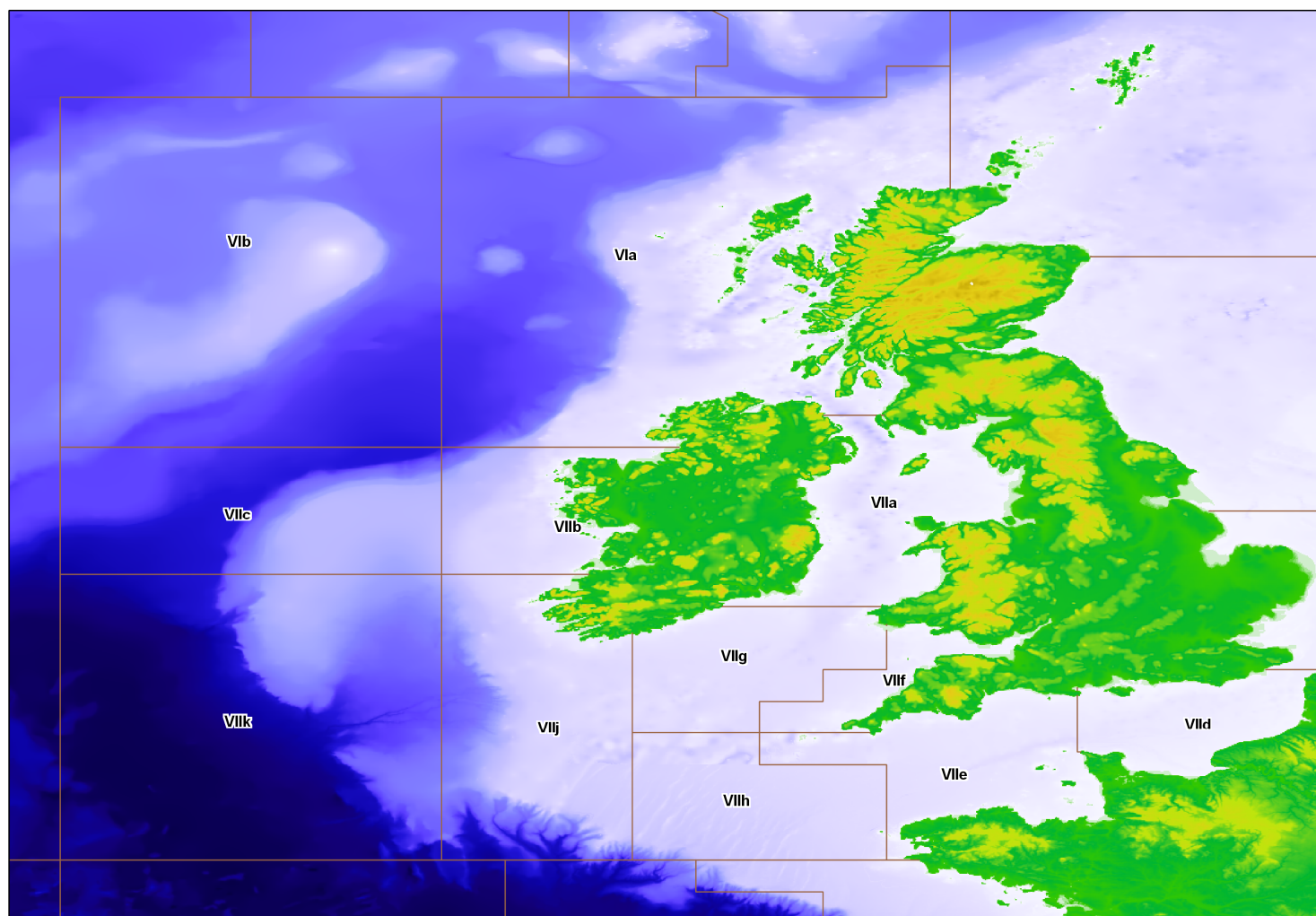




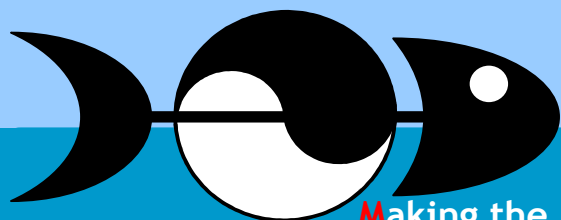
MEFEPO

Making the European Fisheries Ecosystem Plan Operational

North Western Waters Atlas



2nd Edition - August 2011



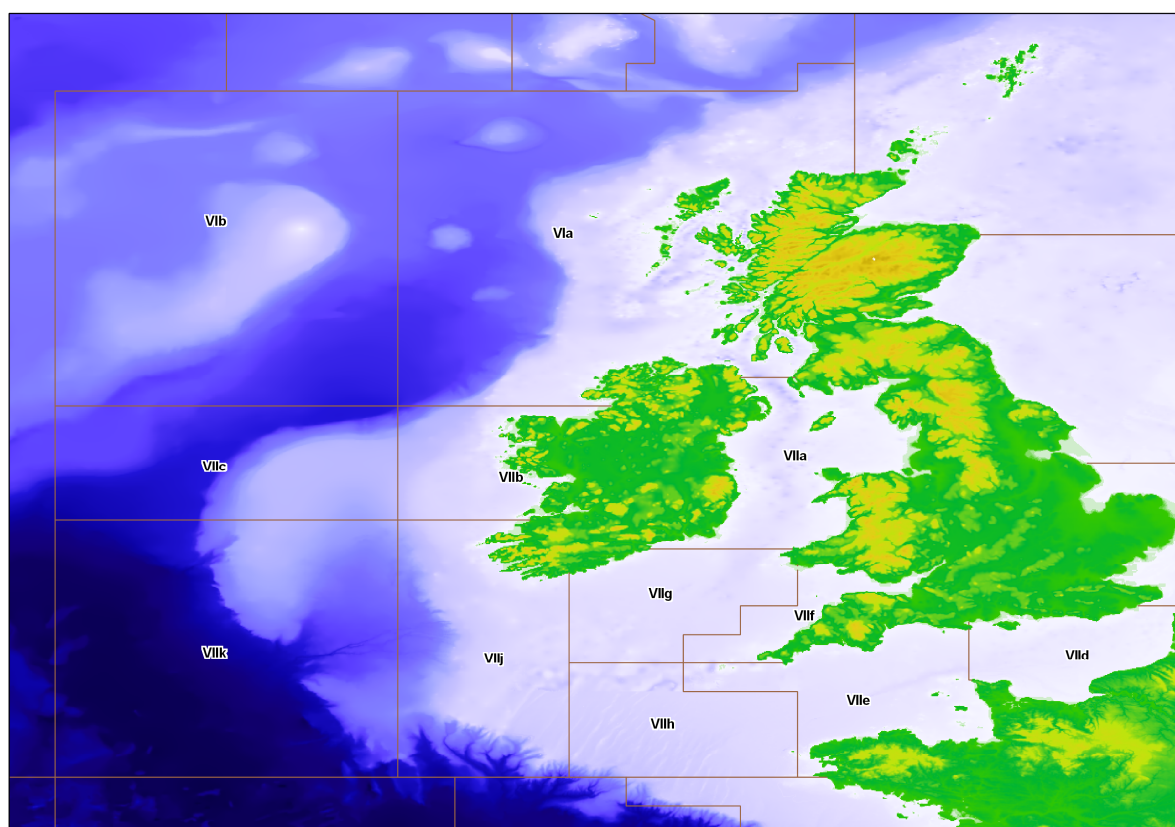
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Making the European Fisheries Ecosystem Plan Operational

North Western Waters

ATLAS

2nd Edition - August 2011



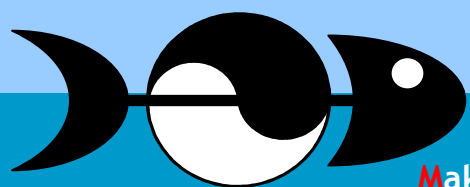
Bathymetry data from gebco_08_Grid ver. 20100927 www.GEBCO.net. ICES Divs. from DIFRES.

“To rebuild a vibrant fishing economy in Europe, the marine environment must be protected more effectively. From now on, EU fisheries will be managed by multi-annual plans and governed by the ecosystem approach and the precautionary principle to ensure that the impacts of fishing activities on the marine ecosystem are limited. The fishing industry will have a better and more stable basis for long-term planning and investment. This will safeguard resources and maximise long-term yields.”

*European Commission
MEMO/11/503 on the Reform of the Common Fisheries Policy 2011*

“The oceans and the seas sustain the livelihoods of hundreds of millions of people, as a source of food and energy, as an avenue for trade and communications and as a recreational and scenic asset for tourism in coastal regions. So their contribution to the economic prosperity of present and future generations cannot be underestimated.”

*José Manuel Barroso,
President EU Commission
EU Green Paper on Maritime Policy 2006*



Welcome to **MEFEPO**

Making the **E**uropean **F**isheries **E**cosystem **P**lan **O**perational

This Atlas was produced by the EU FP-7 funded MEFEPO project; production was led by the Marine Institute, Ireland.

The MEFEPO partners are:

- (1) University of Liverpool, (ULIV), UK, (Project Coordinator)
- (2) Instituto de Investigação das Pescas e do Mar, (IPIMAR), Portugal
- (3) Wageningen IMARES (IMARES), Netherlands
- (4) Université de Bretagne Occidentale, (UMR-CNRS), France
- (5) Marine Institute, (MI) Ireland (NWW WP 1 Leaders)
- (6) University of Tromsø, (UIT), Norway
- (7) Centre for Environmental, Fisheries and Aquaculture Sciences, (CEFAS), UK
- (8) Institute for Fisheries Management, (IFM), Denmark
- (9) Universidad dos Acores, (IMAR/DOP), Portugal
- (10) Instituto Espanol de Oceanografía, (IEO), Spain

Every effort has been made to ensure the accuracy of the information contained in this atlas. However the size of the document means that much of the detail has had to be omitted and some simplifications have been made for the sake of clarity.

MEFEPO has produced a companion technical report that contains more detail and full references to the original sources. This Atlas has also been produced in French, and Atlases for the NS and SWW regions are available to download at:
www.liv.ac.uk/mefepo

MEFEPO have attempted to contact the copyright holders for all the information in this document. However, if you are the copyright holder of information for which we have inadvertently failed to acknowledge you, please contact us (cormac.nolan@marine.ie) so that we may correct this in future publications.

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PREFACE

Welcome to the second edition of the MEFEPO North Western Waters (NWW) Atlas. The MEFEPO (**M**aking the **E**uropean **F**isheries **E**cosystem **P**lan **O**perational) project is made up of a group of ecologists, economists, management experts and fisheries scientists who are trying to make ecosystem based fisheries management (EBFM) a reality in Europe. EBFM seeks to support the 'three pillars of sustainability' (ecological, social and economic).

The MEFEPO project is now in its final phase and we are currently working to develop draft operational Fisheries Ecosystem Plans (FEPs) for our case study regions (North Sea, NS; North Western Waters, NWW; and South Western Waters, SWW), which will be published later this year.

This Atlas is intended for policy makers, managers and interested stakeholders. Its purpose is to provide a broad overview of the ecosystem of the NWW Regional Advisory Council (RAC) area. We have tried to make the science as clear and concise as possible, and keep technical language to a minimum. The information has been presented through a blend of text, tables, figures and images. There is a glossary of terms and a list of more detailed scientific references for those interested in following up certain issues.

The first edition of the Atlas, published in 2009, was extremely well received and this new edition has been modified in response to stakeholder feedback to provide updated information on the physical and chemical features, habitat types, biological features, birds, mammals, fishing activity and other human activities taking place within the NWW region. Background material on four NWW fisheries (mackerel, hake, *Nephrops* and scallop) which have been used throughout the MEFEPO project, and are being developed as case study fisheries in the FEPs, is presented.

The Atlas compliments a *Technical Review Document on the Ecological, Social and Economic Features of the North Western Waters region* (Nolan *et al.*, 2010), which provides more detailed information and is available to download from the project website: www.liv.ac.uk/mefepo. Knowledge of the NWW area is less advanced than other areas (e.g. the North Sea) and the information used in this Atlas was widely dispersed in the grey literature, various national reports, national research programmes and published papers.

As the MEFEPO project ends we hope the Atlases will form a useful part of the legacy and we hope that, if they continue to be useful, further editions will follow. We welcome any feedback; please forward any comments to cormac.nolan@marine.ie.



Table of Contents

SUMMARY	6
1. THE MEFEPO PROJECT	10
2. AREA AND DEPTH	15
3. WATER MOVEMENTS	20
4. CLIMATE	24
5. SEA TEMPERATURE.....	27
6. SEA FLOOR HABITAT.....	33
7. CONTAMINANTS AND NUTRIENTS	37
8. PLANKTON	42
9. SEA BIRDS.....	46
10. MARINE REPTILES.....	53
11. SEA MAMMALS	55
12. SHARKS, SKATES AND RAYS.....	62
13. PROTECTED AREAS AND FISHING RESTRICTIONS.....	66
14. IMPORTANT FISH SPAWNING AREAS.....	73
15. DISTRIBUTION OF JUVENILE FISH	83
16. FISHING ACTIVITY	93
17. NWW CASE STUDIES	107
18. MARICULTURE	129
19. DISTRIBUTION OF OTHER HUMAN ACTIVITIES	133
20. ECOSYSTEM OVERVIEWS	144
REFERENCES.....	159
GLOSSARY	162
ACKNOWLEDGEMENTS.....	166



SUMMARY

- The North Western Waters (NWW) area is situated in the north east Atlantic off the west coast of Ireland and Scotland, and extends into the Celtic Sea, Irish Sea and the English Channel. The NWW covers approximately 1.15 million km² and comprises 12 ICES Divisions and three OSPAR regions. Parts of the EEZ (Exclusive Economic Zone) of three countries (UK, Ireland and France) make up NWW. The majority of the NWW area is composed of water less than 100m deep (20%), while 17% lies between 100m and 200m (17%) and 20% between 1,000m and 1,500m.
- The dominant seabed feature of the western part of NWW area is the Rockall Trough. This opens into the Porcupine Abyssal plane at its southern end and further south is the Porcupine Seabight. Eastward of these seabed features lies the continental slope and shelf. The shelf area comprises the semi enclosed Irish Sea, the Celtic Sea off the south coast of Ireland and the English Channel between France and the UK.
- The main ocean current affecting the NWW area is the Gulf Stream System that draws warm water up from the Gulf of Mexico to the north east Atlantic via the North Atlantic current. This warm water releases its heat when it reaches the colder areas of the north Atlantic and has a moderating influence of the climate of the area.
- Climate has a major impact on the oceans through its interactions with wind speed, rainfall, evaporation and heat exchange between the air and sea. In the NWW area the main climatic influence is the so called North Atlantic Oscillation (NAO). The NAO represents the difference between two persistent sets of contrasting air pressure – high pressure over the Azores and low pressure over Iceland. The interplay between these pressure systems determines seasonal climate over Eastern Europe (e.g. dry or wet winters).
- In their climate change update, the ICES have stated that there “is great confidence within the scientific community that climate change is a reality.” The increase in greenhouse gasses has caused global warming of the atmosphere and ocean, rising sea levels and changing wind patterns. There has been an increase in NWW sea surface temperatures when the means from 2003 to 2007 are compared to the means from 1978 to 1982. There has also been a shift northwards in certain “cold water” plankton communities and an influx of “warm water” plankton communities in the NWW.
- In temperate waters, a phytoplankton bloom occurs every spring, generally followed by a smaller peak in autumn. In the NWW area,

there has been a large increase in Harmful Algal Blooms (HAB) in recent years. These phytoplankton blooms include those connected with Paralytic Shellfish Poisoning (PSP). HAB events may be associated with changes in salinity, sea surface temperature and wind speed.

- The sea bed habitats of the NWW are varied. There are extensive areas of gravel in the Irish Sea and English Channel. Areas of sand occur extensively on the Porcupine and Rockall Banks, the Celtic Sea and in the Irish Sea. Muddy sediments occur in the Irish Sea, the Atlantic Basin, Rockall trough and the Irish Sea. The habitat information is poor for much of the offshore areas to the west of Ireland and Scotland.
- The sea and the extensive and varied coastline of the NWW area are important for birds year round with many being of international or national importance for the individual species or assemblages they support. The coastal and offshore waters of the NWW area provide local breeding and non-breeding seabirds along with passage migrants with a rich source of nutrition, particularly near coastal upwelling and frontal systems (e.g. along the Irish Shelf Front; north of the Porcupine Seabight). Off the west of Ireland and Scotland, petrels, shearwaters, skuas, gannets, gulls and auks dominate. The majority of these birds breed in colonies located in the NWW area, but shearwaters and skuas are passage migrants that use the NWW area as a migratory corridor.
- The NWW support a rich biodiversity of cetaceans (whales, dolphins and porpoises), making this area one of the most important in Europe. A number of these cetaceans including the harbour porpoise, the common, bottlenose, Risso's, Atlantic white sided and white beaked dolphins in addition to the long finned pilot whale are confirmed to breed in the NWW area. Many others, including the blue, fin and humpback whales are not thought to breed in this area, but migrate through it each year.
- The grey and harbour, or common, seal are the two species most common in NWW area. Both species have established themselves in terrestrial colonies along the coastlines of Ireland and the UK. They leave these areas when foraging or migrating and return to rest ashore, rear young and engage in social activity.
- The leatherback turtle is regularly seen in NWW area and while they are reported in every month, sightings peak over the period June to October. They breed in tropical areas and are the only species of marine turtle to have developed adaptations to life in cold water.
- The landings of sharks, skates and rays in NWW are decreasing due to declining stocks and increasing regulations. Most skates and rays are caught as valuable bycatch in mixed fisheries however there are some targeted fisheries in VII.

- There are many restrictions on fishing activity in NWW area. Since 2010 the Porcupine Bank has been seasonally closed to *Nephrops* fishing. In the Irish Sea, there are closed areas to protect cod during spawning. There are similar closed cod boxes in the Celtic Sea. The hake box off the south west of Ireland restricts hake fishing with certain mesh types. There are extensive deep water closures in the NWW to protect orange roughy stocks and important coral grounds. No directed fishing for deep water orange roughy can take place in extensive areas off the west of Scotland and Ireland. There is restricted fishing for cod, whiting and haddock off the west of Scotland. The Biologically Sensitive Area (BSA) situated off the west and south coasts of Ireland is considered to be an area of high ecological importance for the early life history stages of many commercial fish species. It contains important spawning and nursery grounds and is an area subjected to high commercial fishing activity.
- The NWW area is the main spawning area for many commercially important fish species. Mackerel, horse mackerel and blue whiting aggregate in vast schools in this area to spawn each year. The continental shelf area off the southwest of Ireland is also a very important spawning ground for hake and there are important cod spawning areas in the Irish Sea and in the Celtic Sea. Monkfish spawn along the shelf edge off the coast of Ireland and Scotland. Herring spawn on the gravel beds off the south and off the west of Ireland and Scotland.
- There are important fish nursery areas in the NWW area. The shelf and inshore waters are important habitats for juvenile haddock, whiting, cod, monkfish, megrim, hake, mackerel and horse mackerel.
- The NWW area contains some of the most productive fishing grounds in Europe. Landings from the NWW area were estimated at 1.3 million tonnes in 2009. The main countries exploiting the demersal species are France, Spain, UK, Ireland and Belgium. The main countries exploiting the pelagic species are UK, Norway, Netherlands and Ireland. In Sub Area VI, the main pelagic species caught are blue whiting mackerel and horse mackerel. The main demersal species taken are haddock, pollock, ling and monkfish. Other important species taken in VI include crab and *Nephrops*. In Sub Area VII, the main pelagic species taken are blue whiting, horse mackerel and herring. The main demersal species taken are whiting, hake, monkfish, skates and rays and squid. Other important species taken in VII include scallops, crabs, and *Nephrops*.
- It is estimated that 1.3 million tonnes of fish, equivalent to 19.6% of the global total, are discarded in the North East Atlantic, while landings only account for 11% of the worldwide total. Discard rates in the waters west of Ireland and UK (Scotland) vary between 31% and 90%, compared to the global average of 8%.

- Mackerel is mainly exploited in a directed fishery for human consumption. Mackerel catches in NWW 2009 were 211,327 tonnes. The changing mackerel distribution has led to a breakdown in the previously agreed international quota allocations arrangements and there was no internationally agreed TAC for this stock for 2011.
- *Nephrops* are limited to a muddy habitat and the distribution of suitable sediment defines the species distribution. Most stocks in the NWW area appear to be relatively stable in terms of abundance and size composition, apart from the Pocupine Bank functional unit. In 2009, 12,741 tonnes were landed from VI and 17,576 tonnes from VII.
- Hake is widely distributed over the northeast Atlantic shelf, from Norway to Mauritania, with a larger density from the west of Ireland to the south of Spain. This species has been a very important resource for many demersal fisheries of the NWW region. It is landed as targeted or incidental catch by a wide variety of gears (bottom trawls, nets, and long-lines). In 2009, 12,400 tonnes of hake were landed from NWW.
- The scallop is an important commercially exploited species of bi-valve in northern Europe, extending from Norway south to Spain. It attains a large body size, is a high value species and is also the subject of extensive and intensive aquaculture in northern Europe. In 2009, 51,900 tonnes of scallop were landed from NWW, the vast majority from VII.
- There are significant finfish and shellfish mariculture production areas in the coastal areas of NWW. Shellfish production is most significant along the north coast of France while finfish production is most significant on the west coast of Scotland. The production of farmed salmon has seen the largest increase in NWW mariculture over the past two decades.
- NWW waters are subject to a broad range of human activities. There are extensive submarine cable networks in the north Irish Sea, Celtic Sea and English Channel. The coastal areas of NWW region have many fishing ports, commercial ports and leisure ports. There are several large cities and towns on the NWW coast, although they are not on the same scale as the large industrial cities associated with the North Sea. There are busy shipping lanes in the western approaches to the UK and France and in the English Channel. The Channel and the northern part of NWW are busy oil tanker traffic routes. There are aggregate extraction sites in the English Channel and off the Welsh coast. Extensive oil and gas drilling and other licensed activities are carried out in the NWW area. Military activity sites are mostly confined to UK waters. There are many power stations around the coasts of UK, Ireland and France.

**1**

THE MEFEPO PROJECT

MEFEPO are a group of ecologists, economists, management experts and fisheries scientists that are trying to make ecosystem based fisheries management work in Europe.

In recent years considerable effort has been devoted to addressing the governance, scientific, social and economic issues required to develop and introduce an ecosystem approach to European marine fisheries. MEFEPO will seek to harness and apply these efforts.

Fisheries management needs to support the 'three pillars of sustainability' (ecological, social and economic). One of the greatest challenges of management is searching for ways of achieving these objectives simultaneously. The economic and social pillars can be considered subsidiary to the ecological pillar since the loss of an ecological resource base will mean that no social and economic benefits can be derived for the seas.

Making the European Fisheries Ecosystem Plan Operational (MEFEPO) is funded by the EU under the 7th Framework Programme; Food, Agriculture and Fisheries and Biotechnology. There are 8 countries in the collaborative project; UK (coordinator), Portugal, Netherlands, France, Ireland, Norway, Denmark, and Spain. The project commenced in September 2008 and will finish in August 2011.

In recent years considerable effort has been devoted to addressing the governance, scientific, social and economic issues required to develop and introduce an ecosystem approach to European marine fisheries. This change to an ecosystem approach will require a fundamental shift away from traditional single species fisheries management to a system that incorporates broader marine environment issues and the wide range of stakeholder actors.

The Ecosystem Approach – A Definition

“The comprehensive integrated management of human activities based on best available scientific knowledge about the ecosystem and its dynamics, in order to identify and take action on influences which are critical to the health of the marine ecosystems, thereby achieving sustainable use of ecosystem goods and services and maintenance of ecosystem integrity.”

EU Danish Presidency, 2002

Fisheries management needs to support the ‘three pillars of sustainability’ (ecological, social and economic). One of the greatest challenges of management is searching for ways of achieving these objectives simultaneously. In practice this is difficult to achieve and tradeoffs have to be considered. However, the economic and social pillars should be considered subsidiary to the ecological pillar since the loss of an ecological resource base will mean that no social and economic benefits can be derived from the seas. Thus an understanding of the links between ecological, social and economic systems is essential in order to ensure that management decisions are appropriately informed.

Fisheries Ecosystem Plans (FEPS)

In the US, Fisheries Ecosystem Plans (FEPs) were developed to further the development of the ecosystem approach in fisheries management and as a tool to assist managers consider the ecological, social and economic implications of their management decisions. The FP5-funded *European Fisheries Ecosystem Plan* (EFEP) project developed a FEP for European waters, using the North Sea as a case study. This project incorporated social and political sciences, marine ecology, fisheries science and mathematical modeling to identify the effects of various fisheries management scenarios on the ecosystem and their acceptability to a broad range of marine stakeholders including fishers, fish processors, managers, policy makers, scientists and environmentalists. The project also developed a step-wise framework for the transition of management from the current regime to an ecosystem approach, and an outline of how the FEP could be made operational within existing legislation.

The core concept for the MEFEO project is the delivery of an operational framework for three regional seas. These are based on the Regional Advisory Council areas and are the North Sea; North Western Waters and South Western Waters.

MEFEPO will focus on how best to make current institutional frameworks responsive to an ecosystem approach to fisheries management at regional and pan-European levels in accordance with the principles of good governance. This will involve developing new linkages and means of allowing dialogue between the disparate groups of marine stakeholders and developing a decision-making process which integrates a wide breadth of interests.

The MEFEO project will require the integration of the considerable body of ecological, fisheries, social and economic research which has been developed in recent years to support an ecosystem approach and investigate how existing institutional frameworks need to evolve to incorporate this information and promote dialogue between the disparate groups of marine stakeholders and develop a decision-making process which integrates a wide breadth of interests.



MEFEPO
Making the European Fisheries Ecosystem Plan Operational
Project Objectives

Objective 1

To show how an ecosystem approach to fisheries can be made operational within three major European regions by identifying the management objectives, and the operational strategies required to achieve those objectives, using economic, social and ecological approaches

Objective 2

To evaluate the different modes of fisheries governance, and their combinations, and their implications on the development of the institutional frameworks used to manage the fisheries to provide a transitional framework towards a mature ecosystem approach to fisheries management

Objective 3

To develop operational FEPs for three major European marine regions targeted at an audience of non-scientists with managerial, policy and RAC roles, and which provides a vision of an mature ecosystem approach and a description of how it can be delivered

“ The fisheries sector can no longer be seen in isolation from its broader marine environment and from other policies dealing with marine activities.....The Common Fisheries Policy therefore requires us all to take a fresh look at the broader maritime picture as advocated by the Integrated Maritime policy (IMP) and its environmental pillar, the Marie Strategy Framework Directive “

Reform of the Common Fisheries Policy. Green Paper (2009)



Image: Superstock.co.uk

Regional Advisory Councils (RAC's)

The RACs were established as a key element of the Reform of the Common Fisheries Policy in 2002 (Council Decision 2004/585/EC) to provide 'new forms of participation by stakeholders'. The RAC's seek to involve stakeholders in the fisheries sector more closely in the decision making process of the CFP and provide a formal mechanism for communication between the European Union and fisheries stakeholders.

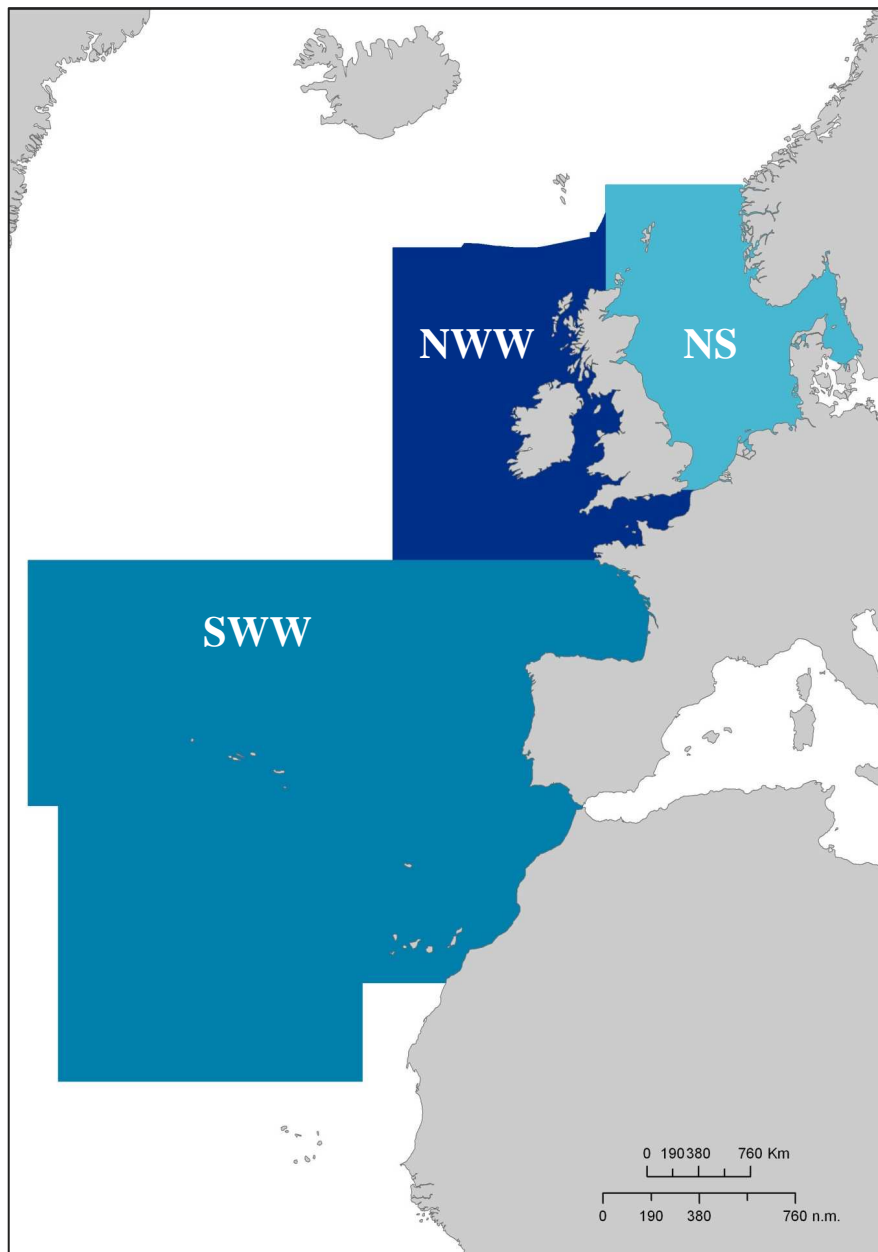
Stakeholders include fishing representatives, conservationists and other organisations such as women's or angling groups.

Five of the RACs have a regional focus (Baltic Seas, Mediterranean Seas, North Sea, North Western Waters and South Western Waters), whilst two are non-regional and consider the pelagic fisheries and distant water fisheries (Pelagic stocks and High Seas/Long Distance Fleets RAC respectively).

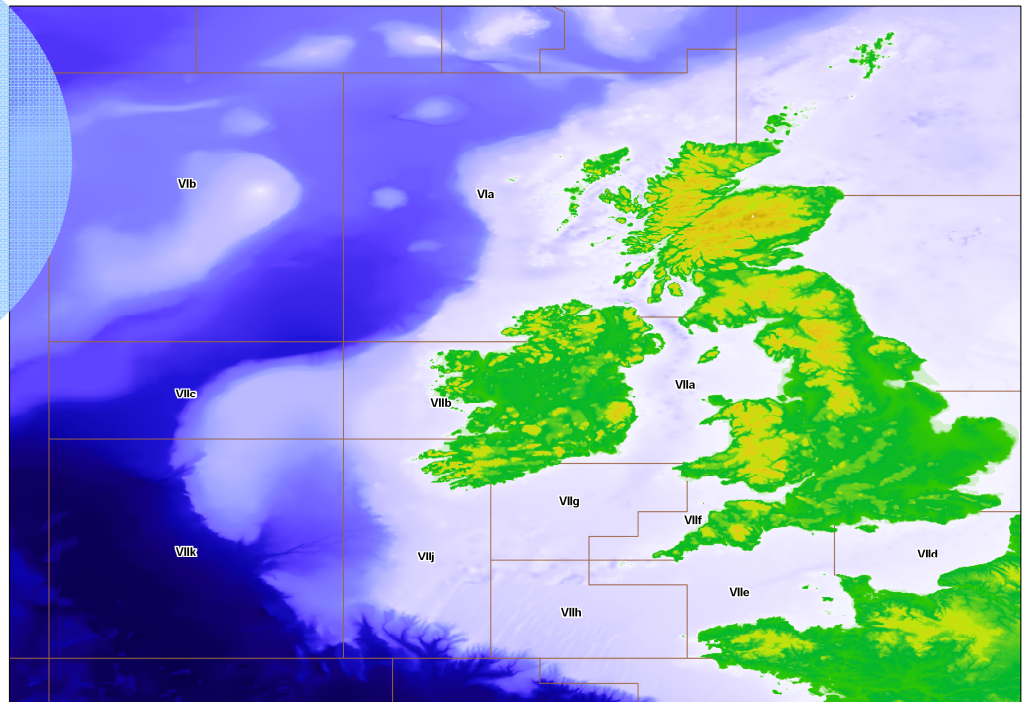
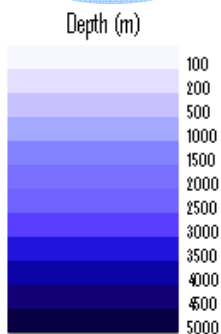
The MEFEP project is using three RAC regions as case studies:

- North Sea (NS)
- North Western Waters (NWW)
- South Western Waters (SWW)

The focus of this Atlas is on the North Western Waters (NWW).



MEFEPO project regions based on Regional Advisory Council (RAC) areas: North Sea (NS), North Western Waters (NWW) and South Western Waters (SWW).

**2**

AREA AND DEPTH

The NWW area consists of 12 ICES Divisions (VIa, VIb, VIIa, VIIb, VIIc, VIId, VIle, VIIf, VIlg, VIlh, VIlj, and VIlk) and covers an area of approximately 1.15 million km². NWW lies within three OSPAR Regions, the Wider Atlantic Region V, the Celtic Seas Region III and the Greater North Sea Region II.

The NWW area comprises the exclusive Economic Zones (EEZ's) for Ireland, part of the UK EEZ and part of the French EEZ.

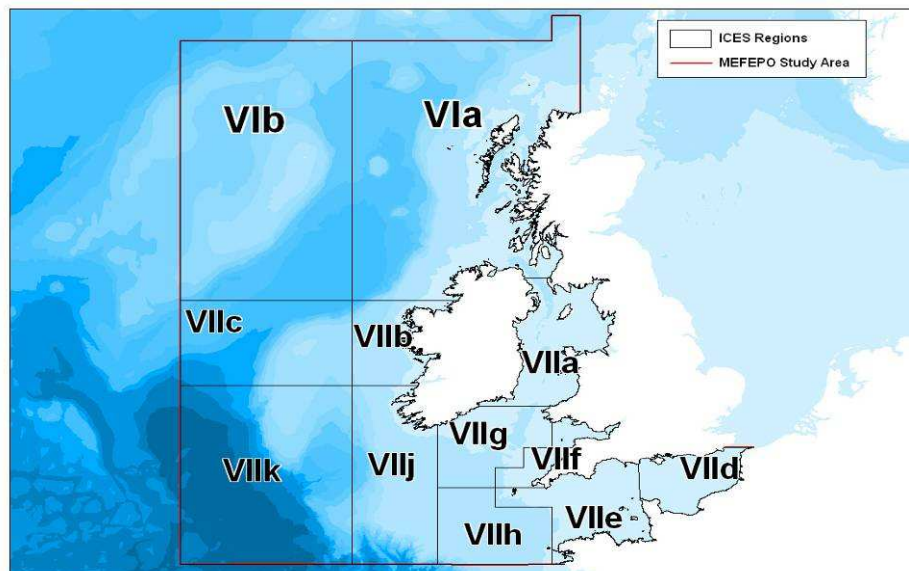
The dominant topographic feature of the western part of the NWW Area is the Rockall Trough, a steep-sided elongate depression in the Continental Shelf, over 1,000 km long and approximately 250 km wide, orientated approximately northeasterly-southwesterly.

The NWW area consists of the semi enclosed Irish Sea, the English Channel, the Celtic Seas shelf area, the Atlantic slope area and the deep waters off the west of Ireland and Scotland.

37% of the NWW is less than 200 meters while 20% is between 1,000 and 1,500 meters.

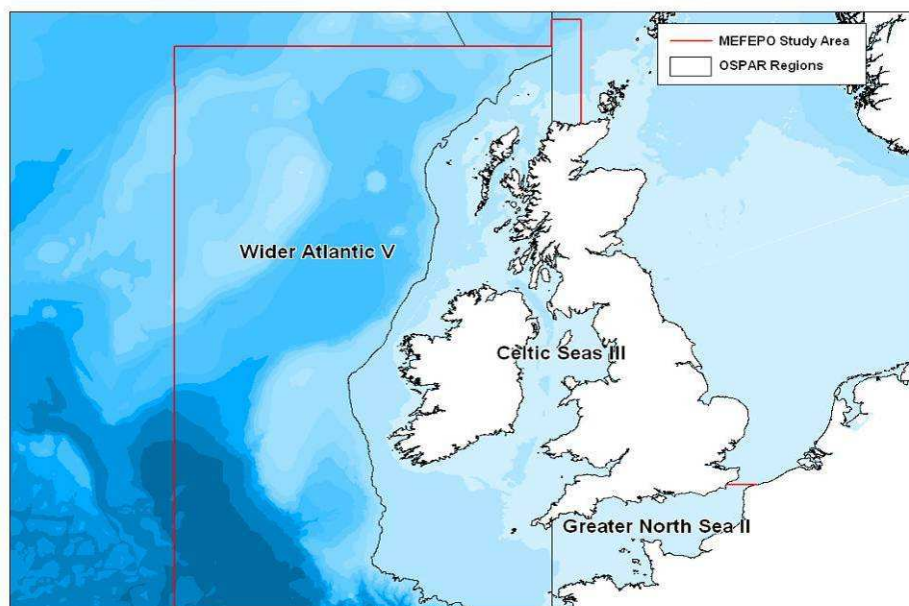
The north Atlantic began to form around 200 million years ago as the European and North American continental plates separated on either side of the mid Atlantic ridge. The Atlantic consists of three depth regimes: the oceanic basins (2,500 to 5,000 m); the continental margins (< 2,500m) and the continental shelf (<400m). The NWW area consists of all three types of regime.

The NWW area consists of 12 ICES Divisions (VIa, VIb, VIIa, VIIb, VIIc, VIId, VIIe, VIIf, VIIg, VIIh, VIIj, and VIIk) and covers an area of approximately 1.15 million km².



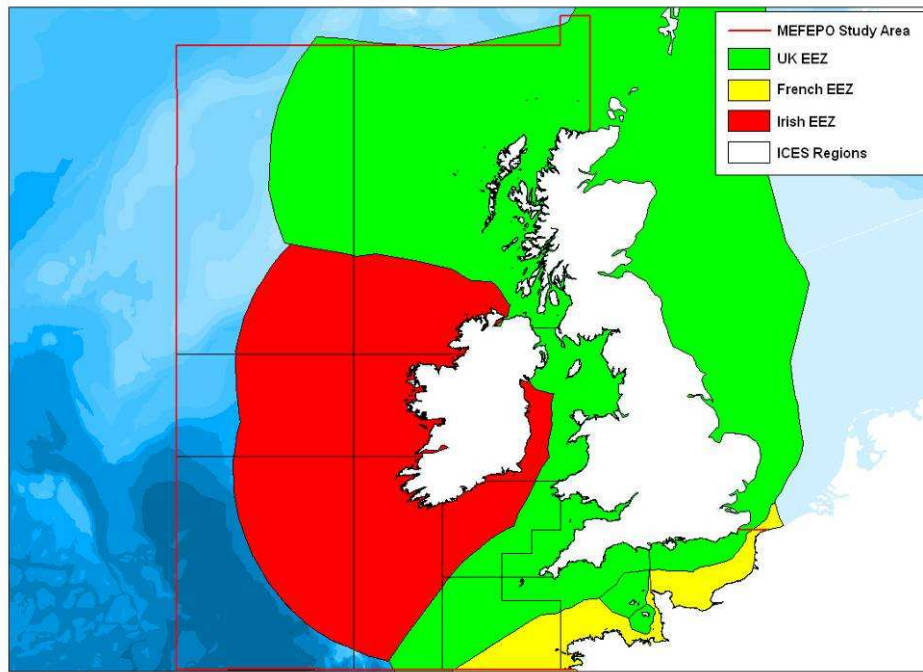
The 12 ICES Divisions that comprise the NWW area.

The NWW lies within three OSPAR Regions, the Wider Atlantic Region V, the Celtic Seas Region III and the Greater North Sea Region II.



The three OSPAR Regions that are part of the NWW area.

The NWW area comprises the entire Exclusive Economic Zone (EEZ) for Ireland and part of the UK and French EEZ. The UK EEZ covers an area of 763,422 km² (including the Channel Islands EEZ), of which approximately 52% lies in the NWW area. The Irish EEZ covers an area of 408,500 km² of which 100% lies in the NWW area. The total French EEZ covers an area of 333,700 km² of which approximately 20% lies in the NWW area.



The three EEZ areas within the NWW area.

The dominant topographic feature of the western part of the NWW Area is the Rockall Trough, a steep-sided elongate depression in the continental shelf, over 1,000 km long and approximately 250 km wide, orientated approximately northeasterly-southwesterly. The trough ranges in depth from 1,000 m to 1,500 m at its northern end west of Scotland where it is bounded by the Wyville-Thomson Ridge and a chain of sea mounts. At its southern end it reaches 3,500 to 4,000m where it opens onto the Porcupine Abyssal Plain. It is bounded to the west by the Rockall Bank and to the east by the Erris and Slyne Ridges and to the north by the slopes of the Porcupine Bank and the Porcupine Ridge.

Further south, another deep water embayment, the Porcupine Seabight, also opens onto the Porcupine Abyssal Plain. The Seabight ranges in depth from about 350m at its northern end to over 3,000m in the south, and is bounded to the east by the Irish Mainland Shelf and the Celtic Shelf, to the north and west by the Porcupine Bank and Porcupine Ridge, and to the south by the Goban Spur. The Porcupine Bank and Ridge, and the Rockall and Hatton Banks, remain as shallower plateau areas separated from the continental shelf by the deep waters of the Rockall Trough and Porcupine Seabight. Inshore of these topographical features is the continental slope.

In the Irish Sea, the seafloor shelves gently westwards from the British coast to water depths of approximately 60m. This Eastern Shelf is mostly flat and featureless although bathymetric highs and lows occur locally. Shoals with islets and sandbanks

occur inshore in the broad bays and estuaries and offshore sandbanks occur parallel to the coast off North Wales and Pembrokeshire and as banner banks northeast off the Isle of Man. In Cardigan Bay there are three shallow water (0 to 10m) moraine ridges, which extend from the coastline to approximately 15km offshore. These features are up to 25km long and 3km wide, with water depths up to 50m greater than the surrounding seabed and occur in Morecambe Bay, west of Anglesey and south of Llyn and are known respectively as the 'Lune Deep', the 'Holyhead Deep' and the 'Muddy Hollow'.

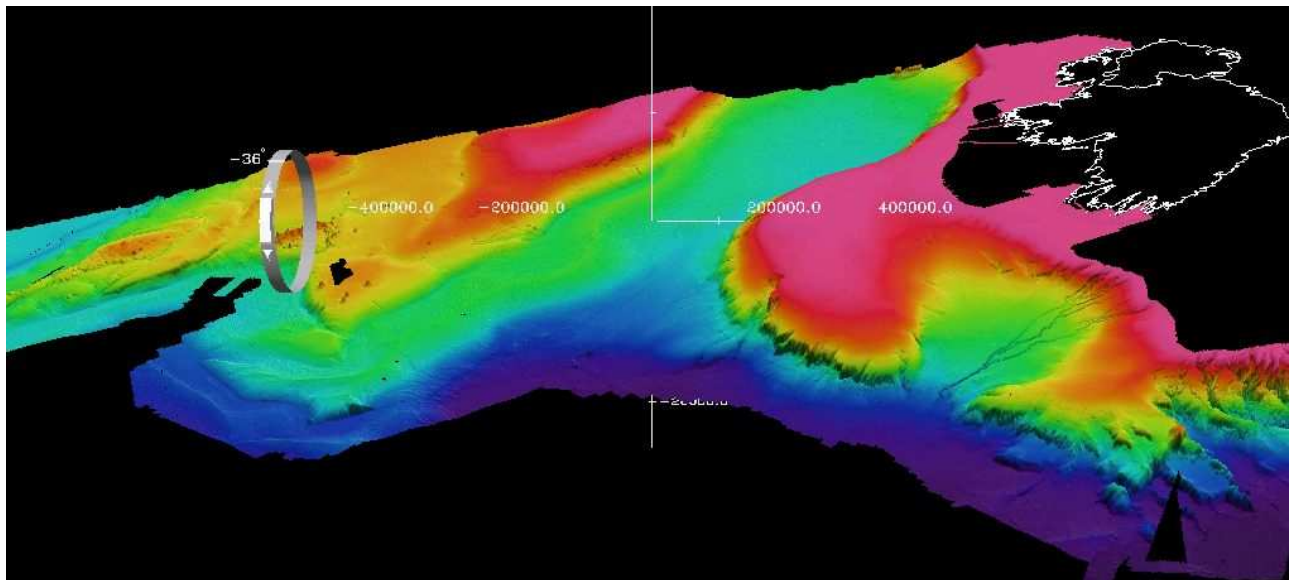
In the Irish Sea the western or Irish Shelf is shallower than 60m and extends for around 20km offshore. South of Rockabill and Lambey Islands the Irish Shelf is distinguished by a series of linear, coast parallel, sand banks for its whole length to Carnsore Point, Co. Wexford. The Lambey Deep and Codling Deep are up to 134m deep.

Between the Eastern and Irish Shelves, the Celtic Trough is up to 70km wide and has water depths greater than 60m. The trough runs from the Celtic Sea to the Malin Sea through St. George's Channel, the western Irish Sea and the North Channel.

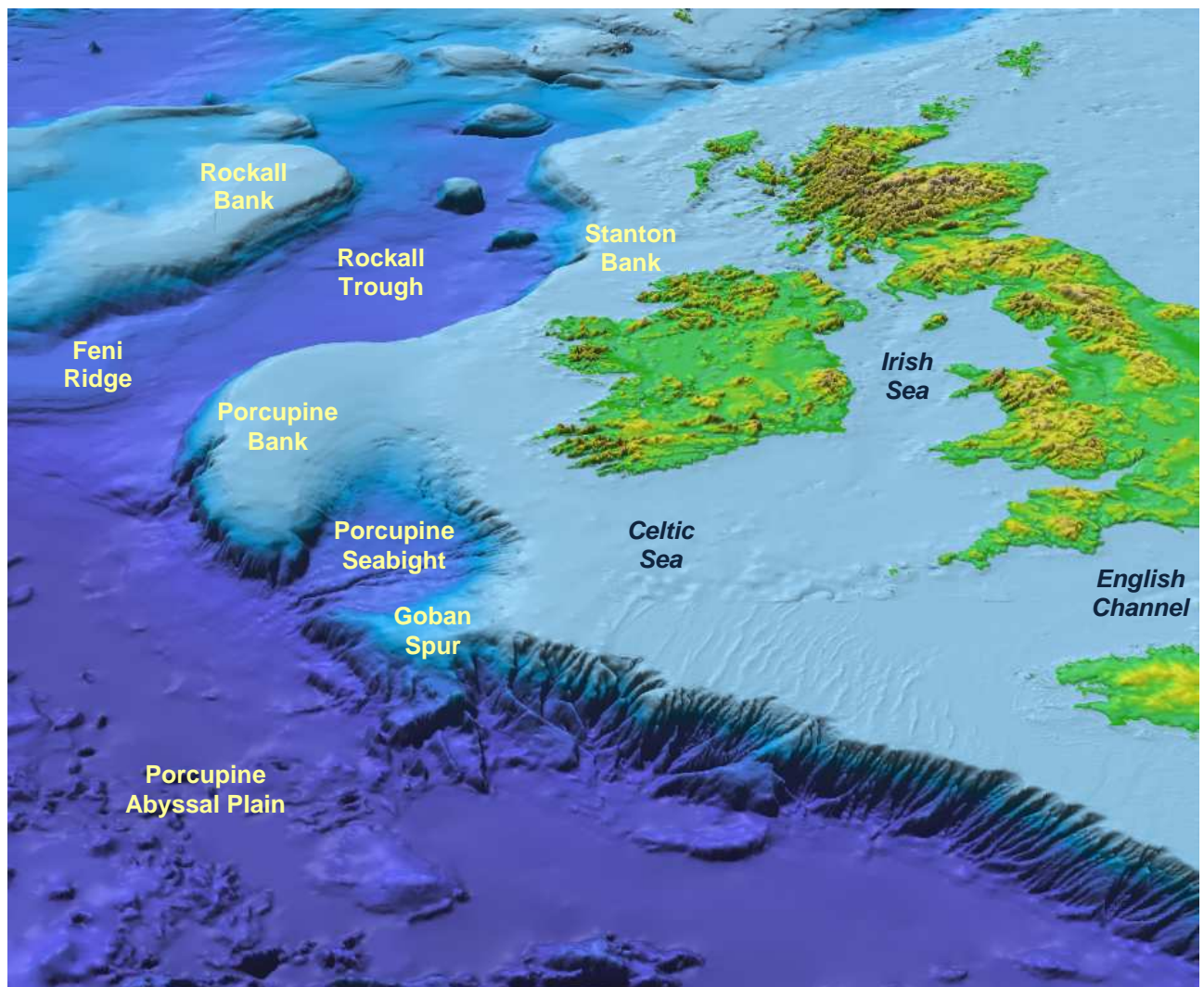
Water depths in the southern part of St. George's Channel are approximately 100m. The seabed is mainly smooth except for locally developed sandwave fields and rare enclosed deeps of approximately 125m. The bathymetry of the northern part of the channel is more complex with general depths ranging from 60 to 120m. There are many sandwaves, some up to 40m in height and numerous localised enclosed deeps between 130 and 180m. The area west of the Isle of Man has a smooth, rolling, seabed down to 120m deep, with rare rocky prominences and enclosed deeps to the north. In the North Channel, the seabed is rough with many rocky outcrops. General depths in the trough are from 60 to 160m, but there are also both upstanding areas and smaller prominences, some forming rocky islets and the notable complex of enclosed deeps of Beaufort's Dyke, which has a maximum water depth of 315m. The volume of the Irish Sea is approximately 2,400 km³, of which 80% lies to the west of the Isle of Man.

Depth Zone <	Area (km ²)	% Area
100m	248,970	19.15
200m	218,896	16.83
500m	85,493	6.57
1000m	891,928	6.86
1500m	258,638	19.9
2000m	78,836	6.06
2500m	78,295	6.02
3000m	78,242	6.02
3500m	23,849	1.83
4000m	20,730	1.59
4500m	37,706	2.9
5000m	80,548	6.19

The area (km²) of the various depth zones in NWW.



