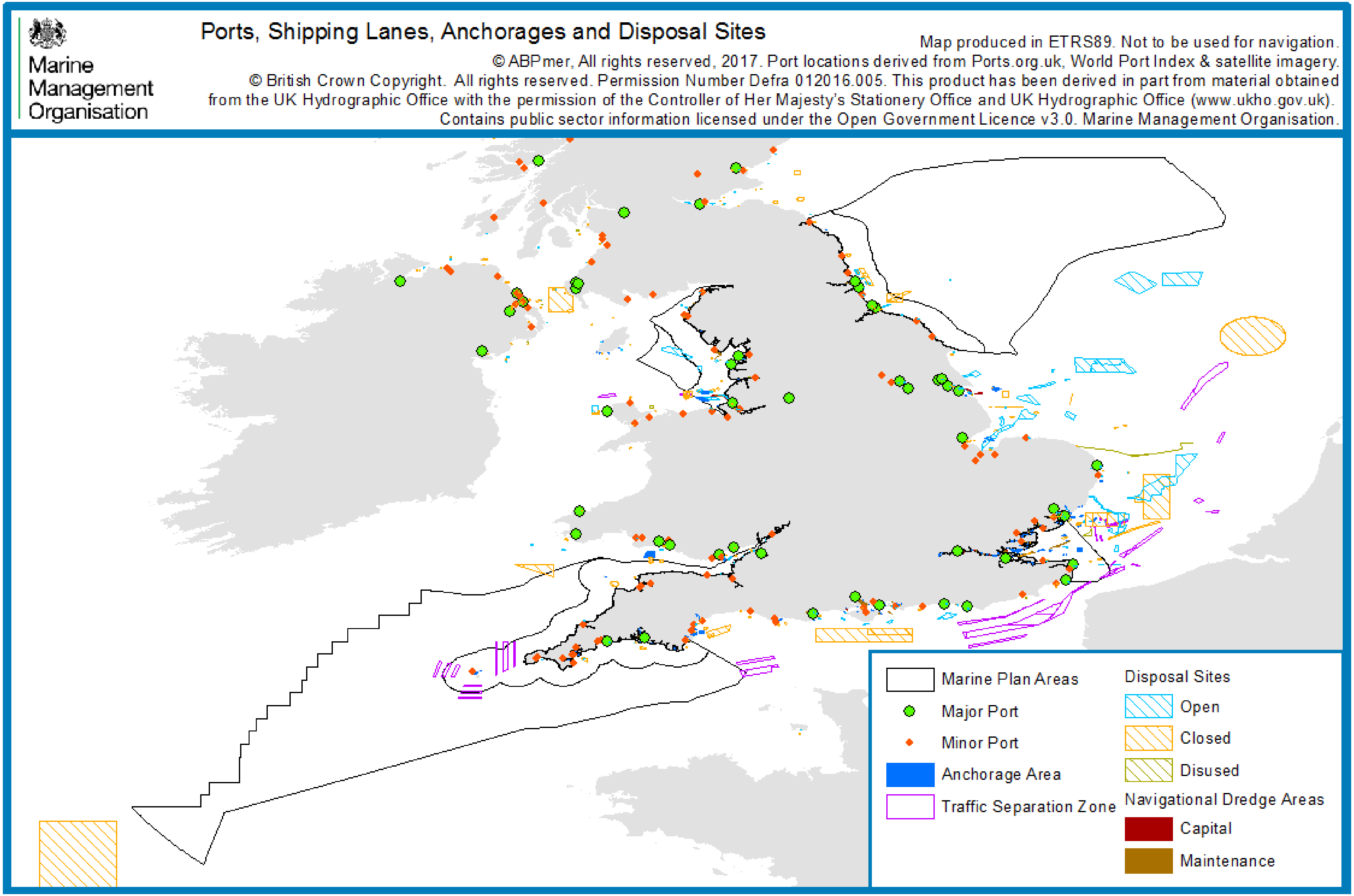


Figure 130: Ports, shipping lanes, anchorages and disposal sites

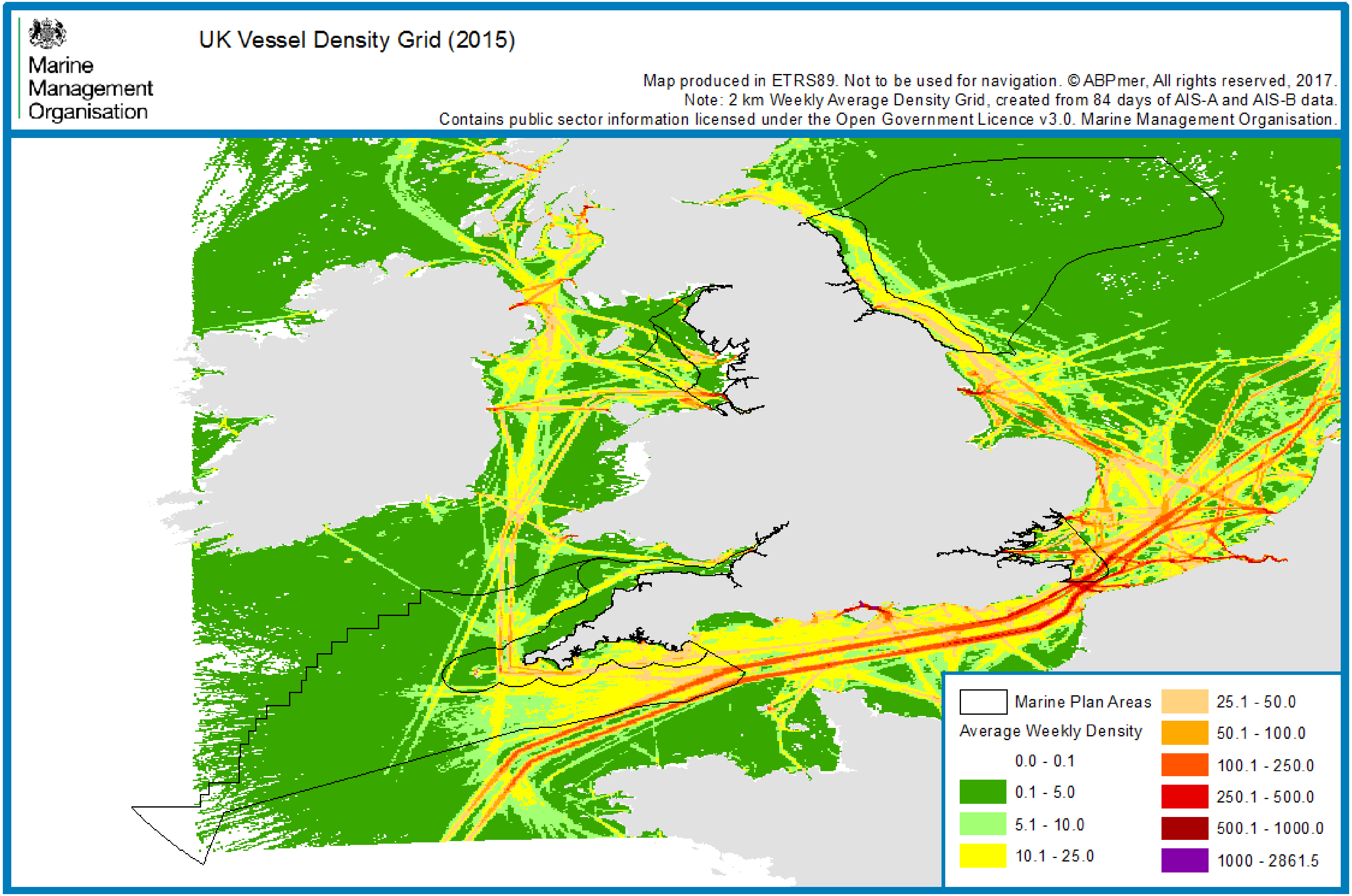


Figure 131: UK vessel density grid (2015)

Review of historical trends

Ports and Shipping

Over the last twenty years, growth in imports has been much stronger than exports, as a consequence of the changing structure of the economy from manufacturing to service industries. Domestic traffic has declined over the same period.

Between the early 1980s and 2000 the total amount of freight tonnage increased by 35%. The 2008 recession resulted in the largest year on year decline seen in the last 30 years, when port freight fell by 11% between 2008 and 2009. Total UK tonnage levels has stabilised in recent years at around half a billion tonnes. However, total freight tonnage traffic decreased by 1 per cent in 2015 to 497 million tonnes, which is the lowest level observed since 1992 (DfT, 2016a). UK major port tonnage fell slightly, by 1% in 2015 to 486 million tonnes.

The trend over the last 10 years in total freight traffic across major ports in the north east, north west, south east and south west marine plan areas is shown in Figure 132. All areas saw a reduction in traffic in 2008/9 as a result of declining trade from the global financial crisis. The major ports in the south east marine plan area have the highest levels of port traffic and these levels increased by 2% in 2015 to 108 million tonnes. Felixstowe port handled the most unitised main freight traffic in 2015 (2.6 million units), of which 91% was Lo-Lo traffic. Felixstowe also handled the most Lo-Lo traffic compared to other UK major ports, with 2 out of every 5 Lo-Lo units being handled by Felixstowe. Dover handled the largest amount of UK Ro-Ro main freight, with 2.6 million units being handled in 2015 representing 34% of all main freight Ro-Ro traffic.

The north east marine plan areas have the second highest levels of port traffic; these fell markedly by 11% in 2015 to 42 million tonnes (Figure 132). Of the top ten busiest UK ports, Tees and Hartlepool experienced the largest decrease in tonnage. This was predominantly due to the decrease in the amount of coal handled at the port resulting from conversion from coal to biomass energy production at the Lynemouth power plant in Northumberland (DfT, 2016a).

The north west marine plan areas have slightly lower levels of port traffic and these have remained the most stable over the last 10 years compared to the north east, south east and south west marine plan areas (Figure 132). In 2015, total freight in the major ports of the north west marine plan areas was 36 million tonnes, an increase in 3% from the previous year.

The south west marine plan areas has the lowest levels of port traffic compared to the north east, north west and south east marine plan areas (Figure 132). This freight traffic has remained relatively stable over the last 10 years, although there was a 14% reduction in 2015 to 12 million tonnes, primarily due to a slump in freight traffic at the Port of Bristol to levels comparable to 2011.

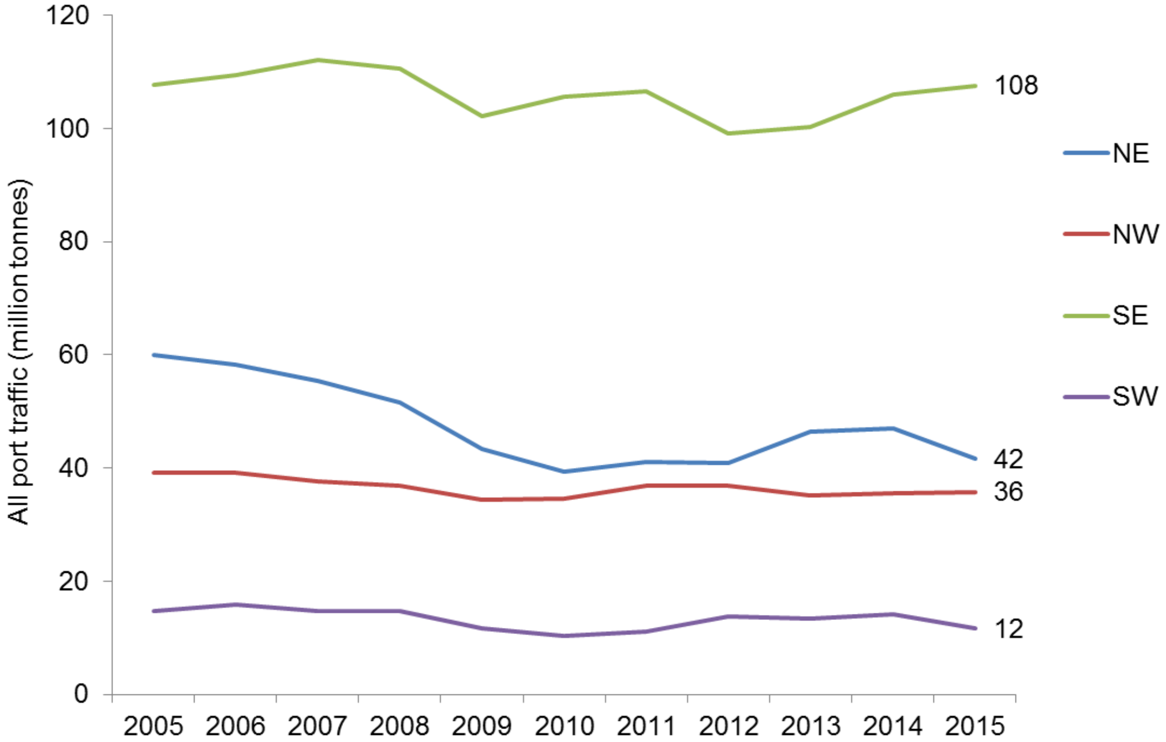


Figure 132 Major port traffic 2005 to 2015

Data source: DfT (2016a)

Over half (62,487) of the vessels arriving at UK ports were at the top ten ports for the amount of tonnage handled. Dover received the largest number of ship arrivals in 2015 (17,000 vessels), however, this was 9% lower than in the previous year. This may be the result of disruptions to the Dover - Calais route in summer 2015, and the cessation of MyFerryLink operations on this route. The large number of ship arrivals at Dover was largely comprised of 14,000 Ro-Ro vessels sized between 5000 and 19,999 deadweight tonnes arriving at Dover port (i.e. ferries). Dover received more Ro-Ro vessels than any other UK port (25%).

Unitised traffic handled at UK major ports in 2015 rose by 4% with 23.6 million units coming in and out of UK major ports, the highest level since 2007. This was mainly due to large increases in the number of container units and import/ export motor vehicles handled at UK major ports (DfT, 2016a).

The number of main freight units handled by major ports rose for the third consecutive year, to 13.4 million units. Main freight accounted for 57% of all unitised traffic. Main freight units travelling through UK major ports grew from the early 1990s, increasing by 87% between 1992 and 2007 to 13.3 million units. However, in 2009 traffic fell to 11.6 million units, following the global recession.

A quarter of the units handled by UK major ports in 2015 were non-freight units in the form of passenger cars and buses (5.8 million units).

The trend over the last 12 years in international sea passenger movements (both ferry and cruise) in the north east, north west, south east and south west marine plan areas is shown in Figure 133. The ports in the south east marine plan area, predominantly Dover and Harwich, have the highest numbers of sea passengers and these levels have remained relatively stable over the 12 year period. The number of passengers in the south east marine plan area reduced marginally from 14.2 million in 2014 to 13.9 million in 2015. The numbers of sea passengers in the north east and south west marine plan areas are relatively similar and have marginally reduced over the 12 year period. In 2015, there were 587,000 passenger movements in the north east (Port of Tyne) and 449,000 passenger movements in the south west (Port of Plymouth). The north west marine plan areas have the least international sea passenger movements (from the Port of Liverpool). There has been a declining trend in sea passengers in the north west marine plan areas over the last 12 years, with dips occurring in 2005 and 2011. Numbers of passengers have remained more stable in recent years since 2011, with 121,000 sea passengers in total recorded in 2015.

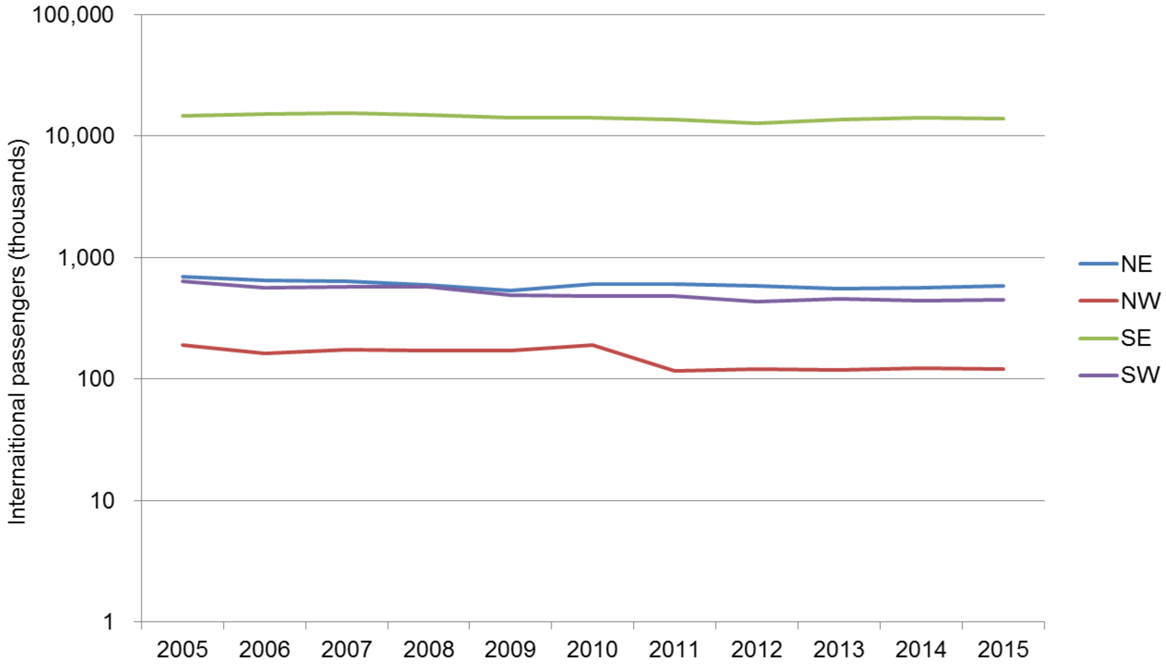


Figure 133: All international sea passenger movements 2003 to 2015

Data source: DfT (2016b)

Dredge and Disposal

Over the past two decades, the areas permitted for disposal have altered. In particular, a large number of sites have been closed, partly in response to legislative changes restricting the disposal at sea of certain types of material (Figure 130). Examples include munitions and liquid industrial waste.

The amount of dredged material disposed of at sea each year from the UK has been relatively consistent since 1985, the variation in annual tonnage being most marked in the quantities of capital dredgings associated with port expansion and channel deepenings; the fluctuations in dredgings reflecting a combination of economics and weather (HM Government, 2011).

Review of key changes and/or advances of significance affecting the sector

The key drivers affecting the development of the ports, shipping, dredging and disposal sector are described in Table 76.

Over the last 20 years, growth in imports has been much stronger than exports, as a consequence of the changing structure of the economy from manufacturing to service industries. These structural changes are a key driver on shipping and freight volumes. The economic downturn since 2008 has also impacted on both shipping numbers and freight tonnages handled by ports within the north east, north west, south east and south west marine plan areas (MDS Transmodal, 2011).

The principle of economies of scale is key to the economics of maritime transportation since in general terms, the larger the ship, the lower the cost per unit transported. The trend towards larger ships is particularly apparent in bulk and containerised shipping. This trend towards larger ships also has implications for dredging requirements with a need for capital dredge projects to increase channel depth and improve access to ports.

The International Maritime Organization (IMO) has a key role in providing drivers for change through conventions and international regulations, for example, the International Convention for the Safety of Life at Sea (SOLAS) and the International Regulations for Preventing Collisions at Sea (COLREGS).

Following a proposal by the EU Member States bordering the North Sea and the Baltic Sea, two Sulphur Emission Control Areas (SECA) were established by the International Maritime Organisation; the Baltic SECA took effect in May 2006, while the North Sea SECA (including the full length of the English Channel) came into force from November 2007. In 2010 the amount of sulphur content in ships fuel used within a SECA was reduced from 1.5% to 1.0%. The ship owner has a choice of whether to use either a higher quality fuel (low sulphur marine gas oil) or the cheaper heavy fuel oil, providing the exhaust gases of the latter are cleaned before emissions (MCCIP, 2013). The European Parliament has also incorporated an IMO accord that will lower sulphur in fuel used by all ships in the Baltic Sea, the North Sea and the English Channel to 0.1% in 2015. There are concerns that this new regulation may lead to an increase in sea transport costs for both goods and passengers. Significant cost increases for transportation by sea as a consequence of using the more expensive low sulphur fuel (MGO) has the potential to reduce the competitiveness of short-sea shipping transport against other transport modes.

Invasive non-indigenous species present a major threat to marine ecosystems, and shipping has been identified as a major pathway for introducing species to new environments. The Ballast Water Management (BWM) Convention, adopted in 2004, aims to establish standards and procedures for the management and control of ships' ballast water and sediments (IMO, 2004). The BWM Convention was recently ratified and will enter into force on 8 September 2017. Once the Convention comes into force, all ships engaged in international transits will be required to manage their ballast water and sediments to a certain standard, according to a ship-specific ballast water management plan. All ships will also have to carry a ballast water record book and an international ballast water management certificate. New systems of ballast water management and reporting procedures will lead to difficulties particularly for smaller ports without reception/treatment facilities and for existing shipping fleets needing to retro-fit filtration systems.

The dredge disposal sector is driven by port and harbour development which itself is influenced by wider economic trends. The economic downturn is likely to influence the short- to medium-term demand for capital dredge projects since finance for port and harbour developments is less readily available.

Table 76: Key drivers affecting development of the ports, shipping, dredging and disposal sector

Driver	Details	Implications
Political	National Policy Statement for Ports (DfT, 2012) considers ports to be of national significance to infrastructure, and indicates that it may be a relevant consideration for MMO decision making	Acknowledges a need for a competitive and efficient port industry to meet needs of importers and exporters
	The Trans-European Network Transport (TEN-T) programme for a core network of ports and Motorways of the Sea (one of which is for western Europe from Portugal and Spain via the Atlantic Arc to the English Channel, North Sea and the Irish Sea)	Potential EU support for ports in English Channel, North Sea and Irish Sea.
Economic	Global consumption patterns linked to economic cycle	Demand for maritime transport will fluctuate according to economic factors and level of UK and global economic growth
	Level of globalisation of markets	Increasing globalisation leads to greater physical flows of goods, higher levels of maritime transport and increase in demand for port services (and *vice versa*)
	Competition between ports	Minor redistribution of trade within and between marine plan areas. More competitive ports may attract disproportionate volume of trade growth
	Changing needs for shipping and other related industries drives the need for construction and upgrading of port infrastructure	Ports required to expand or change infrastructure capabilities and port diversification to handle changes in shipping and other sectors
	Economies of scale drive trend towards larger ships	Increased demand for dredging/dredge disposal
	Trends in global shipping routes will be influenced in the future by the enlargement of the Panama Ship Canal and potential new Arctic routes	The former has the potential to favour western-facing UK ports as transatlantic trade increases, originating in both east Asia and North America

Driver	Details	Implications
	There may be a trend towards ‘port-centric logic’, with road haulage costs being reduced by shipping to ports with improved facilities and distribution networks closer to market. Along with this, there may be an increase in short sea shipping with goods being offloaded from larger vessels for further shipping to smaller ports	This may shift trade away from the south east to other parts of the UK
Social	There may be employment opportunities for expanding ports and associated infrastructure development	Increase in employment (balanced by technological advancements, see below)
Technological	Staff costs drive the progress of more automation on board ships and at ports	Technological advancements lead to a reduced need for personnel on ships and in ports
Legal	New regulations being brought in to reduce pollution from shipping	Low sulphur fuels with higher transport costs for both goods and passengers
	Ballast water management convention	Increased costs for shipping operators/owners leading to higher freight rates. Short sea shipping operators may be forced out of the market due to cost leading less jobs within the sector
	Water Framework Directive (WFD)	More scrutiny of dredge disposal applications, potentially reduce the amount of maintenance dredge disposal
Environmental	Climate change could lead to increased flood risk at ports and increasing frequencies of inclement weather would mean more periods of limited operations and weather downtime	Ports would be reliant on weather windows in order to carry out operations and would need to invest more heavily in flood defences
	Increased temperatures will lead to the Arctic route being open for a larger proportion of the year. This could lead to a larger number of ships transiting through and using ports in the UK	Increased vessel traffic and use of ports, especially favouring deep-water ports located in the north west marine plan areas
	Competing marine uses, especially offshore wind energy expansion	This may restrict shipping movement, and potentially lead to (longer) route changes
	MPAs may affect some dredging and disposal activities	Increased regulation of dredging and disposal activities (e.g. additional licence conditions)

Review of future trends

The primary driver for ports, shipping, dredging and disposal is economic growth. As the global economy continues to grow, there will be increased trade and demand for the maritime import of goods. However, this may be tempered by reductions in the import of raw materials and export of goods with the continued reduction in manufacturing. This is supported by the fact that overall throughput has remained relatively static in the last decade, although with minor variations between marine plan areas.

Under BAU, the growth of maritime transport may be associated with gradual changes in trade and changes in vessel sizes through the use of larger ships. Growth is also focused on the larger ports and locations with modern efficient handling facilities. More dredging and disposal is required to deepen channels to accommodate larger vessels. Changes to maritime passenger numbers are likely to be minimal under the BAU scenario, but there may be small increases as population growth continues.

Under the N@W scenario, there is an increased intensity of shipping from the growth in international trade. Ports accommodate the higher levels of trade through increased infrastructure and technology to handle the larger volumes. Again, growth is also focused on the larger ports and locations with modern efficient handling facilities. More dredging and disposal is required to deepen channels to accommodate larger vessels. There would also be a diversification of ports to service the growing offshore wind and tidal range energy production sectors. The development of these sectors is unlikely to cause significant impacts on shipping as the projects are designed to minimise impacts on commercial navigation. Changes to maritime passenger numbers are likely to be minimal under the N@W scenario, but there may be small increases as population growth continues.

Under the LS scenario, economic growth is lower and there is a lower rate of growth in international trade. Smaller ports will have higher growth rates than larger ports as local and regional trade is encouraged. Smaller feeder shipping routes are likely to become more widely used. The major ports will also continue to grow, but at a lower rate than under the other scenarios. There will be higher levels of tourism within the region which will result in an increase in the number of ferry passengers as local and regional travel increases.

Confidence assessment

Future demand is uncertain as it is linked to economic cycles. The location of demand for port services is uncertain and is dependent on competition between ports both within and outside the region. The location and timing of future port development is also not known.

Anecdotal information from the MCA suggests that *circa* 60% of traffic is recorded through routine data collation using the network of Automatic Identification System (AIS) transceivers. AIS is a relatively new technology (*circa* 2000 onwards) for which long-term records are infrequently kept. The most robust data source is the MCA's archive of AIS data which has been used to generate the spatial distribution of shipping. This data provides Commercial Shipping AIS-A records composed of data from the first seven days of each month in 2015. This method of monthly data selection removes seasonality variations and presents an 84 day record to characterise a year data set for Commercial Shipping. This does leave a significant proportion of missing vessel tracks which are 'non AIS-A' vessels, including:

- Commercial Vessels below 300GT
- Recreational Vessels
- Fishing Vessels
- Naval Vessels whilst on deployment.

Approaches for mapping the AIS shipping data have been developed in a separate MMO project (MMO, 2013d). Whilst AIS data records can provide a detailed spatial and temporal picture of vessel movements, potential sources of error exist within the data. For example, AIS transponders may be switched on or off during a ships passage or defective, thereby not capturing the full transit. Transmitted information such as vessel type or dimensions can also be incorrectly entered, thereby providing a degree of uncertainly.

13.2 North east

In 2015, the total freight traffic by tonnage handled by ports in the north east was around 12% of the total of all ports in England (DfT, 2016a). The north east is a major manufacturing base and key area for UK exports, with the ports playing an increasing role in export of key products such as cars (linked to Nissan's plant in Sunderland). The ports and shipping services in the north east also support the renewable energy sector both in production and in assembly of renewable energy facilities.

There are four major ports in the north east marine plan areas (those with cargo volumes of at least 1 million tonnes annually) plus a small number of ports with less tonnage (Table 77). These are Tyne, Sunderland, Hartlepool and Teesport (Tees and Hartlepool). In 2015, over 41 million tonnes of freight were transported through these major ports (DfT, 2016a). The majority of this freight was transported through Teesport (Table 77). In addition to the major ports, there are also four minor ports within the area. In 2015, around 1.3 million tonnes of freight were transported through three of these minor ports (DfT, 2016a). The other two minor ports, Warkworth and Whitby, primarily cater for the fishing and leisure market.

Each of the major ports is involved in the import and export of materials and goods. The Port of Sunderland is a local authority owned port which deals with imports of forest products, non-ferrous metals, steel, aggregates and refined oil products, together with exports of agricultural limestone, chemicals and maritime cranes. Teesport handles over 5,000 vessels each year and cargos handled include steel, petrochemical, engineering products, general cargo, bulk storage and logistics. The Port of Tyne handles bulk and conventional cargo such as coal, wood-pellet, grain, scrap, steel and other cargoes, notably the importing of coal.

The only international passenger route in the north east is between the Port of Tyne and Amsterdam, with approximately 587,000 international sea passenger movements in 2015 (DfT, 2016b).

In 2015, there were a total of around 6,700 ship arrivals at the ports located in the north east marine plan areas. Of these, the port complex at Tees and Hartlepool was the busiest, with a total of 4,600 of ship arrivals. By contrast, there were approximately 1,300 ship arrivals at the Port of Tyne during this time (Table 78).

Table 77: 2015 freight traffic at major and minor ports in the north east marine plan areas

Port	Type	Thousand tonnes
Hartlepool	Major	35,849
Tees	Major	
Tyne	Major	4,995
Sunderland	Major	748
Blyth	Minor	638
Seaham	Minor	602
Berwick-Upon-Tweed	Minor	51
Whitby	Minor	N/A
Warkworth	Minor	N/A

Data source: DfT (2016a)

Table 78: 2015 port ship arrivals (in number of ships per year) within the north east marine plan areas

Port	Tankers	Ro-Ro vessels	Container vessels	Other dry cargo vessels	Passenger vessels	Other vessels	Total
Tees and Hartlepool	2,074	453	691	852	291	516	4,587
Tyne	50	338	135	580	29	140	1,272
Blyth	17	3	29	243	1	38	331
Sunderland	13	-	-	157	-	73	243
Seaham	-	-	-	224	-	-	224
Berwick-Upon-Tweed	-	-	-	24	-	-	24

Data source: Dft (2016a)

The major ports account for much of the shipping traffic that passes through the north east marine plan areas. There is also a significant amount of shipping transiting through to ports to the north and south of the north east marine plan areas. A large proportion of the shipping in this area follow these well defined routes, but vessels engaged in other activities, such as fishing and leisure, tend to navigate more freely within the area.

All ports in the north east have dredged access channels allowing them to accommodate vessels. There are 38 disposal sites in the north east marine plan areas, 16 of which are open and 22 of which are closed. The majority of these disposal sites are located near to the coast, close to the major ports within the north east marine plan areas, namely Tyne, Sunderland, Tees and Hartlepool. These sites are predominantly used by ports and harbours within the north east marine plan areas which require regular maintenance dredging as a result of estuary processes that deposit suspended material in maintained navigation channels and berth pockets.

Many of the major UK ports provide information about their economic contribution. The Port of Tyne's own research in 2013 reports that the port employs 500 people directly, indirectly supports 10,500 jobs and adds £507 million to the regional economy (Port of Tyne, 2014). Teesport (2013) highlights how the port employs 1,250 staff and has an annual turnover of more than £129 million (PD Ports, 2014).

It is estimated that the ports and shipping sectors directly employed a total of 9,900 people in the north east in 2013 (Oxford Economics, 2015b; c). The sector's direct gross contribution to the UK's GVA in 2013 totalled £420 million. Including indirect and induced employment, these values increase to 19,800 jobs and £920 million contribution to the UK's GVA (Oxford Economics, 2015b; c).

Another economic analysis of the ports and shipping sector found that the north east marine plan areas employs around 3,350 staff across 125 businesses (MMO, 2016a). Indirect jobs supported by the ports and shipping sector number are estimated to be 8,487.

The assumptions used to develop the BAU, N@W and LS scenarios for ports, shipping, dredging and disposal in the north east marine plan areas are provided in Table 79. The projected tonnages under each of the three scenarios is shown in Figure 134. Figure 135, Figure 136 and Figure 137 shows the spatial application of the scenarios to the sector while the text below provides a brief description of the future trends in 6 years and 6 to 20 years.

Table 79: Assumptions and impacts under the future scenarios for ports, shipping, dredging and disposal in the north east marine plan areas

Aspect	Scenario		
	Business as Usual	**Nature @ Work**	**Local Stewardship**
Application to the sector	The primary driver for this sector is economic growth. As the global economy continues to grow, an increase in the import of goods will be tempered by a reduction in the import of raw materials and export of goods.	Economic growth over the 20 year period will be higher under this scenario compared to BAU. It is assumed that growth (in terms of freight tonnage) will initially remain static until 2020 and then rise to 1% until 2027 and then 2% until 2036.	There will be lower levels of economic growth under LS compared to BAU and N@W. It is assumed that growth (in terms of freight tonnage) will initially remain static until 2027 and then rise to 1% until 2036.
	Growth in the north east marine plan areas will be more challenging as major ports in this area are more reliant on bulks which are declining. It is assumed that the growth (in terms of freight tonnage) in the ports, shipping, dredging and disposal sector will initially remain static until 2022 and then rise to 1% until 2036. Climate change will	Climate change will be a stronger driver under the N@W scenario with changing of fuel to Liquefied Natural Gas (LNG) occurring at an increased rate. The bunkering services for this fuel are only likely to be available at larger ports due to the cost of facilities and volatile nature of LNG. There will be some diversification of port	Larger ports will show a decline in growth compared to smaller ports, due to the decline in shipping sector from reduced imports of containers, cars etc. – this will affect the larger ports in this region, namely Hartlepool, Tees, Tyne and Sunderland. Smaller ports will show faster growth due to more regional traffic and trade.

Aspect	Scenario		
	Business as Usual	**Nature @ Work**	**Local Stewardship**
	continue to be a driver with current trends towards low carbon solutions for shipping continuing at the same rate as that currently seen. Passenger numbers for ferry services will be stable (compared to a slight long term decrease over the last 12 years).	infrastructure to accommodate the vessels required for maintenance of offshore wind power. Passenger numbers for ferry services will be stable (compared to a slight long term decrease over the last 12 years).	The decline in imports of manufactured goods would be largely offset by the requirement for import of raw materials possibly leading to a diversification in ports. There will be a slight reduction in international sea passenger numbers (i.e. Newcastle to Amsterdam). However, there will be an increase in regional movements due to increased regional trade and travel.
Assumptions	Annual growth in terms of freight tonnage has been assumed to increase at: ▪ 0% between 2017 and 2022 ▪ 1% between 2023 and 2036. Ferry passenger numbers have been assumed to be stable. For ports the following assumptions have been made: ▪ Footprint of ports is similar to current - some expansion of ports would occur to accommodate increasing trade, vessel movements and larger vessels. ▪ Additional dredging of navigation channels and disposal of dredge arisings would be required in order to allow larger vessels to access ports. ▪ There would be no new ports developed.	Annual growth in terms of freight tonnage has been assumed to increase at: ▪ 0% between 2017 and 2020 ▪ 1% between 2021 and 2027 ▪ 2% between 2028 and 2036. Ferry passenger numbers have been assumed to be stable. For ports the following assumptions have been made: ▪ Footprint similar to current - some expansion (e.g. major ports) would occur to accommodate increasing trade, vessel movements and larger vessels. ▪ Additional dredging of navigation channels and disposal of dredge arisings would be required in order to allow larger vessels to access ports. ▪ Change of infrastructure to correspond with increased offshore sector. ▪ There would be no new ports developed.	Annual growth in terms of freight tonnage has been assumed to increase at: ▪ 0% between 2017 and 2027 ▪ 1% between 2028 and 2036. For ports the following assumptions have been made: ▪ Footprint similar to current – decline in growth of larger ports due to slower increase in international trade, smaller ports faster growth due to more regional traffic and trade. ▪ Smaller ports may focus on local traffic. ▪ Diversification of ports will occur to adapt to the change in demand.
	For shipping the following assumptions have been	For shipping the following assumptions have been	For shipping the following assumptions have been

Aspect	Scenario		
	Business as Usual	Nature @ Work	Local Stewardship
	made: ▪ Footprint similar to current, increased intensity due to growth in trade. ▪ The trend for larger vessels would continue. ▪ Possible minor changes to shipping routes to accommodate offshore wind farms. ▪ Increase in density of shipping proportional to the economic increase. It is assumed that employment will not increase at the same rate as sector growth due to efficiencies and technological advances.	made: ▪ The footprint is similar, with adjustments to shipping routes to accommodate offshore wind farms, increased intensity due to growth in trade. ▪ The trend for larger vessels will continue. ▪ Increase in the number of offshore wind farm maintenance craft. ▪ Greater drive for lower emissions from ships so increase in more carbon efficient fuel sources such as LNG. It is assumed that employment will not increase at the same rate as sector growth due to efficiencies and technological advances.	made: ▪ Footprint largely the same, increased intensity within the region due to increased regional trade and ferry travel. ▪ Minor adjustments to shipping routes to accommodate offshore wind farms. ▪ Less international shipping but increase in smaller coast vessels and wind farm maintenance vessels. ▪ The current trend for ships getting larger would continue for those engaged in international voyages. ▪ International shipping routes would experience a decline in density in this scenario; however regional shipping routes would be likely to show an increase in density. There may be local differentiation in offerings of ports.

6-year projection

Annual throughput in the ports, shipping, dredging and disposal sector in the north east marine plan areas is predicted to remain stable under the BAU and LS scenarios at 42.9 million tonnes per year for the first six years (until 2022). Under the N@W scenario, following a period of zero growth until 2020, there is predicted to be a low rate of growth to 2022 with a projected annual tonnage of 43.7 million tonnes by 2022.

6 to 20 year projection

Under BAU steady but slow growth occurs from 2023 with a projected annual tonnage of 49.3 million tonnes by 2036. The N@W scenario is predicted to have the highest overall economic growth. A period of slow growth until 2028 will be followed by higher growth and a projected annual tonnage of 54.4 by 2036. LS is predicted to have the lowest overall level of growth. Under this scenario, growth will remain stable until 2027 and then rise slowly with a projected annual tonnage of 46.9 million tonnes by 2036.

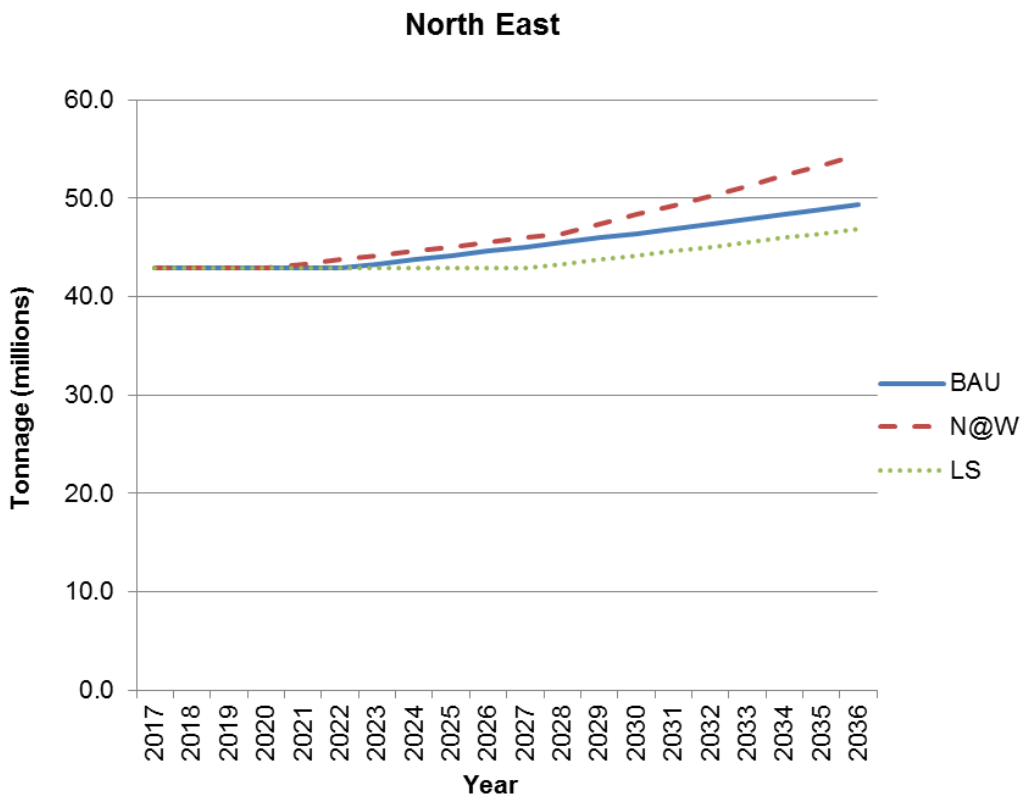


Figure 134: Projected annual tonnage in the north east marine plan areas between 2017 and 2036 under three scenarios

Potential trade-offs

The main potential interactions for future port, shipping, dredging and disposal are likely to be:

- Natural environment (habitat loss/damage, mobile features)
- Recreation (changes to access)
- Other infrastructure.

Within the north east marine plan areas, the main potential trade-offs are likely to be with the natural environment and recreation associated with port expansion projects under all scenarios. Negative trade-offs can be minimised through careful project design.

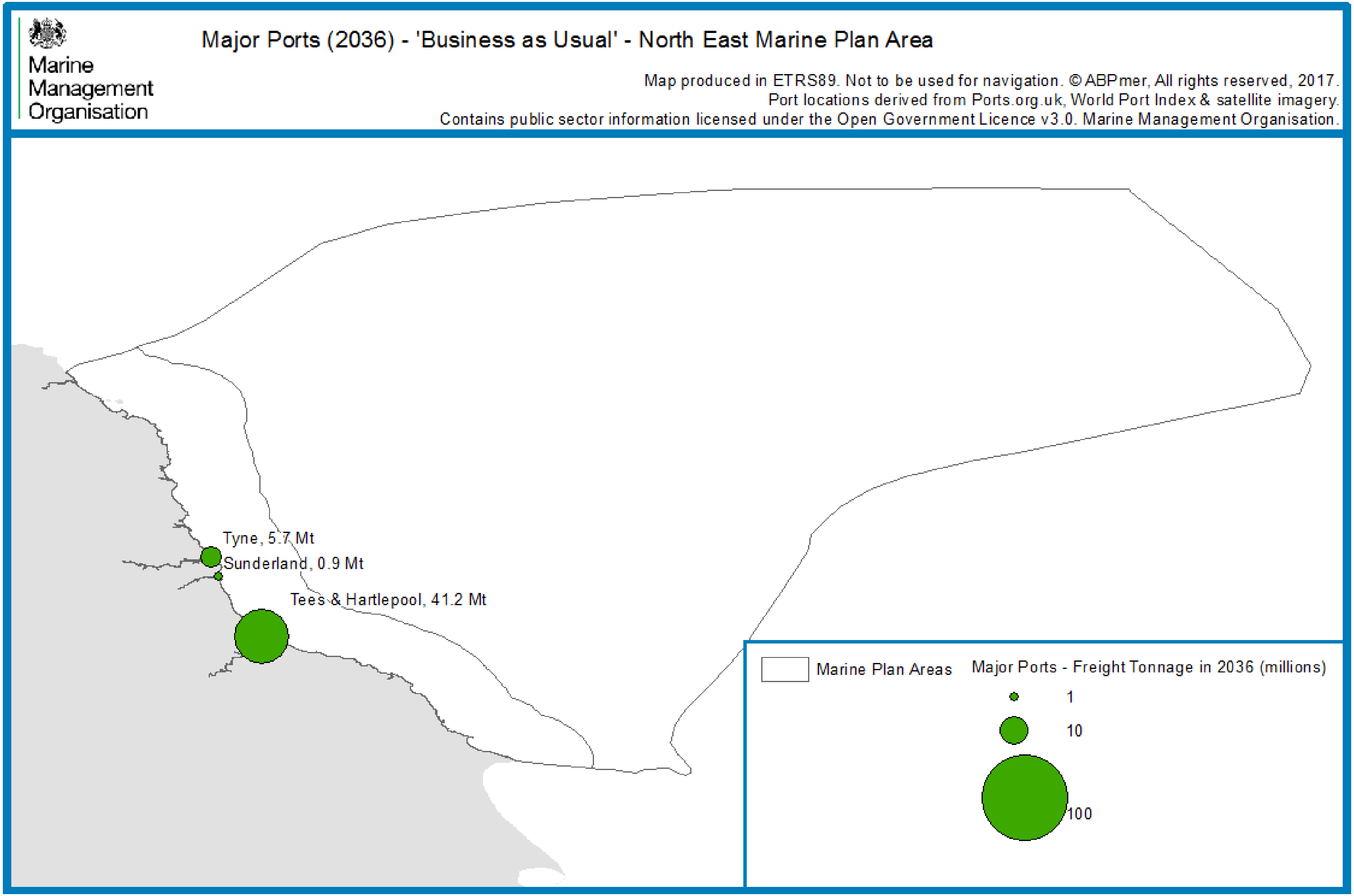


Figure 135: Ports (2036) – BAU – north east marine plan areas

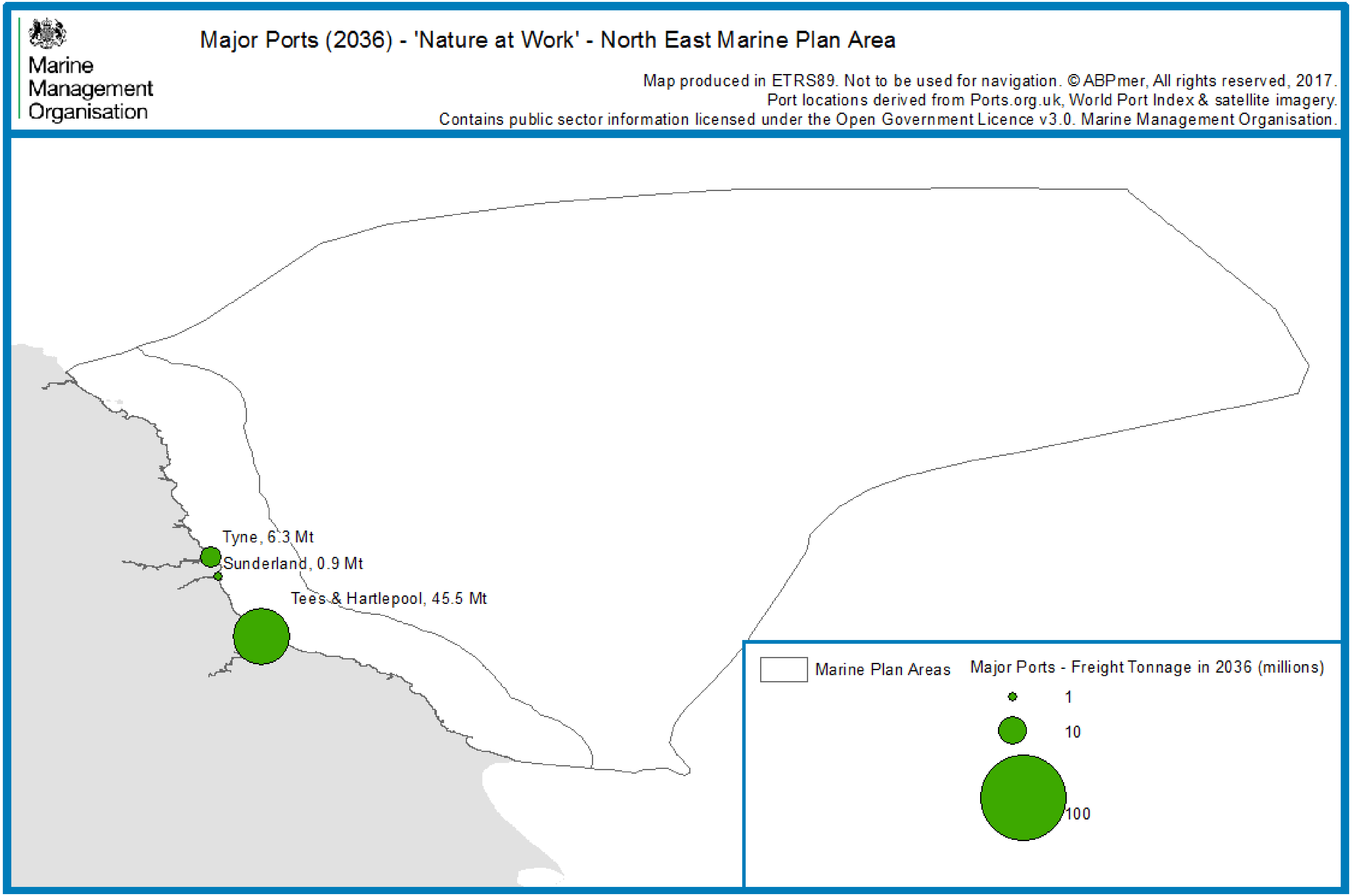


Figure 136: Ports (2036) – N@W – north east marine plan areas

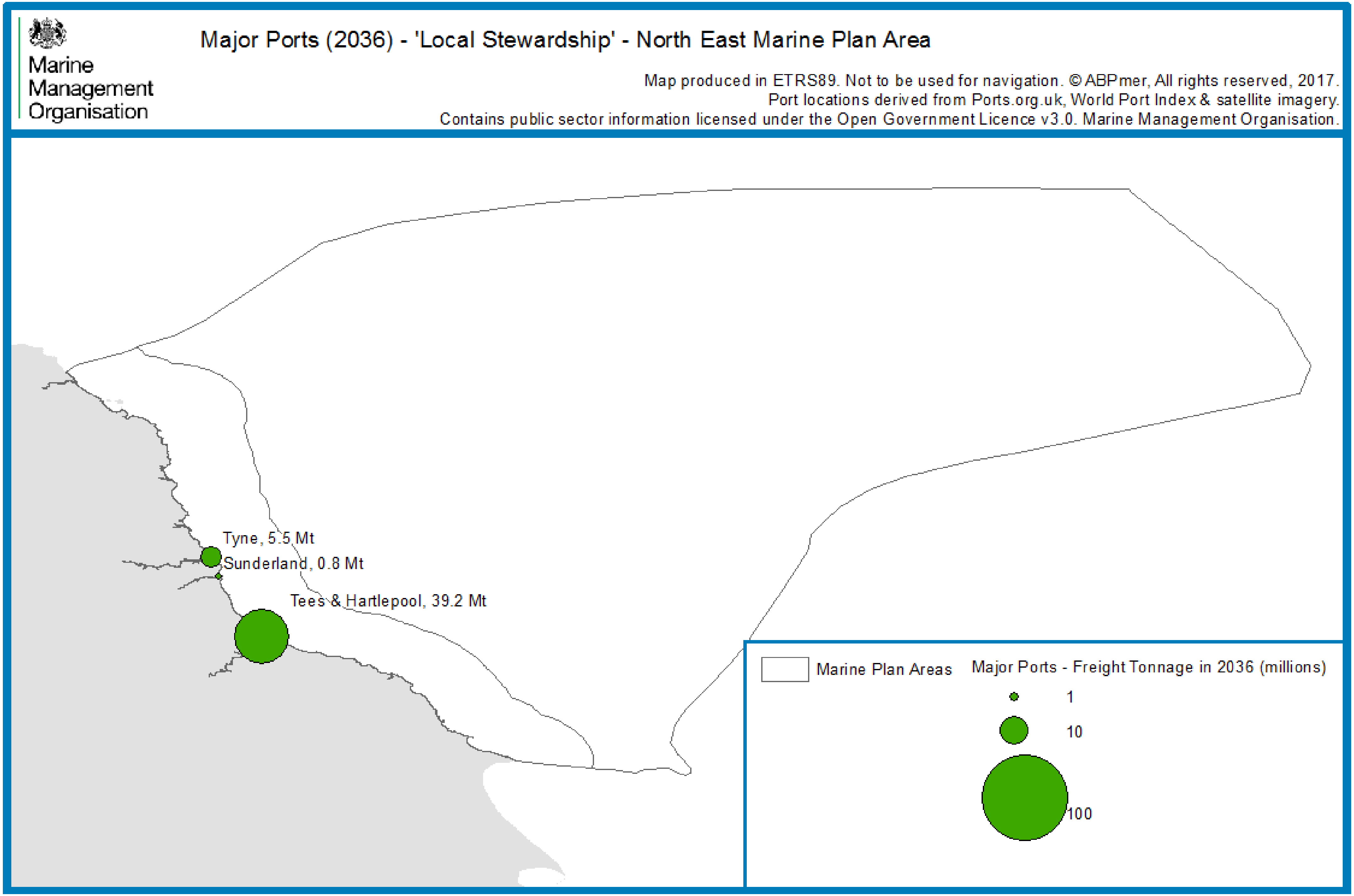


Figure 137: Ports (2036) – LS – north east marine plan areas

13.3 North west

In 2015, the total freight traffic by tonnage handled by ports in the north west was around 11% of the total of all ports in England (DfT, 2016a). The north west is a major manufacturing base and key area for UK exports with several ports playing an increasing role in export of key products like chemicals, cars (e.g. Jaguar Land Rover) and textiles. The ports and shipping services in the north west also support the renewable energy sector in both production and assembly of renewable facilities.