The bathymetric features of NWW using data from the Irish National Seabed Survey.



The dominant topographic features of NWW.



3



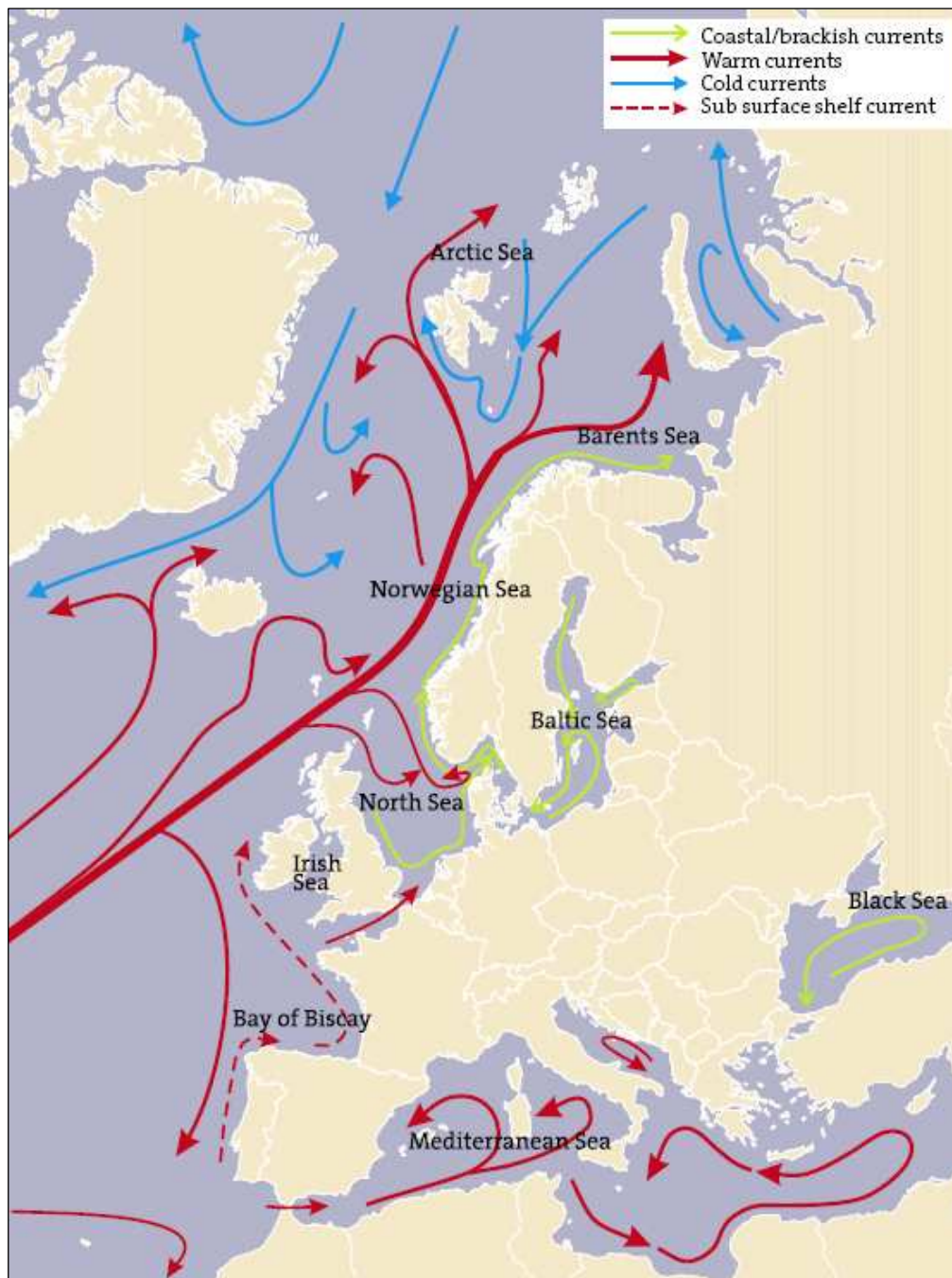
WATER MOVEMENTS

The main ocean current impacting the NWW area is the Gulf Stream System that draws warm water up from the Gulf of Mexico to the north east Atlantic via the North Atlantic current. This warm seawater releases its heat when it reaches colder areas of the north Atlantic. As the saltwater cools, it becomes denser and heavier and so sinks where it joins the deeper southbound cold water currents that come from the Arctic.

In the north Atlantic, the system of warm water travelling north, losing its heat, sinking and merging with southbound cold currents is part of the Global Conveyor Belt (GCB).

In the Celtic Sea, water flow is weak and during the summer months it is strongly stratified and pronounced surface fronts form. These fronts are narrow regions where seawater with different properties (e.g. salinity, temperature) meet. They tend to concentrate nutrients and are important areas for marine species.

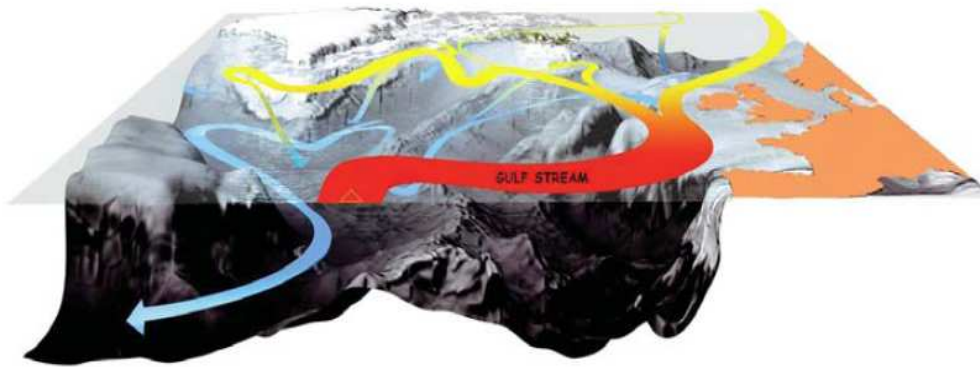
The water masses of the north Atlantic ocean are continuously moving under the influence of tides, winds and storms. In the north Atlantic vast ocean currents cross thousands of miles of ocean bringing warm water up from the tropics to European shores and taking cold water south. The main ocean current affecting the NWW area is the Gulf Stream System that draws warm water up from the Gulf of Mexico to the north east Atlantic via the North Atlantic current. This warm seawater releases its heat when it reaches colder areas of the north Atlantic. As the saltwater cools, it becomes denser and heavier and so sinks where it joins the deeper southbound cold water currents that come from the Arctic.



General schematic of the surface Currents of the North East Atlantic.
(Source: Institute of Marine Research Bergen)

The Global Conveyor Belt

Global ocean currents also work in three dimensions. In the north Atlantic, the system of warm water travelling north, losing its heat, sinking and merging with southbound cold currents is part of the Global Conveyor Belt (GCB). The GCB keeps the NWW and adjacent Seas moving and mixes warm water with cold water, thus mixing nutrient poor and nutrient rich water. This process supports the rich ecosystems of the north east Atlantic.

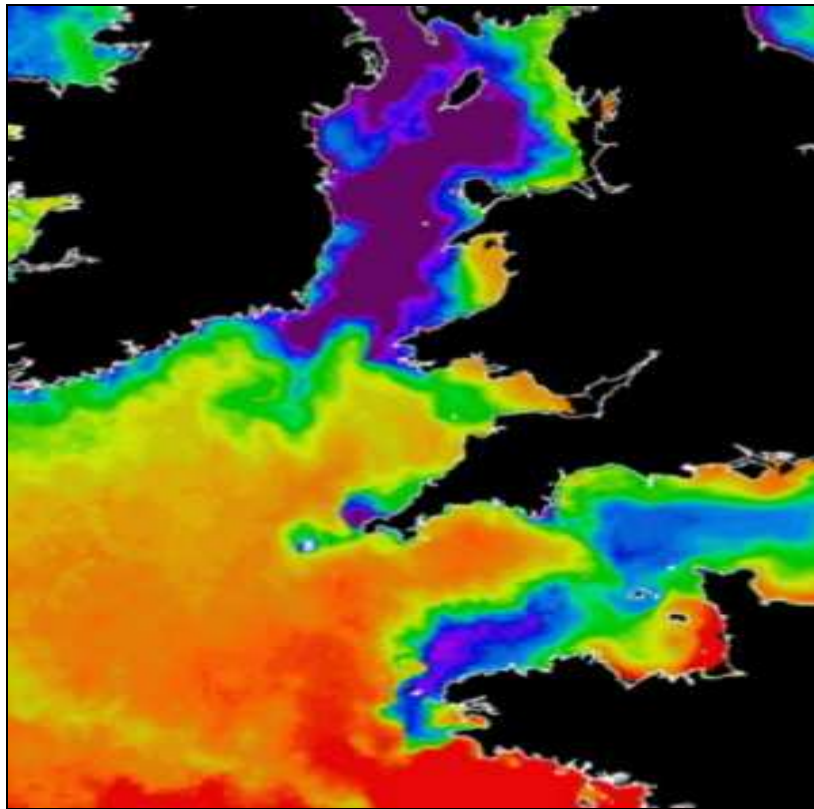


The Gulf Stream has a major influence on NWW area (Source: EU Green Paper, 2006).

Most of the water bodies found in the NWW region either have a North Atlantic source or result from the interaction between Atlantic waters and waters of Mediterranean origin. Salty, dense water from the Mediterranean sea mixes with the Atlantic water and some flows northwards along the west coast of Iberia at depths from 600 to 1,300m. Water circulation of the shallow shelf of the NWW area is controlled by the combined effects of tides, density differences and winds and is known as the Shelf Edge Current. The shelf edge current is an important transport mechanism for the eggs and larvae of important commercial fish species (see Section 17).

The Atlantic Multi-decadal Oscillation (AMO)

In the north Atlantic, there are recognised long term oscillations in ocean temperature that are linked to atmospheric conditions. During the 20th century the period 1900 to 1930 and 1960 to 1990 were characterised by cool periods in sea surface temperature while the periods 1930 to 1960 was characterised by warmer sea surface temperatures. This decadal scale oscillation is known as the **Atlantic Multi-decadal Oscillation (AMO)**. The AMO is linked to changes in weather patterns on both sides of the Atlantic.



A typical summer sea surface temperature image of the Celtic and Irish Seas, from the Advanced Very High Resolution Radiometer satellite sensor. See text for details. (Image supplied by Remote Sensing Division, Plymouth Marine Laboratory, NERC)

In the Celtic Sea, water flow is weak and during the summer months it is strongly stratified and pronounced surface fronts form. These fronts are narrow regions where seawater with different properties (e.g. salinity, temperature) meet. They tend to concentrate nutrients and are important areas for marine species. The figure above shows a typical summer sea surface temperature image of the Celtic and Irish Seas. Orange and red (17–19°C) shows areas of relatively weak tides where summer stratification has developed. Purple and blue (12–14°C) shows tidally energetic regions where the water remains vertically-mixed all year. Sharp tidal mixing fronts (between Ireland/Southwest Wales) separate the stratified and mixed regions. A band of cooler water (southwest of Brittany) lies along the continental shelf edge due to strong mixing by an internal tide. The partitioning into mixed, frontal, and stratified regions is consistent between years.



4



CLIMATE

Climate has a major impact on the oceans through its interaction with wind speed, rainfall, evaporation and heat exchange between the air and sea .

In the north Atlantic, the main climatic influence is a system called the North Atlantic Oscillation (NAO). The NAO represents the difference between two persistent sets of contrasting air pressure – high pressure over the Azores and low pressure over Iceland.

A negative NAO phase results from weak monthly average air pressure in the Azores and Iceland. This results in colder, drier winters in northern Europe and wetter winters in the Mediterranean. The mean winter NAO in 2010 was the lowest recorded in over 60 years of records.

The growing realisation that human action is affecting the earth's climate has developed at the same time as the growing recognition of the importance of naturally occurring variations in the climate. **Climate change** represents the human induced warming trend on the climate, while **climate variability** refers to the “natural” cycles of change in climate over a defined time scale (e.g. decadal scale).

Climate has a major impact on the oceans through its interaction with wind speed, rainfall, evaporation and heat exchange between the air and sea .

In the north Atlantic, the main climatic influence is a system called the North Atlantic Oscillation (NAO). The NAO represents the difference between two persistent sets of contrasting air pressure – high pressure over the Azores and low pressure over Iceland. When the pressure over the Azores is higher than usual and the pressure over Iceland is lower than usual, the NAO is in a positive phase. This results in warm and wet winters for Europe. A negative NAO phase results from weak monthly average air pressure in the Azores and Iceland. This results in colder, drier winters in northern Europe and wetter winters in the Mediterranean.

The mean winter NAO in 2010 was the lowest recorded in over 60 years, which may explain the unusually harsh weather conditions experienced in the NWW.

Positive NAO

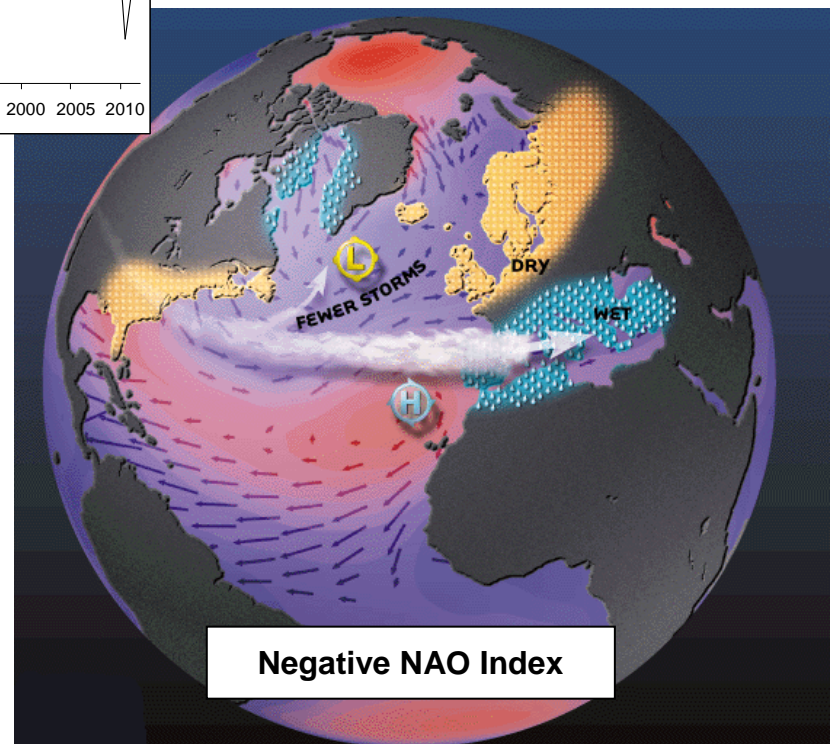
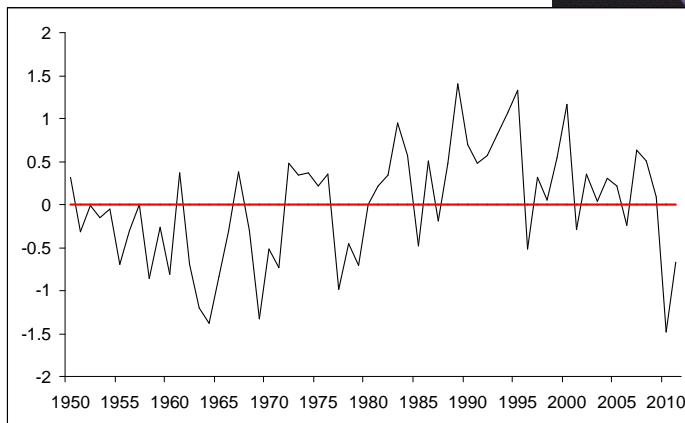
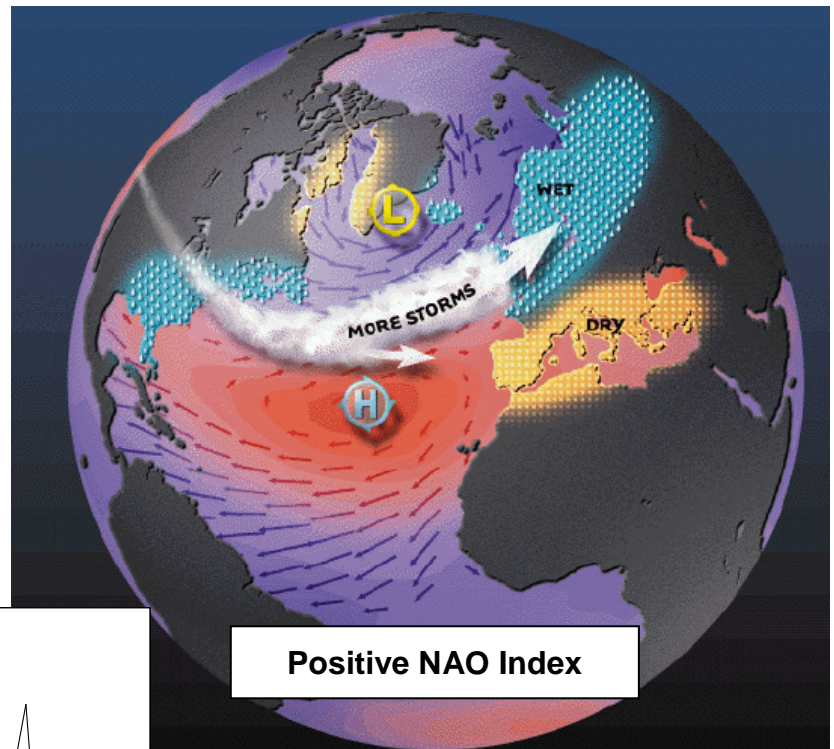
- The + NAO index phase results from a stronger than usual Azores high pressure centre and a deeper than normal Icelandic low.
- The increased pressure difference causes stronger wind storms across the Atlantic ocean on a more northerly track (i.e. straight through the NWW area).
- This results in warm and wet winters in Europe and cold and dry winters in northern Canada and Greenland.

Negative NAO

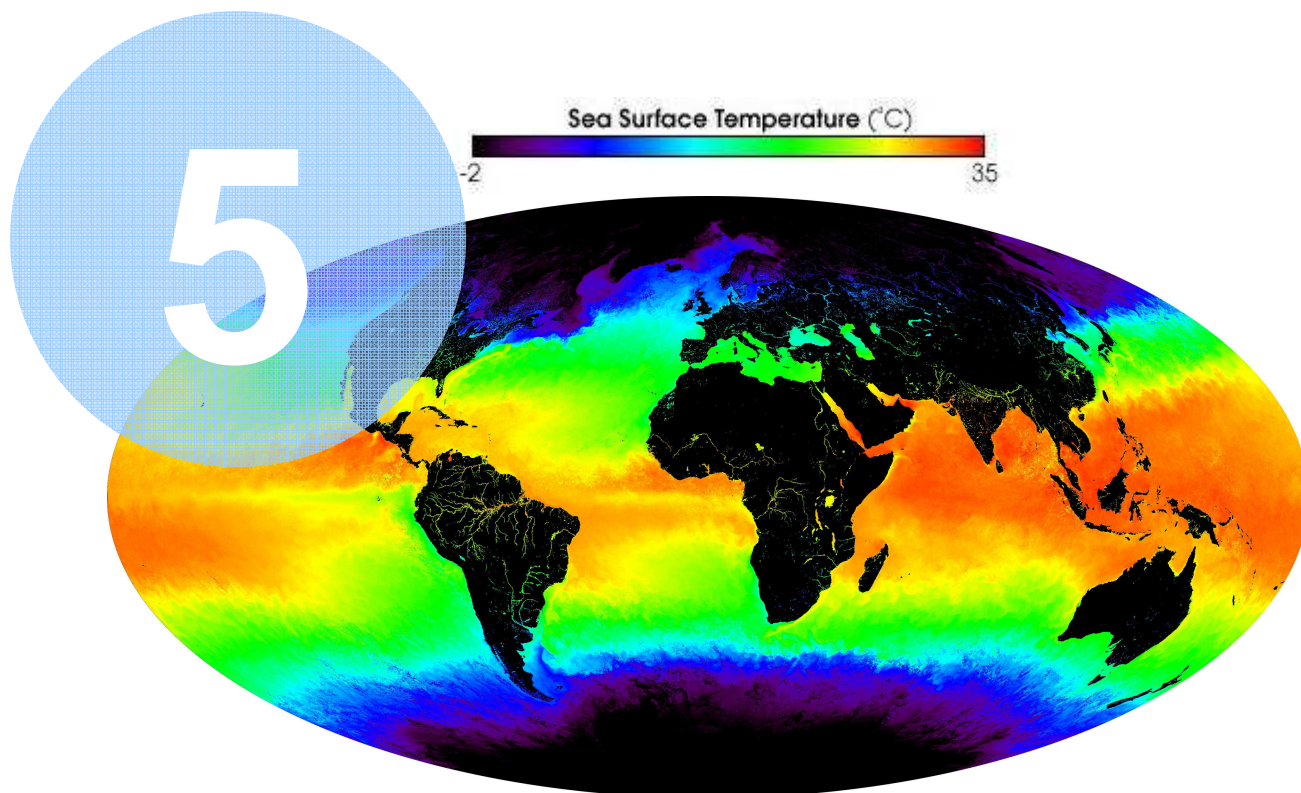
- The – NAO index phase results from a weak Azores high and weak Icelandic low pressure.
- A reduced pressure gradient results in fewer and weaker winter storms crossing on a more west – east pathway (i.e. south of the NWW area).
- Brings moist air into the Mediterranean and cold air into Northern Europe.
- The US east coast experiences more cold air periods and hence snowy weather conditions.

(Modified from ICES Environmental Status of European Seas, 2003)

The North Atlantic Oscillation (NAO)



(Source: Martin Visbeck, Columbia University;
<http://www.ldeo.columbia.edu/res/pi/NAO/>)



SEA TEMPERATURE

The increase in greenhouse gases has caused warming of the atmosphere and ocean, rising sea levels and changing wind patterns. As greenhouse-gas emissions continue to rise, so will the global temperature, leading to further melting of ice and rises in sea level.

The ocean is also predicted to become more acidic over the next few centuries as a consequence of increased levels of CO₂ in the sea. This will have major implications for marine animals and plants (e.g. phytoplankton, zooplankton, corals and bivalves) that make their shells and plates out of calcium carbonate (CaCO₃).

ICES has stated that from the evidence available, there is much uncertainty as to whether marine species, communities, and ecosystems will be able to acclimatize or evolve in response to changes in ocean chemistry.

Image source: MODIS Ocean Group, NASA GSFC, and the University of Miami

In their Climate Change update, ICES have stated that there is “great confidence within the scientific community that climate change is a reality. Global atmospheric concentrations of the ‘greenhouse’ gases – carbon dioxide (CO₂), methane, and nitrous oxide – have increased as a result of fossil fuel use and changing systems of agriculture”.

The increase in these gases has caused warming of the atmosphere and ocean, rising sea levels, and changing wind patterns. As greenhouse-gas emissions continue to rise so will the global temperature, leading to further melting of ice and rises in sea level.

Global Warming - A Reality

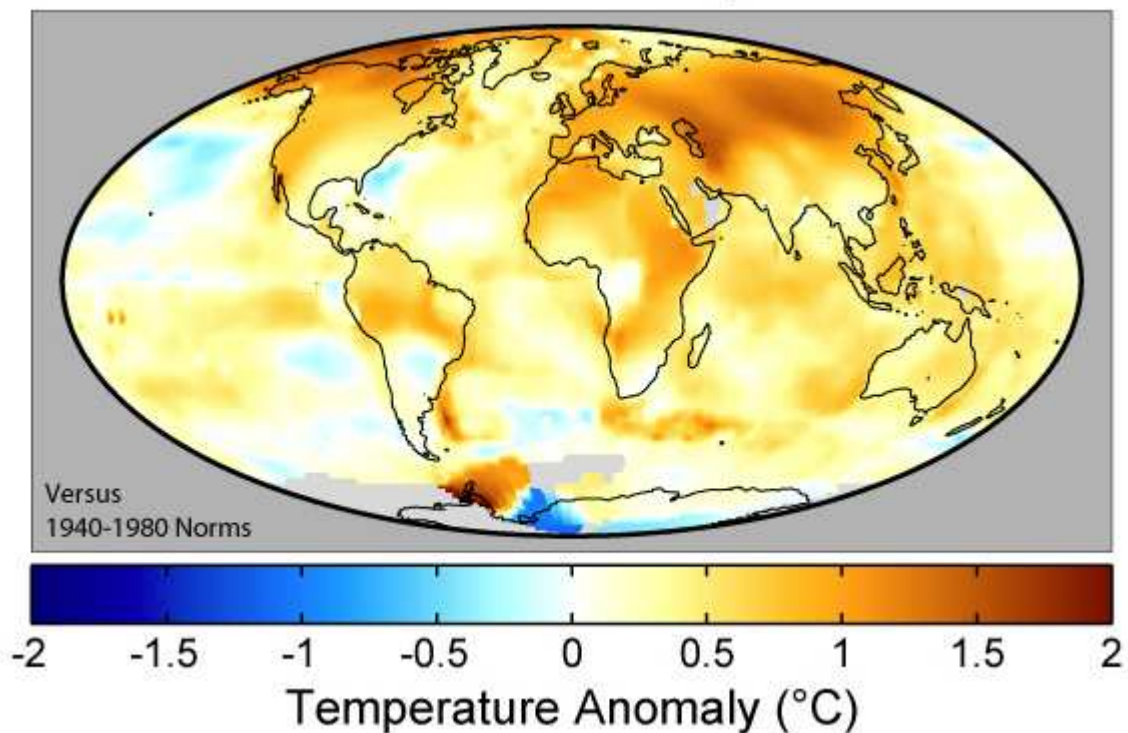
"The warnings about global warming have been extremely clear for a long time. We are facing a global climate crisis. It is deepening. We are entering a period of consequences."

Al Gore

"Most of the observed increase in globally averaged temperatures since the mid-20th century is very likely due to the result of the observed increase in anthropogenic greenhouse gas concentrations"

- In the last 100 years, the average global temperature has increased by 0.74°C.
- This temperature increase is widespread over the globe and is greater at higher northern latitudes. However, temperature anomalies may be patchy and vary regionally.
- Eleven of the 12 years from 1995 to 2006 rank among the 12 warmest years in the instrumental records of global surface temperature, which began in 1850.
- Global average sea level has risen since 1961 at an average rate of 1.8 mm year⁻¹ and since 1993 the rate has nearly doubled to 3.1 mm year⁻¹ as a result of thermal expansion and melting glaciers, ice caps, and polar ice sheets.
- Observed decreases in snow and ice extent are also consistent with warming: satellite data since 1978 reveal that annual average Arctic sea-ice extent has shrunk by 2.7% per decade.

Inter Governmental Panel on Climate Change (2007);
(See: <http://www.ipcc.ch>)



Regional variation in Global Sea Temperature Changes
Average temperature from 1995-2004 versus 1940-1980.
 (Source: ICES, 2007)

The ocean is also predicted to become more acidic over the next few centuries as a consequence of increased levels of CO₂ in the sea. This will have major implications for marine animals and plants (e.g. phytoplankton, zooplankton, corals and bivalves) that make their shells and plates out of calcium carbonate (CaCO₃). The process of “calcification”, which for some marine organisms is important to their biology and survival, will be reduced as the water becomes acidic (less alkaline). ICES have stated that from the evidence available, there is much uncertainty as to whether marine species, communities, and ecosystems will be able to acclimatise or evolve in response to changes in ocean chemistry. At this stage, research into the impacts of high concentrations of CO₂ in the oceans is still in its infancy.

Climate Change Impacts on the NWW ecosystem

Physical and Chemical Impacts

Increased Sea Temperature
 Increasing Freshwater Inputs
 Changed Salinity
 Shelf Sea Stratification
 Increased Storms
 Increased Sea Levels

Reduced Uptake of CO₂ by the Ocean
 Acidification of the Ocean
 Nutrient Enhancement
 Coastal Erosion
 Slower Atlantic Ocean Circulation

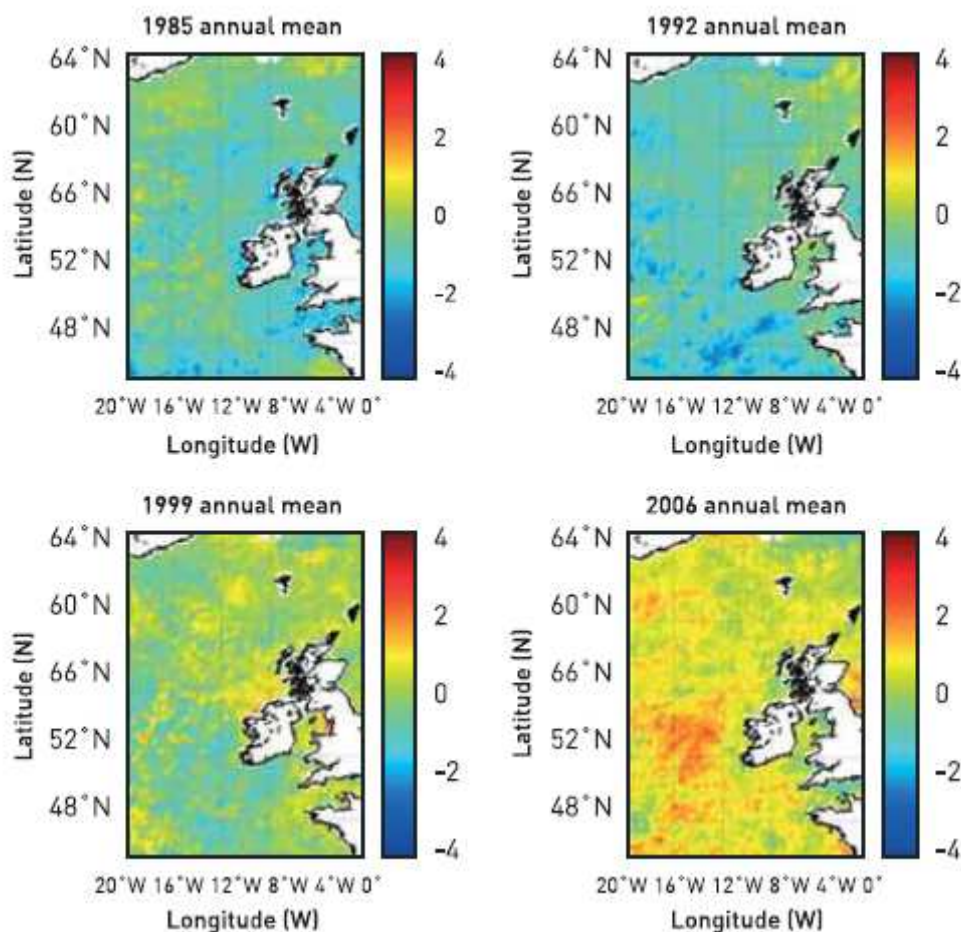
(Based on OSPAR, 2009)

Climate Change Impacts on the NWW ecosystem

Biological Impacts

Phytoplankton	– Shift in Species Abundance and Distribution
Harmful Algal Blooms	– Increasing Incidence
Fish	– Shift in Distributions
Mammals	– Loss of Habitat and Change in Food Supply
Seabirds	– Change in Food Supply
Non Indigenous Species	– Increased Invasions and Establishments
Intertidal Communities	– Change of Species Range
Benthic Ecology	– Vulnerable to abrupt and extreme events

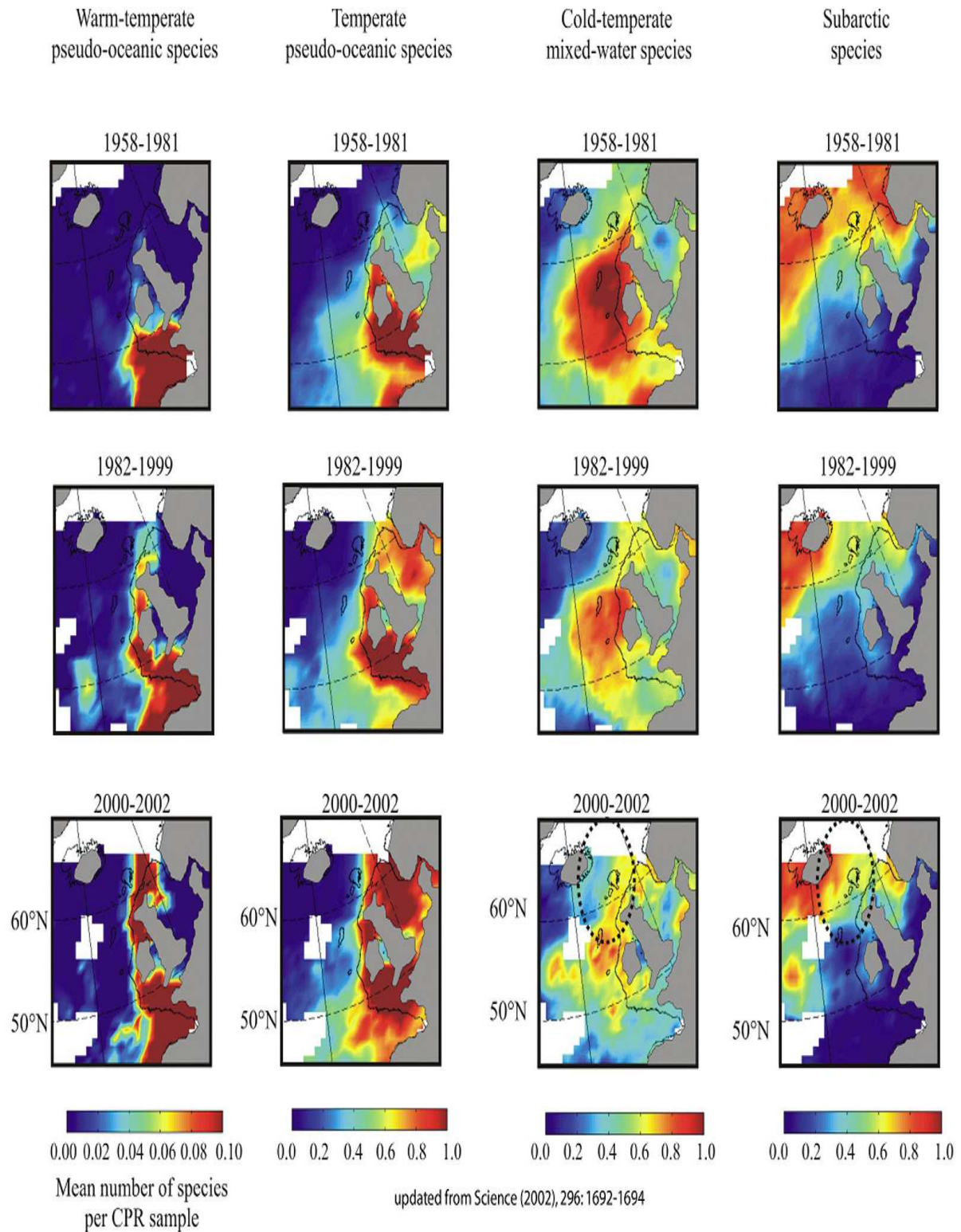
(Based on OSPAR, 2009)

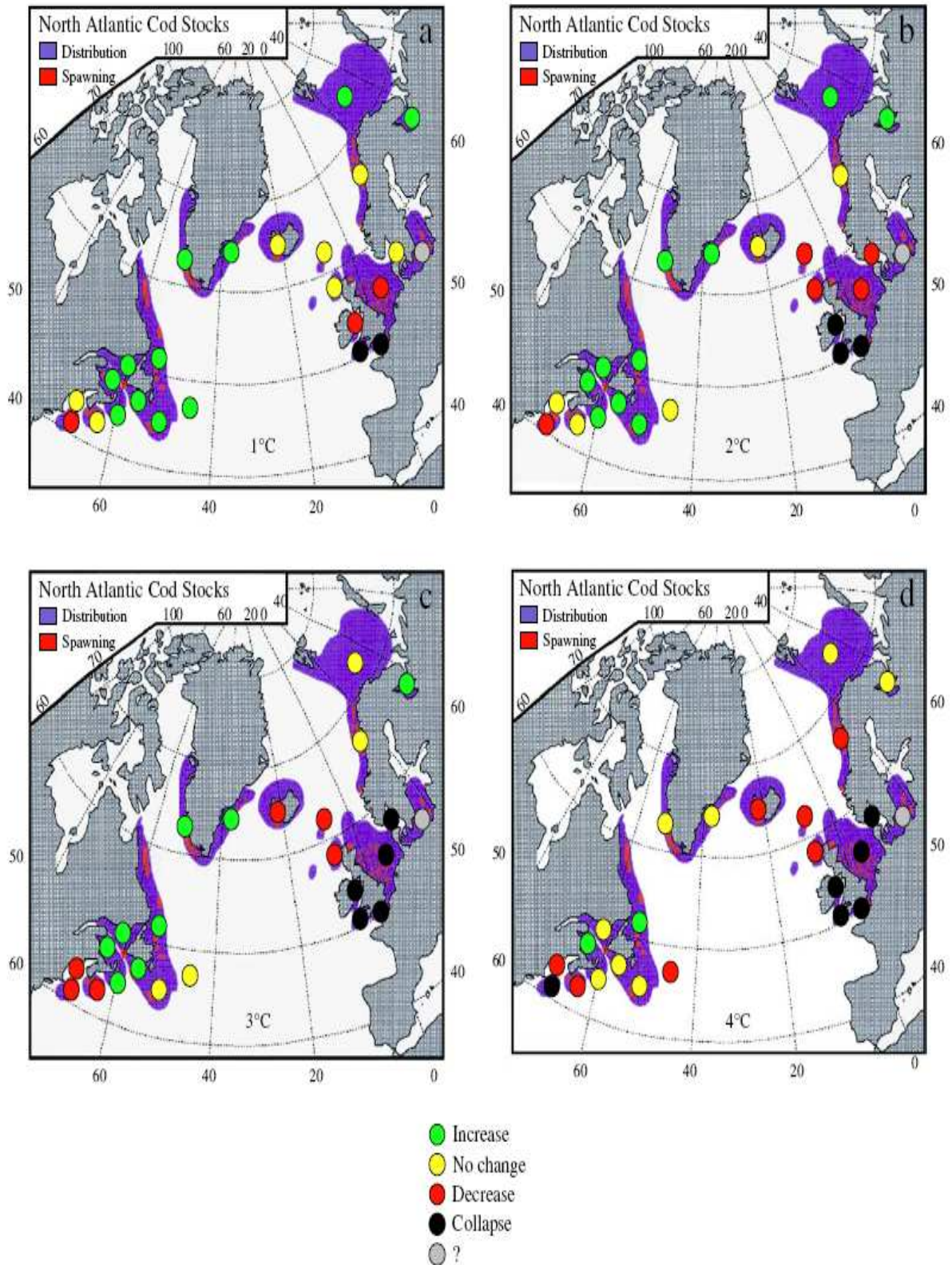


Annual mean anomalies of sea surface temperature (°C)
calculated relative to the 1985-2006 mean.

(Source: Irish Ocean Climate & Ecosystem Status Report, 2009).

Maps showing biogeographical shifts of calanoid copepod communities in recent decades, with the warm-water species shifting northwards and the cold-water species likewise retracting north, by more than 10° of latitude (Source: Edwards *et al.*, 2008).





Expected change in the abundance of the cod stocks with a temperature increase of 1°C, 2°C, 3°C and 4°C (Source: Drinkwater, 2005).



6



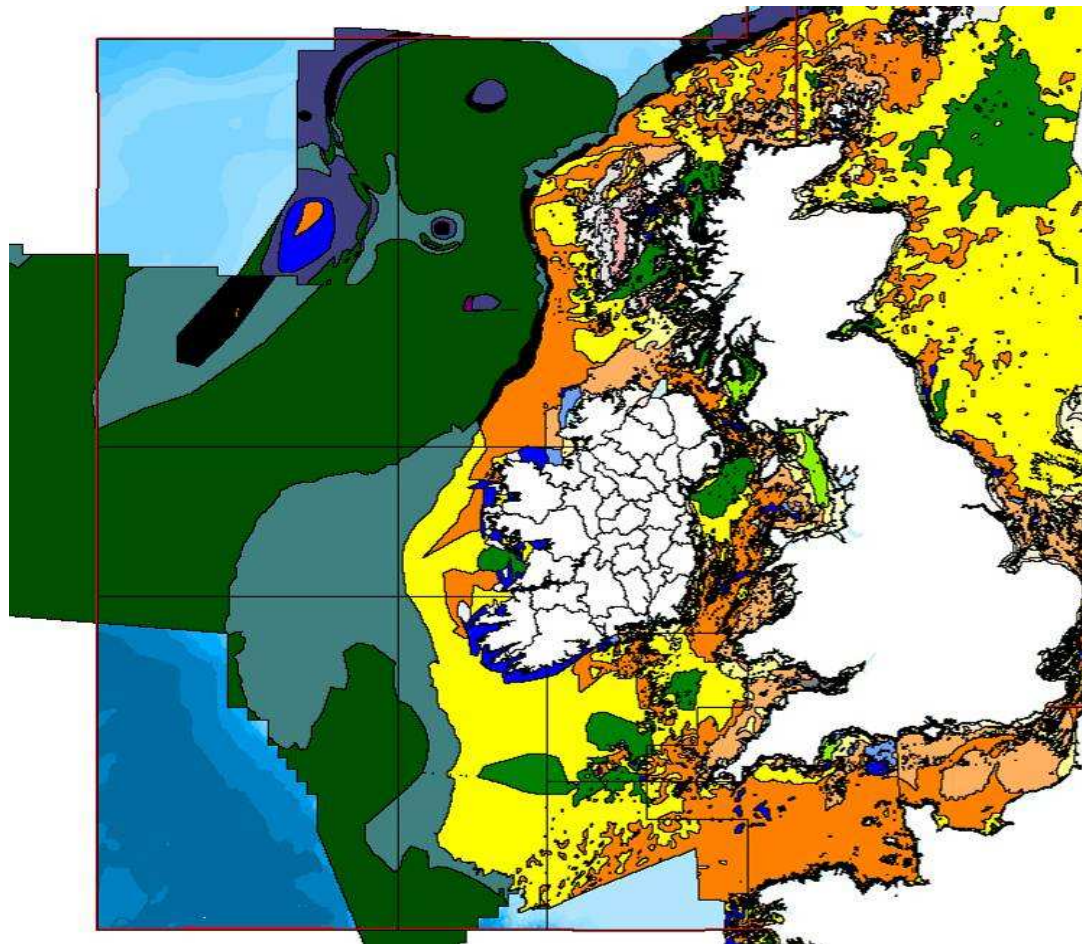
SEA FLOOR HABITAT

Gravelly sediments occur extensively in the Irish Sea, English Channel and Malin Shelf.

Areas of sand in NWW RAC occur extensively on the Porcupine and Rockall Banks, the Celtic Sea and areas of the Irish Sea, where areas of sandwaves and mega-ripples occur north of the Isle of Man, in Liverpool Bay and Cardigan Bay and also in St. George's Channel.

Muddy sediments occur throughout the NWW RAC, particularly in the north of the Irish Sea, in two large areas separated by the central belt of gravelly sediments, in the Atlantic Basins, Rockall Trough and southern Celtic Sea.

A map of benthic habitats within the NWW RAC is presented below. This map was produced from data downloaded from the MESH Project (**M**apping **E**uropean **S** seabed **H**abitats, www.searchmesh.net) where the focus is on mapping according to the EUNIS habitat classification. In addition to the EUNIS classification, each EUNIS habitat type can be linked to different biotopes around the British Isles. A biotope is defined as an area of uniform environmental conditions with a specific assemblage of organisms.



Predicted EUNIS Habitats

- A3.1 Atlantic & Mediterranean High Energy Infralittoral Rock
- A3.2 Atlantic & Mediterranean Moderate Energy Infralittoral Rock
- A3.3 Atlantic & Mediterranean Low Energy Infralittoral Rock
- A4.1 Atlantic & Mediterranean High Energy Circalittoral Rock
- A4.2 Atlantic & Mediterranean Moderate Energy Circalittoral Rock
- A4.27 Fauna Communities on Deep Moderate Energy Circalittoral Rock
- A4.3 Atlantic & Mediterranean Low Energy Circalittoral Rock
- A4.33 Fauna Communities on Deep Low Energy Circalittoral Rock
- A5.12 Infralittoral Coarse Sediment
- A5.13 Circalittoral Coarse Sediment
- A5.14 Deep Circalittoral Coarse Sediment
- A5.23 or A5.24 Infralittoral Fine Sand/Muddy Sand
- A5.25 or A5.26 Circalittoral Fine Sand/Muddy Sand
- A5.27 Deep Circalittoral Sand
- A5.33 or A5.34 Infralittoral Sandy Mud/Fine Mud
- A5.35 or A5.36 Circalittoral Sandy Mud/Fine Mud
- A5.37 Deep Circalittoral Mud
- A5.43 Infralittoral Mixed Sediments
- A5.44 Circalittoral Mixed Sediments
- A5.45 Deep Mixed Sediments
- A6.1 Deepsea Rock & Artificial Hard Substrata
- A6.2 Deep Sea Mixed Substrata
- A6.3 or A6.4 Deepsea Sand/Muddy Sand
- A6.5 Deepsea Mud
- 421/423/523 Deepsea Coarse Sediment

Gravel

Gravelly sediments (labeled as 'Infralittoral coarse sediment', 'Circalittoral Coarse Sediment', 'Deep Circalittoral Coarse Sediment' and 'Deepsea Coarse Sediment') occur extensively in the Irish Sea, English Channel and Malin Shelf. Within the Irish Sea they occupy a broad belt in the centre of the northern Irish Sea extending from Scotland, past the Isle of Man, to Anglesey and are predominant in the Northern Channel, Cardigan Bay and St. George's Channel. There are also large areas of exposed till in St. George's Channel and areas of exposed bedrock occur locally in the North Channel and between Anglesey and the Isle of Man. The gravelly areas, and the areas of exposed till and bedrock, mainly occur in regions dominated by strong tidal currents or wave action and it is likely that the strong currents prevent the deposition of fine material.

Sand

Areas of sand (labeled as 'Infralittoral Fine Sand/Muddy Sand', 'Circalittoral Fine Sand/Muddy Sand', 'Deep Circalittoral Sand' and 'Deepsea Sand/Muddy Sand') in NWW occur extensively on the Porcupine and Rockall Banks, the Celtic Sea and areas of the Irish Sea, where areas of sandwaves and megaripples occur north of the Isle of Man, in Liverpool Bay and Cardigan Bay and also in St. George's Channel. Tidal sand banks and sand ridges occur in the Solway Firth, north of the Isle of Man, in Liverpool Bay, south of Llyn Peninsula and off the east coast of Ireland.

Mud

Muddy sediments (labeled as 'Infralittoral Sandy Mud/Fine Mud', 'Circalittoral Sandy Mud/Fine Mud', 'Deep Circalittoral Mud' and 'Deepsea Mud') occur throughout the NWW, particularly in the north of the Irish Sea, in two large areas separated by the central belt of gravelly sediments, in the Atlantic Basins, Rockall Trough and southern Celtic Sea. The main concentration in the Irish Sea is in the area between the Isle of Man and Northern Ireland, where the sediments have very high mud content. Other areas of muddy sediments also occur in St. George's Channel and smaller areas can be found locally in coastal areas off rivers and estuaries and in small bathymetric depressions.

Further Information on Habitat Types

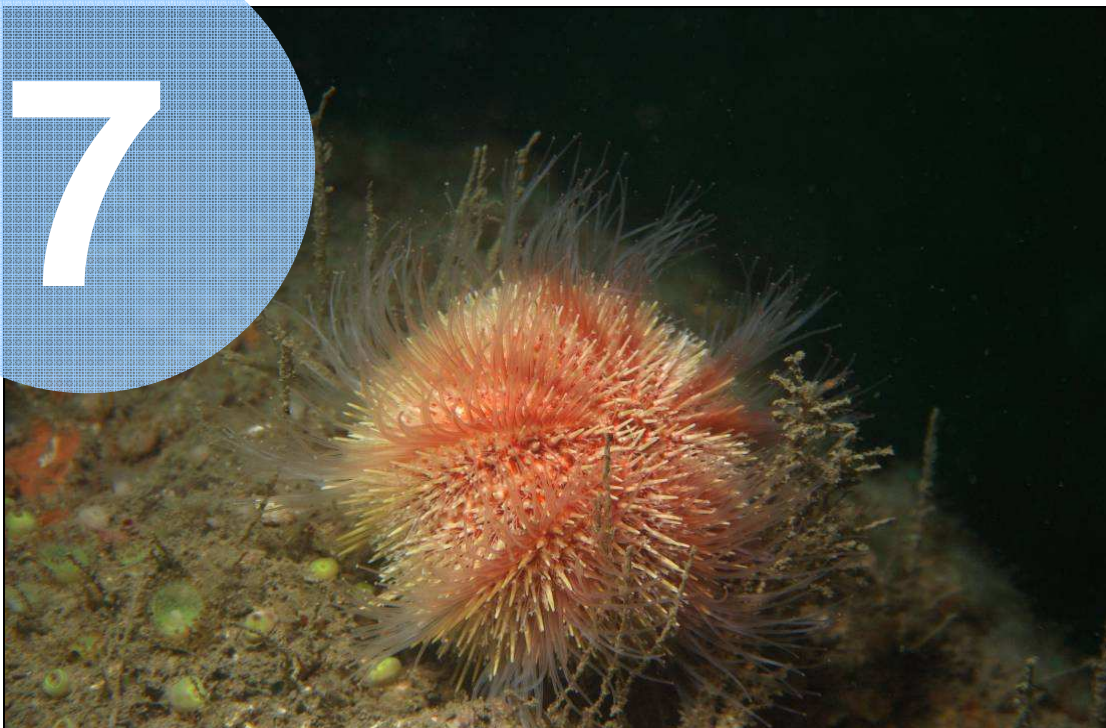
Detailed descriptions of the biotopes and how they relate to EUNIS classification can be found on the JNCC website (www.jncc.gov.uk). The descriptions include physical characteristics (including wave exposure, tidal stress, salinity etc.), distributions and biological characteristics (including species compositions, frequency and similar biotopes).

Seabed Type	Value*	Target Fishing Species
Rock Outcrop /Shelf trough	Refuges for fish, epifaunal habitat, renewable energy sites	Cod, haddock, hake, crab, lobster
Mixed Coarse Sediment	Spawning grounds, infaunal and epifaunal habitat, aggregate supply, renewable energy sites	Cod, haddock, hake, herring, monkfish, dogfish, scallops
Sand	Infaunal and epifaunal habitat, coastal protection, geochemical processes, aggregate supply, renewable energy sites	Cod, haddock, hake, whiting, scallops, plaice, dogfish, monkfish, sole
Mud	Infaunal habitat, geo-chemical recycling, contaminant and carbon capture, renewable energy sites	Dublin Bay prawn, haddock, hake, whiting, plaice, dogfish, sole
Sea Loughs	Infaunal and epifaunal habitat, geochemical recycling and primary or secondary productivity, renewable energy sites	Crab, Dublin Bay prawn, scallops, lobster, cockles, oysters, mussels

*ecosystem goods and services, and direct values for humans

The ecosystem goods and services, and fisheries associated with the main seabed types.
(Source: Northern Ireland State of the Seas, 2010)





CONTAMINANTS AND NUTRIENTS

Contaminants are chemical substances that are detected in locations where they should not normally be found. The effects of contaminants on marine organisms (animals and plants) vary depending upon their behavior and fate following release to the environment.