Three of the ports in the north west marine plan areas are classified as major ports (Table 80). These are Fleetwood, Heysham and Liverpool (although Fleetwood ceased to be operational in 2011). In 2015, around 36 million tonnes of freight were transported through Heysham and Liverpool (DfT, 2016a). The majority of this freight was transported through Liverpool (Table 80). In addition to the major ports, there are also seven minor ports within the north west marine plan areas. In 2015, around 1.2 million tonnes of freight were transported through five of these minor ports (DfT, 2016a). The other two minor ports are home to pleasure craft (Preston) or primarily cater for the fishing sector (Whitehaven).

The major port in the north west is the Port of Liverpool, whilst Heysham also plays a role in the transport of freight and people. The Port of Liverpool is owned by Peel Ports and transports commodities (e.g. cars, energy and dry bulk) as well as people (e.g. cruises). The Port of Liverpool and the smaller ports along the River Mersey are seen as key to economic activities in the future through the Atlantic gateway initiative which is seeking to create 250,000 new jobs and generate £14 billion of new investment by 2030. Plans for the Atlantic Gateway include upgrades of port facilities and other port infrastructure such as Superport.

Superport is the name given to the coordination of projects, investment and activity across the Liverpool City Region to develop a multimodal freight hub to rival international port locations (e.g. New York and Singapore). The vision of Superport is "to bring together and integrate the strengths of the Ports, Airports and Freight Community to create a Superport for freight and passenger operations within the Liverpool City Region that will become a key driver of its economy. It will create the most effective and cost efficient environment for freight cargo and passenger transit in the UK" (Liverpool City Region Local Enterprise Partnership, 2014). As part of the Superport developments; Liverpool2 is now in operation. This is a £300 million project which has delivered a new deep water container terminal at the Port of Liverpool, removing vessel restrictions and unlocking an ability to unload two 13,500 TEU ships simultaneously.

There are several international passenger routes from Liverpool (mainly to Ireland). In 2015, there were approximately 121,000 international sea passenger movements from the Port of Liverpool (DfT, 2016b).

There are also several commercial shipping routes across the region with several key connections to world markets. In 2015, there were a total of around 9,300 ship arrivals at the ports located in the north west marine plan areas. Of these, the Port of Liverpool was the busiest, with a total of 6,500 of ship arrivals. The second busiest port in the north west marine plan areas was Heysham with approximately 2,300 ship arrivals during this time (Table 81).

Table 80: 2015 freight traffic at major and minor ports in the north west marine plan areas

Port	Type	Thousand tonnes
Liverpool	Major	31,256
Heysham	Major	4,557
Garston	Minor	530
Workington	Minor	252
Lancaster	Minor	144
Barrow-In-Furness	Minor	142
Silloth	Minor	124
Fleetwood	Major	-
Preston	Minor	-
Whitehaven	Minor	-

Data source: DfT (2016a)

Table 81: 2015 port ship arrivals (in number of ships per year) within the north west marine plan areas

Port	Tankers	Ro-Ro vessels	Container vessels	Other dry cargo vessels	Passenger vessels	Other vessels	Total
Liverpool	1,216	2,848	706	1,391	59	248	6,468
Heysham	-	2,038	-	18	-	207	2,263
Garston	-	1	-	114	-	67	182
Workington	10	-	-	133	-	12	155
Lancaster	-	-	-	134	-	-	134
Barrow-In-Furness	5	-	-	38	-	33	76
Silloth	11	-	-	43	-	5	59
Fleetwood	-	-	-	-	-	-	-

Data source: DfT (2016a)

The ports at Liverpool and Heysham account for majority of the shipping traffic that occurs in the north west marine plan areas. A large proportion of the shipping in this area follow well defined routes to and from the ports, but vessels engaged in other activities, such as fishing and leisure, tend to navigate more freely within the area.

There are 42 disposal sites in the north west marine plan areas, 19 of which are open, 21 are closed and 2 are disused (Figure 130). These sites are predominantly used by ports and harbours within the north west marine plan areas which require regular maintenance dredging as a result of estuary processes that deposit suspended material in maintained navigation channels and berth pockets.

Many of the major UK ports provide information about their economic contribution. The Port of Liverpool's own research (2009) reports that the port infrastructure contributes over 34,000 jobs and £1.1 billion of GVA per annum to the Liverpool City Region economy (MDS Transmodal, 2009).

It is estimated that the ports and shipping sectors directly employed a total of 16,400 people in the north west in 2013 (Oxford Economics, 2015b; c). The sector's direct gross contribution to the UK's GVA in 2013 totalled £1.4 billion. Including indirect and induced employment, these values increase to 48,500 jobs and £3.0 billion contribution to the UK's GVA (Oxford Economics, 2015b; c).

Another economic analysis of the ports and shipping sector found that the north west marine plan areas employs around 10,870 across 280 businesses (MMO, 2016a). Indirect jobs supported by the ports and shipping sector are estimated to be 27,469.

Despite the lack of information on employment and businesses in relation to the dredging sector, it is known that the industry is an important economic contributor and supporter of other industries. In 2013, the Regional Growth Fund allocated a grant of £35 million to dredge the approach channel in the Mersey Estuary to a depth of 16 m which was overseen by Peel Ports. This has economic benefits as it will allow access for post-Panamax size container ships as well as widening the tidal access window for a range of other river users. It was also reported that this activity would support the Superport developments and ultimately the creation of 5,000 jobs. The assumptions used to develop the BAU, N@W and LS scenarios for ports, shipping, dredging and disposal in the north west marine plan areas are provided in Table 82. The projected tonnages under each of the three scenarios is shown in Figure 138. Figure 139, Figure 140 and Figure 141 show the spatial application of the scenarios to the sector while the text below provides a brief description of the future trends in 6 years and 6 to 20 years.

Table 82: Assumptions and impacts under the future scenarios for ports, shipping, dredging and disposal in the north west marine plan areas

Aspect	Scenario		
	Business as Usual	**Nature @ Work**	**Local Stewardship**
Application to the sector	As for the north east marine plan area (see Table 79).	As for the north east marine plan area (see Table 79).	As for the north east marine plan area (see Table 79).
Assumptions	Annual growth in terms of freight tonnage has been assumed to increase at: ▪ 1.0% between 2017 and 2027 ▪ 2.0% between 2028 and 2036. Ferry passenger numbers have been assumed to be stable.	Annual growth in terms of freight tonnage has been assumed to increase at: ▪ 1.0% between 2017 and 2022 ▪ 2.0% between 2023 and 2036. Ferry passenger numbers have been assumed to be stable.	Annual growth in terms of freight tonnage has been assumed to increase at: ▪ 1.0% between 2017 and 2036.

Aspect	Scenario		
	Business as Usual	**Nature @ Work**	**Local Stewardship**
	For ports the following assumptions have been made: ▪ Footprint of ports is similar to current - some expansion of ports would occur to accommodate increasing trade, vessel movements and larger vessels. ▪ Additional dredging of navigation channels and disposal of dredge arisings would be required in order to allow larger vessels to access ports. ▪ There would be no new ports developed.	For ports the following assumptions have been made: ▪ Footprint similar to current - some expansion (e.g. major ports) to accommodate increasing trade, vessel movements and larger vessels. ▪ Additional dredging of navigation channels and disposal of dredge arisings would be required in order to allow larger vessels to access ports. ▪ Change of infrastructure to correspond with increased offshore sector. ▪ There would be no new ports developed.	For ports the following assumptions have been made: ▪ Footprint similar to current – slower growth of larger ports due to slower increase in international trade, smaller ports faster growth due to more regional traffic and trade. ▪ Smaller ports may focus on local traffic. ▪ Diversification of ports will occur to adapt to the change in demand.
	For shipping the following assumptions have been made: ▪ Footprint similar to current, increased intensity due to growth in trade. ▪ The trend for larger vessels would continue. ▪ Possible minor changes to shipping routes to accommodate offshore wind farms. ▪ Increase in density of shipping proportional to the economic increase. It is assumed that employment will not increase at the same rate as sector growth due to efficiencies and technological advances.	For shipping the following assumptions have been made: ▪ The footprint is similar, with adjustments to shipping routes to accommodate offshore wind farms (especially in Irish Sea), increased intensity due to growth in trade. ▪ The trend for larger vessels will continue. ▪ Increase in the number of offshore wind farm maintenance craft. ▪ Greater drive for lower emissions from ships so increase in more carbon efficient fuel sources such as LNG.	For shipping the following assumptions have been made: ▪ Footprint largely the same, increased intensity within the region due to increased regional trade and ferry travel. ▪ Minor adjustments to shipping routes to accommodate offshore wind farms. ▪ Less international shipping but increase in smaller coast vessels and wind farm maintenance vessels. ▪ The current trend for ships getting larger would continue for those engaged in international voyages.

Aspect	Scenario		
	Business as Usual	Nature @ Work	Local Stewardship
		It is assumed that employment will not increase at the same rate as sector growth due to efficiencies and technological advances.	▪ International shipping routes would have a slower increase in density in this scenario; however regional shipping routes would be likely to show a larger increase in density. There may be local differentiation in offerings of ports.

6-year projection

The rate of growth in the initial six year period (2017 to 2022) will be the same for all three scenarios (BAU, N@W and LS). By 2022, the projected annual tonnage under all scenarios will be 38.9 million tonnes.

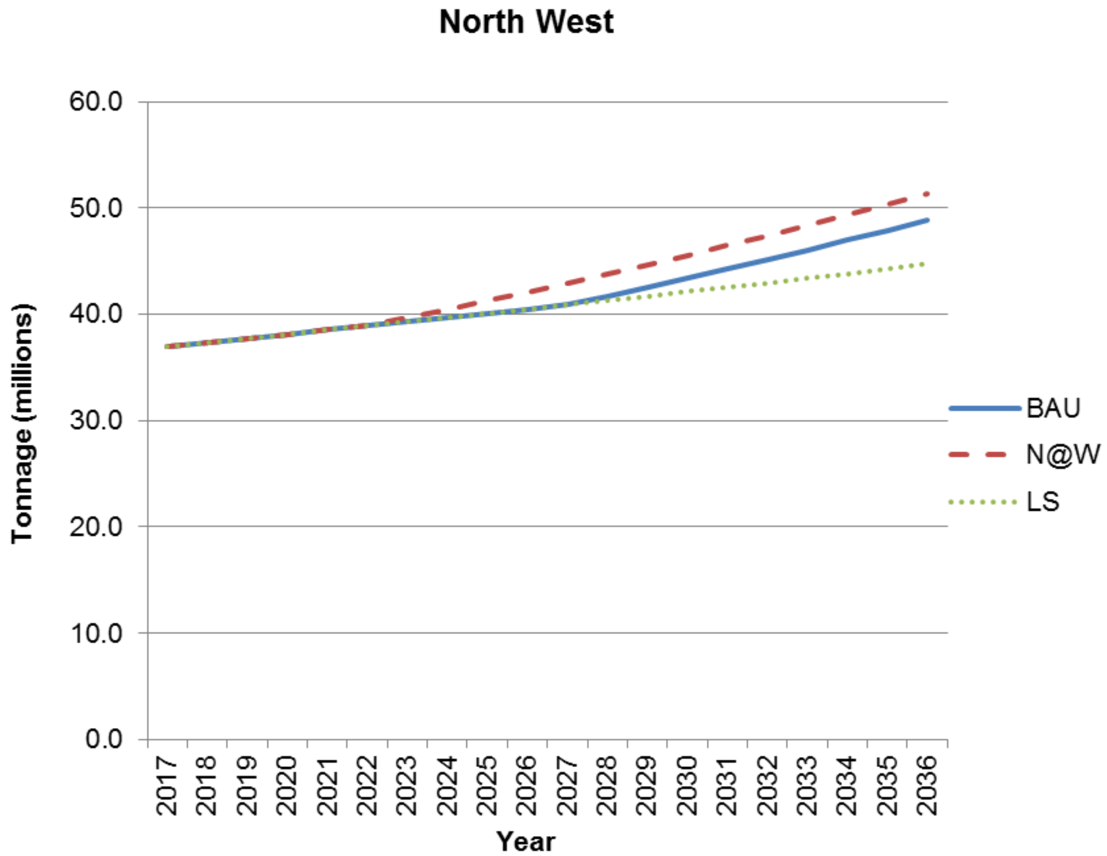


Figure 138: Projected annual tonnage in the north west marine plan areas between 2017 and 2036 under three scenarios

6 to 20 year projection

After six years, the rate of growth under the BAU scenario will continue to grow steadily until 2028 after which it will grow at a slightly higher rate reaching a projected annual tonnage of 48.9 million tonnes by 2036. The growth rate under the N@W scenario will be slightly higher than the other two scenarios. By the end of the 20 year period, the projected annual tonnage under the N@W scenario will be 51.3 million tonnes. Annual throughput under the LS scenario will initially be the same as BAU. After 2027, growth in trade will continue at a lower rate under the LS scenario compared to BAU resulting in a projected annual tonnage in 2036 of 44.7 million tonnes.

Potential trade-offs

The potential trade-offs are similar to the north east marine plan areas.

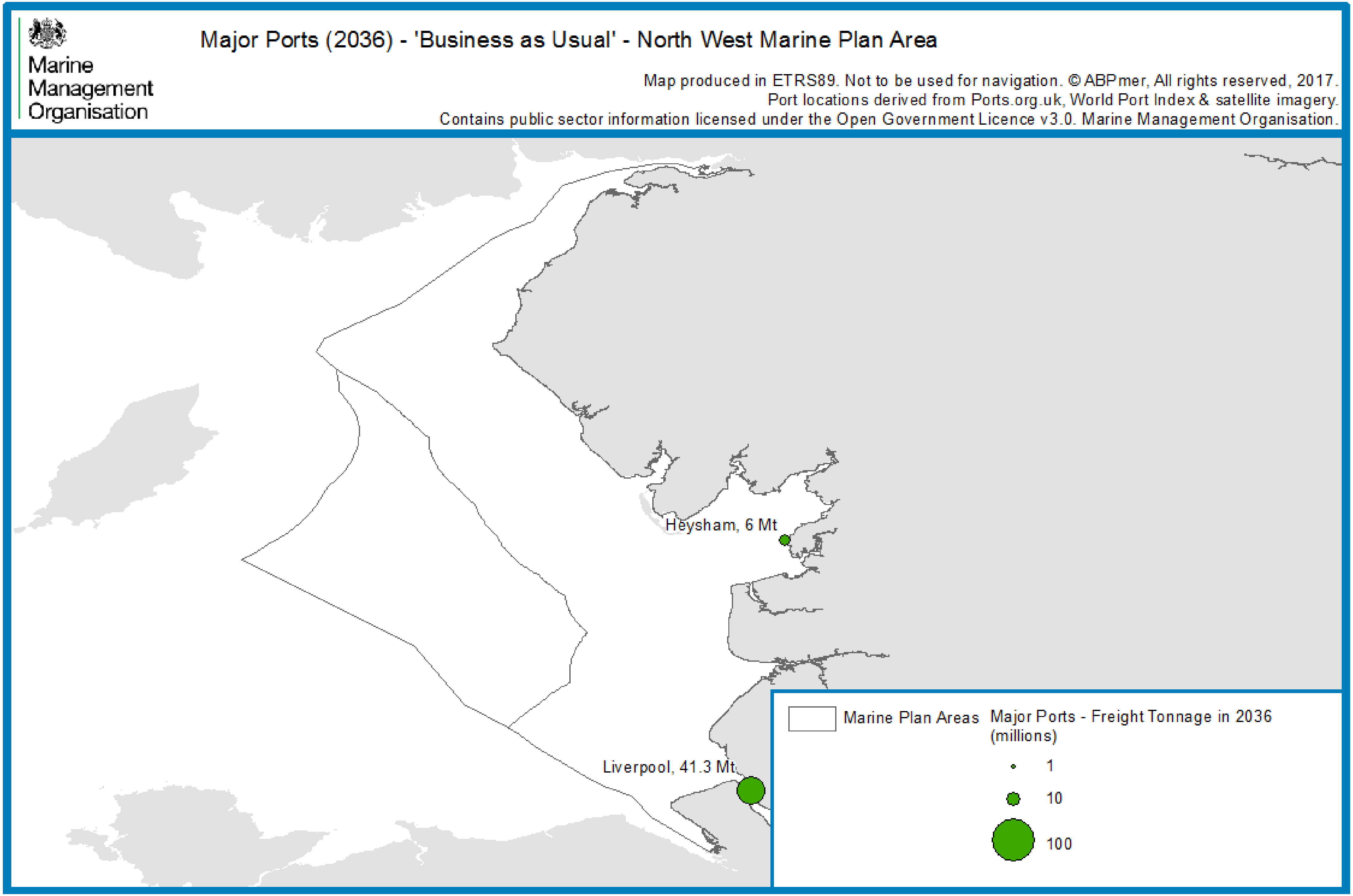


Figure 139: Ports (2036) – BAU – north west marine plan areas

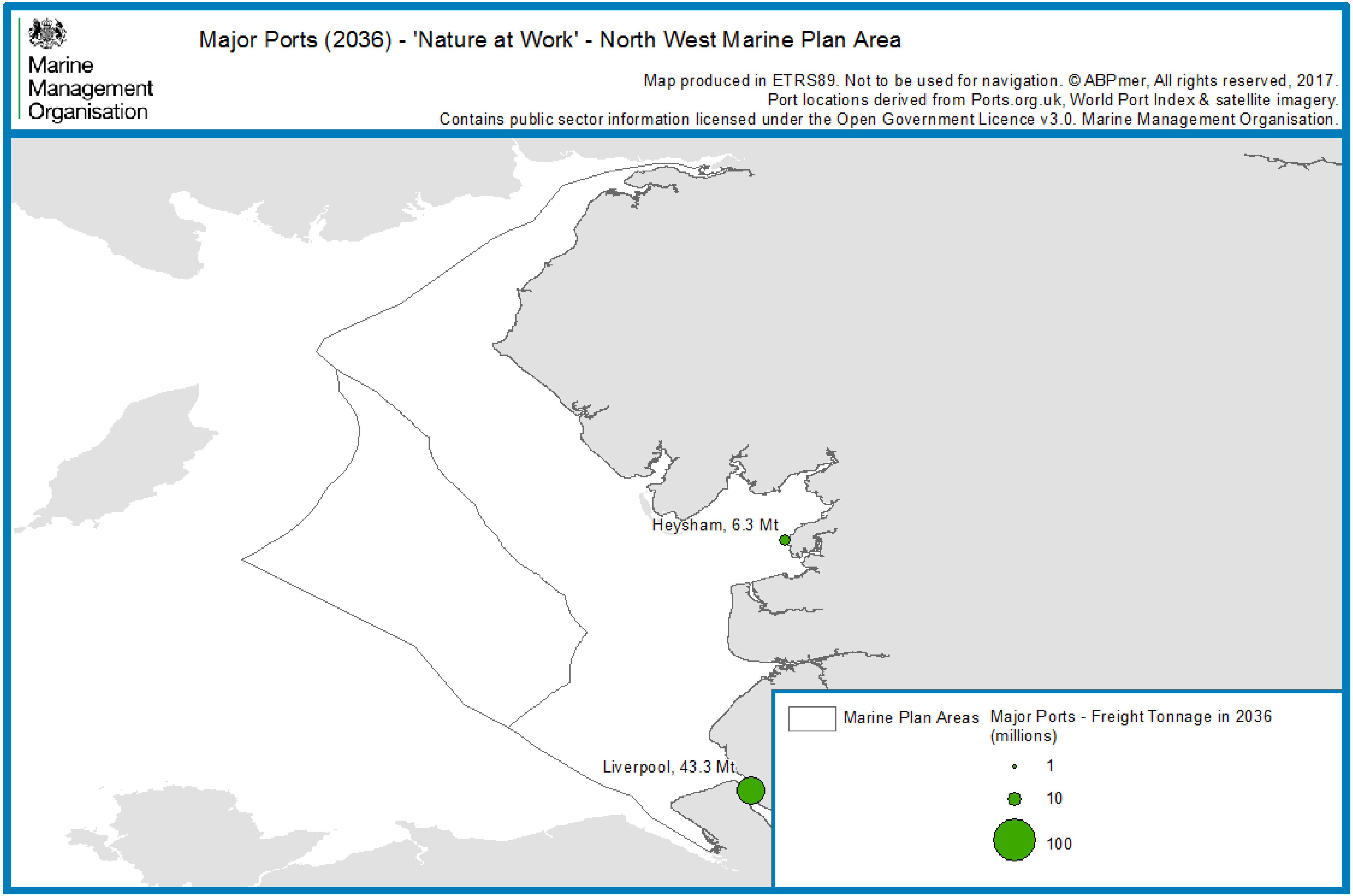


Figure 140: Ports (2036) – N@W – north west marine plan areas

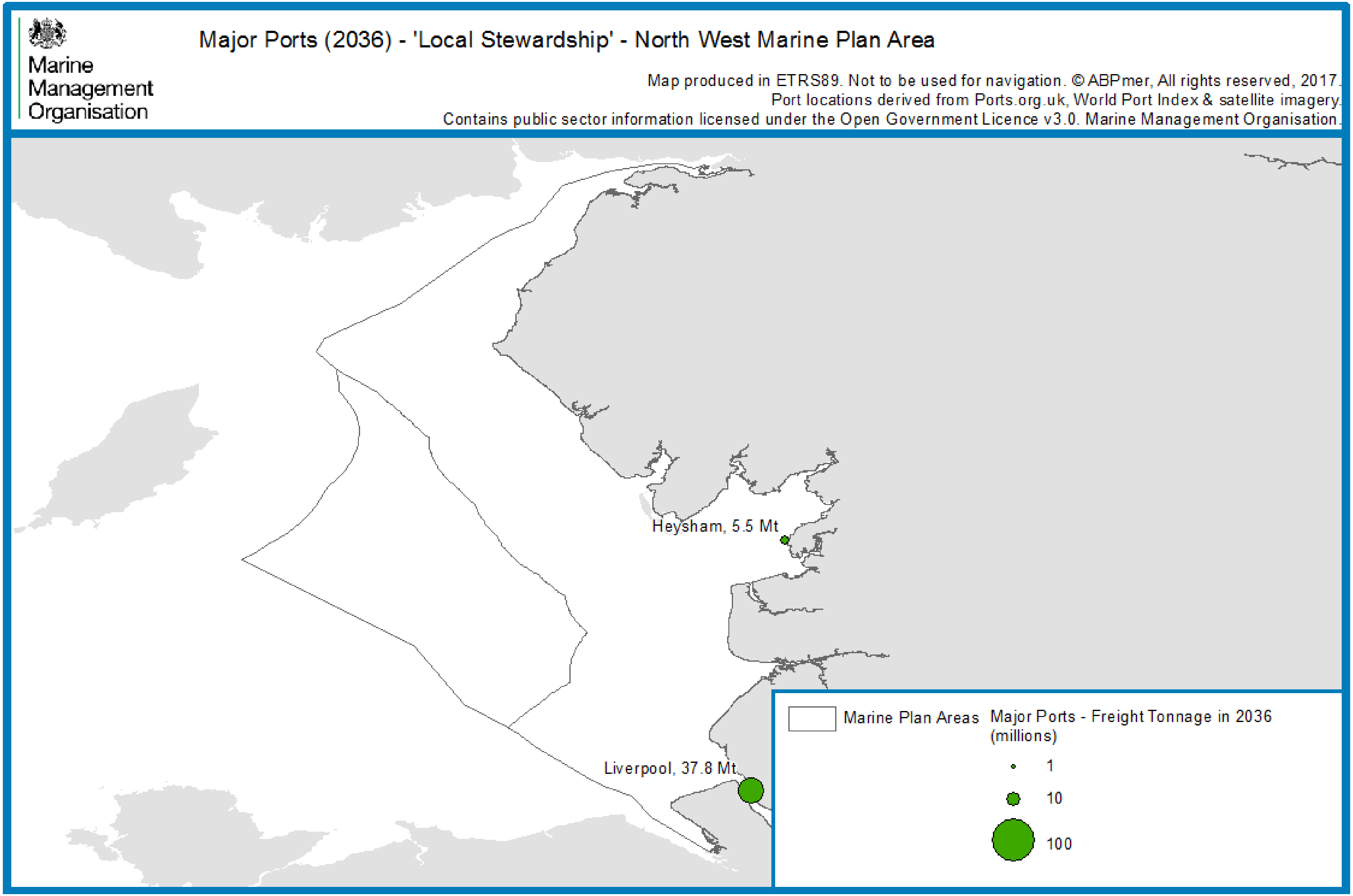


Figure 141: Ports (2036) – LS – north west marine plan areas

13.4 South east

In 2015, the total freight traffic by tonnage handled by ports in the south east was around 31% of the total of all ports in England (DfT, 2016a). The south east is often described as the ‘Gateway to the World’ due to the volumes of both passenger and freight traffic; the region is home to the UK’s largest concentration of ports.

In 2015, around 108 million tonnes of freight were transported through major ports in the south east marine plan area (Table 83). The majority of this freight was transported through the ports of London, Dover and Felixstowe (Table 83). In addition to the major ports, there are also five minor ports within the south east marine plan area. In 2015, around 0.3 million tonnes of freight were transported through these minor ports (Table 83).

Major ports in the south east marine plan area include:

- The Port of Felixstowe on the Suffolk Coast is Britain’s biggest and busiest container port, handling more than 4 million TEUs and 3,000 ships each year (Port of Felixstowe website).
- The Port of London, with 70 terminals and operations mainly in Thurrock and Medway, is the second largest UK port by freight traffic (South East Local Enterprise Partnership website). It supports 45,000 full time equivalent jobs and generates over £4 billion of GVA per year (MMO, 2016a). Specialisms include the handling of paper and forest products, containers and roll-on/roll-off, grain and bulk commodities, construction and building materials, vehicles (Ford at Dagenham) and raw cane sugar (Tate & Lyle Sugars at Silvertown) (Port of London Authority, 2015).
- The Port of Dover is Europe’s busiest ferry port. The Dover-Calais route has consistently handled the largest amount of passengers of all international short sea ferry routes (Port of Dover, 2014). The Port also includes a cargo terminal which handled 2.2 million freight vehicles and £100 billion of trade in 2014. The Dover Western Docks Revival will develop a new cargo terminal and port-centric distribution facility (Port of Dover, 2014).
- The Port of Ipswich handles around 2 million tonnes per year of aggregates, grain, animal feed, fertilisers and cement (ABP website).
- Several other ports which contribute mainly to freight traffic include Port of Harwich, Port of Medway, Port of Ramsgate and Port of Whitstable. Whilst smaller compared to London, Dover and Felixstowe, these ports individually are more significant in terms of freight than some of the larger ports in other regions.

There are a very large number of international sea movements from Dover (mainly to Calais). In 2015, there were approximately 13 million international sea passenger movements from the Ports of Dover and 14,000 international sea passenger movements from London (DfT, 2016b).

There are also several commercial shipping routes across the region with several key connections to world markets. In 2015, there were a total of around 32,200 ship arrivals at the ports located in the south east marine plan area. Of these, the Port of Dover was the busiest, with a total of 17,100 ship arrivals. The second busiest port in the south east marine plan area was London Gateway with approximately 8,851 ship arrivals during this time (Table 84).

The ports of Dover, London and Felixstowe account for vast majority of the shipping traffic that occurs in the south east marine plan area (Table 84). A large proportion of the shipping in this area follows well defined routes to and from the ports, but vessels engaged in other activities, such as fishing and leisure, tend to navigate more freely within the area.

Dredging is only permitted to take place in licenced areas if no significant environmental impacts are predicted. Most ports in the south east have dredged access channels allowing them to accommodate larger vessels.

There are 58 disposal sites in the south east marine plan area, 24 of which are open, 29 of which are closed and 5 of which are disused (Figure 130). These sites are predominantly used by ports and harbours within the south east marine plan area which require regular maintenance dredging as a result of estuary processes that deposit suspended material in maintained navigation channels and berth pockets.

It is estimated that the ports and shipping sectors directly employed a total of 39,600 people in the south east and London in 2013 (Oxford Economics, 2015b; c). The sector's direct gross contribution to the UK's GVA in 2013 totalled £2.1 billion. Including indirect and induced employment, these values increase to 154,300 jobs and £7.8 billion contribution to the UK's GVA (Oxford Economics, 2015b; c). Another economic analysis of the ports and shipping sector found that the south east marine plan area employs around 14,180 across 420 businesses (MMO, 2016a). Indirect jobs supported by the ports and shipping sector number are estimated to be 35,825.

Table 83: 2015 freight traffic at major and minor ports in the south east marine plan area

Port	Type	Thousand tonnes
Tilbury	Major	45,430
Sheerness	Major	
Thamesport	Major	
Chatham	Major	
London Gateway	Major	
Felixstowe	Major	27,971
Dover	Major	27,299
Harwich	Major	4,550
Ipswich	Major	2,293
Brightlingsea	Minor	340
Mistley	Minor	144
Rochford (Wallasea)	Minor	138
Whitstable	Minor	49
Ramsgate	Major	26
Maldon	Minor	< 1

Data source: DfT (2016a)

Table 84: 2015 port ship arrivals (in number of ships per year) within the south east marine plan area

Port	Tankers	Ro-Ro vessels	Container vessels	Other dry cargo vessels	Passenger vessels	Other vessels	Total
Dover	71	16,665	3	140	121	78	17,078
London Gateway	1,193	2,756	1,175	2,262	97	1,368	8,851
Felixstowe	19	791	1,776	19	2	85	2,692
Harwich	134	1,833	3	65	40	150	2,225
Ipswich	11	-	1	725	3	38	778
Ramsgate	1	21	1	22	1	238	284
Brightlingsea	-	-	-	104	-	32	136
Mistley	-	-	-	73	-	-	73
Rochford (Wallasea)	-	-	-	63	-	-	63
Whitstable				25	2	1	28

Data source: DfT (2016a)

The assumptions used to develop the BAU, N@W and LS scenarios for ports, shipping, dredging and disposal in the south east marine plan area are provided in Table 85. The projected tonnages under each of the three scenarios is shown in Figure 142. Figure 143, Figure 144, Figure 145 show the spatial application of the scenarios to the sector while the text below provides a brief description of the future trends in 6 years and 6 to 20 years.

Table 85: Assumptions and impacts under the future scenarios for ports, shipping, dredging and disposal in the south east marine plan area

Aspect	Scenario		
	Business as Usual	**Nature @ Work**	**Local Stewardship**
Application to the sector	As for the north east marine plan area (see Table 79).	As for the north east marine plan area (see Table 79).	As for the north east marine plan area (see Table 79).
Assumptions	Annual growth in terms of freight tonnage has been assumed to increase at: ▪ 1.0% between 2017 and 2027 ▪ 2.0% between 2028 and 2036. Ferry passenger numbers have been assumed to be stable. For ports the following assumptions have been made: ▪ Footprint of ports is similar to current - some expansion of ports would occur to	Annual growth in terms of freight tonnage has been assumed to increase at: ▪ 1.0% between 2017 and 2022 ▪ 2.0% between 2023 and 2036. Ferry passenger numbers have been assumed to be stable. For ports the following assumptions have been made: ▪ Footprint similar to current - some expansion (e.g. major ports) to accommodate	Annual growth in terms of freight tonnage has been assumed to increase at: ▪ 1.0% between 2017 and 2036. For ports the following assumptions have been made: ▪ Footprint similar to current – decline in growth of larger ports due to slower increase in international trade, smaller ports faster growth due to more regional traffic and trade.

Aspect	Scenario		
	Business as Usual	**Nature @ Work**	**Local Stewardship**
	accommodate increasing trade, vessel movements and larger vessels. ▪ Additional dredging of navigation channels and disposal of dredge arisings would be required in order to allow larger vessels to access ports. ▪ There would be no new ports developed. For shipping the following assumptions have been made: ▪ Footprint similar to current, increased intensity due to growth in trade. ▪ The trend for larger vessels would continue. ▪ Possible minor changes to shipping routes to accommodate offshore wind farms. ▪ Increase in density of shipping proportional to the economic increase.	increasing trade, vessel movements and larger vessels. ▪ Additional dredging of navigation channels and disposal of dredge arisings would be required in order to allow larger vessels to access ports. ▪ Change of infrastructure to correspond with increased offshore sector. ▪ There would be no new ports developed. For shipping the following assumptions have been made: ▪ The footprint is similar, with adjustments to shipping routes to accommodate offshore wind farms, increased intensity due to growth in trade. ▪ The trend for larger vessels will continue. ▪ Increase in the number of offshore wind farm maintenance craft. ▪ Greater drive for lower emissions from ships so increase in more carbon efficient fuel sources such as LNG. will not increase at the same rate as sector growth due to efficiencies and technological advances.	▪ Smaller ports may focus on local traffic. ▪ Diversification of ports will occur to adapt to the change in demand. For shipping the following assumptions have been made: ▪ Footprint largely the same, increased intensity within the region due to increased regional trade and ferry travel. ▪ Minor adjustments to shipping routes to accommodate offshore wind farms. ▪ Less international shipping but increase in smaller coast vessels and wind farm maintenance vessels. ▪ The current trend for ships getting larger would continue for those engaged in international voyages. ▪ International shipping routes would have a slower increase in density in this scenario; however regional shipping routes would be likely to show a larger increase in density. ▪ There may be local differentiation in offerings of ports.
	It is assumed that employment will not increase at the same rate as sector growth due to efficiencies and technological advances.	It is assumed that employment will not increase at the same rate as sector growth due to efficiencies and technological advances.	

6-year projection

Annual throughput in the ports, shipping, dredging and disposal sector in the south east marine plan area is predicted to grow at the same rate for the first 6 years under all three scenarios (BAU, N@W and LS). By 2022, the projected annual tonnage under all scenarios will be 113.4 million tonnes.

6 to 20 year projection

Between 2023 and 2036, the growth in annual throughput under the BAU scenario will continue at the same steady rate until 2028 after which it will grow at a slightly higher rate resulting in a projected annual tonnage of 142.5 million tonnes by 2036. The rate of trade growth will be slightly higher over this period under the N@W scenario compared to the other two scenarios. By 2036, the projected annual tonnage in the south east marine plan area will be 149.6 million tonnes under N@W. The rate of growth in throughput under the LS scenario will initially be the same as BAU. After 2027, growth in trade will continue at a lower rate compared to BAU resulting in a projected annual tonnage off 130.4 million tonnes by 2036.

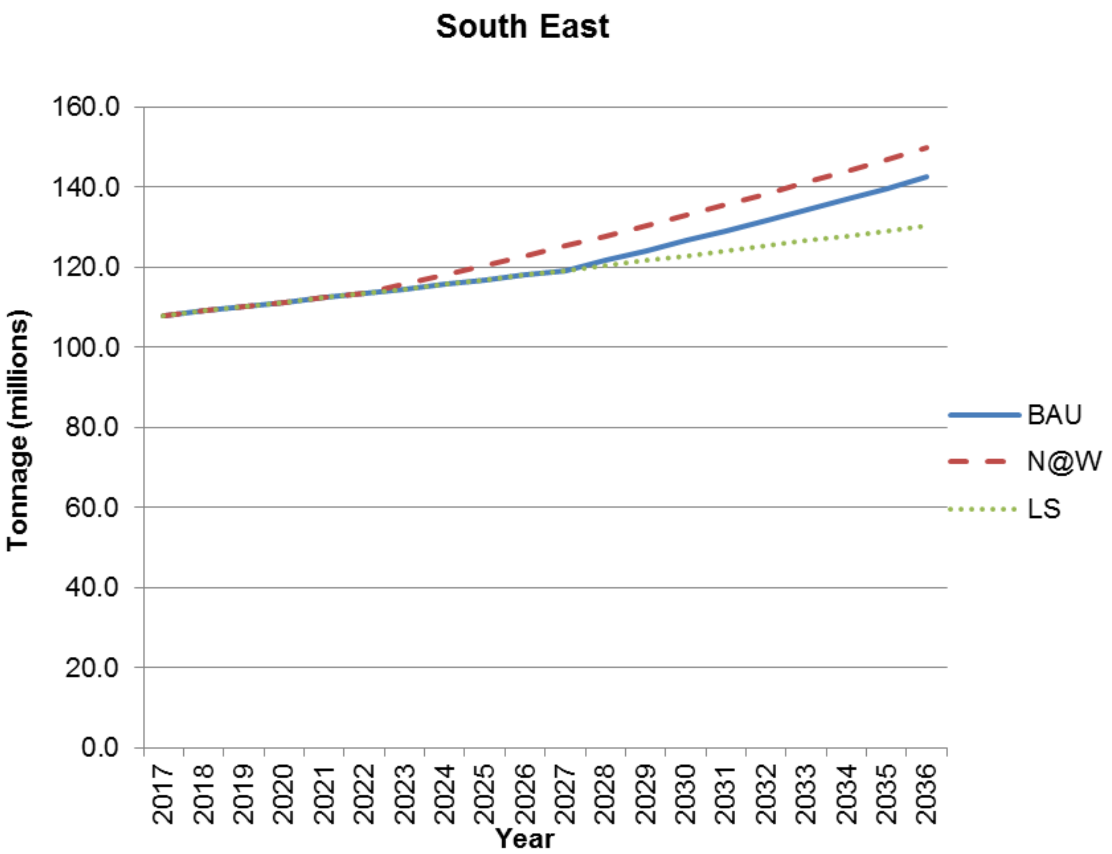


Figure 142: Projected annual tonnage in the south east marine plan areas between 2017 and 2036 under three scenarios

Potential trade-offs

The potential trade-offs are similar to the north east marine plan areas.

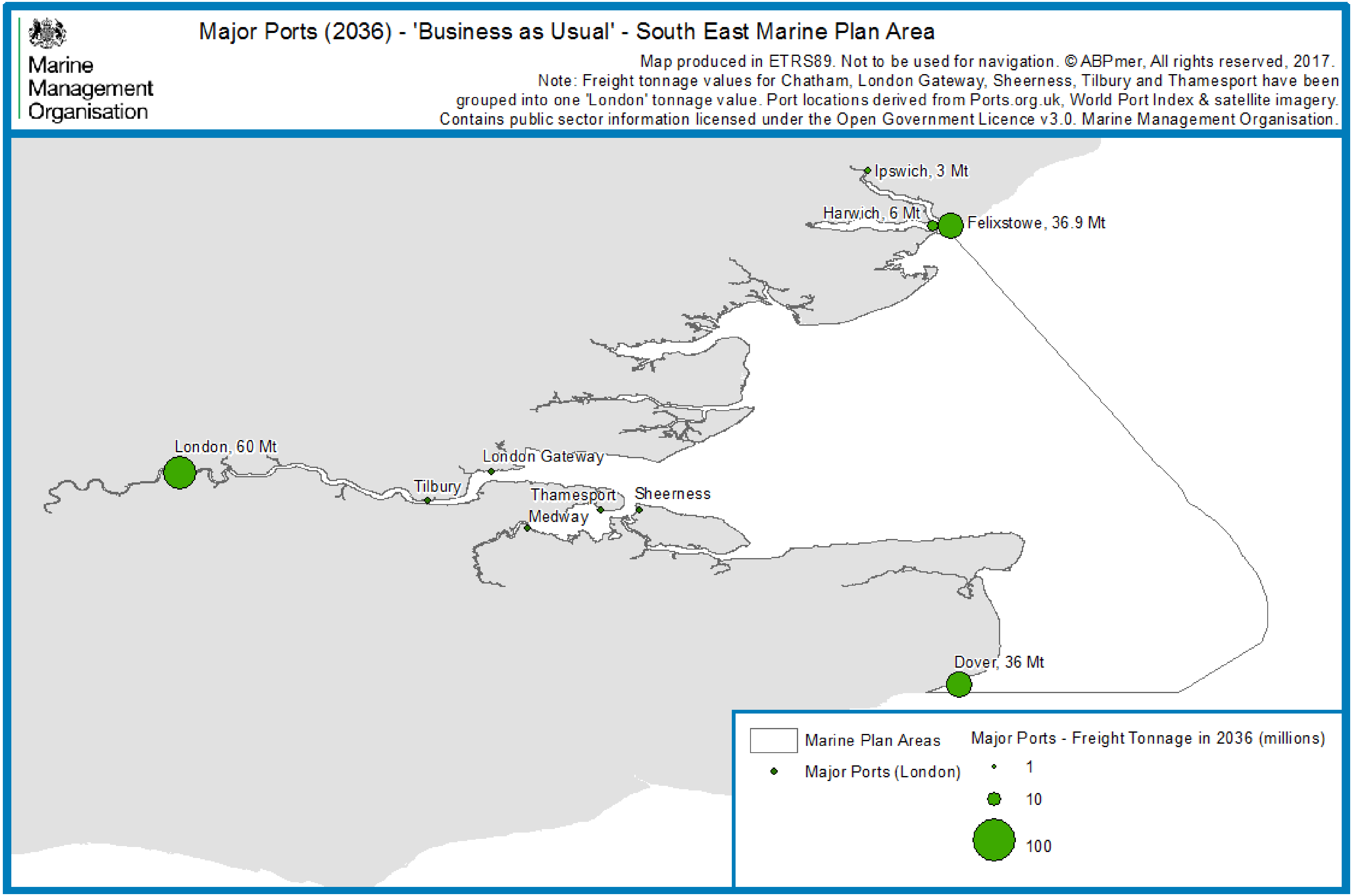


Figure 143: Ports (2036) – BAU – south east marine plan area

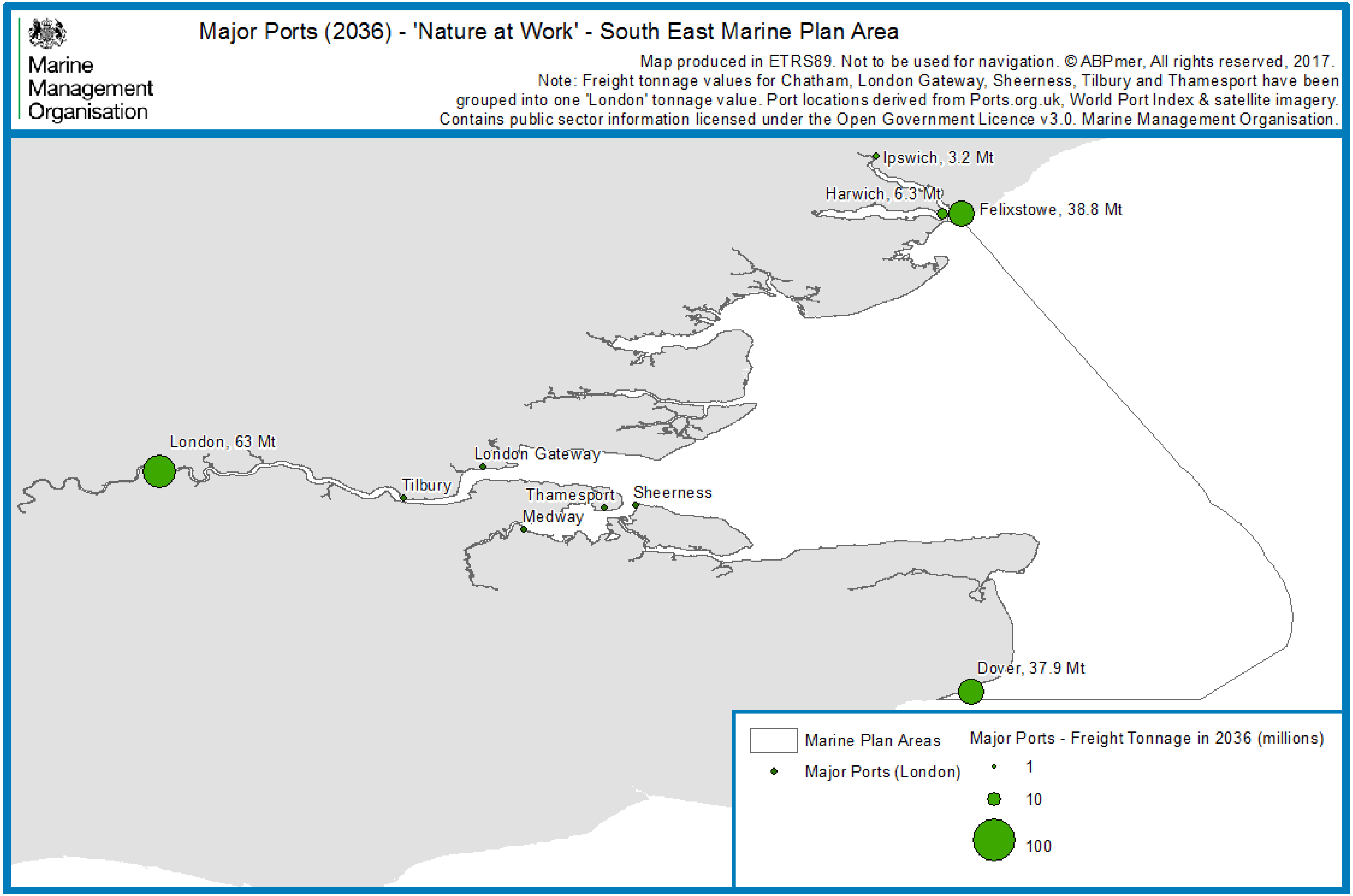


Figure 144: Ports (2036) – N@W – south east marine plan area

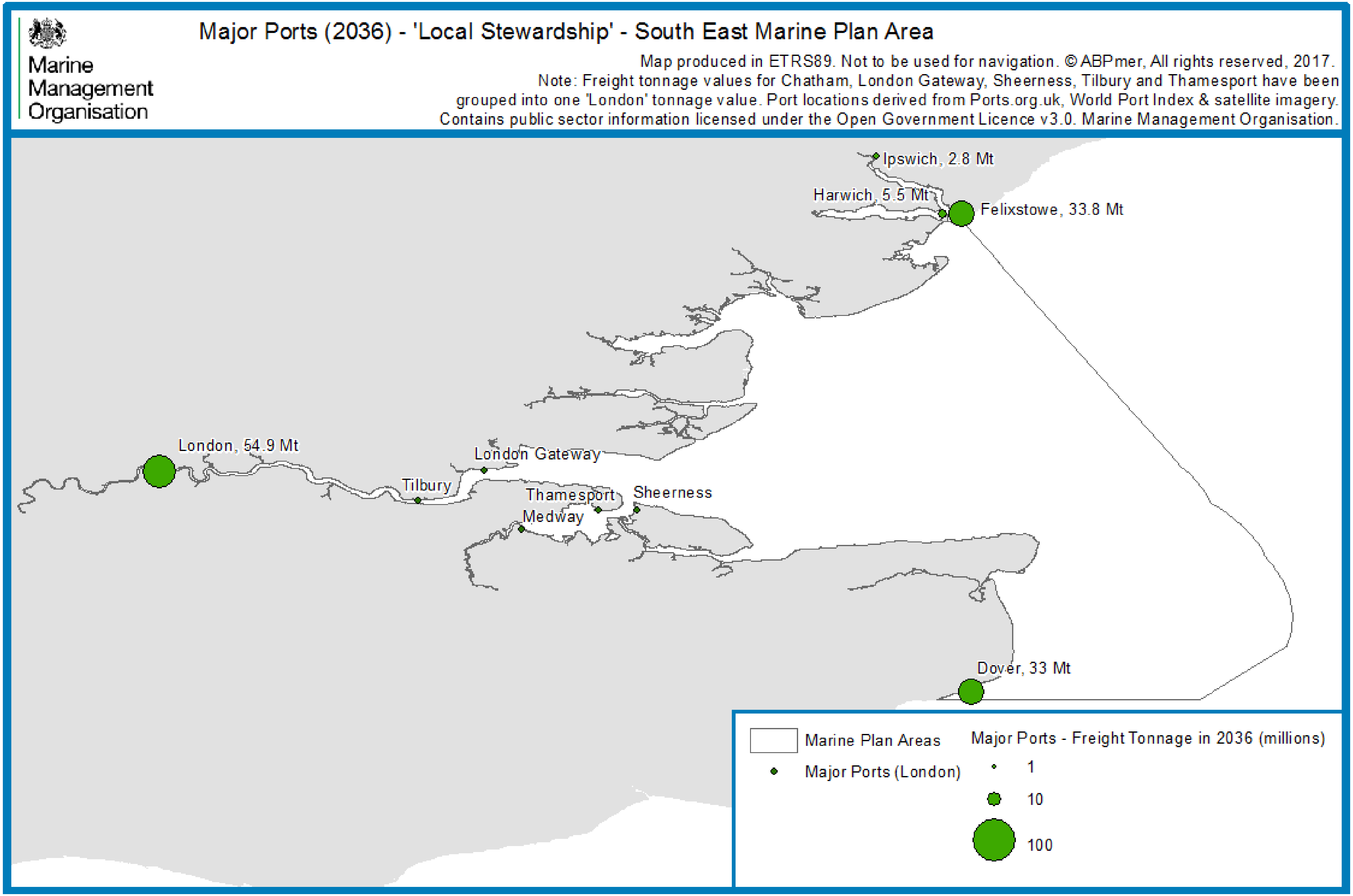


Figure 145: Ports (2036) – LS – south east marine plan area

13.5 South west

In 2015, the total freight traffic by tonnage handled by ports in the south west marine plan areas was around 4% of the total of all ports in England (DfT, 2016a). There are 23 ports in the south west marine plan areas, of which three ports are categorised as major (Table 86, Figure 130). In 2015, around 11.6 million tonnes of freight were transported through the major ports (Table 86). The majority of this freight was transported through the ports of Bristol and Plymouth (Table 86). In 2015, around 1.5 million tonnes of freight were transported through the minor ports (Table 86).

The Royal Portbury Dock and Avonmouth Dock form part of Bristol Port. The docks are a major importer of cars and coal. Plans are in place to increase capacity of Bristol Port by building a new deepsea container terminal.

Appledore Shipbuilders are based at Appledore port. Falmouth is a major bunker refuelling destination. Fowey, Falmouth, Penzance, St. Ives, Padstow and Bideford have important functions as fishing ports.

None of the UK's top ten busiest ports by tonnage of freight handled are located in the south west marine plan areas. Bristol is the largest in the area by units and tonnage. Nevertheless, several small harbours and marinas across the south west play an important role in recreation and larger ports and harbours play a supporting role to shipping activities.

The only international passenger route in the south west marine plan areas is from Plymouth, with approximately 449,000 international sea passenger movements in 2015 (DfT, 2016b).

In 2015, there were a total of around 6,200 ship arrivals at the ports located in the south west marine plan areas. Of these, Bristol was the busiest, with a total of 1,600 ship arrivals. The second busiest port was the Port of Plymouth with approximately 804 ship arrivals (Table 87).

The south west marine plan areas includes the South-West Approaches to the English Channel, which is one of the busiest shipping routes in the world with large numbers of vessels transiting to and from UK and European ports (Table 87). By volume of traffic, the bulk of vessel movements in the South-West Approaches are cargo vessels representing 43% of traffic, fishing vessels (23%) and tankers (16%) (MMO, 2014). In order to manage the high volume of shipping transiting in various directions around Lands End, there are several traffic separation zones around the Isles of Scilly (Figure 130). The major ports in the south west marine plan areas account for a smaller proportion of the shipping traffic. The majority of the shipping in this area follow these well defined routes, and vessels engaged in other activities, such as fishing and leisure, tend to navigate more freely within the area.

Dredging is only permitted to take place in licenced areas if no significant environmental impacts are predicted. Dredging is important for a number of marine activities and several factors need to be considered including disposal and storage of material, reporting and environmental management. Many of the ports in the south west marine plan areas have dredged access channels which allow them to accommodate vessels.

There are 52 disposal sites in the south west marine plan areas, 26 of which are open, 23 of which are closed and 3 of which are disused (Figure 130). These sites are predominantly used by ports and harbours within the south west marine plan areas which require regular maintenance dredging as a result of estuary processes that deposit suspended material in maintained navigation channels and berth pockets.

It is estimated that the ports and shipping sectors directly employed 9,700 people in the south west in 2013 (Oxford Economics, 2015b; c). The sector's direct gross contribution to the UK's GVA in 2013 totalled £280 million. Including indirect and induced employment, these values increase to 34,100 jobs and £1.5 billion contribution to the UK's GVA (Oxford Economics, 2015b; c).

Another economic analysis of the ports and shipping sector found that the south west marine plan areas employs around 16,270 across 620 businesses (MMO, 2016a). Indirect jobs supported by the ports and shipping sector number are estimated to be 41,110.

Table 86: 2015 freight traffic at major and minor ports in the south west marine plan areas

Port	Type	Thousand tonnes
Bristol (Avonmouth)	Major	8,877
Plymouth	Major	2,217
Fowey	Major	513
Sharpness	Minor	487
Teignmouth	Minor	359
Falmouth	Minor	254
Padstow	Minor	191
Porthoustock	Minor	82
Bridgwater	Minor	59
Appledore	Minor	26
Hughtown (St Mary's)	Minor	21
Penzance	Minor	18
Bideford	Minor	13
Truro	Minor	5
Barnstaple	Minor	0
Charlestown	Minor	-
Dartmouth	Minor	-
Dean Point Quarry	Minor	-
Gweek	Minor	-
Newlyn	Minor	-
Par	Minor	-
Penryn	Minor	-
Watchet	Minor	-

Data source: DfT (2016a)

Table 87: 2015 port ship arrivals (in number of ships per year) within the south west marine plan areas

Port	Tankers	Ro-Ro vessels	Container vessels	Other dry cargo vessels	Passenger vessels	Other vessels	Total
Bristol	103	27	239	901	27	326	1,623
Plymouth	155	344	-	287	10	8	804
Falmouth	183	16	5	77	23	15	319
Fowey	2	-	-	172	8	1	183
Teignmouth	-	-	-	168	1	-	169
Sharpness	-	1	-	158	1	-	160
Porthoustock	1	-	-	32	-	-	33
Bridgwater	-	-	-	-	-	16	16
Bristol	103	27	239	901	27	326	1,623
Plymouth	155	344	-	287	10	8	804
Falmouth	183	16	5	77	23	15	319
Fowey	2	-	-	172	8	1	183

Data source: DfT (2016a)

The assumptions used to develop the BAU, N@W and LS scenarios for ports, shipping, dredging and disposal in the south west marine plan areas are provided in Table 88. The projected tonnages under each of the three scenarios is shown in Figure 146. Figure 147, Figure 148 and Figure 149 show the spatial application of the scenarios to the sector while the text below provides a brief description of the future trends in 6 years and 6 to 20 years.

Table 88: Assumptions and impacts under the future scenarios for ports, shipping, dredging and disposal in the south west marine plan areas

Aspect	Scenario		
	Business as Usual	**Nature @ Work**	**Local Stewardship**
Application to the sector	As for the north east marine plan area (see Table 79).	As for the north east marine plan area (see Table 79).	As for the north east marine plan area (see Table 79).
Assumptions	Based on trends over the last 10 years (DfT, 2016a), sector growth in terms of freight tonnage has been assumed to increase at: - 0% between 2017 and 2022 - 1% between 2023 and 2036. Ferry passenger numbers have been assumed to be stable. For ports the following assumptions have been made:	Sector growth in terms of freight tonnage has been assumed to increase at: - 0% between 2017 and 2022 - 1% between 2023 and 2027 - 2% between 2028 and 2036. Ferry passenger numbers have been assumed to be stable. For ports the following assumptions have been made:	Sector growth in terms of freight tonnage has been assumed to increase at: - 0% between 2017 and 2027 - 1% between 2028 and 2036. For ports the following assumptions have been made: - Footprint similar to current – decline in growth of larger ports due to slower increase in international trade, smaller ports faster growth due to more

Aspect	Scenario		
	Business as Usual	Nature @ Work	Local Stewardship
	▪ Footprint of ports is similar to current - some expansion of ports would occur to accommodate increasing trade, vessel movements and larger vessels. ▪ Additional dredging of navigation channels and disposal of dredge arisings would be required in order to allow larger vessels to access ports. ▪ There would be no new ports developed.	▪ Footprint similar to current - some expansion (e.g. major ports) to accommodate increasing trade, vessel movements and larger vessels. ▪ Additional dredging of navigation channels and disposal of dredge arisings would be required in order to allow larger vessels to access ports. ▪ There would be no new ports developed.	regional traffic and trade. ▪ Smaller ports may focus on local traffic. ▪ Diversification of ports will occur to adapt to the change in demand.
	For shipping the following assumptions have been made: ▪ Footprint similar to current, increased intensity due to growth in trade. ▪ The trend for larger vessels would continue. ▪ Possible minor changes to shipping routes to accommodate offshore wind farms. ▪ Increase in density of shipping proportional to the economic increase. It is assumed that employment will not increase at the same rate as sector growth due to efficiencies and technological advances.	For shipping the following assumptions have been made: ▪ The footprint is similar, with increased intensity due to growth in trade. ▪ The trend for larger vessels will continue. ▪ Greater drive for lower emissions from ships so increase in more carbon efficient fuel sources such as LNG. It is assumed that employment will not increase at the same rate as sector growth due to efficiencies and technological advances.	For shipping the following assumptions have been made: ▪ Footprint largely the same, increased intensity within the region due to increased regional trade and ferry travel. ▪ Less international shipping but increase in smaller coast vessels. ▪ The current trend for ships getting larger would continue for those engaged in international voyages. ▪ International shipping routes would have a slower increase in density in this scenario; however regional shipping routes would be likely to show a larger increase in density.

6-year projection

Throughput in the ports, shipping, dredging and disposal sector in the south west marine plan areas is predicted to remain stable at 13.1 million tonnes for the first six year period under all three scenarios (BAU, N@W and LS).

6 to 20 year projection

Between 2023 and 2036, the growth in throughput under the BAU and N@W scenarios will remain the same until 2027 after which growth in trade will continue at the same rate under BAU and increase further under the N@W scenario. This will result in a projected annual tonnage of 15.1 and 16.5 million tonnes by 2036 under the BAU and N@W scenarios respectively. Under the LS scenario, economic growth will remain static until 2027, after which a slow steady growth in trade is anticipated resulting in a projected annual tonnage of 14.4 million tonnes by 2036.

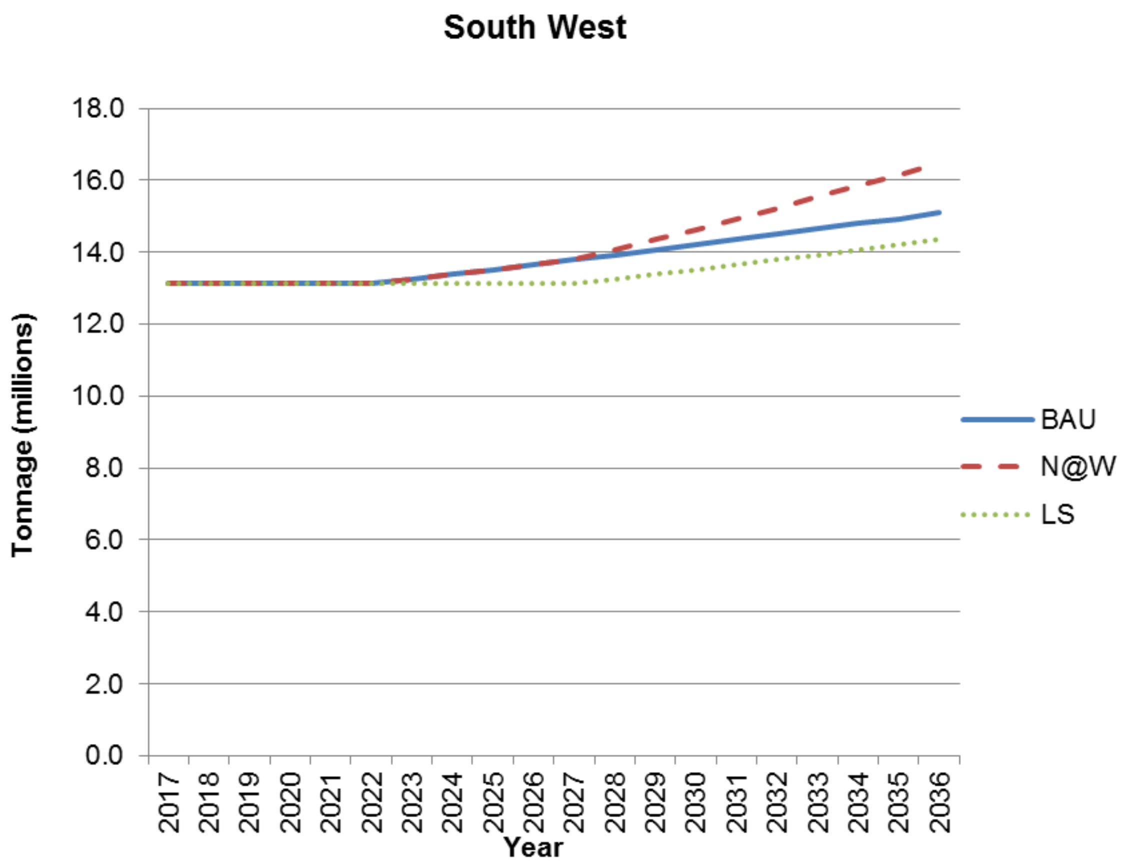


Figure 146: Projected annual tonnage in the south west marine plan areas between 2017 and 2036 under three scenarios

Potential trade-offs

The potential trade-offs are similar to the north east marine plan areas.

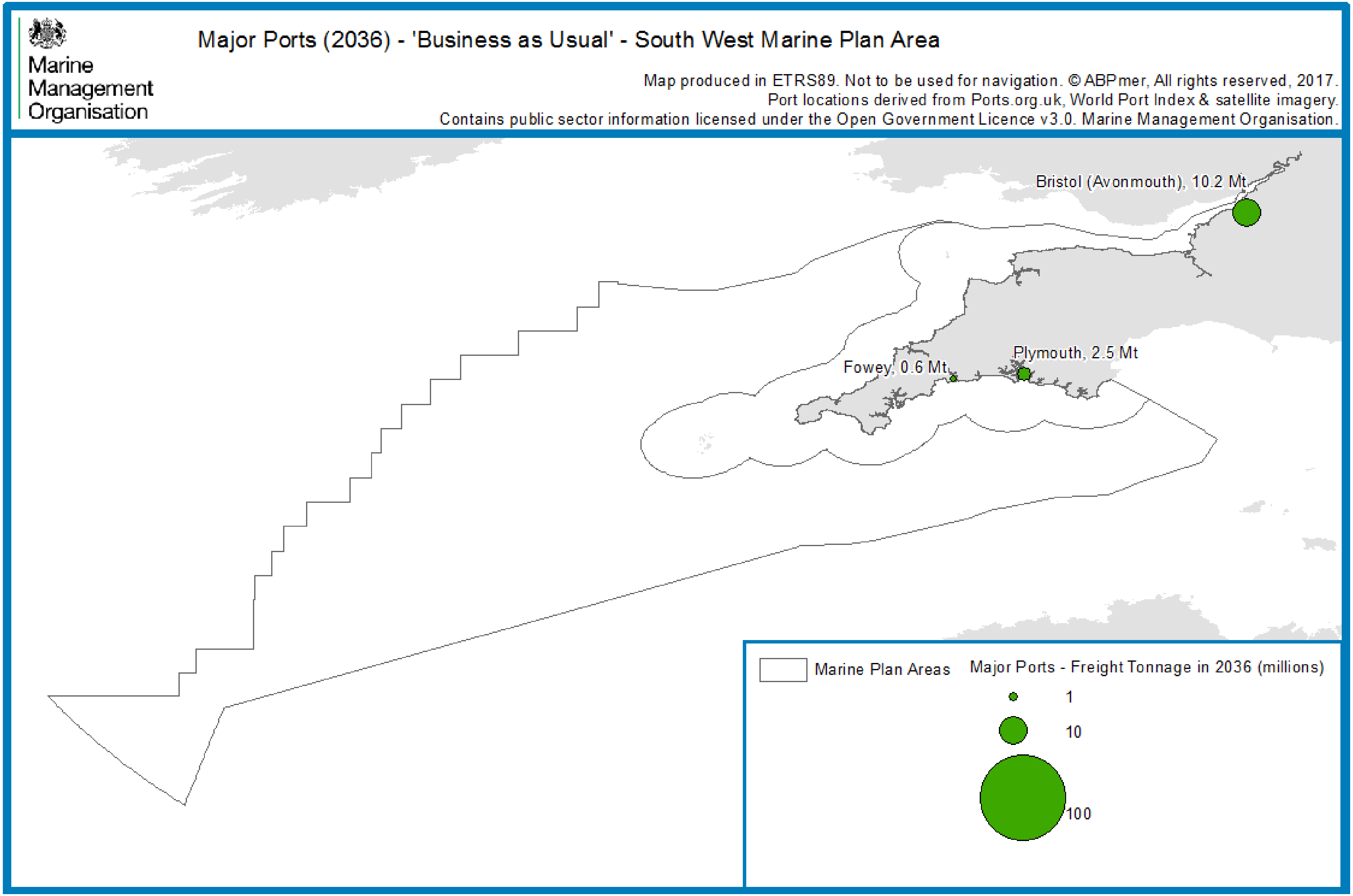


Figure 147: Ports (2036) – BAU – south west marine plan areas

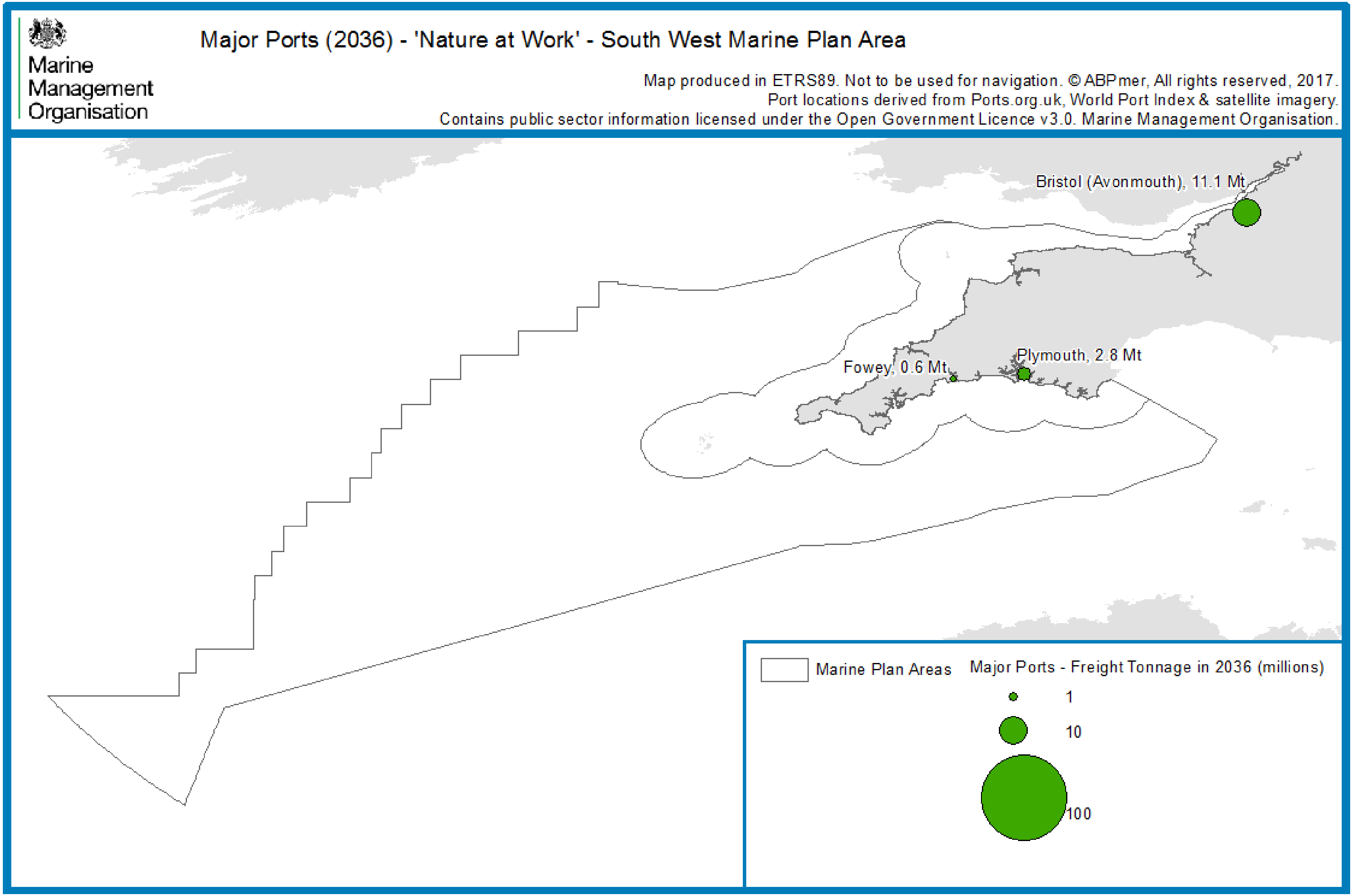


Figure 148: Ports (2036) – N@W – south west marine plan areas

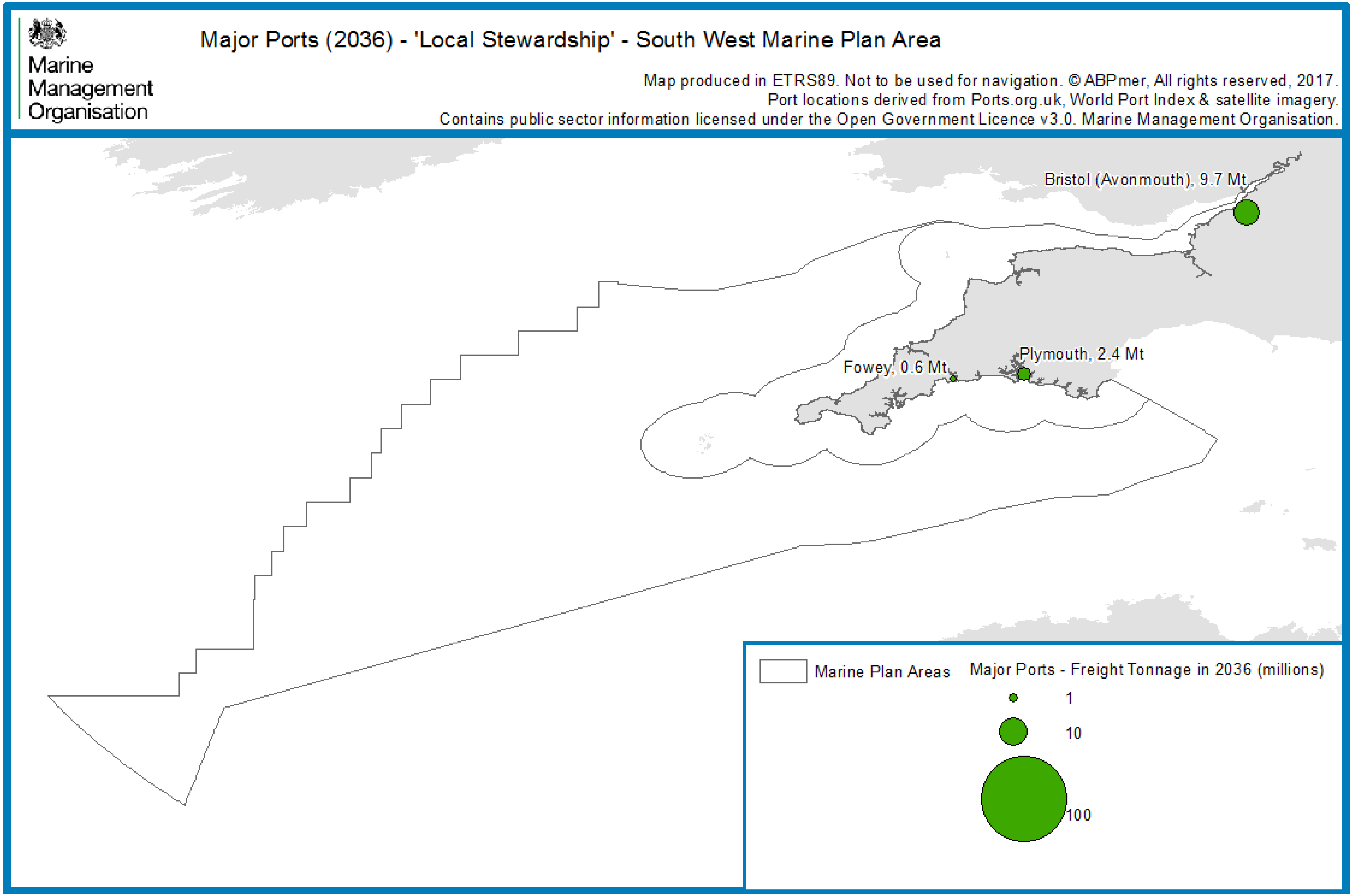


Figure 149: Ports (2036) – LS – south west marine plan areas

14 Surface water/wastewater management

Sector definition

Disposal of waste material into the marine environment includes the regulated discharge of waste water and unregulated surface water runoff. The disposal of dredged material from capital and maintenance dredging is discussed in Section 3.11.

Disposal of waste at sea is regulated for environmental protection purposes. Since the 1980s, disposal at sea of radioactive wastes, industrial wastes, colliery minestone and sewage sludge have progressively been prohibited. There has also been increasing control with time over the disposal of effluents into the marine environment.

There are three main types of collection system for surface water and waste water discharges (Department for Environment, Food and Rural Affairs (Defra), 2012):

- Surface-water drainage that collects rainwater run-off from roads and urban areas and discharges direct to local waters;
- Combined sewerage that collects rainwater run-off and waste water from domestic, industrial, commercial and other premises; and
- Foul drainage that collects domestic waste water from premises (no rainwater is collected).

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 waste water discharges.

Data sources

A variety of different information sources have been reviewed to inform this baseline, including published reports and papers and spatial data layers. The main information sources used are provided in the list below:

- Environment Agency Catchment Data Explorer (http://environment.data.gov.uk/catchment-planning)
- Second Cycle (2016 – 2021) River Basin Management Plans (RBMPs), including Part 1 (National Overview) (Environment Agency, 2015)
- Environment Agency Bathing Water Quality (http://environment.data.gov.uk/bwq/profiles)
- Environment Agency annual bathing water compliance reports
- Urban waste water treatment plant locations and discharge points in the UK (http://www.eea.europa.eu/themes/water/water-pollution/uwwtd/interactive-maps/urban-waste-water-treatment-maps-1)
- Waste water treatment in the United Kingdom – 2012: Implementation of the European Union Urban Waste Water Treatment Directive (Defra, 2012)

- Global Energy Observatory (GEO) coastal power stations (coal/biomass, gas and nuclear) (http://globalenergyobservatory.org)
- Water UK website for Water Resources Management Plans (WRMPs) an areas operated by water/waste water companies (http://www.water.org.uk).

14.1 National review

Overview of national activity

Water treatment works and sewage disposal discharges are located along the majority of the UK coastline, although higher concentrations do exist around the main urban conurbations (Figure 150). The level of treatment provided at waste water treatment plants can involve:

- Preliminary treatment – to remove grit and gravel and screening of large solids
- Primary treatment – to settle larger suspended, generally organic, matter
- Secondary treatment – to biologically break down and reduce residual organic matter
- Tertiary treatment – to address different pollutants using different treatment processes.

There are currently around 30 water and/or waste water companies and local suppliers in the UK[31]. The UK water industry manages more than 11 billion litres of waste water a day through 624,200 km of sewers and approximately 9,000 waste water treatment plants. This involves collecting, processing, and returning the water to the environment, with treatment applied according to the sustainability of local conditions. In 2013, there were 1,808 urban waste water treatment plants in the UK reported for agglomerations of greater than 2,000 population equivalent (p.e.), for which two provided primary or no treatment, 1,420 provided secondary treatment and 386 provided more stringent (e.g. tertiary) treatment[32].

In some instances, secondary treatment alone may not protect waters from other types of contaminants present in waste water and tertiary treatment may be required at waste water treatment plants to protect water ecosystems or to meet water quality standards of a number of directives. Environmental waters in need of more protection than is provided by secondary treatment are generally designated as 'sensitive areas'. Sensitive areas are areas which are rich in nutrients (eutrophic) or could become so in the near future without tertiary protection. In England, the following sites were considered 'sensitive areas' under the Urban Waste Water Treatment Directive (91/271/EEC) in 2012 (Defra, 2012):

- 11 coastal waters/areas
- 181 bathing waters (159.06 km2)
- 48 shellfish waters (1,199.20 km^2).

[31] http://www.water.org.uk/consumers/find-your-supplier (Accessed March 2017).
[32] http://www.eea.europa.eu/themes/water/water-pollution/uwwtd/interactive-maps/urban-waste-water-treatment-maps-1 (Accessed March 2017)

The Water Framework Directive (WFD) (2000/60/EC) came into force in 2000 and establishes a framework for the management and protection of Europe’s water resources. It is implemented in England and Wales through the Water Environment (WFD) (England and Wales) Regulations 2003 (the Water Framework Regulations). The overall objective of the WFD is to achieve good status in all inland, transitional, coastal and ground waters by 2015, unless alternative objectives are set or there are appropriate reasons for time limited derogation.

The WFD divides rivers, lakes, lagoons, estuaries, coastal waters (out to 1 nm from the low water mark), man-made docks and canals into a series of discrete surface water bodies, as well as separate groundwater water bodies. It sets ecological and chemical targets (objectives) for each surface water body and quantitative and chemical targets for groundwater water bodies. River Basin Management Plans (RBMPs) are a requirement of the WFD, setting out measures for each river basin district to maintain and improve quality in surface and groundwater water bodies where necessary. There are ten river basin districts which cover England and cross-boundary districts between England and Wales/Scotland, with two further river basin districts covering Wales and Scotland. RBMPs have been published for each river basin district, firstly in 2009 to cover the first cycle (2009 to 2015) and then updated in 2015 to cover the second cycle (2016 to 2021), reporting the latest status and objectives of each individual water body.

Based on second cycle RBMPs, there are 62 coastal and 104 transitional (estuarine) water bodies in England. In terms of the latest overall status of these water bodies, 49 are classified as high/good, 110 are classified as moderate, 5 are classified as poor and 2 are classified as bad (Figure 151). This suggests that 21% of transitional water bodies and 44% of coastal water bodies in England are currently classified at good or better overall status; this represents a higher percentage than the average for all surface water bodies in England combined (17%). Ecological status (or potential for heavily modified water bodies) is good or better in 21% and 47% of transitional and coastal water bodies, respectively (Figure 152), while a much higher proportion are achieving good chemical status (94% of transitional and 92% of coastal water bodies; see Figure 153) (Environment Agency, 2015). All coastal and transitional water bodies have the objective of meeting overall good status by at least 2027.

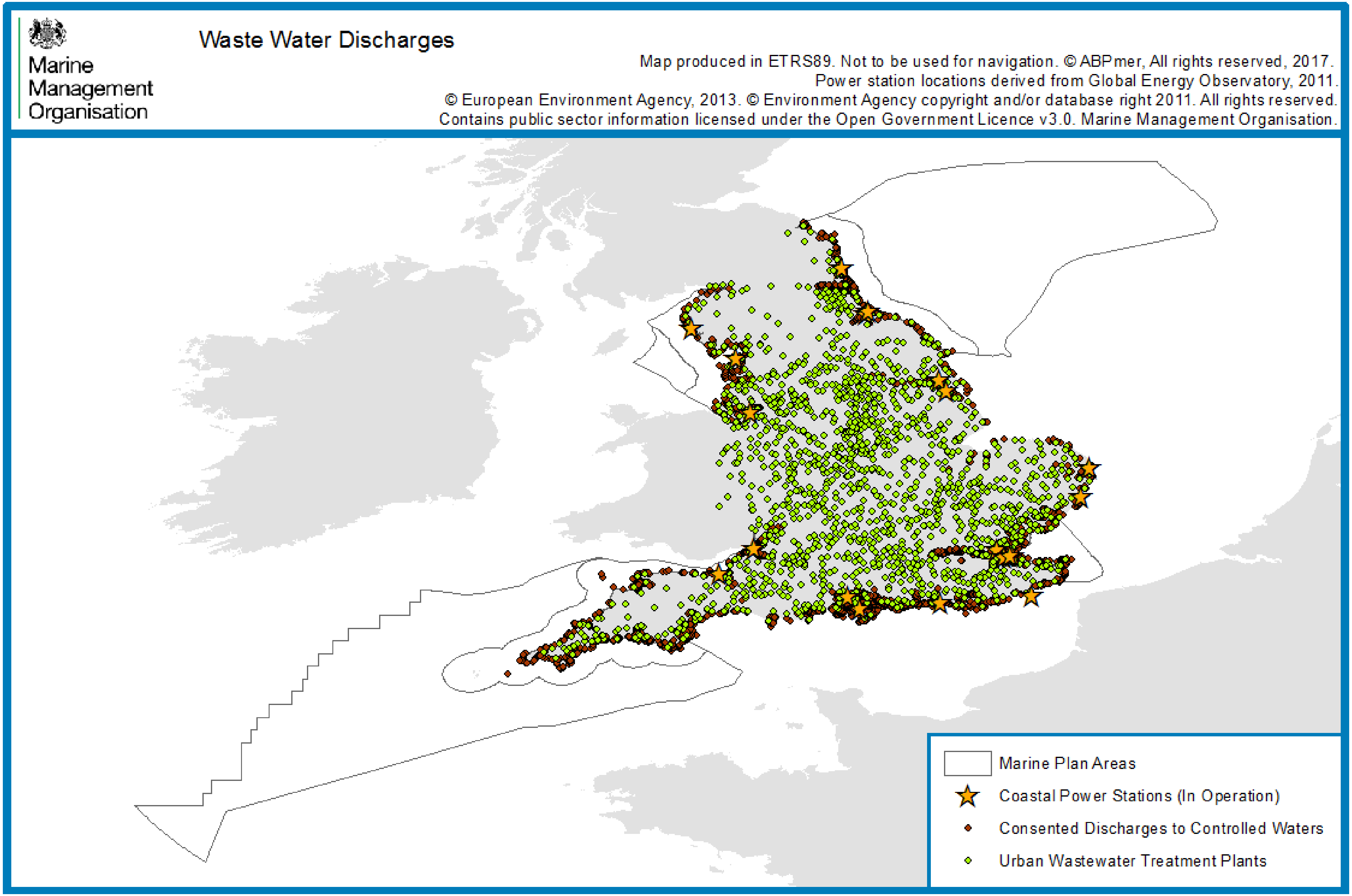


Figure 150: Urban waste water treatment plants, consented discharge points and coastal power stations in England

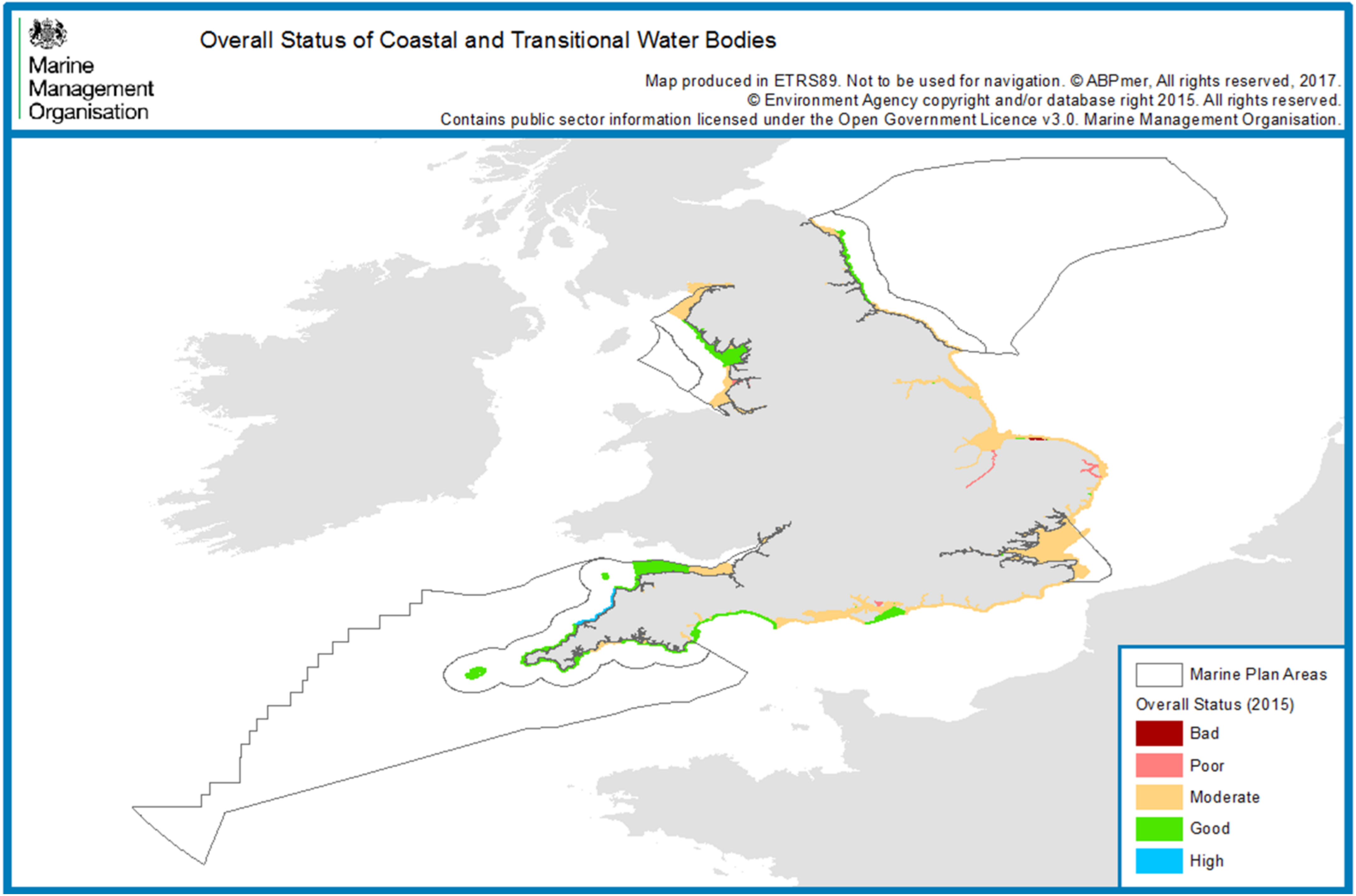


Figure 151: Overall status of coastal and transitional water bodies in England in 2015

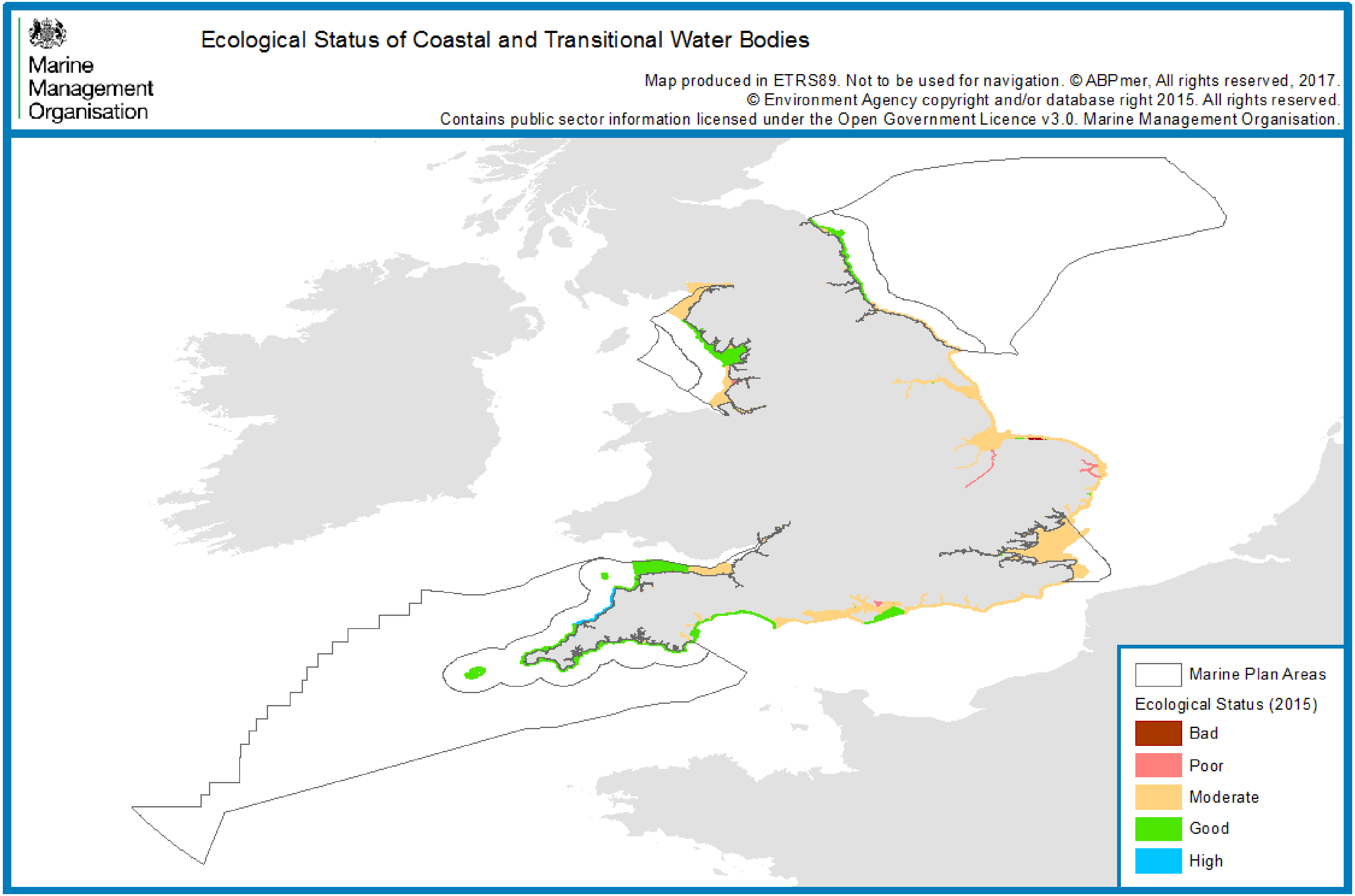


Figure 152: Ecological status/potential of coastal and transitional water bodies in England in 2015

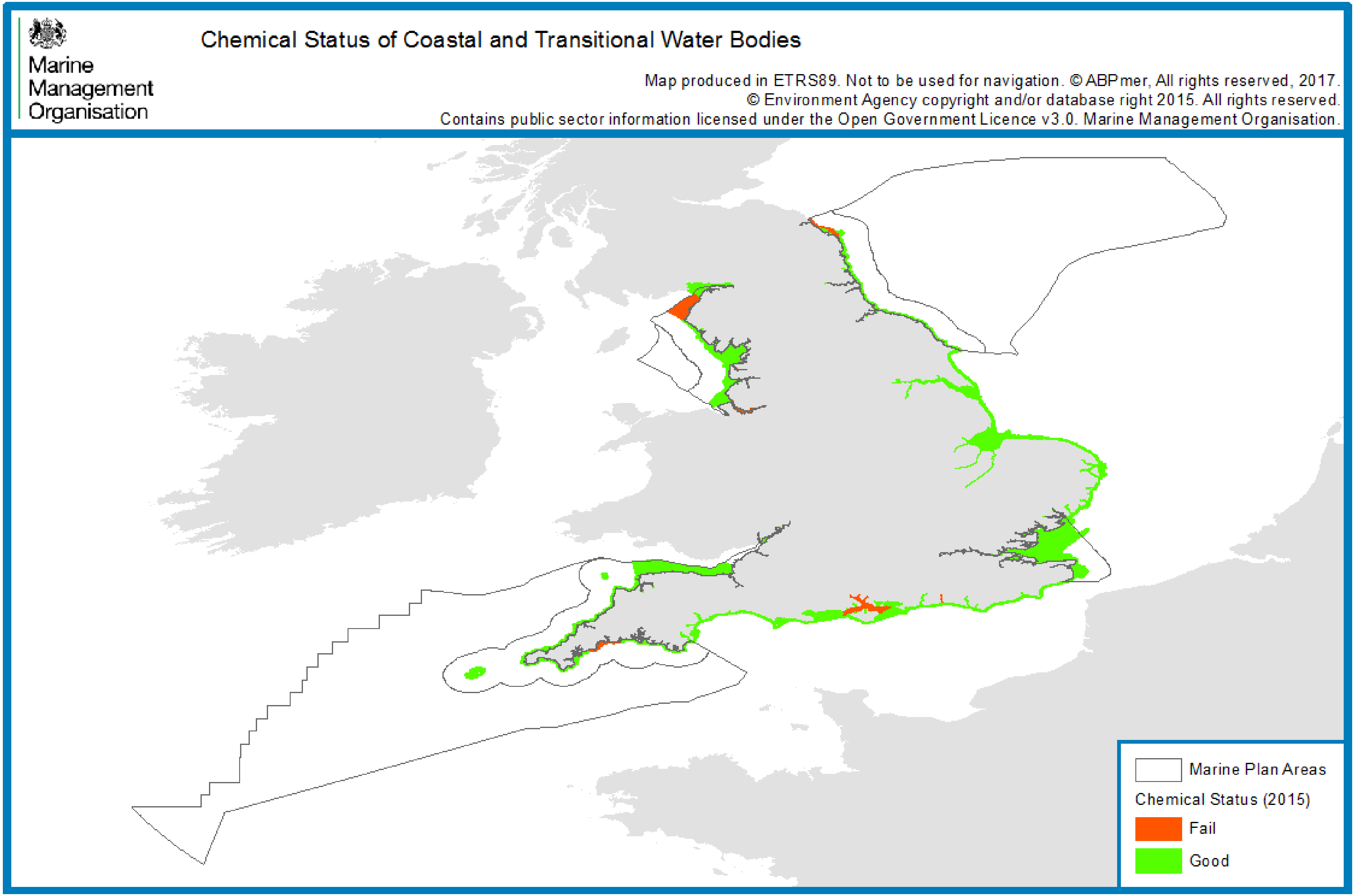


Figure 153: Chemical status of coastal and transitional water bodies in England in 2015

A Nitrate Vulnerable Zone (NVZ) is an area of land that drains into polluted waters and contributes to the pollution of those waters. Polluted waters are waters that are affected by nitrate pollution or could be if the Nitrate Pollution Prevention Regulations 2015 are not applied in the area concerned. As part of a review of NVZ designations for implementation in 2017, the Environment Agency (2016) recommended 14 transitional and coastal water bodies associated with 9 NVZ (see Table 89).