Contaminants can be natural or manmade and fall into four main groups: Trace metals: metals such as cadmium and mercury, which are generated in metallurgic industries such as the manufacture of batteries, and copper, which is widely used as an antifoulant; Organic compounds: including pesticides and herbicides that occur in agricultural runoff; Oil: from energy extraction and marine transport; Radioactive elements: radioactive caesium is released from nuclear reprocessing operations.

Excess nutrients, or eutrophication, can lead to overgrowth of marine algae. The major sources of nitrogen and phosphorus input in the NWW environment are diffuse losses (agriculture and atmospheric deposition) and sewage treatment works.

Contaminants

Contaminants are chemical substances that are detected in locations where they should not normally be found. Their input to marine areas follows three main routes: directly into the sea, via rivers, or via the atmosphere. The relative importance of these routes depends on the substance in question and the geographic area. In the open ocean, far from sources on land, inputs from the atmosphere are the most important while in coastal areas riverine and direct inputs are more significant.

Contaminants can be natural or manmade and in the marine environment fall into four main groups: 1) Trace metals such as cadmium and mercury, which are generated in metallurgic industries such as the manufacture of batteries, and copper, which is widely used as an antifoulant 2) Organic compounds including pesticides and herbicides that occur in agricultural runoff 3) Oil from energy extraction and marine transport 4) Radioactive elements such as caesium is released from nuclear reprocessing operations.

The effects of contaminants on marine organisms (animals and plants) vary depending upon their chemical behaviour and fate following release to the environment. After release, substances can remain in the water (either in solution or attached to small particles), or be deposited in sediments, or be taken up by organisms. Some contaminants can also be transported long distances from their sources by ocean currents and through the atmosphere. Transport through the atmosphere is a particularly important mechanism in transferring certain persistent organic compounds from their sources in temperate latitudes (e.g., the USA and Europe) to the Arctic regions. The uptake of substances by organisms (bioavailability) is an important feature in determining their effects.

Examples of Marine Contaminants

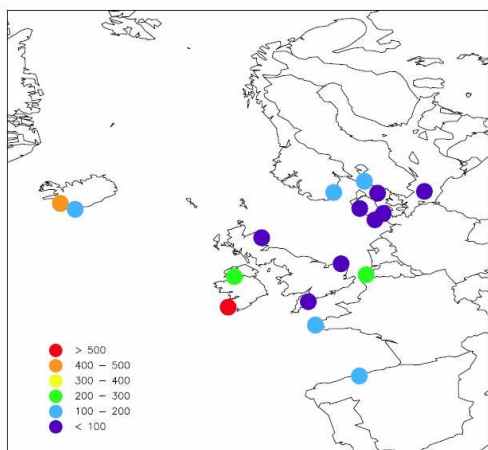
Antifoulants are used to prevent the growth of marine plants and animals on the hulls of ships, as this growth slows the vessels down and increases their fuel consumption.

Drill cuttings are the fragments of rock removed when a well is being drilled, in association with the fluid circulating within the drilling system that aids removal of the cuttings from the hole and can be used to lubricate the drill itself.

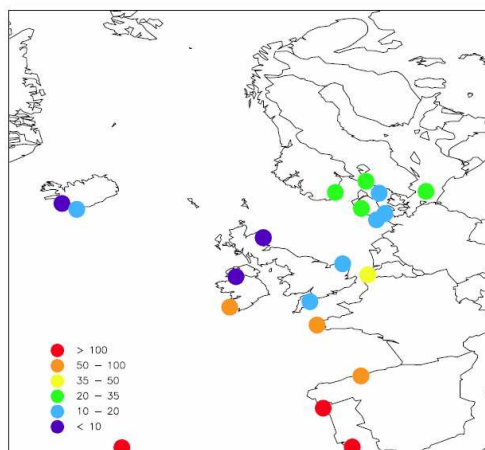
Produced water is water from the underground formation that rises to the surface with the oil. This is cleaned on board the production platform and then either discharged overboard or returned to the formation (re-injected).

Chlor-alkali plants manufacture chlorine gas and caustic soda by the electrolysis of sodium chloride brine. Brine sludge is a by product and may contain magnesium, calcium, iron, and other metal hydroxides.

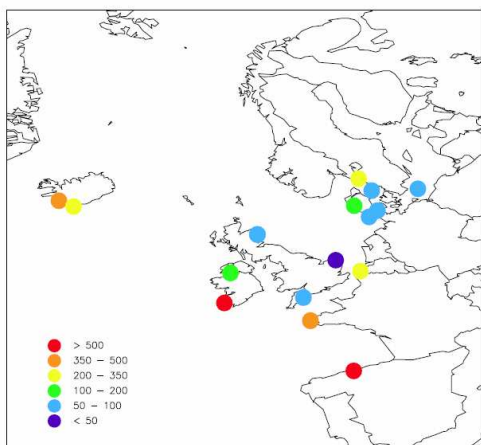
Dioxins are by-products of industrial processes and low-temperature incineration (particularly of plastics). They bio-accumulate in animals and can cause sterility and cancer.



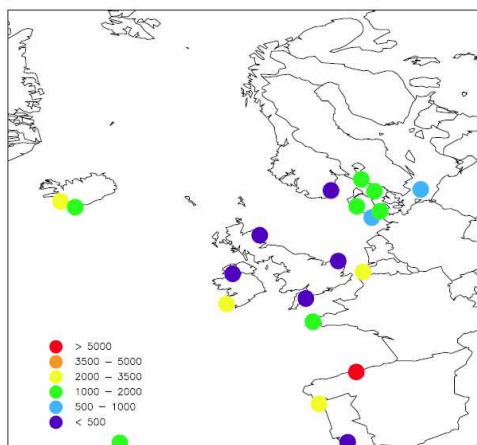
As depositions 2007, µg/m² p.a.



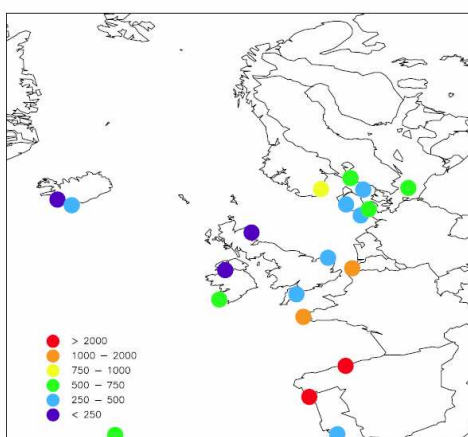
Cd depositions 2007, µg/m² p.a.



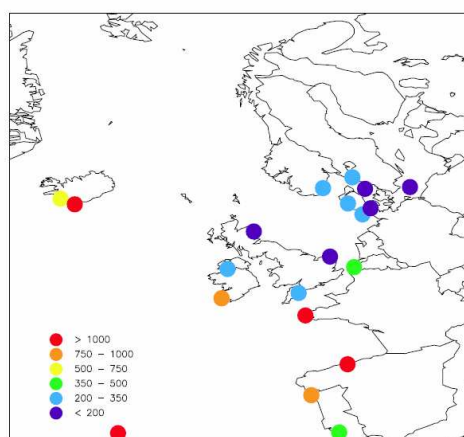
Cr depositions 2007, µg/m² p.a.



Cu depositions 2007, µg/m² p.a.



Pb depositions 2007, µg/m² p.a.



Ni depositions 2007, µg/m² p.a.

Deposition of Arsenic, Cadmium, Chromium, Copper, Lead and Nickel in the North East Atlantic.
(Source: OSPAR COMMISSION, 2009)

Nutrients

Eutrophication is defined as the anthropogenic enrichment of water by nutrients, (principally nitrates and phosphates) causing an accelerated growth of algae and higher forms of plant life. This produces an undesirable disturbance of the balance of organisms present in the water and also the quality of the water itself. High nutrient levels can lead to depletion of oxygen (anoxia) followed by loss of bottom dwelling animals and shifts in the structure of the food web.

The urbanization of coastal areas is associated with nutrient releases and related pressures on the marine environment, e.g from waste water treatment plants or from economic activities. Population sizes in Europe's coasts are steadily increasing. Coasts are converted to manmade artificial surfaces at a fast pace, replacing agricultural and natural land.

The most important sources contributing to eutrophication in the NWW maritime area are agriculture, atmospheric deposition, urban waste water, industry and agriculture.

The major sources of nitrogen and phosphorous input in the environment are diffuse losses (agriculture and atmospheric deposition) and sewage treatment works. A major contribution to atmospheric deposition, and therefore to the overall input of nitrogen to the environment, is the emission by international ship traffic.

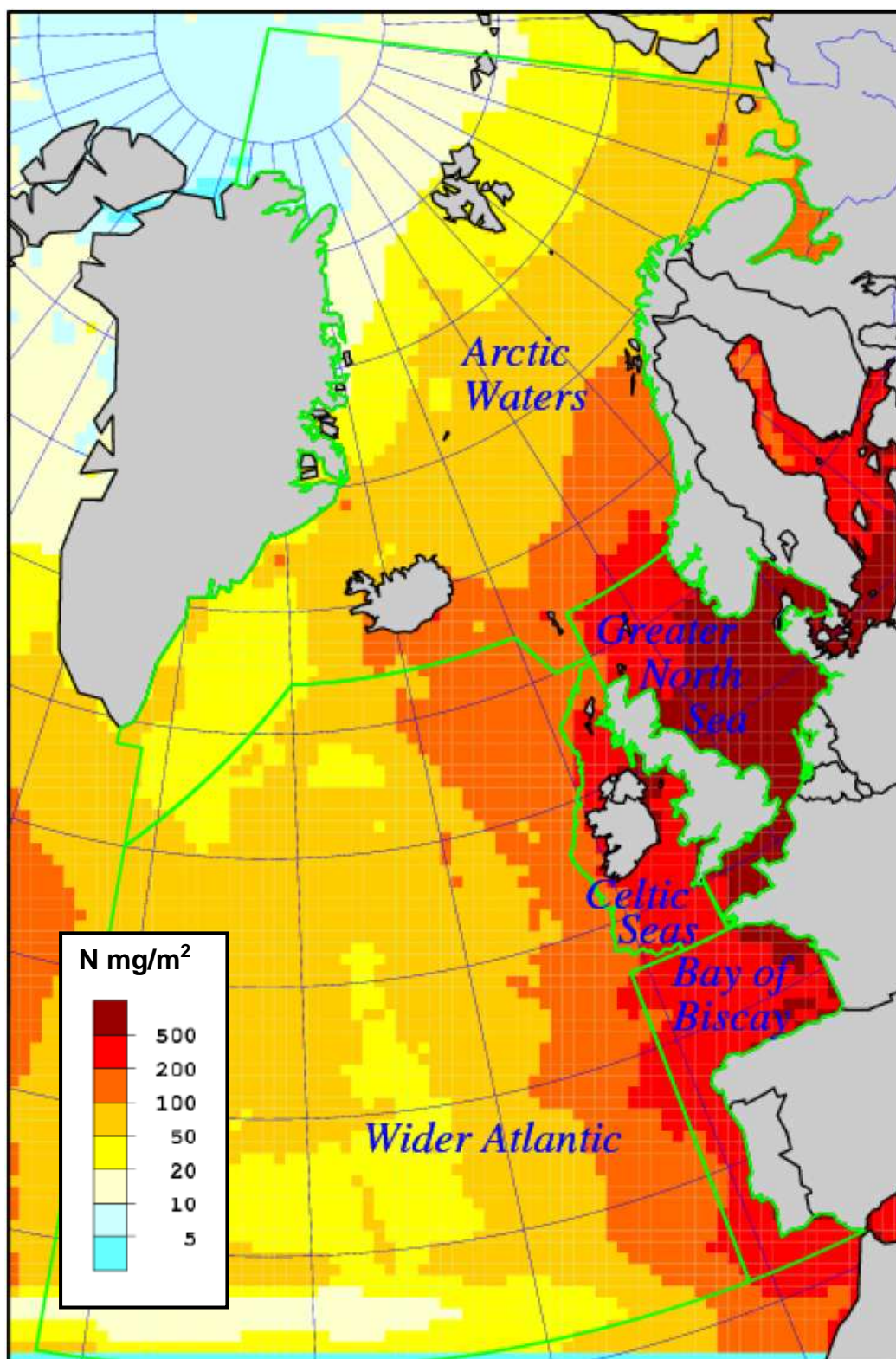
Nitrogen and Eutrophication

The greater North Sea is the most problematic region in the North-East Atlantic in terms of eutrophication. Reasons for this are high population densities and related high nutrient inputs, mostly via rivers. Furthermore the shallow character of the shelf sea and its hydrodynamics enhance eutrophication processes. For the Greater North Sea atmospheric deposition of nitrogen is estimated to represent one third of all nitrogen inputs.

In the Celtic Seas eutrophication is restricted to fjords, estuaries and harbours, where the pressures are associated with higher population densities and agricultural activities. Atmospheric deposition of nitrogen is estimated to provide about one third of all inputs of nitrogen.

The Bay of Biscay and the Iberian Coast are also less affected by eutrophication processes because the hydrodynamic conditions at the open ocean (e.g. fast dilution) inhibit the conversion of discharged nutrients to extended phytoplankton blooms. Eutrophication is therefore limited to a few inshore areas.

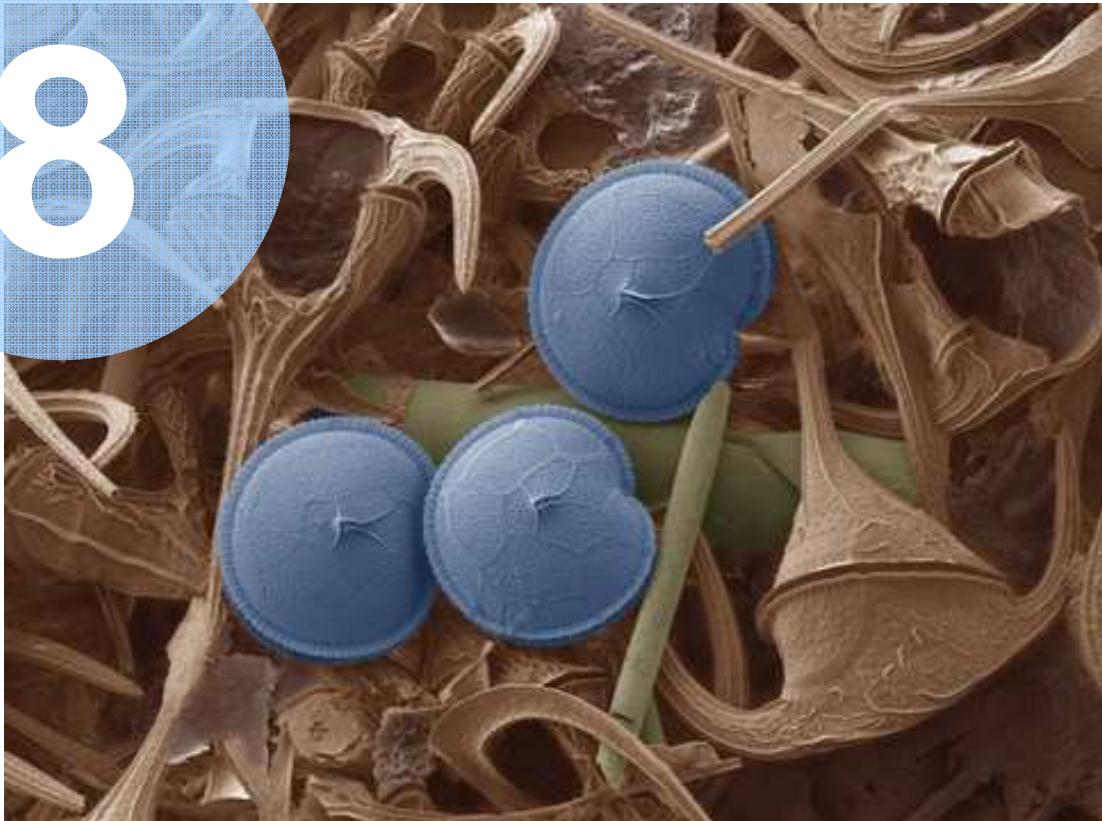
Total inputs of nitrogen in the wider Atlantic are very low compared to the other regions. Atmospheric deposition is estimated to be the largest source.



Modeled annual total nitrogen in the North-East Atlantic.
(Source: OSPAR, 2008)



8



Marine dinoflagellates

PLANKTON

Plankton consists of drifting organisms that inhabit the pelagic zone of the oceans and they provide a crucial source of food for many organisms. The plankton community comprises a plant component (phytoplankton) and an animal component (zooplankton).

The local abundance of plankton varies horizontally, vertically and seasonally. The main cause of this variability is the availability of light and this confines primary production to surface waters. Another cause of variability is the availability of nutrients.

Although large areas of the tropical and sub-tropical oceans have abundant light, they experience relatively low primary production because of the poor availability of nutrients such as nitrate, phosphate and silicate. Nutrient availability is driven by large-scale ocean circulation and stratification of the water column.

Image source: SuperStock.co.uk

The plankton community comprises a plant component (phytoplankton) and an animal component (zooplankton). The biology and ecology of plankton is closely coupled with environmental factors and as a result they act as an important link between the biological and physical components of the ecosystem. Changes in plankton populations will have impacts on organisms at higher trophic levels, with important environmental and economic consequences.

The majority of the plankton is found within the top 20m of the water column, where light can penetrate thus allowing photosynthesis to take place. The phytoplankton community is dominated by dinoflagellates and diatoms. The zooplankton communities are dominated by copepods, such as *Calanus finmarchicus* and *Calanus helgolandicus*, and they are an important prey item for many species at higher trophic levels. There is a strong geographical separation between these two species, with *C. finmarchicus* more abundant in colder, more northern waters and *C. helgolandicus* more abundant in warmer, more southerly waters (although their ranges do overlap). The larger zooplankton includes Euphausiids (krill), Thaliacea (salps and doliolids) and Medusae (jellyfish).



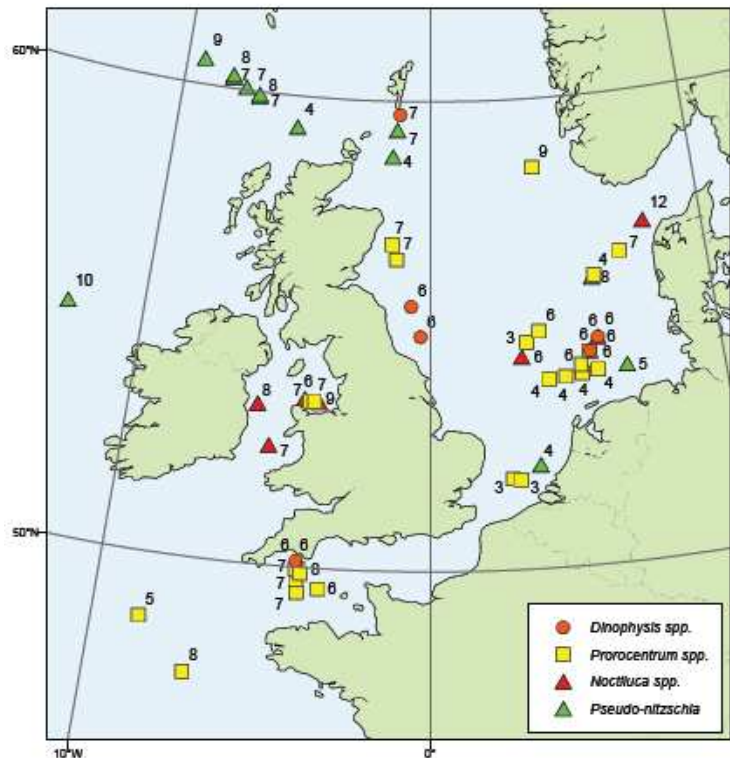
**Phytoplankton bloom off the Irish coast.
(Image: NASA)**



Red tide on the West coast of Ireland.

Harmful Algal Blooms

In the temperate seas a phytoplankton bloom occurs every spring, generally followed by a smaller peak in the autumn. The size of the bloom will be determined by seasonal changes in light penetration and nutrient content of the water column through mixing and turbulence caused by winds. The bloom is followed by nutrient depletion as the phytoplankton consumes the available resources. Some of these blooms involve nuisance or noxious species and are described as Harmful Algal Blooms (HABs). Examples include those connected with Paralytic and Amnesic Shellfish Poisoning. HABs may be related to water surface temperatures in spring, as early seasonal stratification may favor phytoplankton, growth in the water column (Joint *et al.* 1997). In the Atlantic area there has been a large increase in HAB events associated with changes in salinity, sea surface temperature and wind speed.



The geographical distribution of some exceptional HABs in 2007. Numbers indicate the month of the bloom.
(Source: SAHFOS Report Edwards *et al.*, 2009)

Phytoplankton in the North East Atlantic

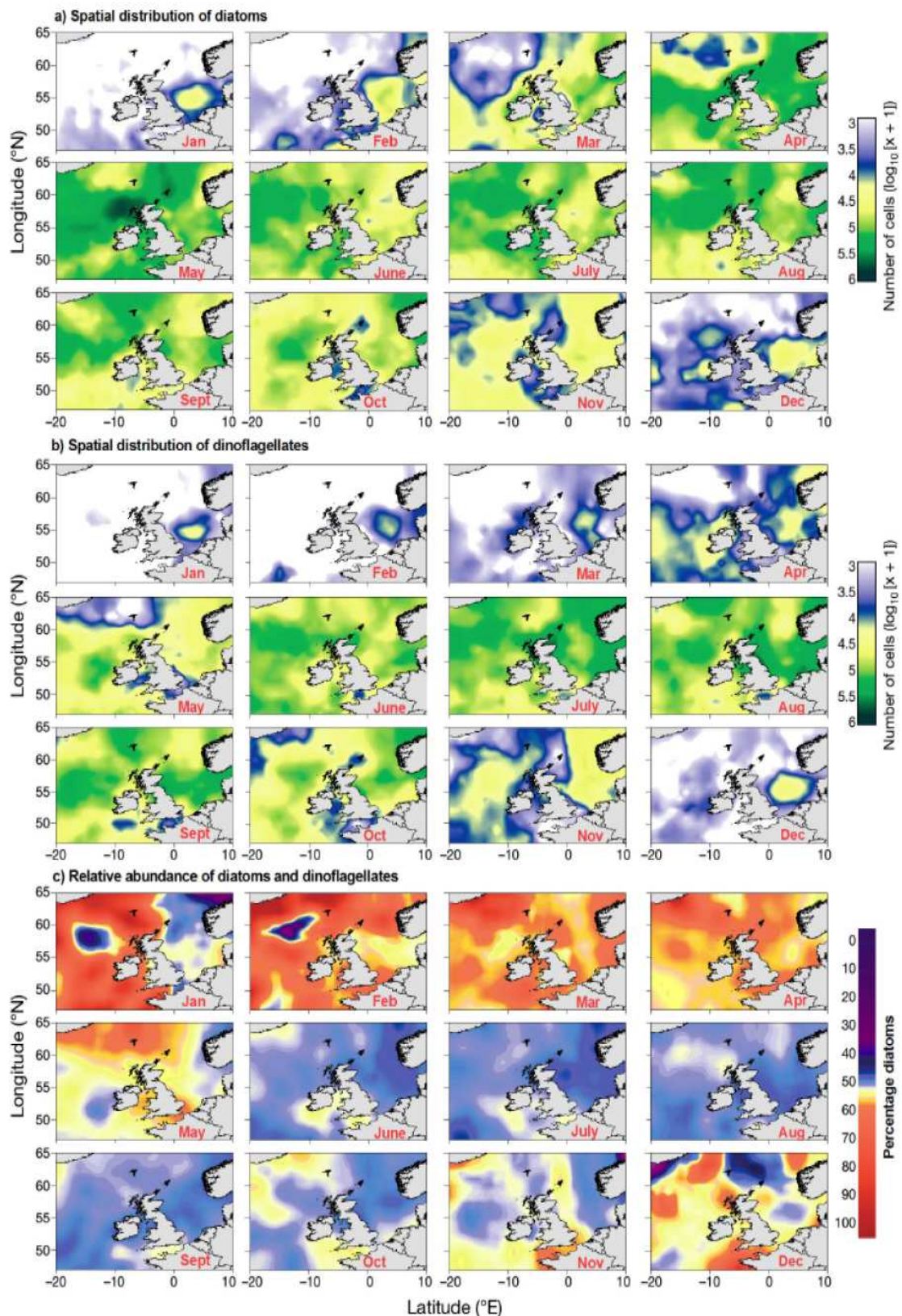
Phytoplankton have diverse roles, different spatial patterns and contrasting food value. Diatoms are the foundation of the copepod-fish food web, while dinoflagellates appear less valuable.

Changes in the relative abundance of phytoplankton have been linked to climate change and pollution.

Seasonal and spatial changes in phytoplankton for the North East Atlantic have been analysed based on over 100,000 Continuous Plankton Recorder (CPR) samples. The diatom bloom peaks first during May, with a smaller peak in summer. Dinoflagellates abundance reaches a peak in August. The blooms of both species start in the North Sea and spread outwards across the North East Atlantic region.

The results from this study are presented on the maps on the following page.

(Source: McQuatters-Gollop *et al.*, 2007)



Mean monthly spatial patterns of (a) diatoms, (b) dinoflagellates and (c) their relative community abundances (as percentage diatoms) in NE Atlantic between 1958-2003 (Source: McQuatters-Gollop *et al.*, 2007)



9



SEA BIRDS

The coastal and offshore waters of the NWW area provide local breeding and non-breeding seabirds, along with pelagic and passage migrants, with a rich source of nutrition, particularly near coastal upwelling and frontal systems (e.g. along the Irish Shelf front, north of the Porcupine Seabight).

Off the west coasts of Ireland and Scotland, petrels, shearwaters, skuas, gannets, gulls and auks dominate. The majority of these birds breed in colonies located on the southwest coast of Ireland while others overwinter in Irish waters. Species such as shearwaters and skuas use the NWW area as a migratory corridor. Species such as Northern Fulmar, Manx Shearwaters, Northern Gannet, Common Guillemot and Black-Legged Kittiwake dominate the NWW area as a migratory corridor.

Bird abundance can provide good indicators of the state of the ecosystem due to the wide range of habitats which they exploit and their high position in the food chain.

The seas and coastline of the NWW area are important for birds year round, with many areas being of international or national importance for the individual species or assemblages they support. The coastal and offshore waters of the NWW area provide local breeding and non-breeding seabirds, in addition to pelagic and passage migrants, with a rich source of nutrition, particularly near coastal upwelling and frontal systems (e.g. along the Irish Shelf front and north of the Porcupine Seabight).

Furthermore, the exposed and inaccessible west coasts of Ireland and Scotland provide perfect breeding habitats for many seabird species. The NWW are important fishing grounds and nursery and spawning areas for fish and invertebrate species. As a result, the NWW area is an important area for seabirds. Off the west of Ireland and Scotland, petrels, shearwaters, skuas, gannets, gulls and auks dominate. The majority of these birds breed in colonies located on the southwest coast of Ireland while others overwinter in Irish waters. Some species such as shearwaters and skuas are passage migrants that use the area as a migratory corridor.

Indicators of Ecosystem Health

Bird abundance can provide a good indication of the state of the ecosystem due to the wide range of habitats which they exploit and their high position in the food chain. Changes in the abundance of their prey at lower trophic levels can have major impacts on bird populations. The decline in breeding success at many seabird colonies has been related to low food availability (e.g. sandeel availability in the North Sea). Changes in the levels of discarded fish from commercial fishing vessels can also alter the availability of food for many species which scavenge.

The Mackey and Giménez (2004) report summarises seabird data generated by all parties for the NWW. The most common species encountered in NWW were the Northern Fulmar, Manx Shearwater, Northern Gannet, Common Guillemot and the Black Legged Kittiwake.

The **Northern Fulmar** is a common resident along British and Irish coastlines, whose breeding range has expanded rapidly in the northeast Atlantic during the last century. This highly pelagic seabird was the most frequently recorded and the most widespread species, where it was recorded throughout most of the study area during all seasons.

The **Manx Shearwater** is a common local breeder and passage migrant that are regularly recorded between March and October (IRBC, 1998). The breeding distribution of this long distance migrant is largely restricted to northwestern Europe, where the largest concentrations are located along the west coasts of Britain and Ireland

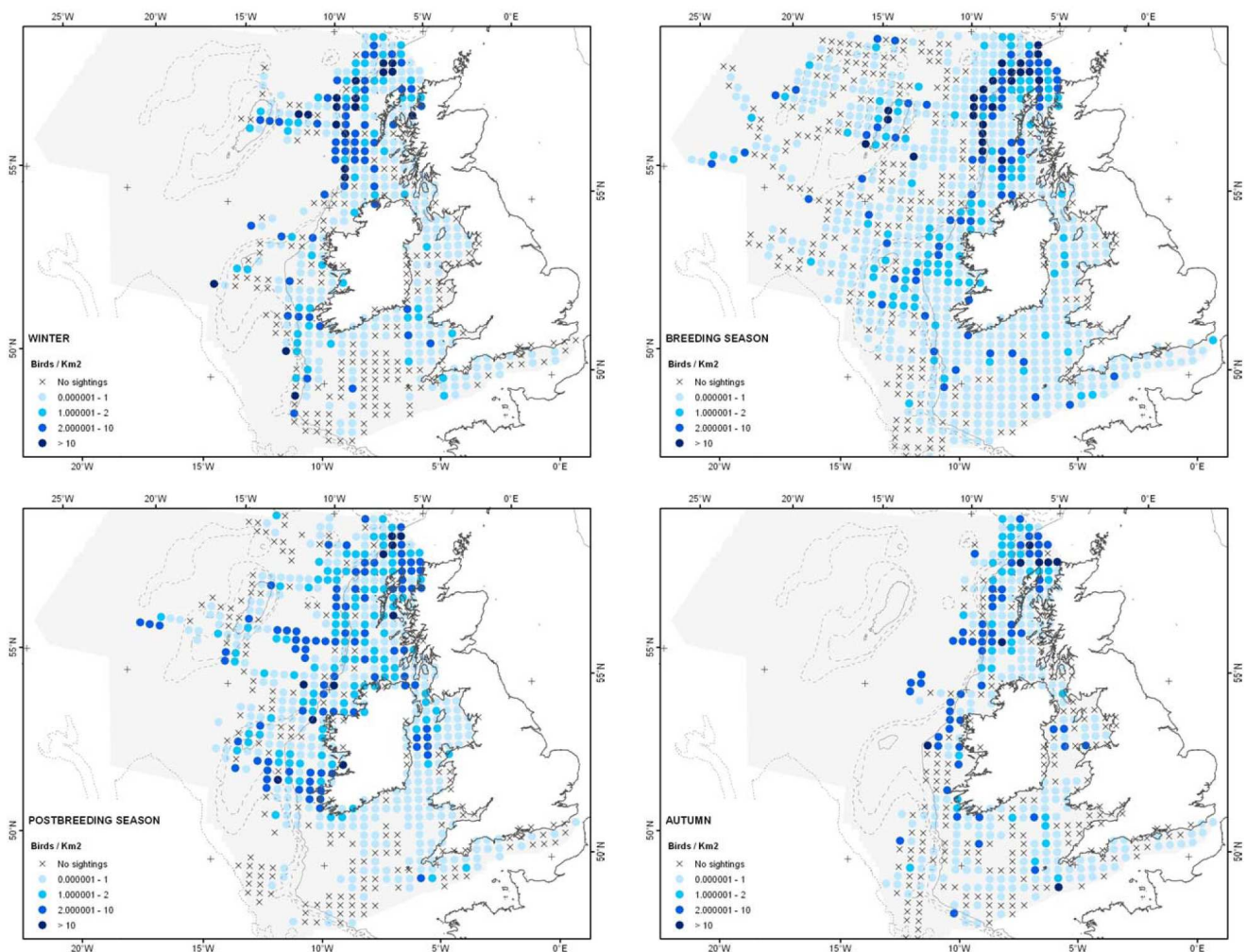
The **Northern Gannet** is the largest of Europe's seabirds. This prominent species, widely known for its spectacular diving behaviour, breeds on both mainland cliffs and

remote islands off Scotland and Ireland. British and Irish colonies support approximately 67.5% of the world's growing breeding population.

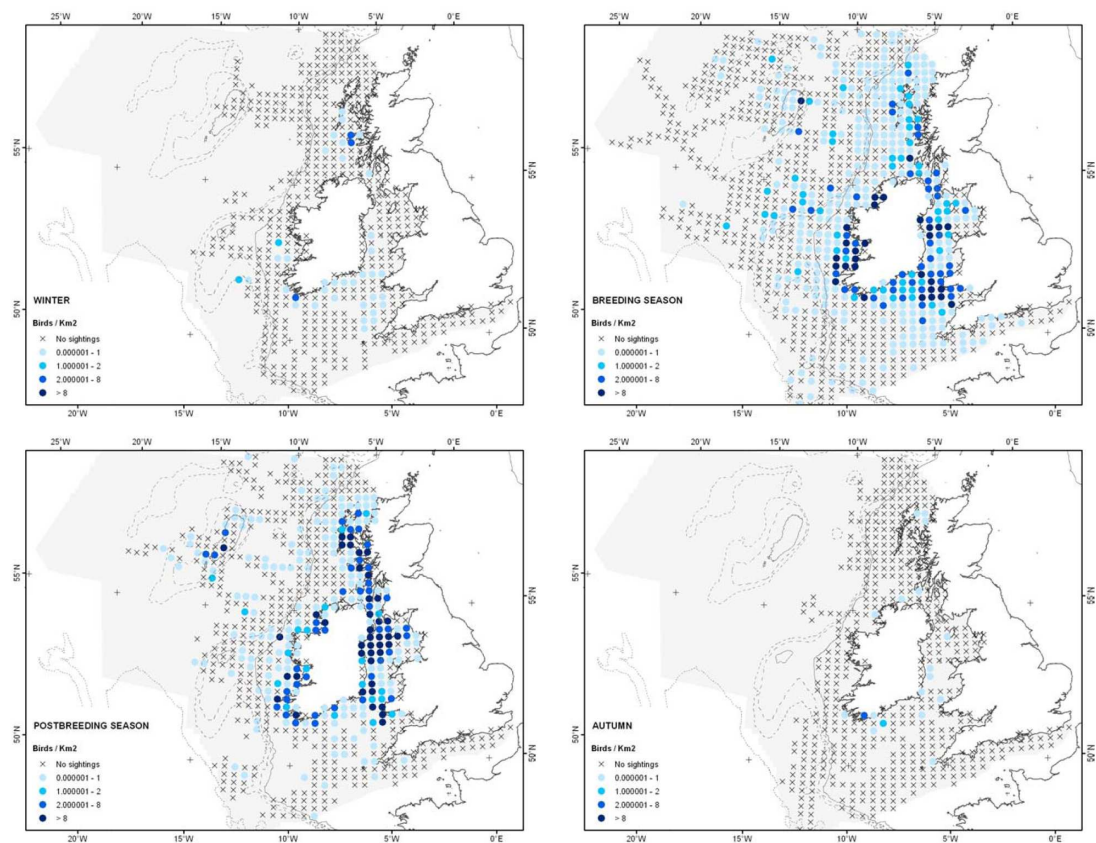
The **Common Guillemot** is the largest of the four auk species that breed in Britain and Ireland. The most widespread of all auk species, its population size has continued to fluctuate in response to a combination of human-related and natural events. The main stronghold of the local breeding population is located in Shetland, Orkney and Scotland.

The **Black-legged Kittiwake** is a small, cliff-nesting gull species that breeds along much of the British and Irish coastlines. It is the most pelagic of the local gull species especially during the winter when birds disperse to the Bay of Biscay, the North Sea and westward to the northern Atlantic

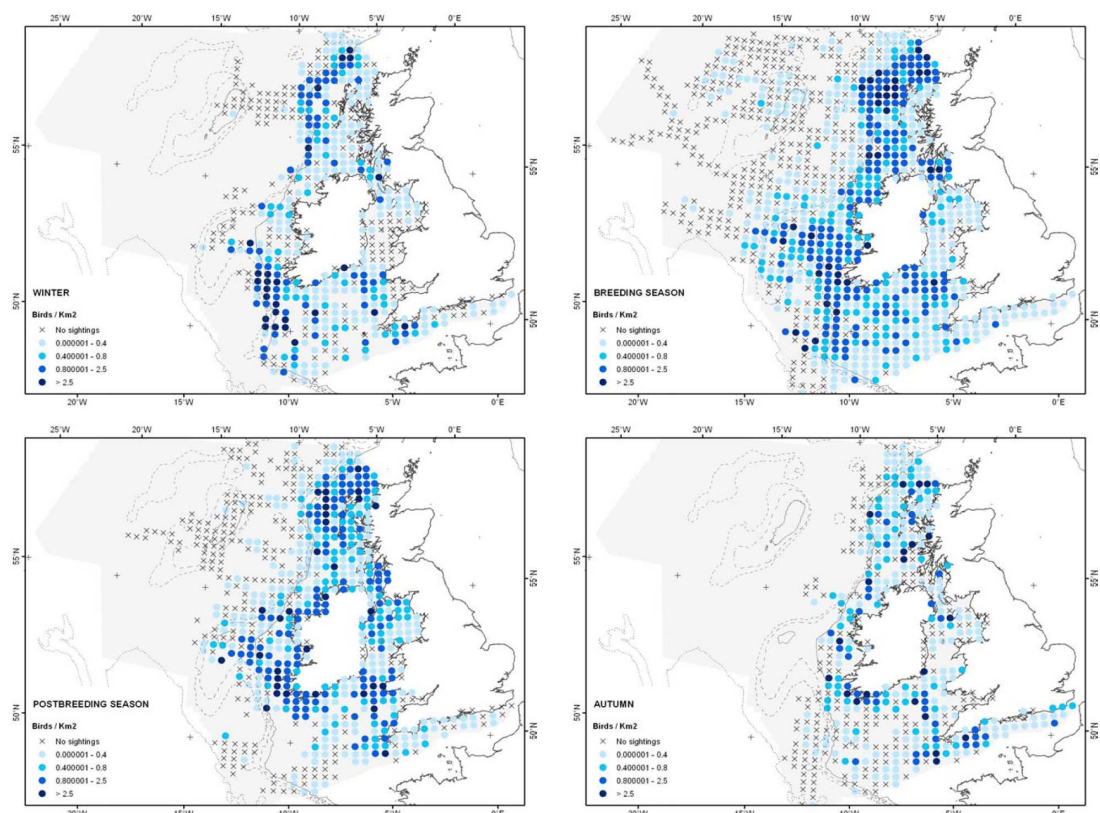
Mackey, M. & Giménez, D.P. 2004. *SEA 678 Data Report for Offshore Seabird Populations. A report for the DTI.* Available http://www.offshore-sea.org.uk/consultations/SEA678/SEA678_Seabirds.pdf



Seasonal distribution and density of the Northern Fulmar within NWA, 1980-2003.
(Source: Mackey & Giménez, 2004)



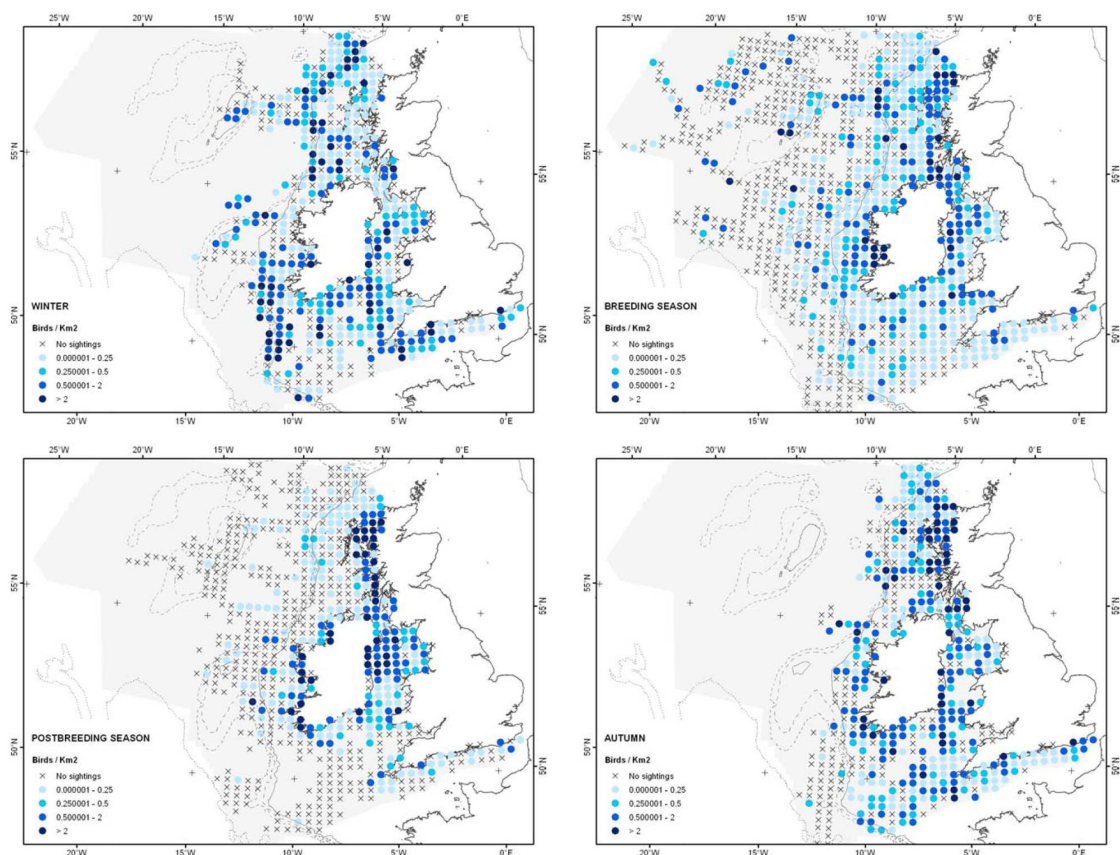
Seasonal distribution and density of the Manx Shearwater within NWW, 1980-2003.
(Source: Mackey & Giménez, 2004)



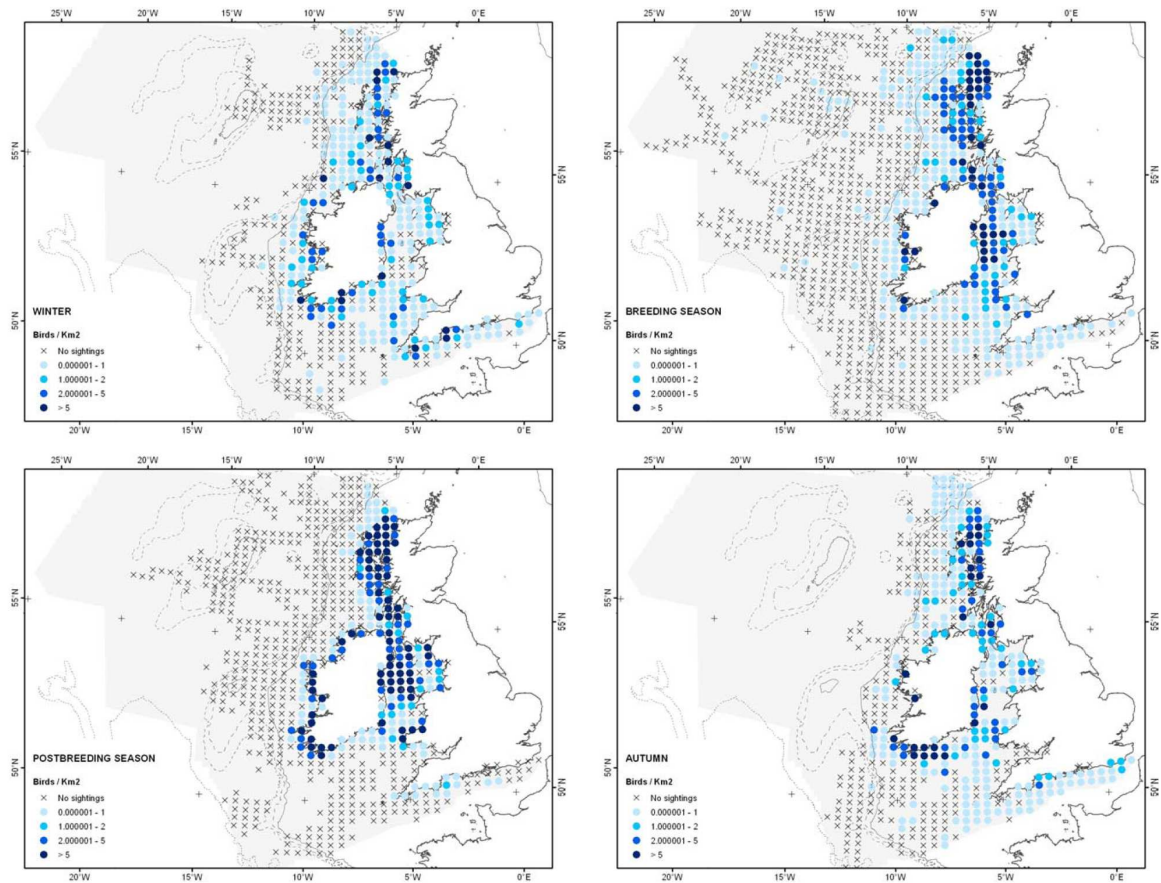
Seasonal distribution and density of the Northern Gannett within NWW, 1980-2003.
(Source: Mackey & Giménez, 2004)



Northern Fulmar (Photo: Mick Mackey, University College Cork, Ireland).



Seasonal distribution and density of the Black Legged Kittiwake within NWW, 1980-2003.
(Source: Mackey & Giménez, 2004)



Seasonal distribution and density of the Common Guillemott within NWW, 1980-2003.
(Source: Mackey & Giménez, 2004)



Kittiwake (Photo: Mick Mackey, University College Cork, Ireland).



Northern Gannet (Photo: Mick Mackey, University College Cork, Ireland).

Common Name	Latin Name	Uncorrected Total
Northern Fulmar	<i>Fulmarus glacialis</i>	357,661
Great Shearwater	<i>Puffinus gravis</i>	5,654
Sooty Shearwater	<i>Puffinus griseus</i>	2,730
Manx Shearwater	<i>Puffinus puffinus</i>	187,354
European Storm-petrel	<i>Hydrobates pelagicus</i>	23,460
Leach's Storm-petrel	<i>Oceanodroma leucorhoa</i>	1,232
Northern Gannet	<i>Morus bassanus</i>	196,334
Great Cormorant	<i>Phalacrocorax carbo</i>	1,812
European Shag	<i>Phalacrocorax aristotelis</i>	7,046
Pomarine Skua	<i>Stercorarius pomarinus</i>	557
Arctic Skua	<i>Stercorarius parasiticus</i>	833
Long-tailed Skua	<i>Stercorarius longicaudus</i>	380
Great Skua	<i>Stercorarius skua</i>	3,785
Black-headed Gull	<i>Larus ridibundus</i>	11,561
Mew Gull	<i>Larus canus</i>	8,764
Lesser Black-backed Gull	<i>Larus fuscus</i>	36,721
Herring Gull	<i>Larus argentatus</i>	56,019
Great Blacked-backed Gull	<i>Larus marinus</i>	24,360
Black-legged Kittiwake	<i>Rissa tridactyla</i>	126,324
Common Tern	<i>Sterna hirundo</i>	1,747
Arctic Tern	<i>Sterna paradisaea</i>	1,233
Common Guillemot	<i>Uria aalge</i>	136,934
Razorbill	<i>Alca torda</i>	34,015
Black Guillemot	<i>Cepphus grylle</i>	1,132
Atlantic Puffin	<i>Fratercula arctica</i>	28,504

Total Number of the commonly encountered seabird species recorded during ship based surveys in NWW July 1980 to August 2003.
(Source: Mackey & Giménez, 2004)



10



MARINE REPTILES

The leatherback turtle is regularly seen in NWW and while they are reported in every month, sightings peak from June to October. They breed in tropical areas and are the only species of marine turtle to have developed adaptations to life in cold water.

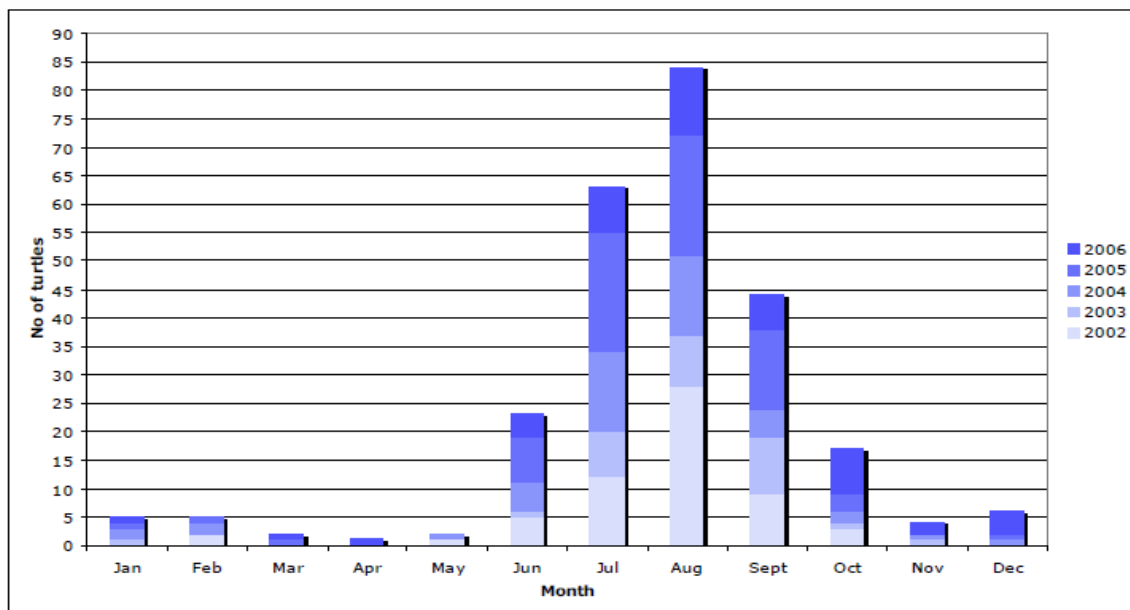
Leatherbacks are one of the few predators which forage almost exclusively on gelatinous zooplankton. In NWW leatherback sightings have recently been linked to areas of high jellyfish abundance.

Foraging on such a temporally and spatially sporadic prey is the primary driving force behind the annual migration of leatherbacks.

Leatherback populations in the Atlantic are considered to be stable.

Photo: Tom Doyle, University College Cork, Ireland

The main marine reptile species recorded from NWW are marine turtles. Five species of marine turtle have been recorded in UK and Irish waters. However, only one species, the Leatherback turtle (*Dermochelys coriacea*), is reported annually and is considered a regular and normal member of NWW marine fauna. Loggerhead turtles *Caretta caretta* and Kemp's ridley turtles *Lepidochelys kempii* occur less frequently, with most specimens thought to have been carried north from their usual habitats by adverse currents. Records of two other vagrant species, the Hawksbill turtle *Eretmochelys imbricata* and the Green turtle *Chelonia mydas* are very rare. Turtles are protected under the EU Habitats Directive (EU Council Directive 92/43/EEC).