Table 89: Transitional and coastal water bodies recommended for NVZ designation in 2017

WFD Water Body (ID)	NVZ (ID)
Fleet Lagoon (GB510080077000)	The Fleet (ET002)
Chichester Harbour (GB580705210000)	Chichester Harbour (ET004)
Langstone Harbour (GB580705130000)	Langstone Harbour (ET004)
Portsmouth Harbour (GB580705140000)	Portsmouth Harbour (ET004)
Holy Island and Budle Bay (GB680301430000)	Lindisfarne (Fenham Flats and Budle Bay) (ET005)
Eastern Yar (GB520710102000)	Eastern Yar (ET006)
Medina (GB520710101600)	Medina Estuary (ET006)
Newtown River (GB520710101700)	Newtown Harbour (ET006)
Carrick Roads Inner (GB520804814400)	Truro, Tresillian and Fal Estuaries (ET007)
Kingsbridge (GB520804609000)	Kingsbridge/Salcombe Estuary (ET032)
Taw/Torridge (Part of GB540805015500)	Taw Estuary (ET058)
Southampton Water (Part of GB520704202800)	Hamble Estuary (ET060)
Carrick Roads Outer (GB650806250000)	Lower Fal Estuary (not specified)

Source: Environment Agency (2016)

The revised Bathing Water Directive (2006/7/EC) was adopted in 2006, updating the microbiological and physico-chemical standards set by the original Bathing Waters Directive (76/160/EEC) and the process used to measure/monitor water quality at identified bathing waters. The revised Directive focuses on fewer microbiological indicators, whilst setting higher standards, compared to those previously set. Bathing waters are classified as excellent, good, sufficient or poor under the revised Directive according to the levels of certain types of bacteria (intestinal enterococci and *Escherichia coli*) in samples obtained during the bathing season (May to September). Monitoring of water quality has been reported against revised Directive indicators since 2015. The UK Government's target under the revised Directive is to achieve 'sufficient' for all bathing waters by 2015, as described under the Bathing Water Regulations 2013 which transposes the revised Directive into UK law.

In 2016, there were 401 coastal bathing waters designated in England, with a further 12 inland bathing waters and 2 closed/un-assessed bathing waters. In terms of coastal bathing waters, 278 were classified as excellent, 96 were classified as good and 21 were classified as sufficient, indicating 98.5% compliance with the minimum bathing water standard (i.e. sufficient or better; see Table 90). There were 6 coastal bathing waters classified as poor in 2016, namely Scarborough South Bay, Clacton (Groyne 41), Walpole Bay (Margate), Instow, Ilfracombe Wildersmouth and Burnham Jetty North (Defra, 2016).

Table 90: Coastal bathing water classification in England against the revised Bathing Water Directive

Year	Excellent	Good	Sufficient	Poor	Closed/ Insufficiently Sampled
2010 (402)	206	98	52	44	2
2011 (403)	217	96	49	39	2
2012 (405)	203	115	41	45	1
2013 (405)	224	111	30	38	2
2014 (406)	247	99	36	23	1
2015 (402)	256	106	28	10	2
2016 (403)	278	96	21	6	2
Note: 2015 – 2016 (actual results); 2010 – 2014 (projected results)					

While designated bathing waters have been classified under the revised Bathing Water Directive since 2015, the Environment Agency has published projected results for bathing waters prior to this period using the new parameters. There has been a significant improvement in bathing water quality since the early 1990s when just a quarter of bathing waters met strict water quality standards of the original Bathing Water Directive. Table 90 and Figure 154 show the continued improvement in bathing water quality since 2010 (see Figure 155 for bathing water locations in 2016).

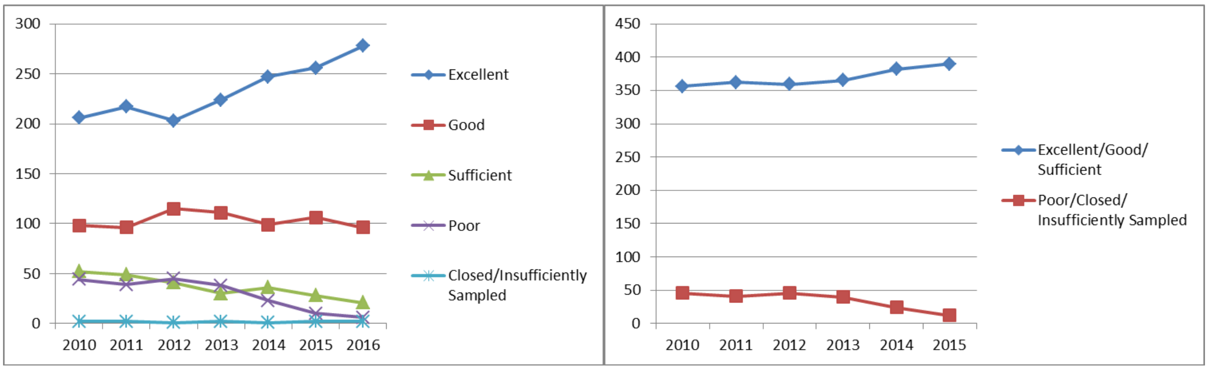


Figure 154: Trends in coastal bathing water classification in England against the revised Bathing Water Directive between 2010 and 2016

The Shellfish Waters Directive (2006/113/EC) was repealed in December 2013 and subsumed within the WFD. However, the latest standards for the implementation of the WFD in England and Wales suggest ‘Protected areas under WFD include shellfish waters and we are proposing to direct the Agencies to continue to endeavour to observe the microbial standard in shellfish waters, to contribute to a high quality shellfish product directly edible by humans’ (Defra, 2014). It is understood that the guideline bacteriological standard of the former directive has been retained but the water column standards have been dispensed with as these are considered to be adequately covered by other aspects of the WFD (Environment Agency and Water UK, 2013). There are currently 94 designated shellfish water protected areas in England, predominantly located in the Solway Firth, Morecambe Bay, the Solent, Outer Thames Estuary and the Wash (Defra, 2016; see Figure 155). In 2016, there were 55 designated bivalve production areas in England and Wales. Within each production area, classification zones are reported for a range of bivalve species according bacteriological criteria (levels of *Escherichia coli* found in samples from the site) which determine what treatment is required before molluscs can be placed on the market for human consumption.

Waste water discharges are important for a number of trades and industries as well as power stations; however, they do not generate a measurable economic value by themselves. It is therefore not possible to measure the contribution of waste water to the marine environment in terms of gross value added (GVA) or employee jobs. However, control of waste water discharges are fundamental to sustaining certain key economic activities, such as shellfisheries, tourism and recreation, as well as the industries which rely on making discharges to the marine environment (e.g. power stations and water and sewage companies). The provision of effective surface and waste water treatment systems also contributes more widely to ecosystem services. This includes flood prevention through surface water drainage and avoidance of damage to sensitive coastal and estuarine habitats due to the control of pollution through sewage treatment works.

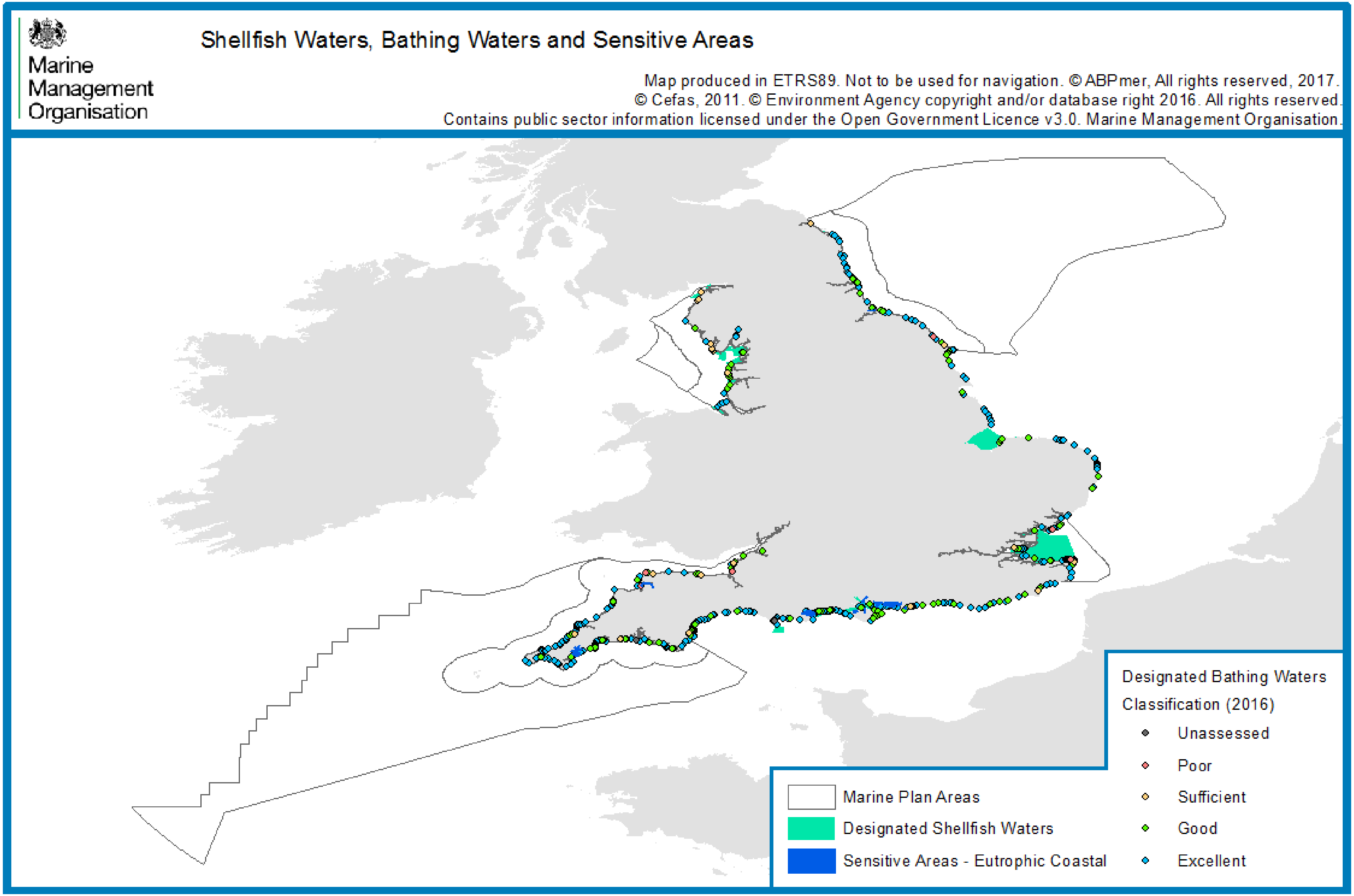


Figure 155: Designated bathing water classifications (2016) and shellfish waters in England

Review of historical trends

Since privatisation of the water and sewage companies in 1989 there have been significant improvements to water quality across the UK. This is largely due to increasingly strict legislation and substantial investment by water and sewage companies. Excluding spending on infrastructure maintenance, investment in sewerage services between 1990 and 2015 has been projected at £39.1 billion in the UK (£26.1 billion in England). The Urban Waste Water Treatment Directive (and Regulations) requires a collection and treatment system for all agglomerations of people with populations over 2,000 p.e. that discharge their effluent into freshwater and estuaries, and for all agglomerations of over 10,000 p.e. that discharge their effluent into coastal areas. The level of appropriate treatment can be no treatment or preliminary through to tertiary treatment depending on uses of the receiving water environment and associated standards (Defra, 2012).

This investment from the water companies in the sewerage system is reflected in the steady improvement of bathing water and shellfish water quality. Although variations occur from year to year, these are related to weather conditions, as combined sewer overflows operate more frequently during wet weather and diffuse pollution from urban and agricultural sources is increased, rather than on the failure of the sewage treatment system. The European Environment Agency (2016) report on UK bathing water quality in 2015 highlights the continued improvement over the last two decades. In 1990, approximately 75% of coastal bathing waters in the UK were achieving at least ‘sufficient’ status compared to 94.5% in 2015 (results projected against the revised Bathing Water Directive parameters). In England and Wales, during the 2010-2015 water company investment period, a capital investment of around £220 million has delivered an extensive programme of investigations and enhancement schemes to improve the quality of bathing waters (European Environment Agency, 2016).

In terms of WFD water body status, there have been changes to the ‘building blocks’ upon which water bodies are classified between 2009 and 2015. Use of the 2009 classification parameters with the 2015 results indicates a slight decline in the proportion of water bodies achieving good or better status in England. While the chemical status of surface water bodies at good or better status has increased from 8% to 14%, ecological status of surface water bodies has decreased from 26% to 21% between 2009 and 2015, respectively. However, based on the new building blocks, 17% of surface water bodies are currently reported to be at good or better status. In particular, 21% of transitional water bodies and 44% of coastal water bodies in England are currently classified at good or better overall status (Environment Agency, 2015).

Review of key changes and/or advances of significance affecting the sector

Population, housing and industry growth in the UK are likely to put increased pressure on water and sewage works. All water companies in England have a statutory requirement to prepare, maintain and publish a Water Resources Management Plan (WRMP) under the Water Industry Act 1991 (as amended by the Water Act 2003). Reviewed on a rolling five-year basis, WRMPs set out how the balance between water supply and demand will be maintained and how the security of supply over the coming 25 years will be ensured in a way that is economically, socially and environmentally sustainable (the latest WRMP were published in 2014).

Due to the ecological, economic and social importance of coastal waters, a large number of standards and regulations are in place to control the level of harmful contaminants in the water. The Environment Agency is responsible for maintaining or improving the quality of fresh, marine, surface and underground water in England. Key policy drivers are summarised in Table 91.

Table 91: Key drivers of change for the surface water and waste water management sector

Driver	Details	Implications
Political	High-level vision for clean, healthy, safe, productive and biologically diverse oceans and seas as set out in the UK Marine Policy Statement (HM Government, 2011)	Improved/maintained water quality and improvement in management practices
Economic	Ongoing requirement to balance the cost and benefits of waste water treatment	Improved/maintained water quality and improvement in management practices
Social	Population growth and thus increase in housing developments	Increased pressure on sewage and treatment works
	Use of coastal waters for recreation and wider social expectation of improving environmental standards	Increased demand for clean bathing waters
Technological	Development of technology to meet new and revised standards of waste water treatment and measures to reduce nutrient load from diffuse sources	Improved/maintained water quality and improvement in management practices
Legal	The Water Framework Directive (WFD) sets 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 revised Bathing Water Directive sets out water quality standards to protect the environment at bathing waters throughout the bathing season (May – September)	Improved/maintained water quality and improvement in management practices
	The Shellfish Waters Directive sets physical, chemical and microbiological water quality requirements (Note: this Directive was repealed in 2013 and subsumed under the WFD)	Improved/maintained water quality and improvement in management practices
	The Urban Waste Water Treatment Directive seeks to protect the environment from the adverse effects of sewage discharges by setting treatment levels on the basis of sizes of sewage discharges and the sensitivity of waters receiving the discharges	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
	Climate change could lead to increased storm frequency, while sea level rise could influence waste water discharge points	Increased investment in waste water treatment to maintain resilient service

Review of future trends

Significant reductions in the concentration of contaminants discharged from point source discharges over the past 30 years are likely to be sustained in future years. Water companies are major dischargers to the environment and improving the way they operate can lead to improvements in estuarine and coastal waters. Changes to legislation and regulation over the coming years may have wide-ranging investment implications for water and sewage companies. Population growth is also predicted to continue in the UK and this will put added pressure on water and sewage companies to improve their infrastructure and associated discharges.

Increasing waste water pollution events in the future may arise due to:

- More frequent and intense storm events linked to climate change, resulting in an increased frequency of potential storm overflows;
- Population growth putting more demand on the sewage network and water companies to dispose of waste water;
- Urban creep increasing the impermeable nature of the catchment and thus promoting the rapid response of watercourses to rainfall events; and
- Diffuse urban and rural pollution from wider catchment areas.

As stricter legislation, population growth and tighter environmental controls emerge, water companies will need to take action to, where necessary, improve their waste water treatment processes. For example, all designated bathing waters are expected to achieve at least ‘sufficient’ status under the revised Bathing Water Directive standards, while the overarching objective of the WFD is to achieve good status in all surface water bodies. However, six coastal bathing waters in England were reported as poor in 2016 and a large proportion of surface water bodies in England were classified as moderate or worse overall status in the latest RBMPs (2015).

Under the Business as Usual (BAU) scenario, it is assumed that bathing water quality will continue to improve towards 100% compliance over the long term, while surface water body status will achieve current projections by the end of the third cycle of RBMPs (2027) with no further improvement. Under the Nature at Work (N@W) scenario, it is assumed that an increased environmental focus will result in earlier improvement in bathing water quality (compared to the BAU scenario), while surface water body status will continue to improve after the end of the third cycle of RBMPs (2027). The Local Stewardship (LS) scenario is the same as the N@W scenario, although additional bathing waters are designated (sufficient or better) to support local recreation and tourism, and shellfish water quality is assumed to improve with new shellfish waters/bivalve production areas introduced.

Refer to Section 3.4 for assumptions regarding nuclear new build power stations (for which significant volumes of water will need to be extracted for cooling purposes). The implications of cooling water discharges raising local water temperatures will also need to be taken into account under different future scenarios.

Confidence assessment

There is a lack of published information on water company forward investment plans, as well as detailed information on Water Framework Directive (WFD) improvement plans at national scale and for specific river basin districts.

Improvements in surface water and waste water management will be reliant on investment from water and sewage companies which in turn will be largely driven by stricter legislation and policy requirements. Specific management actions for surface water and waste water management over the next 20 years are unclear, although it has been assumed that water quality management will continue to improve during this period. The effectiveness of these management measures on the quality of particular bathing and shellfish waters, as well as the status of individual coastal and/or transitional water bodies, is unknown.

14.2 North east

There are 8 coastal water bodies and 9 transitional water bodies located within the north east marine plan areas, specifically within the Solway Tweed, Northumbria and Humber River Basin Districts. In terms of overall status, 4 water bodies (3 coastal and 1 transitional) were classified as good and 13 water bodies (5 coastal and 8 transitional) were classified as moderate in 2015, primarily due to ecological parameters failing to achieve good (see Table 92). There is one coastal area (Seal Sands, Tees Estuary) which is designated as a 'Sensitive Area (Eutrophic)' under the Urban Waste Water Treatment Directive (Defra, 2012).

In 2016, 43 bathing waters were designated in the north east marine plan areas. Overall, 33 bathing waters were classified as 'excellent', 7 as 'good', 2 as 'sufficient' and 1 as 'poor (Scarborough South Bay) (see Table 93). As shown in Figure 156, there has been a slight increase in the number of bathing waters within the north east marine plan areas which are achieving at least 'sufficient' between 2010 (40) and 2016 (42; approximately 98% compliance). There are 26 bathing waters which are designated as 'Sensitive Areas (Bathing Waters)' under the Urban Waste Water Treatment Directive (Defra, 2012).

There is also one shellfish water protected area located within the north east marine plan areas, namely Holy Island (Defra, 2016). The 'Ross Links – R9' classification zone, located within the Holy Island bivalve production area and shellfish water, is designated for harvesting of *Crassostrea gigas* (Pacific oyster) (Table 94). The species is categorised as Class B whereby 90% of sampled molluscs must contain less than or equal to 4,600 *E. coli* per 100 grams (g) of flesh and the remaining 10% of samples must not exceed 46,000 *E. coli* per 100 g of flesh. Harvested products can go for human consumption after purification in an approved plant or after relaying in an approved Class A relaying area or after a European Commission (EC) approved heat treatment process (all samples must be less than 46,000 *E.coli* per 100 g).

The Hartlepool nuclear power station (1,180 megawatts (MW)), Seal Sands gas-fired power station (50MW) and Lynemouth coal and biomass power station (420MW) are located on the coast within the north east marine plan areas, for which water is abstracted for cooling water purposes and subsequently discharged to the marine environment as waste water. There are 2,340 consented discharge points in the north east marine plan areas of which approximately 1,200 are located within the Tyne, Wansbeck and Blyth rivers and 400 within the Tees.

Table 92: Coastal and transitional water body classifications (2015) in the north east marine plan areas

River Basin District	Water Body Name	Water Body Type	Overall Status	Ecological Status/Potential	Chemical Status	Target Status	Objective Date
Humber	Yorkshire North (GB650401500004)	Coastal	Moderate	Moderate	Good	Good	2027
	Yorkshire South (GB640402491000)		Moderate	Moderate	Good	Good	2027
	Esk (E) (GB510402703400)	Transitional	Moderate	Moderate	Fail	Good	2027
Northumbria	Farne Islands to Newton Haven (GB620301100000)	Coastal	Good	Good	Good	Good	2015
	Northumberland North (GB650301440000)		Moderate	Good	Fail	Good	2027
	Northumberland South (GB650301500001)		Good	Good	Good	Good	2015
	Holy Island and Budle Bay (GB680301430000)		Moderate	Moderate	Good	Good	2027
	Tyne and Wear (GB650301500002)		Good	Good	Good	Good	2015
	Tees Coastal (GB650301500005)		Moderate	Moderate	Good	Good	2027
	Coquet (GB510302203000)	Transitional	Moderate	Moderate	Good	Good	2027
	Blyth (N) (GB510302203200)		Moderate	Moderate	Good	Moderate	2015
	Aln (GB510302203300)		Good	Good	Good	Good	2015
	Wansbeck (GB510302210100)		Moderate	Moderate	Good	Good	2027
	Tyne (GB510302310200)		Moderate	Moderate	Good	Moderate	2015
	Wear (GB510302402900)		Moderate	Moderate	Good	Moderate	2015
	Tees (GB510302509900)		Moderate	Moderate	Good	Moderate	2015
Solway Tweed	Tweed (GB510202110000)	Transitional	Moderate	Moderate	Good	Good	2027

Table 93: Coastal bathing water classifications for the north east marine plan areas against the revised Bathing Water Directive

Year (Number of Bathing Waters)	Excellent	Good	Sufficient	Poor	Closed	Bathing Waters Not Achieving At Least Sufficient or Closed
2010 (44)	22	13	5	4	0	Saltburn, Spittal, Staithes, Robin Hoods Bay
2011 (44)	25	10	6	3	0	Spittal, Staithes, Robin Hoods Bay
2012 (44)	19	15	6	4	0	Seaton Carew North, Saltburn, Spittal, Staithes
2013 (44)	18	16	5	5	0	Seaton Carew North, Seaham Beach, Spittal, Staithes, Scarborough South Bay
2014 (44)	22	14	6	2	0	Spittal, Staithes
2015 (43)	24	14	4	1	0	Spittal
2016 (43)	33	7	2	1	0	Scarborough South Bay
Note: 2015 – 2016 (actual results); 2010 – 2014 (projected results)						

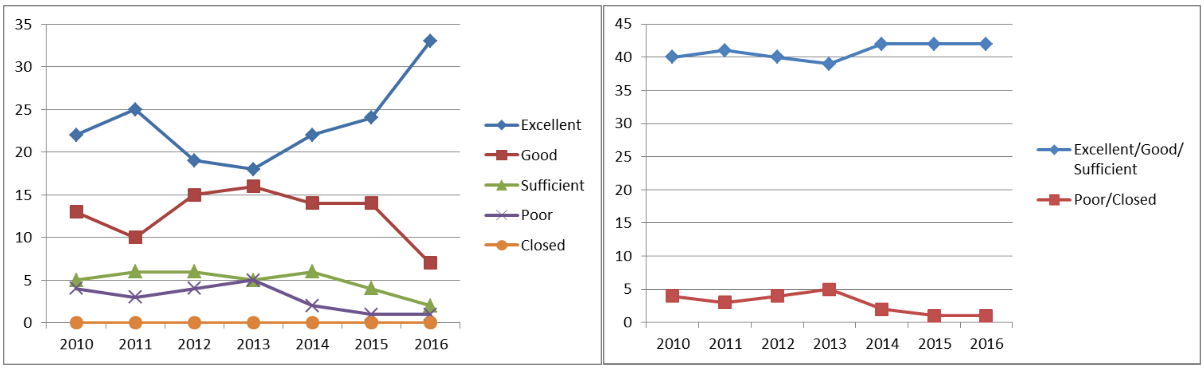


Figure 156: Trends in coastal bathing water classification in the north east marine plan areas against the revised Bathing Water Directive between 2010 and 2016

Table 94: Designated bivalve mollusc production areas in the north east marine plan areas in 2016

Bivalve Production Area	Bivalve Classification Zone	Species (Class)
Holy Island	Ross Links – R9	*C. gigas* (B – LT)
LT – Denotes long-term classification		

The assumptions used to develop the BAU, N@W and LS scenarios for surface and wastewater management in the north east marine plan areas are provided in

Table 95. The text below provides a brief description of the future trends in 6 years and 6 to 20 years.

Table 95: Assumptions under the future scenarios for surface water and waste water management in the north east marine plan areas

Aspect	Scenario		
	BAU	N@W	LS
Application to the sector	Continued investment in waste water treatment reflected in bathing water quality improvements and surface water body projections being achieved in line with current trends.	Increased investment in waste water treatment reflected in bathing water quality improvements and current status projections (objectives) being surpassed for certain coastal and transitional water bodies.	Increased investment in waste water treatment processes reflected in bathing water quality improvements, with additional bathing waters designated to support local recreation and tourism, and current status projections (objectives) being exceeded for certain coastal and transitional water bodies. Increased investment in local shellfisheries results in additional bivalve production areas being designated.
Assumptions	Bathing water quality to improve whereby all designated sites within the north east marine plan areas are reported as sufficient or better by 2026 (i.e. within 10 years). This includes bathing waters currently reported as poor (Scarborough South Bay) and ensuring all other bathing waters maintain at least sufficient status from 2026 onwards. The overall status of surface water bodies (coastal and transitional) within the north east marine plan areas is anticipated to follow current projections by the end of the third cycle of RBMPs (2027; see Table 92). Post-2027, it is assumed that no further improvement in surface	The bathing water and surface water body status assumptions are the same as BAU except all bathing waters within the north east marine plan areas are reported as sufficient or better by 2021 (i.e. within 5 years) and, post-2027, it is assumed that further improvement in surface water body status is achieved as a result of technological improvements.	The bathing water and surface water body assumptions are the same as N@W except additional bathing waters are designated within the north east marine plan areas and additional bivalve production areas are introduced by 2036. The location of additional bathing waters and bivalve production areas is unknown.

Aspect	Scenario		
	BAU	N@W	LS
	water body status is achieved.		

6 year projection

As shown in Table 92, there are currently 4 water bodies (3 coastal, 1 transitional) at good status within the north east marine plan areas. However, no additional coastal or transitional water bodies are anticipated to achieve good status by 2021 (end of second cycle of RBMPs) and therefore it is assumed that no improvements are made in the next 6 years under all three scenarios.

In 2016, one designated bathing water within the north east marine plan areas was reported at poor status (Scarborough South Bay; see Table 93). Under the BAU scenario, it is assumed that this bathing water (or at least one other bathing water) does not achieve sufficient status over the next 6 years and thus 100% compliance is not attained. However, under the N@W and LS scenarios, it is assumed that all designated bathing waters within the north east marine plan areas are reported as sufficient or better by 2021 (i.e. within 5 years).

6–20 year projection

There are 9 water bodies (5 coastal, 4 transitional) within the north east marine plan areas which are currently at moderate status and have been projected to achieve good status by 2027 (Table 92). In contrast, 4 water bodies (all transitional) are not predicted to achieve good status by this stage (i.e. remain moderate). Under the BAU scenario, it is assumed that these surface water body projections will be realised, but no further improvement will be made post-2027 due to technological constraints and disproportionate costs (amongst other reasons for derogation). However, it is assumed that improvements in overall status will be achieved for one or more of these failing coastal/transitional water bodies by 2036 under the N@W and LS scenarios; it is not possible to determine which water bodies might be targeted for improvement.

It is assumed that 100% compliance of bathing water standards is achieved in the north east marine plan areas by 2026 under the BAU scenario (already achieved under the N@W and LS scenarios by 2021). However, under the LS scenario, it is assumed that additional bathing waters will be designated within the north east marine plan areas to support local recreation and tourism; the location of these additional bathing waters is unknown.

There is currently one shellfish water located within the north east marine plan areas, namely Holy Island for harvesting of *C. gigas* (Pacific oyster). Under the LS scenario, it is assumed that improved water quality as a result of increased investment in waste water treatment would result in new shellfish waters/bivalve production areas being designated within the north east marine plan areas; the location of these additional shellfish waters/bivalve production areas is unknown.

Potential trade-offs

The main interactions for surface water/wastewater management are beneficial and relate to the natural environment (impacts on water quality, fish), recreation and shellfisheries.

14.3 North west

There are 5 coastal water bodies and 12 transitional water bodies located within the north west marine plan areas, specifically within the Solway Tweed, North West and Dee River Basin Districts. In terms of overall status, 6 water bodies (3 coastal and 3 transitional) were classified as good, 9 water bodies (2 coastal and 7 transitional) were classified as moderate, 1 transitional water body was classified as poor and 1 transitional water body was classified as bad in 2015, primarily due to ecological parameters failing to achieve good (see Table 96).

In 2016, 27 bathing waters were designated in the north west marine plan areas. Overall, 8 bathing waters were classified as 'excellent', 11 as 'good' and 8 as 'sufficient' (see Table 97). As shown in Figure 157, there has been a significant increase in the number of bathing waters within the north west marine plan areas which are achieving at least 'sufficient' between 2010 (15) and 2016 (27; i.e. 100% compliance). There are 27 bathing waters which are designated as 'Sensitive Areas (Bathing Waters)' under the Urban Waste Water Treatment Directive (Defra, 2012).

There are 11 shellfish water protected areas located within the north west marine plan areas (Defra, 2016) of which 9 are designated as 'Sensitive Areas (Shellfish Waters)' under the Urban Waste Water Treatment Directive (Defra, 2012). In 2016, there were 7 bivalve production areas within the north west marine plan areas, namely the Dee, Ribble, Lune, Morecambe Bay – East, Morecambe Bay – Roosebeck, Morecambe Bay – Barrow and Silloth. Within these production areas are a number of classification zones for *Cerastoderma edule* (Common edible cockle), *Mytilus* spp. (Blue mussel, Mediterranean mussel and hybrids) and *C. gigas* (Pacific oyster) (Table 98). Most classification zones are categorised as Class B whereby 90% of sampled molluscs must contain less than or equal to 4,600 *E. coli* per 100 g of flesh and the remaining 10% of samples must not exceed 46,000 *E. coli* per 100 g of flesh. Class B harvested products can go for human consumption after purification in an approved plant or after relaying in an approved Class A relaying area or after an EC approved heat treatment process (all samples must be less than 46,000 *E.coli* per 100 g). The Ribble Walls North and Wyre Approaches classification zones for *Mytilus* spp. are categorised as Class C whereby molluscs must contain less than 46,000 *E. coli* per 100 g of flesh; harvested products can go for human consumption only after relaying for at least two months in an approved relaying area followed, where necessary, by treatment in a purification centre, or after an EC approved heat treatment process.

The Heysham 1 and 2 nuclear power stations (1,155MW and 1,230MW, respectively), Fellside gas-fired power station (188MW) and Rocksavage gas-fired power station (810MW) are located on the coast within the north west marine plan areas, for which water is abstracted for cooling water purposes and subsequently discharged to the marine environment as waste water. There are 758 consented discharge points in the north west marine plan areas of which approximately 250 are located within the River Mersey.

The assumptions used to develop the BAU, N@W and LS scenarios for surface and wastewater management in the north west marine plan areas are provided in Table 96. The text below provides a brief description of the future trends in 6 years and 6 to 20 years.

Table 96: Coastal and transitional water body classifications (2015) in the north west marine plan areas

River Basin District	Water Body Name	Water Body Type	Overall Status	Ecological Status/Potential	Chemical Status	Target Status	Objective Date
North West	Morecambe Bay (GB641211171000)	Coastal	Good	Good	Good	Good	2015
	Duddon Sands (GB641211172000)		Good	Good	Good	Good	2015
	Mersey Mouth (GB641211630001)		Moderate	Moderate	Good	Good	2027
	Cumbria (GB641211630002)		Good	Good	Good	Good	2015
	Solway Outer South (GB641211630003)		Moderate	Moderate	Fail	Moderate	2015
	Mersey (GB531206908100)	Transitional	Moderate	Moderate	Fail	Good	2027
	Alt (GB531206908300)		Moderate	Moderate	Good	Good	2027
	Ribble (GB531207112400)		Poor	Poor	Good	Good	2027
	Lune (GB531207212100)		Bad	Bad	Good	Good	2027
	Wyre (GB531207212200)		Moderate	Moderate	Fail	Moderate	2015
	Leven (GB531207311900)		Moderate	Moderate	Good	Good	2027
	Kent (GB531207312000)		Good	Good	Good	Good	2015
	Esk (W) (GB531207408400)		Good	Good	Good	Good	2015
	Duddon (GB531207411800)		Good	Good	Good	Good	2015
	Derwent (GB531207508700)		Moderate	Moderate	Good	Good	2021
	Maryport (GB531207508800)		Moderate	Moderate	Good	Moderate	2015
Solway Tweed	Solway (GB530207614700)	Transitional	Moderate	Moderate	Good	Good	2027

Table 97: Coastal bathing water classifications for the north west marine plan areas against the revised Bathing Water Directive

Year (Number of Bathing Waters)	Excellent	Good	Sufficient	Poor	Closed	Bathing Waters Not Achieving At Least Sufficient or Closed
2010 (27)	4	3	5	14	1	Allonby South, Allonby, Silloth, Walney Biggar Bank, Walney Sandy Gap, Haverigg, Seascale, Blackpool Central, Blackpool North, St Annes, St Annes North, Morecambe South, Fleetwood, Ainsdale, Southport
2011 (27)	3	4	5	14	1	Allonby, Silloth, Walney Biggar Bank, Walney Sandy Gap, Haverigg, Seascale, Blackpool South, Blackpool Central, Blackpool North, St Annes, St Annes North, Morecambe South, Morecambe North, Fleetwood, Ainsdale
2012 (27)	2	5	2	18	0	Allonby, Silloth, Walney Biggar Bank, Walney Sandy Gap, Walney West Shore, Haverigg, Seascale, Blackpool South, Blackpool Central, Blackpool North, St Annes, St Annes North, Morecambe South, Morecambe North, Cleveleys, Fleetwood, Ainsdale, Southport
2013 (27)	4	5	5	13	0	Allonby, Silloth, Haverigg, Seascale, Blackpool South, Blackpool Central, Blackpool North, St Annes, St Annes North, Morecambe South, Cleveleys, Fleetwood, Southport
2014 (27)	5	6	9	7	0	Allonby, Silloth, Haverigg, Blackpool Central, Blackpool North, Cleveleys, Fleetwood
2015 (27)	8	10	6	3	0	Allonby, Silloth, Cleveleys
2016 (27)	8	11	8	0	0	N/A
Note: 2015 – 2016 (actual results); 2010 – 2014 (projected results)						

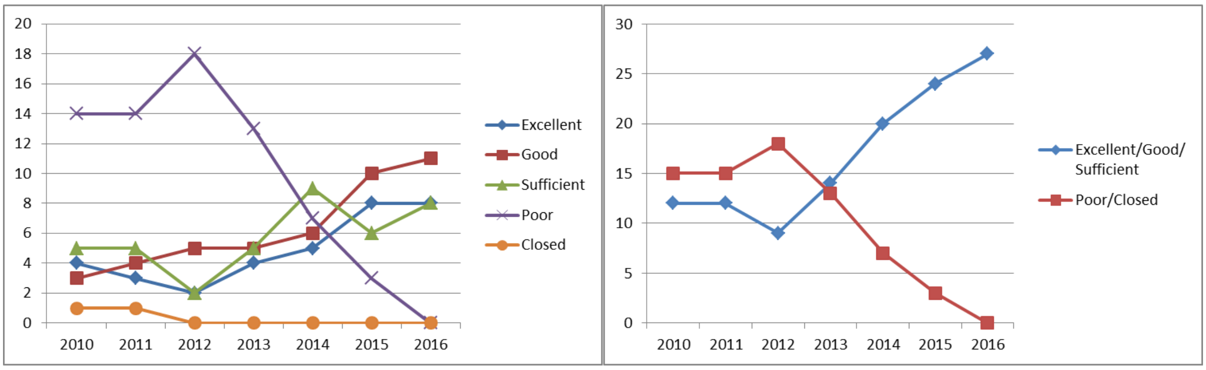


Figure 157: Trends in coastal bathing water classification in the north west marine plan areas against the revised Bathing Water Directive between 2010 and 2016

Table 98: Designated bivalve mollusc production areas in the north west marine plan areas in 2016

Bivalve Production Area	Bivalve Classification Zone	Species (Class)
Dee	Caldy Blacks	*C. edule* (B - LT)
	Thurstaston	*C. edule* (B - LT)
	West Kirby	*C. edule* (B – LT); *Mytilus* spp. (B – LT)
Ribble	Ribble Walls North	*Mytilus* spp. (C)
	Penfold North	*C. edule* (B)
Lune	Wyre Estuary	*Mytilus* spp. (B – LT)
	Wyre Approaches	*Mytilus* spp. (C)
	Pilling Sands	*C. edule* (B)
Morecambe Bay – East	Bare Ayre	*Mytilus* spp. (B – LT)
	Heysham Flat Skeer	*Mytilus* spp. (B – LT)
	Old Skeer	*Mytilus* spp. (B – LT)
Morecambe Bay – Roosebeck	Bed 1	*C. gigas* (B)
	Foulney Twist	*Mytilus* spp. (B – LT)
	Central West	*C. edule* (B)
	Central East	*C. edule* (B)
Morecambe Bay – Barrow	North Walney Channel: Lowsey Point	*Mytilus* spp. (B – LT)
	North Walney Channel: Cocken Tunnel	*Mytilus* spp. (B – LT)
	North Walney Channel: Jubilee Bridge	*Mytilus* spp. (B – LT)
	South Walney Channel: Roa Island	*Mytilus* spp. (B – LT)

Bivalve Production Area	Bivalve Classification Zone	Species (Class)
	South Walney Channel: Head Scar	*Mytilus* spp. (B – LT)
	Roa Island	*Mytilus* spp. (B – LT)
	North Walney	*Mytilus* spp. (B – LT)
	Foulney	*Mytilus* spp. (B – LT)
Silloth	Dubmill Scar	*C. gigas* (B – LT)
	Silloth South – Lees Scar	*Mytilus* spp. (B – LT)
LT – Denotes long-term classification		

Table 99: Assumptions under the future scenarios for surface water and waste water management in the north west marine plan areas

Aspect	Scenario		
	BAU	N@W	LS
Application to the sector	As for the north east marine plan area (see Table 95).	As for the north east marine plan area (see Table 95).	As for the north east marine plan area (see Table 95).
Assumptions	Bathing water quality to improve whereby all designated sites within the north west marine plan areas are reported as sufficient or better by 2026 (i.e. within 10 years). While all bathing waters within the north west marine plan areas were reported as sufficient or better in 2016, it is feasible that certain bathing waters may fail to achieve these standards over the next 10 years. Therefore, this scenario assumes that all bathing waters maintain at least sufficient status from 2026 onwards. The overall status of surface water bodies (coastal and transitional) within the north west marine plan areas is anticipated to follow current projections by the end of the third cycle of RBMPs (2027; see Table 96). Post-2027, it is assumed that no further improvement in surface water body status is achieved.	The bathing water and surface water body status assumptions are the same as BAU except all bathing waters within the north west marine plan areas are reported as sufficient or better by 2021 (i.e. within 5 years) and, post-2027, it is assumed that further improvement in surface water body status is achieved as a result of technological improvements.	The bathing water and surface water body assumptions are the same as N@W except additional bathing waters are designated within the north west marine plan areas and additional bivalve production areas are introduced by 2036. The location of additional bathing waters and bivalve production areas is unknown.

6 year projection

As shown in Table 96, there are currently 6 water bodies (3 coastal, 3 transitional) at good status within the north west marine plan areas. One further transitional water body (Derwent) is anticipated to achieve good status by 2021 (end of second cycle of RBMPs) and therefore it is assumed that this occurs in the next 6 years under all three scenarios.

In 2016, there were no designated bathing waters within the north west marine plan areas which were reported at poor status (see Table 97). However, under the BAU scenario it is assumed that at least one bathing water does not achieve sufficient status over the next 6 years and thus 100% compliance is not attained. Under the N@W and LS scenarios, it is assumed that increased investment in waste water treatment results in all designated bathing waters within the north west marine plan areas being reported as sufficient or better by 2021 (i.e. within 5 years).

6-20 year projection

There are 8 water bodies (1 coastal, 7 transitional) within the north west marine plan areas which are currently at moderate status and have been projected to achieve good status by 2027 (Table 96). In contrast, 3 water bodies (1 coastal, 2 transitional) are not predicted to achieve good status by this stage (i.e. remain moderate). Under the BAU scenario, it is assumed that these surface water body projections will be realised, but no further improvement will be made post-2027 due to technological constraints and disproportionate costs (amongst other reasons for derogation). However, it is assumed that improvements in overall status will be achieved for one or more of these failing coastal/transitional water bodies by 2036 under the N@W and LS scenarios; it is not possible to determine which water bodies might be targeted for improvement.

It is assumed that 100% compliance of bathing water standards is achieved in the north west marine plan areas by 2026 under the BAU scenario (already achieved under the N@W and LS scenarios by 2021). However, under the LS scenario, it is assumed that additional bathing waters will be designated within the north west marine plan areas to support local recreation and tourism; the location of these additional bathing waters is unknown.

There are currently 11 shellfish waters located within the north west marine plan areas, within which there are 7 bivalve production areas. Under the LS scenario, it is assumed that improved water quality as a result of increased investment in waste water treatment would result in new shellfish waters/bivalve production areas being designated within the north west marine plan areas; the location of these additional shellfish waters/bivalve production areas is unknown.

Potential trade-offs

The potential trade-offs are similar to the north east marine plan areas.

14.4 South east

There are 9 coastal water bodies and 11 transitional water bodies located within the south east marine plan area, specifically within the Anglian, Thames and South East River Basin Districts. In terms of overall status, 19 water bodies (9 coastal and 10 transitional) were classified as moderate and 1 transitional water body was classified as poor in 2015. While chemical status is reported as good for each coastal and transitional water body within the south east marine plan area, all 20 of these water bodies are failing to achieve good ecological status/potential (see Table 100).

In 2016, 41 bathing waters were designated in the south east marine plan area. Overall, 24 bathing waters were classified as 'excellent', 13 as 'good', 2 as 'sufficient' and 2 as 'poor' (see Table 101). As shown in Figure 158, there has not been any increase in the number of bathing waters within the south east marine plan area which are achieving at least 'sufficient' between 2010 and 2016 (39 out of 41; approximately 95% compliance). There are 19 bathing waters which are designated as 'Sensitive Areas (Bathing Waters)' under the Urban Waste Water Treatment Directive (Defra, 2012).

There are also 20 shellfish water protected areas located within the south east marine plan area (Defra, 2016) of which 8 are designated as 'Sensitive Areas (Shellfish Waters)' under the Urban Waste Water Treatment Directive (Defra, 2012). In 2016, there were 8 bivalve production areas within the south east marine plan area, namely the Colne, West Mersea, Blackwater, Crouch, Roach, Thames Estuary, Swale and North Kent Coast. Within these production areas are a number of classification zones for *C. edule* (Common edible cockle), *Mytilus* spp. (Blue mussel, Mediterranean mussel and hybrids), *C. gigas* (Pacific oyster), *Mercenaria mercenaria* (Hard clam), *Ostrea edulis* (Native or Flat oyster) and *Tapes* spp. (Manilla clam and Palourde, native clam or carpet shell clam) (Table 102). There are 7 classification zones which are categorised as Class A, namely Dengie Flats, Ray Channel, St Peter's Flats, St Peters and Batchelor, Barrow Deep, Kentish Flats and Off Leysdown. To be categorised as Class A, 80% of sampled molluscs must contain less than or equal to 230 *E. coli* per 100 g of flesh and no results can exceed 700 *E. coli* per 100 g flesh. Consequently, molluscs from these Class A sites within the south east marine plan area can be harvested for direct human consumption.

Most classification zones within the south east marine plan area are categorised as Class B whereby 90% of sampled molluscs must contain less than or equal to 4,600 *E. coli* per 100 g of flesh and the remaining 10% of samples must not exceed 46,000 *E. coli* per 100 g of flesh. Class B harvested products can go for human consumption after purification in an approved plant or after relaying in an approved Class A relaying area or after an EC approved heat treatment process (all samples must be less than 46,000 *E.coli* per 100 g). The Middleway, Inner Roach, Leigh Foreshore, Southend Flats and Swale Inner North classification zones are categorised as Class C whereby molluscs must contain less than 46,000 *E. coli* per 100 g of flesh; harvested products can go for human consumption only after relaying for at least two months in an approved relaying area followed, where necessary, by treatment in a purification centre, or after an EC approved heat treatment process.

The Damhead Creek gas-fired power station (792MW), Medway gas-fired power station (735MW) and Grain oil-fired power station (1,275MW) are located on the coast within the south east marine plan area, for which water is abstracted for cooling water purposes and subsequently discharged to the marine environment as waste water. There are 1,810 consented discharge points in the south east marine plan area of which approximately 600 are located within the middle Thames.

The assumptions used to develop the BAU, N@W and LS scenarios for surface and wastewater management in the south east marine plan area are provided in Table 103. The text below provides a brief description of the future trends in 6 years and 6 to 20 years.

Table 100: Coastal and transitional water body classifications (2015) in the south east marine plan area

River Basin District	Water Body Name	Water Body Type	Overall Status	Ecological Status/Potential	Chemical Status	Target Status	Objective Date
Anglian	Harwich Approaches (GB650503190000)	Coastal	Moderate	Moderate	Good	Moderate	2015
	Blackwater Outer (GB650503200000)		Moderate	Moderate	Good	Moderate	2015
	Essex (GB650503520001)		Moderate	Moderate	Good	Moderate	2015
	Hamford Water (GB680503713700)		Moderate	Moderate	Good	Moderate	2015
	Orwell (GB520503613601)	Transitional	Moderate	Moderate	Good	Moderate	2015
	Stour (Essex) (GB520503613602)		Moderate	Moderate	Good	Moderate	2015
	Crouch (GB520503704100)		Moderate	Moderate	Good	Moderate	2015
	Colne (GB520503713800)		Moderate	Moderate	Good	Moderate	2015
	Blackwater (GB520503714000)		Moderate	Moderate	Good	Moderate	2015
South East	Whitstable Bay (GB640604290000)	Coastal	Moderate	Moderate	Good	Moderate	2015
	Thames Coastal South (GB640604640000)		Moderate	Moderate	Good	Moderate	2015
	Kent South (GB640704540001)		Moderate	Moderate	Good	Good	2027
	Kent North (GB650704510000)		Moderate	Moderate	Good	Moderate	2015
	Stour (Kent) (GB520704004700)	Transitional	Poor	Poor	Good	Moderate	2027
Thames	Thames Coastal North (GB640603690000)	Coastal	Moderate	Moderate	Good	Moderate	2015
	Thames Lower (GB530603911401)	Transitional	Moderate	Moderate	Good	Moderate	2015
	Thames Middle (GB530603911402)		Moderate	Moderate	Good	Moderate	2015
	Thames Upper (GB530603911403)		Moderate	Moderate	Good	Good	2027
	Medway (GB530604002300)		Moderate	Moderate	Good	Moderate	2015
	Swale (GB530604011500)		Moderate	Moderate	Good	Moderate	2015

Table 101: Coastal bathing water classifications for the south east marine plan area against the revised Bathing Water Directive

Year (Number of Bathing Waters)	Excellent	Good	Sufficient	Poor	Closed	Bathing Waters Not Achieving At Least Sufficient or Closed
2010 (41)	15	18	6	2	0	Southend Chalkwell, Clacton (Groyne 41)
2011 (41)	21	11	5	4	0	Southend Chalkwell, Leigh Bell Wharf, Clacton (Groyne 41), Walpole Bay (Margate)
2012 (41)	16	16	6	3	0	Leigh Bell Wharf, Clacton (Groyne 41), Walpole Bay (Margate)
2013 (41)	19	16	4	2	0	Clacton (Groyne 41), Walpole Bay (Margate)
2014 (41)	23	12	3	3	0	Southend Jubilee, Clacton (Groyne 41), Walpole Bay (Margate)
2015 (41)	26	10	3	2	0	Clacton (Groyne 41), Walpole Bay (Margate)
2016 (41)	24	13	2	2	0	Clacton (Groyne 41), Walpole Bay (Margate)
Note: 2015 – 2016 (actual results); 2010 – 2014 (projected results)						

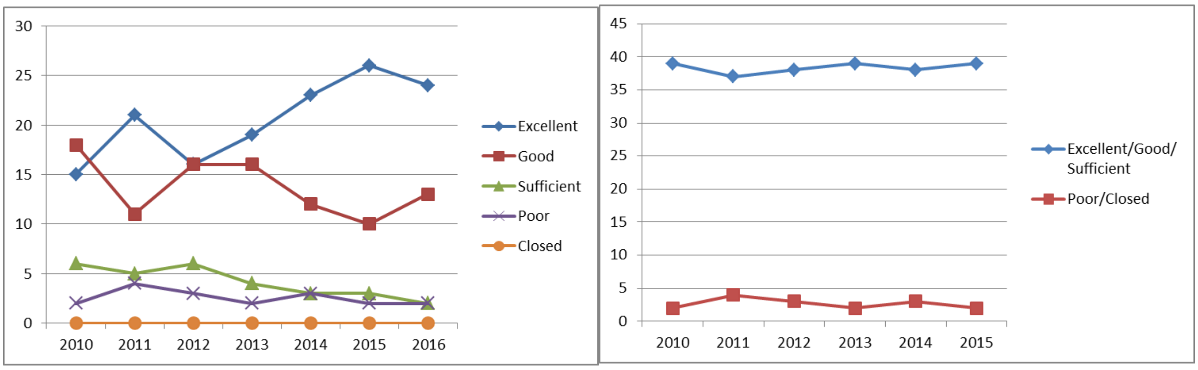


Figure 158: Trends in coastal bathing water classification in the south east marine plan area against the revised Bathing Water Directive between 2010 and 2016

Table 102: Designated bivalve mollusc production areas in the south east marine plan area in 2016

Bivalve Production Area	Bivalve Classification Zone	Species (Class)
Colne	Brightlingsea Creek Inner	*C. gigas* (B); *M. mercenaria* (B)
	Brightlingsea Creek Outer	*C. gigas* (B); *M. mercenaria* (B)
	Geedon Creek	*C. gigas* (B – LT); *O. edulis* (B – LT)
	Main Channel Central	*C. gigas* (B – LT); *M. mercenaria* (B – LT); *O. edulis* (B – LT)
	Main Channel Outer	*C. gigas* (B – LT); *O. edulis* (B – LT)
	Pyefleet Channel	*C. gigas* (B – LT); *O. edulis* (B – LT)
West Mersea	Little Ditch	*C. gigas* (B – LT); *O. edulis* (B – LT)
	Mersea Flats East	*C. gigas* (B – LT); *O. edulis* (B – LT)
	Mersea Flats West	*C. gigas* (B – LT); *O. edulis* (B – LT)
	Ray Creek	*C. gigas* (B – LT); *O. edulis* (B – LT)
	Salcott Channel	*C. gigas* (B – LT); *O. edulis* (B – LT); *M. mercenaria* (B – LT)
	Strood Channel	*C. gigas* (B – LT); *O. edulis* (B – LT)
	Tollesbury North	*C. gigas* (B – LT); *O. edulis* (B – LT); *M. mercenaria* (B – LT)
Blackwater	Buxey Sands	*C. edule* (B – LT)
	Central Blackwater	*C. gigas* (B – LT); *O. edulis* (B – LT)
	Dengie Flats	*C. edule* (A)
	Goldhanger	*C. gigas* (B – LT); *O. edulis* (B – LT)
	Osea South	*C. gigas* (B); *O. edulis* (B)
	Outer Blackwater	*C. gigas* (B – LT); *O. edulis* (B – LT)
	Ray Channel	*C. gigas* (A); *O. edulis* (A)
	St Peter's Flats	*C. gigas* (A)
	St Peters and Batchelor	*C. gigas* (A); *O. edulis* (A)
Crouch	Brandy Hole	*C. gigas* (B – LT)
	Bridgemarsh	*C. gigas* (B – LT); *M. mercenaria* (B – LT); *Mytilus* spp. (B – LT); *O. edulis* (B – LT)
	Easter Reach	*C. gigas* (B – LT); *M. mercenaria* (B – LT)
	Fambridge	*C. gigas* (B); *M. mercenaria* (B – LT)
	Outer Crouch	*O. edulis* (B – LT)
Roach	Barlinghall Creek	*C. gigas* (B); *M. mercenaria* (B – LT); *O. edulis* (B – LT)
	Middleway	*C. gigas* (Seasonal C); *M. mercenaria* (Seasonal C); *Mytilus* spp. (Seasonal C); *O. edulis* (Seasonal C)
	Inner Roach	*Mytilus* spp. (C); *O. edulis* (C); *C. gigas* (C); *M. mercenaria* (C)
	Paglesham Pool	*C. gigas* (B – LT);
	Paglesham Reach	*C. gigas* (B – LT); *M. mercenaria* (B – LT); *O. edulis* (B – LT)
Thames Estuary	Maplin West	*C. edule* (B – LT)
	Maplin Central	*C. edule* (B – LT)
	Maplin East	*C. edule* (B – LT)
	East of Southend Pier	*C. gigas* (B)
	Leigh Foreshore	*C. edule* (C); *Mytilus* spp. (C)
	Phoenix	*C. edule* (B – LT)
	Barrow Deep	*O. edulis* (A)
	Southend Flats	*Mytilus* spp. (C); *C. edule* (C)
	West of Southend Pier	*C. gigas* (B – LT)

Bivalve Production Area	Bivalve Classification Zone	Species (Class)
Swale	North Sheppey	*C. edule* (B – LT); *Mytilus* spp. (B – LT)
	Swale Causeway	*C. gigas* (B – LT); *O. edulis* (B – LT)
	Swale Inner North	*C. gigas* (C)
	Swale Inner South	*C. gigas* (B)
	Swale Outer	*C. gigas* (B – LT)
North Kent Coast	Hampton Pier	*C. gigas* (B – LT); *Mytilus* spp. (B – LT)
	Kentish Flats	*O. edulis* (A)
	Off Leysdown	*O. edulis* (A)
	Pollard	*C. edule* (B – LT); *Tapes* spp. (B – LT)
	South Oaze	*C. gigas* (B – LT); *Mytilus* spp. (B – LT); *O. edulis* (B – LT)
	Swale Entrance	*C. edule* (B – LT)
	Swalecliffe	*C. gigas* (B – LT); *Mytilus* spp. (B – LT)
	Westbeach	*C. gigas* (B – LT); *O. edulis* (B – LT)
	Whitstable Bay	*O. edulis* (B – LT)
LT – Denotes long-term classification		

Table 103: Assumptions under the future scenarios for surface water and waste water management in the south east marine plan area

Aspect	Scenario		
	BAU	N@W	LS
Application to the sector	As for the north east marine plan area (see Table 95).	As for the north east marine plan area (see Table 95).	As for the north east marine plan area (see Table 95).
Assumptions	Bathing water quality to improve whereby all designated sites within the south east marine plan area are reported as sufficient or better by 2026 (i.e. within 10 years). This includes bathing waters currently reported as poor (Clacton (Groyne 41) and Walpole Bay (Margate)) and ensuring all other bathing waters maintain at least sufficient status from 2026 onwards. The overall status of surface water bodies (coastal and transitional) within the south east marine plan area is anticipated to follow current projections by the end of the third cycle of RBMPs (2027; see Table 100). Post-2027, it is assumed that no further improvement in surface water body status is achieved.	The bathing water and surface water body status assumptions are the same as BAU except all bathing waters within the south east marine plan area are reported as sufficient or better by 2021 (i.e. within 5 years) and, post-2027, it is assumed that further improvement in surface water body status is achieved as a result of technological improvements.	The bathing water and surface water body assumptions are the same as N@W except additional bathing waters are designated within the south east marine plan area and additional bivalve production areas are introduced by 2036. The location of additional bathing waters and bivalve production areas is unknown.

6 year projection

As shown in Table 100, there are currently no coastal or transitional water bodies at good status within the south east marine plan area. Furthermore, no coastal or transitional water bodies are anticipated to achieve good status by 2021 (end of second cycle of RBMPs) and therefore it is assumed that no improvements are made in the next 6 years under all three scenarios.

In 2016, two designated bathing waters within the south east marine plan area were reported at poor status (Clacton (Groyne 41) and Walpole Bay (Margate); see Table 101). Under the BAU scenario, it is assumed that these two bathing waters (or at least one other bathing water) do not achieve sufficient status over the next 6 years and thus 100% compliance is not attained. However, under the N@W and LS scenarios, it is assumed that all designated bathing waters within the south east marine plan area are reported as sufficient or better by 2021 (i.e. within 5 years).

6–20 year projection

There are no coastal or transitional water bodies within the south east marine plan area which are currently at moderate/poor status and have been projected to achieve good status by 2027 (Table 100). Under the BAU scenario, it is assumed that these surface water body projections will be realised and no further improvement will be made post-2027 due to technological constraints and disproportionate costs (amongst other reasons for derogation). However, it is assumed that improvements in overall status will be achieved for one or more of these failing coastal/transitional water bodies by 2036 under the N@W and LS scenarios; it is not possible to determine which water bodies might be targeted for improvement.

It is assumed that 100% compliance of bathing water standards is achieved in the south east marine plan area by 2026 under the BAU scenario (already achieved under the N@W and LS scenarios by 2021). However, under the LS scenario, it is assumed that additional bathing waters will be designated within the south east marine plan area to support local recreation and tourism; the location of these additional bathing waters is unknown.

There are currently 20 shellfish waters located within the south east marine plan area, within which there are 8 bivalve production areas. Under the LS scenario, it is assumed that improved water quality as a result of increased investment in waste water treatment would result in new shellfish waters/bivalve production areas being designated within the south east marine plan area; the location of these additional shellfish waters/bivalve production areas is unknown.

Potential trade-offs

The potential trade-offs are similar to the north east marine plan areas.

14.5 South west

There are 18 coastal water bodies and 18 transitional water bodies located within the south west marine plan areas, specifically within the Severn and South West River Basin Districts. In terms of overall status, 2 water bodies (1 coastal and 1 transitional) were classified as high, 14 water bodies (11 coastal and 3 transitional) were classified as good and 20 water bodies (6 coastal and 14 transitional) were classified as moderate in 2015, primarily due to ecological parameters failing to achieve good (see Table 104). There are two coastal areas (Truro, Tresillian and Fal Estuary and Taw Estuary) which are designated as a 'Sensitive Areas (Eutrophic)' under the Urban Waste Water Treatment Directive (Defra, 2012).

In 2016, 123 bathing waters were designated in the south west marine plan areas. Overall, 94 bathing waters were classified as 'excellent', 19 as 'good', 6 as 'sufficient', 3 as 'poor' and 1 as 'closed' (see Table 105). As shown in Figure 159, there has been a steady increase in the number of bathing waters within the south west marine plan areas which are achieving at least 'sufficient' between 2010 (106) and 2016 (119; approximately 97% compliance). There are 58 bathing waters which are designated as 'Sensitive Areas (Bathing Waters)' under the Urban Waste Water Treatment Directive (Defra, 2012).

There are also 17 shellfish water protected areas located within the south west marine plan areas (Defra, 2016) of which 13 are designated as 'Sensitive Areas (Shellfish Waters)' under the Urban Waste Water Treatment Directive (Defra, 2012). In 2016, there were 14 bivalve production areas within the south west marine plan areas, namely the Start Bay, Salcombe, Bigbury and Avon, Yealm, Lantivet Bay, Fowey, St Austell Bay, Percuil, Fal (Upper), Fal (Lower), Helford, Camel, Taw/Torridge and Porlock. Within these production areas are a number of classification zones for *Mytilus* spp. (Blue mussel, Mediterranean mussel and hybrids), *C. gigas* (Pacific oyster), *O. edulis* (Native or Flat oyster), *Spisula solida* (Thick trough shell) and Ensis spp. (Razor clams) (Table 106). There is one classification zones which is categorised as Class A, namely Porlock for *C. gigas*. To be categorised as Class A, 80% of sampled molluscs must contain less than or equal to 230 *E. coli* per 100 g of flesh and no results can exceed 700 *E. coli* per 100 g flesh. Consequently, molluscs from this Class A site within the south west marine plan areas can be harvested for direct human consumption. However, it should be noted that the classification at Porlock is provisional due to insufficient sample results, either in number or period of time covered, or for returning less than 10 samples in the review year.

Most classification zones within the south west marine plan areas are categorised as Class B whereby 90% of sampled molluscs must contain less than or equal to 4,600 *E. coli* per 100 g of flesh and the remaining 10% of samples must not exceed 46,000 *E. coli* per 100 g of flesh. Class B harvested products can go for human consumption after purification in an approved plant or after relaying in an approved Class A relaying area or after an EC approved heat treatment process (all samples must be less than 46,000 *E.coli* per 100 g). The South Hexdown, Fox Cove (*Mytilus* spp. only), Grimes Bar, Lambe Creek, Malpas, Turnaware Pontoon/South Wood, Falmouth Wharves and Chivenor classification zones are categorised as Class C whereby molluscs must contain less than 46,000 *E. coli* per 100 g of flesh; harvested products can go for human consumption only after relaying for at least two months in an approved relaying area followed, where necessary, by treatment in a purification centre, or after an EC approved heat treatment process.

The Hinkley Point B nuclear power station (955MW) and Seabank gas-fired power station (1,145MW) are located on the coast within the south west marine plan areas, for which water is abstracted for cooling water purposes and subsequently discharged to the marine environment as waste water. There are 2,350 consented discharge points in the south west marine plan areas of which approximately 350 are located within the Severn Estuary.

Table 104: Coastal and transitional water body classifications (2015) in the south west marine plan areas

River Basin District	Water Body Name	Water Body Type	Overall Status	Ecological Status/Potential	Chemical Status	Target Status	Objective Date
Severn	Severn Middle (GB530905415402)	Transitional	Moderate	Moderate	Good	Good	2027
	Severn Upper (GB530905415403)		Moderate	Moderate	Good	Good	2027
	Bristol Avon (GB530905415405)		Moderate	Moderate	Good	Good	2021
South West	Salcombe Harbour (GB680806460000)	Coastal	Moderate	Moderate	Good	Moderate	2015
	Lands End To Trevose Head (GB610807680001)		Good	Good	Good	Good	2015
	Cornwall North (GB610807680002)		High	High	Good	High	2015
	Barnstaple Bay (GB610807680003)		Good	Good	Good	Good	2015
	Bristol Channel Outer South (GB610807680004)		Good	Good	Good	Good	2015
	Lundy (GB610878040000)		Good	Good	Good	Good	2015
	St Austell (GB620806110001)		Moderate	Good	Fail	Good	2027
	Devon South (GB620806110002)		Good	Good	Good	Good	2015
	Plymouth Coast (GB620806110003)		Good	Good	Good	Good	2015
	Cornwall South (GB620806570000)		Good	Good	Good	Good	2015
	Scilly Isles (GB620807080000)		Good	Good	Good	Good	2015
	Bridgwater Bay (GB670807410000)		Moderate	Moderate	Good	Good	2027
	Bristol Channel Inner South (GB640807670000)		Moderate	Moderate	Good	Moderate	2015
	Plymouth Sound (GB650806230000)		Moderate	Moderate	Good	Good	2027

River Basin District	Water Body Name	Water Body Type	Overall Status	Ecological Status/Potential	Chemical Status	Target Status	Objective Date
	Carrick Roads Outer (GB650806250000)		Moderate	Moderate	Fail	Moderate	2015
	Fal/Helford (GB650806330000)		Good	Good	Good	Good	2015
	Penzance (GB650806340000)		Good	Good	Good	Good	2015
	Lyme Bay West (GB650806420000)		Good	Good	Good	Good	2015
	Gannel (GB540804906500)	Transitional	High	High	Good	High	2015
	Taw/Torridge (GB540805015500)		Moderate	Moderate	Good	Moderate	2015
	Parrett (GB540805210900)		Moderate	Moderate	Good	Good	2027
	Avon (GB510804606000)		Good	Good	Good	Good	2015
	Erme (GB510804606100)		Moderate	Moderate	Good	Good	2027
	Fowey (GB510804806400)		Moderate	Moderate	Good	Good	2027
	Kingsbridge (GB520804609000)		Moderate	Moderate	Good	Good	2027
	Yealm (GB520804706200)		Good	Good	Good	Good	2015
	Plymouth Tamar (GB520804714300)		Moderate	Moderate	Good	Good	2021
	Looe (GB520804806300)		Good	Good	Good	Good	2015
	Helford (GB520804809100)		Moderate	Moderate	Good	Moderate	2015
	Carrick Roads Inner (GB520804814400)		Moderate	Moderate	Fail	Moderate	2015
	Camel (GB530804906600)		Moderate	Moderate	Good	Moderate	2015
	Hayle (GB530804906700)		Moderate	Moderate	Good	Moderate	2015
	Dart (GB510804605900)		Moderate	Moderate	Good	Good	2027

Table 105: Coastal bathing water classifications for the south west marine plan areas against the revised Bathing Water Directive

Year (Number of Bathing Waters)	Excellent	Good	Sufficient	Poor	Closed	Bathing Waters Not Achieving At Least Sufficient or Closed
2010 (122)	75	16	15	16	0	Weston-super-Mare Uphill Slipway, Western Main, Burnham Jetty North, Blue Anchor West, Seaton (Cornwall), East Looe, Rock, Readymoney, Par, Porthluney, Plymouth Hoe East, Plymouth Hoe West, Instow, Ilfracombe Wildersmouth, Combe Martin, Mothecombe
2011 (122)	74	26	10	12	0	Weston-super-Mare Uphill Slipway, Burnham Jetty North, Seaton (Cornwall), East Looe, Rock, Gorran Haven Little Perhaver, Porthluney, Plymouth Hoe West, Instow, Ilfracombe Wildersmouth, Combe Martin, Mothecombe
2012 (124)	68	33	11	12	0	Weston-super-Mare Uphill Slipway, Burnham Jetty North, Seaton (Cornwall), East Looe, Gorran Haven Little Perhaver, Porthluney, Porth, Instow, Ilfracombe Wildersmouth, Ilfracombe Hele, Combe Martin, Mothecombe
2013 (124)	79	32	2	11	0	Weston-super-Mare Uphill Slipway, Burnham Jetty North, Seaton (Cornwall), East Looe, Gorran Haven Little Perhaver, Porthluney, Porth, Instow, Ilfracombe Wildersmouth, Combe Martin, Mothecombe
2014 (124)	86	24	6	8	0	Burnham Jetty North, Seaton (Cornwall), East Looe, Porthluney, Porth, Instow, Ilfracombe Wildersmouth, Combe Martin
2015 (123)	85	26	7	4	1	Burnham Jetty North, East Looe, Instow, Ilfracombe Wildersmouth, Whitsand Bay (Sharrow), Great Western
2016 (123)	94	19	6	3	1	Burnham Jetty North, Instow, Ilfracombe Wildersmouth, Whitsand Bay (Sharrow)
Note: 2015 – 2016 (actual results); 2010 – 2014 (projected results)						

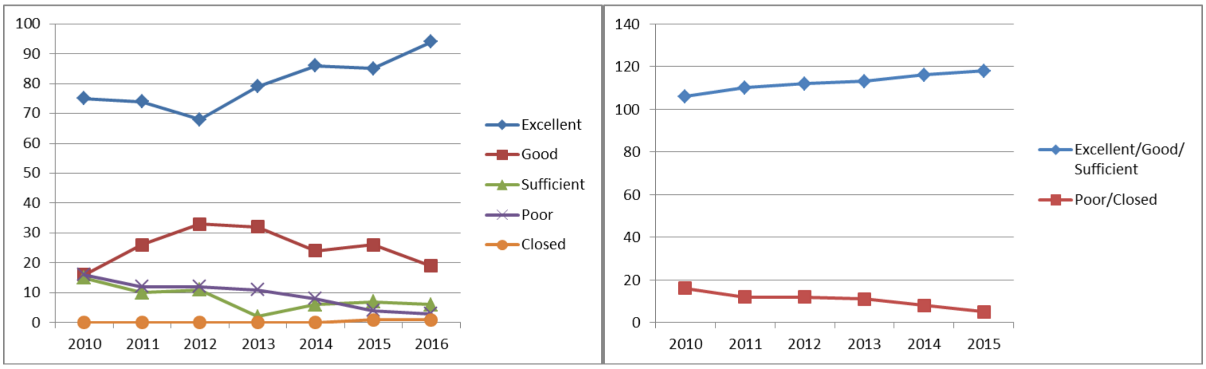


Figure 159: Trends in coastal bathing water classification in the south west marine plan areas against the revised Bathing Water Directive between 2010 and 2016

Table 106: Designated bivalve mollusc production areas in the south west marine plan areas in 2016

Bivalve Production Area	Bivalve Classification Zone	Species (Class)
Start Bay	Strete	*S. solida* (B – LT)
	Slapton	*S. solida* (B – LT)
Salcombe	Geese Quarries	*C. gigas* (B – LT)
Bigbury and Avon	South Hexdown	*C. gigas* (C)
Yealm	Fox Cove	*C. gigas* (B – LT); *Mytilus* spp. (C)
	Thorn	*C. gigas* (B – LT)
Lantivet Bay	Lantivet Bay	*Ensis* spp. (B)
Fowey	Pont Pill	*Mytilus* spp. (B – LT)
	Wisemans	*Mytilus* spp. (B)
St Austell Bay	Ropehaven	*Mytilus* spp. (B – LT)
	Ropehaven Outer	*Ensis* spp. (B); *Mytilus* spp. (B – LT)
Percuil	All Beds	*C. gigas* (B – LT); *O. edulis* (B – LT)
Fal (Upper)	Coombe Creek	*O. edulis* (B – LT)
	Grimes Bar	*O. edulis* (Seasonal C)
	King Harry Reach	*O. edulis* (B)
	King Harry Reach mussel lines	*Mytilus* spp. (B)
	Lambe Creek	*Mytilus* spp. (C)
	Maggoty Bank	*O. edulis* (B – LT)
	Malpas	*Mytilus* spp. (C)
	Tolverne	*O. edulis* (B – LT)
	Ruan Pontoon/ Tregothnan	*Mytilus* spp. (B)
	Turnaware Bar	*O. edulis* (B – LT)
	Turnaware Pontoon/South Wood	*Mytilus* spp. (C)
Fal (Lower)	Falmouth Wharves	*O. edulis* (C)
	Mylor Bank	*O. edulis* (B – LT)
	East Bank	*O. edulis* (B – LT)
	Parsons Bank	*O. edulis* (B – LT)
	Mylor Creek	*Mytilus* spp. (B); *O. edulis* (B – LT)
	Restronguet Creek	*O. edulis* (B – LT); *Mytilus* spp. (B)
Helford	Bosahan	*C. gigas* (B)
	East of Groyne Point	*C. gigas* (B – LT); *Mytilus* spp. (B – LT); *O. edulis* (B – LT)
	Helford Creek	*Mytilus* spp. (B)
	Porth Navas Quay	*C. gigas* (B – LT); *Mytilus* spp. (B – LT); *O. edulis* (B – LT)
	South of Porth Navas Bar	*C. gigas* (B – LT); *Mytilus* spp. (B); *O. edulis* (B – LT)
Camel	Ball Hill	*C. gigas* (B – LT); *Mytilus* spp. (B – LT)
	Gentle Jane	*C. gigas* (B – LT); *Mytilus* spp. (B)
	Longlands	*C. gigas* (B – LT)
	Pinkson Creek	*Mytilus* spp. (B – LT)
	Porthilley Rock	*C. gigas* (B – LT)
	Porthilley Cove	*Mytilus* spp. (B – LT)

Bivalve Production Area	Bivalve Classification Zone	Species (Class)
Taw/Torridge	Chivenor	*Mytilus* spp. (C)
	Coolstone	*Mytilus* spp. (B)
	Lifeboat Slip	*Mytilus* spp. (B – LT)
	Outer Estuary (main beds)	*Mytilus* spp. (B)
	Power Station	*Mytilus* spp. (B)
	Westleigh	*C. gigas* (B)
	Zeta Berth	*C. gigas* (B); *Mytilus* spp. (B)
Porlock	Porlock	*C. gigas* (A)

The assumptions used to develop the BAU, N@W and LS scenarios for surface and wastewater management in the south west marine plan areas are provided in Table 107.

Table 107: Assumptions under the future scenarios for surface water and waste water management in the south west marine plan areas

Aspect	Scenario		
	BAU	N@W	LS
Application to the sector	As for the north east marine plan area (see Table 95).	As for the north east marine plan area (see Table 95).	As for the north east marine plan area (see Table 95).
Assumptions	Bathing water quality to improve whereby all designated sites within the south west marine plan areas are reported as sufficient or better by 2026 (i.e. within 10 years). This includes bathing waters currently reported as poor/closed (Burnham Jetty North, Instow, Ilfracombe Wildersmouth and Whitsand Bay (Sharrow)) and ensuring all other bathing waters maintain at least sufficient status from 2026 onwards. The overall status of surface water bodies (coastal and transitional) within the south west marine plan areas is anticipated to follow current projections by the end of the third cycle of RBMPs (2027; see Table 104). Post-2027, it is assumed that no further improvement in surface water body status is achieved.	The bathing water and surface water body status assumptions are the same as BAU except all bathing waters within the south west marine plan areas are reported as sufficient or better by 2021 (i.e. within 5 years) and, post-2027, it is assumed that further improvement in surface water body status is achieved as a result of technological improvements.	The bathing water and surface water body assumptions are the same as N@W except additional bathing waters are designated within the south west marine plan areas and additional bivalve production areas are introduced by 2036. The location of additional bathing waters and bivalve production areas is unknown.

6 year projection

As shown in Table 104, there are currently 2 water bodies at high status (1 coastal and 1 transitional) and 14 water bodies at good status (11 coastal and 3 transitional) within the south west marine plan areas. Two further transitional water bodies (Bristol Avon and Plymouth Tamar) are anticipated to achieve good status by 2021 (end of second cycle of RBMPs) and therefore it is assumed that this occurs in the next 6 years under all three scenarios.

In 2016, three bathing waters were reported at poor status (Burnham Jetty North, Instow and Ilfracombe Wildersmouth) and one bathing water was reported as closed (Whitsand Bay (Sharrow)) within the south west marine plan areas; see Table 105). Under the BAU scenario, it is assumed that these four bathing waters (or at least one other bathing water) do not achieve sufficient status over the next 6 years and thus 100% compliance is not attained. However, under the N@W and LS scenarios, it is assumed that all designated bathing waters within the south west marine plan areas are reported as sufficient or better by 2021 (i.e. within 5 years).

6–20 year projection

There are 10 water bodies (3 coastal, 7 transitional) within the south west marine plan areas which are currently at moderate status and have been projected to achieve good status by 2027 (not including two water bodies which are projected to achieve good status by 2021 as described above; Table 104). In contrast, 8 water bodies (3 coastal, 5 transitional) are not predicted to achieve good status by this stage (i.e. remain moderate). Under the BAU scenario, it is assumed that these surface water body projections will be realised, but no further improvement will be made post-2027 due to technological constraints and disproportionate costs (amongst other reasons for derogation). However, it is assumed that improvements in overall status will be achieved for one or more of these failing coastal/transitional water bodies by 2036 under the N@W and LS scenarios; it is not possible to determine which water bodies might be targeted for improvement.

It is assumed that 100% compliance of bathing water standards is achieved in the south west marine plan areas by 2026 under the BAU scenario (already achieved under the N@W and LS scenarios by 2021). However, under the LS scenario, it is assumed that additional bathing waters will be designated within the south west marine plan areas to support local recreation and tourism; the location of these additional bathing waters is unknown.

There are currently 17 shellfish waters located within the south west marine plan areas, within which there are 14 bivalve production areas. Under the LS scenario, it is assumed that improved water quality as a result of increased investment in waste water treatment would result in new shellfish waters/bivalve production areas being designated within the south west marine plan areas; the location of these additional shellfish waters/bivalve production areas is unknown.

Potential trade-offs

The potential trade-offs are similar to the north east marine plan areas.

15 Telecommunication cables

Sector Definition

This sector relates to submarine telecommunication cables, which carry telephone calls, internet connections and data as part of national and international data transfer networks utilised for the majority of international communication transmissions. These cables service many other industries such as finance, commerce and media both nationally and internationally. Cables can be classified into short-distance, long-distance and disused cables. The internet makes heavy use of international communication mechanisms, and these are now almost entirely provided through fibre optic submarine cables, rather than earth-orbiting satellites (Pugh, 2008).

Data sources

A variety of different information sources have been reviewed to inform this baseline, including published reports and papers and spatial data layers. The main information sources used are provided in the list below:

- Economic baseline assessment for the North East, North West, South East and South West Marine Plans (MMO, 2016a)
- An economic and social evaluation of the UK Subsea Cables Industry (Elliott *et al*., 2016)
- European Subsea Cables Association website
- The Crown Estate data.

15.1 National review

Overview of national activity

The telecoms and communications activity of most relevance to this report is the laying, operation and maintenance of submarine telecommunication cables and their associated facilities such as sub-stations. A total of 238 individual telecommunications cables are present in UK waters, 149 of which are active, linking the UK to the USA, Canada and mainland Europe (Figure 160). The remaining 89 are no longer operating and classed as disused. Telecommunication cables support many services for local communities and major industries, carrying over 95% of the world's international communications traffic including telephone, internet and data (European Subsea Cables Association, 2016).

Telecoms and communications cables can affect and be affected by the activities of other business sectors. For example, there is risk to and from the fishing industry as trawls and anchors may become caught on submarine cables, which can prove costly to both fishing and pipeline operations in terms of maintenance (MMO, 2016a).

An indicative GVA of £2.7 billion was estimated for telecom cables in the UK based on the number of international phone calls (UKMMAS, 2010). However, this figure does not include the value of internet and data capacity which are now the primary commodity and which are increasing. The true value of telecommunication cables should incorporate both the value of the traffic which is carried and the significance held by the UK as a key strategic location for international systems looking to reach markets in America, Europe, Africa and Asia. These are difficult to capture in market value terms but are significant.

The overall telecoms and communications sector has more recently been estimated to contribute approximately £45 billion to the economy and employ approximately 250,000 people across 8,000 companies (MMO, 2016a). A further preliminary estimate of the economic value of the UK telecommunications subsea cables industry to the digital economy values it at £62.8 billion per annum (Elliott *et al.*, 2016).

Defining the employment of the telecommunication sector within the marine environment alone is difficult given that that much of the sector is related to onshore activity (MMO, 2016a). However, the only known estimate that has been published estimates that about 26,750 jobs in the UK telecommunications sector are marine-related (Pugh, 2008).

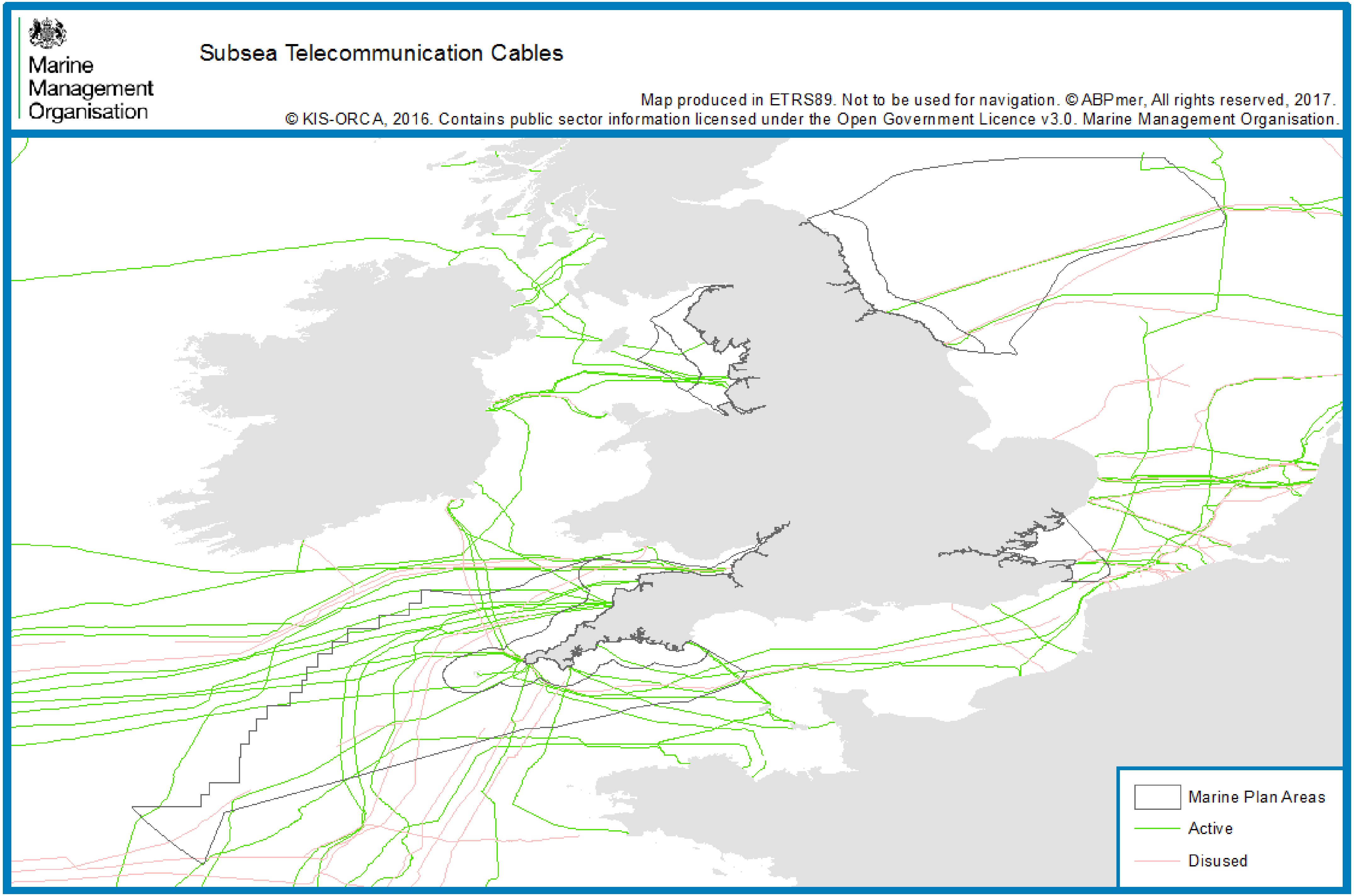


Figure 160: Telecommunication cables in England

Review of historical trends

The first international submarine cable, a copper-based telegraph cable, was laid across the Channel between the United Kingdom and France in 1850 (European Subsea Cables Association, 2016). The first installation of a trans-Atlantic cable, between Ireland and Newfoundland, was made in 1858. From the mid-20th century onwards, many telecommunication cables have been laid in the marine environment.

By 1986, the first international fibre-optic cable was installed across the English Channel to link the United Kingdom and Belgium. In 1988, the first trans-oceanic fibre-optic cable was installed, which marked the transition when sub marine cables started to outperform satellites in terms of the volume, speed and economics of data and voice communications.

At about that time, the internet began to take shape. As newer and higher-capacity cable systems evolved, they had large bandwidth at sufficiently low cost to provide the necessary economic base to allow the internet to grow. In essence, the two technologies complemented each other perfectly: cables carried large volumes of voice and data traffic with speed and security; the internet made that data and information accessible and usable for a multitude of purposes. As a result, communications, business, commerce, education and entertainment underwent radical change (Carter *et al*., 2009).

Around 97% of the world's communications are now transported around the world via fibre optic submarine cables instead of satellite. In other words, telephone conversations, the internet, emails and television are all reliant on cables.

Telecommunications is a major sector of the UK economy with strong growth particularly as result of the growth of internet usage. In 1984, 1.5% of household expenditure within the UK was on telecoms, but by 2002 this had increased to 2.5% (Pugh, 2008). Additionally, Cordah (2001) stated that between 1998 and 2001, internet traffic on a global scale had grown by over 500%. This rapid development led to an increase in the number of new subsea telecommunication cables connecting the UK with mainland Europe and traversing the Atlantic to link the UK with North America.

Review of key changes and/or advances of significance affecting the sector

Changes and advances in telecom cables are driven significantly by consumer demand and technology such as the development of high speed internet. Advances are also driven by government policies such as the UK Digital Strategy (DCMS, 2017) which outlines the importance of the communications sector, its crucial contribution to the economy and its role in building Britain's industrial future. The Strategy is formed of a number of strands, including building world-class digital infrastructure for the UK, which relies heavily on the submarine telecommunications networks within the waters surrounding the UK.

The positioning of cables is influenced by other maritime users and competition for space, for example, from industry and the development of offshore wind farms. Environmental concerns may also affect positioning of cables, such as potential restrictions to cable laying through designated sites. Table 108 highlights the key drivers affecting the sector.

Table 108: Key drivers affecting development of the telecommunications sector

Driver	Details	Implications
Political	Government policy (UK Digital Strategy) on telecommunication capabilities (DCMS, 2017)	Potential further development of network
Economic	Interference with or interfered by other uses e.g. bottom trawling or cable laying/maintenance in areas heavily used by shipping	Potential restrictions on location of cables
Social	Increased demand for internet and mobile data services	Potential further development of network
Technological	Advances in telecommunication technology (e.g. increased data capacity, speed) and potential development of satellite and photonics technology	Potential further development of network and/or cables becoming redundant depending on nature of technological advances
Legal	No significant drivers identified	N/A
Environmental	Concern regarding environmental impacts of subsea cable laying	Potential restrictions to cable laying over sensitive features within designated sites

Review of future trends

Future trends and developments in telecommunication cables are likely to be focused on extending the global reach of the submarine networks, investing in higher capacity circuits and increasing resilience by diversity and the operation of networks over a number of different cables. Despite being an economically valuable sector, the footprint of this sector is relatively small and unlikely to change significantly over the next 20 years under all three scenarios (BAU, N@W and LS).

In the short term, a steady increase in demand for telecommunication cables is predicted in association with expansion of high speed internet, however this is expected to be met using the spare capacity within the current telecommunication network (UKMMAS, 2010). This may require access to the current system for maintenance.

In the longer term, further development of submarine telecommunication cables is likely to be required in order to incorporate more resilient networks with a greater diversity of cables such as for different bandwidths. Bandwidths, the development of high speed internet as well as continued growth in the sector are likely to use up the current spare capacity. Additionally cables have a typical life of 15–20 years (Carter *et al*., 2009) and therefore the replacement of the majority of the current telecommunication cables is likely to be required in the longer term.

Additional telecommunication cable capacity is also likely to be required in addition to replacement of existing capacity, particularly under the BAU and N@W scenarios. Due to potential advances in technology, the future capacity of telecommunication cables is likely to increase without increasing the current footprint of a cable. Therefore, although replacement may require access to the length of the cables, there is the potential that the spatial footprint and landfall areas would remain the same as the current situation. The N@W scenario is likely to particularly favour telecommunications cables as remote communications is preferred to face-to-face meetings involving a lot of travel.

Under the LS scenario, economic growth will be lower. The requirement or option to increase the telecommunication cable capacity may therefore not be possible in the next 20 years under the LS scenario.

Confidence assessment

There is currently no agreed method for valuing the services provided by cables as they form part of a wider infrastructure. The timing of future cable replacement and the level of future demand are uncertain. Advancements in telecommunication technologies may significantly alter requirements for marine space.

15.2 North east

A total of 11 telecommunication cables are present in the north east marine plan areas (Figure 160). Four of these are currently active while the remaining seven are disused. Two of the active cables are domestic, running between England and Scotland while the other two are international, connecting the UK to Denmark and Holland.

The MMO (2016a) suggested that the marine specific sector of the telecommunication industry in the north east marine plan areas supports 40 businesses and 880 jobs. Indirect and induced employment from the sector was estimated at 1,035 jobs using an employment multiplier of 1.18 (MMO, 2016a).

The assumptions used to develop the BAU, N@W and LS scenarios for telecommunications cables in the north east marine plan areas are provided in Table 109. Figure 161 shows the spatial application of the scenarios to the sector while the text below provides a brief description of the future trends in 6 years and 6 to 20 years.

6-year projection

The number of cables (4) in the north east marine plan areas will remain the same over the initial 6-year period (2017-2022) under all three scenarios (BAU, N@W and LS).

6 to 20 year projection

The number of cables (4) in the north east marine plan areas will remain the same over the 6 to 20 year period (2023-2036) under all three scenarios (BAU, N@W and LS).

Table 109: Assumptions and impacts under the future scenarios for telecommunication cables in the north east marine plan areas

Aspect	Scenario		
	Business as Usual	**Nature @ Work**	**Local Stewardship**
Application to the sector	The primary driver for changes and advances in this sector is consumer demand (linked to economic growth) and technology. Maintenance of the existing cable network will continue. Replacement of existing cables will occur at the end of their lifetime. The future capacity of cables is also likely to increase. Anticipated technological advances and competition for space on the seabed will mean that this additional capacity may be incorporated as part of a replacement and update of the current system.	Same as the BAU scenario.	Consumer demand (linked to economic growth) and technology will be less of a driver under the LS scenario. Maintenance of the existing cable network will continue. Replacement of existing cables will occur at the end of their lifetime. The future capacity of cables is likely to remain the same.
Assumptions	The spatial footprint of telecommunication cables is assumed to remain constant. Maintenance and/or replacement of cables will require access along the length of the cables.	The spatial footprint of telecommunication cables is assumed to remain constant. Maintenance and/or replacement of cables will require access along the length of the cables.	The spatial footprint of telecommunication cables is assumed to remain constant. Maintenance and/or replacement of cables will require access along the length of the cables.

Potential trade-offs

The main potential interactions for telecommunication cables relate to fisheries and other infrastructure/extractive industries. On the basis that the footprint of cables is likely to remain unchanged under all scenarios, then no change in trade-offs are associated with replacement of cables.

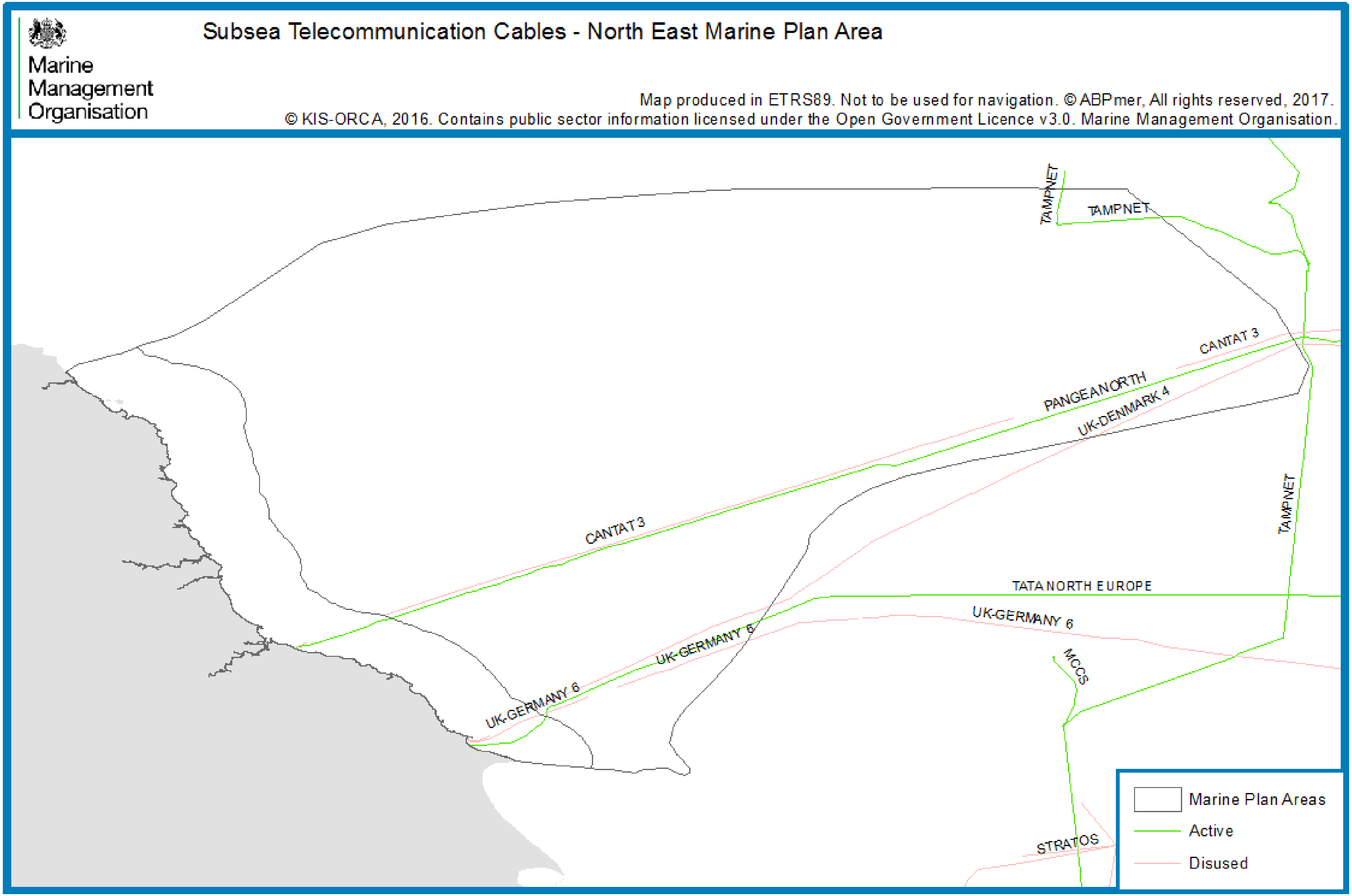


Figure 161: Telecommunications – BAU, N@W and LS - north east marine plan areas

15.3 North west

Six telecommunication cables are present in the north west marine plan areas, all of which are currently active (Figure 160). These cables, operated by BT, Hibernia Atlantic, Vodafone and Virgin Media, connect the UK with the Isle of Man and Ireland.

The offshore telecommunication industry in the north west marine plan areas is estimated to support 180 businesses and 10,060 jobs. A further 11,860 jobs (using an employment multiplier of 1.18) are estimated to result from indirect employment in the industry (MMO, 2016a).

The assumptions used to develop the BAU, N@W and LS scenarios for telecommunications cables in the north west marine plan areas are provided in Table 110. Figure 162 shows the spatial application of the scenarios to the sector while the text below provides a brief description of the future trends in 6 years and 6 to 20 years.

Table 110: Assumptions and impacts under the future scenarios for telecommunication cables in the north west marine plan areas

Aspect	Scenario		
	Business as Usual	**Nature @ Work**	**Local Stewardship**
Application to the sector	As for the north east marine plan area (see Table 109).	As for the north east marine plan area (see Table 109).	As for the north east marine plan area (see Table 109).
Assumptions	The spatial footprint of telecommunication cables is assumed to remain constant. Maintenance and/or replacement of cables will require access along the length of the cables.	The spatial footprint of telecommunication cables is assumed to remain constant. Maintenance and/or replacement of cables will require access along the length of the cables.	The spatial footprint of telecommunication cables is assumed to remain constant. Maintenance and/or replacement of cables will require access along the length of the cables.

6-year projection

The number of cables (6) in the north west marine plan areas will remain the same over the initial 6-year period (2017-2022) under all three scenarios (BAU, N@W and LS).

6 to 20 year projection

The number of cables (6) in the north west marine plan areas will remain the same over the 6 to 20 year period (2023-2036) under all three scenarios (BAU, N@W and LS).

Potential trade-offs

The potential trade-offs are similar to the north east marine plan areas.