Leatherback turtle sightings for Ireland and the UK 2002 to 2006
(Source: Irish Offshore Strategic Environmental Assessment, 2008; <http://www.dcenr.gov.ie>)

Leatherback Turtle

The leatherback turtle is the largest marine turtle that occurs in warm waters and has been regularly recorded in the NWW area. They breed in tropical areas, but range widely to forage temperate and boreal waters outside the nesting season. They are the only species of marine turtle to have developed adaptations to life in cold water. Long-distance migration has been documented from tag returns and more recently using satellite telemetry. There are distinct seasonal peaks in the occurrence of leatherback turtles in northern waters. Around Irish and UK waters, most sightings are reported between August and October but they have been recorded in every month.

See Also: <http://www.jellyfish.ie/turtle.asp>



SEA MAMMALS

Cetaceans and seals are the main marine mammals found in NWW. The NWW is an area of particularly high species richness for cetaceans. To date 24 cetacean species have been recorded in Irish and UK waters. The availability and distribution of prey is the primary factor for this species richness. This availability of food is in turn related to the North Atlantic Drift. This warm oceanic current, meeting the western European continental shelf water body results in upwelling of deep nutrient rich water that produces areas of seasonally high productivity along the Atlantic margin of the NWW.

Many cetaceans breed in NWW while others use the area as a migration route.

The grey and harbour, or common, seal are the two species of pinniped most common in NWW area. Both species have established themselves in terrestrial colonies along the coastlines of Ireland and the UK. They leave these areas when foraging or moving between areas and return to rest ashore, rear young and engage in social activity. The fur seal and walrus are visitors to NWW area.

Cetaceans

The NWW area is very important for a wide range of cetacean (whales, dolphins and porpoise) species. There is substantial background evidence promoting the Atlantic Margin as an area of high species richness for cetaceans. To date 24 cetacean species have been recorded in Irish and UK waters. The majority of these have been recorded from sightings or acoustic recordings and from strandings.

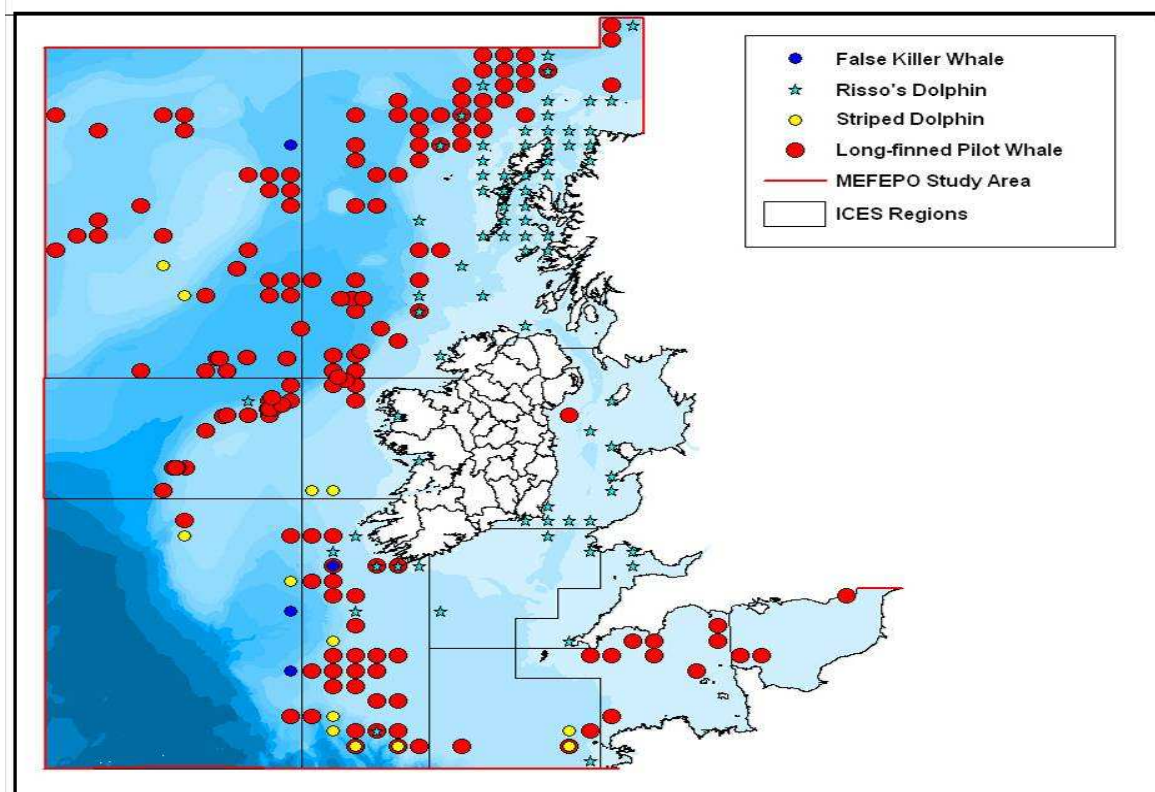
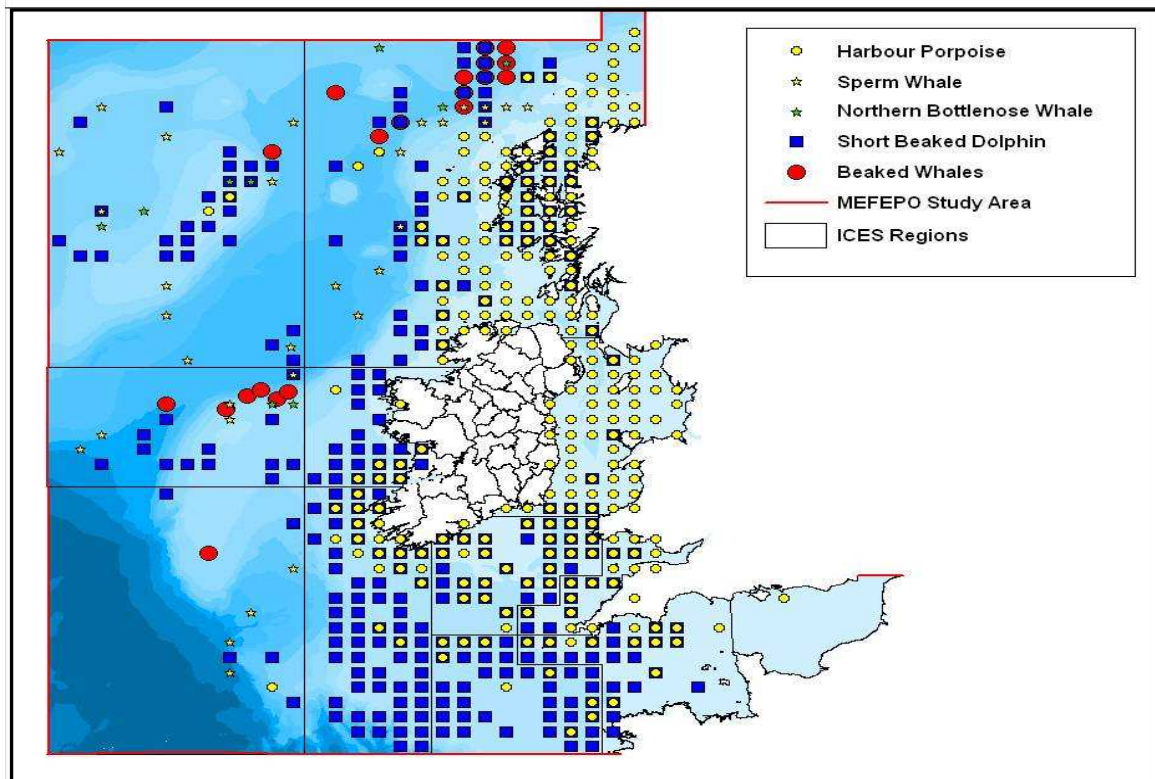
Breeding in NWW has been confirmed for a number of cetacean species including harbour porpoise (*Phocoena phocoena*), common (*Delphinus delphis*), bottlenose (*Tursiops truncatus*), Risso's (*Grampus griseus*), white sided (*Lagenorhynchus acutus*) and white-beaked (*L. albirostris*) dolphins and pilot whale (*Globiocephala melas*), while other species such as bottlenosed (*Hyperoodon ampullatus*) and minke whale (*Balaenoptera acutorostrata*) are also suspected of breeding.

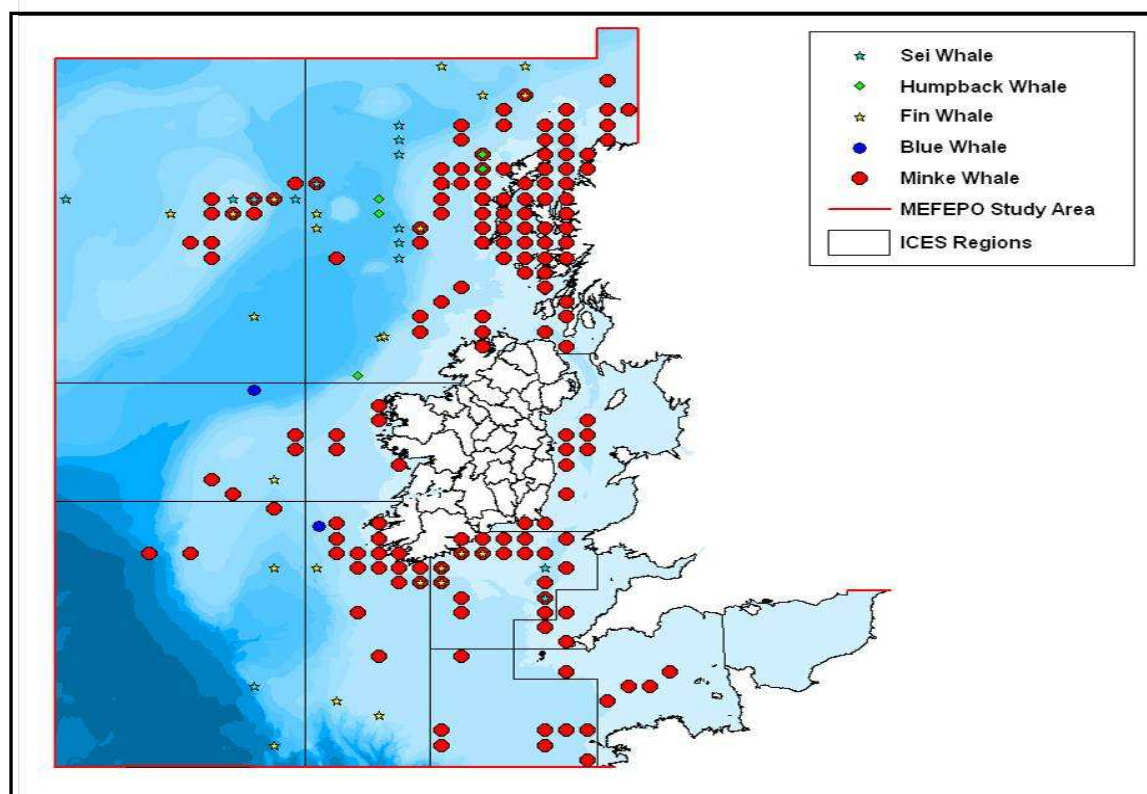
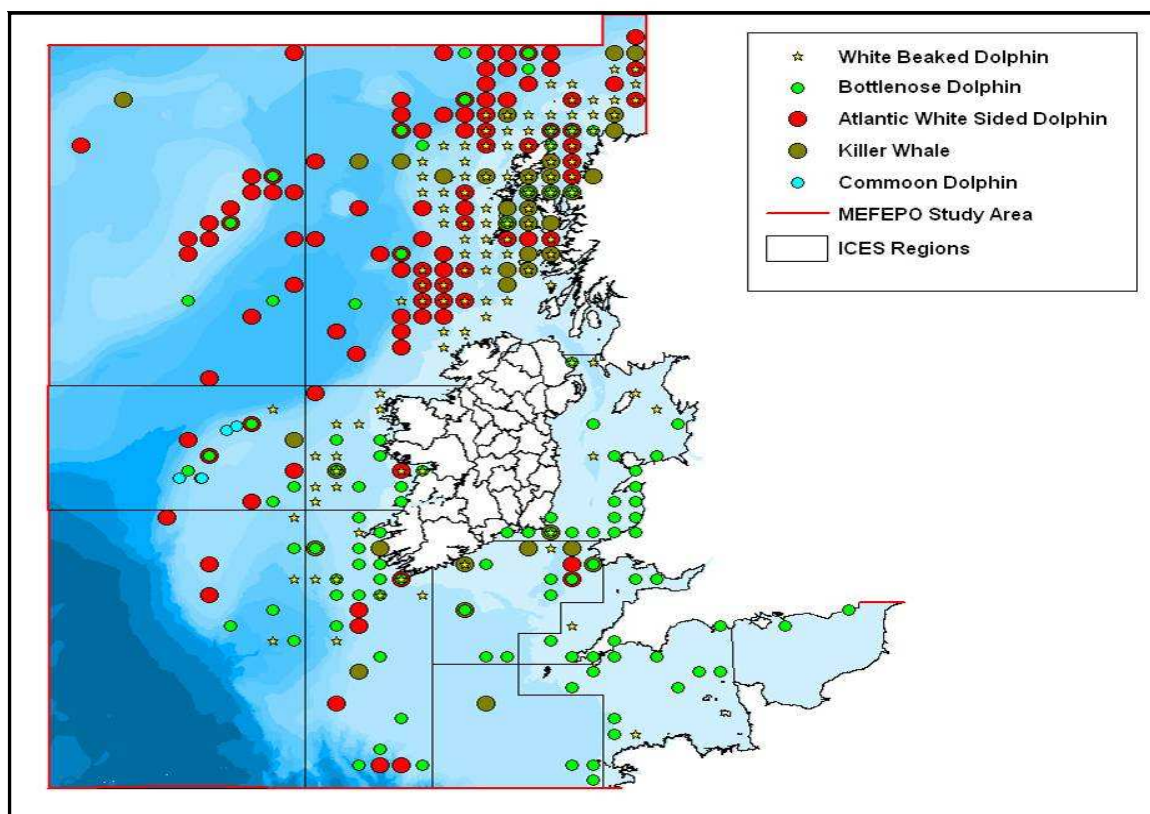
Many cetacean species are not known to breed in the NWW but migrate annually along the western seaboard. Recent data suggests that some of these species feed year-round in NWW, including the fin whale (*Balaenoptera physalus*) and humpback whale (*Megaptera novaeangliae*), whereas others may over-winter in waters south of Ireland (e.g. blue whale *Balaenoptera musculus*).



**Humpback whale breaching off the south east coast of Ireland.
(Photo: Pádraig Whooley, Irish Whale and Dolphin Group, Ireland)**

The following maps represent sightings data only for various cetacean species and are based on material from Mackey *et al.*, 2004; Reid *et al.*, 2003, and the Irish Whale and Dolphin Group sightings.





Cetacean Abundance and Distribution

There are a number of key factors that determine cetacean distribution and abundance in NWW. The availability and distribution of prey is the primary factor. Another feature, which may play an important role in the distribution and abundance of cetaceans in the region, is the North Atlantic Drift. This warm oceanic current meeting the western European continental shelf water body, results in seasonal, climatic, sea temperature and salinity conditions and regional upwelling of deep nutrient-rich oceanic water, giving areas of seasonally high productivity along the Atlantic margin of the NWW. Seabed bathymetry is also an important factor. Areas of complex bathymetry are important to deep diving species (e.g. beaked whales) and restrict these types to suitable habitats. The distribution of other species such as the white sided dolphins may be restricted by more than one factor (e.g. water depth and water temperature). Species with quite specific habitat requirements are more vulnerable to disturbance from anthropogenic sources and added measures for their protection are required.



Grey Seal Mother and Pup.
(Photo: Michelle Cronin, University College Cork, Ireland)

Seals

The grey (*Halichoerus grypus*) and harbour, or common, (*Phoca vitulina*) seal are the two species of pinniped most common in NWW. Both species have established themselves in terrestrial colonies (haul out sites) along the coastlines of Ireland and the UK. They leave these areas when foraging or moving between areas and return ashore to rest, rear young and engage in social activity.

Common Seals

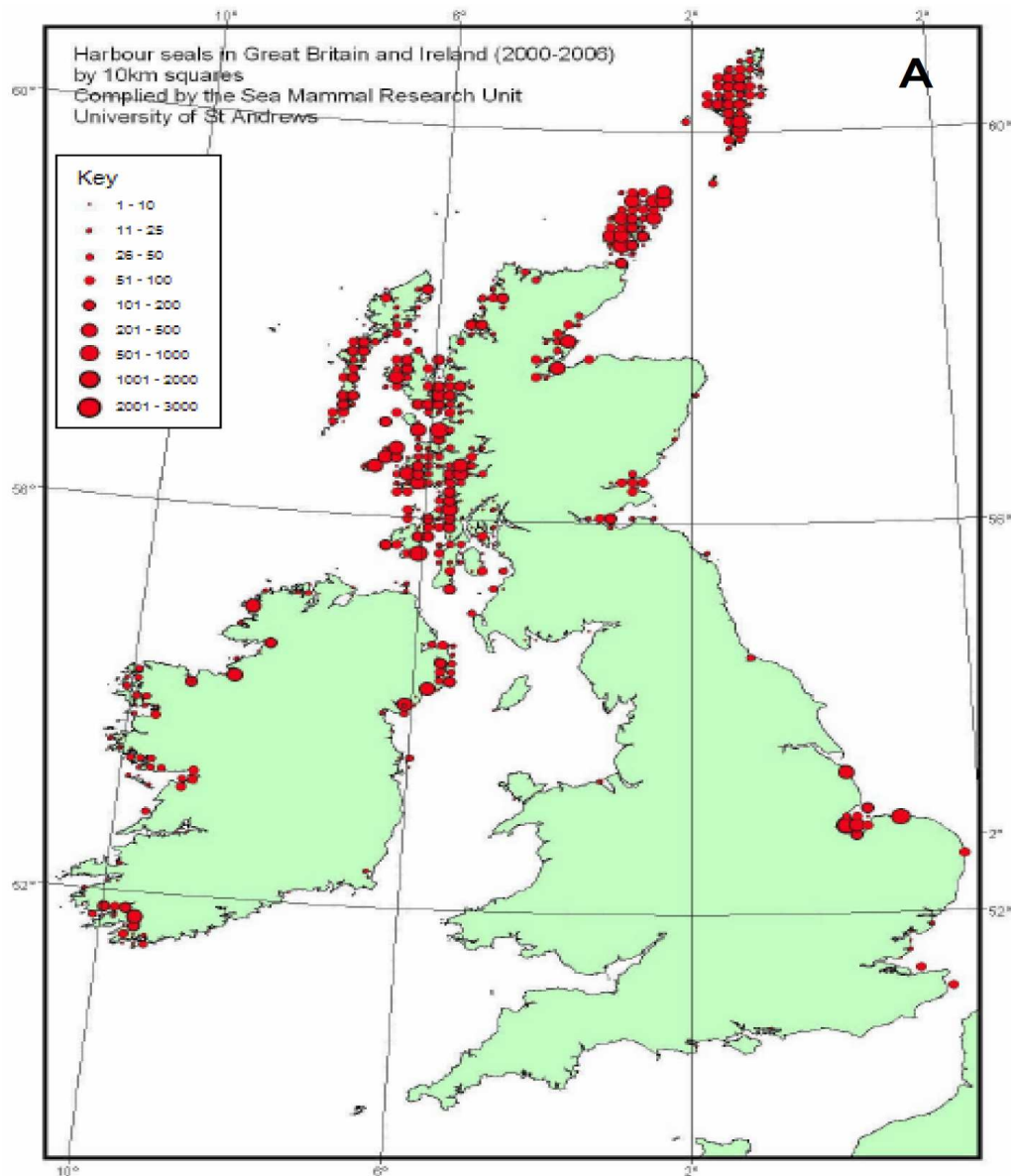
Harbour (or common) seals are one of the most widespread pinniped species and have an almost circumpolar distribution in the Northern Hemisphere. Around Britain and Ireland, harbour seals haul out on tidally exposed areas of rock, sandbanks or mud. Pupping occurs on land from June to July, while the moult is centred around August and extends into September. Therefore, from June to September harbour seals are ashore more often than at other times of the year. In the UK, the largest concentrations are found in Scotland, primarily on Orkney, Shetland and the Inner and Outer Hebrides. Many other haul-out sites supporting lower numbers are present around the UK coast, the largest of which are found in the Moray Firth, the east coast of Northern Ireland, the Firths of Tay and Forth, and southwest Scotland. Common seals are widespread throughout coastal waters surrounding these haul-out sites. Their distribution at sea is constrained by the need to return periodically to land. Although harbour seals seem to show some fidelity to particular haul-out sites, they occasionally make rapid, relatively long-distance movements to other locations.

Grey Seals

Grey seals are found across the North Atlantic Ocean and in the Baltic Sea. Approximately half of the world's population occurs in the northeast Atlantic.

Most of the grey seal population will be on land for several weeks from October to December during the pupping and breeding season, and again in February and March during the annual moult. Densities at sea are likely to be lower during this period than at other times of the year. They also haul-out and rest throughout the year between foraging trips to sea. Studies at two Scottish colonies have indicated that breeding females tend to faithfully return to their natal breeding colony for most of their lives. Mature females give birth to a single pup which is nursed for about three weeks before it is weaned and moults into its sea-going adult coat. Grey seal pups tagged in the UK have been recaptured or recovered along the North Sea coasts of Norway, France and The Netherlands, mostly during their first year.

Grey seal foraging movements are on two geographical scales: long and distant trips from one haul-out site to another; and local repeated trips to discrete offshore areas.



Common Seal numbers at various colonies (haul out sites) in UK and Ireland. The numbers are derived from aerial surveys over the period 2000-2006 by 10 km².

(Source: Data compiled by the Sea Mammal research Unit, St Andrews, Scotland; <http://www.offshore-sea.org.uk/>).

Diet

Grey seal diet is dominated by fish species. The fish species composition of the diet varies both spatially and temporally. In studies carried out on grey seals in the Hebrides, sandeel, cod and haddock were dominant in the diet. The interaction between seals and fish stocks is complex and poorly understood.

Basking shark (*Cetorhinus maximus*)

SHARKS, SKATES AND RAYS

Sharks, skates and rays belong to a group of fish called elasmobranchs that have cartilaginous skeletons. Due to their reproductive biology, elasmobranchs are particularly vulnerable to over-exploitation.

In 2008 almost 21,000 tonnes of sharks, skates and rays were landed in NWW. There has been a substantial decrease in landings over the last decade due to declining stocks and increased regulations.

In 2003 the EU banned the wasteful practice of shark finning but loopholes in the regulations are still being dealt with.

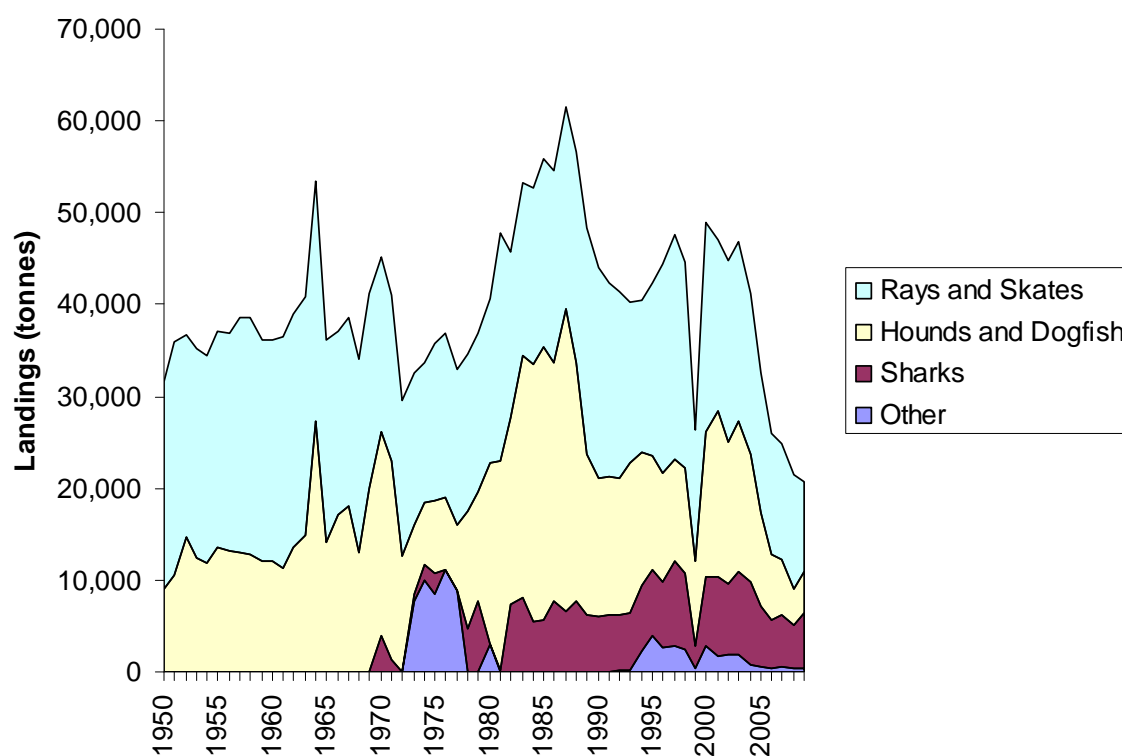
Nursery areas for important sharks, skates and rays exist in NWW.

Image source: SuperStock.co.uk

Sharks, skates and rays belong to a group of fish called elasmobranchs. The defining characteristic is a skeleton made of cartilage (rather than bone as with other fishes).

Elasmobranchs generally produce a handful of offspring per reproductive cycle but invest a greater amount of energy and resources in each one. This, however, makes them far more vulnerable to over-exploitation in comparison to most broadcast spawning bony-fishes. NWW contain populations of some elasmobranch species listed as critically endangered (Angel Shark) and vulnerable (Porbeagle and Common Smooth-hound) by the IUCN.

The total landings of sharks, skates and rays have declined substantially over the last decade. This is mainly due to declining stocks and increased restrictions but changing consumer preferences have also played a role. The graph below shows this trend in various groups but it should be stressed that this shows landings only and not discarded bycatch.



Landings of elasmobranchs in NWW from 1950-2009 (Source: FAO FishStat).

Note: French data not available for 1999. “Other” may contain some fishes that are not elasmobranchs but have cartilaginous skeletons, e.g. chimeras

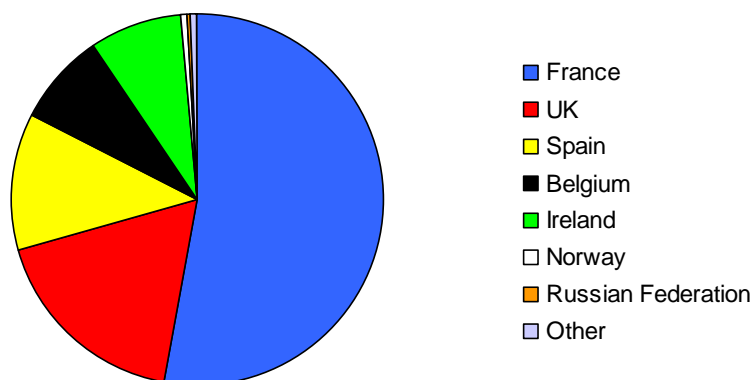
In NWW, most elasmobranchs are taken as bycatch in commercial mixed fisheries. The directed fisheries are mainly for skates and rays in VIIa. Recreational fisheries, including charter angling, may be an important component of the tourist industry in some areas.

Portuguese dogfish and Leafscale gulper sharks are two species of deepwater elasmobranchs found in NWW. Trawlers, longliners and gillnetters in VI and VII were

the fleets targeting these species. However, since 2003, reported landings have declined due to stock depletion and the introduction, and gradual reduction, of EU TACs and quotas in response to ICES advice, which in recent years has been for a zero TAC. However, deep-water sharks continue to be taken as by-catch in a mixed deepwater trawl fishery VI and VII (STECF review of Scientific Advice 2011).

2008 Elasmobranch Landings in NWW Total: 21,508 tonnes

Spain, France and the UK land the highest numbers of elasmobranchs in NWW, together accounting for almost 85% of the 21,500 tonnes caught in 2008. Indeed, Spain, France, Portugal and the UK are among the top 20 nations in the world in terms of total shark landings.



Shark Finning

Shark finning is the removal and retention of shark fins and the discard of the remaining carcass at sea. The reason for this practice is the price discrepancy between the valuable fins and the rest of the body. The demand for shark fins comes mainly from certain Asian countries; in Hong Kong the price of shark fins is around €300/kg. Fins removed from bodies take up less storage space onboard fishing vessels and require less onboard processing or dressing. However, the practice is wasteful and promotes over-exploitation due to the fact that space would no longer limit a boat's shark catch.



Image: SuperStock.com

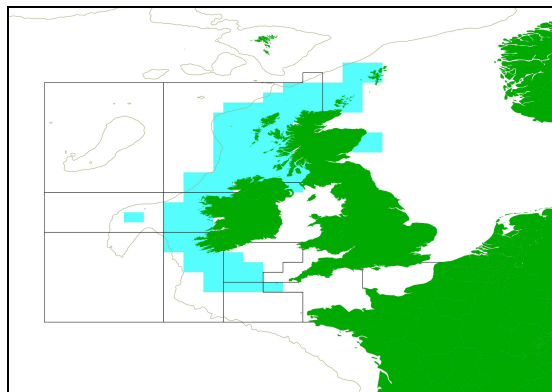
In 2003 the EU banned shark finning through its Finning Regulation and made it compulsory for the carcasses to be retained onboard. Many loopholes exist however. Special derogations can allow vessels to land fins and meat at different ports, which makes effective checking of the landings extremely difficult. Fins and meat may be stored separately but only at a maximum fin:whole weight ratio of 5%. But this ratio is very lenient and applies to all shark species, which may enable the fins of more than one shark to be landed under the allowance of one carcass. In 2010 the EU began the process of closing these loopholes with its Shark Finning Roadmap. The roadmap set out a number of different strategies that could be used but landing all sharks with fins still naturally attached may to be the most practical solution.

(Source:Fowler and Séret 2010)

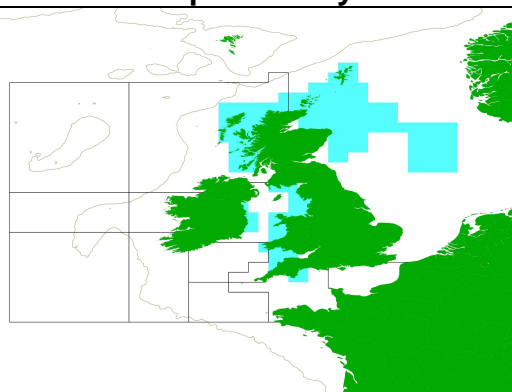
Elasmobranch Nursery Areas

The following maps depict the nursery areas of some sharks, skates and rays commonly caught in NWW. The 500m depth contour and NWW boundary are included in each.

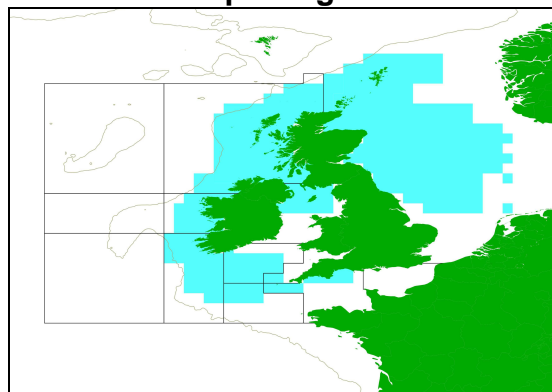
Common Skate



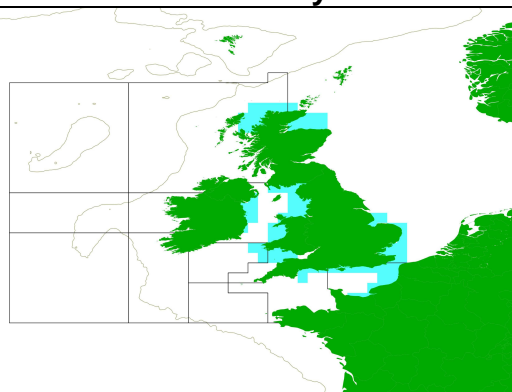
Spotted Ray



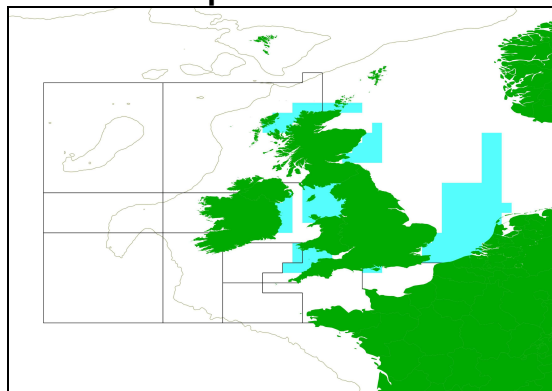
Spurdog



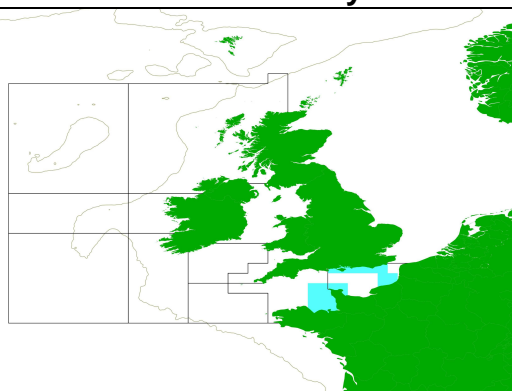
Thornback Ray



Tope Shark



Undulate Ray



(GIS Source: CEFAS)

**13**

PROTECTED AREAS AND FISHING RESTRICTIONS

There are closed areas that prevent directed fishing for orange roughy and other deep water fishing restrictions that protect deep water corals.

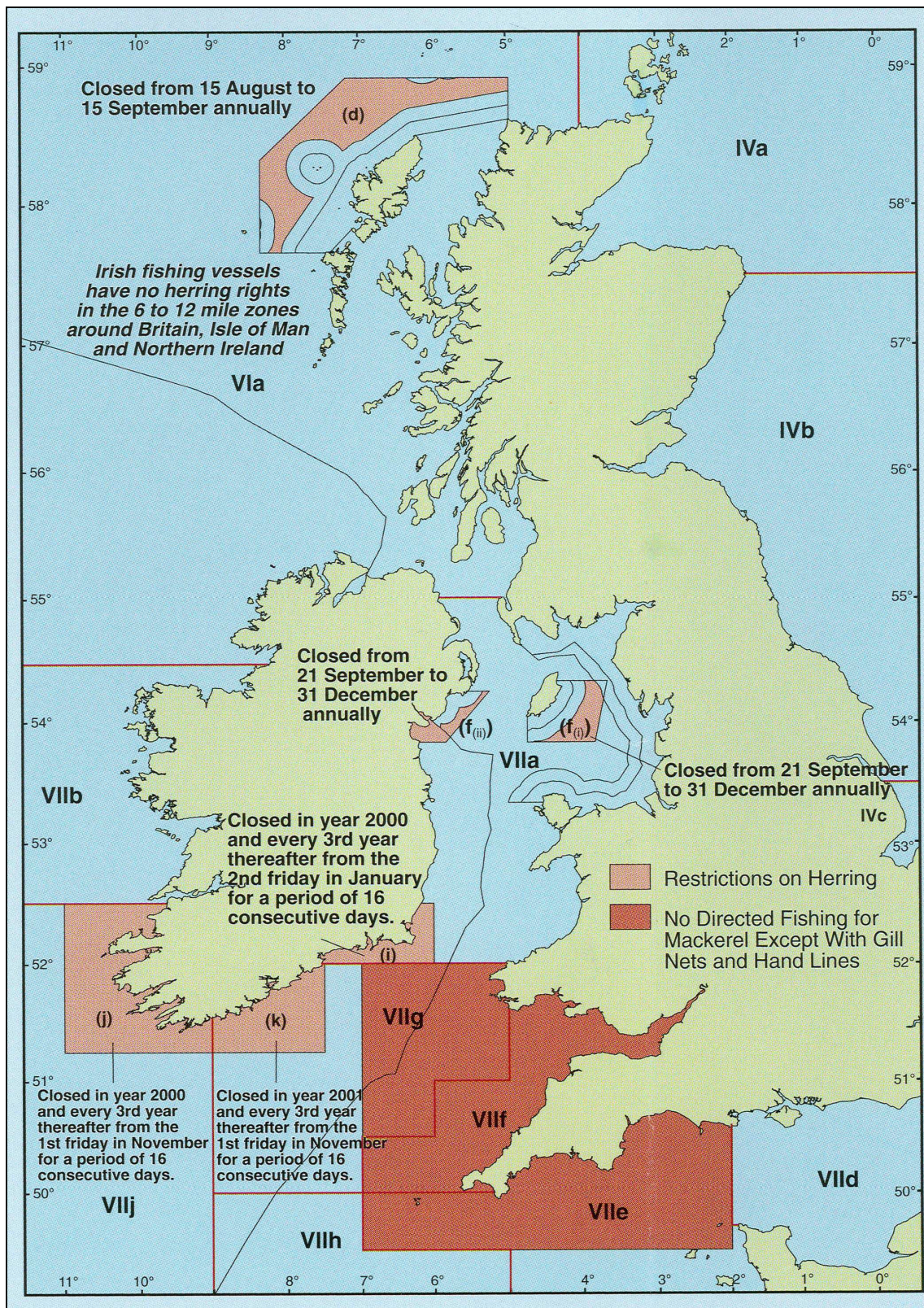
There is an extensive network of Special Areas of Conservation (SACs) and Special Protection Areas (SPAs) associated with the EU Habitats and Birds Directives that form the NATURA 2000 network for NWW.

The Biologically Sensitive Area (BSA) is situated off the west and south coasts of Ireland and is considered to be an area of high ecological importance for the early life history stages of many commercial fish species. It contains important spawning and nursery grounds and is an area subjected to high commercial fishing activity.

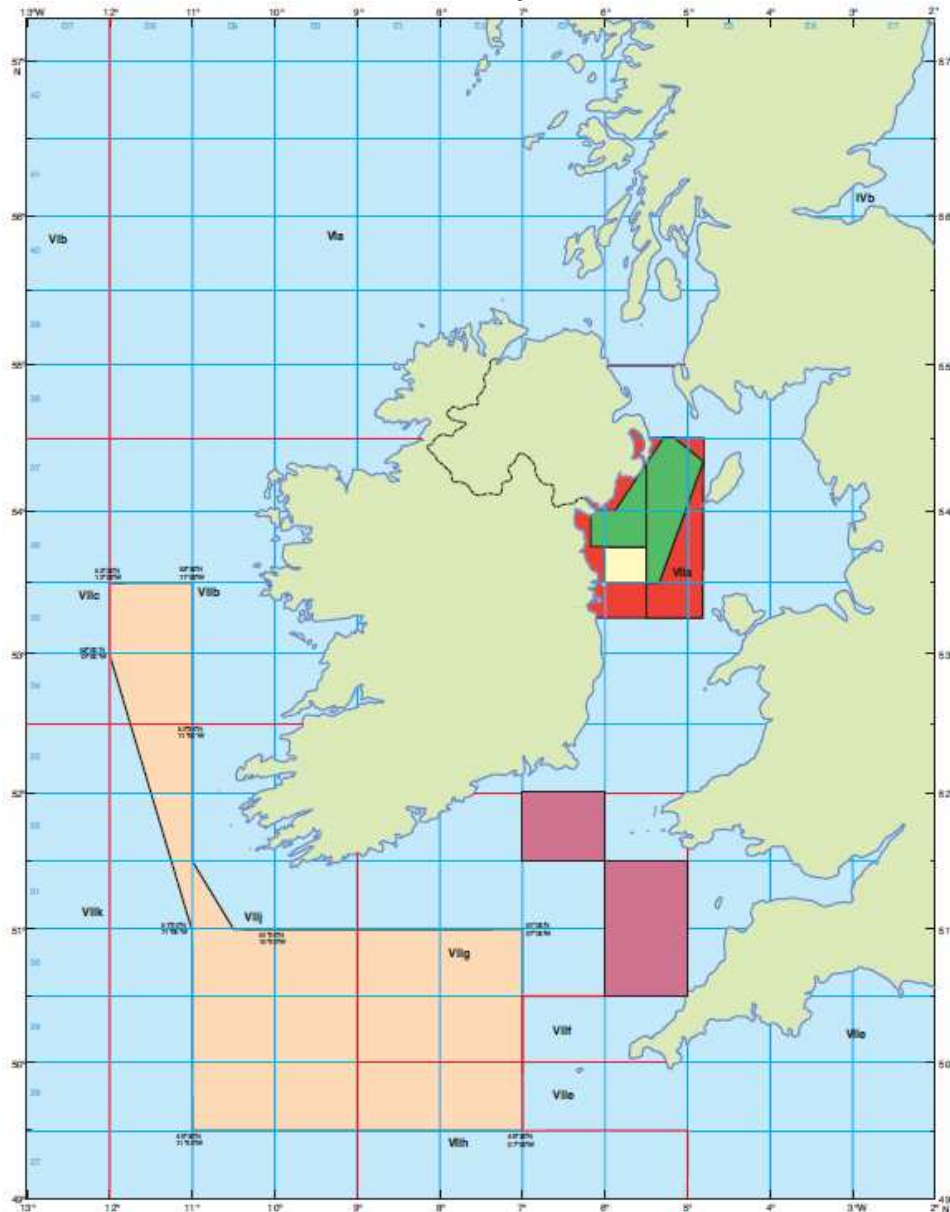
There are restrictions on mackerel and herring fishing in parts of the NWW area.

There are seasonal closed areas in the Irish Sea and Celtic Sea area to protect spawning cod and aid cod recovery.

There are many protected areas and fishing restrictions in place for NWW. The following maps provide a brief overview of the main protected areas and restrictions and are reproduced courtesy of Board Iascaigh Mhara (Irish Sea Fisheries Board).



Cod and hake recovery boxes in 2011



IRISH SEA COD BOX

- Closed to all fishing with any demersal trawl, seine or similar towed net, any gill net, trammel net or similar static net or any fishing gear incorporating hooks from the 14th of February to 30th April 2011.
- Fishing is permitted with a prawn net in the areas of the closed boxes coloured green provided:
 - A minimum of 35% live weight of prawns is on board.
 - Only one mesh size range is carried on board, 70-79mm or 80-99mm.
 - No other type of gear is carried on board.
 - No mesh in any part of the net is greater than 300mm.
- Fishing is permitted with a prawn net in this area provided that in addition to the above:
 - It complies with the provisions made for the green zone.
 - It includes an inclined separator panel.
 - If the total weight of cod retained on board is greater than 18% of the total catch, the vessel must stop fishing in this area for at least 24 hours.

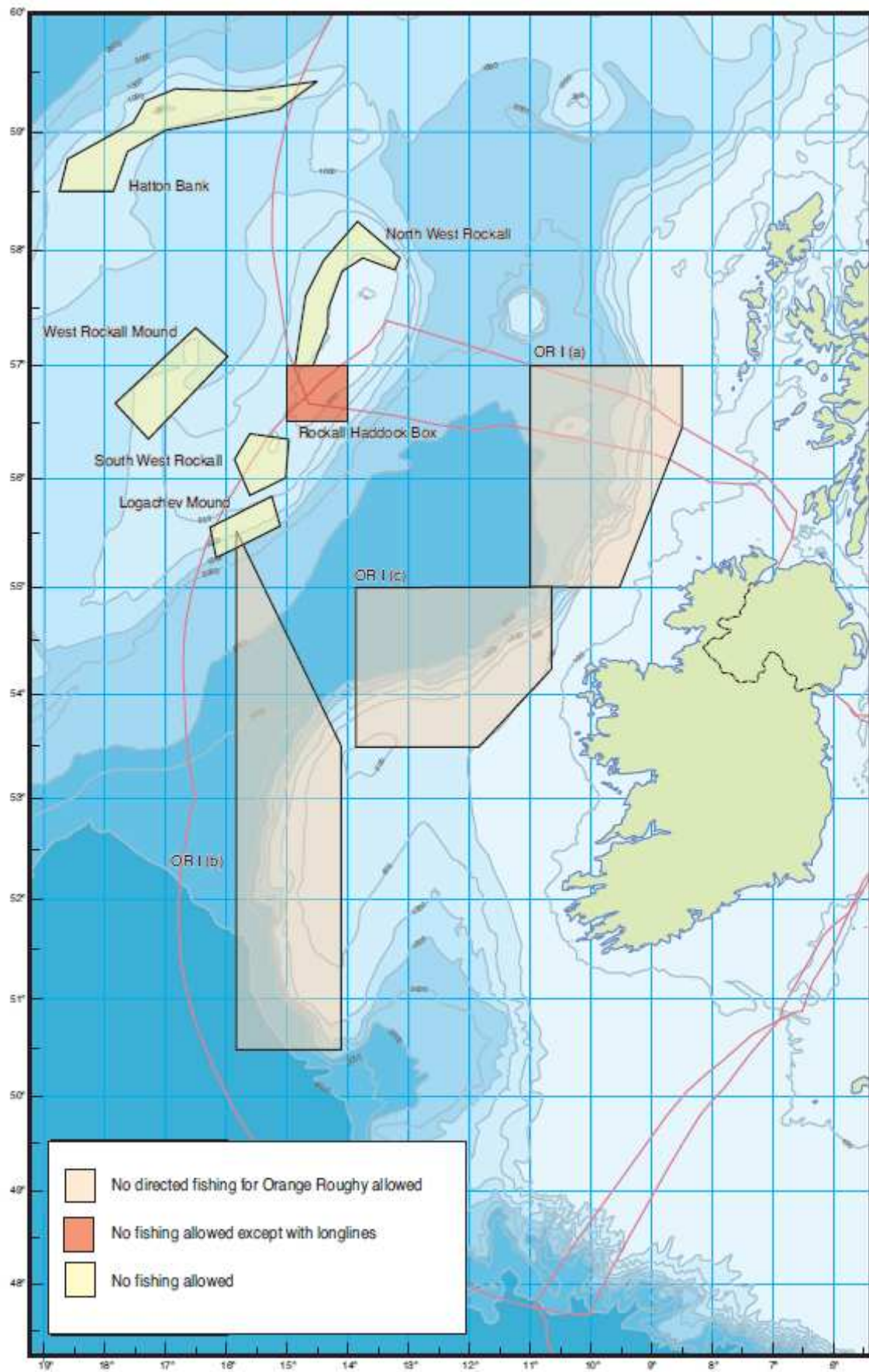
CELTIC SEA CONSERVATION AREA

- From 1st February to 31st March 2011 the highlighted areas are closed to all fishing except with pots and creels provided no fish other than shellfish are retained on board or Pelagic trawls with a codend mesh size of $\leq 55\text{mm}$ provided no fish other than herring, mackerel, pilchard/sardines, sardinellas, horse mackerel, sprat, blue whiting and argentinies are retained on board.

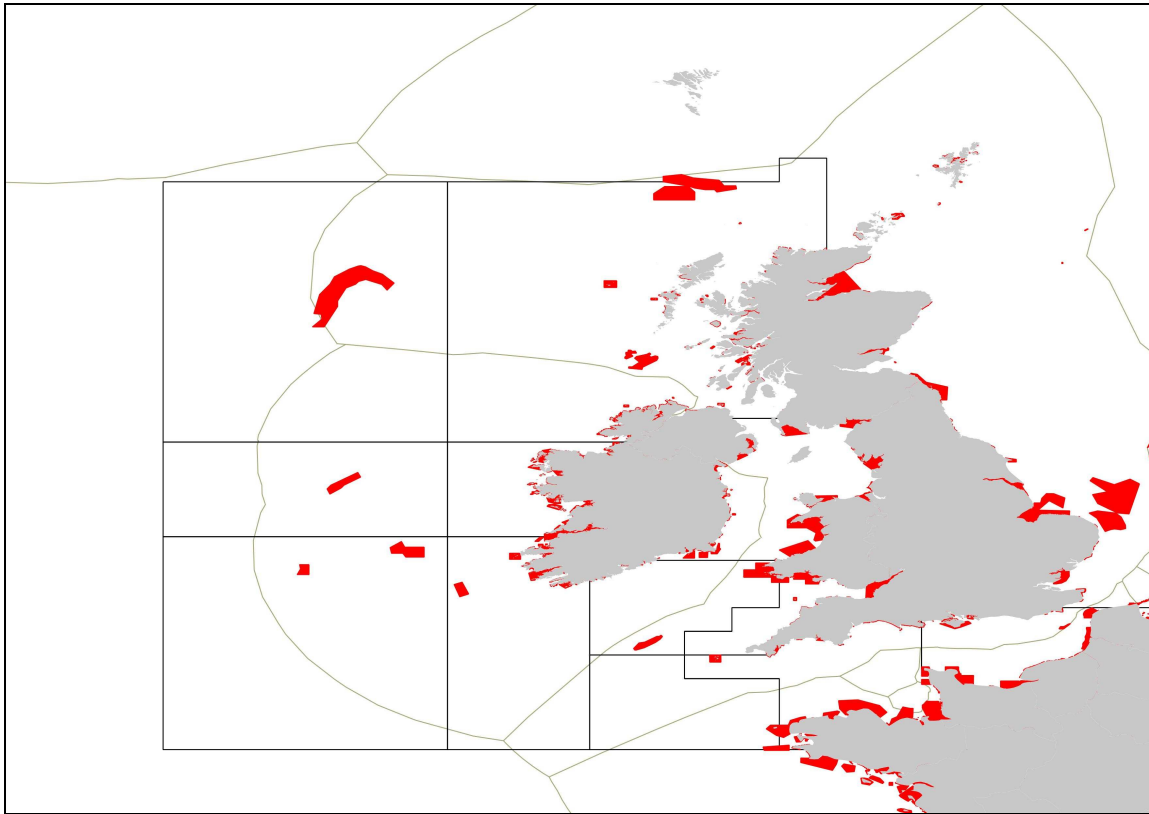
HAKE BOX

- Within this area a minimum mesh size of 100mm must be used for all towed gears and a minimum mesh size of 120mm used for all gillnets, entangling and trammel nets. Beam trawls of between 55-99mm may be used east of $7^{\circ}30'$ west in the period April to October.