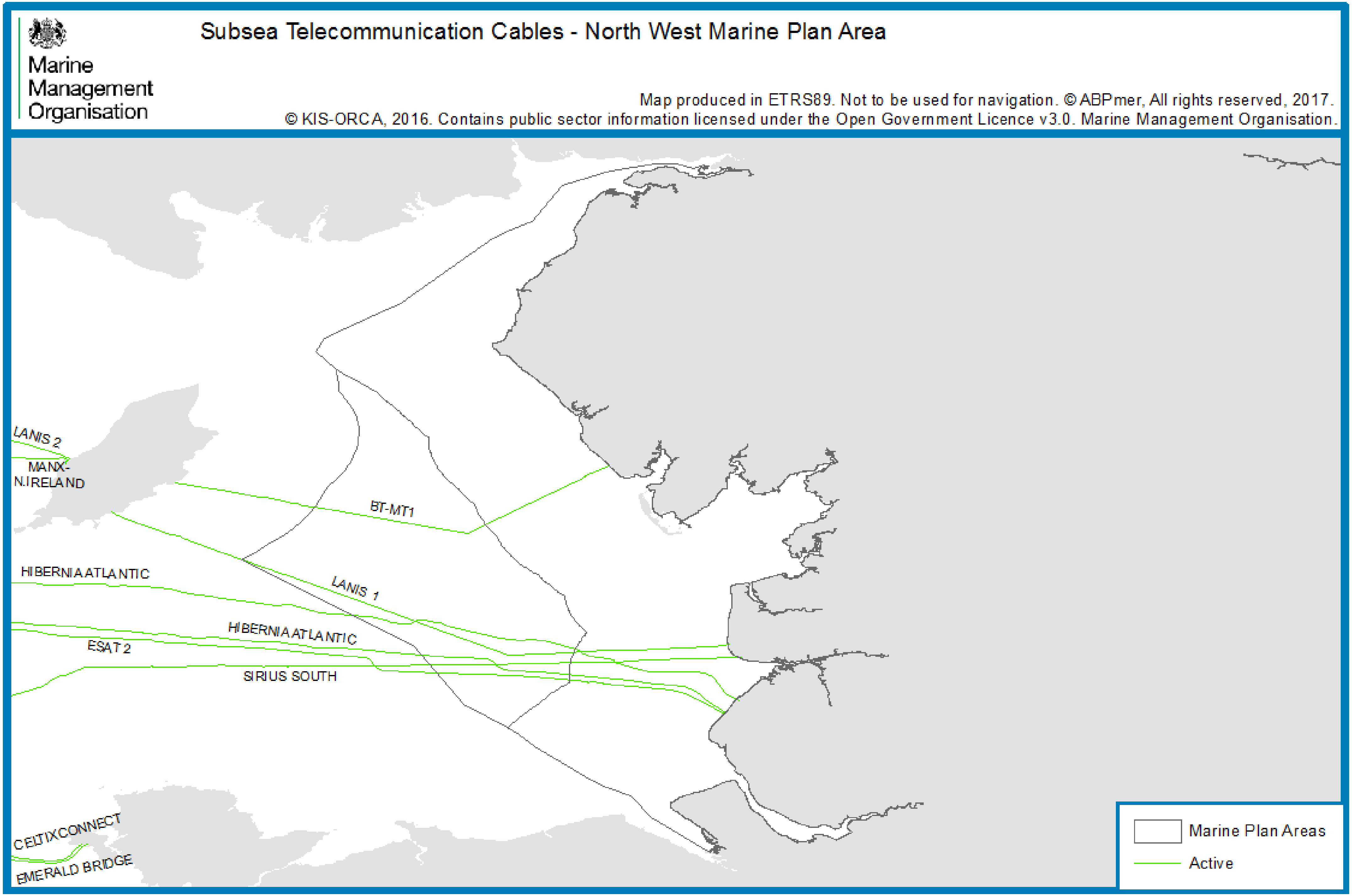


Figure 162: Telecommunication cables in the north west marine plan areas

15.4 South east

Nine telecommunication cables are present in the south east marine plan area. Three of these are currently active while the remaining six are classed as disused (Figure 160). Two of the active cables run from Broadstairs in the UK to Belgium. The third does not make landfall in the south east but runs between Sennen in Cornwall to Holland, running through the south east marine plan area *en route*.

The marine specific proportion of the telecommunication industry in the south east marine plan area supports 720 businesses and employs 8,220 people. An additional 9,695 indirect and induced jobs are generated by the sector (using an employment multiplier of 1.18) (MMO, 2016a).

The assumptions used to develop the BAU, N@W and LS scenarios for telecommunications cables in the south east marine plan area are provided in Table 111. Figure 163 shows the spatial application of the scenarios to the sector while the text below provides a brief description of the future trends in 6 years and 6 to 20 years.

Table 111: Assumptions and impacts under the future scenarios for telecommunication cables in the south east marine plan area

Aspect	Scenario		
	Business as Usual	**Nature @ Work**	**Local Stewardship**
Application to the sector	As for the north east marine plan area (see Table 109).	As for the north east marine plan area (see Table 109).	As for the north east marine plan area (see Table 109).
Assumptions	The spatial footprint of telecommunication cables is assumed to remain constant. Maintenance and/or replacement of cables will require access along the length of the cables.	The spatial footprint of telecommunication cables is assumed to remain constant. Maintenance and/or replacement of cables will require access along the length of the cables.	The spatial footprint of telecommunication cables is assumed to remain constant. Maintenance and/or replacement of cables will require access along the length of the cables.

6-year projection

The number of cables (3) in the south east marine plan area will remain the same over the initial 6-year period (2017-2022) under all three scenarios (BAU, N@W and LS).

6 to 20 year projection

The number of cables (3) in the south east marine plan area will remain the same over the 6 to 20 year period (2023-2036) under all three scenarios (BAU, N@W and LS).

Potential trade-offs

The potential trade-offs are similar to the north east marine plan areas.

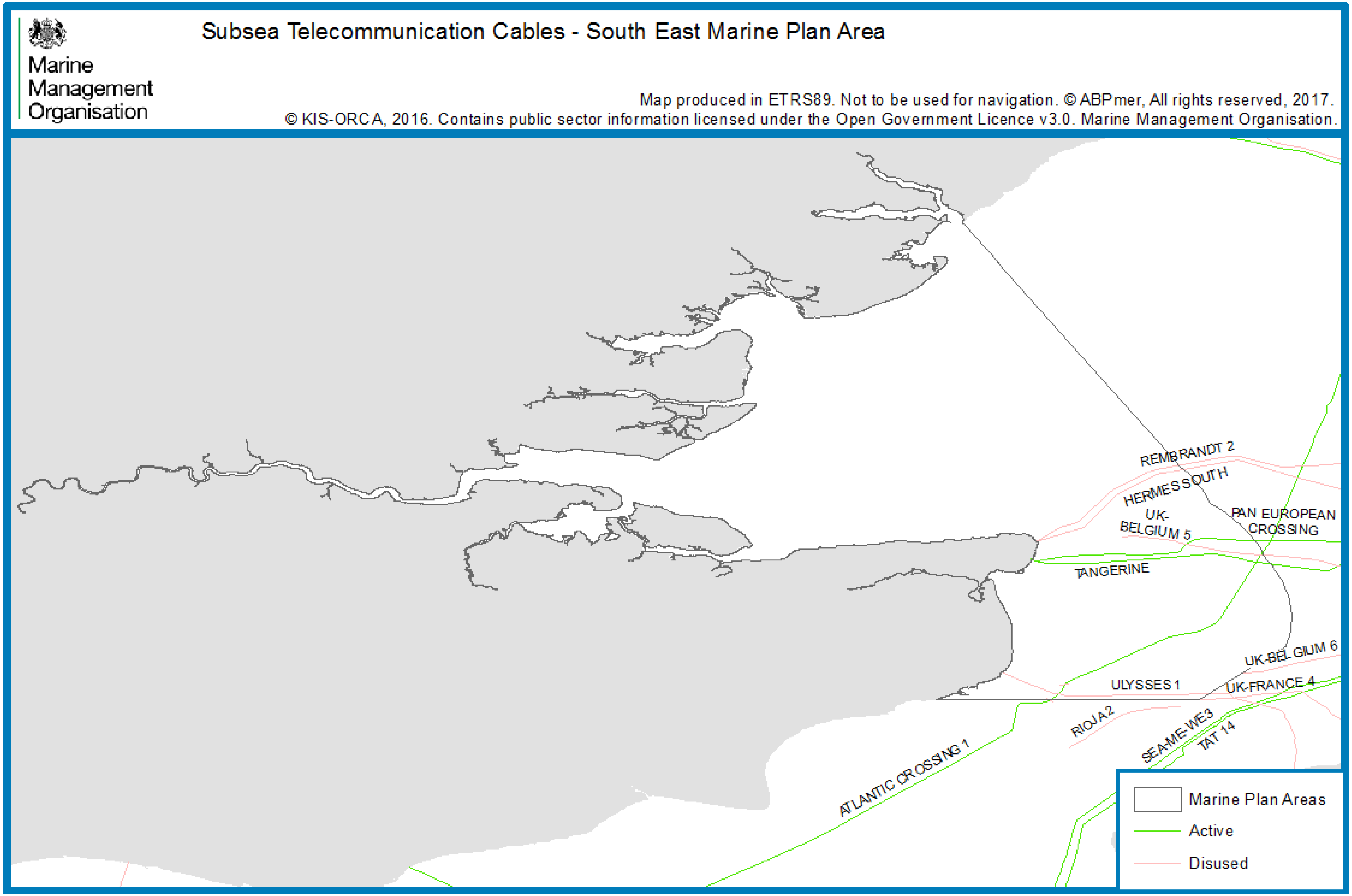


Figure 163: Telecommunication cables in the south east marine plan area

15.5 South west

The south west marine plan areas contain 47 telecommunication cables, a larger number than the north east, north west or south east marine plan areas and reflecting the strategic importance of the south west as a telecommunications gateway. Of these, 30 are active and the remaining 17 are classed as disused (Figure 160). The active cables are owned by a number of different companies, namely Level 3, Apollo SCS, BT, Vodafone, Reliance Globalcom, Globacom Ltd, Hibernia Express, Jersey Telecoms, Tata Communications and Guernsey Telecoms, many of which own more than one cable in the region. Cables making landfall in the south west marine plan areas connect the UK to Europe, Ireland, Africa and North America. The majority of cables are transatlantic, connecting the UK to North America.

MMO (2016a) suggests that the marine proportion of the telecommunications sector employs 1,600 people across 150 businesses in the south west marine plan areas and a further 1,890 jobs through indirect and induced employment (using an employment multiplier of 1.18).

The assumptions used to develop the BAU, N@W and LS scenarios for telecommunications cables in the south west marine plan areas are provided in Table 112. Figure 164 shows the spatial application of the scenarios to the sector while the text below provides a brief description of the future trends in 6 years and 6 to 20 years.

Table 112: Assumptions and impacts under the future scenarios for telecommunication cables in the south west marine plan areas

Aspect	Scenario		
	Business as Usual	Nature @ Work	Local Stewardship
Application to the sector	As for the north east marine plan area (see Table 109).	As for the north east marine plan area (see Table 109).	As for the north east marine plan area (see Table 109).
Assumptions	The spatial footprint of telecommunication cables is assumed to remain constant. Maintenance and/or replacement of cables will require access along the length of the cables.	The spatial footprint of telecommunication cables is assumed to remain constant. Maintenance and/or replacement of cables will require access along the length of the cables.	The spatial footprint of telecommunication cables is assumed to remain constant. Maintenance and/or replacement of cables will require access along the length of the cables.

6-year projection

The number of cables (30) in the south west marine plan areas will remain the same over the initial 6-year period (2017-2022) under all three scenarios (BAU, N@W and LS).

6 to 20 year projection

The number of cables (30) in the south west marine plan areas will remain the same over the 6 to 20 year period (2023-2036) under all three scenarios (BAU, N@W and LS).

Potential trade-offs

The potential trade-offs are similar to the north east marine plan areas.

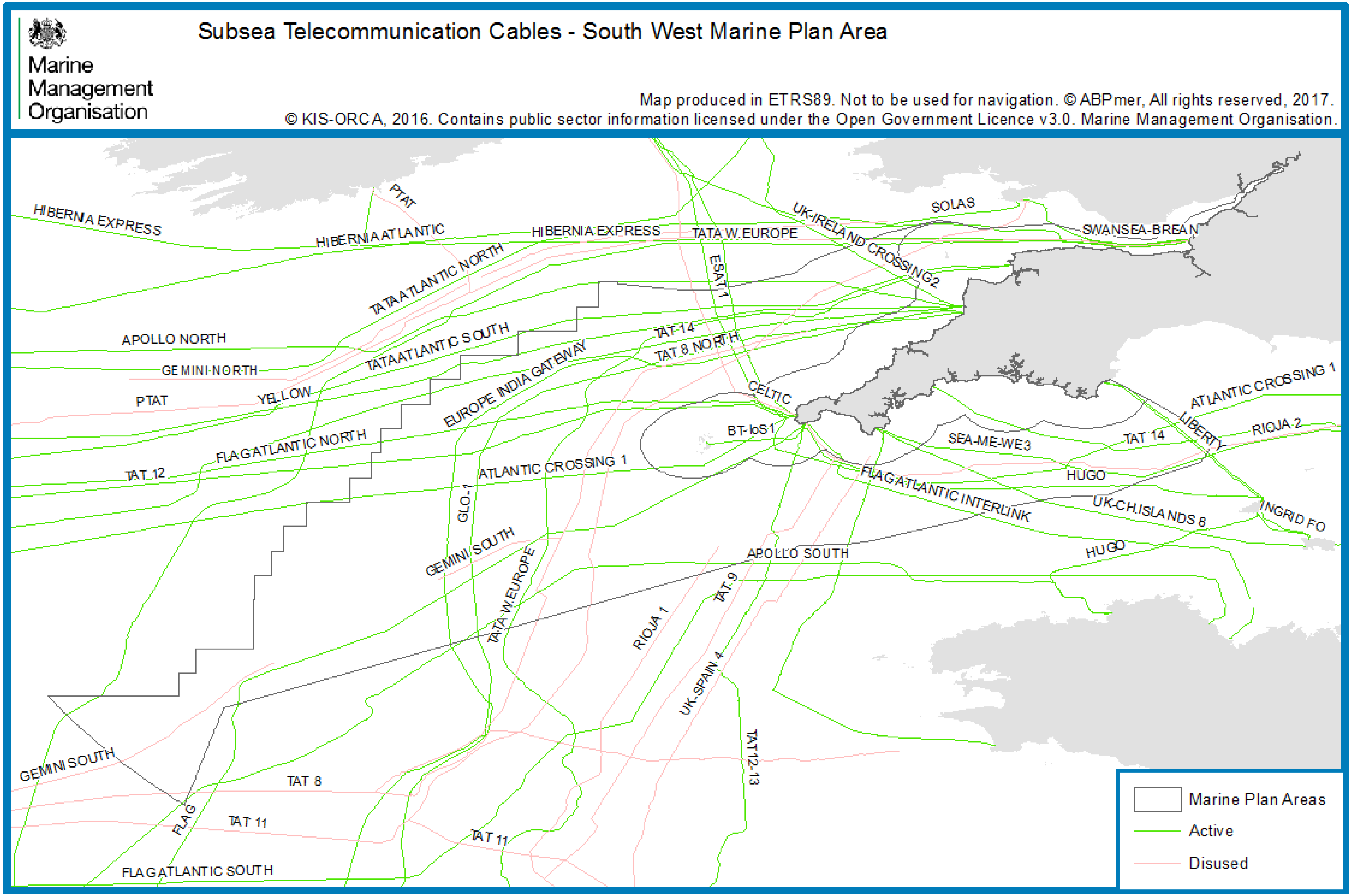


Figure 164: Telecommunication cables in the south west marine plan areas

16 Tourism and recreation

Sector definition

Tourism and recreation are two distinct but interlinked sets of activities. Recreation activities can take place both within and outside of an individual's usual living environment (e.g. within / outside a certain distance of their home or usual sphere of travel), whereas tourism refers only to activities undertaken outside of an individual's usual living environment (see Figure 165).

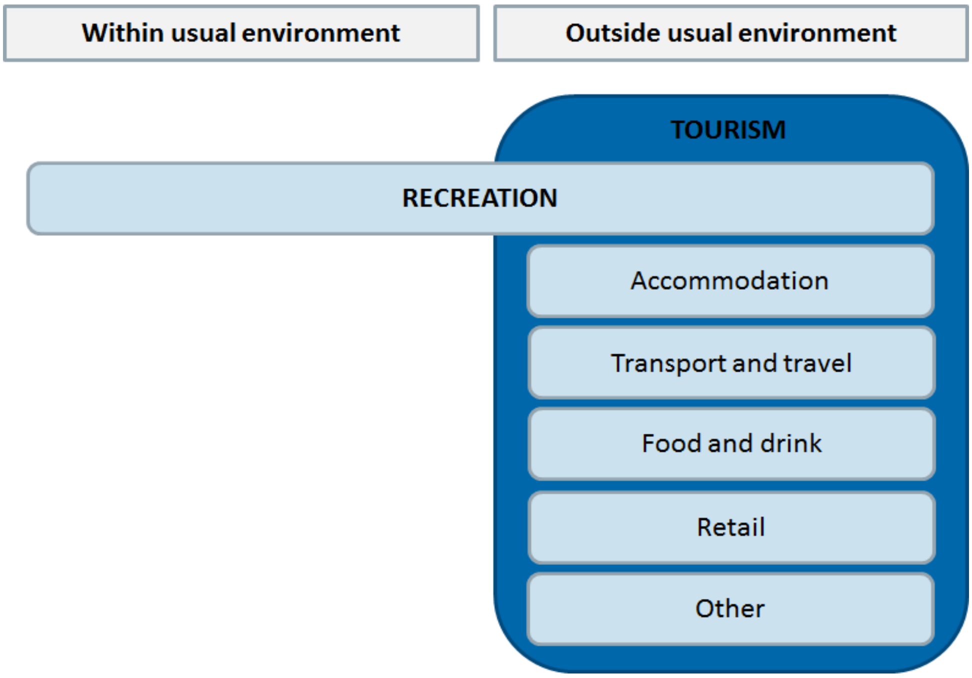


Figure 165: Relationship linking tourism and recreation

Source: European Commission – DG Environment, 2011

Marine recreation can be defined as all recreational activities that make use of the marine environment. It covers a range of activities including recreational boating, water skiing/wakeboarding, windsurfing, kayaking, surfing, kitesurfing, scuba diving, recreational sea angling, coasteering, coastal swimming and marine wildlife watching. Coastal recreation activities are 'land-based' recreation in the coastal environment such as coastal walking, cliff climbing and spending general leisure time at the beach. They may also include those with potentially limited relationships to the marine area, such as cultural activities in coastal locations. Marine and coastal tourism overlaps with the above, whereby the recreation activity is undertaken by tourists. In addition, it includes activities such as cruise tourism, which can be considered only to be undertaken by tourists.

As an economic sector, tourism is broader than recreation. It includes a range of other services that are provided to tourists as part of their tourism visit. For example, accommodation; food and drink; passenger transport; the renting and leasing of cars; recreational goods, sports goods and water transport equipment; creative arts, entertainment and cultural activities; gambling and betting activities; and general retail.

These recreation and tourism activities are supported by a range of suppliers. For example, those specifically related to the recreation activity, including the construction, maintenance and operation of marinas, moorings, slipways and artificial reefs; building, maintenance and repair of boats; manufacture of sports equipment; operation of sport, transport and beach facilities; and renting and selling of sports goods and equipment; as well as those related to the range of tourism sector goods and services.

The tourism and recreation sector and its supply chain are highly dependent on small businesses. Barriers to entry are relatively small and the sector provides significant opportunities for entrepreneurship and new entrants at the local level.

Data sources

A variety of different information sources have been reviewed to inform the analysis, including published reports and papers and spatial data layers. The main information sources used are provided in the list below:

- Watersports participation survey 2015 – Full report (Arkenford, 2015)
- The GB Tourist – Statistics 2015 (Visit England, 2015a)
- The GB Day Visitor – Statistics 2015 (Visit England, 2015b)
- Spatial data relating to seaside / coastal visits and spend (Visit England, 2013)
- International Passenger Survey (IPS) (ONS, 2016)
- Future Trends in the Celtic Seas (ABPmer, 2016)
- Economic baseline assessment for the North East, North West, South East and South West Marine Plans (MMO, 2016a)
- Marine Plan Areas Sustainability Appraisal (MMO, 2016b)
- Strategic Scoping Report for Marine Planning in England (MMO, 2013c).

16.1 National review

Overview of national activity

Marine and coastal tourism and recreation is socially and economically important to England and the UK as a whole. Coastal areas attract significant numbers of visitors to participate in marine and coastal recreation and tourism activities and spend money in the local economy on accommodation, food and drink, transport and other tourism goods and services. These expenditures provide a significant contribution to local coastal economies by supporting local employment and incomes.

It is possible to produce estimates of all tourism visits, expenditures and impacts in English coastal areas, using data from the Visit England tourism and day visit surveys and the International Passenger Survey (IPS). The Visit England surveys cover domestic overnight and day tourism visits and associated expenditures (i.e. those undertaken by UK and/or English residents) and these estimates can be disaggregated to focus on trips to the seaside/coastline only. The IPS covers overnight visits and associated expenditures of international visitors to England and estimates have been produced for their trips and expenditures in coastal areas[33].

Table 1 presents data and estimates from these surveys, which suggest that domestic and international visitors undertook a combined total of 1.4 billion trips in England in 2015 and spent £83 billion. These included 140 million trips to coastal areas of England and expenditures of £9.6 billion. Applying standard metrics for the GVA and employment directly supported by tourism expenditures suggests that the £9.6 billion of expenditure by participants in marine and coastal recreation activities directly supports £4.8 billion of GVA and 178,000 jobs in English coastal areas[34]. These are estimates of direct impacts only. Indirect and induced effects, which would also include the expenditures of the recreation and tourism businesses, their suppliers and employees, are not included here.

Table 113: Tourism volume and value, 2015

Type of trip	Total England (inland and coastal)			England seaside/coast		
	Trips	Days/nights	Spend	Trips	Days/nights	Spend
Domestic overnight trips	103m	300m	£19.6bn	19.4m	71.3m	£4.4bn
Day visits	1,298m		£4.4bn	118m		£4.5bn
International overnight trips	32m	241m	£19.4bn	2.4m	8.8m	£0.7bn
Total	**1,433m**	**1,839m**	**£83.4bn**	**140m**	**198m**	**£9.6bn**

Source: Visit England, 2015

The above figures focus on 'tourism' visits, which are defined as overnight stays and day trips of greater than three hours that take place in a different place from where the participant lives (Visit England, 2015). They exclude trips and expenditures associated with local residents of coastal areas and/or activities that take less than three hours.

Natural England's Monitor of Engagement with the Natural Environment (MENE) survey estimates that there were a total of 313 million England coastal visits undertaken by England residents (adults), with total spend of £5.7 billion (excluding overnight costs such as accommodation). This includes all visits to the coast and does not focus solely on 'tourism' visits. The difference between the MENE

[33] The total numbers of trips and expenditures by international visitors have been disaggregated using data from the 2012 IPS, which asked inbound visitors about the nature of their trips and the types of activities they had undertaken. It found that 11% of overseas visits included a trip to the coast, representing 2.4 million visitors (in 2015). Unfortunately, it is not possible to determine the specific duration of coastal trips or associated spend at the coast from the survey responses. However, assuming that overseas visitors spend the same number of nights in coastal areas as domestic overnight visitors (3.6 nights per trip at the national level), this suggests that overseas visitors spend 8.8 million nights and £0.7bn in coastal areas of England.
[34] These estimates combine the expenditure estimates from Table 1 with the tourism metrics and multipliers presented in Deloitte and Oxford Economics (2013) Tourism: jobs and growth - The economic contribution of the tourism economy in the UK.

estimates and the Visit England domestic tourism overnight and day visits can therefore be used to estimate the number of visits and expenditures associated with other ‘non-tourist’ visits (i.e. ‘non-tourist’ visits are defined for this purpose as trips of less than 3 hours duration and/or trips involving local residents). The results are presented in Table 114.

Table 114: Total volume, value and impact of all coastal tourism and recreation trips involving domestic and international visitors and local residents, 2015

Type of trip	Days / nights	Total spend	GVA (£m)	Employment (FTEs)
Domestic overnight trips	71.3m	£4.4bn	£2.2bn	81,000
Day visits	118m	£4.5bn	£2.3bn	84,000
Other ‘non-tourist’ trips	124m	£1.2bn	£0.6bn	22,000
Total domestic trips	313m	£10.1bn	£5.0bn	187,000
International overnight trips	8.8m	£0.7bn	£0.4bn	13,000
Total trips (domestic and international)	322m	£10.8bn	£5.4bn	200,000
Note: Numbers may not add to totals due to rounding				

Source: ICF analysis of Visit England, 2015 and MENE, 2016

Combining all of the above sources suggests that 322 million visitor day trips / nights were spent in coastal areas of England in 2015, including trips made by domestic and international visitors and local residents (i.e. ’non-tourists’). These visits are estimated to have generated expenditures of £10.8 billion, which would directly support £5.4 billion of GVA and 200,000 full-time equivalent (FTE) jobs in English coastal economies in 2015. If indirect and induced effects are also included, the overall impacts of marine and coastal tourism and recreation are estimated to support more than £15 billion of GVA and 440,000 FTE jobs in coastal economies of England (Deloitte and Oxford Economics, 2013).

There is a notable divergence in the employment estimates generated through the above approach and those generated through interrogation of ONS employment statistics. Estimates based on ONS data, report total jobs in coastal tourism and recreation of nearly 273,000 (MMO, 2016a), which is significantly higher than the estimate of 200,000 direct employment impacts in Table 114. A possible reason for this divergence is that the estimates based on ONS data relate to actual job numbers (e.g. full and part time employment) whereas the above estimate of 200,000 jobs are expressed as full time equivalents (FTEs). Another estimate (Beatty *et al*., 2014), based on data from the UK Business Register and Employment Survey (BRES) for SIC codes relating to tourism, suggests that employment in seaside tourism totals 212,000 jobs for England and Wales. This is also based on total jobs rather than FTE jobs and covers Wales as well as England. As such it is likely that the estimate presented in Table 114 falls somewhere between these other two estimates.

Review of historical trends

Figure 166 presents past trends in trips and expenditures (expressed in 2015 prices) in coastal areas of England between 2010 and 2015 and shows some significant differences between the different types of visitor.

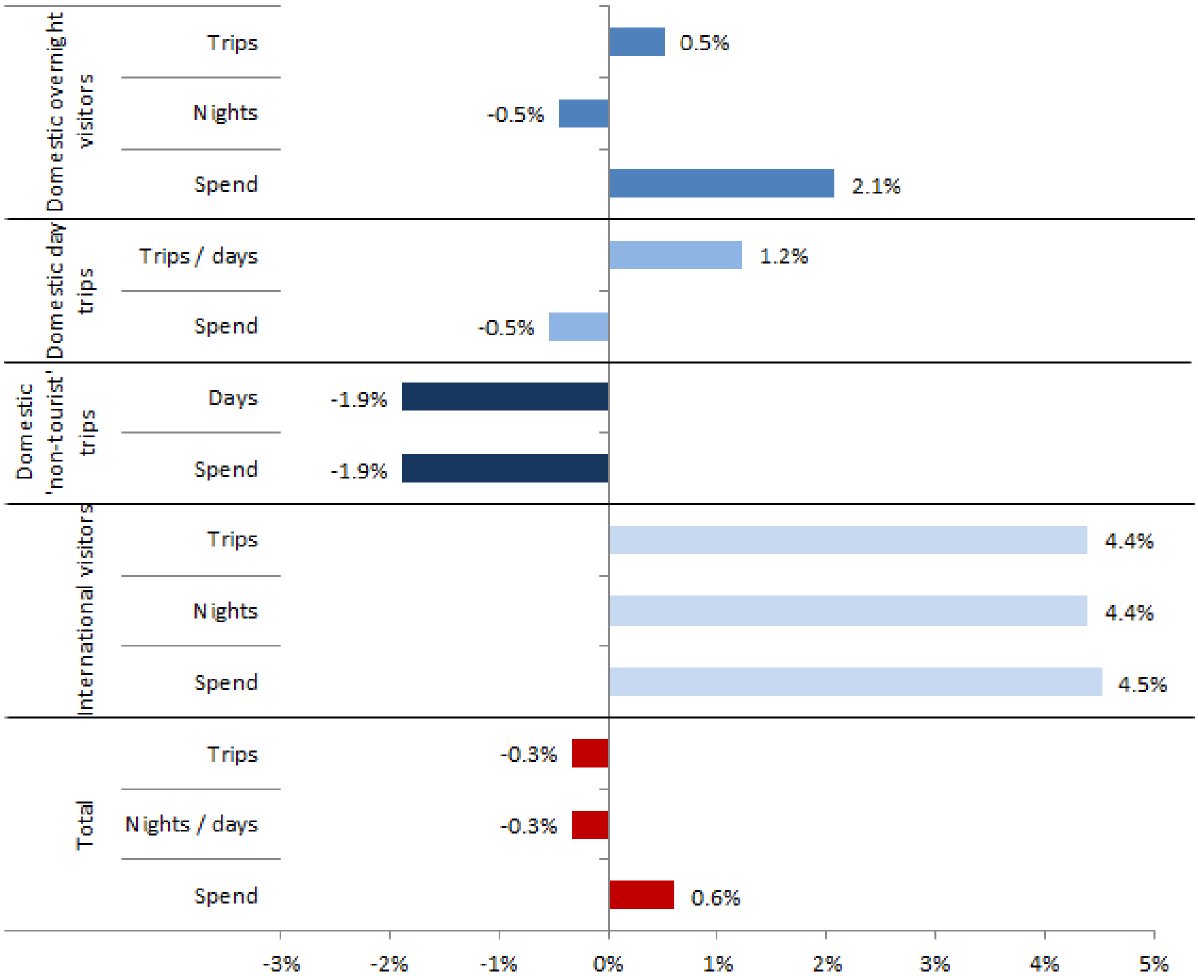


Figure 166: Past trends in trips and spend in coastal areas of England (% change per annum, 2010-15)

Source: ICF analysis of Visit England, IPS and MENE data, 2010 to 2015

Note: The average annual growth rate for domestic day trips is based on the period from 2011 to 2015, as 2011 is the first year of data available from the Day Visits Survey.

The estimates suggest that there has been significant growth in the number of trips and expenditures of international visitors to coastal areas of England between 2010 and 2015. However, this has been offset by declining numbers of domestic trips and visits made by England residents. There are also some interesting differences between domestic overnight and day visitors. While the total number of trips has increased, the duration of overnight stays has decreased, although associated expenditures have shown growth in real terms over the period. This is in contrast to the domestic day visitors, where the number of day trips has increased between 2010 and 2015 but the associated spend has declined in real terms. The combined effect of these trends is heavily influenced by the relatively large numbers of domestic visitors, and suggests that the number of trips and tourism nights / days has declined by around -0.3% p.a. between 2010 and 2015. However, visitor spend has continued to increase slightly in real terms, by around 0.6% p.a. over the period.

Activity-specific estimates and trends

Participants in marine recreation activities are a subset of the above marine and coastal tourism and recreation estimates. Marine recreation activity can be estimated using the UK watersports participation survey, which provides the best available definition of coastal trips and experiences involving activities directly interacting with the marine area. The findings of the survey suggest that the breadth and scale of marine recreation activities is significant in England and the UK. Approximately 12.4 million UK residents are estimated to have participated in marine recreation activities in 2015, including more than 10 million England residents, representing a participation rate of 25% of the adult population. UK residents undertook 223 million experiences (trips) to participate in these activities, of which more than 200 million took place in coastal areas of the UK.

A comprehensive list of marine, and marine-related coastal, recreation activities and associated expenditures is provided in Table 115 below. This shows that the most common activities undertaken in coastal areas are: coastal walking; leisure time at the beach; coastal swimming; recreational boating; sea angling and surfing. Total expenditures have been estimated for each activity by multiplying the estimated number of experiences in coastal areas by the latest survey evidence of the daily expenditures of participants (Land Use Consultants, 2016). It shows that UK participants in marine and marine-related coastal recreation activities are estimated to spend £6.25 billion per annum in coastal economies of the UK. The most significant expenditures are associated with coastal walking (£2.3 billion), leisure time at the beach (£2.3 billion), sea angling (£0.6 billion) and boating activities (£0.5 billion).

Trends in participation of specific recreation activities are more volatile and vary from year to year. Overall numbers of participants in boating and other recreational activities has been declining over the last 10 to 15 years. However, the number of experiences/trips is also influenced by the frequency of participation and while the overall trend in experiences is also negative, it has been declining by less than the numbers of participants. This suggests that while the overall numbers of participants might have fallen, those who have continued to participate have, in many cases, increased their frequency (and duration) of participation. This again varies considerably between activities and from year to year, although there appears to have been more consistent growth in some activities (e.g. coastal walking, sea angling, diving and cliff climbing), while others have seen greater declines (e.g. coastal swimming, leisure boating, leisure time at the beach).

Comparing the data from the Watersports participation and MENE surveys suggests some significant differences, which are difficult to reconcile; a key difference is in the estimates of coastal walking, with the Watersports participation survey estimating 90 million trips per year but MENE estimating it at well over 200 million. The divergence in walking levels may result from a difference in interpretation between the defined activities (particularly short, local walking with dogs) i.e. those that are engaging with the environment (MENE survey) compared with activities which are more formally participated in (Watersports participation survey). However, it is not possible to conclude on this point.

Table 115: Scale of marine recreation activities in the UK

Activity	Participants ('000s)	Experiences in coastal areas ('000s)	Daily expenditure (£)	Total expenditure (£m)
Small Sail Boat Racing	109	723	25	18
Small Sail Boat Activities	418	2,068	62	128
Yacht Racing	94	332	62	21
Yachting	253	1,321	62	82
Using Personal Watercraft (jet-ski / similar)	171	99	34	3
Motor Boating	421	460	62	29
Power Boating	297	1,236	103	127
Canoeing	1,408	2,292	40	92
Windsurfing	109	153	34	5
Water skiing / Wake-boarding	273	289	34	10
Total boating activities	**3,176**	**8,972**	**-**	**515**
Surfing / bodyboarding / paddle boarding	996	5,004	34	170
Kitesurfing	36	24	34	1
Sea angling/fishing	798	7,109	82	583
Cliff climbing	382	1,133	28	32
Coastal walking	4,668	90,340	25	2259
Leisure time at the beach	6,393	74,256	31	2302
Outdoor swimming	4,278	11,636	25	291
Leisure sub-aqua diving	350	1,350	70	95
Coasteering	101	262	28	7
Marine wildlife watching	Not available	Not available	40	Not available
Total (all activities)	**12,364**	**200,086**	**-**	**6,253**
Note: Numbers may not add to totals due to rounding				

Source: ICF analysis of Arkenford, 2015 and Land Use Consultants, 2016

A significant coastal recreational activity that is not included in the Watersports participation survey is cruise tourism. The number of UK and international passengers calling at a UK port during a cruise was estimated to have surpassed one million for the first time in 2015. This figure has been increasing rapidly over time, achieving double digit growth for eight consecutive years (CLIA, 2016). The total expenditure of these cruise passengers is estimated to total £78 million in the UK or £39 million in England[35].

The above analysis also excludes other tourism activities (such as cultural tourism, visiting harbours, eating in seafront restaurants, etc.) that take place in coastal areas but are not directly associated with marine and marine-related coastal recreation activities. These experiences/trips and associated expenditures can be estimated as the difference between the overall coastal tourism figures (presented in Table 114) and the estimates of marine recreation and cruise tourism experiences and expenditure in England. The results are presented in Table 116, which disaggregates the overall volume, value and impact of coastal tourism and recreation activities by type of activity.

Table 116: Volume, value and impact of coastal tourism and recreation activities in England, 2015

Type of activity	Days / nights (million)	Total spend (£ billion)	GVA (£ million)	Employment (FTEs)
Cruising	0.5	0.04	0.02	700
Boating	11	0.4	0.2	7,800
Beach activities (leisure, swim, surf, kite-surf)	48	1.6	0.8	29,900
Coastal walking	59	2.0	1.0	36,300
Sea angling	15	0.5	0.25	9,400
Other recreational activities	3.5	0.1	0.06	2,100
Other tourism activities	176	5.5	2.7	101,300
Total domestic trips	***313***	***10.1***	***5.0***	***187,000***
International overnight trips	8.8	0.7	0.4	13,000
Total trips (domestic and international)	**321**	**10.8**	**5.4**	**200,000**

Note: it was not possible to disaggregate the figures for international visitors as the Watersports participation and MENE surveys for on UK/England residents only. Also numbers may not add to totals due to rounding.

Source: ICF analysis of Visit England, 2015 and MENE, 2016

[35] England estimates are based on the number of cruise passengers calling at English ports as a proportion of those calling at UK ports.

The data show that coastal walking has the greatest impact of the coastal recreation activities and is estimated to directly support £1 billion of GVA and more than 36,000 FTE jobs in English coastal economies. This is closely followed by beach-based activities, which are estimated to directly support £0.8 billion of GVA and 30,000 FTE jobs around the English coast. Sea angling and boating activities are also significant but the scale of participation is lower than for coastal walking and the combined beach-related activities.

Spatial distribution of activity

Most of these recreation activities are widespread around the English coast, although there are particular concentrations of boating and other watersports activities around the south coast, the south-west of England, the Thames estuary and Merseyside (see Figure 167 and Figure 168).

At more localised levels, many of the marine recreation activities are typically concentrated around marinas and/or beaches, both of which provide safe points of access to the water. There are estimated to be:

- 256 coastal marinas in the UK, including 185 in England, providing a total of 51,600 and 37,000 berths for leisure boats in the UK and England respectively (British Marine Federation Tourism, 2014).
- 1,265 beaches in the UK, including 738 in England. These include 125 Blue Flag beaches in the UK and 66 in England (The Beach Guide website).

The spatial distribution of these marinas and beaches provides a good indication of the distribution of marine recreation activities at a localised level. Since the watersports participation data focuses on activities in the UK rather than England, the UK estimates (presented in Table 115) have been disaggregated to the England level according to the spatial distribution of these indicators. For example, the estimate of £515 million of expenditure associated with boating activities at the UK coast has been disaggregated and estimated to total £370 million for England, based on England's share of the total number of coastal marina berths in the UK. The same approach has also been used to disaggregate estimates for the individual marine plan areas.

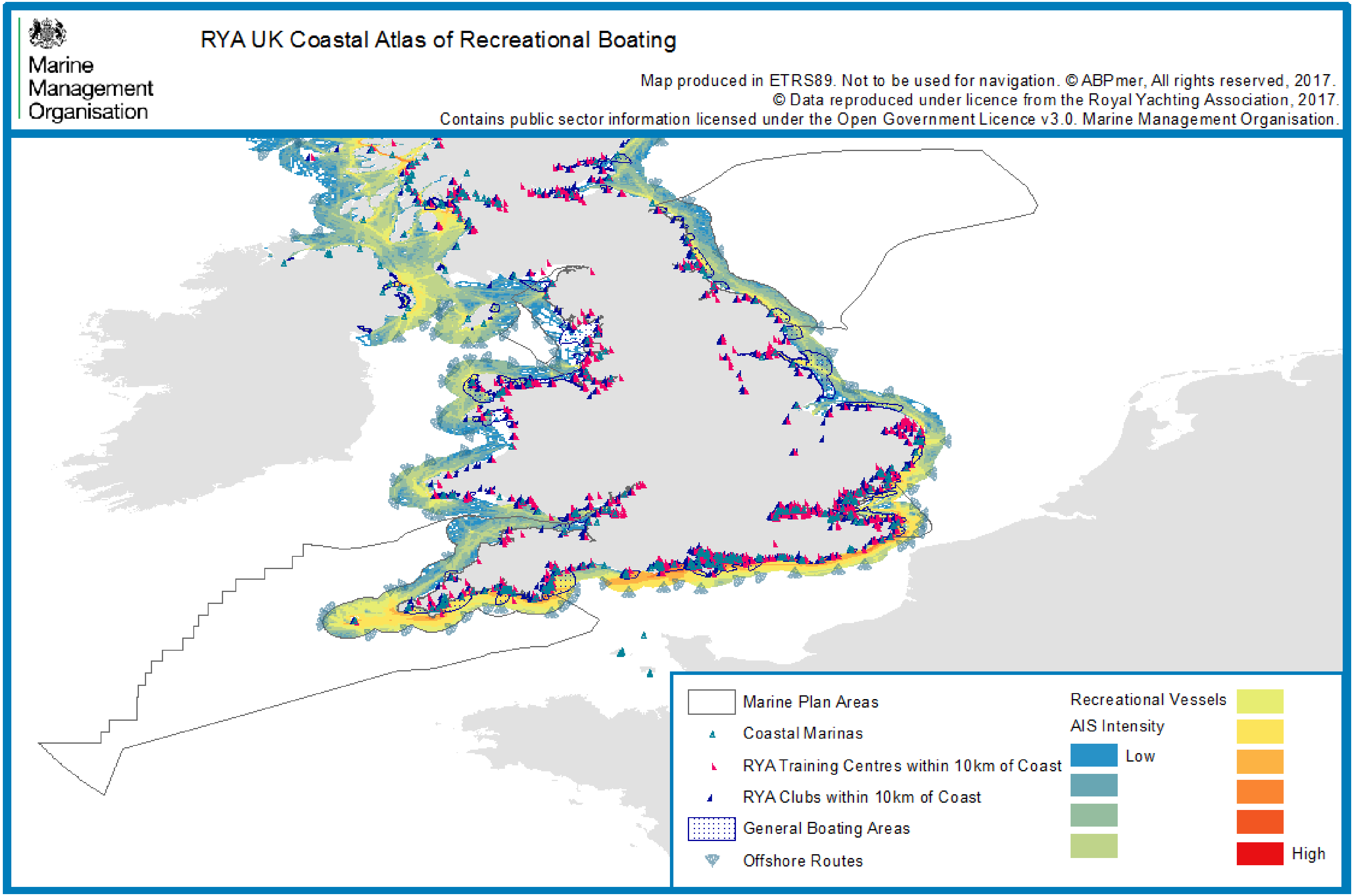


Figure 167: RYA UK coastal atlas of recreational boating

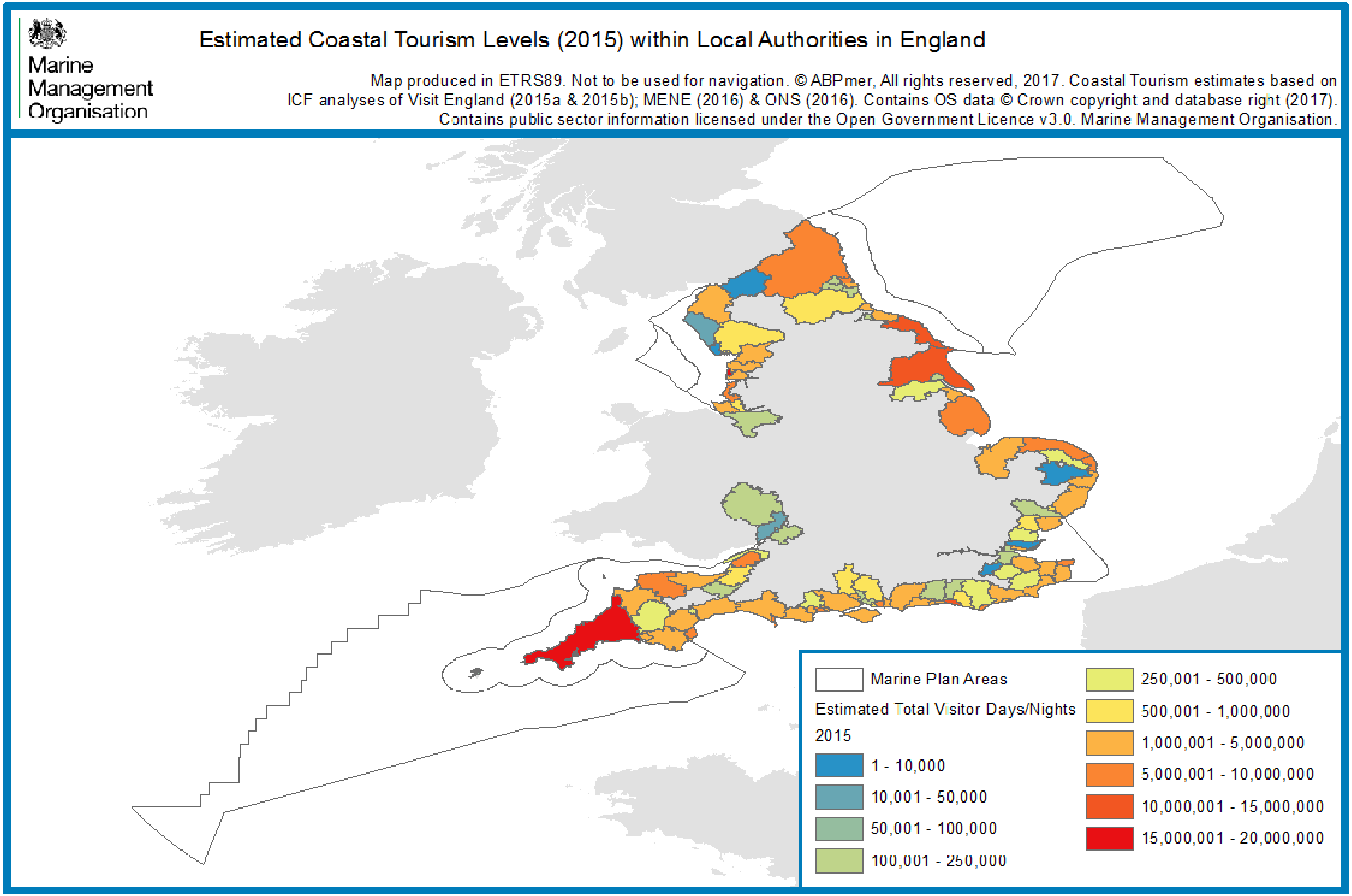


Figure 168: Coastal tourism by local authority

Review of key changes and/or advances of significance affecting the sector

These trends in the tourism and recreation sector are related to a number of political, economic, demographic and seasonal or climate factors, which are presented in Table 117. Demand for, and supply of, recreation and tourism opportunities are closely interconnected, with changes in one influencing the other. In summary, the demand side is heavily influenced by social and economic trends – in particular, the rate of population growth, leisure preferences and discretionary spend, which directly impact levels and rates of participation. The supply side (e.g. the supply of services and construction of infrastructure) is also heavily influenced by economics. Both aspects are also driven by other factors that influence the price, quality and accessibility of opportunities.

Table 117: Key drivers affecting tourism and recreation

Driver	Details	Implications
	Changes in exchange rates may affect the attractiveness of the UK as a holiday destination.	Movements in exchange rates affect the purchasing power of visitors and thereby affect the attractiveness of the UK as a holiday destination (e.g. a low value of the pound would make the UK a more attractive destination for international visitors, whilst also encouraging more UK residents to stay in the UK rather than travel abroad – and *vice versa*).
Economic	The future growth and stability of the tourism and recreation sector is heavily dependent on the general health of the economy. The relatively high concentration of small businesses and start-ups in the sector means that growth and stability can also be dependent on the support provided to these types of business.	Tourism and recreation activities are non-essential purchases and are therefore relatively vulnerable to economic changes and pressures and changes in disposable incomes. However, the relationship can be more complex as domestic tourism and recreation activities can also increase (relative to overseas trips) during periods of below-trend economic performance.
	Coastal tourism in England faces increasing competition from other coastal destinations, and particularly from low-cost destinations.	Many destinations are becoming more accessible and affordable and this is increasing price competition and restricting the growth and value of tourism and recreation.
	Coastal tourism is being supported and promoted by wider initiatives and strategies at sub-national, national and international levels. For example, VisitBritain and VisitEngland are working together to promote Britain and its regions to both domestic and overseas visitors, while international initiatives such as the Atlantic Action Plan also include themes that aim to support tourism across the Atlantic Ocean area.	These strategies and initiatives aim to support tourism and recreation activities in coastal areas of England by attracting and servicing greater numbers of both domestic and overseas visitors, whilst also protecting, securing and enhancing the marine and coastal environment.