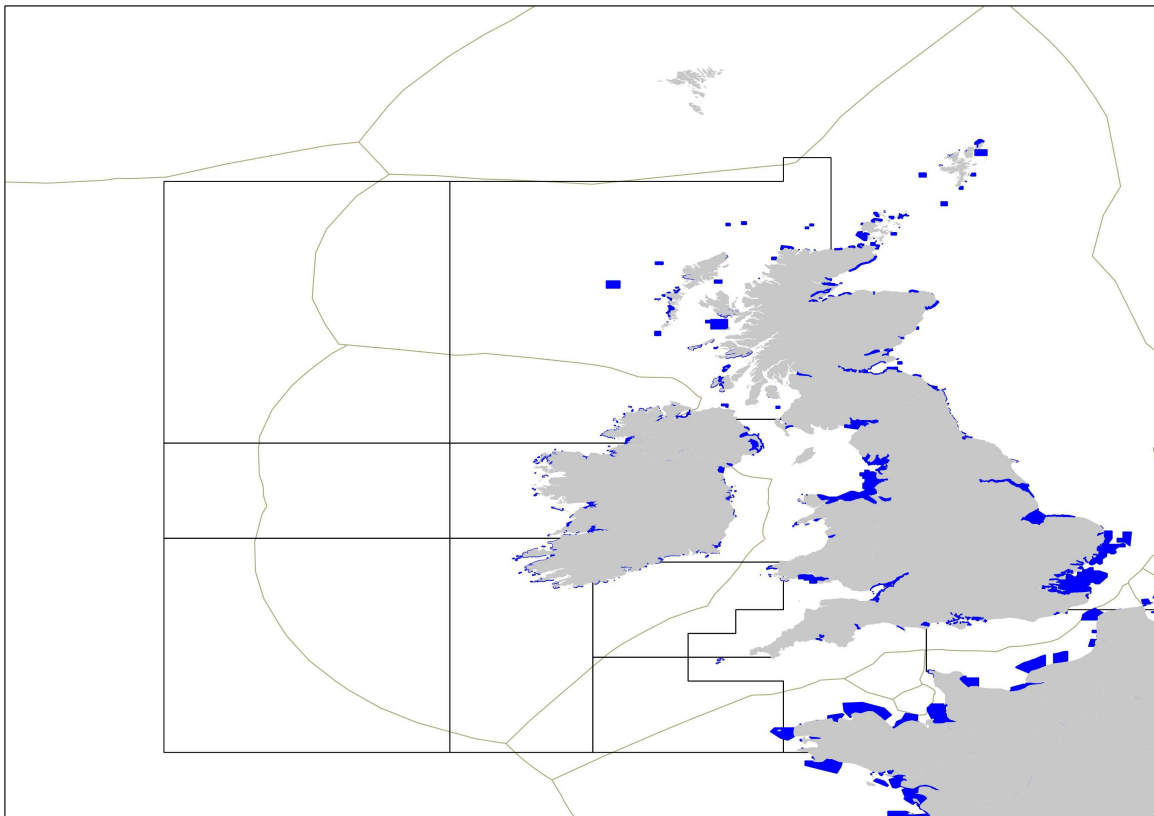
Haddock, Orange Roughy & Deep Sea Closures



Natura 2000

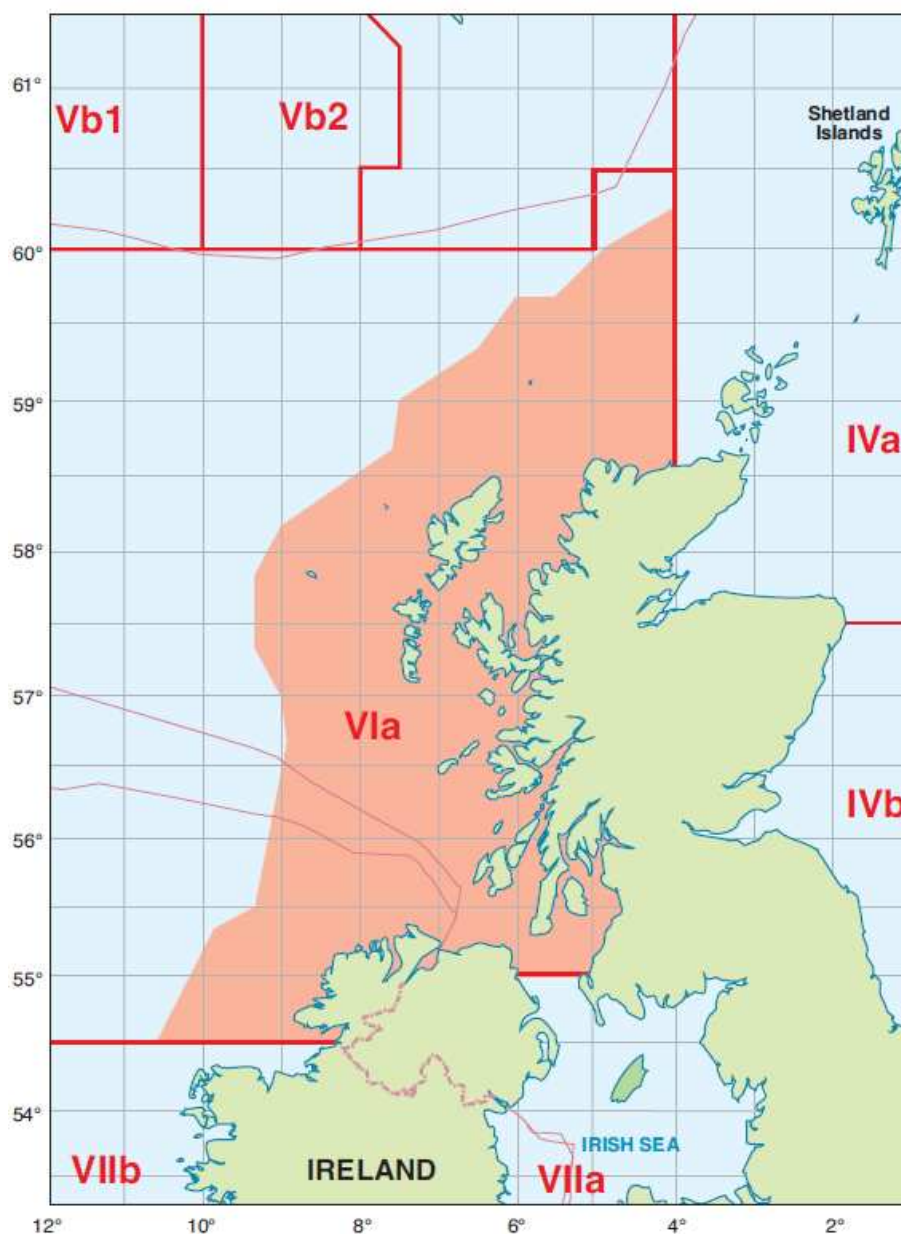


Habitats Directive - Special Areas of Conservation (SACs) and Sites of Community Importance (SCIs) in NWW.



Birds Directive - Special Protection Areas (SPAs) in NWW (note overlap with above).
(GIS Source: European Environment Agency, <http://www.eea.europa.eu>)

Restrictions on Fishing for Cod, Haddock and Whiting in ICES Area VIa.

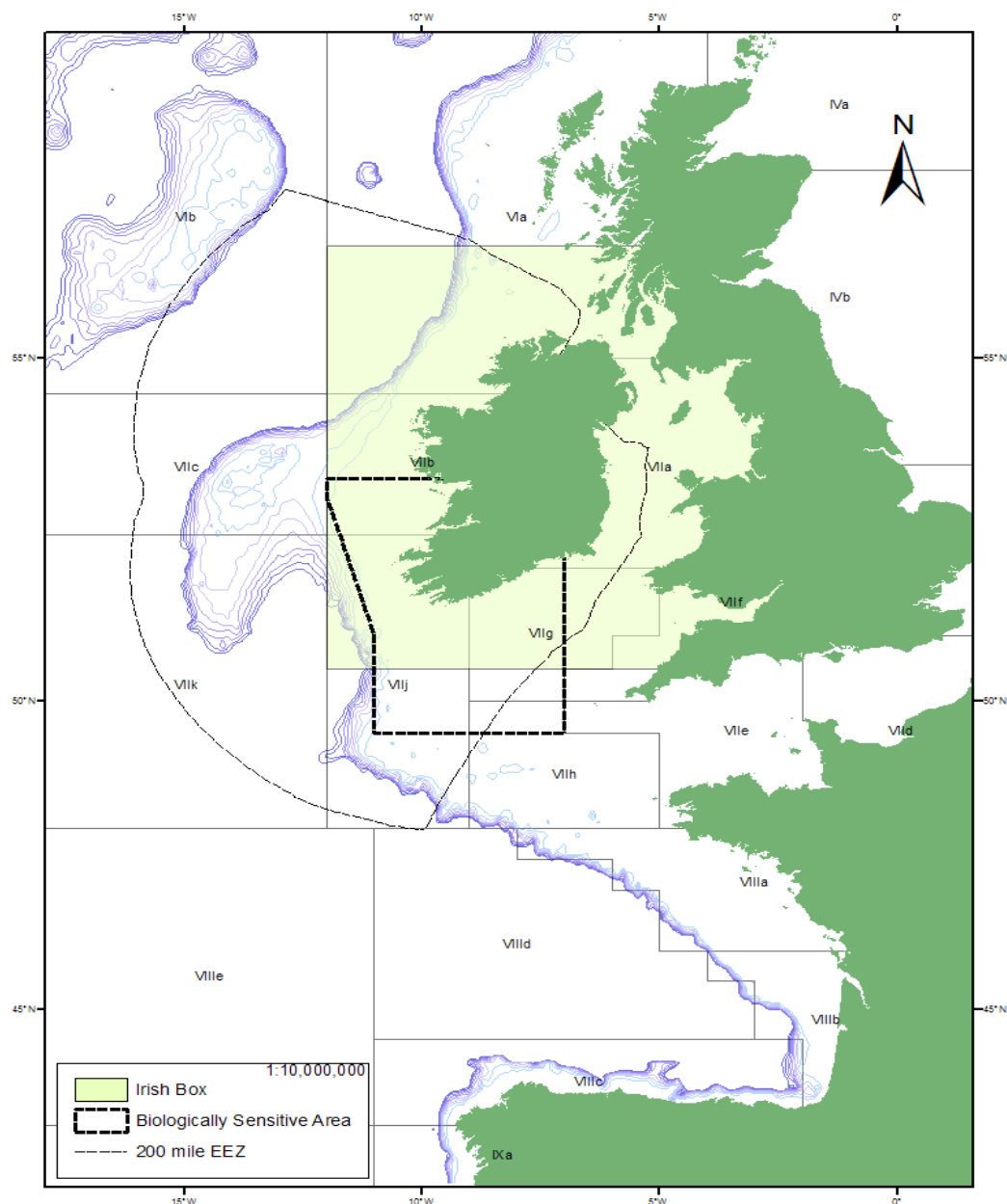


The highlighted area is closed to all fishing until 31 December 2011 except with the following gears:

- Vessels ≥ 15 Metres with trawls, demersal seines or similar gears with a minimum mesh size of 120 mm and a 120mm square mesh panel and no more than 30 % of the retained catch by weight is comprised of cod, haddock and whiting.
- Vessels ≤ 15 Metres with trawls, demersal seines or similar gears with a minimum mesh size of 110 mm and a 110mm square mesh panel and no more than 30 % of the retained catch by weight is comprised of cod, haddock and whiting. This will apply from 1st April 2011.
- Trawls of 80mm mesh size for targeting prawns provided that the fishing gear used incorporates a sorting grid or a 120mm square mesh panel, have at least 30 % of the retained catch by weight of prawns and no more than 10 % of the retained catch by weight comprised of any mixture of cod, haddock and or whiting.
- Trawls of mesh size less than 55 mm, provided that no net of mesh size greater than or equal to 55 mm is carried on board; and no fish other than herring, mackerel, pilchard sardines, sardinellas, horse mackerel, sprat, blue whiting and argentines are retained on board.
- Inshore static nets fixed with stakes, scallop dredges, handlines, mechanized jigging, mussel dredges, pots and creels provided that no other fishing gear is carried on board and no fish other than mackerel, pollack, salmon, shellfish and crustacea are retained on board, landed or brought ashore.

The Biologically Sensitive Area (BSA)

The Biologically Sensitive Area (BSA) is situated off the west and south coasts of Ireland and is considered to be an area of high ecological importance for fish life history stages. It contains important spawning and nursery grounds for exploited Northeast Atlantic fish species and is an area subjected to high commercial fishing activity. The BSA was established under Article 6 of Council Regulation No. 1954/2003, and replaced the Irish box which was set up under the Iberian Act of Accession 1986, in order to protect the area from increased fishing pressure. The BSA comprises parts of ICES Sub Areas VIIb, VIIg, VIIj and VIIh. There are specific effort measures in place for the BSA.



The position of the Irish Box (now dismantled) and the Biologically Sensitive Area (BSA).



14



IMPORTANT FISH SPAWNING AREAS

NWW are very important spawning areas for mackerel, horse mackerel and blue whiting. These species migrate into and out of the NWW area each year. Herring spawn on gravel beds in the inshore waters of Ireland and Scotland.

There are also important whitefish spawning areas in NWW. Cod spawning takes place in the north western Irish Sea and in the Celtic Sea off the south east of Ireland and off Cornwall.

There are hake and megrim spawning areas off the south and south west of Ireland.

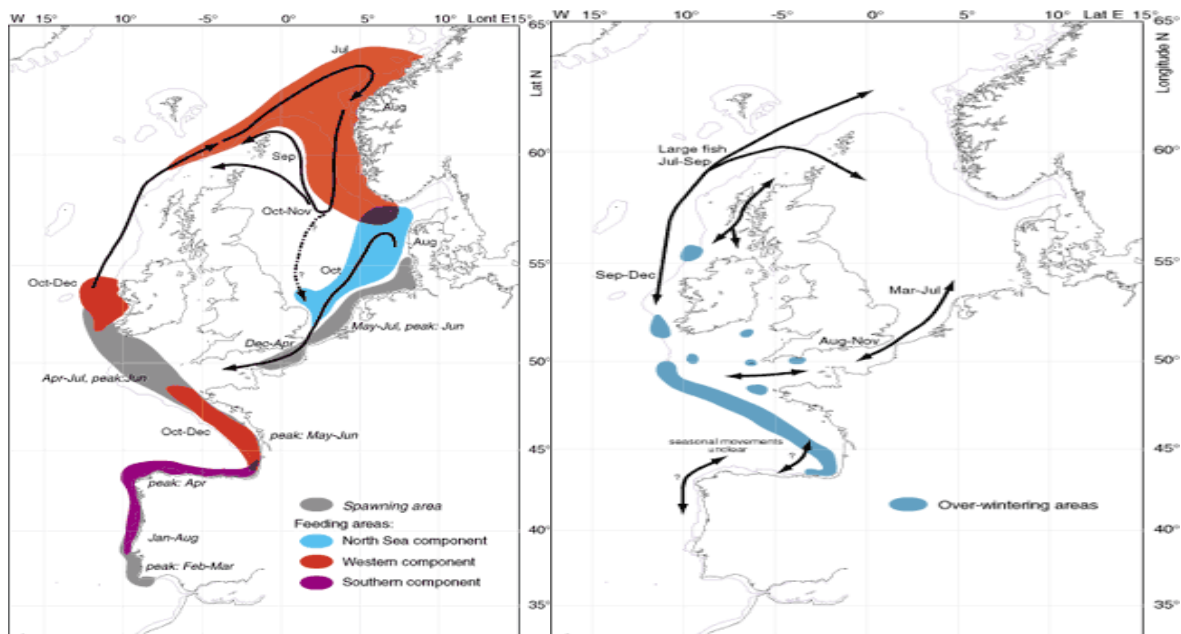
Monkfish spawn on the slope areas to the west of Ireland and Scotland. Whiting and haddock spawn in the Celtic Seas and in the Irish Sea.

There are important herring spawning areas in the Celtic Sea, North west of Ireland and along the west coast of Scotland.

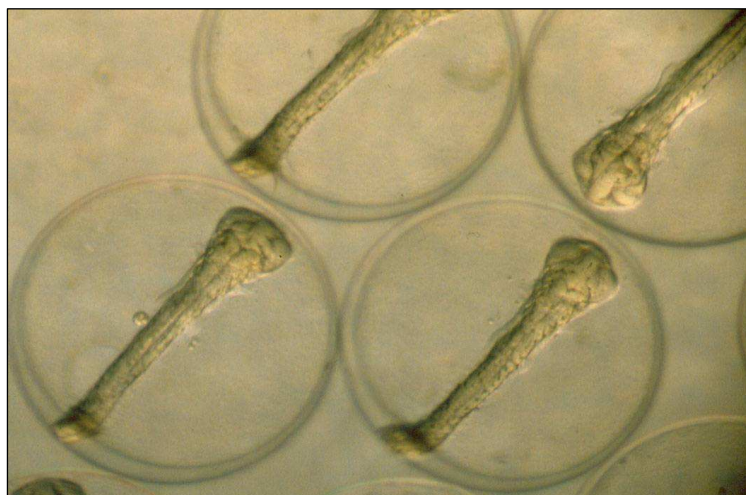
The NWW area is a very important area for the spawning of blue whiting, mackerel and horse mackerel. Each year these highly migratory species move into this area, spawn and move away from the western part of NWW. There are also important whitefish spawning areas in NWW. Cod spawning takes place in the north western Irish Sea and in the Celtic Sea off the south east of Ireland and off Cornwall. There are hake and megrim spawning areas off the south and south west of Ireland. Monkfish spawn on the slope areas to the west of Ireland and Scotland. Whiting and haddock spawn in the Celtic Seas and in the Irish Sea. There are important herring spawning areas in the Celtic Sea, North west of Ireland and along the west coast of Scotland.

Horse Mackerel Migration

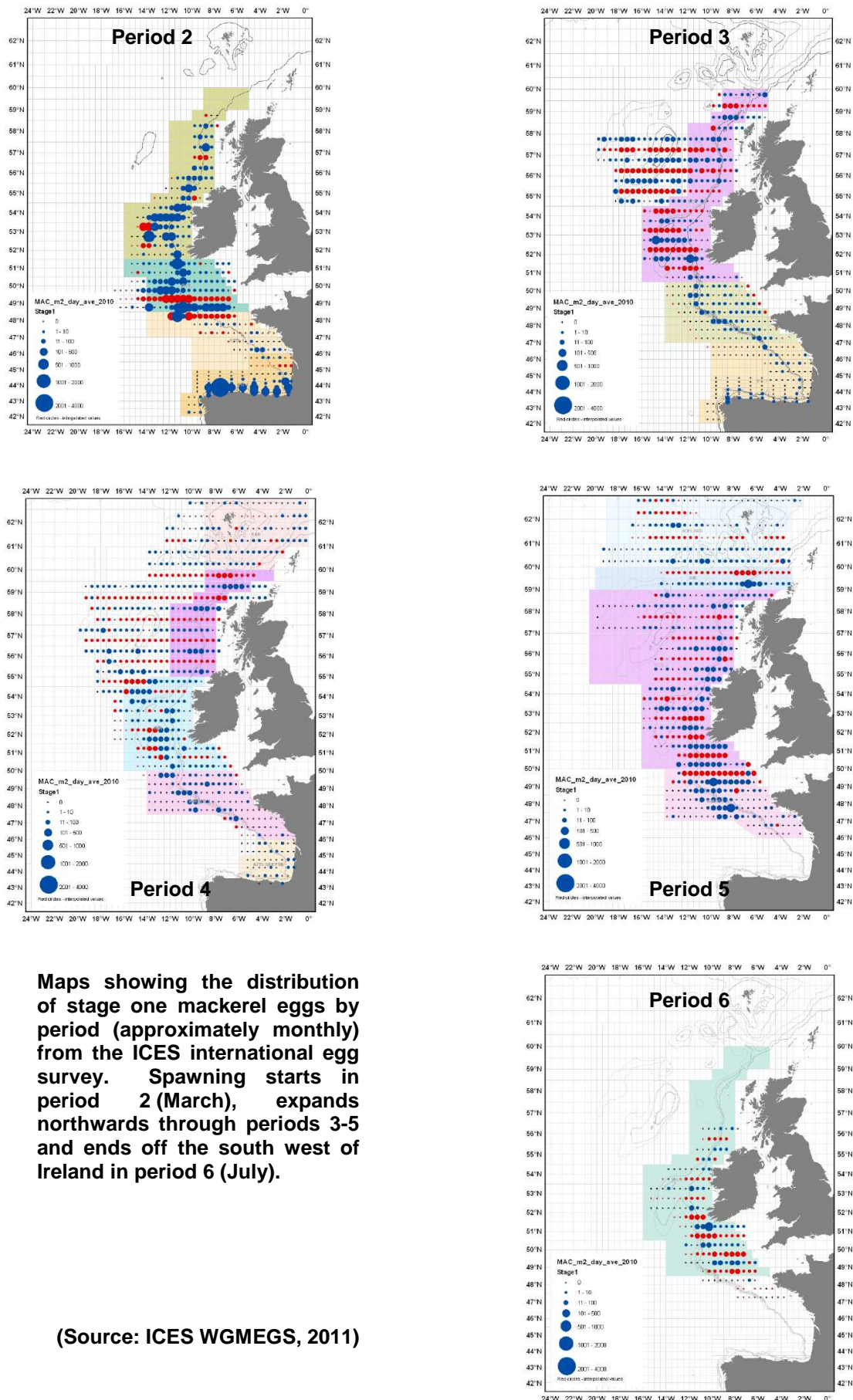
The figures below show a schematic outline of assumed migration route, spawning areas and overwintering areas for the three horse mackerel stocks in the north east Atlantic.



(Source: www.HOMSIR.org)

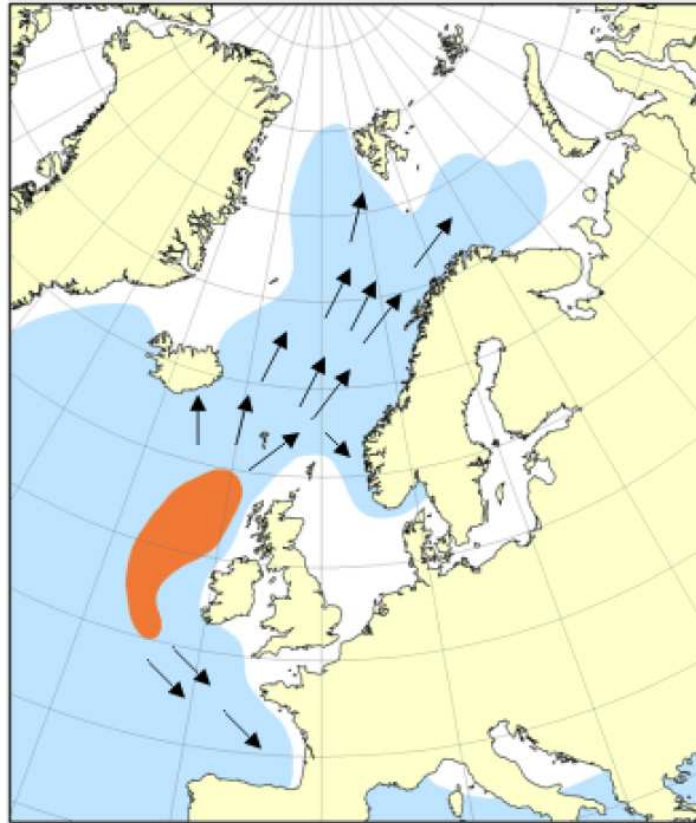


Spawning of Mackerel



Spawning of Blue Whiting

The figure below shows the spawning area of Blue Whiting in orange, and the larval drift pattern, shown by arrows. The position and strength of the North Atlantic sub-polar gyre appears to influence the spawning success of blue whiting by constraining spawning along the European continental slope and south of Porcupine Bank (Hatun et al., 2009).

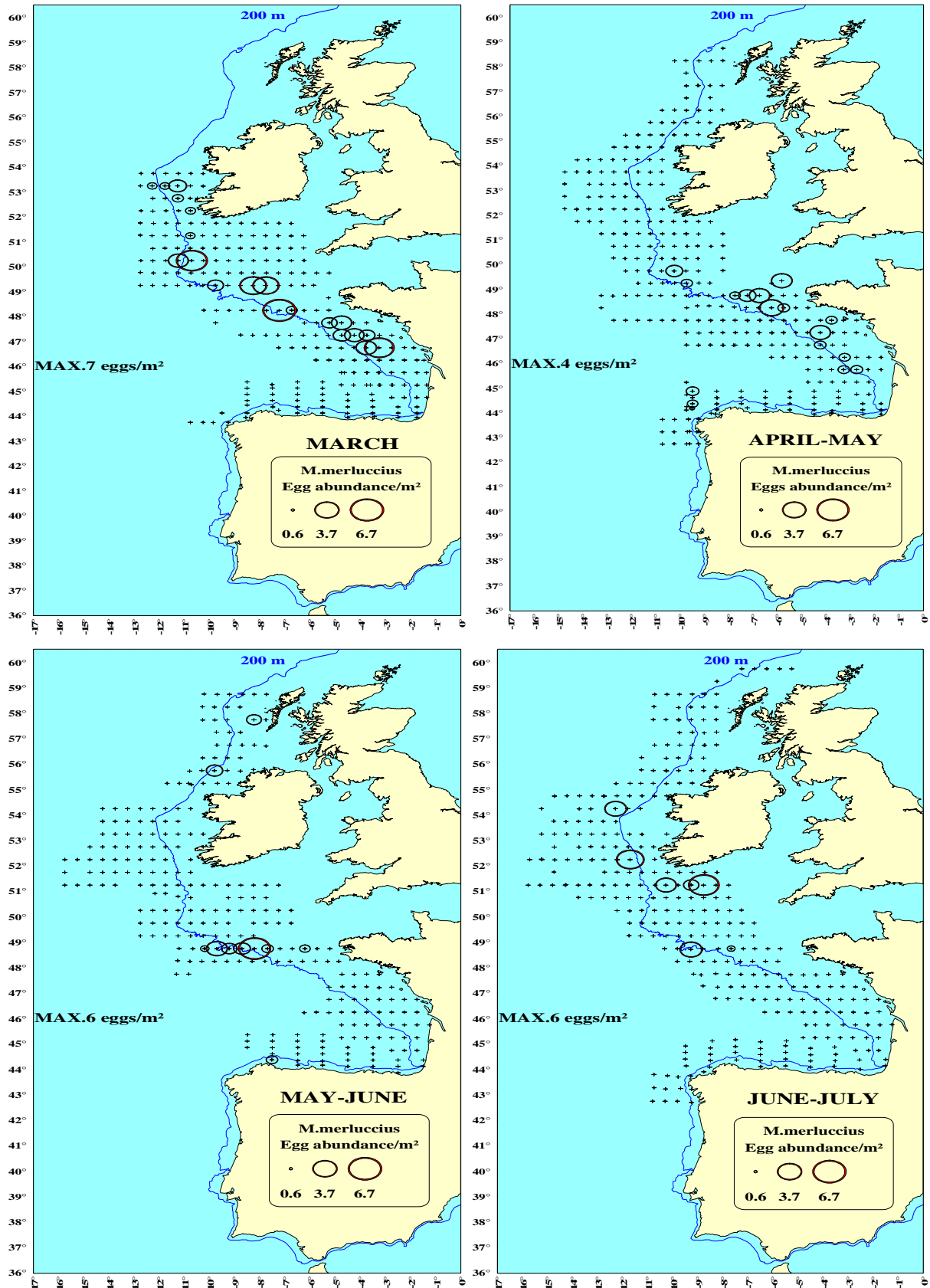


(Source: ICES WGRED, 2008)



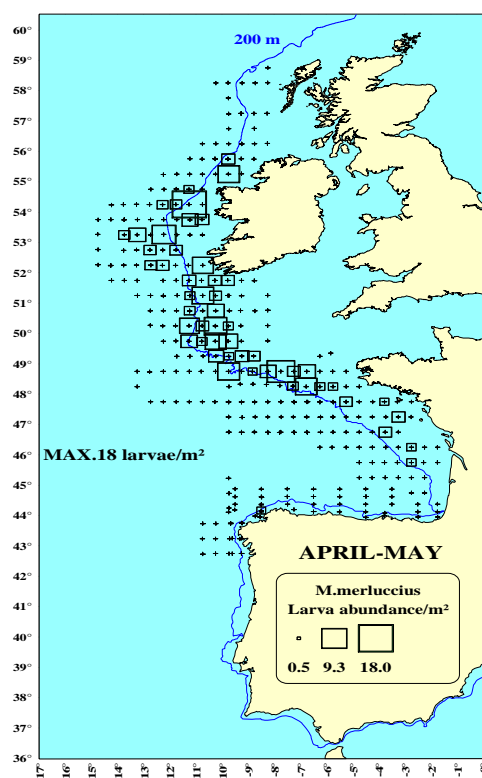
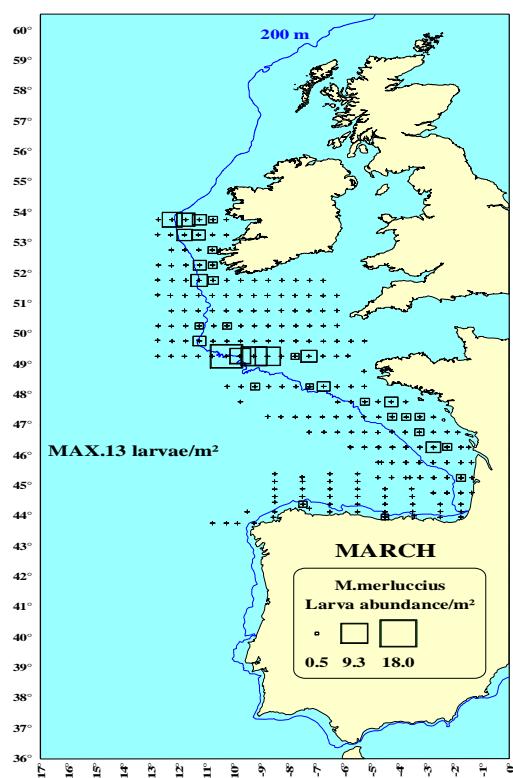
Image: Superstock.co.uk

Spawning of Hake



Distribution and abundance of hake eggs/ m^2 for 1998 (Alvarez *et al.*, 2000).

Hake Larvae



Distribution and abundance of hake larvae/m² for 1998 (Alvarez *et al.*, 2000).



Important Spawning and Nursery Grounds

The following pages show maps of important spawning and nursery grounds for many commercially caught species of fish in and around the NWW. Included in each diagram are the 500m depth contour and the ICES divisions that make up the NWW.

Spawning Grounds

Nursery Grounds

Spawning Intensity



High

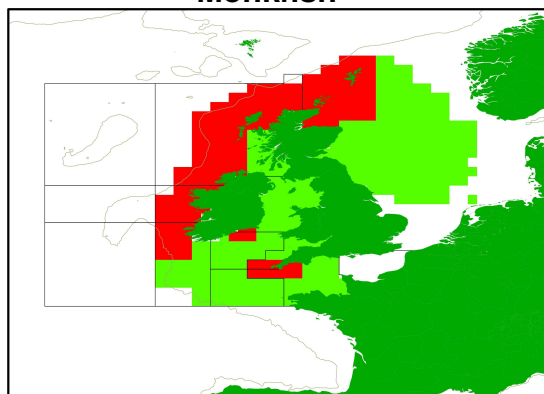


Low

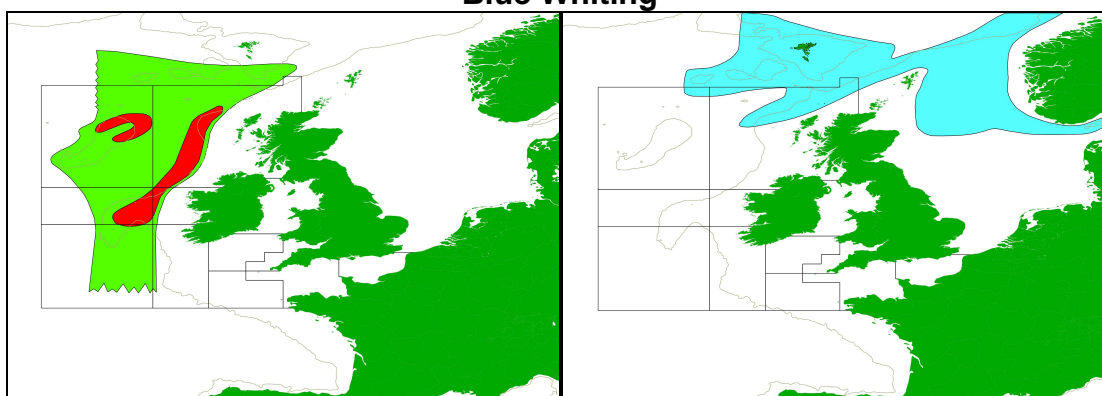


Undetermined

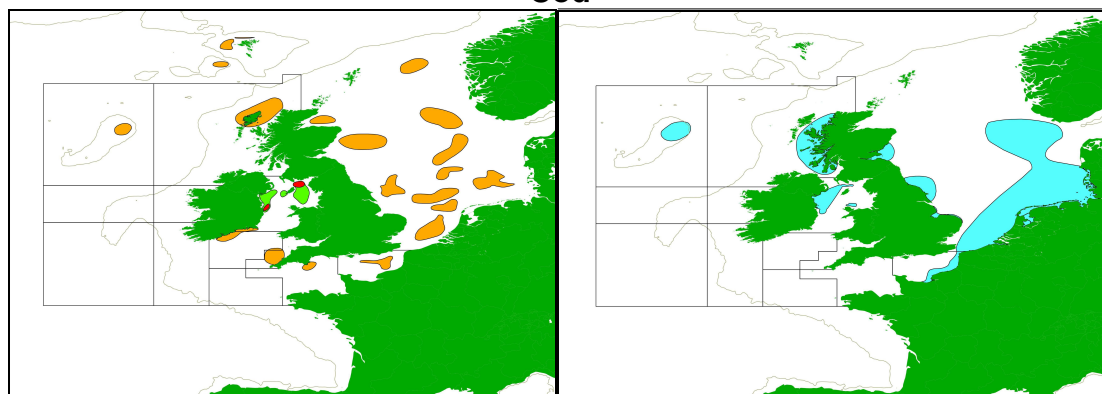
Monkfish



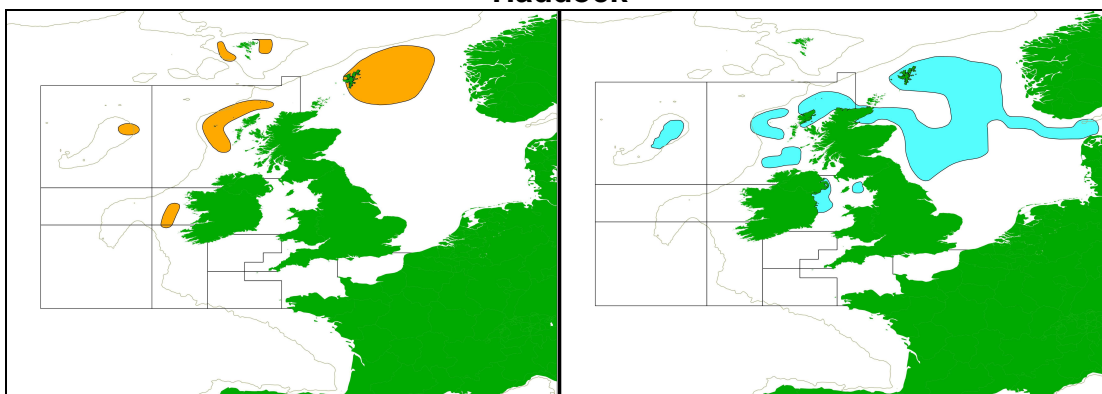
Blue Whiting



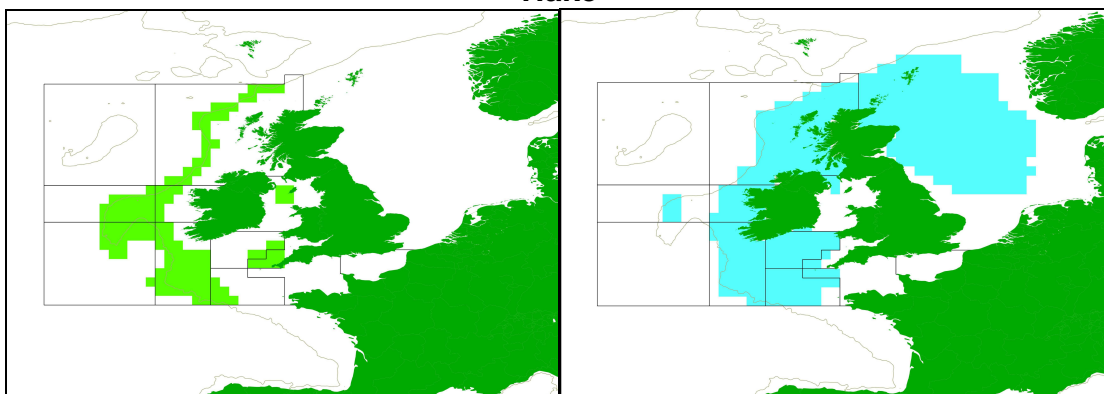
Cod



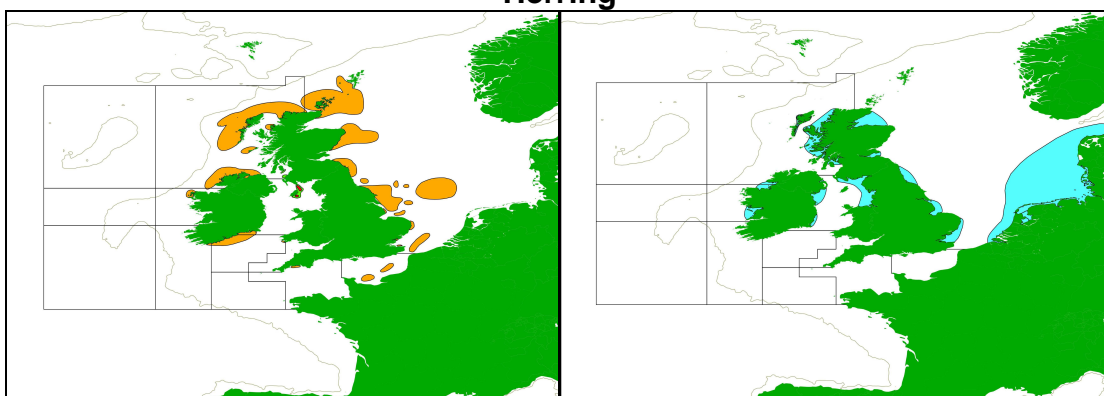
Haddock



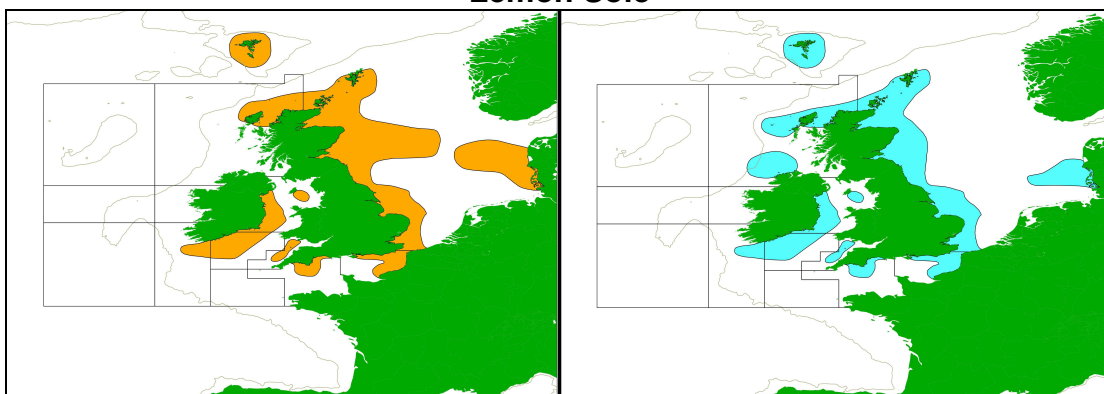
Hake



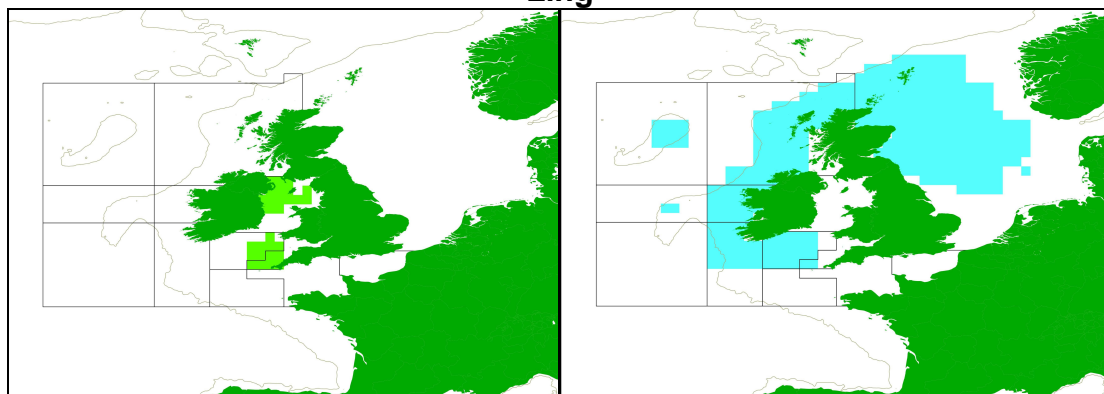
Herring



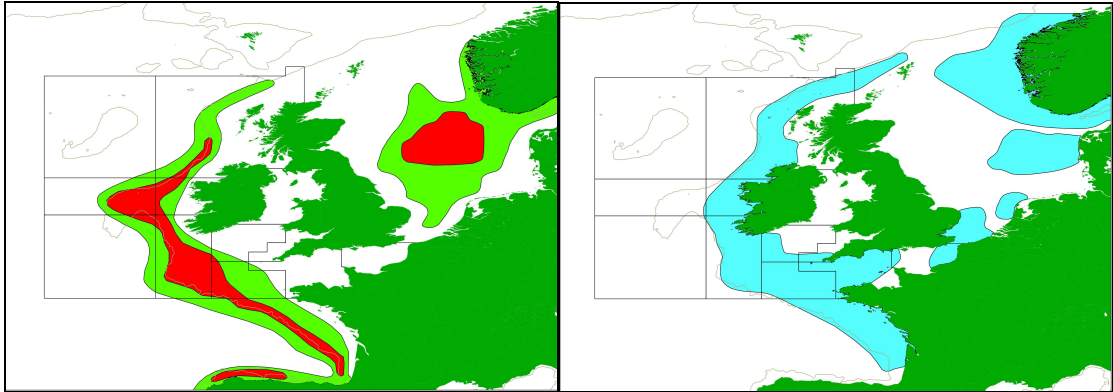
Lemon Sole



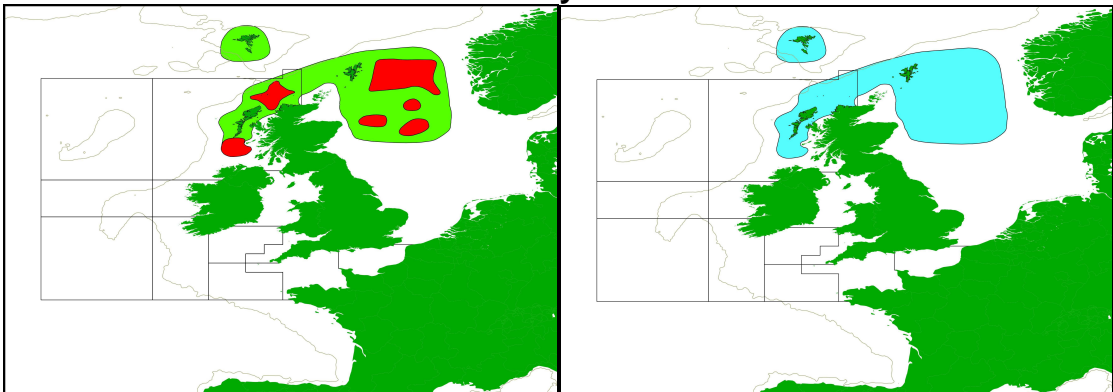
Ling



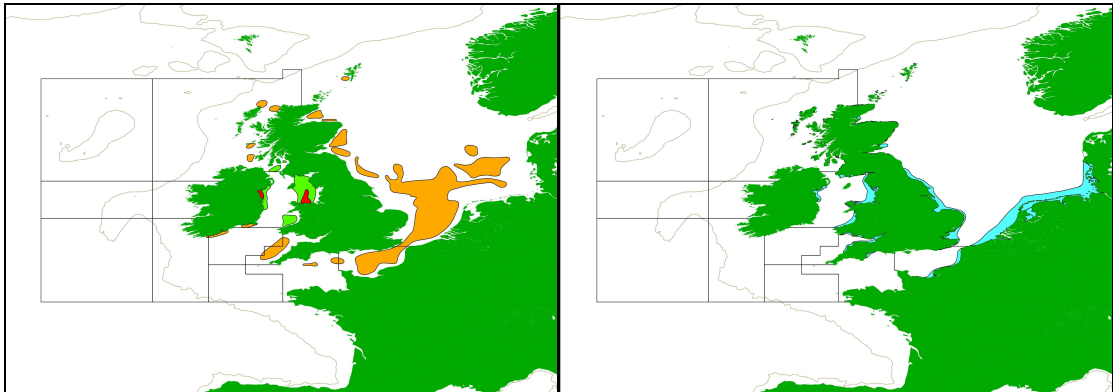
Mackerel



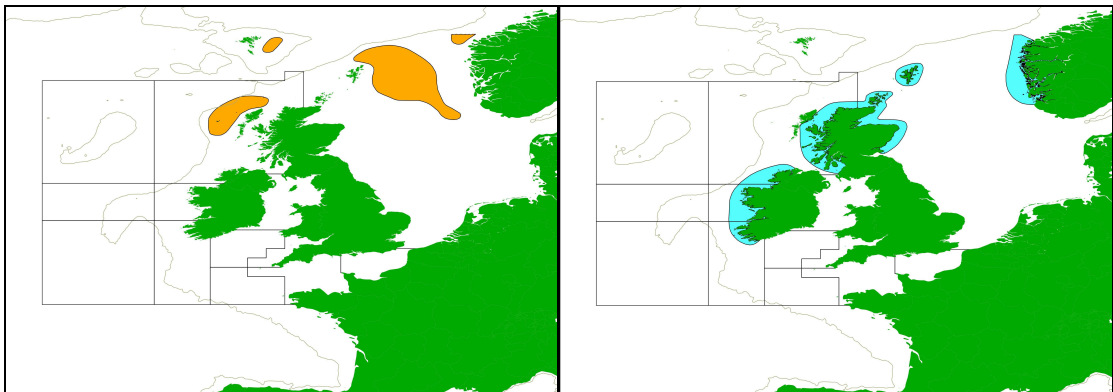
Norway Pout



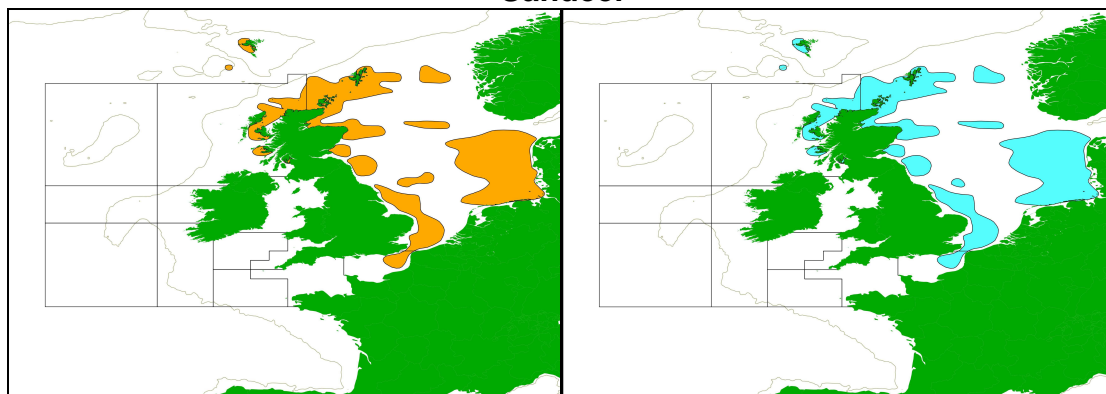
Plaice



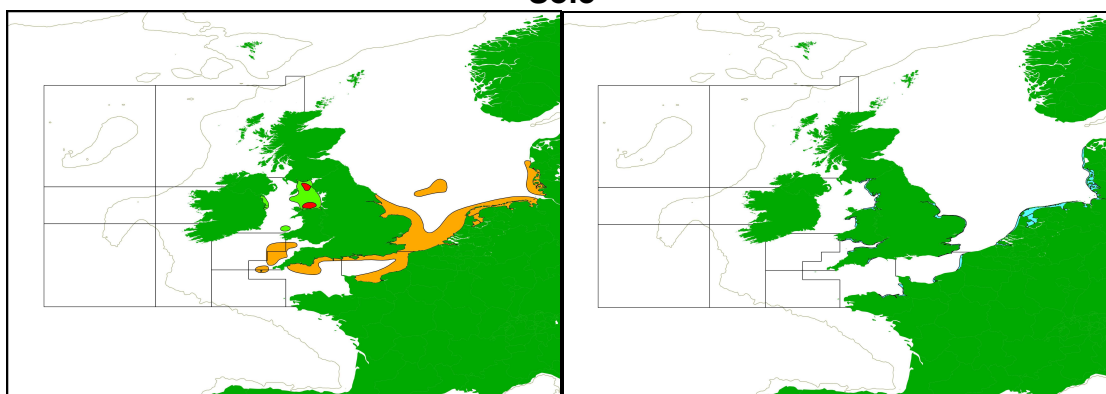
Saithe



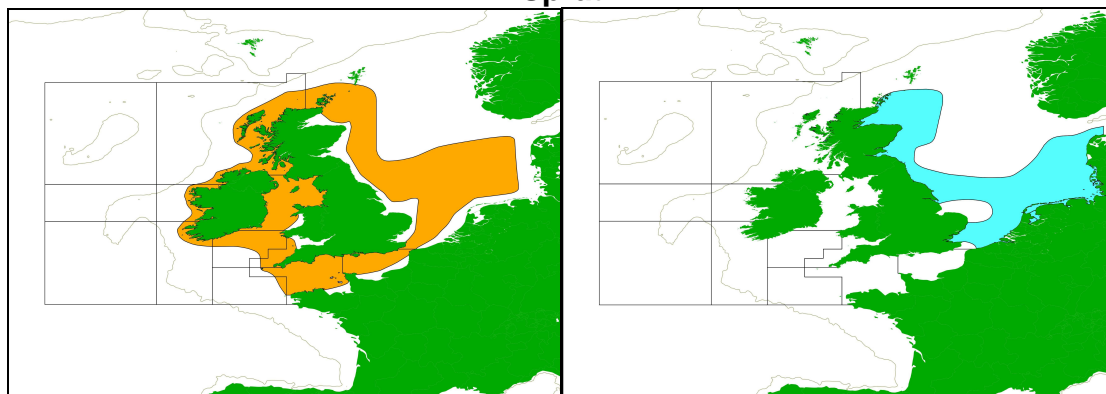
Sandeel



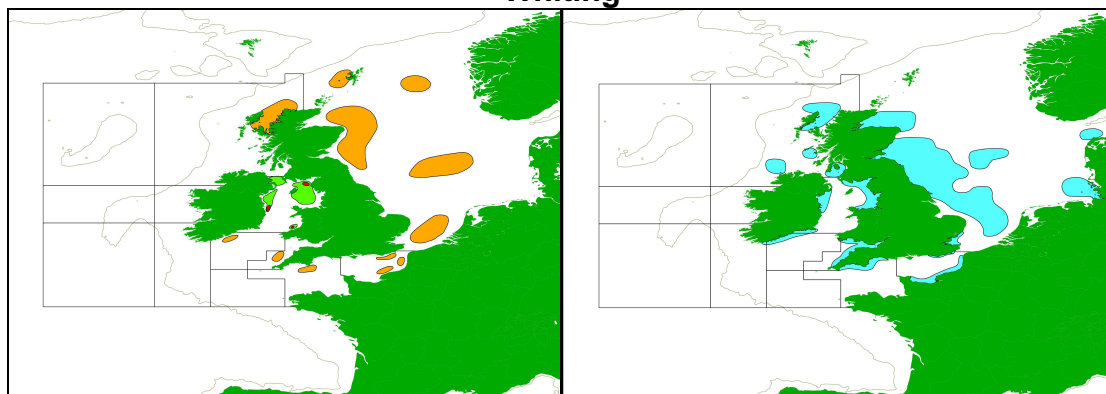
Sole



Sprat



Whiting



(GIS Source: CEFAS 2010)



DISTRIBUTION OF JUVENILE FISH

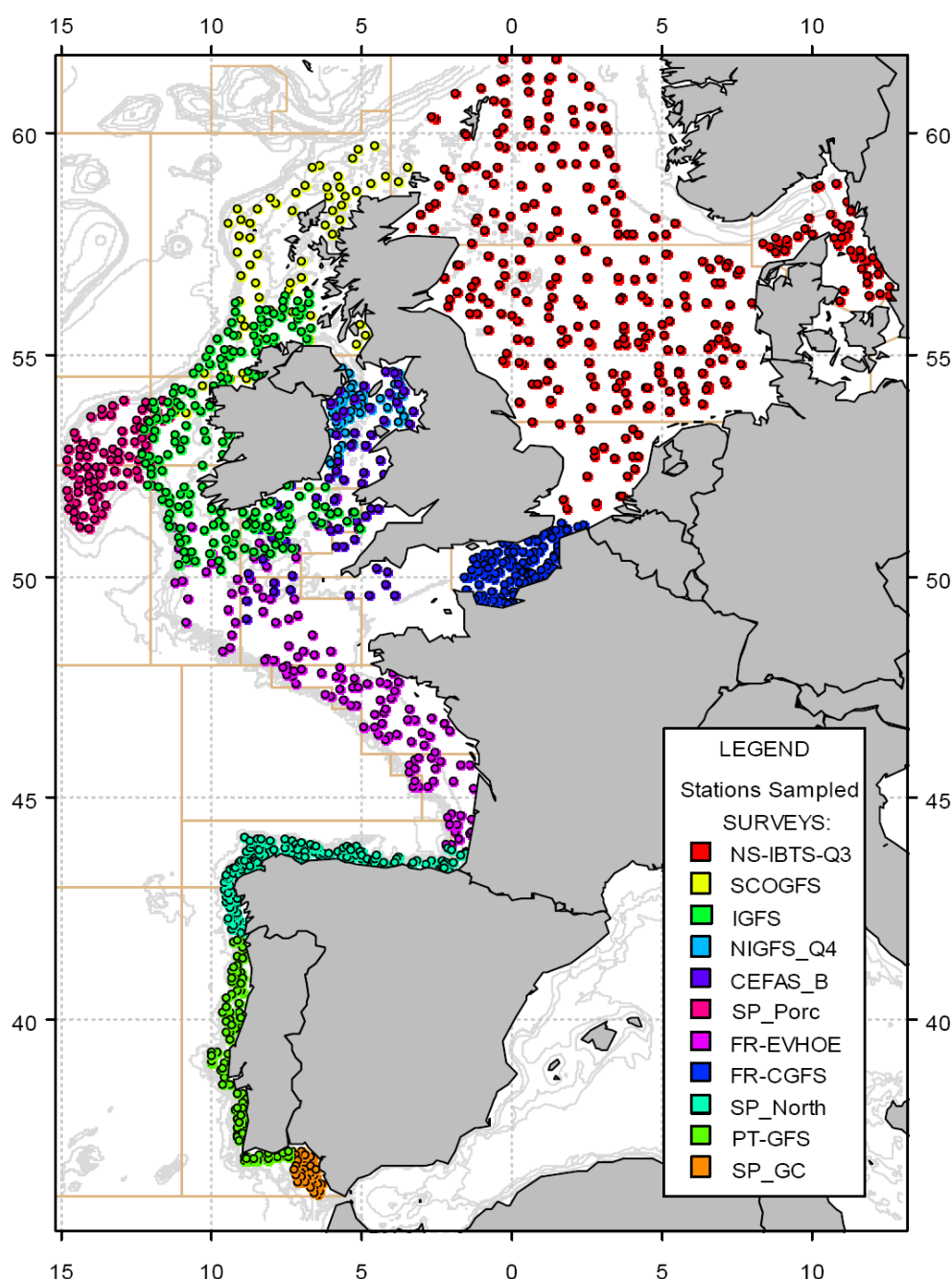
Research surveys use a small mesh to capture juvenile fish. These provide information so that the distribution of juvenile fish can be mapped in order to identify important nursery areas.