Driver	Details	Implications
	Future growth in the sector is dependent on the supply and cost of infrastructure / services to meet demand from participants and enable them to gain access to the water and recreational equipment. These services / infrastructure include marina berths, moorings, slipways, anchorages, club facilities, and training provision.	Restrictions on the potential growth of recreational boating (and other activities that use these services and infrastructure to access the water) in areas with unmet demand. For example, an inability to match the supply and cost of marina berths with demand from boat owners can restrict growth in some areas. Conversely, areas with capacity can benefit as a result (e.g. some boat owners in the south of England have found it more cost-efficient to keep their boat elsewhere).
	Marina developments typically require large investments and are often financed with public funds. Recent economic conditions have restricted investments from both public and privates sources.	Restricted opportunities for developing new marinas.
Social	Population growth is a key driver of activity. The total population of England has been increasing by 0.8% pa between 2005 and 2015. This is slightly higher than the previous rate Population growth is also projected to slow slightly (0.7% pa from 2016-2022 and 0.6% from 2022-2036) (ONS, 2016).	Population growth is a driver of participation in marine recreation activities and domestic tourism visits to coastal areas. Population growth is expected to continue to have a positive impact on participation and tourism.
	An ageing population has more leisure time and is more likely to participate in tourism and recreation activities outside of the peak summer season, thereby helping to address seasonality issues.	This is likely to have a positive impact on the demand for recreational activities.
	Activity-based tourism provides an opportunity for coastal destinations to differentiate and add value to their tourism offer. These activities also tend to be less seasonal in nature. There are also opportunities for activity-based tourism to benefit from increasing demand for complementary tourism activities such as eco-tourism and gastro-tourism.	This is likely to have a positive impact on the demand for recreational activities and provides opportunities to address seasonality issues that face many coastal locations.
Technological	Technology can drive growth in marine recreation activities. For example, new technologies have improved the targeting of fish and increased catch rates, thereby increasing the demand for sea angling, while advances in wetsuit technology have helped to extend participation in watersports outside the peak summer season.	Growth in marine recreation activities.
Legal	No significant drivers identified	N/A

Driver	Details	Implications
Environmental	Tourism and recreation activities are heavily dependent on the health of the marine environment and are generally more attractive in a healthy environment. For example, swimming and beach activities are more popular on Blue Flag beaches, healthy and abundant wildlife are important for angling and marine wildlife watching activities . The health and attractiveness of the coastal landscape/seascape and improvements to coastal footpaths are also particularly important for coastal walking.	This highlights the importance of ensuring the environmental pressures of tourism and recreation activities do not cause damage to the environment or restrict future demand for tourism. These pressures can be directly related to tourism and coastal activities (e.g. causing damage to sensitive dune and estuarine habitats through participation in tourism activities) or indirectly related (e.g. by stimulating demand for increased development of coastal areas to provide additional accommodation and other services for visitors).
	MCZs and Natura 2000 sites	These sites have the potential to displace some activities, such as recreational boating and sea angling.
	Climate change is expected to cause: increases in sea and air temperatures; increases in sea levels; and increases in precipitation and the severity of storms. Climate change could therefore have positive and negative impacts for tourism and recreation.	Increases in air and sea temperatures could support increased coastal tourism and participation in recreation activities. It could also affect the habitats and movements of marine wildlife, which could have impacts for wildlife tourism, although the scale and direction of these impacts are poorly understood. However, increases in sea levels, precipitation and the severity of storms threaten to damage to coastal infrastructure and recreational craft, deter visitors and increase the short-term dangers for participants of recreation activities.

Review of future trends

In the BAU scenario, recent trends are expected to continue. As described above, participation is expected to grow in some activities and decline in others. It is assumed that there is no change in the long term economic growth rate or population growth trends. The short term decline in participation is offset by population growth and over the longer term, as the decline in participation softens, overall levels of participation begin to increase in line with population growth. The net effect is that growth is expected to be flat over the short-term (i.e. 2016 to 2022), and positive over the longer-term (i.e. 2022 to 2036). No changes in the spatial distribution of activity are anticipated.

In the N@W scenario, a healthier marine environment and greater interest in engaging with nature lead to increased participation rates for marine recreation activities. This uplift is likely to be most significant for activities that are most dependent on the quality of the marine and coastal environment (e.g. diving, angling, and wildlife watching). Whilst increased protection of sensitive areas can restrict certain activities, this effect is likely to be limited for the recreation sector. Emphasis on growth in ‘responsible’ eco-tourism activities will help mitigate any such potential restrictions. This scenario is also expected to have an influence on the overall geographic distribution of activity, although the effect is expected to be localised, so the broader regional picture is likely to be in line with the BAU scenario. For other activities, such as ‘general leisure time spent at the beach’, there is a minor positive effect on participation and hence overall levels, with a shift in demand for rural and remote coastal areas rather than urban coastal locations. The limitations placed on the development of marinas and harbours in this scenario, are expected to slow the rate of development and in turn constrain boating activity and the cruise sector in the medium to long term. This is expected to have a limiting effect on the overall growth of the sector over the longer term.

Under the LS scenario, lower levels of economic growth and stronger local identity and brands are expected to result in an increase in domestic tourism at a local level, but a decline in international and inter-regional tourism. This has a significant influence on overall coastal tourism levels, although the effect is less pronounced when considering only marine activities. A drive for more localised living is likely to affect both the location of tourism (i.e. overnight coastal activities) as well as second order economic impacts through more localised supply chains, both of which will increase the retention of recreation and tourism expenditure within local economies. The potential benefits for the tourism and recreation sector are relatively high given the local focus and concentration of small and medium enterprises (SMEs) within the sector. There would also be significant opportunities for these SMEs to work in partnership with local authorities and local enterprise partnerships to improve the local offer and increase the marketing and promotion of local destinations and the availability of tourism and recreation activities.

Figure 169 presents the projected change in visitor days, expenditures and their associated GVA and employment impacts under each of the above scenarios.

The short term performance of the tourism and recreation sector is uncertain based on recent trends, and the declining participation in marine and coastal recreation activities. As a result, each scenario has projected zero growth in the short term to 2022. However, from 2022 onwards, tourism and recreation days, spend and associated impacts are projected to grow under each scenario. The projected growth rates are presented in Table 118 below, and show that visitor days, spend (in real prices) and GVA/employment impacts are expected to increase by 6% between 2022 and 2036 under the BAU scenario, by 8-9% under the local stewardship scenario, and are expected to be greatest under the nature at work scenario, increasing by 16% between 2022 and 2036.

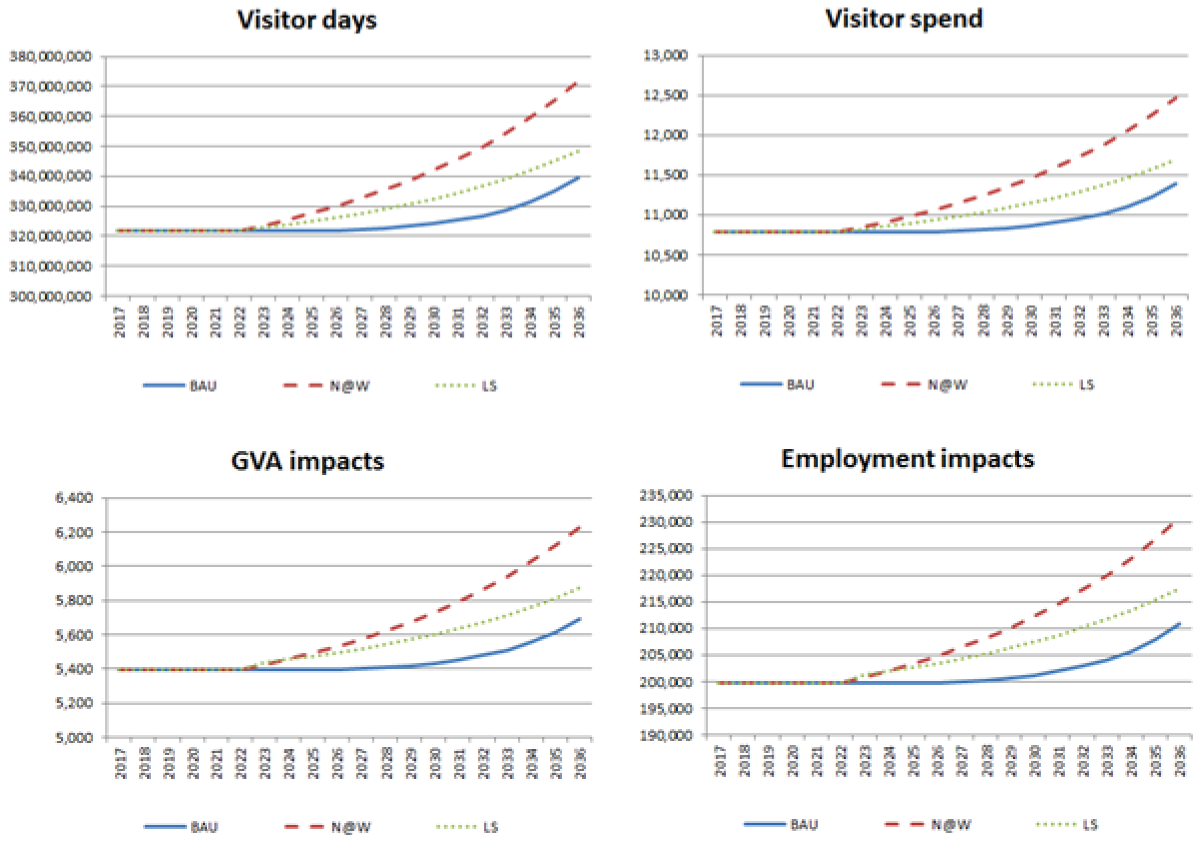


Figure 169: Projected visitor days, spend and associated GVA and employment impacts for all marine and coastal tourism and recreation (Total England)

Table 118: Summary projections by scenario for England as a whole

Visitor days (m)	BAU		N@W		LS	
	Number	% change from 2016	Number	% change from 2016	Number	% change from 2016
2016	322		322		322	
2022	322	0%	322	0%	322	0%
2036	340	6%	372	16%	349	8%
Visitor expenditures (£m)						
2016	10,800		10,800		10,800	
2022	10,800	0%	10,800	0%	10,800	0%
2036	11,400	6%	12,500	16%	11,700	8%
Direct GVA impacts (£m)						
2016	5,400		5,400		5,400	
2022	5,400	0%	5,400	0%	5,400	0%
2036	5,700	6%	6,200	16%	5,900	9%
Direct employment impacts (FTEs)						
2016	200,000		200,000		200,000	
2022	200,000	0%	200,000	0%	200,000	0%
2036	210,800	6%	230,800	16%	217,500	9%

Note: Rates of growth across the different categories are constant for each scenario as the average expenditure per visit and conversation metrics (e.g. output per FTE) are held constant over the forecast period.

Growth is expected to be strongest under the N@W scenario as improvements to the health of the marine environment drive increased demand for tourism and recreation activities in coastal areas. Growth is projected to be less significant under the local stewardship scenario as growth in day visits is likely to be offset by some significant declines in international and interregional tourism visits.

Confidence assessment

None of the available data sets provides a complete picture of marine and coastal tourism and recreation. As such, different data sources need to be drawn together, and in some instances assumptions borrowed to support secondary analysis (such as in the case of international tourism, using data from the IPS). As such, there is greater uncertainty in the overall estimates of activity and value than is inherent in the individual data sources themselves.

The sector is not well captured in economic sector classifications. This is particularly the case for tourism (i.e. there is no 'tourism' sector in the standard industrial classification - SIC), whilst there are also challenges in separating out marine and coastal recreation from wider recreation. As such, ONS datasets on employment and outputs of the UK economy provide poor indications of activity in the sector and are not relied upon as the main data sources for the analysis in this Section.

Spatially disaggregated data sources are limited. This is particularly the case for specific recreation activities (e.g. diving or coastal swimming). In many national surveys, small sample sizes preclude such analysis. Localised spatially explicit data sets (e.g. RYA cruising route or Stakmap data from the MCZ Regional Projects) provide no or only limited indications of the volume of activity occurring in each spatial area, and thereby provide limited benefit for analyses of changes in the future levels and value of the sector required in this report.

Appropriately defined data predicting future spatial and temporal trends in tourism and recreation activity in the marine plan areas are limited.

There is a general lack of data relating to participation in recreation and tourism activities at the sub-national level. This has required the use of assumptions to disaggregate the national level estimates, as described above.

The north east marine plan areas cover the whole coastline of the north east region (comprising the counties of Northumberland, Tyne and Wear and County Durham), as well as the county of North Yorkshire. It also includes a very small length of approximately 10km of coast to the north of Flamborough Head, which falls within the county of East Riding of Yorkshire. While this does not fit neatly within regional boundaries, the counties of Northumberland, Tyne and Wear, County Durham and North Yorkshire provide a good basis for estimating the scale of coastal tourism and recreation activities and impacts.

The south east marine plan area covers the whole of the Essex coastline, and the north and east Kent coast from Dartford to Dover. This makes it relatively difficult to produce estimates of tourism and recreation activities and impacts for the south east marine plan area as it does not fit neatly within regional and county level boundaries. Local authorities provide the best match, including Dover (although this includes approximately 10km of coast from Dover to Folkestone, which is part of the south marine plan area).

The south west marine plan areas do not fit neatly within the regional, county or local authority boundaries. This makes it more difficult to produce estimates of tourism and recreation activities and impacts, as it does not align with most data sources. Local authorities provide the closest match although the South Hams also covers a small length of approximately 10km of coast from Dartmouth to Torbay, which is part of the south marine plan area.

In contrast, the north west marine plan area covers the coastal areas of Merseyside, Cheshire, Lancashire and Cumbria and is consistent with the North West region, thereby better aligning to the available datasets which makes it easier to estimate the scale of tourism and recreation activities and impacts in this area.

16.2 North east

The north east inshore marine plan area is relatively small in terms of the length of coastline. It stretches from the Scottish border to Flamborough Head in Yorkshire, covering approximately 687km of coastline. It accounts for approximately 10% of all visitors to coastal areas of England and this is consistent across each type of visitor including:

- Overnight visitors – the north east marine plan areas accounts for 9% of overnight visits and 11% of associated expenditures of all coastal areas of England
- Day visitors – it accounts for 8% of all day visits and 10% of all day visit spend in English coastal areas
- International visitors – it accounts for 11% of all nights spent by international visitors in English coastal areas and 8% of their expenditures.

The combined visitor days, expenditures and associated impacts are presented in Table 119. These figures suggest that visitors spend 31m days/nights and almost £1bn in the north east marine plan areas, directly supporting £0.5 billion of GVA and more than 18,000 FTE jobs in the local economy.

Despite its relatively short length, the north east marine plan areas has a relatively large number of beaches, and the number of beaches per 100km of coast is broadly similar to the south west. The analysis suggests that the north east marine plan areas include:

- 83 beaches (including 8 Blue Flag beaches), representing 11% of all beaches in England. The beaches are distributed fairly evenly along the coast, with 30 beaches in Northumberland, 24 in North Yorkshire (including the section of East Riding of Yorkshire to Flamborough Head), 15 in County Durham and 14 in Tyne and Wear
- 7 coastal marinas and 1,414 berths, representing 4% of all coastal marina berths in England (British Marine Federation Tourism, 2014)
- 62 charter boats for sea fishing, representing 16% of the total for England as a whole (Defra, 2012). There are particular concentrations of sea fishing boats in Amble, Hartlepool, Seahouses and the Tyne, while shore angling is concentrated

in Saltburn, Whitley Bay, Alnmouth and Berwick upon Tweed (Drew Associates (2004)

- 10% of all cruise passengers docking at ports in England.

Table 119: Total volume, value and impact of all coastal tourism and recreation trips in the north east marine plan area, 2015

Type of visitor	Visitor nights / days (m)	Visitor spend (£m)	Direct GVA impacts (£m)	Direct employment impacts
Domestic overnight trips	6.5	476	238	8,800
Day visits	11.7	343	171	6,350
Other 'non-tourist' trips	12.0	115	58	2,150
Total domestic trips	***30.1***	***934***	***467***	***17,300***
International overnight trips	1.0	53	27	1,000
Total trips (domestic and international)	**31.2**	**988**	**494**	**18,300**
Note: Numbers may not add to totals due to rounding				

Source: ICF analysis of Visit England, 2015 and MENE, 2016

These estimates suggest that the north east inshore marine plan area represents around 10% of all beaches and cruise passengers in England and around 16% of all charter boats for sea fishing. However, the number of marina berths is lower, representing only around 4% of the national total. Overall, the figures in Table 16 suggest that the north east inshore marine plan area accounts for 9% of all marine recreation and coastal tourism activities in England. This is also lower than the south west and north west marine plan areas but slightly higher than the shares of marine recreation and coastal tourism activities in the south east marine plan area.

Table 120: Estimated volume and value of coastal tourism and recreation activities in the north west marine plan area, 2015

Type of activity	Visitor nights / days (m)	Visitor spend (£m)	% of the total spend in England for each activity
Cruising	0.05	4	10%
Boating	0.4	14	4%
Beach activities	5.7	181	11%
Coastal walking	5.7	180	9%
Sea angling	2.5	79	16%
Other recreational activities	0.3	11	9%
Other tourism activities	15.4	466	8%
Total domestic trips	***30.1***	***934***	***9%***
International overnight trips	1.0	53	8%
Total trips (domestic and international)	**31.2**	**988**	**9%**
Note: Numbers may not add to totals due to rounding			

Source: ICF analysis of Visit England, 2015 and MENE, 2016

Recent trends in tourism activities in the north east marine plan areas are broadly consistent with the national trends. The area has experienced a decline in the total number of trips and visitor days between 2010 and 2015 (each declining by -0.3% p.a.), while associated expenditures have increased in real terms (by 0.7% p.a.)[36].

The assumptions used to develop the BAU, N@W and LS scenarios for tourism and recreation in the north east marine plan areas are provided in Table 121. The projected visitor days, spend and associated GVA and employment impacts under each of the three scenarios are shown in Figure 170.

Table 121: Assumptions and impacts under the future scenarios for tourism and recreation in the north east marine plan areas

Aspect	Scenario		
	Business as Usual	**Nature @ Work**	**Local Stewardship**
Application to the sector	Participation in tourism and recreation activities are in line with current trends. Whilst some activities see growth, there is no change in the overall level of activity. Over the medium term, declining participation trends level out and an increasing population provides a key impetus for growth.	There is a minor increase in tourism and recreation activities relative to the BAU. Growth is expected to be broadly in line with the national trend. Key activities such as angling, diving and wildlife watching are less prevalent in the north east than further south and hence the region does not experience the full benefit of shifts towards nature-based activities. But more general coastal tourism activities (e.g. coastal walking), particularly in rural and remote locations, will support growth.	Growth is expected to be slightly above the national trend level. Whilst the region will benefit from greater retention of coastal tourists, this will be partially offset by the fact that the regional market is currently relatively reliant on inflows of coastal tourists.
Assumptions	No change in the short-term to 2022 as growth in some activities is likely to be offset by declines in others, resulting in no overall change in the short-term. Participation rates are expected to start increasing in the longer term in line with projected population growth for the north east marine plan areas.	No variation from the BAU scenario in the short term as changes in market demand and supply take time to become established. 1% pa uplift in all activities from 2022 to 2036, resulting from population growth and a healthier marine environment. Boating and cruise activities will only grow at 1% pa from 2022 to 2026 and then experience zero growth from 2027 to 2036	No variation from the BAU scenario in the short term as changes in market demand and supply take time to become established. Visitor days, spend and impacts increase in line with projected population growth for north east marine plan areas from 2022 to 2036. 0.5% pa uplift in GVA and employment from localised supply chains from 2022 to 2036.

[36] Based on sub-national data from the GB Tourism and Day Visits Surveys and the International Passenger Survey

Aspect	Scenario		
	Business as Usual	Nature @ Work	Local Stewardship
		due to reduced infrastructure developments. Additional 1% pa uplift in 'environment focused' recreational activities (diving, angling, etc.) from 2022 to 2036.	More localised tourism trends resulting in: • a 10% reduction in cruise visitors and overseas visits, nights and spend by 2036 • a 5% reduction in overnight visits from outside the north east by 2036 • a 10% increase in day visits and spend by 2036.

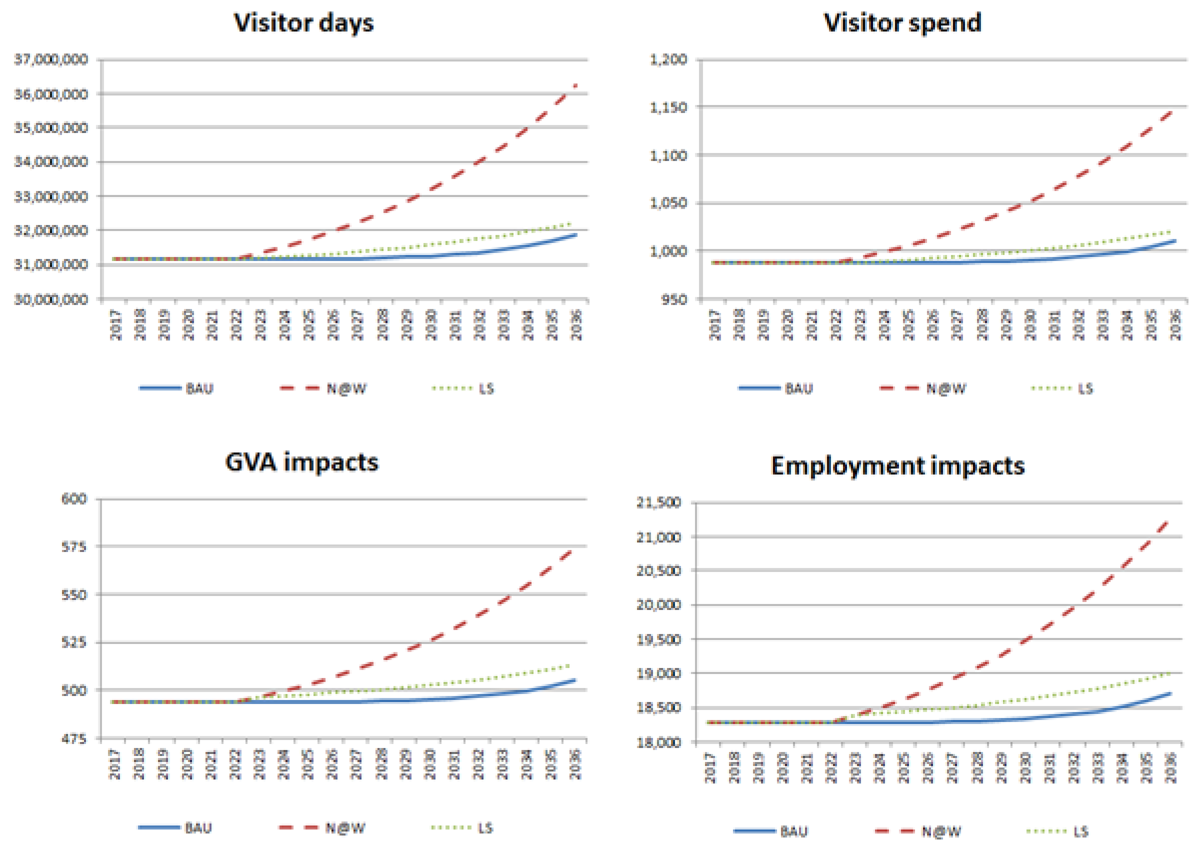


Figure 170: Projected visitor days, spend and associated GVA and employment impacts for all marine and coastal tourism and recreation (north east marine plan area)

6-year projection

There is expected to be zero growth in visitor days, spend and associated impacts between 2016 and 2022 in the north east marine plan areas.

6 to 20 year projection

The projected numbers of visitor days, spend and associated impacts are presented in Figure 7 and Table 18 for each scenario. This shows that visitor days, spend and GVA and employment impacts are projected to increase between 2022 and 2036 in the north east marine plan areas by:

- 2% under the BAU scenario. This is the lowest of all marine plan areas and reflects the relatively low projections of population growth in the north east marine plan areas over this period.
- 3-4% under the local stewardship scenario. This is also the lowest of all marine plan areas and also reflects the low projections of population growth as well as the relatively high proportion of overnight visitors from outside the north east, which are projected to decline by 10% under this scenario.
- 16% under the nature at work scenario. This is broadly consistent with the other regions but the gap between this and the other two scenarios is most significant in the north east.

Potential trade-offs

The main potential interactions for future tourism and recreation are likely to be:

- Natural environment (habitat damage, visual and noise disturbance)
- Aquaculture.

Within the north east marine plan areas, growth in coastal tourism and recreational activity is predicted under all scenarios. Potential ecological impacts can be minimised through visitor management. Existing marine recreational activities are likely to limit the scope for coastal/nearshore aquaculture development.

16.3 North west

The north west inshore marine plan area covers an area of approximately 1,280km of coastline from the Solway Firth border with Scotland to the River Dee border with Wales. It covers the coastal areas of Merseyside, Cheshire, Lancashire and Cumbria. It is also consistent with the North West region, which makes it easier to estimate the scale of tourism and recreation activities and impacts in this area.

The north west inshore marine plan area is estimated to account for 12% of all day visits to the coast in England and 14% of day visit expenditures. This is a slightly higher share than for overnight stays as it is estimated to account for 10% of all domestic overnight trips to coastal areas of England, 9% of the tourism nights and 8% of the associated expenditures. This greater share of day visits compared to overnight stays is likely to be due to the close proximity of the North West coast to some large urban areas including Liverpool and Manchester. Further, analysis of data suggests that the north west marine plan areas also account for 10% of international visitor expenditures in coastal areas of England.

When added together, these estimates suggest that visitors spend approximately 35m days/nights and more than £1.2 billion in the north west marine plan areas. These expenditures are estimated to directly support £0.6 billion of GVA and almost 23,000 FTE jobs in the north west marine plan areas. These estimates are significantly lower than the south west marine plan areas but are higher than the shares of marine and coastal activities in the south east and north east marine plan areas.

Table 122: Total volume, value and impact of all coastal tourism and recreation trips in the north west marine plan area, 2015

Type of visitor	Visitor nights / days (m)	Visitor spend (£m)	Direct GVA impacts (£m)	Direct employment impacts
Domestic overnight trips	5.9	412	206	7,600
Day visits	14.4	616	308	11,400
Other 'non-tourist' trips	13.4	129	64	2,400
Total domestic trips	***33.7***	***1,156***	***578***	***21,400***
International overnight trips	1.2	73	36	1,350
Total trips (domestic and international)	**34.8**	**1,229**	**614**	**22,750**
Note: Numbers may not add to totals due to rounding				

Source: ICF analysis of Visit England, 2015 and MENE, 2016

A spatial analysis of beaches, marina berths, cruise passengers and charter boats suggests that the north west inshore marine plan area includes:

- 55 beaches (including the Blue Flag beach at South Beach, Blackpool), representing 7% of all English beaches. The distribution of beaches is broadly consistent with the length of coastline of each county, with 29 beaches in Cumbria, 13 in Merseyside and another 13 in Lancashire.
- 6 coastal marinas and 1,427 coastal marina berths, representing 4% of all coastal berths in England (British Marine Federation Tourism, 2014).
- 9 charter boats for sea fishing, representing 2% of the total across England as a whole (Defra, 2012). Sea angling by boat and shore occurs along the North West coast with particular concentrations around Liverpool Bay, Blackpool, Morecambe and Barrow in Furness (Drew Associates, 2004).
- 16% of all cruise passengers visiting English ports (http://www.cruiseeurope.com/). The north west inshore marine plan area is home to some large ports capable of accommodating and attracting cruise ships, including the Port of Barrow and Liverpool.

These estimates suggest that the north west inshore marine plan area has the smallest number of beaches, marina berths and sea fishing charter boats of all of the marine plan areas. However, it also has a relatively high proportion of cruise passengers and day visitors and expenditures. Table 12 presents the results of the analysis, which suggests that the north west marine plan areas account for 11% of all marine recreation and coastal tourism activities in England. This is significantly lower than the south west marine plan areas but is slightly higher than the shares of marine and coastal activities in the south east and north east marine plan areas.

Table 123: Estimated volume and value of coastal tourism and recreation activities in the north west marine plan area, 2015

Type of activity	Visitor nights / days (m)	Visitor spend (£m)	% of the total spend in England for each activity
Cruising	0.08	6	16%
Boating	0.4	14	4%
Beach activities	3.4	120	7%
Coastal walking	6.4	224	11%
Sea angling	0.3	11	2%
Other recreational activities	0.4	13	11%
Other tourism activities	22.7	767	14%
Total domestic trips	***33.7***	***1,156***	***12%***
International overnight trips	1.2	73	10%
Total trips (domestic and international)	**34.8**	**1,229**	**11%**
Note: Numbers may not add to totals due to rounding			

Source: ICF analysis of Visit England, 2015 and MENE, 2016

Recent trends in tourism activities in the north west marine plan areas suggest there has been minimal change in the total numbers of trips, days and spend since 2010, as the changes for the different types of visitor have offset one another. As a result, the north west marine plan areas has experienced a very small decline in the total number of trips and visitor days between 2010 and 2015 (each declining by 0.2% p.a.) and very small growth in overall trip expenditures (0.1% p.a.)[37].

The assumptions used to develop the BAU, N@W and LS scenarios for tourism and recreation in the north west marine plan areas are provided in Table 124. The projected visitor days, spend and associated GVA and employment impacts under each of the three scenarios is shown in Figure 171.

[37] Based on sub-national data from the GB Tourism and Day Visits Surveys and the International Passenger Survey

Table 124: Assumptions and impacts under the future scenarios for tourism and recreation in the north west marine plan areas

Aspect	Scenario		
	Business as Usual	**Nature @ Work**	**Local Stewardship**
Application to the sector	Participation in tourism and recreation activities are in line with current trends. Whilst some activities see growth, there is no change in the overall level of activity. Over the medium term, declining participation trends level out and an increasing population provide a key impetus for growth.	Growth is expected to be slightly below the national trend, but still above the BAU case. The north west marine plan areas are not expected to reap the benefits of the changes in consumer preferences as the tourism market is less well aligned for activities to engage people with the marine environment. This is expected to change to some extent over the longer term, as the market adjusts.	Growth is expected to be above the national trend level. A relatively low proportion of overnight tourists are from outside the region and the region currently has a net outflow of coastal tourists. The north west marine plan areas are less likely to be affected by the loss of coastal tourists from outside of the region, and likely to benefit more than other regions from a reduction in the net outflows of local tourists to other regional coasts.
Assumptions	No change in the short-term to 2022 as growth in some activities is likely to be offset by declines in others, resulting in no overall change in the short-term. Participation rates are expected to start increasing in the longer term in line with projected population growth for the north west marine plan areas.	No variation from the BAU scenario in the short term as changes in market demand and supply take time to become established. 1% pa uplift in all activities from 2022 to 2036, resulting from population growth and a healthier marine environment. Boating and cruise activities will only grow at 1% pa from 2022 to 2026 and then experience zero growth from 2027 to 2036 due to reduced infrastructure developments. Additional 1% pa uplift in 'environment focused' recreational activities (diving, angling, etc.) from 2022 to 2036.	No variation from the BAU scenario in the short term as changes in market demand and supply take time to become established. Visitor days, spend and impacts increase in line with projected population growth for north west marine plan areas from 2022 to 2036. 0.5% pa uplift in GVA and employment from localised supply chains from 2022 to 2036. More localised tourism trends resulting in: • a 10% reduction in cruise visitors and overseas visits, nights and spend by 2036 • a 5% reduction in overnight visits from outside the North West region by 2036 • a 10% increase in day visits and spend by 2036.

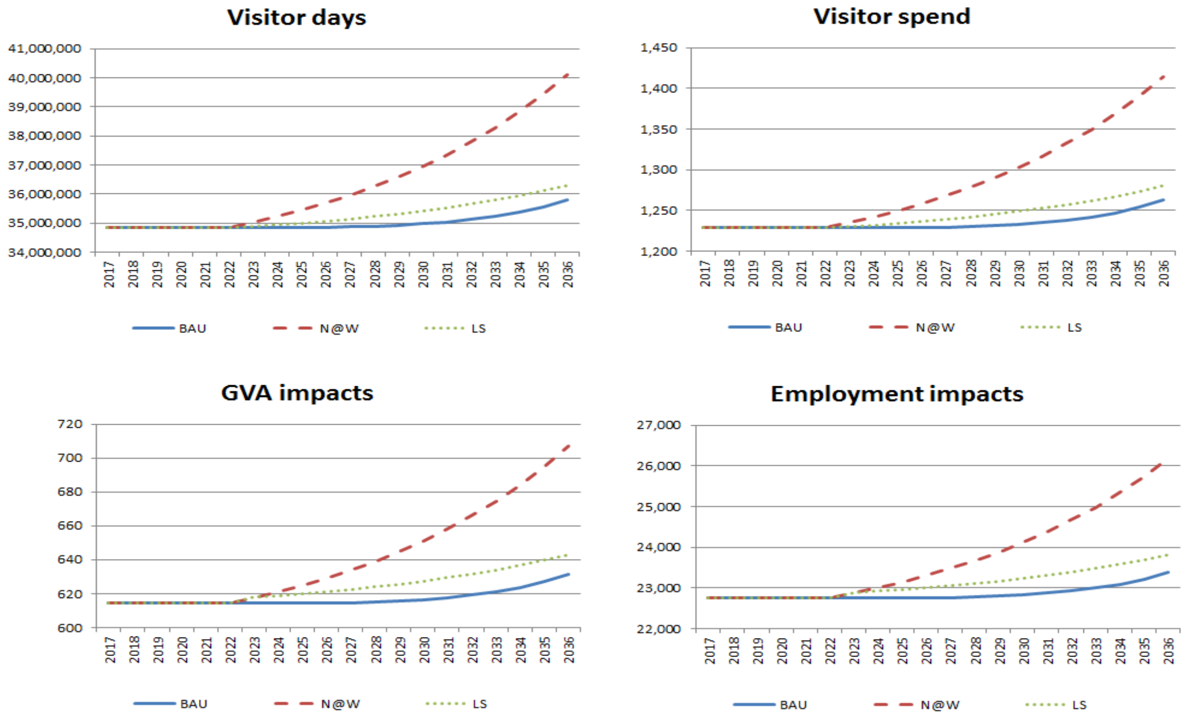


Figure 171: Projected visitor days, spend and associated GVA and employment impacts for all marine and coastal tourism and recreation (north west marine plan area)

6-year projection

As at the national level, there is expected to be zero growth in visitor days, spend and associated impacts between 2016 and 2022. This is due to the conflicting recent trends between different types of activity and visitor, and an overall reduction in participation. Any significant changes in market demand and supply are expected to take time to become established and hence not be apparent during this six year period.

6 to 20 year projection

Figure 6 and Table 14 summarise the projected number of visitor days, spend and associated impacts under each scenario. Overall, visitor days, spend (in real prices) and GVA and employment impacts in the north west marine plan areas are expected to increase between 2022 and 2036 by:

- 3% under the BAU scenario
- 4-5% under the local stewardship scenario
- 15% under the nature at work scenario.

Growth is expected to be strongest under the nature at work scenario, although the 15% increase is the smallest of all of the marine plan areas. This is due to the relatively lower weight of marine environmental-related activities compared to other areas, such that the potential uplift under this scenario is more limited than for the other marine plan areas.

The projected growth under the BAU scenario is also relatively low, as in the North East, as a result of the lower projections for future population growth in these areas relative to the south east and south west marine plan areas.

Potential trade-offs

The potential trade-offs are similar to the north east marine plan areas.

16.4 South east

The south east marine plan area covers an area of approximately 1,400km of coastline from Felixstowe to Dover. It therefore covers the whole of the Essex coastline, and a large proportion of the north and east Kent coast from Dartford to Dover.

The area is significantly smaller than the other marine plan areas in terms of its share of tourism activity in coastal areas of England. It represents 6% of all overnight trips made by English residents in coastal areas but only 4% in terms of the number of visitor nights and associated expenditures. However, despite its close proximity to London, its share of day visits and expenditures are only slightly higher at 7% and 6% of the respective England totals. The area is estimated to have a slightly higher share of expenditures of international visitors at 9% of the total for all English coastal areas.

Table 125: Total volume, value and impact of all coastal tourism and recreation trips in the north east marine plan area, 2015

Type of visitor	Visitor nights / days (m)	Visitor spend (£m)	Direct GVA impacts (£m)	Direct employment impacts
Domestic overnight trips	3.2	189	95	3,500
Day visits	7.9	282	141	5,200
Other ‘non-tourist’ trips	7.7	74	37	1,400
Total domestic trips	***18.7***	***545***	***273***	***10,100***
International overnight trips	1.3	62	31	1,150
Total trips (domestic and international)	**20.1**	**607**	**304**	**11,250**

Note: Numbers may not add to totals due to rounding

Source: ICF analysis of Visit England, 2015 and MENE, 2016

Overall the south east marine plan area accounts for just 6% of all visitor nights/days and expenditures in coastal areas of England. This equates to approximately 20 million visitor nights/days and £0.6 billion of visitor expenditures. These expenditures are estimated to directly support £0.3 billion of GVA and 11,250 FTE jobs in the south east marine plan area. This is significantly lower than the estimates for the other marine plan areas.

A spatial analysis of beaches, marina berths and charter boats suggests that the south east marine plan area includes:

- 61 beaches, including 24 in Essex and 37 in Kent (between Dartford and Dover). These beaches are very high in quality and one in four beaches in this area is classified as a Blue Flag beach (i.e. 16 of the 61 beaches are Blue Flag beaches). The south east marine plan area therefore represents 8% of all beaches in England and 24% of all Blue Flag beaches in England.
- 29 coastal marinas and 6,169 coastal marina berths, representing 17% of all coastal berths in England (British Marine Federation Tourism, 2014).
- 82 charter boats for sea fishing, representing 21% of the English total (Defra, 2012). There are particular concentrations of sea fishing boats in Dover, Ramsgate, Southend, Burnham, Bradwell and Lowestoft, while shore angling is popular all along the Kent and Essex coasts (Drew Associates, 2004).
- Approximately half of all cruise passengers visiting English ports due to the presence of significant ports at Dover and Tilbury.

These estimates suggest that the south east marine plan area has the largest share of boating and cruising activities of all four marine plan areas. However, some of the other activities, and particularly the number of overall tourism visits and expenditures, are relatively small in the south east marine plan area.

Table 126: Estimated volume and value of coastal tourism and recreation activities in the north west marine plan area, 2015

Type of activity	Visitor nights / days (m)	Visitor spend (£m)	% of the total spend in England for each activity
Cruising	0.3	22	56%
Boating	2.1	62	17%
Beach activities	4.5	133	8%
Coastal walking	3.7	111	6%
Sea angling	3.5	104	21%
Other recreational activities	0.2	7	6%
Other tourism activities	4.4	107	2%
Total domestic trips	**18.7**	**545**	**5%**
International overnight trips	1.3	62	9%
Total trips (domestic and international)	**20.1**	**607**	**6%**
Note: Numbers may not add to totals due to rounding			

Source: ICF analysis of Visit England, 2015 and MENE, 2016

Recent trends in tourism activities in the south east marine plan area are consistent with those at the national level. In the last five years, there has been a very small decline in the number of trips and visitor days (each declining by -0.2% p.a. between 2010 and 2015), although this has been offset by a similarly small increase in expenditures (0.2% p.a.)[38].

The assumptions used to develop the BAU, N@W and LS scenarios for tourism and recreation in the south east marine plan areas are provided in Table 127. The projected visitor days, spend and associated GVA and employment impacts under each of the three scenarios is shown in Figure 172.

Table 127: Assumptions and impacts under the future scenarios for tourism and recreation in the south east marine plan areas

Aspect	**Scenario**		
	Business as Usual	**Nature @ Work**	**Local Stewardship**
Application to the sector	Participation in tourism and recreation activities are in line with current trends. Whilst some activities see growth, there is no change in the overall level of activity. Over the medium term, declining participation trends level out and an increasing population provide a key impetus for growth.	The region will see strong growth in absolute levels of activity as it is already a population location for marine and coastal recreation and tourism. Good accessibility and supply of marine recreation activities will enable an increase in demand to be readily accommodated. However, given the existing popularity of yachting in this area (and other forms of sailing and water-sports) and the existing cyclical constraints imposed by the supply of supporting infrastructure, the region is expected to be disproportionately affected by the longer-term constraints on marina and harbour development, depressing its longer term growth prospects.	The region is expected to grow in line with national trends. It will benefit from the overall increase in domestic tourism. Its coastal tourism flows are more balanced than that of other regions, and the more regionalised changes in preferences are expected to have a more limited effect in the south east.
Assumptions	No change in the short-term to 2022 as growth in some activities is likely to be offset by declines in others, resulting in no overall change in the short-term. Participation rates are	Assumes no variation from the BAU scenario in the short term as changes in market demand and supply take time to become established. Assumes 1% pa uplift in all	Assumes no variation from the BAU scenario in the short term as changes in market demand and supply take time to become established. Assumes visitor days,

[38] Based on sub-national data from the GB Tourism and Day Visits Surveys and the International Passenger Survey

Aspect	Scenario		
	Business as Usual	**Nature @ Work**	**Local Stewardship**
	expected to start increasing in the longer term in line with projected population growth for the south east marine plan area.	activities from 2022 to 2036, resulting from population growth and a healthier marine environment. Assumes that boating and cruise activities will only grow at 1% pa from 2022 to 2026 and then experience zero growth from 2027 to 2036 due to reduced infrastructure developments. Assumes an additional 1% pa uplift in 'environment focused' recreational activities (diving, angling, etc.) from 2022 to 2036.	spend and impacts increase in line with projected population growth for south east marine plan area from 2022 to 2036. Assumes 0.5% pa uplift in GVA and employment from localised supply chains from 2022 to 2036. Assumes more localised tourism trends resulting in: • a 10% reduction in cruise visitors and overseas visits, nights and spend by 2036 • a 5% reduction in overnight visits from outside the South East region by 2036 • a 10% increase in day visits and spend by 2036

6-year projection

As in the other areas, there is expected to be zero growth in visitor days, spend and associated impacts in the south east marine plan area between 2016 and 2022.

6 to 20 year projection

The projected changes in visitor days, spend (in real prices) and GVA and employment impacts over the longer term are expected to be stronger for the south east marine plan area than for any other marine plan area. Figure 8 and Table 22 show that visitor days, spend and impacts in the area are expected to increase between 2022 and 2036 by:

- 7% under the BAU scenario;
- 11% under the local stewardship scenario; and
- 17% under the nature at work scenario.

The relatively large increase under the BAU and local stewardship scenarios is due to the relatively strong population projections for the South East.

Growth is again expected to be strongest under the nature at work scenario and the south east marine plan area is projected to benefit from the relatively large scale of sea angling activities, which are dependent on the health of the marine environment. However, growth under this scenario is also likely to be somewhat constrained during the period from 2026 and 2036, due to the lack of projected growth in boating and cruising activities, which are relatively significant activities in the south east marine plan area. This is due to the anticipated constraints on infrastructure developments in the medium to long term.

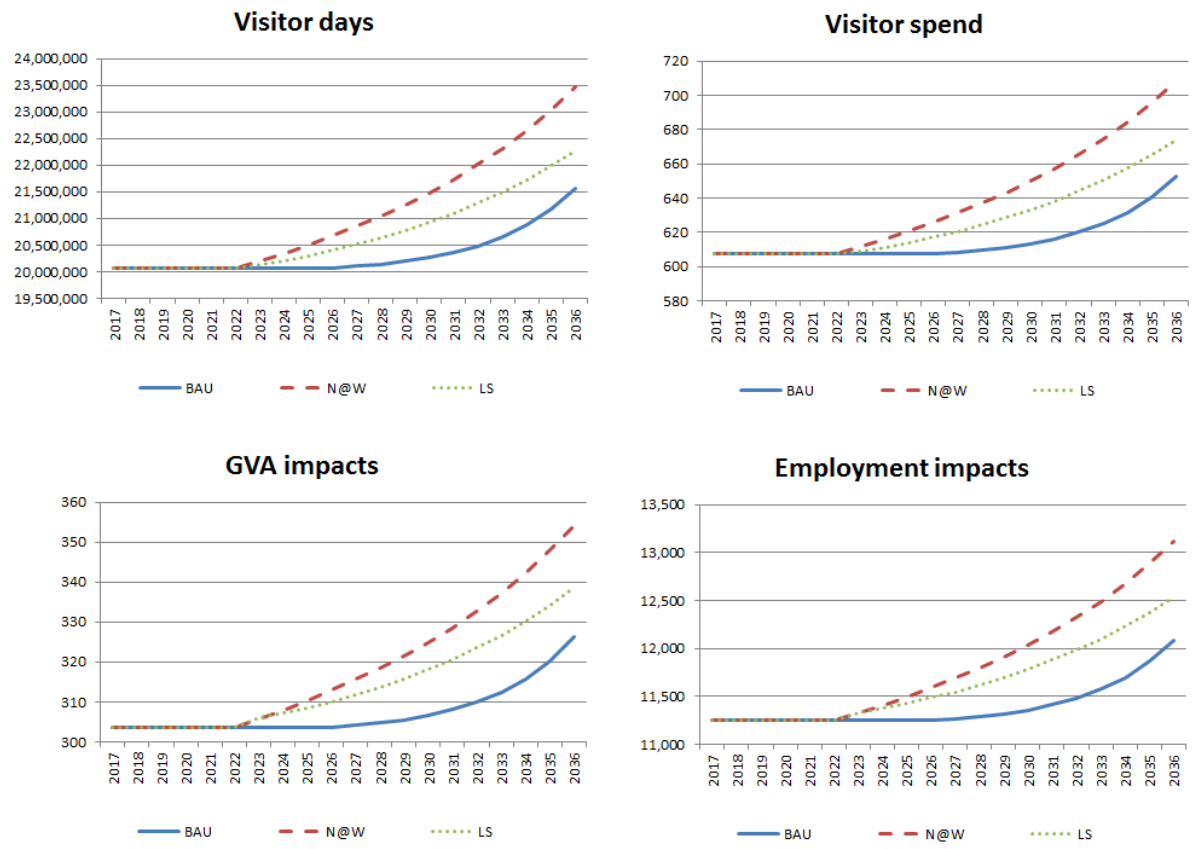


Figure 172: Projected visitor days, spend and associated GVA and employment impacts for all marine and coastal tourism and recreation (south east marine plan area)

Potential trade-offs

The potential trade-offs are similar to the north east marine plan areas.

16.5 South west

The south west marine plan areas cover a relatively large area of approximately 2,000km of coastline from the River Severn border with Wales to the River Dart in Devon. It covers Cornwall and the Isles of Scilly, the north coasts of Devon and Somerset, the Severn Estuary, and approximately half of the south Devon coast, from Plymouth to Dartmouth. It represents a key area for coastal tourism and recreation activities in England and there are significant impacts associated with all of the individual activities within this marine plan area.

The national estimates of coastal tourism visits and expenditures, presented above for England, have been disaggregated by marine plan area. For domestic trips and expenditures (i.e. Visit England and MENE data), this has been based on data from the 2013 GB tourism and day visit surveys for all local authorities in England. The data suggest that the south west marine plan areas account for 25% of all overnight trips to coastal areas in England, 32% of the nights spent in coastal areas and 33% of the associated visitor expenditures. It is also estimated to account for 12% of all day visits and associated expenditures. The significant difference between overnight and day visits is because the south west is a popular holiday destination for many England residents and therefore attracts a relatively large proportion of overnight visitors.

IPS data is available at county level and estimates suggest that the south west marine plan areas account for 4% of all international visitor expenditures in England (including coastal and inland destinations). However, applying assumptions on the likelihood of international tourists visiting the coast[39], and assuming that the duration of such trips is consistent with domestic overnight visitors, suggests that the south west marine plan areas account for 37% of all international visitor expenditures in coastal areas of England.

Estimates for visitor days, spend and impacts of each type of visitor are presented in Table 7. These combine to suggest that 68m days/nights were spent in the south west marine plan areas in 2015 and were associated with almost £2.5bn of spending in the local economy. Applying the same tourism metrics as at the national level, suggests that these visitor expenditures support approximately £1.2bn of GVA and almost 46,000 FTE jobs in the south west marine plan areas.

Table 128: Total volume, value and impact of all coastal tourism and recreation trips in the south west marine plan areas, 2015

Type of visitor	Visitor nights / days (m)	Visitor spend (£m)	Direct GVA impacts (£m)	Direct employment impacts
Domestic overnight trips	22.8	1,441	720	26,700
Day visits	14.4	523	214	9,700
Other 'non-tourist' trips	26.1	252	126	4,700
Total domestic trips	***63.2***	***2,215***	***1,108***	***41,000***
International overnight trips	4.8	262	131	4,900
Total trips (domestic and international)	**68.0**	**2,477**	**1,239**	**45,900**
Note: Numbers may not add to totals due to rounding				

Source: ICF analysis of Visit England, 2015 and MENE, 2016

The national estimates of visitor days and expenditures for each activity have been disaggregated based on the distribution of beaches, marina berths, cruise passengers, sea fishing charter boats and overall tourism expenditures within each marine plan area. For example, as many of the tourism and recreation activities are beach based activities, this provides a useful means of disaggregating activities such

[39] 48% of visitors to the south west marine plan area are assumed to visit the coast compared to 8% of international visitors to England as a whole, based on Visit Britain (2013), In bound tourism to Britain regions

as leisure time on the beach and surfing. In summary the south west marine plan areas account for:

- 253 beaches (including 10 Blue Flag beaches), representing 34% of all beaches in England. This includes 157 beaches in Cornwall and the Isles of Scilly, 62 in the relevant areas of Devon, and 34 in Somerset.
- 28 coastal marinas and 4,822 berths, representing 13% of all coastal marina berths in England (British Marine Federation Tourism, 2014).
- 118 charter boats for sea fishing, representing 30% of the total across England as a whole (Defra, 2012).
- 4% of cruise passengers visiting English ports (Cruise Europe website). This is relatively low compared to the other types of activity and is due to constraints in terms of the availability of the port infrastructure required to accommodate cruise ships compared to some other regions such as the south, east and south east marine plan areas.

These estimates have been used to disaggregate the national estimates of relevant recreational activities. All other activities not linked to the number of beaches, marine berths, charter boats for sea fishing, or cruise passengers, have been disaggregated based on the total expenditures of visitors in different coastal areas. The results of the analysis are presented in Table 8. It shows that the south west marine plan areas account for 23% of all coastal activities in England on average. This increases to 34% for beach-based activities, given the relatively high number of beaches in the area, but is lower for cruising and boating activities given the relatively small number of cruise passengers and marina berths compared to other regions.

Table 129: Estimated volume and value of coastal tourism and recreation activities in the south west marine plan area, 2015

Type of activity	Visitor nights / days (m)	Visitor spend (£m)	% of the total spend in England for each activity
Cruising	0.02	2	4%
Boating	1.4	48	13%
Beach activities	16.0	553	34%
Coastal walking	12.4	427	23%
Sea angling	4.3	150	30%
Other recreational activities	0.7	25	23%
Other tourism activities	28.3	879	18%
Total domestic trips	***63.2***	***2,083***	***22%***
International overnight trips	4.8	262	37%
Total trips (domestic and international)	**68.0**	**2,345**	**23%**
Note: Numbers may not add to totals due to rounding			

Source: ICF analysis of Visit England, 2015 and MENE, 2016

Tourism and recreation activities are widely distributed along the full length of coast for the south west marine plan areas. For example, the south west coast path covers most of this area from Minehead in Somerset, covering the north and south coasts of Devon and Cornwall, and continues to Dorset, while beaches are also located throughout Devon, Cornwall and Somerset. However, there are also spatial concentrations for some activities. For example, there are notable differences in sea, wind and surf conditions between the north Atlantic coast and the south coasts of Devon and Cornwall. As a result, boating, diving and swimming activities are more likely to occur on the more sheltered south coast, while surfing activities are more likely to occur on the more exposed north coast.

Sea angling from boat and shore are also popular in the south west. The warmer waters of the Gulf Stream provide opportunities for an increasing number of warm water species. Boat angling is popular along the south Cornwall and Devon coasts with significant numbers of charter fishing boats in Looe, Mevagissey, Plymouth and Dartmouth, and the north Cornwall, Devon and Somerset coasts (particularly Padstow, Newquay, Ilfracombe, Watchet, Minehead and Portishead). Shore angling is also popular along the Cornish and south Devon coast, with particular concentrations around Plymouth and south east Cornwall, Mevagissey, The Lizard, Falmouth, St Ives and Padstow (Drew Associates, 2004).

Recent trends in tourism activities in the south west marine plan areas have mirrored those described above at the national level with a slight decline in the number of trips and visitor days between 2010 and 2015 (-0.6% p.a. and -0.5% p.a. respectively) and an increase of 1.1% p.a. in visitor expenditures[40].

The assumptions used to develop the BAU, N@W and LS scenarios for tourism and recreation in the south west marine plan areas are provided in Table 130. The projected visitor days, spend and associated GVA and employment impacts under each of the three scenarios is shown in Figure 173.

Table 130: Assumptions and impacts under the future scenarios for tourism and recreation in the south west marine plan areas

Aspect	Scenario		
	Business as Usual	**Nature @ Work**	**Local Stewardship**
Application to the sector	Participation in tourism and recreation activities are in line with current trends. Whilst some activities see growth, there is no change in the overall level of activity. Over the medium term, declining participation trends level out and an increasing population provide a key impetus for growth.	The region will see relatively strong growth. It is already a popular location for marine and coastal recreation and tourism. As a major destination for activities such as marine wildlife watching, diving and angling, and engagement with the marine environment more generally, the region is expected to benefit more than other regions from the shift in	The increase in domestic tourism will support growth in the south west. However, as the region is currently a major net recipient of domestic tourists, this domestic tourism growth will be partially tempered by a rebalancing of activity as UK residents choose to undertake more activities closer to home (i.e. a relative reduction in inter-regional domestic tourism to

[40] Based on sub-national data from the GB Tourism and Day Visits Surveys and the International Passenger Survey

Aspect	Scenario		
	Business as Usual	**Nature @ Work**	**Local Stewardship**
		consumer preferences towards nature-based activities. Some limitations may emerge over the longer terms as a result of constraints on marina and harbour development, but these effects are likely to be more moderate than in the south east.	the south west compared to other regions).
Assumptions	No change in the short-term to 2022 as growth in some activities is likely to be offset by declines in others, resulting in no overall change in the short-term. Participation rates are expected to start increasing in the longer term in line with projected population growth for the south west marine plan areas.	No variation from the BAU scenario in the short term as changes in market demand and supply take time to become established. 1% pa uplift (on the BAU) in all activities from 2022 to 2036, resulting from population growth and a healthier marine environment. Boating and cruise activities will only grow at 1% pa from 2022 to 2026 and then experience zero growth from 2027 to 2036 due to reduced infrastructure developments. Additional 1% pa uplift in 'environment focused' recreational activities (diving, angling, etc.) from 2022 to 2036.	Assumes no variation from the BAU scenario in the short term as changes in market demand and supply take time to become established. Assumes visitor days, spend and impacts increase in line with projected population growth for south west marine plan areas from 2022 to 2036. Assumes 0.5% pa uplift in GVA and employment from localised supply chains from 2022 to 2036. Assumes more localised tourism trends resulting in: • a 10% reduction in cruise visitors and overseas visits, nights and spend by 2036 • a 5% reduction in overnight visits from outside the South West region by 2036 • a 10% increase in day visits and spend by 2036.

6-year projection

As at the national level, there is expected to be zero growth in visitor days, spend and associated impacts between 2016 and 2022. This is due to the conflicting recent trends between different types of activity and visitor, and an overall reduction in participation. Any significant changes in market demand and supply are expected to take time to become established and hence not be apparent during this six year period.

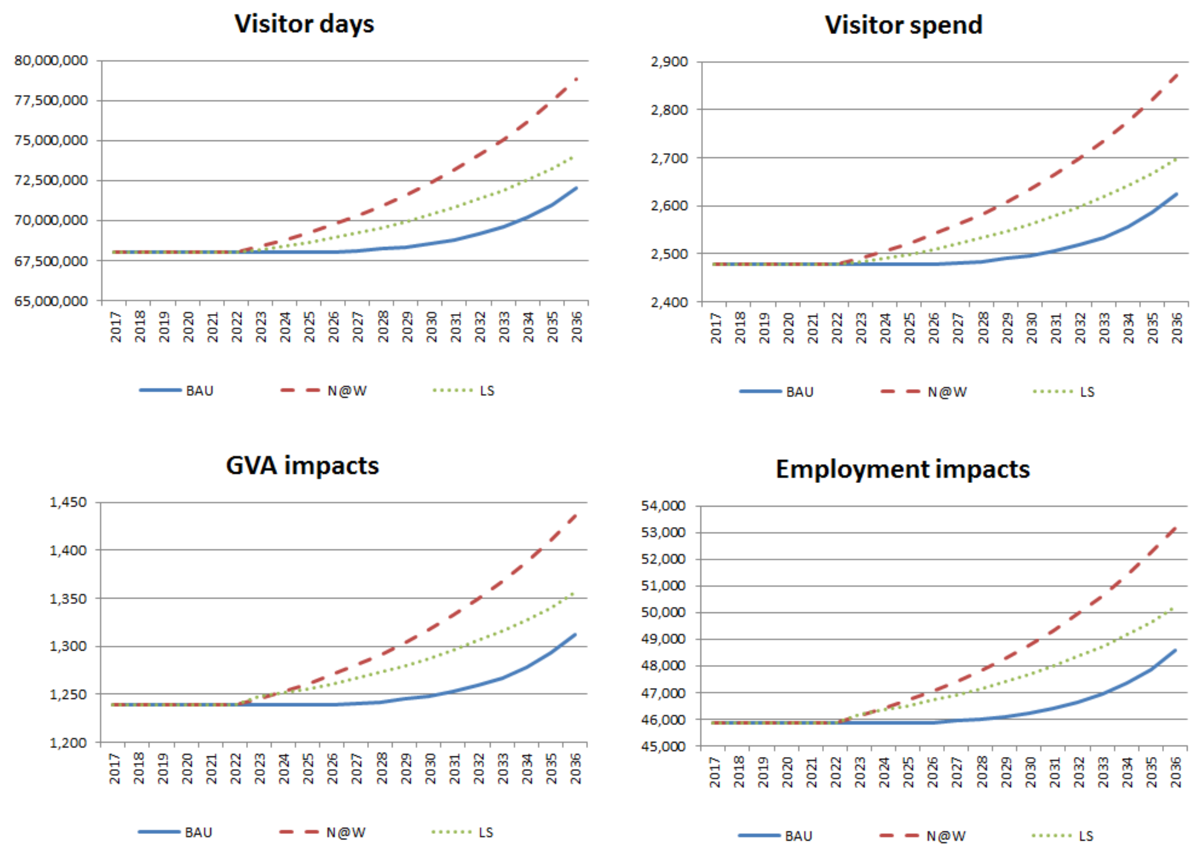


Figure 173 Projected visitor days, spend and associated GVA and employment impacts for all marine and coastal tourism and recreation (south west marine plan area)

6 to 20 year projection

Visitor days, spend and associated GVA and employment impacts are projected to grow in the longer term under each scenario, as presented in Figure 5 and Table 10 below. As described above at the national level, growth is expected to be strongest under the nature at work scenario as improvements to the health of the marine environment, and changes in consumer preferences, drive increases in demand for tourism and recreation activities in coastal areas. This is likely to be particularly important for the south west marine plan areas, given that the local economy is highly dependent on tourism and the quality of the local marine and coastal environment.

Overall, visitor days, spend (in real prices) and GVA/employment impacts are expected to increase between 2022 and 2036 in the south west marine plan areas by:

- 6% under the BAU scenario;
- 9% under the local stewardship scenario; and
- 16% under the nature at work scenario.

Potential trade-offs

The potential trade-offs are similar to the north east marine plan areas.

References

ABP website. Webpage on Ipswich port. Available at: http://www.abports.co.uk/Our_Locations/Short_Sea_Ports/Ipswich/ [Accessed 21/02/17].

ABPmer (2016) Future Trends in the Celtic Seas, Summary Report, ABPmer Report No. R.2584a. A report produced by ABPmer and ICF International for the Celtic Seas Partnership, August 2016.

ABPmer & ICF International (2016). Future Trends in the Celtic Seas, Baseline Report, ABPmer Report No. R.2584c. A report produced by ABPmer & ICF International for Celtic Seas Partnership, August 2016.

ABPmer and Stirling University 2015. A Risk Benefit Analysis of Mariculture as a means to reduce the impacts of terrestrial production of food and energy. A study commissioned by the Scottish Aquaculture Research Forum (SARF) and WWF-UK. Available online: http://www.sarf.org.uk/

ABPmer and Stirling University 2016. Strategic Considerations for Locational Regulation of Shellfish Aquaculture in Scotland. A study commissioned by the Scottish Aquaculture Research Forum (SARF). http://www.sarf.org.uk/

Acoura (2015a). Project Inshore: Stage 3 – Strategic sustainability review. North Eastern Inshore Fisheries and Conservation Authority.

Acoura (2015b). Project Inshore: Stage 3 – Strategic sustainability review. Northumberland Inshore Fisheries and Conservation Authority.

Acoura (2015c). Project Inshore: Stage 3 – Strategic sustainability review. Cornwall Inshore Fisheries and Conservation Authority.

Acoura (2015d). Project Inshore: Stage 3 – Strategic sustainability review. Devon and Severn Inshore Fisheries and Conservation Authority.

ADS website (Aerospace, Defence, Security and Space sector body). Facts and Figures 2016. Available online at: https://www.adsgroup.org.uk/facts2016/ [Accessed 01/03/17].

AEA. (2008). Future Value of Coal Carbon Abatement Technologies to UK Industry. URN 09/738. Final report to the Department of Energy and Climate Change. ED02733478. Version 1. December 2008. Available online at: http://ee.ricardo.com/cms/assets/MediaRelease/PR_190609.pdf [Accessed 01/03/17].

Atlantis Resource Ltd. (2017). Meygen Update – AR1500 Turbine Deployed In Record Time [Online] Available at: https://www.atlantisresourcesltd.com/2017/02/20/2225/ [Accessed 22/02/17]

Barclay, C. (2012). Wind Farm consents – offshore [Online] Available at: https://www.google.co.uk/url?sa=t&rct=j&q=&esrc=s&source=web&cd=1&ved=0ahUKEwiJiqao3vHRAhUhKsAKHXuGCigQFggaMAA&url=http%3A%2F%2Fresearchbriefings.files.parliament.uk%2Fdocuments%2FSN05088%2FSN05088.pdf&usg=AFQjCNHiEGynLpO_ECQERuUSOBtDeVB40g&sig2=3Ouhvfy7B6k3CnJwm-Jyqw&bvm=bv.146073913,d.d2s&cad=rja [Accessed 02/02/17]

BBSRC and NERC 2015. Towards a research and innovation initiative in sustainable aquaculture. Available online: http://www.bbsrc.ac.uk/documents/1511-research-innovation-initiative-sustainable-aquaculture-pdf/ [Accessed 02/02/17]

Beatty, C., Fothergill, S., Gore, T. (2014). Seaside Towns in the Age of Austerity. Recent trends in employment in seaside tourism in England and Wales. Centre for 7Regional Economic and Social Research at Sheffield Hallam University.

British Marine Aggregate Producers Association (BMAPA). (2016). Strength from the depths. Tenth sustainable development report for the British marine aggregate industry. December 2016. Available online at: http://www.mineralproducts.org/documents/BMAPA_SD_Report_final_Feb17.pdf [Accessed 02/02/17]

British Marine Federation Tourism (2014). Economic Benefits of UK Boating Tourism.

Brooks, K. 2016. Social licence to operate: Why, how and so what of social licence. Presentation to 'A social licence to operate (SLO) workshop – A Seafish Common Language Group special event. Available online: http://www.seafish.org/media/1639377/seafishslo_workshoppresentation.pdf [Accessed 02/02/17]

Brown, I., Harrison, P., Ashley, J., Berry, P., Everard, M., Firbank, L., Hull, S., Lundy, L., Quine, C., Rowan, J., Wade, R., Walmsley, S., Watts, K., & Kass, G. (2014). UK National Ecosystem Assessment Follow-on. Work Package Report 8: Robust response options: What response options might be used to improve policy and practice for the sustainable delivery of ecosystem services? UNEP-WCMC, LWEC, UK. Available online at http://uknea.unep-wcmc.org/LinkClick.aspx?fileticket=F3RVcJwAlI0%3d&tabid=82. [Accessed 01/03/17].

Brownsort, P., Scott, V. and Sim, G. (2015). Carbon dioxide transport plans for carbon capture and storage in the North Sea region. A summary of existing studies and proposals applicable to the development of Projects of Common Interest. Project: SCCS0123. July, 2015. Scottish Carbon Capture and Storage.

Burbobank Extension (No Date) About Burbo Bank Extension [Online] Available at: http://www.burbobankextension.co.uk/en/about-burbo-bank-extension [Accessed 16/02/17]

Carter L., Burnett D., Drew S., Marle G., Hagadorn L., Bartlett-McNeil D., and Irvine N. (2009). Submarine Cables and the Oceans – Connecting the World. UNEP-

WCMC Biodiversity Series No. 31. ICPC/UNEP/UNEP-WCMC. Available at: https://www.iscpc.org/publications/ [Accessed 02/03/17].

Cefas (2017). Unpublished aquaculture production statistics supplied by Cefas, March 2017.

Cefas (2015). Aquaculture statistics for the UK with a focus on England and Wales: 2012.

Cordah,(2001). Human Activities in the North Sea Relevant To SEA2. Technical report produced for Strategic Environmental Assessment – SEA2.

Cruise Europe website. Available online at: http://www.cruiseeurope.com [Accessed 02/03/17].

Cruise Lines International Association – CLIA (2016). The Cruise Review: UK and Ireland

DBEIS (2016) Digest of UK Energy Statistics 2016 [Online] Available at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/541318/DUKES_2016_Press_Notice.pdf [Accessed 01/03/17]

DECC (2013) Oil and gas: petroleum licensing guidance. 4 December 2012. www.gov.uk/oil-and-gas-petroleum-licensing-guidance. Accessed on 26 March 2013.

Defra, 2015. United Kingdom multiannual national plan for the development of sustainable aquaculture. October 2015.

Deloitte. (2016). A need unsatisfied. Blueprint for enabling investment in CO_2 storage. Report for The Crown Estate. February 2016. Available online at: https://www.thecrownestate.co.uk/media/502093/ei-a-need-unsatisfied-blueprint-for-enabling-investment-in-co2-deloitte.pdf [Accessed 02/03/16].

Deloitte and Oxford Economics (2013). Tourism: jobs and growth - The economic contribution of the tourism economy in the UK (Type II multipliers for tourism in England are estimated to be 2.8 for GVA and 2.2 for employment).

Defra (2012). Sea Angling 2012 – a survey of recreational sea angling activity and economic value in England

Department for Communities and Local Government. (2017). Fixing our broken housing market. Housing White Paper. February 2017. Available online at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/590464/Fixing_our_broken_housing_market_-_print_ready_version.pdf [Accessed 02/03/17].

Department for Culture, Media & Sport (DCMS) (2017). UK Digital Strategy. Available at: https://www.gov.uk/government/publications/uk-digital-strategy [Accessed 02/03/17].

DECC (2011) National Policy Statement for Nuclear Power Generation (EN-6). July 2011.
EDF Hartlepool webpage [Online] Available at: https://www.edfenergy.com/energy/power-stations/hartlepool [Accessed 15/02/17]

Department of Energy and Climate Change (DECC) (2011). National Policy Statement for Nuclear Power Generation (EN-6). July 2011.
EDF Hartlepool webpage [Online] Available at: https://www.edfenergy.com/energy/power-stations/hartlepool [Accessed 15/02/17]

DECC (2012) Energy and Climate Change - Eleventh Report. The Future of Marine Renewables in the UK. February 2012.

DECC (2013) Innovation funding for low-carbon technologies: opportunities for bidders [Online] Available at: www.gov.uk/innovation-funding-for-low-carbon-technologies-opportunities-for-bidders#how-decc-funding-has-been-allocated Accessed on 8 March 2013 [Accessed 17/02/17]

DECC (2016) DECC Public Attitudes Tracker – Wave 17, Summary of key findings April 2016 [Online] Available at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/519488/PAT_Wave_17_Summary_of_key_findings.pdf [Accessed 22/02/17]

Dong (No Date) Hornsea Project One Website [Online] Available at: http://www.hornseaprojectone.co.uk/en/about-hornsea-project-one [Accessed 03/02/17]

Dong energy (2016) DONG Energy divests 50% of Race Bank Offshore Wind Farm to Macquarie [Online] Available at: http://www.dongenergy.com/en/investors/company-announcements/company-announcement-detail?omxid=1518462 [Accessed 16/02/17]

DTI (2003) Our Energy Future – Creating a Low Carbon Economy. Energy White Paper. Department for Trade and Industry.

Dudgeon offshore (No Date) Timetable [Online] Available at: http://dudgeonoffshorewind.co.uk/about/timetable [Accessed 16/02/17]

EC (2017) Projects of Common Interest [Online] Available at: https://ec.europa.eu/energy/en/topics/infrastructure/projects-common-interest [Accessed 14/03/17]

EDF Hartlepool website (2017) [Online] Available at: https://www.edfenergy.com/energy/power-stations/hartlepool [Accessed 01/03/17]

EMU Limited. (2012). South Coast Marine Aggregate Regional Environmental Assessment, Volume 1 and 2. Report for the South Coast Dredging Association. Available online at: www.marine-aggregate-rea.info/scda-south-coast-dredging-association [Accessed 17/02/17]

European Environment Agency (EEA). (2015). State of Europe's Seas. EEA Report, No 2/2015. Copenhagen. Available online at: http://www.eea.europa.eu/publications/state-of-europes-seas [Accessed 28/03/17]

European Subsea Cables Association (2017). Submarine Power Cables [Online] Available at: http://www.escaeu.org/articles/submarine-power-cables/ [Accessed 28/03/17]

DECC (2012). CCS Roadmap Supporting deployment of Carbon Capture and Storage in the UK. April 2012. Available online at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/48317/4899-the-ccs-roadmap.pdf [Accessed 21/02/17].

DECC (2016). DECC Public Attitudes Tracker – Wave 17, Summary of key findings April 2016 [Online] Available at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/519488/PAT_Wave_17_Summary_of_key_findings.pdf [Accessed 22/02/17]

Department of Trade (DTI) (2003). Our Energy Future – Creating a Low Carbon Economy. Energy White Paper. Department for Trade and Industry.

Department for Transport (DfT) (2012). National policy statement for ports. Available at: https://www.gov.uk/government/publications/national-policy-statement-for-ports [Accessed 21/02/17].

DfT (2016a). Port Freight Statistics: 2015 final figures. Available at: https://www.gov.uk/government/statistics/port-freight-statistics-2015-final-figures [Accessed 21/02/17].

DfT (2016b). Final sea passenger statistics: 2015. Available at: https://www.gov.uk/government/statistics/final-sea-passenger-statistics-2015 [Accessed 21/02/17].

Dong (No Date). Hornsea Project One Website [Online] Available at: http://www.hornseaprojectone.co.uk/en/about-hornsea-project-one [Accessed 03/02/17]

Dong energy (2016). DONG Energy divests 50% of Race Bank Offshore Wind Farm to Macquarie [Online] Available at: http://www.dongenergy.com/en/investors/company-announcements/company-announcement-detail?omxid=1518462 [Accessed 16/02/17]

Drew Associates (2004). Research into the Economic Contribution of Sea Angling

DTI (2007) Meeting the Energy Challenge: A White Paper on Energy. May 2007. Available online at www.berr.gov.uk/files/file39387.pdf, accessed on 12 March 2013. Department for Trade and Industry.

Dudgeon offshore (No Date). Timetable Available at: http://dudgeonoffshorewind.co.uk/about/timetable [Accessed 16/02/17]

E3G (2017). North Seas Grid Available at: https://www.e3g.org/showcase/North-Seas-Grid/ [Accessed 17/03/17]

EC (2017). Projects of Common Interest Available at: https://ec.europa.eu/energy/en/topics/infrastructure/projects-common-interest [Accessed 14/03/17]

EDF Hartlepool website (2017). Available at: https://www.edfenergy.com/energy/power-stations/hartlepool [Accessed 01/03/17]

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. Available at: http://www.escaeu.org/news/?newsid=59 [Accessed 02/03/16].

English Seafood Industry Task Force (2016) Seafood 2040 Strategy [Online] Available at: http://www.seafish.org/about-seafish/news-and-events/news/seafood-2040-strategy-for-england

E.ON (2017). Rampion Offshore Wind Farm, Current Status [Online] Available at: https://www.eonenergy.com/About-eon/our-company/generation/planning-for-the-future/wind/offshore/rampion-offshore-wind-farm [Accessed 13/03/17]

Eunomia Research and Consulting Limited. (2011). The East Irish Sea CCS Cluster. A Conceptual Design. February 2011.

European Subsea Cables Association (2016). Submarine Telecommunication Cables [Online] Available at: http://www.escaeu.org/articles/submarine-telecommunications-cables/ [Accessed 20/02/17].

FAO. 2016. The State of World Fisheries and Aquaculture 2016. Contributing to food security and nutrition for all. Rome. 200 pp.

FCI (2012). Food Certification International – Project Inshore: Stage 1. December 2012. Available online at: http://www.seafish.org/media/publications/Project_Inshore_Stage_1_Report.pdf

Global CCS Institute. (2016). The global status of CCS: 2016. Summary Report. Available online at: http://hub.globalccsinstitute.com/sites/default/files/publications/201158/global-status-ccs-2016-summary-report.pdf [Accessed 20/02/17].

Gray, M., Stromberg, P-L., Rodmell, D. (2016). Changes to fishing practices around the UK as a result of the development of offshore windfarms – Phase 1. The Crown Estate, 121 pages. ISBN: 978-1-906410-64-3. Available online at: http://www.thecrownestate.co.uk/media/502008/ei-changes-to-fishing-practices-around-the-uk-as-a-result-of-the-development-of-offshore-windfarms.pdf Accessed 30.03.16.

Gubbins, M., Bricknell, I., Service, M. 2013. Impacts of climate change of aquaculture. Marine Climate Change Impacts Partnership: Science Review, 2013: 318-327.

Hambrey. J. and Evans, S. (2016). SR694 Aquaculture in England, Wales and Northern Ireland: An analysis of the economic contribution and value of the major sub-sectors and the most important farmed species. Final Report to Seafish, September 2016.

ICES (2015b). ICES Advice, Northeast Atlantic Ecoregion. Section 1.6.1.4 Indicators 5, 6, and 7 of DCF Annex XII. Published 17 December 2015. Available at http://www.ices.dk/sites/pub/Publication%20Reports/Advice/2015/2015/DCF_indicators_567.pdf. Accessed 12 January 2016.

Haines-Young, R., Tratalos, J., Birkinshaw, S., Butler, S., Gosling, S., Hull, S., Kass, G., Lewis, E., Lum, R., Norris, K., Potschin, M., & Walmsley, S. (2014). UK National Ecosystem Assessment Follow-on. Work Package Report 7: Operationalising scenarios in the UK National Ecosystem Assessment Follow-on, UNEP-WCMC, LWEC, UK. Available online at http://uknea.unep-wcmc.org/LinkClick.aspx?fileticket=d%2bPcl3V8Sfo%3d&tabid=82. [Accessed 01/03/17].

Hendry, C. (2016) The Roll of Tidal Lagoons, Final Report [Online] Available at: https://hendryreview.files.wordpress.com/2016/08/hendry-review-final-report-english-version.pdf [Accessed 22/02/17]

Highley, D.E., Hetherington, L.E., Brown, T.J., Harrison, D.J. and Jenkins, G.O. (2007). The strategic importance of the marine aggregate industry to the UK. British Geological Survey Research Report, OR/07/019.

HM Government (2011). Marine Policy Statement (MPS). Available online at www.gov.uk/government/publications/uk-marine-policystatement [Accessed 01/03/17].

HM Treasury (2015). Autumn Statement 2015. Available online at: https://www.gov.uk/government/publications/spending-review-and-autumn-statement-2015-documents/spending-review-and-autumn-statement-2015 [Accessed 01/03/17].

HM Treasury (2017). Spring Budget 2017. Available online at: https://www.gov.uk/government/publications/spring-budget-2017-documents [Accessed 26/04/17].

House of Commons Energy and Climate Change Committee. (2016). Future of carbon capture and storage in the UK. Second Report of Session 2015–16. HC 692. February 2016. Available online at: https://www.publications.parliament.uk/pa/cm201516/cmselect/cmenergy/692/692.pdf [Accessed 01/03/17].

IMO (2004). International Convention for the Control and Management of Ships' Ballast Water and Sediments (BWM). Available at: http://www.imo.org/en/About/Conventions/ListOfConventions/Pages/International-Convention-for-the-Control-and-Management-of-Ships'-Ballast-Water-and-Sediments-(BWM).aspx [Accessed 21/02/17].
Infrastructure and Projects Authority. (2016). National Infrastructure Delivery Plan 2016–2021. March 2016. Infrastructure and Projects Authority. Reporting to HM Treasury and Cabinet Office Available online at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/520086/2904569_nidp_deliveryplan.pdf (Accessed March 2017).

Keep Our Future Afloat (KOFAC) (2017). Northwest Shipbuilding webpage. Available at: http://www.navalshipbuilding.co.uk/navalship_nwship.asp [Accessed 01/03/17].

Kemp, A.G. and Stephan, L. (2017) The Prospects for Activity in the UKCS to 2050 under "Lower for Longer" Oil and Gas Price Scenarios, and the Unexploited Potential. NORTH SEA STUDY OCCASIONAL PAPER No. 138. February 2017 [Online] Available at: https://www.abdn.ac.uk/news/documents/nsp-138.pdf [Accessed 03/03/17]

Kent Partnership (2017). CORE - Centre for Offshore Renewable Engineering [Online] Available at: http://www.tgkp.org/kent-centre-for-offshore-renewable-engineering [Accessed 16/02/17]

Land Use Consultants (2016). Scottish Marine Recreation & Tourism Survey 2015

Liverpool City Region Local Enterprise Partnership (2014). Liverpool City Region Superport. Market Analysis Land and Property. March 2014. Available at: https://www.liverpoollep.org/wp-content/uploads/2015/06/LCR-superport-market-analysis-03.2014.pdf [Accessed 26/04/17]

Magnox website (2017). [Online] Available at: https://magnoxsites.com [Accessed 17/02/17]

Marine Science Co-ordination Committee (MCSS). (2014). Economic value and employment in the UK of activities carried out in the marine environment. December 2014. Available online at: http://www.gov.scot/Topics/marine/science/MSCC/PSEG [Accessed 17/02/17]

MCCIP (2013). Ports and Shipping. Available at: www.mccip.org.uk/ [Accessed 01/03/17].

MDS Transmodal (2009). The Mersey Partnership: Liverpool Superport Economic Trends Study. Available at: http://www.knowsley.gov.uk/pdf/LC07_LiverpoolSuperportEconomicTrendsStudy.pdf [Accessed 21/02/17]

MDS Transmodal, (2011). Port Infrastructure Development UK.

Mineral Products Association. (2016a). In Focus: Update on the MPA long-term aggregates supply and demand scenarios (2016-30). October 2016.

Mineral Products Association. (2016b). The Mineral Products Industry at a Glance. 2016 Edition. Available online at: http://www.mineralproducts.org/documents/Mineral_Products_Industry_At_A_Glance_2016.pdf [Accessed 21/02/17]

MMO (2013a). 'South Marine Plan Futures Analysis'. A report produced for the Marine Management Organisation by ABP Marine Environmental Research Ltd, 246 pages. MMO Project No: 1039. ISBN: 000-0-000000-00-0 (This will be added by the MMO).

MMO (2013b). Future trends in Fishing and Aquaculture in the South Inshore and Offshore Marine Plan Areas. A report produced by ABP Marine Environmental Research Ltd, Ichthys Marine Ecological Consulting Ltd and Dr Michael Pawson for the Marine Management Organisation, pp 257. MMO Project No: 1051. ISBN: 978-1-909452-20-6.MMO, 2015.

MMO (2013c). Strategic Scoping Report for marine planning in England. August 2013.

MMO (2013d). Spatial Trends in Shipping Activity. A report produced for the Marine Management Organisation, pp 46. MMO Project No: 1042. ISBN: 978-1-90945212-1. Available at: http://webarchive.nationalarchives.gov.uk/20140108121958/http:/www.marinemanagement.org.uk/evidence/documents/1042.pdf [Accessed 21/02/17]

MMO (2014). Mapping UK Shipping Density and Routes from AIS. A report produced for the Marine Management Organisation, pp 35. MMO Project No: 1066. ISBN: 9781-909452-26-8. Available at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/317770/1066.pdf [Accessed 21/02/17]

MMO (2016a). Economic baseline assessment for the North East, North West, South East and South West marine plans. A report produced for the Marine Management Organisation by Atkins, pp 202. MMO Project No: MMO1119. ISBN: 978-1-909452-41-1. Submitted June 2016. Available online at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/581428/MMO1119_-_Economic_baseline_assessment_for_the_North_East__North_West__South_East_and_South_West_marine_plans_final_report.pdf [Accessed 01/03/17].

MMO (2016b). Marine Plan Areas Sustainability Appraisal. Sustainability Appraisal Scoping Report. A report produced for the Marine Management Organisation.

MMO (2016c). UK Sea Fisheries Statistics 2015. 156 pages. Marine Management Organisation. Available online at www.gov.uk/government/uploads/system/uploads/attachment_data/file/598208/UK_Sea_Fisheries_Statistics_2015_full_report.pdf. Accessed 9 May 2017.

MMO (2017a). Marine plan development workshops announced. 23 January 2017. Available online at: https://www.gov.uk/government/news/marine-plan-development-workshops-announced [Accessed 01/03/17].

MMO (2017b) Fishing Activity for ≥ 15m United Kingdom Vessels 2015. February 2017. Available from environment.data.gov.uk/ds/catalogue. [Accessed 09/03/2017].

Ministry of Defence (2012). Ministry of Defence: byelaws review. Available online at: https://www.gov.uk/guidance/ministry-of-defence-byelaws [Accessed 01/03/17].

MOD (2015). Quarterly Civilian Personnel Report. Oct 2015

MOD (2016a). Defence budget increases for the first time in six years. Available online at: https://www.gov.uk/government/news/defence-budget-increases-for-the-first-time-in-six-years [Accessed 01/03/17].

MOD (2016b). UK Armed Forces Monthly Service Personnel Statistics. Jan 2016

MSCC (2014). Economic value and employment in the UK of activities carried out in the marine environment Summary Document. Available at: http://www.gov.scot/Topics/marine/science/MSCC/PSEG/summary [Accessed 01/03/17].

Nakicenovic, N., Alcamo, J., Davis, G. *et al*. (2000). Special Report on Emissions Scenarios: A Special Report of Working Group III of the Intergovernmental Panel on Climate Change, Cambridge University Press, Cambridge, U.K., 599 pp. Available online at: http://www.grida.no/climate/ipcc/emission/index.htm. [Accessed 01/03/17].

National Audit Office (2016). The Department of Energy & Climate Change, Nuclear power in the UK [Online] Available at: https://www.nao.org.uk/wp-content/uploads/2016/07/Nuclear-power-in-the-UK-Summary.pdf [Accessed 15/02/17]

National Audit Office. (2017). Carbon capture and storage: the second competition for government support. Department for Business, Energy and Industrial Strategy. HC 950. Session 2016-17. January 2017. Available online at: https://www.nao.org.uk/wp-content/uploads/2017/01/Carbon-Capture-and-Storage-the-second-competition-for-government-support.pdf [Accessed 01/03/17].

National Grid (No Date) Interconnectors – Iceland, IceLink – In Development [Online] Available at: http://www2.nationalgrid.com/About-us/European-business-development/Interconnectors/Iceland/ [Accessed 16/02/17]

National Grid (2012). Electricity Ten Year Statement. November 2012. Published by National Grid.

National Audit Office (2016) The Department of Energy & Climate Change, Nuclear power in the UK [Online] Available at: https://www.nao.org.uk/wp-content/uploads/2016/07/Nuclear-power-in-the-UK-Summary.pdf [Accessed 15/02/17]

Nimmo, F, McLaren, K, Miller, J and Cappell, R. 2016. Independent Review of the Consenting Regime for Scottish Aquaculture.

NWIFCA (2016). North Western IFCA: Fifth Annual report.

Office for Budget Responsibility (OBR). (2016). Economic and fiscal outlook. November 2016. Available online at: http://cdn.budgetresponsibility.org.uk/Nov2016EFO.pdf [Accessed 06/03/17].

Offshore Renewable Energy Catapult (2014). Generating Energy and Prosperity: Economic Impact Study of the offshore renewable energy industry in the UK [Online] Available at: http://www.marineenergypembrokeshire.co.uk/wp-content/uploads/2010/03/ORE-Catapult-UK-economic-impact-report-March-2014.pdf [Accessed 28/03/17]

Ofgem (2017) Electricity interconnectors [Online] Accessed at: https://www.ofgem.gov.uk/electricity/transmission-networks/electricity-interconnectors [Accessed 20/02/17]

Ofgem (2016) Cap and floor regime: unlocking investment in electricity interconnectors [Online] Accessed at: https://www.ofgem.gov.uk/system/files/docs/2016/05/cap_and_floor_brochure.pdf [Accessed 20/02/17]

Ofgem (2014) The regulation of future electricity interconnection: Proposal to roll out a cap and floor regime to near-term projects [Online] Accessed at: https://www.ofgem.gov.uk/publications-and-updates/regulation-future-electricity-interconnection-proposal-roll-out-cap-and-floor-regime-near-term-projects [Accessed 20/02/17]

Oil and Gas UK (2016) Economic Review 2016 [Online] Available at: http://oilandgasuk.co.uk/wp-content/uploads/2016/09/Economic-Report-2016-Oil-Gas-UK.pdf [Accessed 14/02/17]

ONS (2016). Mid-year population estimates; ONS (2016) Subnational population projections

Oxford Economics (2015a). The Economic Impact of the UK Maritime Services Sector [Online] Available at: http://www.britishports.org.uk/system/files/documents/combined_the_economic_impact_of_the_uk_maritime_services_sector_0.pdf [Accessed 21/02/17]

Oxford Economics (2015b). The Economic Impact of the UK Maritime Services Sector: Ports [Online] Available at: http://www.britishports.org.uk/system/files/documents/ports_the_economic_impact_of_the_uk_maritime_services_sector.pdf [Accessed 21/02/17]

Oxford Economics (2015c). The Economic Impact of the UK Maritime Services Sector: Shipping [Online] Available at: https://www.maritimeuk.org/publications/shipping-economic-impact-report/ [Accessed 21/02/17]

Pale Blue Dot Energy. (2016). Progressing Development of the UK's Strategic Carbon Dioxide Storage Resource. A Summary of Results from the Strategic UK CO_2 Storage Appraisal Project. April 2016. Pale Blue Dot Energy, Coastain, Axis Well Technology, Energy Technologies Institute. Available online at: https://s3-eu-west-1.amazonaws.com/assets.eti.co.uk/legacyUploads/2016/04/D16-10113ETIS-WP6-Report-Publishable-Summary.pdf [Accessed 21/02/17].

PD Ports (2014). Teesport and Hartlepool Port Handbook. 7th Edition. Available at: http://www.pdports.co.uk/Documents/Media%20Centre/Brochures/Teesport_2013-14.pdf [Accessed 24/02/17]

Poortinga, W., Pidgeon, N.F., Capstick, S. and Aoyagi, M. (2013). Public attitudes to nuclear power and climate change in Britain two years after the Fukushima accident. Cardiff (UK).

Port of Dover (2014). Annual Report & Accounts, available at: http://www.doverport.co.uk/administrator/tinymce/source/PDF/Port%20of%20Dover%20Annual%20Report%202014.pdf [Accessed 24/02/17]

Port of London Authority (2015). River Thames Economic Prosperity. Available at: http://www.pla.co.uk/assets/economicreport.pdf [Accessed 24/02/17]

Port of Tyne (2014). Port of Tyne recognised as a gold investor in people. 18 December 2014. Available at: http://www.portoftyne.co.uk/news/port-of-tyne/port-of-tyne-recognised-as-a-gold-investor-in-people [Accessed 21/02/17]

Pöyry (2016). Costs and benefits of GB interconnection. A Pöyry report to the National Infrastructure Commission [Online] Available at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/505222/080_Poyry_CostsAndBenefitsOfGBInterconnection_v500.pdf [Accessed 20/02/16]

Pugh, D. (2008). Socio-Economic Indicators of Marine-Related Activities in the UK Economy. The Crown Estate. 68 pp. Available at: https://www.thecrownestate.co.uk/media/5774/socio_economic_uk_marine.pdf [Accessed 20/02/16].

Renewables UK (2012) Marine Energy in the UK. State of the Industry Report 2012. March 2012.

Renewables UK (No Date) Wave & Tidal Energy [Online] Available at: http://www.renewableuk.com/page/WaveTidalEnergy [Accessed 21/02/17]

RenewableUK (No Date). Wind Energy [Online] Available at: http://www.renewableuk.com/page/WindEnergy [Accessed 28/03/17]

Ross, L.G., Telfer, T.C., Falconer, L., Soto, D. & Aguilar-Manjarrez, J., eds. (2013). Site selection and carrying capacities for inland and coastal aquaculture. FAO/Institute of Aquaculture, University of Stirling, Expert Workshop, 6–8 December 2010. Stirling, the United Kingdom of Great Britain and Northern Ireland. FAO Fisheries and Aquaculture. Proceedings No. 21. Rome, FAO. 46 pp. + 282 pp.

Royal Navy (2017). Fishery Protection. Available online at: http://www.royalnavy.mod.uk/news-and-latest-activity/operations/uk-home-waters/fishery-protection [Accessed 01/03/17].

Ruddick, G., and Phillips, T. (2016). China must wait four years for decision on Bradwell nuclear plant. The Guardian, 16 September. Available at:https://www.theguardian.com/uk-news/2016/sep/16/china-must-wait-four-years-for-decision-on-bradwell-nuclear-plant [Accessed 16/02/17]

Scottish Government (2016). Scottish Type I and Type II output, income, employment and GVA multipliers [Online] Available at: http://www.gov.scot/Topics/Statistics/Browse/Economy/Input-Output/Downloads [Accessed 15/02/17]

Scottish Power Renewables (2017). Offshore Wind [Online] Available at: https://www.scottishpowerrenewables.com/pages/east_anglia_timeline.aspx [Accessed 03/02/17].

Scottish and Southern Electricity Networks (No Date). Eastern HVDC link [Online] Available at: https://www.ssepd.co.uk/EasternHVDClink/ [Accessed 17/03/17]

Sellafield Website (No Date). [Online] Available at: http://www.sellafieldsites.com/press-office/facts/ [Accessed 17/02/17]

SOEC (2007) The case for establishing an evaluation and research centre for ocean energy technologies on the Isle of Wight. November 2007. Solent Ocean Energy Centre.
South West Marine Energy Park (2012) [Online] Available at: http://www.wavehub.co.uk/downloads/Marketing_Leaflets/South_West_Marine_Energy_Park_Prospectus.pdf [Accessed 17/02/17]

South West Marine Energy Park (2012) South West Marine Energy Park: Unlocking the potential of the global marine energy industry [Online] Available at: http://www.wavehub.co.uk/downloads/Marketing_Leaflets/South_West_Marine_Energy_Park_Prospectus.pdf [Accessed 01/03/17]

STECF (2015). The 2015 Annual Economic Report on the EU Fishing Fleet (STECF 15-07). Scientific, Technical and Economic Committee for Fisheries. Publications Office of the European Union, Luxembourg. 434 pages. Available at https://stecf.jrc.ec.europa.eu/documents/43805/1034590/2015-07_STECF+15-07+-+AER+2015_JRCxxx.pdf. Accessed 24 February 2016.

Teesside Collective. (2017). A Proposition for an Industrial Carbon Capture and Storage (CCS) Pilot. February 2017. Available online at: http://www.teessidecollective.co.uk/wp-content/uploads/2017/02/Teesside-Collective-—-a-proposition.pdf [Accessed 01/03/17].

The Beach Guide: Guide to Britain's beaches Available online at: https://www.thebeachguide.co.uk/beach-list [Accessed 01/03/17].

The Crown Estate. (2010). Marine Estate Research Report. Carbon footprint of marine aggregate extraction. July 2010. Available online at: https://www.thecrownestate.co.uk/media/5453/ei-carbon-footprint-of-marine-aggregate-extraction.pdf [Accessed 05/05/17].

The Crown Estate (2012) UK Wave and Tidal Key Resource Areas Project Summary Report [Online] Available at: https://www.thecrownestate.co.uk/media/5476/uk-wave-and-tidal-key-resource-areas-project.pdf [Accessed 22/02/17]

The Crown Estate. (2016a). Marine Aggregates. Capability and Portfolio 2016.

The Crown Estate. (2016b). Integrated Annual Report 2015/16. Conscious commercialism in action. Available online at: https://www.thecrownestate.co.uk/media/761966/annual-report-and-accounts-2016.pdf [Accessed 22/02/17]

The Crown Estate (2017) Wave and Tidal [Online] Available at: https://www.thecrownestate.co.uk/energy-minerals-and-infrastructure/wave-and-tidal/ [Accessed 22/02/17]

The Crown Estate (2017). Offshore Wind Electricity [Online] Available at: https://www.thecrownestate.co.uk/energy-minerals-and-infrastructure/offshore-wind-energy/ [Accessed 02/02/17]

The Crown Estate and British Marine Aggregate Producers Association (BMAPA). (2010). Marine Aggregate terminology: A glossary. Available online at: http://www.bmapa.org/documents/BMAPA_Glossary.pdf [Accessed 02/02/17]

The Crown Estate and British Marine Aggregate Producers Association (BMAPA). (2013). Marine aggregate dredging and the coastline: a guidance note. Best practice guidance for assessment, evaluation and monitoring of the possible effects of marine aggregate extraction on the coast – a Coastal Impact Study. December 2013.

The Crown Estate and British Marine Aggregate Producers Association (BMAPA). (2014). Marine aggregate dredging 1998-2012. A fifteen-year review. Available online at: https://www.thecrownestate.co.uk/media/5360/ei-marine-aggregate-dredging-fifteen-year-review-1998-2012.pdf [Accessed 02/02/17]

The Crown Estate and British Marine Aggregate Producers Association (BMAPA). (2016). The Area Involved – Annual Report. Marine Aggregate Dredging 2015. Available online at: https://www.thecrownestate.co.uk/media/883245/bmapa_18th_annual_report.pdf [Accessed 02/02/17]

The World Bank (2017). UK military expenditure (% of GDP). Available online at: http://data.worldbank.org/indicator/MS.MIL.XPND.GD.ZS?end=2015&locations=GB&start=1997&view=chart [Accessed 01/03/17].

Three Dragons (2014) Infrastructure Plan Part of the strategic plan for the Isles of Scilly May 2014 [Online] Available at: http://www.scilly.gov.uk/sites/default/files/events/Infrastructure%20Plan%20final.pdf [Accessed 11/05/17]

Transport for the North Webpage (2017). [Online] Available at: http://www.transportforthenorth.com/ [Accessed 17/02/17]

UK Government (2013) Wave and tidal energy: part of the UK's energy mix [Online] Available at: https://www.gov.uk/guidance/wave-and-tidal-energy-part-of-the-uks-energy-mix [Accessed 21/02/17]

UK Government (2016a). Government sets out plans to upgrade UK energy infrastructure and increase clean energy investment [Online] Available at: https://www.gov.uk/government/news/government-sets-out-plans-to-upgrade-uk-energy-infrastructure-and-increase-clean-energy-investment [Accessed 17/02/17]

UK Government (2016b). Innovation funding for low-carbon technologies: opportunities for bidders [Online] Available at: https://www.gov.uk/guidance/innovation-funding-for-low-carbon-technologies-opportunities-for-bidders [Accessed 09/02/17]

UK Government (2017) Electricity Market Reform: Contracts for Difference [Online] Available at: https://www.gov.uk/government/collections/electricity-market-reform-contracts-for-difference [Accessed 09/02/17]

UKMMAS, (2010). Charting Progress 2 Feeder Report: Productive Seas. Available online at http://chartingprogress.defra.gov.uk/productive-seas-feeder-report [Accessed 20/02/16].

Visit England (2015) The GB Day Visitor: Statistics 2015.

Walney Extension (No Date). Project proposal [Online] Available at: http://www.walneyextension.co.uk/en/about-walney-extension/project-programme [Accessed 16/02/17]

WaveHub website (2017a) [Online] Available at: http://www.wavehub.co.uk/wave-hub-site/developers [Accessed 08/02/17]

WaveHub website (2017b) [Online] Available at: http://www.wavehub.co.uk/latest-news/falmouth-making-waves-in-renewable-energy-sector http://www.wavehub.co.uk/wave-hub-site/developers [Accessed 08/02/17]

Welsh Government, 2015. A spatial assessment of the potential for aquaculture in Welsh waters. A report by ABPmer, MESL, MPC and Eno Consulting for the Welsh Government.

West Somerset Tidal Lagoon (No Date) [Online] Available at: https://www.westsomersetlagoon.com/project-4 [Accessed 05/05/17]

Whiteley, R. (2016). UK Shellfish Production and Several, Regulating and Hybrid Orders: The Contribution and Value of Orders in Relation to the Sector's Past Development and Future Growth. Final Report to Seafish, August, 2016. ISBN No: 978-1-911073-01-7

WindPowerOffshore (2014). Updated: UK offshore Round Three projects hit choppy waters [Online] Available at: http://www.windpoweroffshore.com/article/1281739/updated-uk-offshore-round-three-projects-hit-choppy-waters [Accessed 17/02/17]

WNA (2013). Nuclear Power in the United Kingdom. Available online at: www.world-nuclear.org/info/Country-Profiles/Countries-T-Z/United-Kingdom/ [Accessed 20/02/16].