ICES co-ordinates 15 annual ground fish surveys in the NWW, which are carried out by the UK (Scotland, Northern Ireland, England and Wales), France, Spain and Ireland.

These surveys assess the distribution and abundance of fish species (adult and juveniles) for stock assessment and ecological studies.

A total of 976 valid hauls were made during these ground fish surveys in 2009.

A total of 15 ground fish surveys were co-ordinated and carried out in the ICES west and south area of the Eastern Atlantic in 2009 and a total of 976 valid hauls were made. The main purpose of these surveys is to assess the distribution and abundance of fish species (adult and juveniles) for stock assessment and ecological studies. The surveys are co-ordinated through the ICES International Bottom Trawl Survey Working Group (IBTS). In the NWW area, ground fish surveys are conducted by the UK (Scotland, Northern Ireland, England and Wales), France, Spain and Ireland.



Station positions of the various ground fish surveys carried out in North East Atlantic and North Sea in 2008 (Source: ICES IBTS, 2009).

Information from Ground fish Surveys

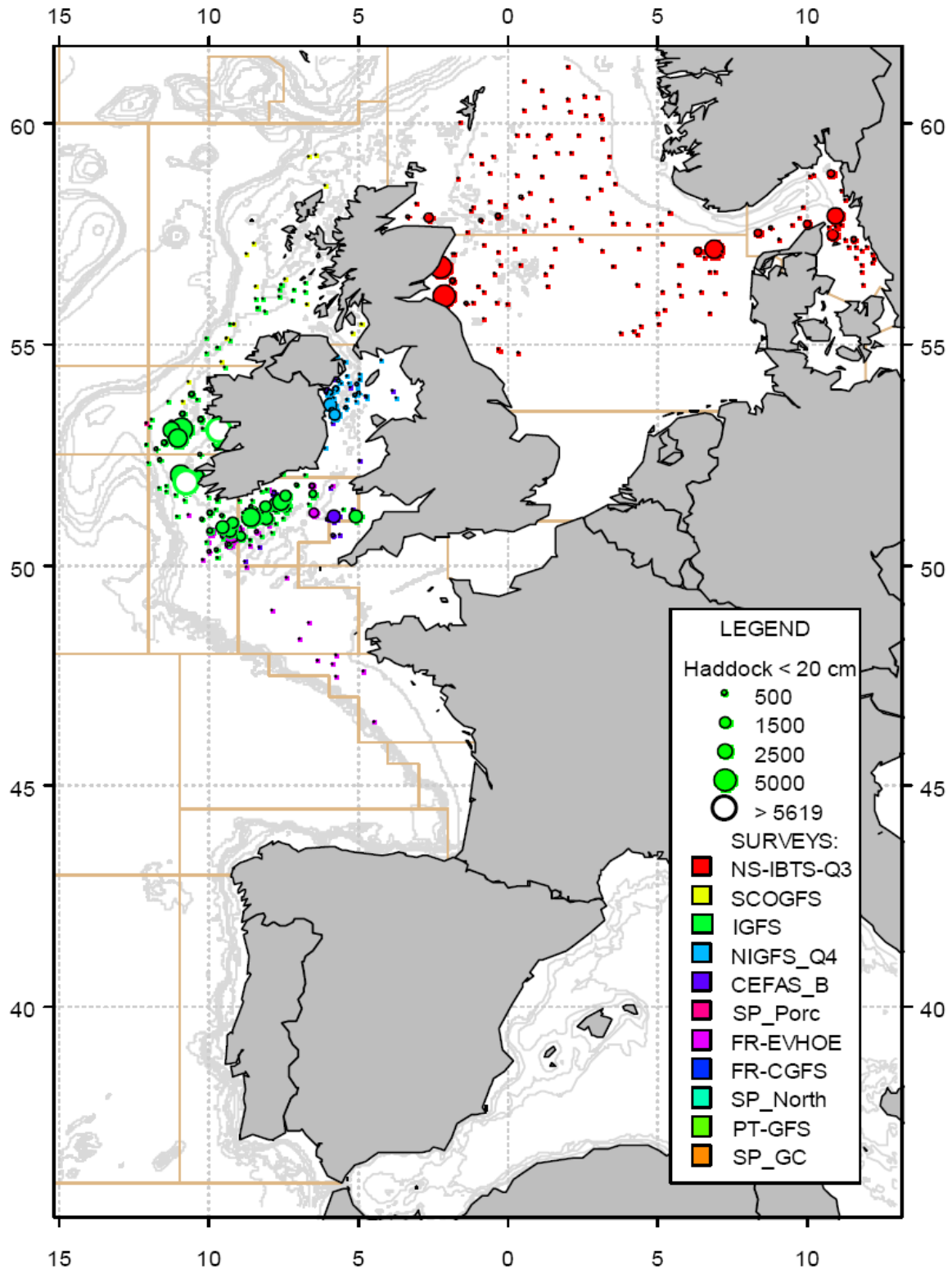
As part of ongoing efforts to standardize the format and usefulness of reporting for surveys, in 2008, the IBTS produce a number of overview maps combining the North Sea and Western Atlantic areas (St. Georges Channel, Irish Sea and Western Atlantic). In examining the following maps of species distribution, two aspects need to be borne in mind: (1) The North Sea (NS) survey relates to Quarter 3 while the Western Area (WA) relates to Quarter 4. (2) There are a number of different trawl types used in the WA, whereas a single trawl gear is used in the NS.

The maps give catch numbers per hour for fish which have spawned in the current year of the survey (i.e. fish less than 1 year old – 0 group fish). A selected number of species are presented.

(See: <http://www.ices.dk/datacentre/datras/survey.asp>)

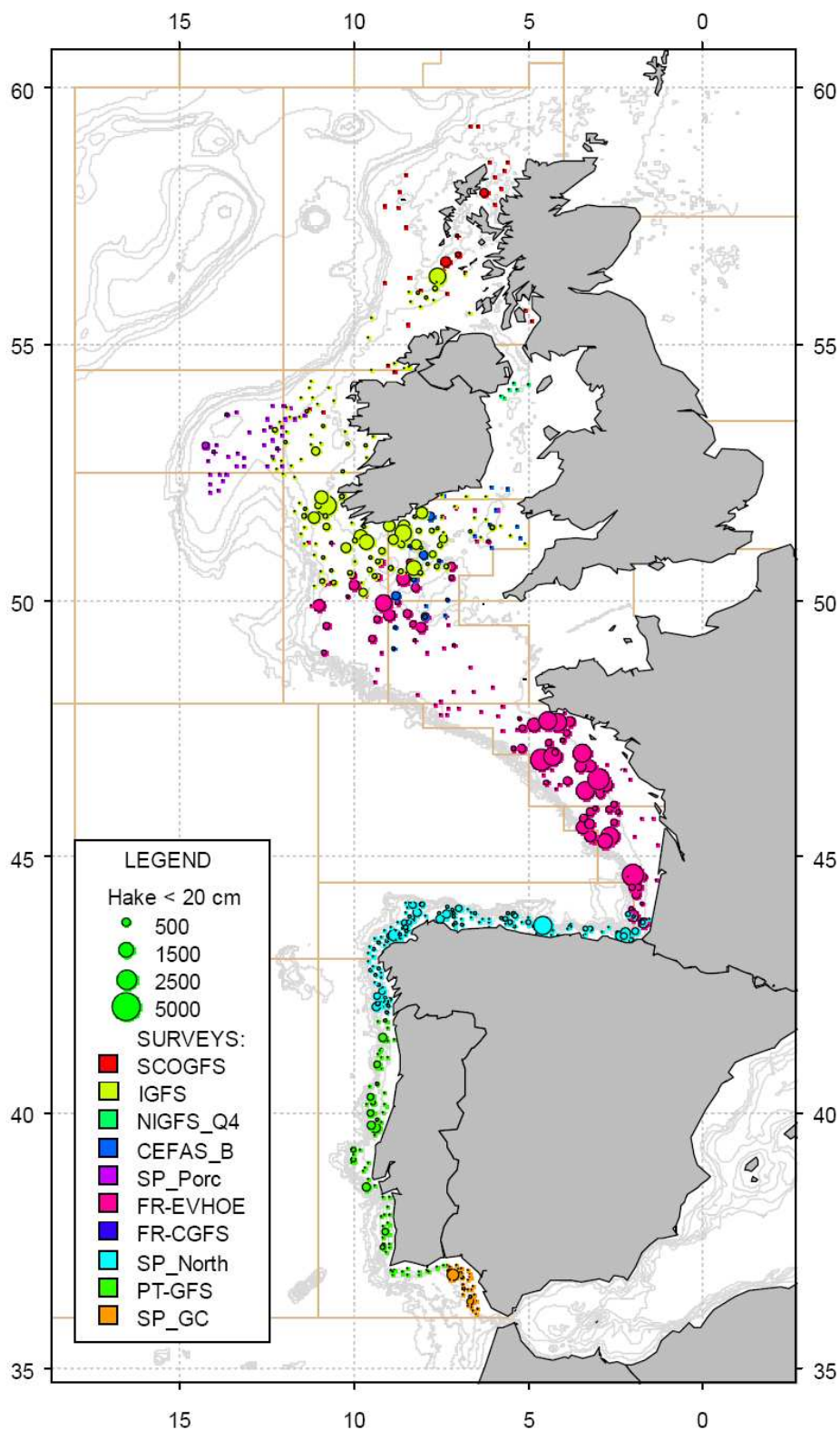


Juvenile Haddock



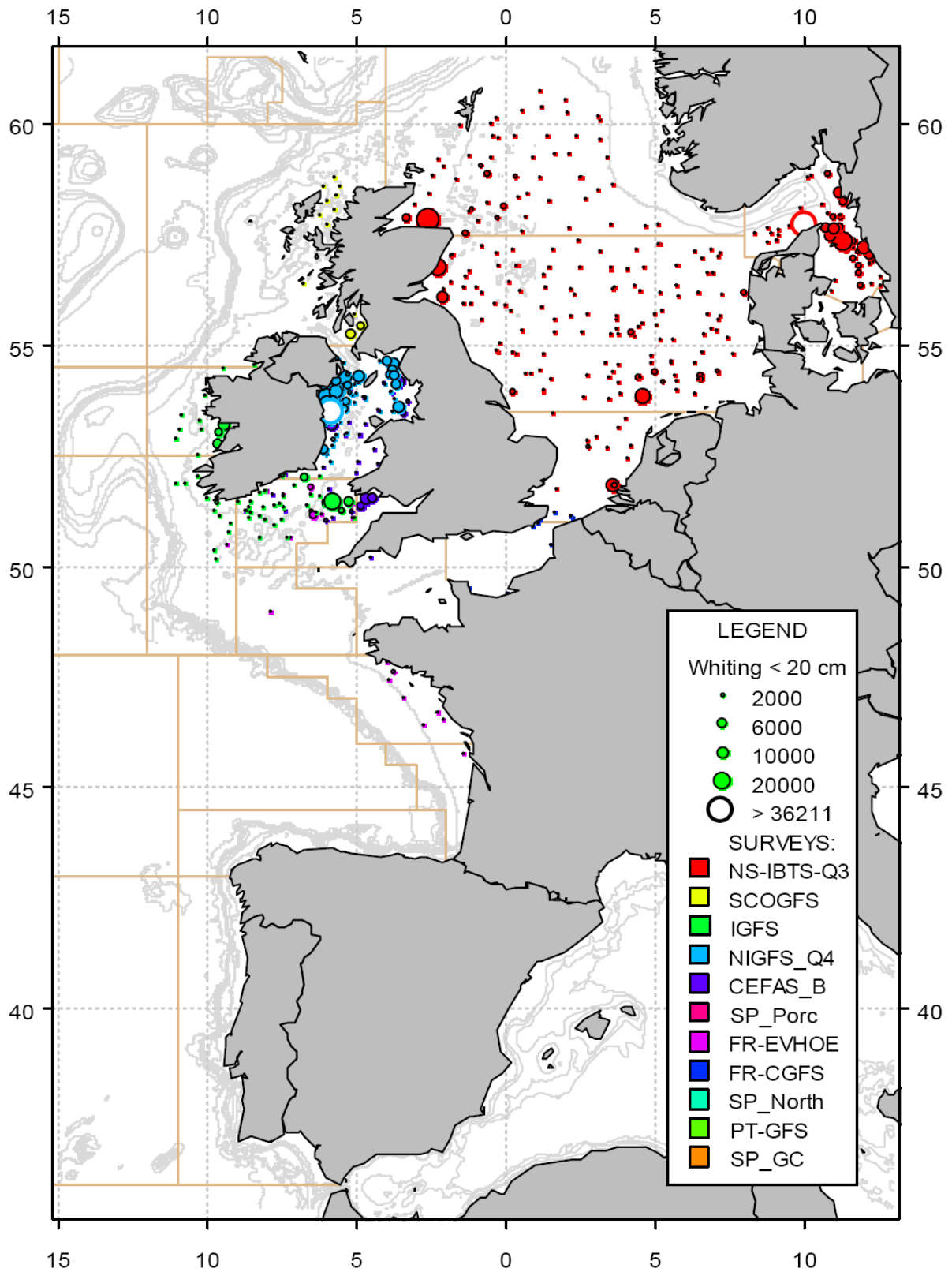
Catches in numbers per hour of 0-group haddock (<20cm)
from the 2008 ground fish surveys. (Source: ICES IBTS, 2009)

Juvenile Hake



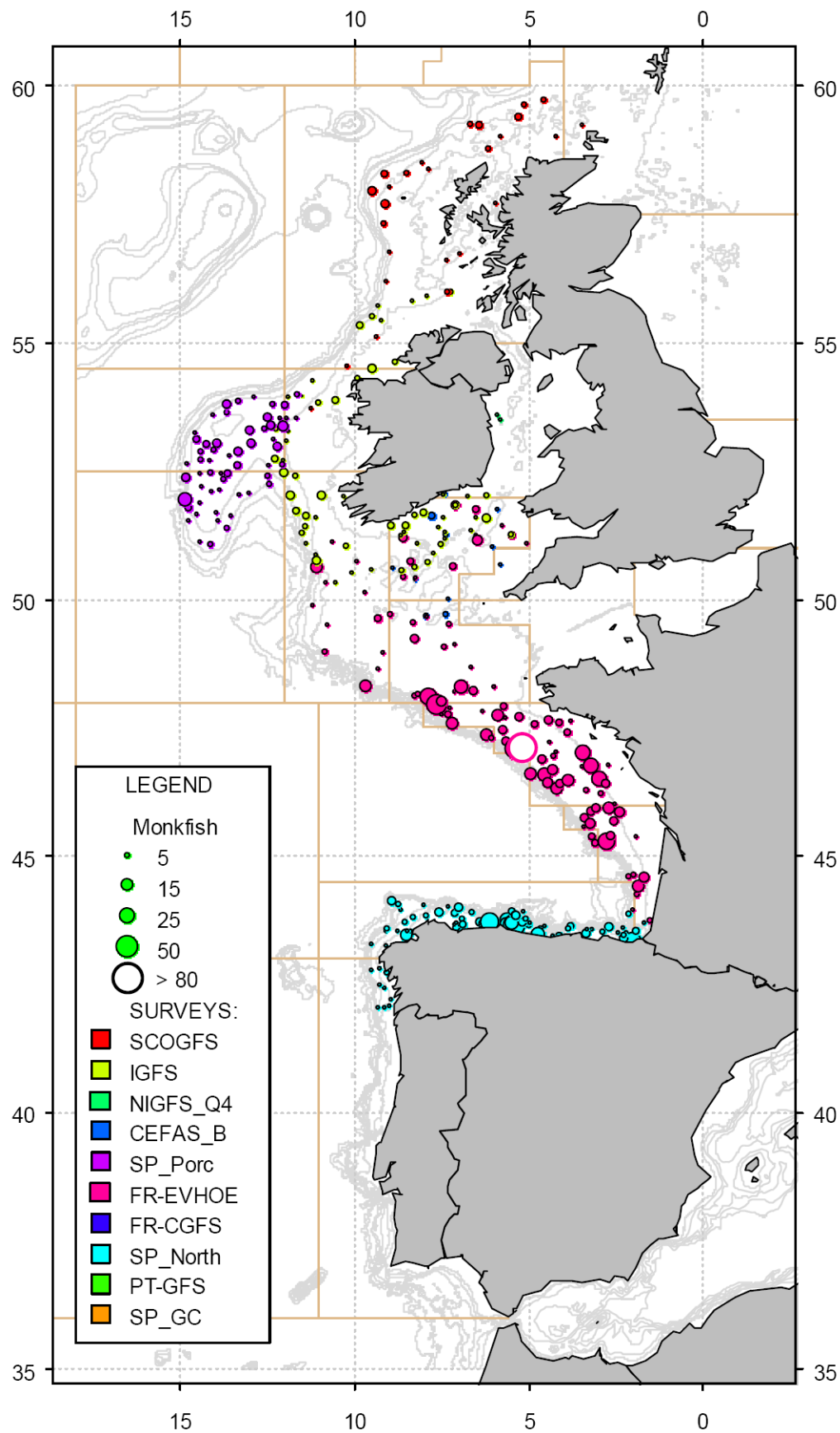
Catches in numbers per hour of 0-group hake (<20cm)
from the 2008 ground fish surveys (Source: ICES IBTS, 2009).

Juvenile Whiting



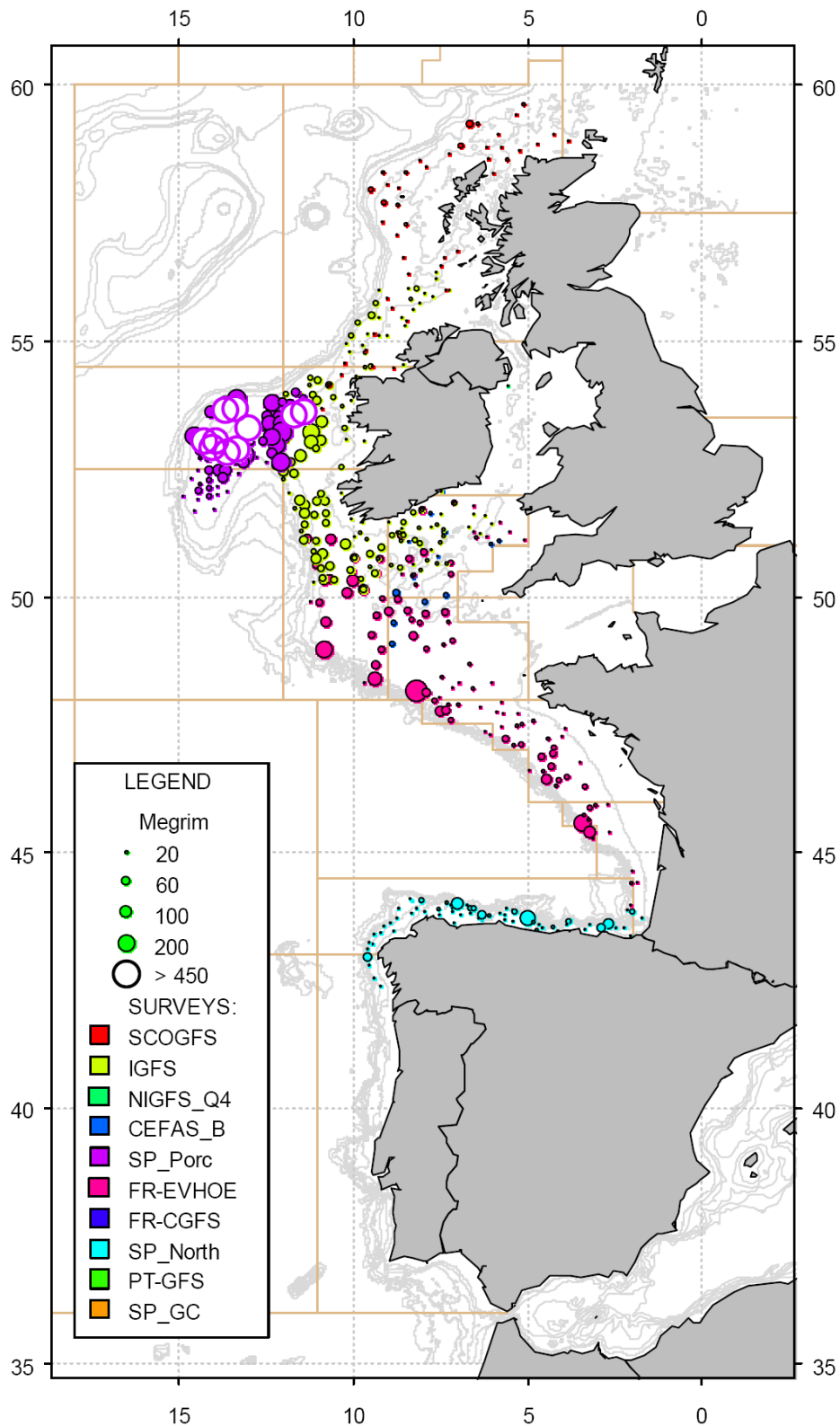
Catches in numbers per hour of 0-group whiting (<20cm)
from the 2008 ground fish surveys (Source: ICES IBTS, 2009).

Adult and Juvenile Monkfish



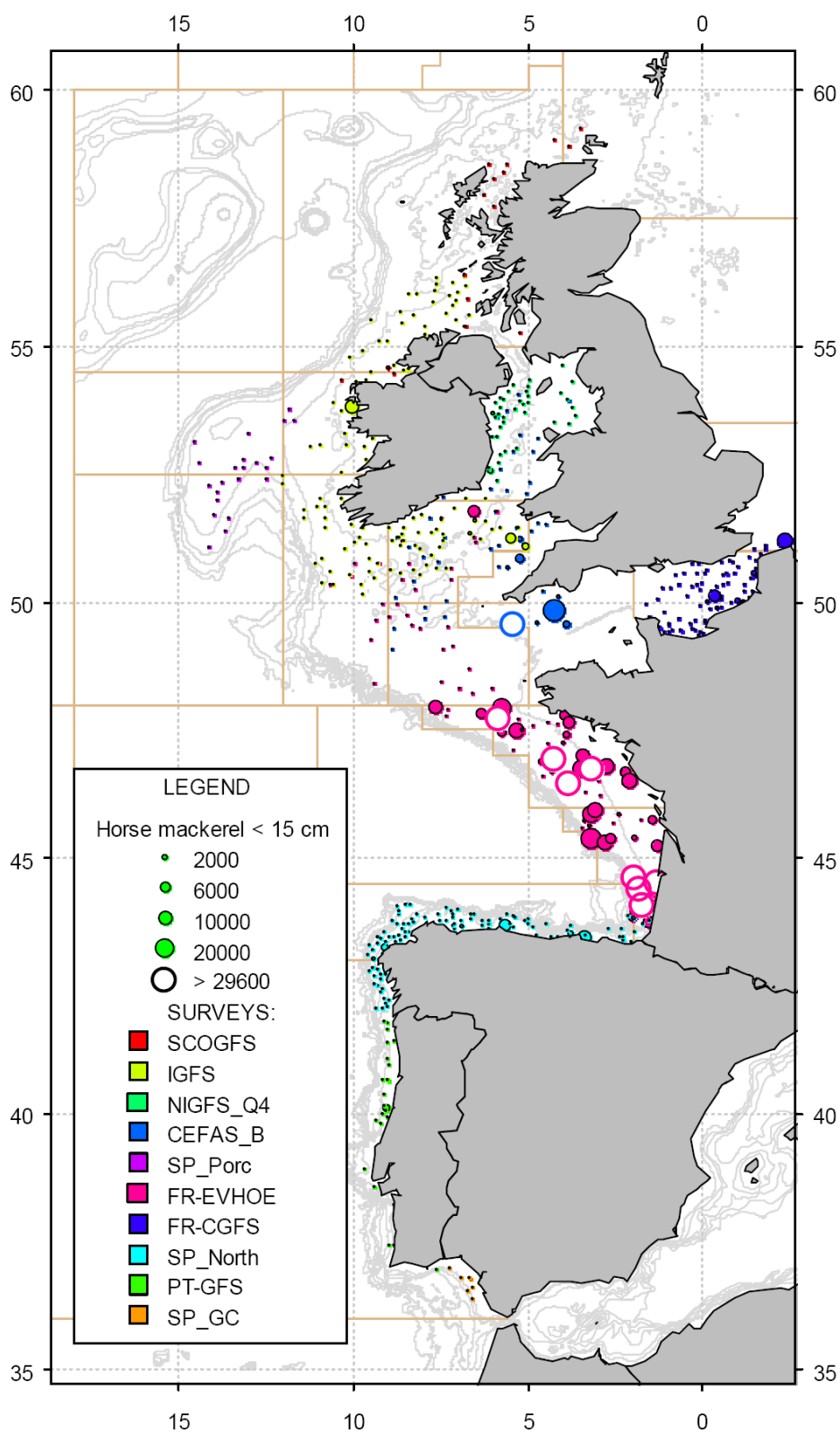
Catches in numbers per hour of all monkfish from the 2008 ground fish surveys (Source: ICES IBTS, 2009).

Adult and Juvenile Megrin



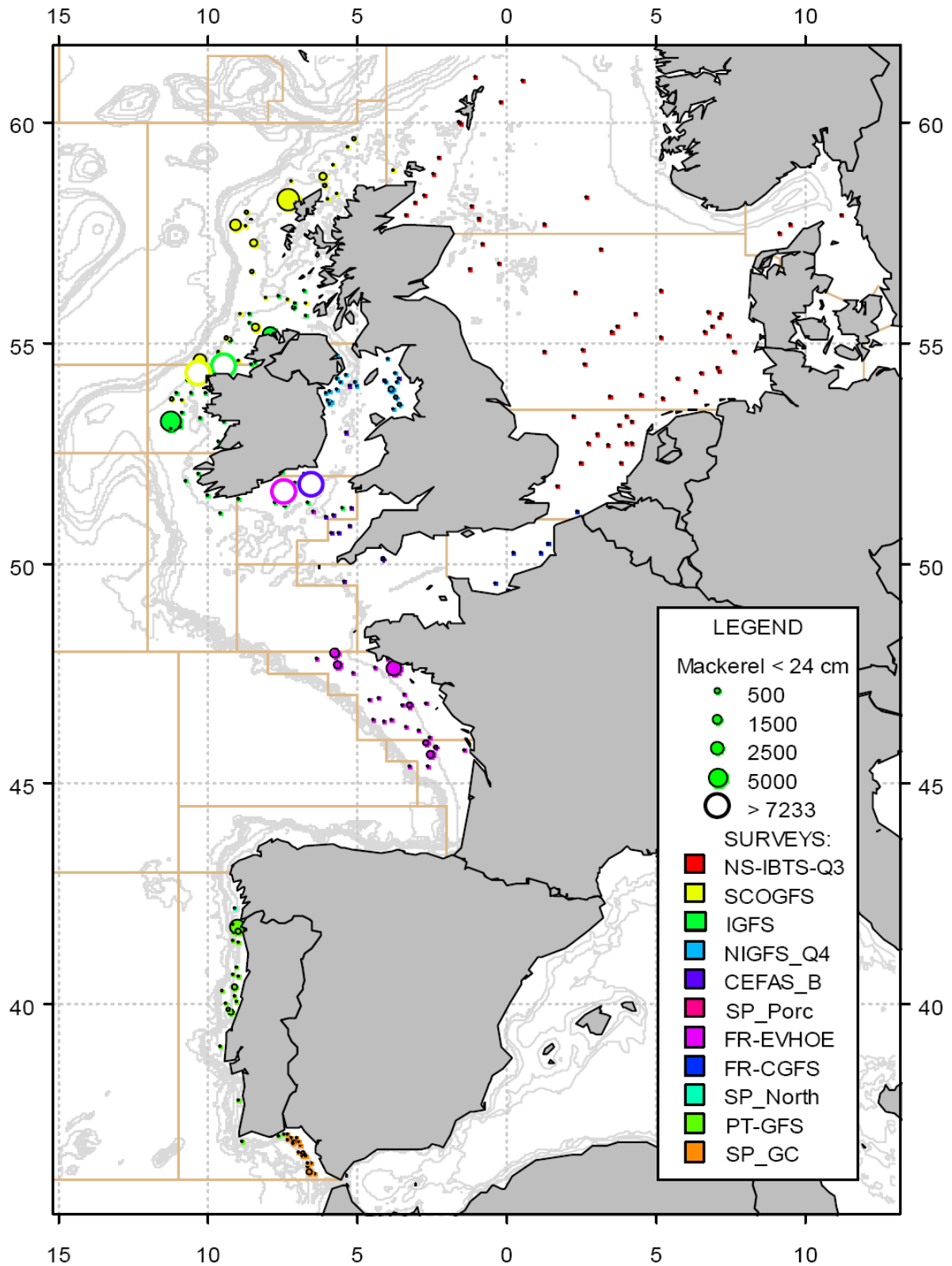
Catches in numbers per hour of all megrim from the 2008 ground fish surveys (Source: ICES IBTS, 2009).

Juvenile Horse Mackerel



Catches in numbers per hour of juvenile horse mackerel (<15cm) from 2008 ground fish surveys (Source: ICES IBTS, 2009).

Juvenile Mackerel



Catches in numbers per hour of juvenile mackerel (<24cm) from 2008 ground fish surveys (Source: ICES IBTS, 2009).



16



FISHING ACTIVITY

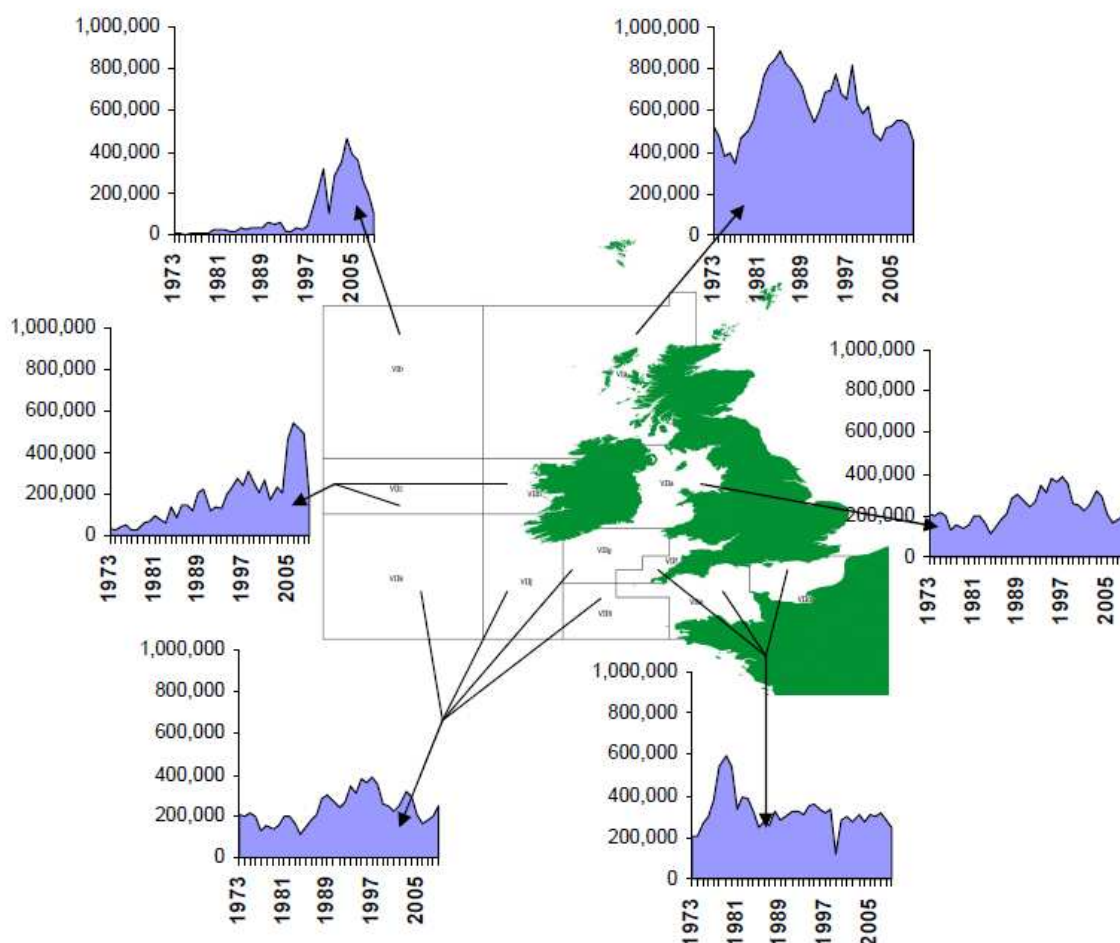
Total landings of wild capture fisheries from the NWW area (i.e. ICES Sub Areas VI and VII) for 2009 were around 1.3 million tonnes.

In Sub Area VI (North of Ireland and West of Scotland), the main pelagic species caught are blue whiting mackerel and horse mackerel. The main demersal species taken are haddock, pollock, ling and monkfish. Other important species taken in VI include crab and *Nephrops*.

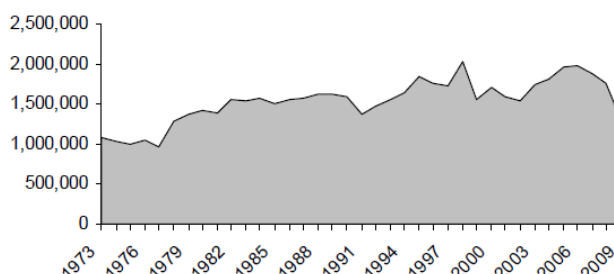
In Sub Area VII (South and West of Ireland including the Irish Sea), the main pelagic species taken are blue whiting, horse mackerel and herring. The main demersal species taken are whiting, hake, monkfish, skates and rays and squid. Other important species taken in VII include scallops, crabs, and *Nephrops*.

It is estimated that 1.3 million tonnes of fish, equivalent to 19.6% of the global total, are discarded in the North East Atlantic, while landings only account for 11% of the worldwide total. Discard rates in the waters west of Ireland and UK (Scotland) vary between 31% and 90%, compared to the global average of 8%.

Official landings data have been reported to ICES for all species, areas, years and countries in the North-eastern Atlantic since 1973. The official data may vary somewhat from the best estimates used in ICES assessment working groups where more accurate data is sometimes provided by national scientists. Nevertheless the data can be use as a best estimate of landings of all species from each area. Total landings from the NWW area for 2009 were estimated to be about 1.3 million tonnes (ICES Catch Statistics from FAO FishStat Plus). No Spanish data available for 2009; average Spanish landings in NWW is 40-45,000 tonnes per year.



Total Wild Capture Fisheries in NWW



International wild capture fisheries landings in NWW as reported to ICES since 1973 by ICES Division (Landings in tonnes. All species combined).

Note: Landings for France are not available for 1999 and 2007.

(Source: FAO FishStat, <http://www.ices.dk/fish/CATCHSTATISTICS.asp>)

Total Landings of Wild Capture Fisheries in 2009 from ICES Sub Area VI

Main Pelagic Species

Country	Argentine	Blue whiting	Herring	Horse mackerel	Mackerel
Faeroe Islands	3,923	31,728	2,097	0	3,526
France	0	4,436	0	0	6
Germany	200	2,556	27	0	10,943
Iceland	0	48,691	0	0	0
Ireland	0	4,311	10,425	16,596	24,627
Lithuania	0	0	0	593	0
Netherlands	3,186	12,359	5,121	2,257	11,631
Norway	110	140,672	0	27	121
Russia	36	35,607	0	0	0
UK	6	3,311	11,840	0	88,179
Grand Total	7,461	283,671	29,510	19,473	139,033

Main Demersal Species

Country	Cod	Hake	Haddock	Ling	Megrim	Monkfish	Pollack	Skates & Rays	Whiting
Faeroe Islands	3	0	10	279	0	6	60	4	0
France	74	1,964	140	581	168	1,301	2,106	95	1
Germany	0	0	0	6	0	0	298	0	0
Ireland	44	361	649	124	236	419	412	87	129
Netherlands	0	139	0	0	0	0	0	0	0
Norway	43	0	89	2,833	0	9	68	116	0
Russia	1	0	55	35	0	0	4	0	0
UK	166	2,068	5,331	1,368	1,118	0	3,516	277	366
Grand Total	331	4,532	6,274	5,226	1,522	1,735	6,464	579	498

Main Shellfish Species

Country	Blue mussel	Edible crab	European lobster	Nephrops	Scallop
Ireland	505	2,477	37	53	2
UK	11	6,585	349	12,688	5,800
Grand Total	516	9,062	386	12,741	5,802

(Source: FAO FishStat)

Total Landings of Wild Capture Fisheries in 2009 from ICES Sub Area VII

Main Pelagic Species

Country	Blue Whiting	Boarfish	Herring	Horse mackerel	Mackerel	Jack and Horse mackerel	Sardine
Belgium	0	0	0	0	0	1	0
Denmark	0	14,472	0	2,710	0	0	0
Faeroe Islands	4,135	0	0	3	0	0	0
France	2,453	0	3,081	956	6,678	131	14,738
Germany	2,468	0	4,442	0	5,352	14,236	0
Ireland	4,940	68,584	5,814	23,776	23,896	0	33
Isle of Man	0	0	2	0	10	0	0
Lithuania	0	0	0	3,098	111	0	0
Netherlands	23,235	0	8,225	45,991	8,507	0	3,402
Norway	64,690	0	0	0	0	0	0
Russia	7,890	0	0	0	0	0	0
UK	2,988	0	6,511	4	27,740	14,989	2,541
Grand Total	112,799	83,056	28,075	76,538	72,294	29,357	20,714

Main Demersal Species 1

Country	Argentine	Bib	Brill	Cod	Conger	Dab	Gurnard	Hake	Plaice	Haddock
Belgium	0	369	222	140	28	221	543	8	1,469	139
Faeroe Islands	0	0	0	0	0	0	0	0	0	0
France	13	4,597	350	3,837	2,009	877	3,866	4,954	2,191	5,429
Germany	0	0	0	0	0	0	0	0	0	0
Ireland	1	0	66	1,022	38	3	20	1,258	250	3,371
Netherlands	0	135	1	39	0	59	347	8	18	1
UK	0	821	240	807	306	152	820	1,654	1,617	1,164
Grand Total	14	5,922	879	5,845	2,381	1,312	5,596	7,882	5,545	10,104

Main Demersal Species 2

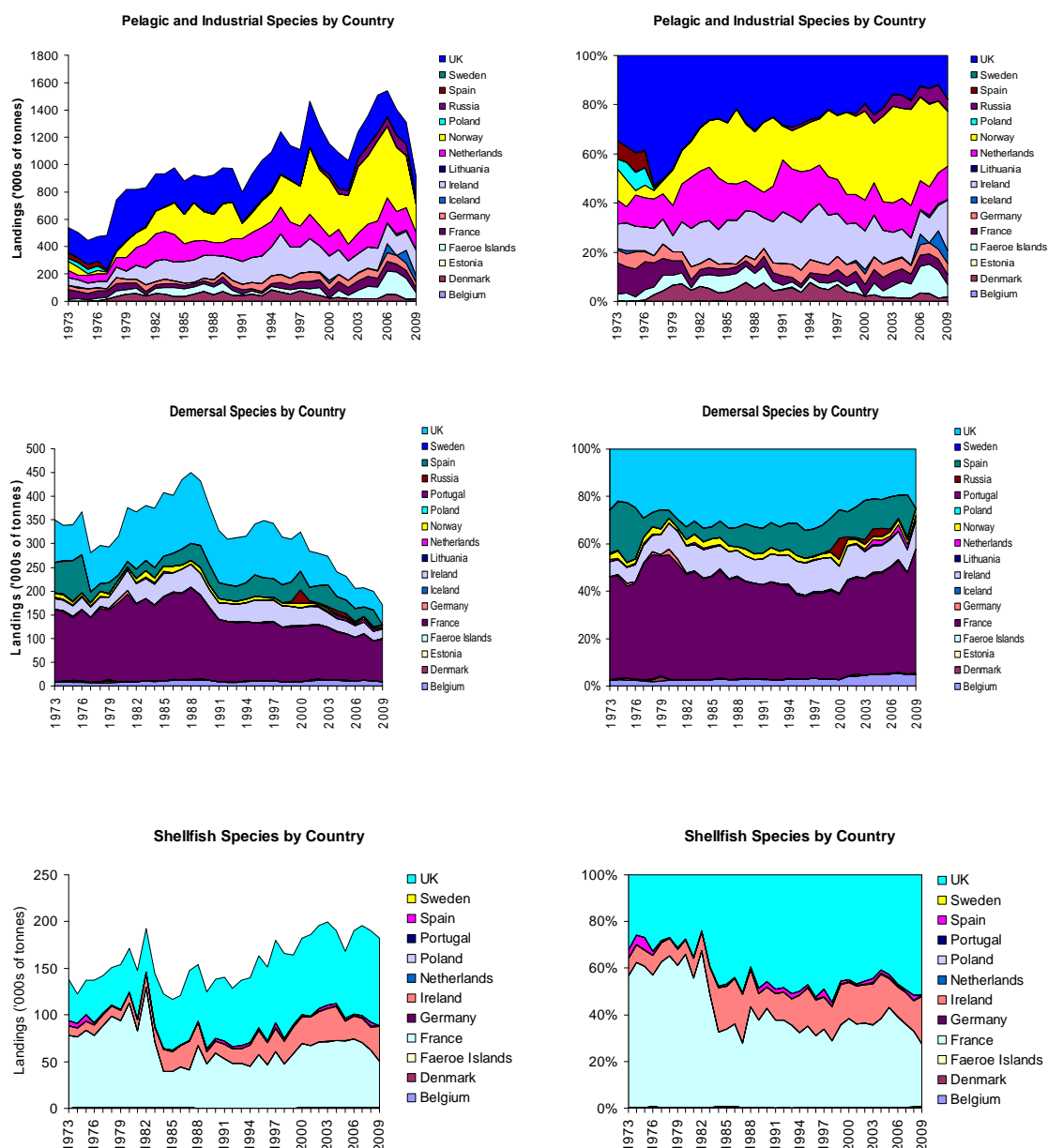
Country	John dory	Ling	Megrim	Monkfish	Pollack	Skates & Rays	Sole	Squid	Turbot	Whiting
Belgium	0	23	204	519	43	883	2,563	333	206	160
Faeroe Islands	0	0	0	0	1	0	0	0	0	0
France	1,202	892	2,020	9,576	1,841	3,973	4,296	8,101	461	9,038
Germany	0	6	0	181	0	2	0	0	0	0
Ireland	167	353	1,930	2,843	1,082	941	452	29	132	2,876
Netherlands	1	1	0	9	4	8	9	37	4	136
UK	264	467	2,350	4,543	1,657	1,182	2,712	2,813	263	988
Grand Total	1,634	1,742	6,504	17,671	4,628	6,989	10,032	11,313	1,066	13,198

Main Shellfish Species

Country	Blue mussel	Cockle	Crab	European lobster	Nephrops	Scallop	Spider crab	Whelk
Belgium	0	0	23	1	15	878	0	36
France	965	64	2,288	317	2,270	24,399	3,066	10,117
Ireland	14,018	63	1,851	359	7,102	2,633	429	2,026
Netherlands	0	0	0	0	0	700	0	0
UK	2,978	1,522	8,801	1,009	8,189	26,977	1,106	12,509
Grand Total	17,961	1,649	12,963	1,686	17,576	55,587	4,601	24,688

(Source: FAO FishStat)

Trends in International landings since 1973, both as total weight and percentage, by country are shown below. These data show several features: a general decline in the landings of demersal species; a general increase in the landings of shellfish species since the 1970s; and that the landings of small pelagics have fluctuated and generally declined since the mid 1990's. The landings of deep water species increased and subsequently decreased rapidly around the turn of this century, the landings of industrial species have increased rapidly in the last 10 years, and the landings of elasmobranch species have decreased rapidly in the last 5 years (see Sharks, Skates and Rays).



(Source: FAO FishStat)

**Landings by country from Sub Areas VI and VII
in 2009, by species category (weights in tonnes)**

Country	Small Pelagics & Industrial	Shellfish	Demersal	Deepwater	Sharks and Rays	Other
Belgium	1	1,320	7,029	32	1,407	214
Denmark	17,182	-	-	9	-	-
Faeroe Islands	41,489	121	801	4,351	7	1,216
France	35,550	59,714	73,958	13,840	14,167	21,400
Germany	40,636	186	704	127	2	-
Iceland	48,691	-	-	-	-	-
Ireland	187,275	36,927	18,717	2,122	1,478	2,005
Isle of Man	12	3,707	16	-	-	1
Lithuania	3,802	-	-	-	-	2,941
Netherlands	121,197	997	1,775	2,645	22	13
Norway	205,510	-	3,123	4,430	150	-
Portugal	-	-	-	-	50	1
Russian Federation	43,497	-	97	76	1	1
UK	162,224	91,014	39,750	6,081	3,447	869
Grand Total	907,066	193,986	145,970	33,713	20,731	28,661

(Source: FAO FishStat)

Discards

Discards are fish and other organisms that are caught accidentally in fishing gear and are thrown back, often dead or dying, to the sea. The FAO definition of discards includes both commercially exploited marine species and any other marine animal that is caught incidentally such as non-target finfish, crustaceans, molluscs, sea mammals and seabirds.

The FAO (2005) estimated that worldwide discards amounted to about 8% by weight, but this figure varies from area to area and fishery to fishery. In the north east Atlantic it is estimated that some 1.3 million tonnes of fish, equivalent to 19.6% of the global total, are discarded yearly, while landings in the same area only account for 11% of the worldwide total. Discards in the waters west of Ireland and Scotland vary between 31% and 90 % compared to the global average of 8%. Deepwater trawl fisheries off the west coast of Ireland (Rockall Trough, Hatton Bank) targeting roundnose grenadier, blue ling and orange roughy have high discards of shark and grenadier. Inshore bivalve dredge fisheries for scallop and razor recorded discard rates of 25 and 60 percent respectively. Total discards by the French fleet fishing in ICES Areas VII and VIII are estimated to be approximately 150,000 tonnes or 18.7% of the total estimated catch (FAO 2005). Beam and otter trawling in ICES Sub-area VII discarded 71% and 64% of their catch by numbers, respectively and 42% and 36% by weight (Enever *et al.*, 2007).

Recently the issue of discarding in the EU has attracted much media attention. Partially spurred by this, the EU Commissioner for Fisheries and Maritime Affairs,

Maria Damanaki, is considering a ban on discarding fish by European fleets. This could come into force with the revised Common Fisheries Policy in 2013.

“So far we have tried to tackle discards with technical measures. But let’s be honest, if we continue this it is like treating a serious illness with Aspirin. We have to recognize that our policy gives sometimes incentives to discarding. So, I am convinced that we have to start thinking outside the box. To effectively tackle discarding we need to look at new ways forward. Therefore, I am considering proposing a discard ban as part of the CFP reform proposals.”

Commissioner Damanaki, Brussels, 1st March 2011

Reasons for Discarding

There are various reasons for discarding but they can be broadly divided into three categories:

- 1) By-catch discards. Organisms caught incidentally while targeting other species. Could be wrong species, size or sex, poisonous or incompatible with other catch (because of slime or spines). Prevalent in mixed fisheries.
- 2) Quota/legislation discards. Discards to comply with TAC or quota allowances, minimum landing sizes or prohibitions on species, gears, seasons or area.
- 3) Economic discards. Fish returned to the sea for market reasons. Reasons may include: those damaged during the fishing process or ‘high-grading’, the release of lower value catch to keep storage space available for future high value catch.

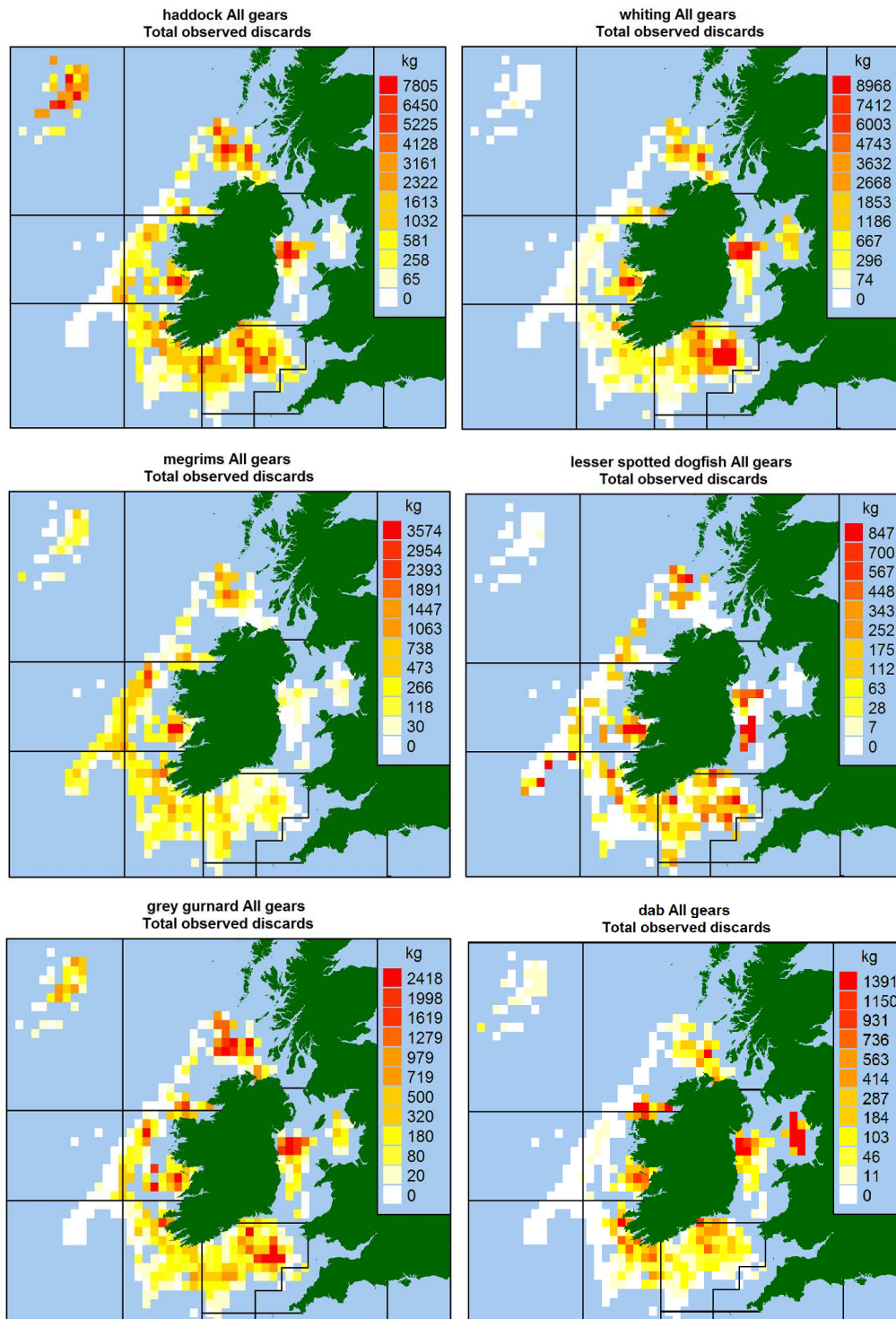
“Discards occur because fishing methods and gears are not perfectly selective or because there is pressure on fishermen to catch more of the target species than they can market. Avoiding catching these unwanted individuals at an acceptable cost (be it economic or social) is a major challenge.”

Source: FAO, 2005

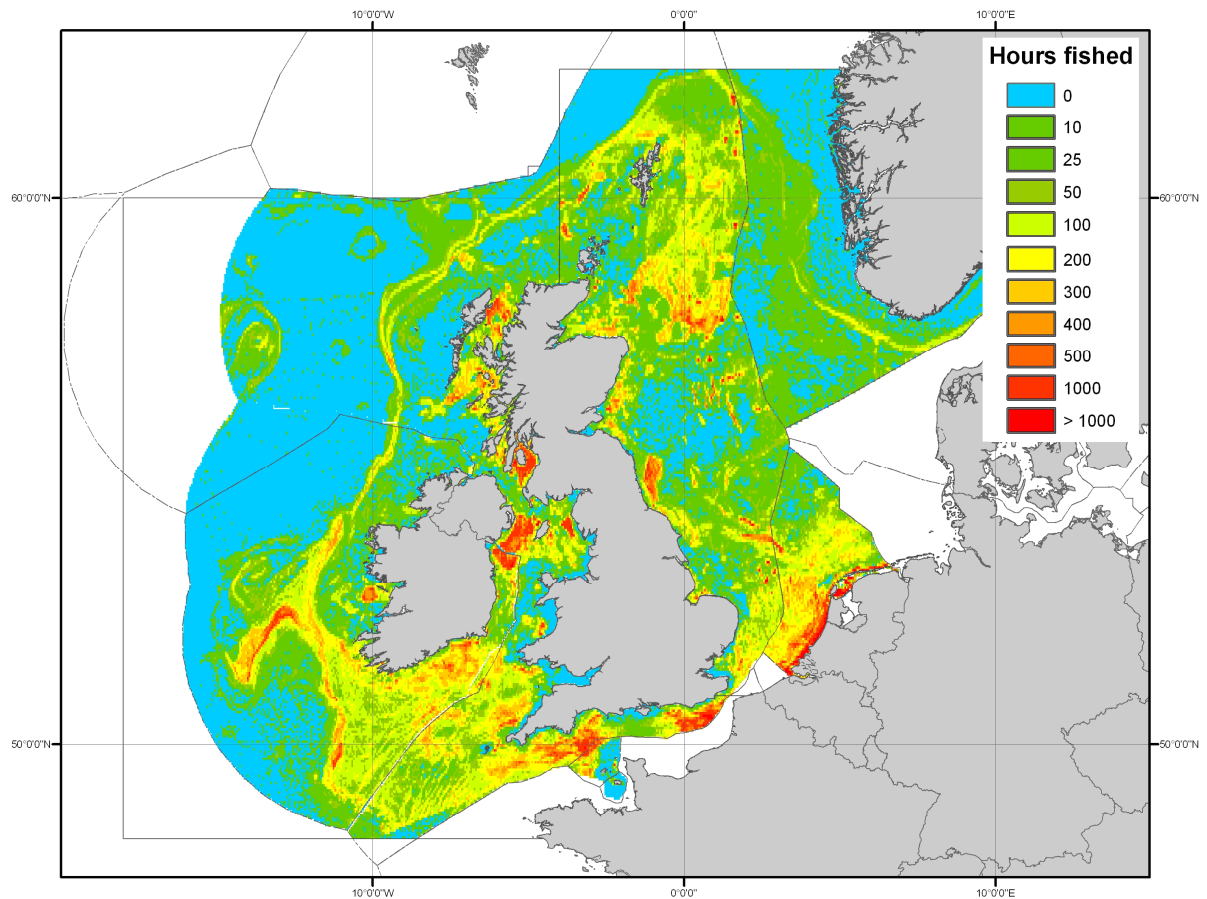
Discarding of perfectly usable fish is unethical and a waste of effort and resources, there is little disagreement in that regard. However, due to the complex reasons for discarding, there is concern that a blanket ban may not be the best method to affect the change. Requiring fishers to land their entire catch creates issues with storage space onboard and the marketability of the sub-prime fish. The recently released package on the reform of the CFP (COM (2011) 425 final) proposes an obligation to land all catches of commercial fish species with a phased introduction from 2014 to 2016.

Example: Discarding by the Irish Fleet in the Celtic Seas

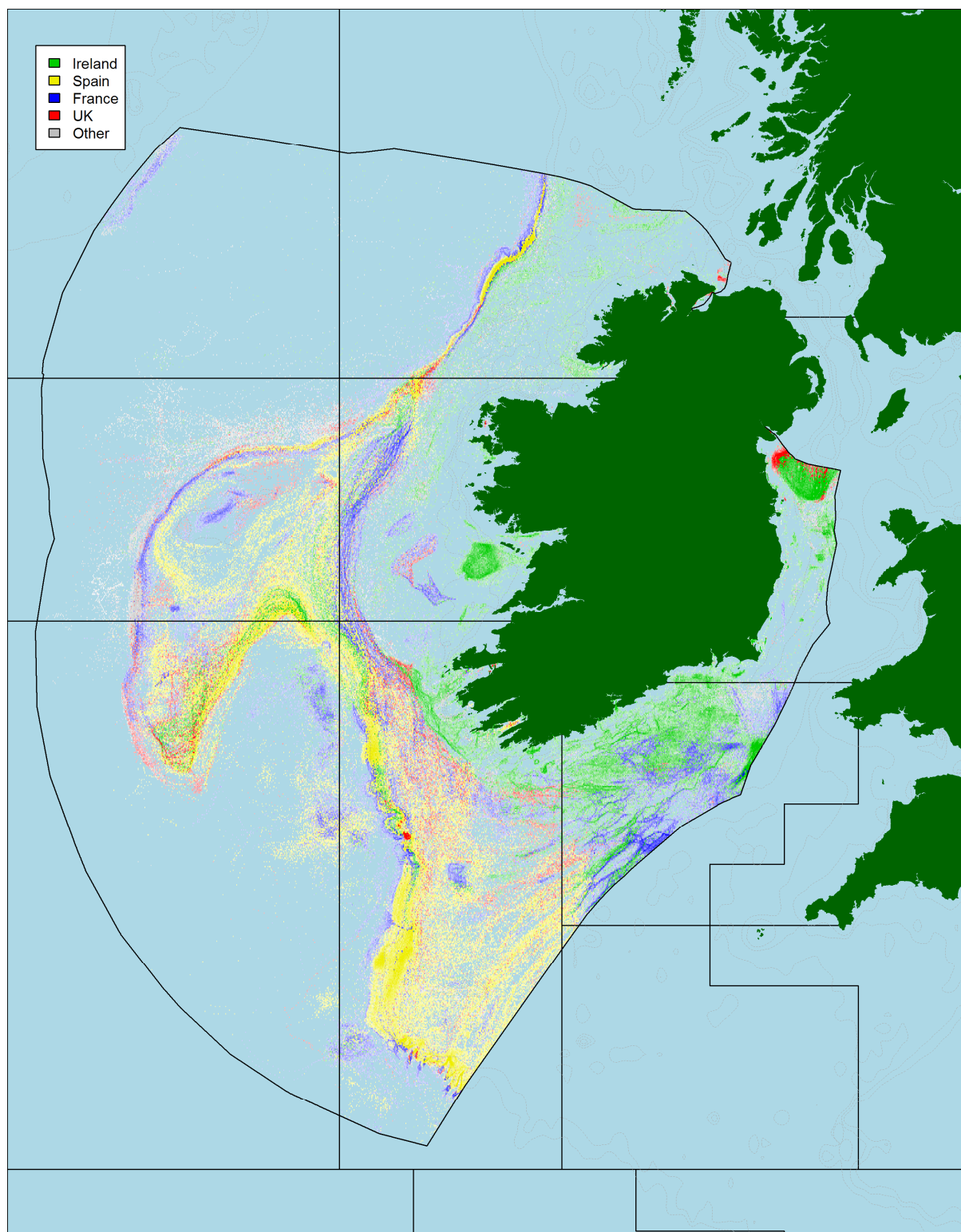
The following maps show discarding patterns of the Irish demersal fishing fleet in the Celtic Seas as observed by the Marine Institute's 'at sea' sampling programme (MI Demersal Discard Atlas, 2011, *in press*). Total observed discards from 1995-2009 are shown for the top three commercial (haddock, whiting and megrim) and non-commercial (lesser spotted dogfish, grey gurnard and dab) fish species that were caught from 2003-2009 (by weight discarded). The maps are intended to give an overview of the observed spatial discard pattern around the Irish coast and do not indicate the absolute values. Discarding in many Irish demersal fisheries is high, but is no different to other nationalities operating in the same area.



Fishing Activity in and around NWW



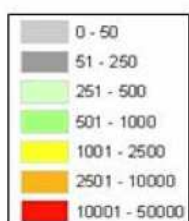
**Fishing intensity by mobile bottom gears in and around NWW in 2007 from VMS data.
No French Data (Source: MEFEPO, NWW WP 2 Report, 2010 www.liv.ac.uk/mefepo)**



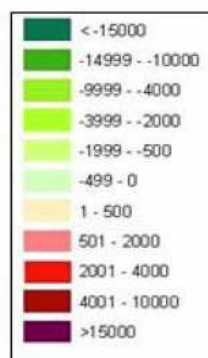
Fishing activity inside the Irish EEZ by country in 2008, derived from VMS data.

Keys

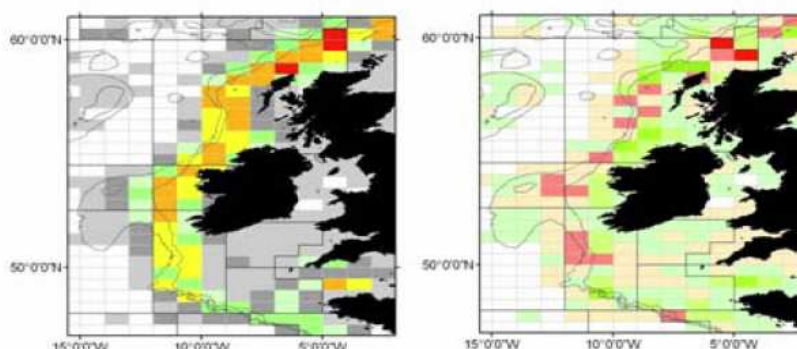
Mean Catch 1998-2006



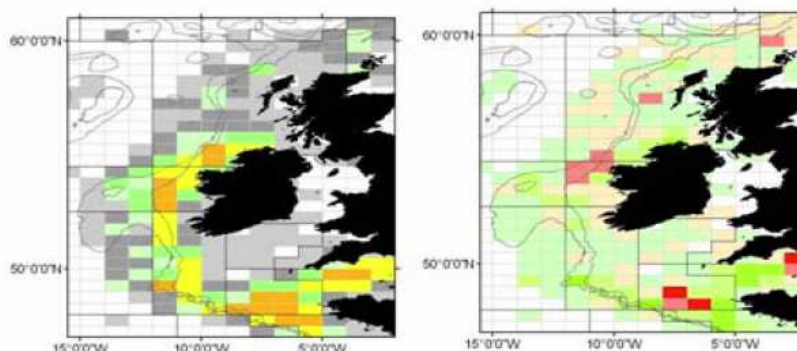
Change in Catch 2003-2006 minus 1998-2002



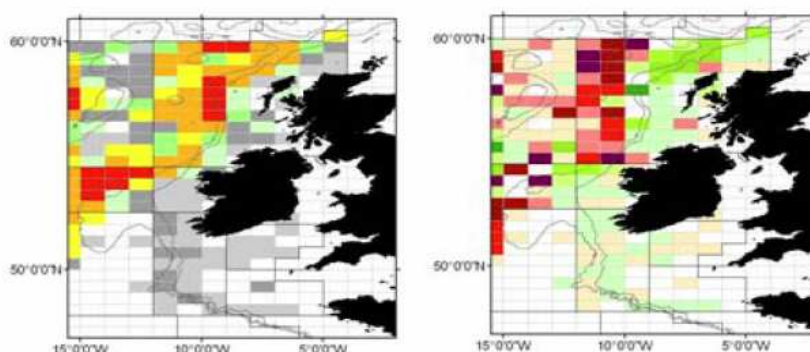
Mackerel



Horse mackerel



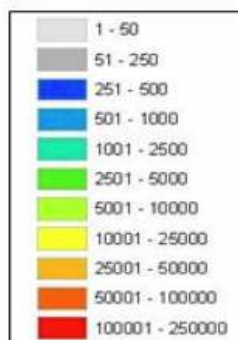
Blue whiting



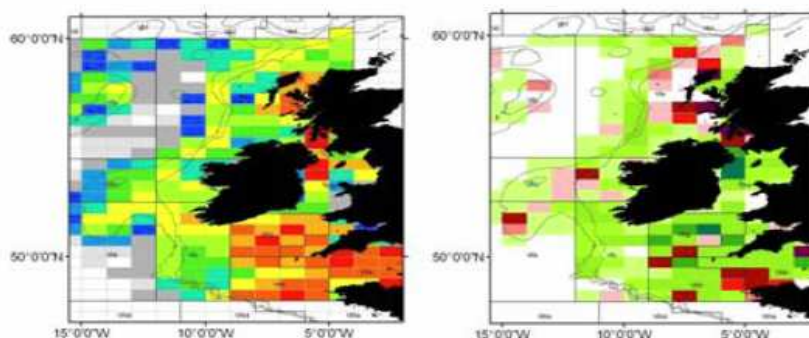
Commercial catches of the major pelagic species (mackerel, horse mackerel and blue whiting) by ICES rectangle for the NWW area. The left column represents catches from 1998 to 2006 and the right column represents recent changes in catch (2003-2006 minus 1998-2002) (Source: ICES Advice, 2008)

Mean Effort (KW days) 2003-2006 **Change in Effort (KW days) 2005-2006 minus 2003-2004**

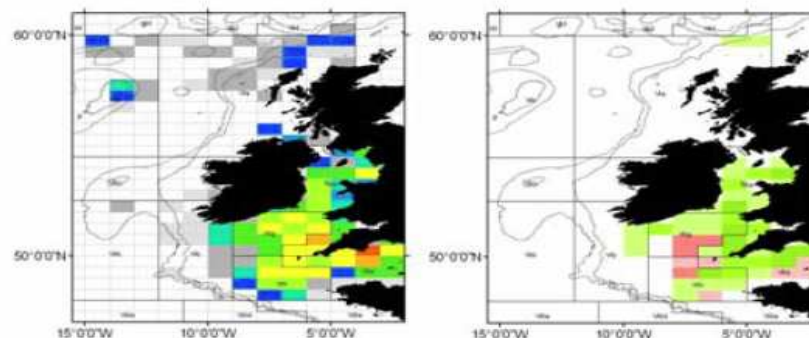
Keys



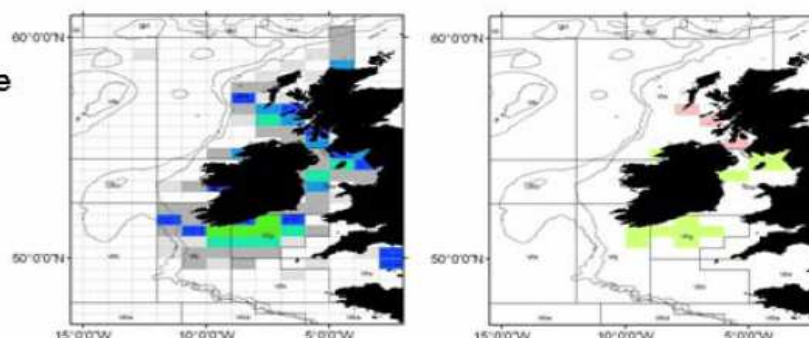
Otter trawl



Beam trawl



Demersal Seine



Demersal effort (KW days) by three main gear types (otter trawl, beam trawl and demersal seine) by ICES rectangle for NWW. Left column represents mean effort 2003-2006 and right column represents change in effort (2005-2006 effort minus 2003-2004 effort). No Spanish effort data were supplied to ICES
(Source: ICES Advice, 2008)

Inshore Fisheries in NWW

Inshore fisheries in Ireland, UK and France are dominated by vessels specialising in the crab, lobster, shrimp, *Nephrops* (Scotland mainly) and whelk fisheries. Availability of whitefish to the under 12m fleet is higher in the UK and France than it is in Ireland. France has highly productive and valuable inshore scallop grounds in Normandy which employs hundreds of vessels seasonally. Scallop are important also west of Scotland and in the Channel. In Ireland 90% of scallop are landed from the eastern Celtic Sea. UK has important cockle fisheries.

Crustacean stocks are generally thought to be stable although economic viability is declining and effort is increasing.

Effort increase is mainly due to increase in effort per vessel rather than the number of vessels.

Bivalve stocks are more variable in abundance than finfish stocks and their management is more complex. Management of bivalves varies by species and includes effort and TAC regulation, minimum sizes and closed seasons. Successful management regimes operate on cockle and scallop in UK, France and Ireland in situations where entry to the fishery can be limited by licensing.

Diversity of fishing opportunity, which is an important aspect of the viability of inshore fisheries, is declining. This is leading to a higher degree of specialization and an increased risk of over-investment and economic failure.

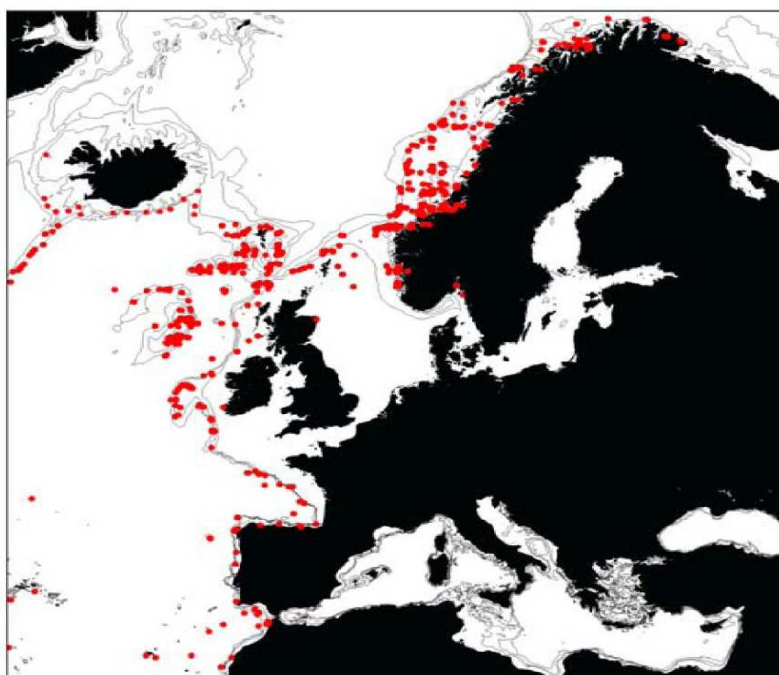
Transfer of capacity from the whitefish fleet to the inshore fleet is an issue throughout the NWW region. Furthermore, the main inshore species compete for the same markets in Europe.



Deep Water Fisheries in NWW

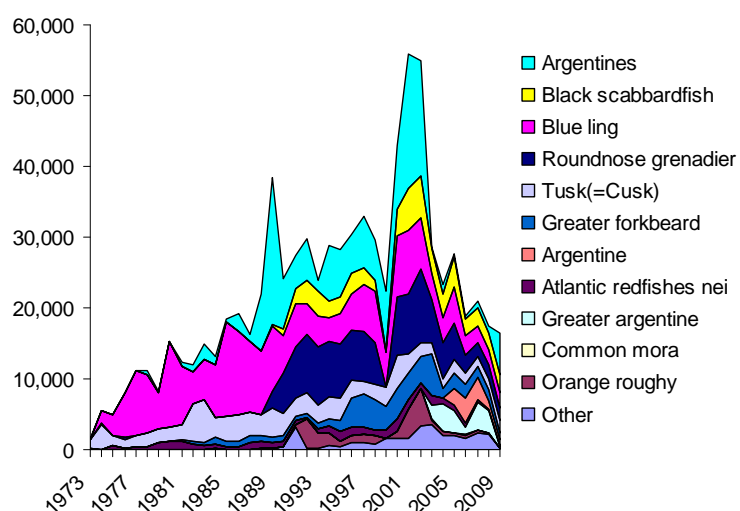
NWW have been subjected to deep water fishing activity along the continental slope to depths of 1,500 m. Modern fishing fleets have caused significant reduction in demersal deepwater fish biomass, resulting in the collapse of several deep water fisheries (e.g. orange roughy). In addition to catching target species, deepwater fisheries take unwanted species that are either too small or currently unmarketable and discarding rates are often high (in the order of 50%).

Deepwater trawling can damage deep sea benthic communities, impacting particularly on structurally complex habitats such as deep water coral reefs (*Lophelia* reefs). Deep-water set nets can also have a negative impact, both on the fish community due to ghost fishing and targeting vulnerable species such as sharks. Long-line fishing can also have negative effects on the ecosystem through breaking off branches of coral, overturning large sponges and may also have by-catch of seabirds. The degree of perturbation and damage caused by deepwater fisheries depends on their spatial extend and the frequency of their activities.



Distribution of known deepwater coral reefs in the North East Atlantic.
(Source: WGRES, 2007)

Landings (in tones) of deepwater species in NWW.
(Source: FAO FishStat)





NWW CASE STUDIES

Mackerel is mainly exploited in a directed fishery for human consumption. Mackerel catches in NWW 2009 were 211,327 tonnes. The changing mackerel distribution has led to a breakdown in the previously agreed international quota allocations arrangements and there was no internationally agreed TAC for this stock for 2011.

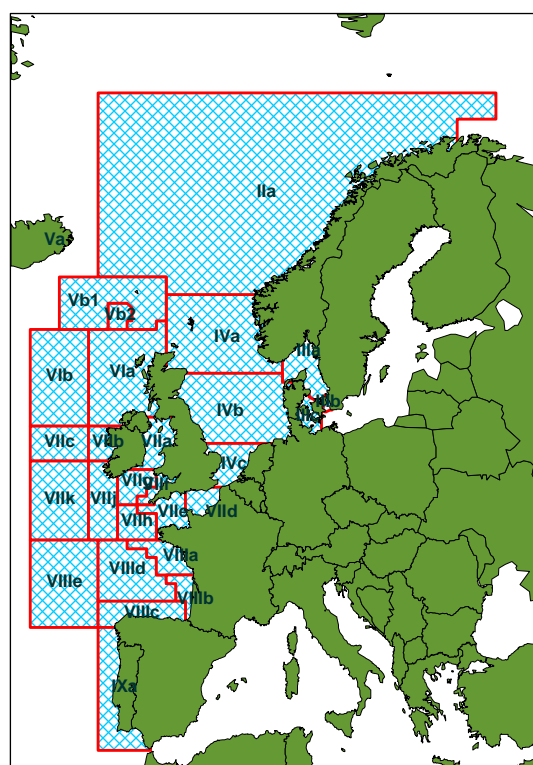
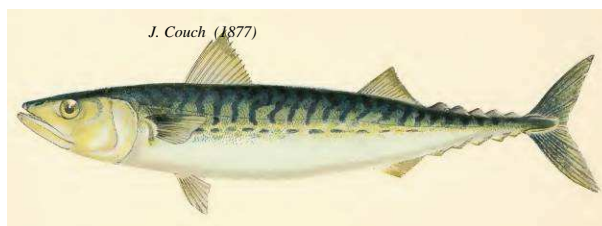
Nephrops are limited to a muddy habitat and the distribution of suitable sediment defines the species distribution. Most stocks in the NWW area appear to be relatively stable in terms of abundance and size composition, apart from the Pocupine Bank functional unit. In 2009, 12,741 tonnes were landed from VI and 17,576 tonnes from VII.

Hake is widely distributed over the northeast Atlantic shelf, from Norway to Mauritania, with a larger density from the west of Ireland to the south of Spain. This species has been a very important resource for many demersal fisheries of the NWW region. It is landed as targeted or incidental catch by a wide variety of gears (bottom trawls, nets, and long-lines). In 2009, 12,400 tonnes of hake were landed from NWW.

The scallop is an important commercially exploited species of bi-valve in northern Europe, extending from Norway south to Spain. It attains a large body size, is a high value species and is also the subject of extensive and intensive aquaculture in northern Europe. In 2009, 51,900 tonnes of scallop were landed from NWW, the vast majority from VII.

Case Study I: North East Atlantic Mackerel

The mackerel fishery is one of the largest (by weight of landings) and most profitable fisheries in the Northeast Atlantic. ICES currently uses the term “Northeast Atlantic Mackerel” to define the mackerel present in the area extending from ICES Division IXa in the south to Division IIa in the north, including mackerel in the North Sea and Division IIIa. Mackerel is mainly exploited in a directed fishery for human consumption using purse seines and mid-water trawls; however an industrial fishery started to develop and has increased since 2007. Overall mackerel catches in 2009 were estimated to be about 627,000 tonnes which was above the agreed Total Allowable Catch (TAC) of 569,000 tonnes with discards estimated to be 13,000 tonnes. Landings in NWW in 2009 amounted to 211,327 tonnes. The fisheries target shoals of mackerel with echo-sounding equipment, so they are generally clean and efficient and result in low by-catch. However, shoals may consist of mixed species (most notable of herring and horse mackerel), which could result in non-target species being discarded. In addition to discarding of non-target species, low value small or poor quality mackerel can also be discarded or ‘slipped’ (released from the nets before being brought on deck). High-grading, discarding and slipping of mackerel has been partially driven by the increasing price of large mackerel in Asian markets. Since January 2010 high-grading, discarding, and slipping from pelagic fisheries targeting mackerel, horse mackerel, and herring has been banned.



Red Boxes-TAC/Management Areas
Blue Shading- Assessment Area

Total Allowable Catch

TAC of 646,000 tonnes set for 2011 for sub-areas VI, VII, VIIla, VIIlb, VIIld and VIIle; EU and international waters of Vb; international waters of IIa, XII and XIV between Norway and EU. No internationally agreed TAC for 2011 as Iceland and Faroes set unilateral TACs for themselves.

Minimum Landing Size (MLS)

The minimum legal size for fish caught is set at 20cm in all sub-areas except IV (North Sea), which is 30cm.

Mesh Size and Catch Composition

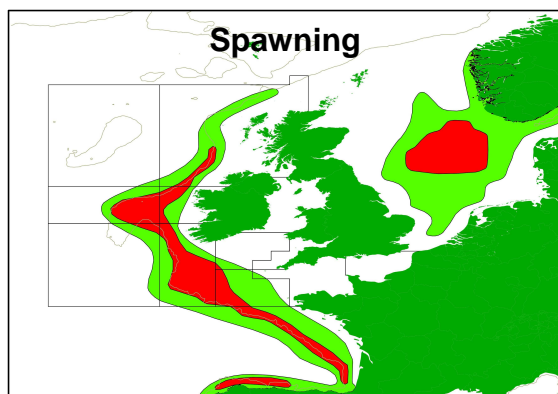
Pelagic Gear: Mesh Size 32-54mm and catch must consist of 90% of two or more of the target species (Mackerel, Herring, Scad, Boarfish).

Closed Areas

No directed fishing for mackerel except with gillnets or handlines in sub-area VIIe and parts of VIIe and g.

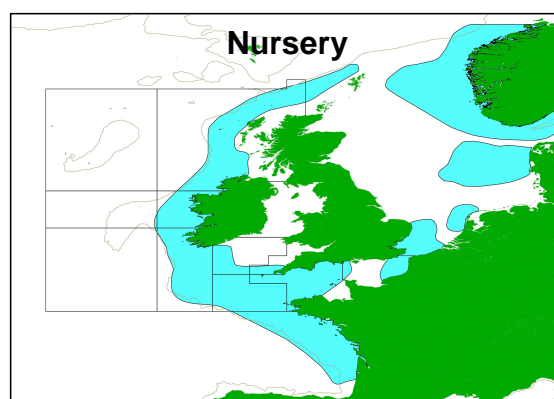
Ban on high grading, discards and slipping

Ban on high-grading, discarding, and slipping from pelagic fisheries targeting mackerel, horse mackerel, and herring beginning in January 2010.



The spawning areas of mackerel are widely spread, and only the stock in the North Sea is sufficiently distinct to be clearly identified as a separate spawning component. Tagging experiments have demonstrated that after spawning, fish from Southern and Western areas migrate to feed in the Norwegian Sea and the North Sea during the second half of the year.

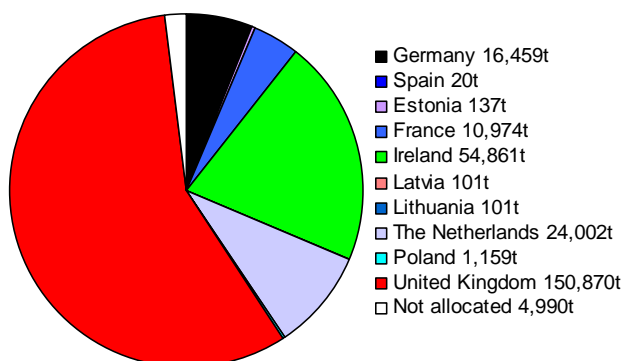
In the North Sea they mix with the North Sea component. Since it is currently impossible to allocate catches to the stocks previously considered by ICES, they are at present, for practical reasons, considered as one stock: the Northeast Atlantic mackerel stock. Catches cannot be allocated specifically to spawning area components on biological grounds, but by convention the catches from the Southern and Western components are separated according to the area in which they are taken.



In order to be able to keep track of the development of the spawning biomasses in the different spawning areas, the Northeast Atlantic mackerel stock is divided into three area components: the Western Spawning Component, the North Sea Spawning Component, and the Southern Spawning Component. The Western component currently accounts for 76% of the entire Northeast Atlantic stock.

Northeast Atlantic mackerel			
Distributed and fished in ICES Sub Areas and Divisions IIa, IIIa, IV, Vb, VI, VII, VIII, and IXa.			
Spawning component	Western	Southern	North Sea
Spawning Areas	VI, VII, VIIIa,b,d,e.	VIIIc, IXa.	IV, IIIa.

2011 EU TAC : 258,684 tonnes



Quota allocations for VI, VII, VIIIa, VIIIb, VIId and VIIE; EU and international waters of Vb; international waters of IIa, XII and XIV

State of the Stock

The widespread mackerel stock has previously been managed under international agreements between the EU, Norway, Russia and the Faroe Islands. Recently the distribution of the spawning and feeding areas have shifted westward away from the 'traditional' feeding grounds off Norway towards Iceland. Although the mackerel population has been expanding over the last 5 years, catches have been declining off Norway and new fishing opportunities have opened in Icelandic waters. The changing mackerel distribution has led to a breakdown in the previously agreed international quota allocations arrangements as Iceland and the Faroe Islands have allocated themselves unilaterally determined quotas. Catches since 2007 have been considerably in excess of the ICES advice, which was based on the management plan agreed October 2008 by EU, Norway and Faroes. This situation is expected to continue until effective international management agreements are re-established.

The absence of effective international agreements between all nations involved in the fishery is a cause of continued concern and prevents control of the exploitation rate. The total estimated catch in 2010 resulted in an estimated fishing mortality of 0.31, which is well above the long-term F_{MSY} target of 0.22, and transitional F_{pa} target of 0.23, stipulated in the management plan although the spawning stock biomass (SSB) remains above MSY SSB trigger level.

The SSB has increased from a low of 1.8 million t in 2002 to around 2.5 million t in 2008, a level similar to that seen in the 1990s. Available information indicates that the distribution of the spawning area and feeding areas of mackerel have expanded in recent years. Mackerel has been commercially fished in areas where it was previously not fished, particularly in the Icelandic EEZ. In 2008 and 2009, catches in this area constituted approximately 18% of the total catch. This illustrates the inter-annual dynamics of a fast moving species. The distribution pattern coincided with considerably warmer surface waters in 2009 than in earlier years in both the western part of the Norwegian Sea and in the northern part of the Icelandic zone. Together with temperature, feeding opportunities seem to affect the distribution of the mackerel stock.

State of By-catch Stocks

The statuses of the stocks of the most common by-catch in the mackerel fishery are varied. Herring to the North-west of Ireland (Divisions VIa South & VIIb,c) is depleted and needs to be rebuilt. But Blue Whiting spawning stock biomass was just above the precautionary limit in 2009, although the estimated fishing mortality was well above the precautionary limit.

ICES Advice 2010

**Total Allowable Catch, discards and catch for the western component of NEA mackerel.
(Source: ICES Advice, 2010)**

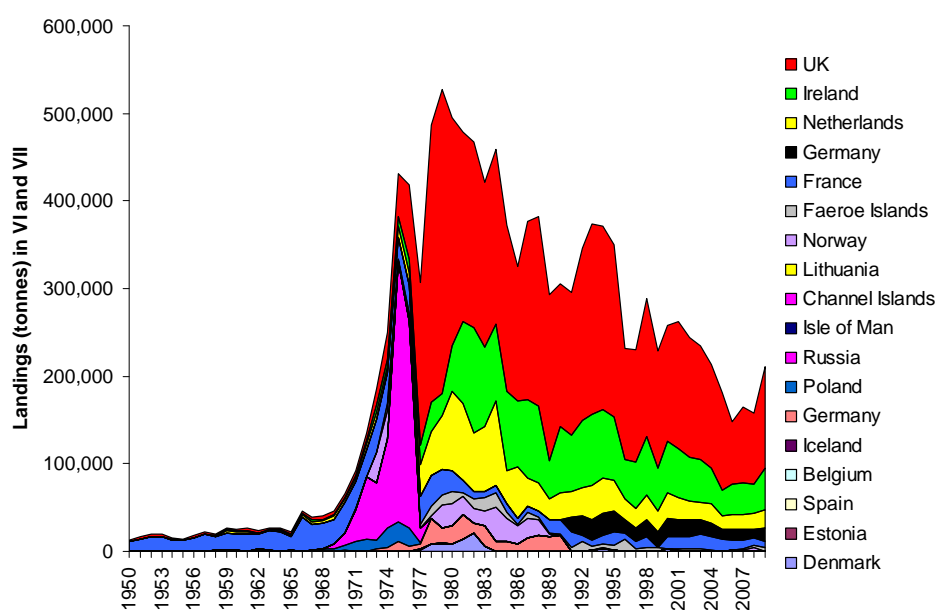
Year	Agreed TAC ¹	Discards & Slippage	ICES Catch ²
1987	405	11	633
1988	573	36	656
1989	495	7	571
1990	525	16	606
1991	575	31	647
1992	670	25	742
1993	730	18	805
1994	800	5	796
1995	608	8	728
1996	422	11	529
1997	416	19	529
1998	514	8	623
1999	520	0	597
2000	573	2	703
2001	630	1	694
2002	642	24	723
2003	548	9	644
2004	500	11	615
2005	397	20	494
2006	418	17	420
2007	472	8	519
2008	431	27	552
2009	569	13	627
2010	None ³		

Weights in '000t

¹TAC for mackerel taken in all Divisions and Subareas VI, VII, VIIIa,b,d, Vb, IIa, IIIa, and IVa.

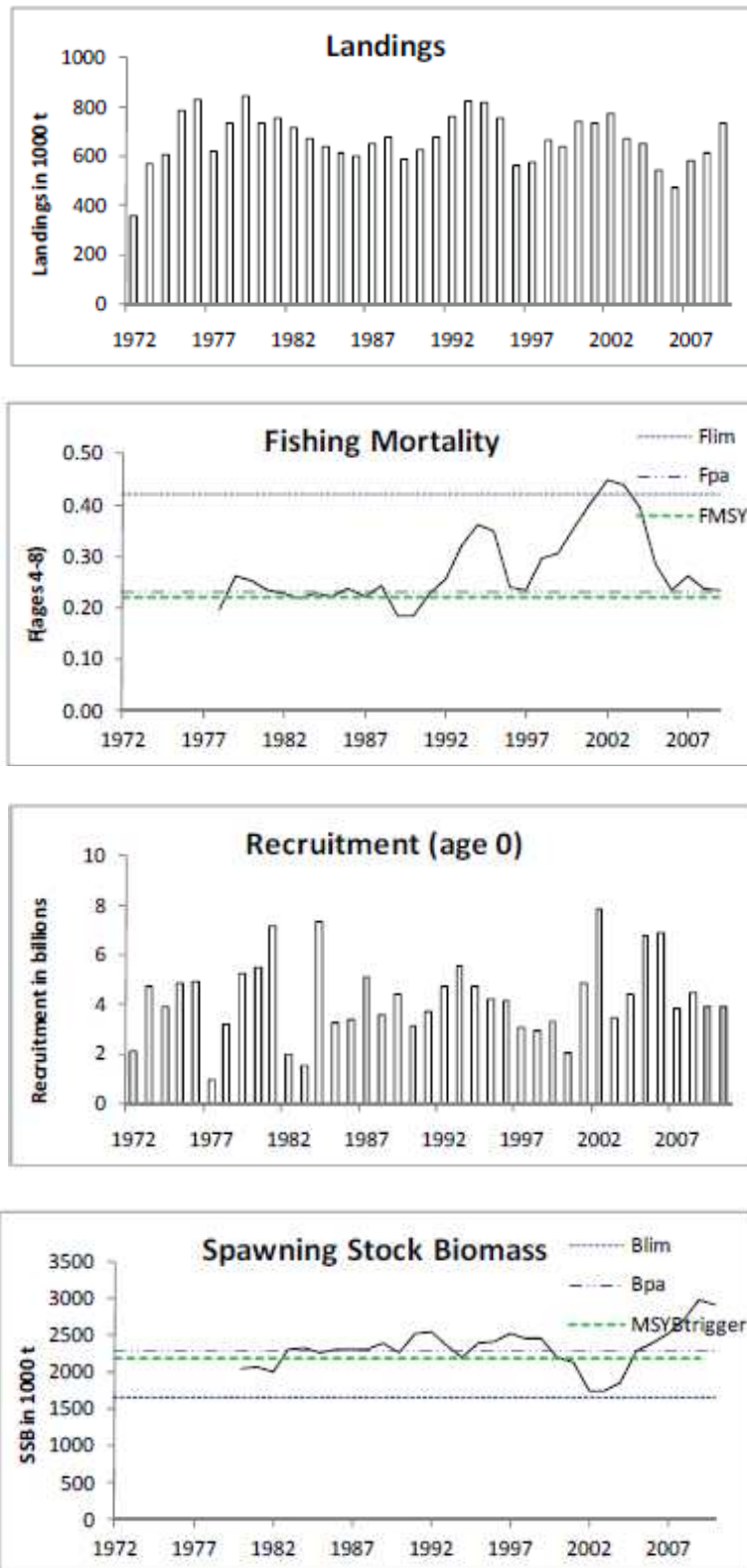
²Landings and discards of Western component; includes some catches of North Sea component.

³No internationally agreed TAC for 2010.



Landings (tonnes) of Mackerel in NWW (Source: FAO FishStat)

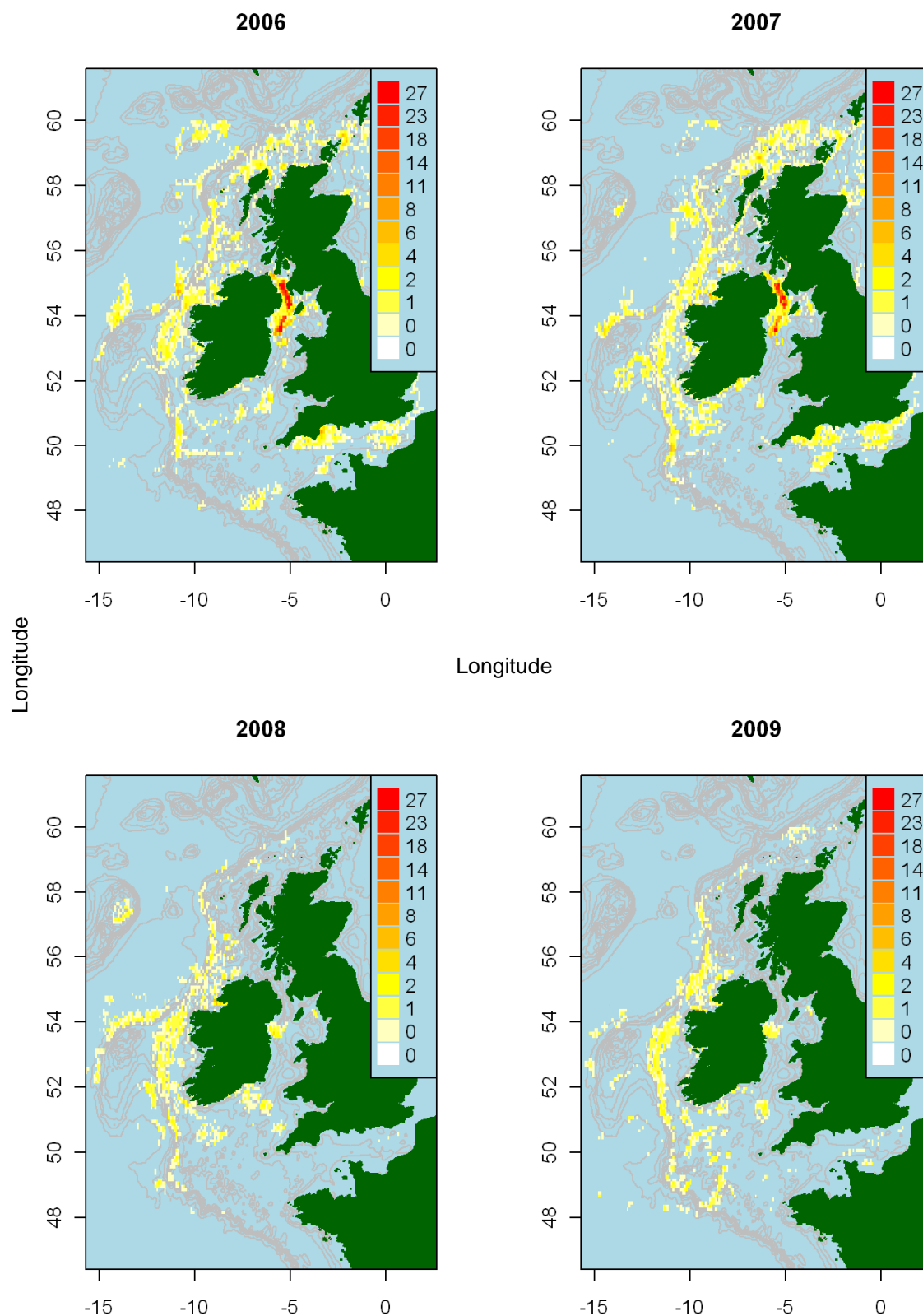
Mackerel



Northeast Atlantic mackerel (combined Southern, Western, and North Sea spawning components). Landings, fishing mortality, recruitment and SSB.

(Source: ICES Advice, 2010)

Effort Pelagic gears (hours/nm²)

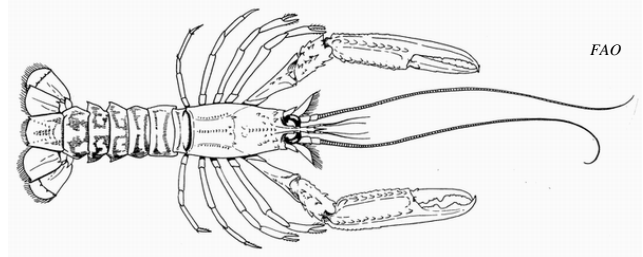


The above VMS maps for 2006 and 2007 are combined UK and Irish data. 2008 and 2009 show Irish data only. Other international data sets were not available. The maps clearly show the main pelagic fisheries in VI and VII along the shelf edge to the west of Ireland and Scotland. There are also pelagic fisheries in the Irish Sea, Celtic Sea, and the English Channel.

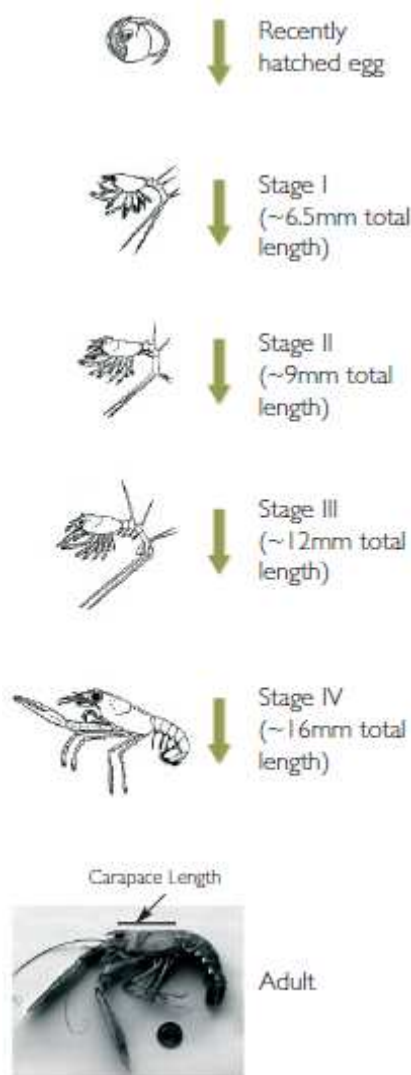
Case Study II: Dublin Bay Prawn (*Nephrops*)

Nephrops in Division VIa (West of Scotland)

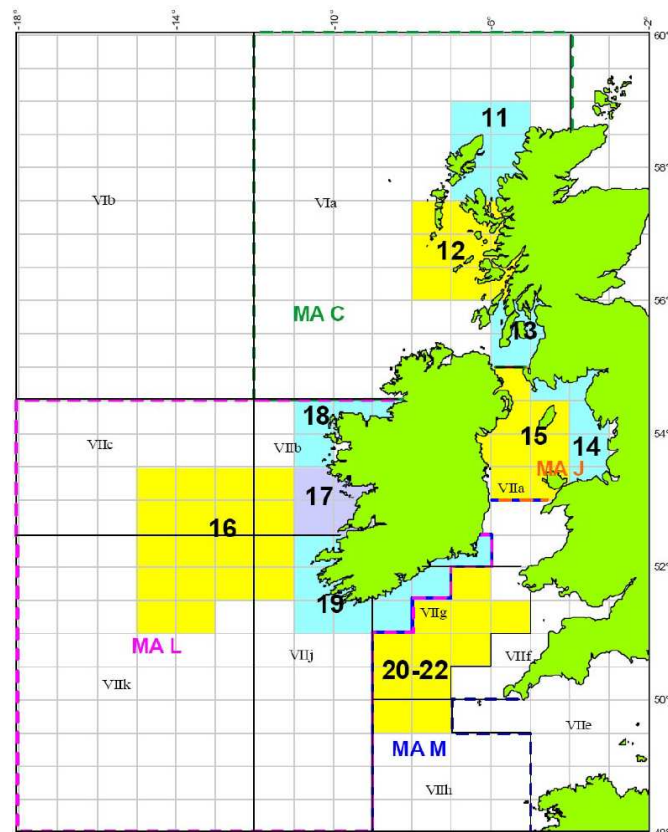
Nephrops are limited to a muddy habitat. This means that the distribution of suitable sediment defines the species distribution and the stocks are therefore assessed as three separate Functional Units. There are also some smaller catches from areas outside these Functional Units. There are three Functional Units in Division VIa: North Minch (FU 11), South Minch (FU 12), and Firth of Clyde (FU 13). In 2009, 12,741 tonnes of *Nephrops* were landed from VI.



Nephrops (above) and Functional Units (below).

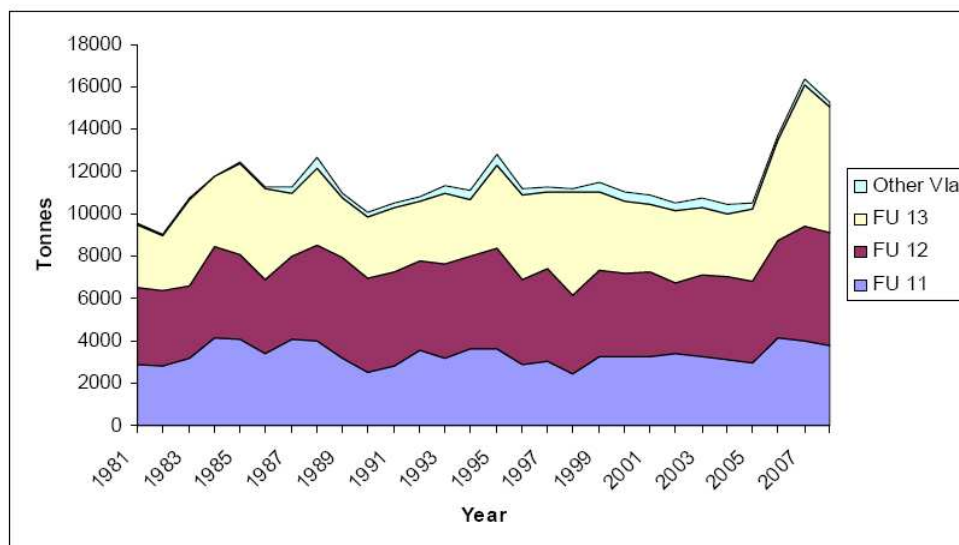


Nephrops lifecycle, modified from Cobb and Philips, 1980.



2011 Quota Allocations for Division VIa. TAC 13,681 tonnes.

Bycatches of cod are generally low in the Division VIa *Nephrops* fisheries. Inshore areas have been important for young cod in the past and any emerging year classes of cod should be protected from high mortality rates in *Nephrops* directed fisheries. A continuing problem is the capture of juvenile haddock and whiting, which are discarded at a high rate and whose populations are presently much reduced. This problem can be addressed with the use of more selective gear. Efforts are being made in Scotland through the Conservation Credits scheme, requiring vessels targeting *Nephrops* to use gear with larger square-meshed panels (110 mm). Subject to evaluation of the effectiveness of these measures, further action may be required to reduce bycatch.



Landings of *Nephrops* in Division VIa. from 1981-2008 by FU and Other rectangles.

***Nephrops* in VIa - State of the Stocks**

Underwater TV surveys of the *Nephrops* stocks in the Functional Units of Division VIa indicate a decline in abundance in 2007 following increases up to 2006 when the highest population abundances in the time-series were observed. The most marked decline was in the South Minch (FU 12), with a smaller decline in the North Minch (FU 11) and Clyde (FU 13). Trends in landings of different Functional Units are shown in Figure above. According to the latest ICES advice (2010), two out of the three FUs in VIa were fished above F_{MSY} in 2009. Length composition indicators have been stable over a long period of time. Overall the stocks are perceived to be stable.

Landings by some fleets prior to 2006 are thought to have been underreported. The implementation of the Buyers and Sellers legislation in the UK in 2006 and “sales notes” in Ireland in 2007, coupled with the increased TAC, is thought to have improved the reliability of reported landings data. Therefore the advice for this stock refers to average landings 2006-2008 only and does not use landings data prior to 2006.

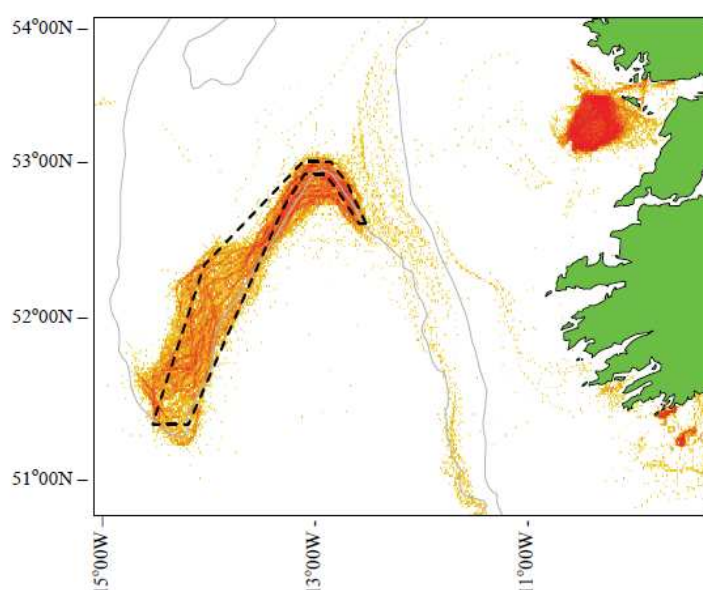
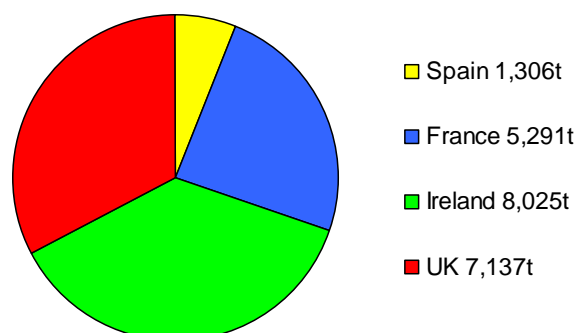
Nephrops in Sub Area VII

Nephrops in ICES Sub Area VII are assessed as six separate Functional Units (FU): FU 14 = Irish Sea East; FU 15 = Irish Sea West; FU 16 = Porcupine Bank; FU 17 = Aran Grounds; FU 19 = Ireland South West Coast; FU 20-22 = Celtic Sea. There are also some smaller catches from areas outside these Functional Units. In 2009, 17,576 tonnes of *Nephrops* were landed from VII.

Nephrops in VII - State of the stocks

Most stocks in this area appear to be stable in terms of abundance and size composition. The notable exception is the Porcupine Bank (FU 16) where effort in the fishery and mean size in the catches had increased in the past and where the LPUEs had declined. FUs 14 and 15 in the Irish Sea were fished above F_{MSY} in 2009 and ICES advise the harvest ratio be reduced. FU 16, the Porcupine Bank, had falling catch and abundance so catches should be reduced to lowest possible level. FU 18, Aran, was fished below F_{MSY} . For FUs 19-22, F_{MSY} is unknown but LPUEs were stable and the advice called for reduced landings.

2011 allocation of quota in ICES Area VII. TAC 21,759 tonnes, of which no more than 5.75% may be taken in VII (Porcupine Bank – Unit 16)



(Source: Marine Institute, 2010)

A closure of the Porcupine bank for fisheries between 1 May – 31 July was introduced in 2010 (EC Reg. 53/2010). This may be an appropriate management tool to substantially reduce catches and allow the stock to recover. The measure is expected to be quite effective at reducing fishing mortality provided that effort is not increase outside the time/area to compensate for the closure. The area on the Porcupine Bank closed seasonally to fishing in 2010 shown as a dotted black line overlaid on the distribution of recent (2006-2008) Irish fishing effort directed towards *Nephrops*.

Given the apparent stability of the stocks, current levels of exploitation and effort appear to be sustainable, ICES recommends not increasing effort and catches above the recent average values (2006–2007). The notable exception is the Porcupine Bank (FU 16) where ICES recommends a reduction in effort and catches.

Current management of *Nephrops* in Sub Area VII (both in terms of TAC and effort) allows for catches to be taken anywhere in the ICES Division and this



could imply inappropriate harvest rates from some parts. More importantly, vessels are free to move between grounds, allowing effort to develop on some grounds in a largely uncontrolled way. This appears to have been a particular problem in the Porcupine Bank where a large increase in effort has occurred over the past four years.

An overriding management consideration for these stocks is that management should be at a Functional Unit rather than the ICES Sub Area level. Management at the Functional Unit level could provide the controls to ensure that catch opportunities and effort are compatible and in line with the scale of the resources in each of the stocks defined by the Functional Units.

Discarding of small *Nephrops* is substantial. The trawls currently used to target *Nephrops* are not technically adapted to select marketable *Nephrops*. Discarding of other fish species, such as juvenile whiting, cod and hake, is also a problem in the *Nephrops* fishery. Catches of cod and whiting should be reduced to as low a level as possible because of the poor status of these stocks, particularly in the Irish Sea.

Cod has been identified as a predator of *Nephrops* in some areas, and the generally low level of the cod stock is likely to have resulted in reduced predation on *Nephrops*.

Effort (days at sea)

In west of Scotland and the Irish Sea (areas VIa and VIIa) maximum allowable fishing effort for bottom trawls with mesh sizes between 70 and 99mm in 2011 is 479,043 kW days in VIa and Vb, and 584,047 kW days in VII.

Minimum Landing Size

VII and VIb: 85mm Total length, 25mm Carapace length, 46mm Tail length.

VIa and VIIa: 70mm Total length, 20mm Carapace length, 37mm Tail length.

Mesh Size Restrictions (including catch composition)

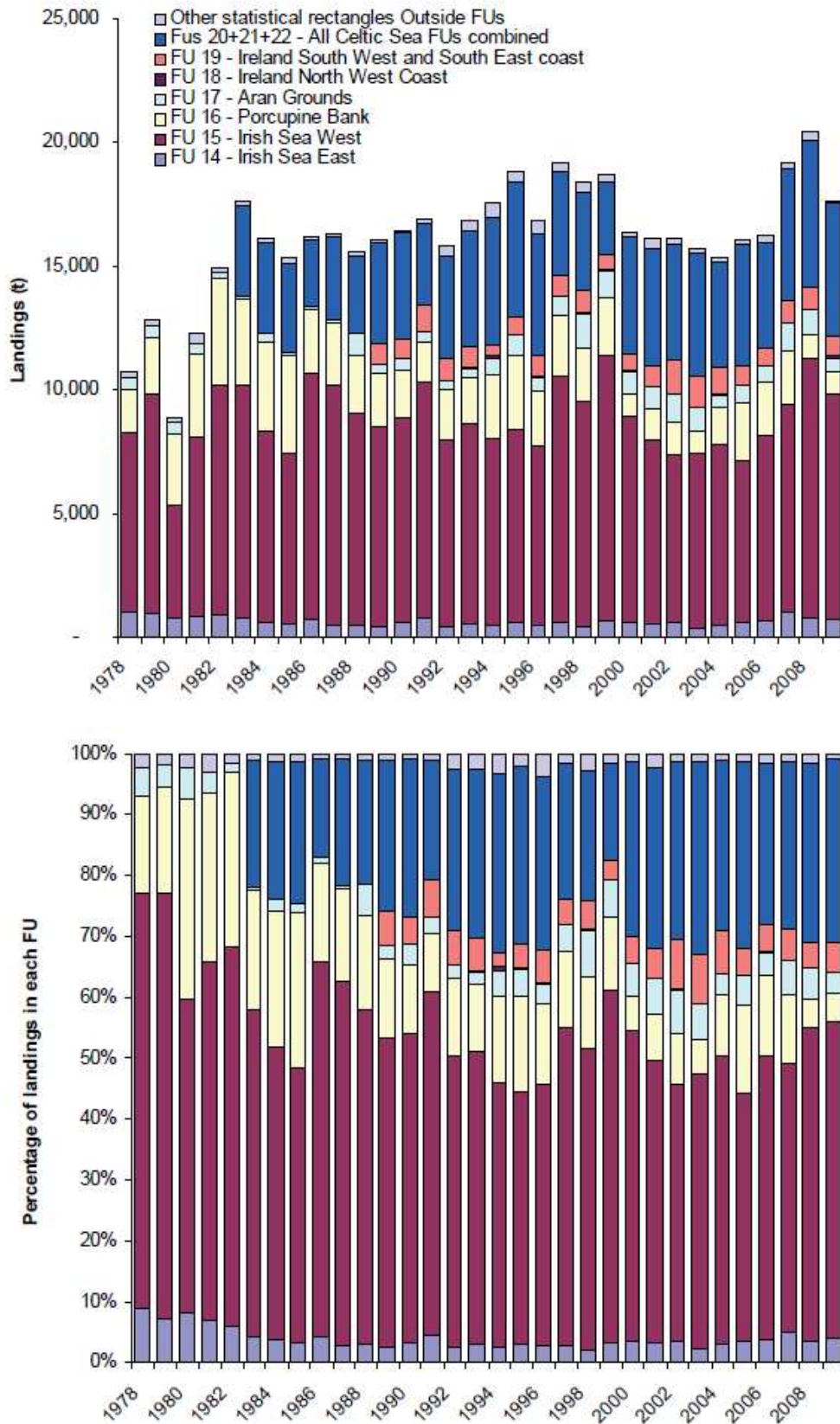
Area VII and VI outside restricted area in VIa: require 70 mm diamond mesh plus an 80 mm square mesh panel as a minimum.

Inside Cod LTMP area in VIa: In 2009 minimum mesh size went up from 70 mm to 80 mm.

Seasonal Closures

See previous page.

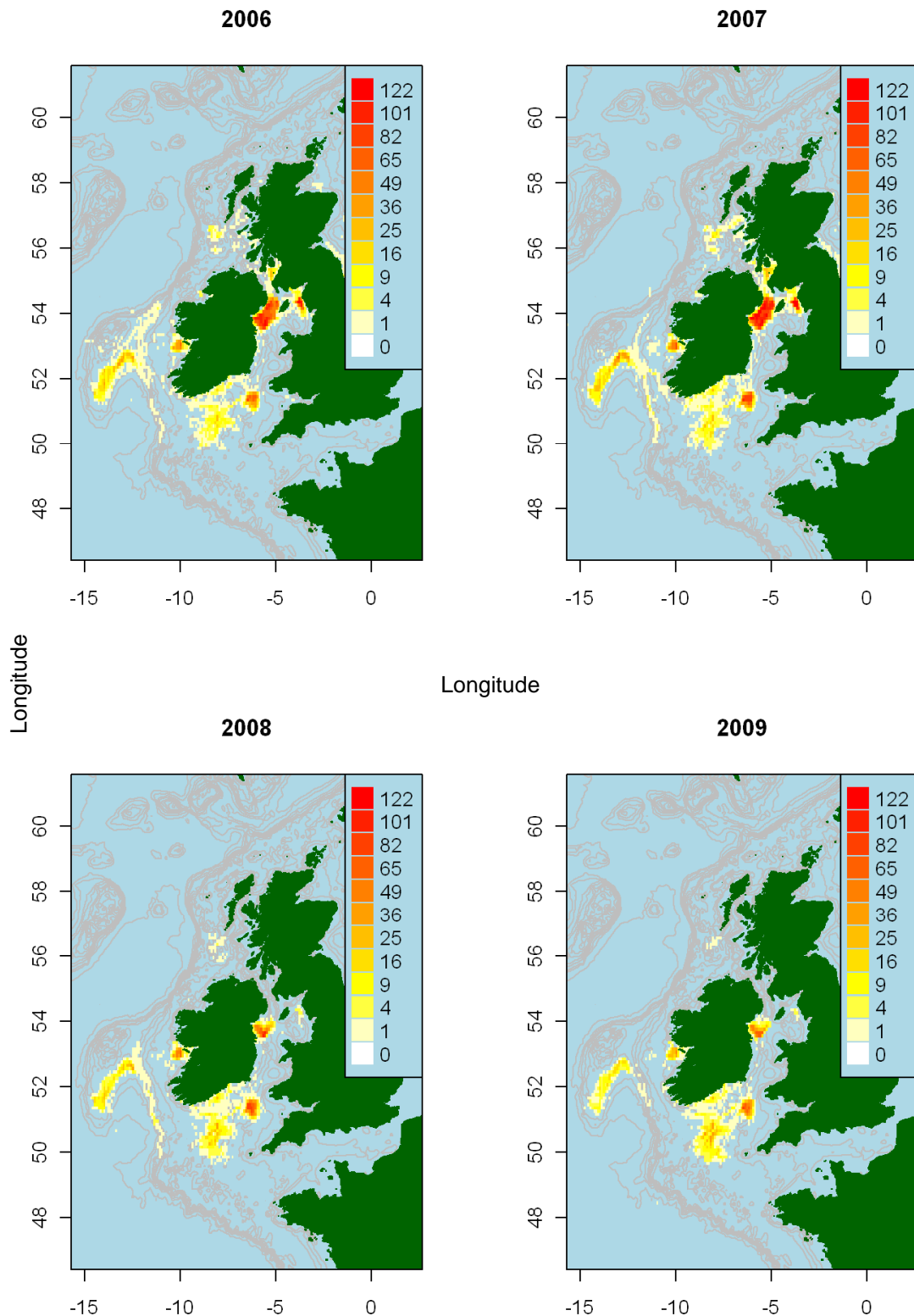
Nephrops in VII



Nephrops in Sub Area VII. Total landings and percentage of the total landings from Sub Area VII by Functional Unit (FU) and from rectangles outside FUs

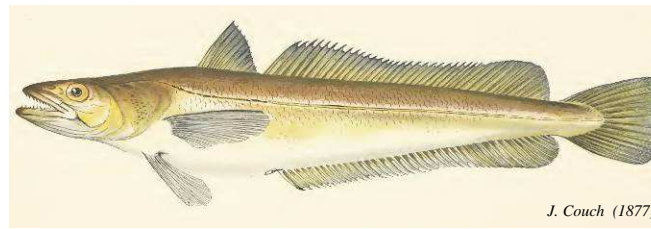
(Source: ICES Advice 2008)

Effort Bottom Otter Trawl *Nephrops* (hours/nm²)



The above VMS maps for 2006 and 2007 are combined UK and Irish data. 2008 and 2009 show Irish data only. Other international data sets were not available. The maps clearly show the main *Nephrops* fishing areas in VI (west of Scotland) and in VII (Irish Sea, Celtic Sea, Porcupine and Aran Grounds off the west of Ireland).

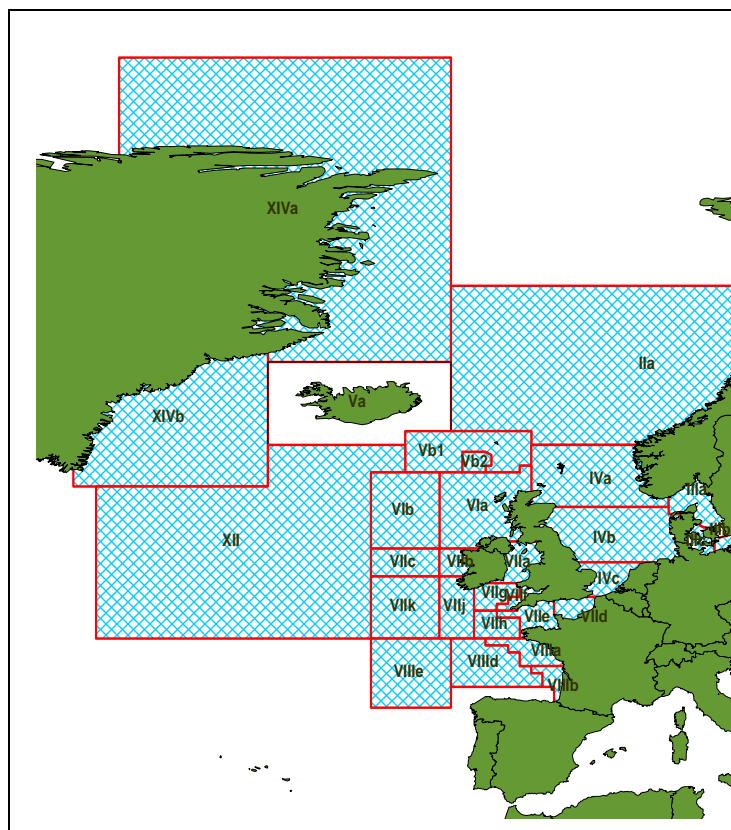
Case Study III: Northern Hake



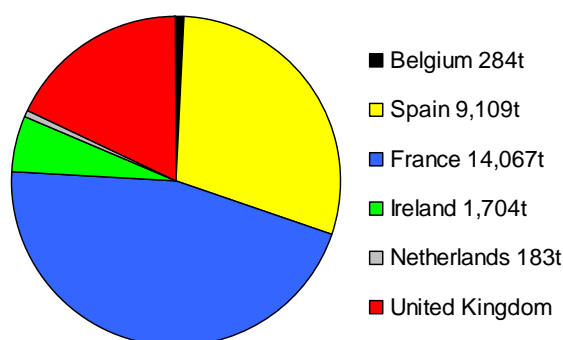
European hake is widely distributed over the northeast Atlantic shelf, from Norway to Mauritania, with a larger density from the west of Ireland to the south of Spain and in the Mediterranean and Black sea. This species has been a very important resource for many demersal fisheries of the NWW region. It is landed as targeted or incidental catch by a wide variety of gears (bottom trawls, nets, and long-lines). In 2009, 12,400 tonnes of hake were landed from NWW.

The hake fishery includes a diverse community of species including megrim, anglerfish, *Nephrops*, sole, seabass, ling, blue ling, greater forkbeard, tusk, whiting, blue whiting, *Trachurus spp*, conger, pout, cephalopods (octopus, *Loligidae*, *Ommastrephidae*, and cuttlefish), and rays. The relative importance of these species in the hake fishery varies between years depending on gears, sea areas, and biological conditions.

Management and assessment areas for Northern Hake Stock



Red Boxes-TAC/Management Areas
Blue Shading– Assessment Area



Northern Hake 2011 Quota Allocations for areas VI and VII; EU and international waters of Vb; international waters of XII and XIV. TAC 30,900.

State of the Stock

The 2008 ICES assessment indicated that the estimates of SSB and fishing mortality showed the stock at full reproductive capacity and as being harvested sustainably. SSB was estimated to be about at the desired level (B_{pa}) in 2008, and F had been around the desired level (F_{pa}) since 2001. However, for reasons outlined below, the 2010 ICES advice did not include reference limits for hake. It was noted however that there was a positive trend in SSB and that recruitment has been relatively stable over the last decade.

Management Plan

There are explicit management objectives for this stock in the EU recovery plan (EC Reg. No. 11/2004). The aim is to increase the SSB to above 140,000 tonnes. An agreed fishing mortality ($F < 0.25$) is constrained by a year-on-year change in TAC not to exceed 15%, unless the stock is below 100,000 tonnes. In this case a lower TAC will be applied. The northern hake stock met the SSB target in the recovery plan of 140,000 tonnes for three consecutive years, according to the results from the 2006, 2007 and 2008 assessments. Following this a long-term management plan was proposed in 2009 (COM 122/2009). This management plan is yet to come into operation.

New Stock Assessment for 2010

Tagging of hake gave evidence of substantial growth underestimation (de Pontual *et al.* 2006). A subsequent ICES workshop (WKA EK, ICES, 2010) confirmed that the previous internationally agreed ageing method is neither accurate nor precise and provides overestimation of age. A replacement ageing method with sufficient precision and accuracy was not available and consequently a new stock assessment was required. The new method uses a length-based approach which allows direct incorporation of the quarterly length composition data and explicit modelling of a retention process that partitions total catch into discarded and retained portions. Initial results show that this approach is more flexible than the previous method and yields more reliable management advice.

Recovery of the Hake Stock

In June 2001 an Emergency Plan was implemented for the northern hake stock (Council Regulations Nos. 1162/2001, 2602/2001 and 494/2002). Firstly, a 100 mm minimum mesh size was introduced for otter-trawlers when hake comprises more than 20% of the total amount of marine organisms retained onboard. This measure did not apply to vessels less than 12 m in length and which return to port within 24 hours of their most recent departure. Secondly, two areas have been defined, one in Sub Area VII (SW of Ireland) and the other in Sub Area VIII (Bay of Biscay), where a 100 mm minimum mesh size is required for all otter-trawlers, regardless of the amount of hake caught. The fishing mortality of juvenile hake (in the landings) is estimated to have decreased between 1997 and 2001 and has remained low since.

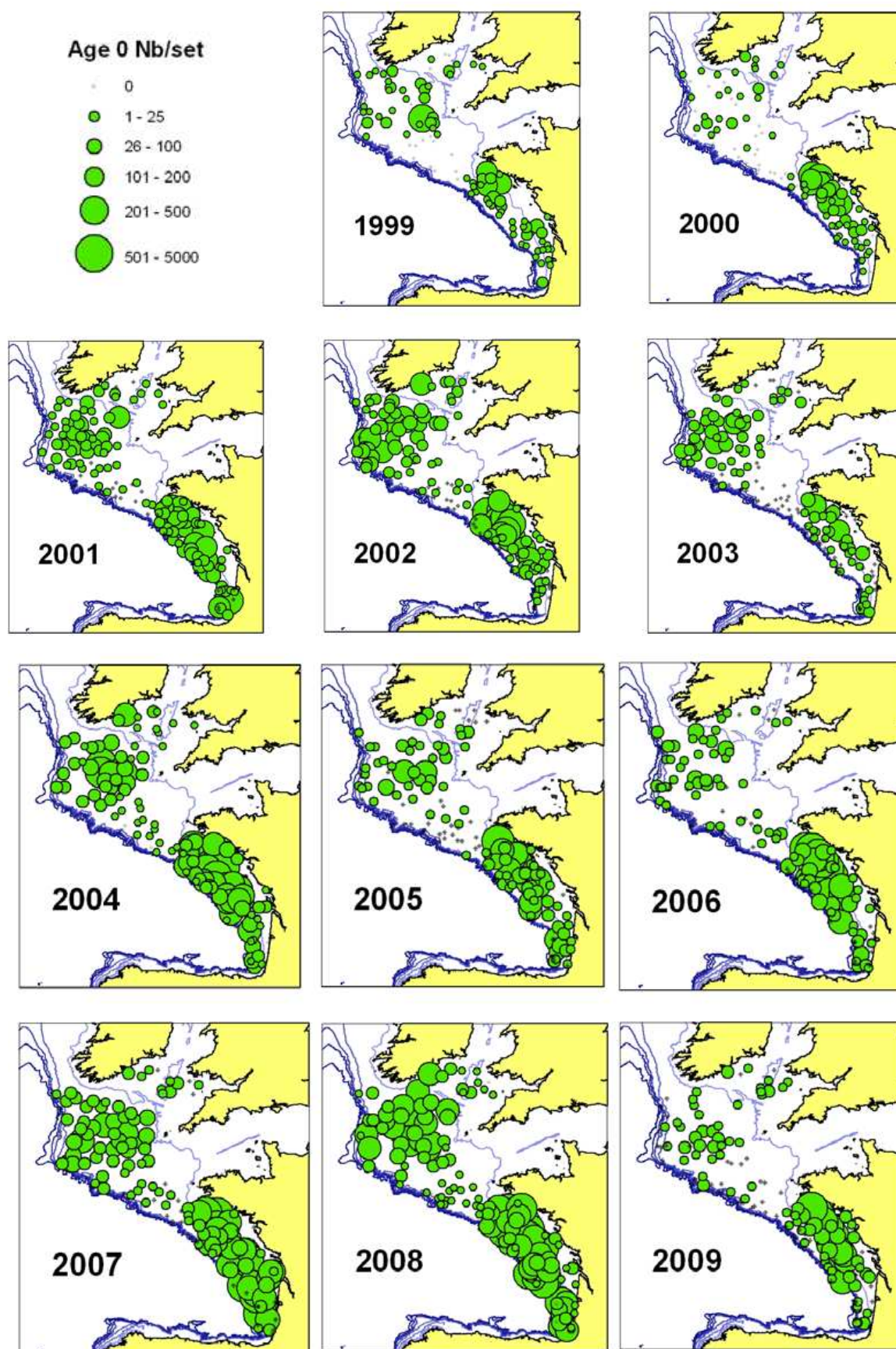
Council Regulation (EC) No. 1954/2003 established measures for the management of fishing effort in a 'biologically sensitive area' in Sub Areas VIIb, VIIj, VIIg, and VIIh. Effort exerted within the 'biologically sensitive area' by the vessels of each EU Member State may not exceed their average annual effort (calculated over the period 1998–2002). The hake recovery plan (EC Reg. No. 811/2004) came into operation in 2004 and replaced the emergency plan.

Since 2006 in Sub Area VIII, otter-trawlers using a squared mesh panel are allowed to use a 70 mm mesh size in the area defined in Council Regulations Nos. 1162/2001, 2602/2001, and 494/2002, while a 100 mm minimum mesh size is required for all otter-trawlers (EC Reg. No. 51/2006; EC Reg. No. 41/2007). Furthermore, a ban on gillnets was implemented in Sub Areas VIa,b and VIIb,c,j,k for fishing at depths of more than 200 m (EC Reg. No. 51/2006) during the first semester of 2006.

All of these regulations, which were expected to reduce fishing mortality and discarding, may have contributed to the recovery of the stock, although the extent of the effect of the measures cannot be precisely quantified.

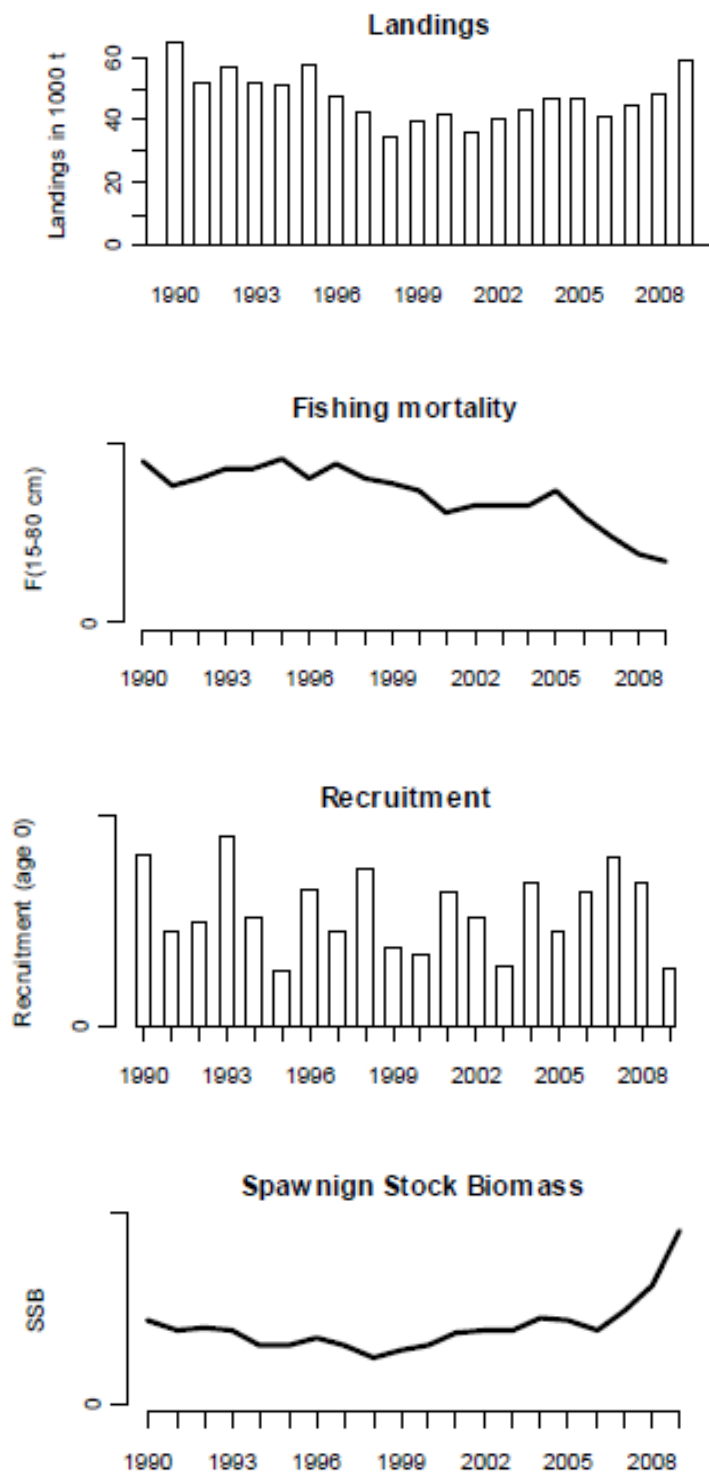
Discarding

Discards of juvenile hake can be substantial in some areas and fleets but discard data are not included in the assessments. The advice based on the assessment should be valid under the assumption that the discard mortality rates do not change substantially. The spawning biomass and the long-term yield can be substantially improved by reducing discard mortality of small fish. This could be achieved by technical measures that reduce unwanted bycatch and other measures that shift the selection pattern towards larger fish. Some improvement in discard data availability (number of fleets sampled and area coverage) has been observed. However, sampling does not cover all fleets contributing to hake catches, discard rates of several fleets are simply not known and when data are available, it has not yet been possible to incorporate them in a consistent way.



Northern Hake – Spatial Distribution of Age 0 indices from French ground fish survey.
(Source: ICES WGHMM 2010)

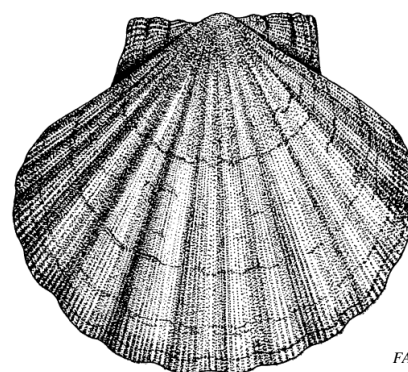
Northern Hake



Northern Hake -Landings, fishing mortality, recruitment, and SSB
(Source: ICES Advice 2010)

Case Study IV: Scallops

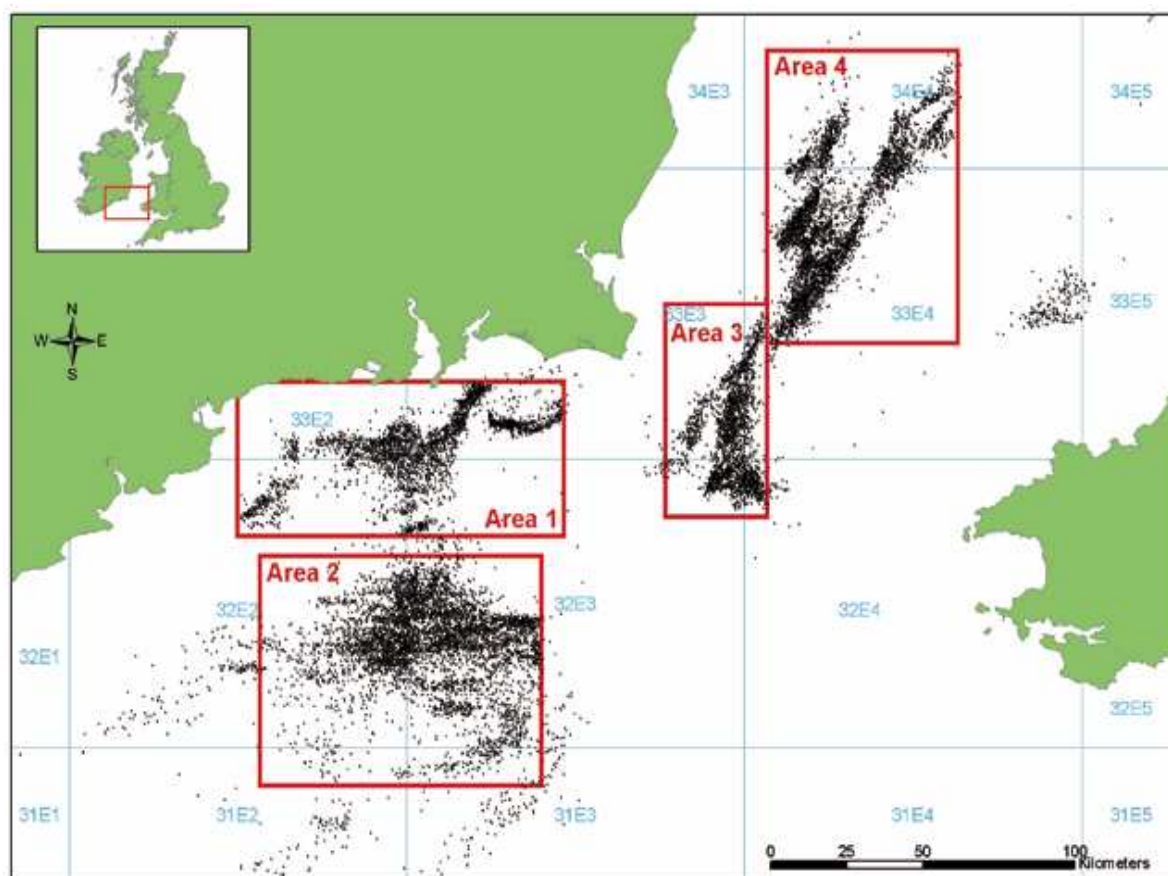
The scallop (*Pecten maximus*) is a commercially important species of bi-valve in northern Europe, which has a distribution extending from Norway to Spain. They are most abundant on gravel, sand/shell or stony substrates at depths of 15-75 meters. It attains a large body size, is a high value species and is also the subject of extensive and intensive aquaculture in northern Europe.



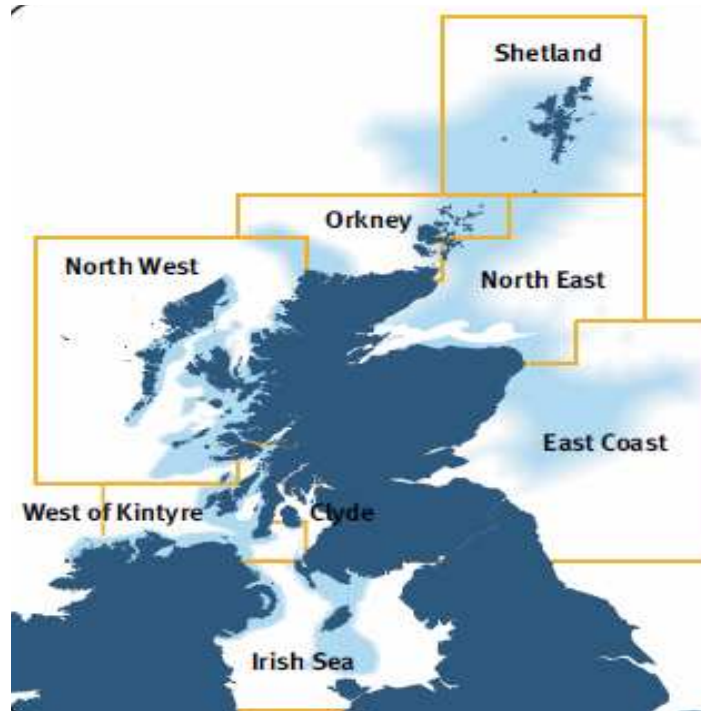
FAO

In NWW, the fishery for scallops occurs mainly in inshore waters off the south east coast of Ireland, in the south Irish Sea and in the western approaches to the UK and France. There are also important fisheries around the Isle of Man and off the west coast of Scotland. In these areas, fleets from the UK, Ireland and France exploit stocks both within and outside of national 12nm territorial limits. These fisheries are economically important to local coastal communities.

Scallops do not come under the remit of the Common Fisheries Policy (CFP). ICES do not assess these stocks nor do they provide advice for the management of the fisheries. Management of the scallop fisheries in NWW is based on a national level. In 2009 an estimated 51,900 tonnes of scallop were landed from the NWW area.



Distribution of fishing by the Irish scallop fleet off the south east coast (2000-2004). Data were derived from vessel monitoring system (VMS). (Source: Tully *et al.*, 2008)



The eight management areas for scallops defined by Marine Scotland. The shaded areas represent sediment types where scallops are likely to occur.
(Source Marine Laboratory, Aberdeen)

Life Cycle of Scallop

The life cycle of scallop is divided into two distinct phases; a pelagic larval phase and a benthic juvenile/adult phase. Fertilisation of gametes is external and success is related to the proximity of male and female spawners and to the population density of scallops on the seabed. The larval phase lasts from 18-42 days depending on temperature. The larvae seek suitable substrate on which to settle and once settled, scallops are mainly sedentary. Growth is related to temperature and food supply and is relatively fast. In Irish waters scallops attain a size of approximately 25 mm shell height in the first year after settlement and 40 mm at 2 years. Significant spawning does not occur until the third or fourth year but this pattern is spatially variable. Annual growth rings are deposited, which allows age to be estimated, although in some areas the annual pattern of ring formation is unclear. Recruitment to the fishery occurs mainly at 4 years. Scallops may live for 10-15 years.

(Source: Tully *et al.*, 2008)

In Ireland, France and the UK different assessment methods and management measures are applied to scallop fisheries. Some fisheries in France are quota controlled and are assessed by age based analytical methods or by annual survey corrected for dredge efficiencies. In Scotland age based virtual population analysis is used together with survey data.

The biology of scallop poses real difficulties for assessment and management. There is usually significant spatial (geographic) variability in biological characteristics, commercial catch rates, abundance and recruitment within a given stock. The boundaries between stocks and the interconnection between 'populations' of adult scallops, via larval dispersal, are also generally unknown. As a result, the interpretation of commercial catch and effort data, survey data and forecasting the impacts of management measures, such as minimum landings sizes, effort or catch limitation, can be difficult.

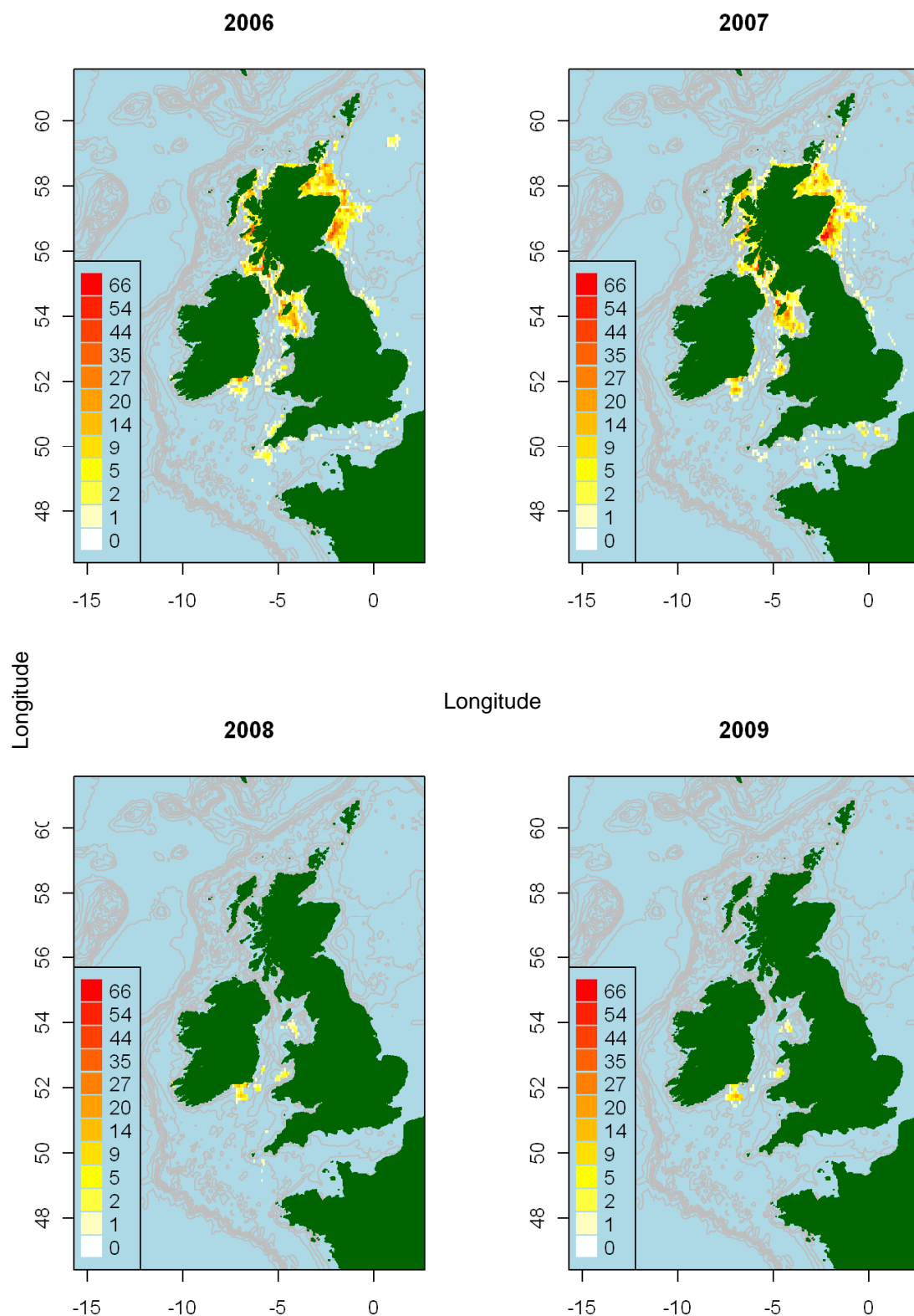
Benefits of Closed Areas

A study was carried out over a 14 year period (1989 to 2003) on the impacts of closed areas on the scallop fishery in the Isle of Man. Scallop densities were very low in the areas when the closed area was set up. However, they increased at an accelerated rate over time within the closed area. Scallop densities also increased on the adjacent fishing ground, but not to the same extent. There was also a shift towards much older and larger scallops in the closed area as a result of reduced total mortality. The patterns of scallop density, age and size structure resulted in the exploitable biomass (adductor muscle and gonad) of scallops being nearly 11 times higher in the closed area than in the fished area by 2003. This is a significant discovery for fisheries management because the build up of high densities of large individual scallops enhanced local reproductive potential and therefore the likelihood of export of larvae to the surrounding fishing grounds. Fisheries for relatively sedentary and long-lived species such as scallops appear to be particularly suitable for this type of management.

(Source: Beukers-Stewart, *et al.*, 2005)



Effort Scallop Dredge (hours/nm²)



The above VMS maps for 2006 and 2007 are combined UK and Irish data. 2008 and 2009 show Irish data only. Other international data sets were not available. The maps clearly show the main dredge fisheries (mainly Scallop) in VI (west of Scotland) and in VII (Irish Sea, Celtic Sea, English Channel).



18



MARICULTURE

Marine aquaculture (mariculture) is growing in NWW and three species dominate: Atlantic salmon, blue mussel and Pacific cupped oyster.

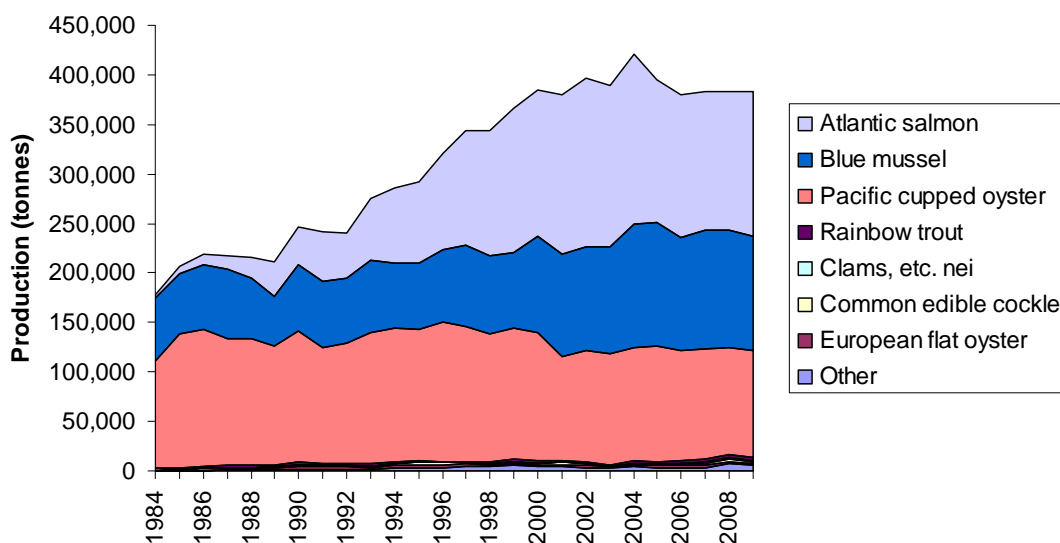
One way of farming blue mussels is on suspended ropes such as those pictured above in the Beara Peninsula, South West Ireland.

Although mariculture can reduce the need for practices such as trawling, it is not without its own risks. ICES identifies the dependence on wild caught fish for feed as the greatest risk of increased finfish mariculture in European waters.

Image: SuperStock.com

In 2010 the FAO reported an increasing trend in global aquaculture production. Worldwide, aquaculture is set to overtake wild capture fisheries as the main source of human consumed fish. This trend is mainly driven by freshwater farms in south-east Asia but the figures below also show a substantial increase in marine aquaculture (mariculture) in the NWW.

Three species dominate mariculture in the NWW countries: Atlantic salmon, Blue mussel and Pacific cupped oyster. The last quarter of a century has seen a huge increase in salmon farming in the area, from almost nothing in the early 1980s to the largest share of the total 2009 mariculture production. The maps below show that the main fish farming country in NWW is Scotland and the main shellfish country is France.



Annual production of the top 7 species farmed in the Channel Islands, the Isle of Man, France, Ireland and the United Kingdom (Source: FAO FishStat).

Note: As data is aggregated by country, this graph includes some areas that are outside NWW.

Blue Mussel Farming

One way of rearing blue mussels is by rope. Seed mussels (spat) are harvested from wild beds and used to populate ropes suspended from floating structures in sheltered coastal areas. The mussels attach to the rope using byssal threads and filter their food from the passing water, reaching marketable size in two years.



Image: SuperStock.co.uk

Effects of Finfish Mariculture on Populations of Wild Fish

While the farming of fish in coastal cages may have advantages over wild capture fisheries, such as reducing the pressure on seafloor integrity from trawling, it is not without its risks.

Escaped Fish: Large numbers of escaped fish have the potential to significantly dilute the genetic diversity in local wild populations, particularly if the wild stock is already in a poor condition. Farmed fish are selected for fast growth, good feed conversion and disease resistance. These traits may not be ideal for the conditions encountered by hybrids of wild and farmed fish.

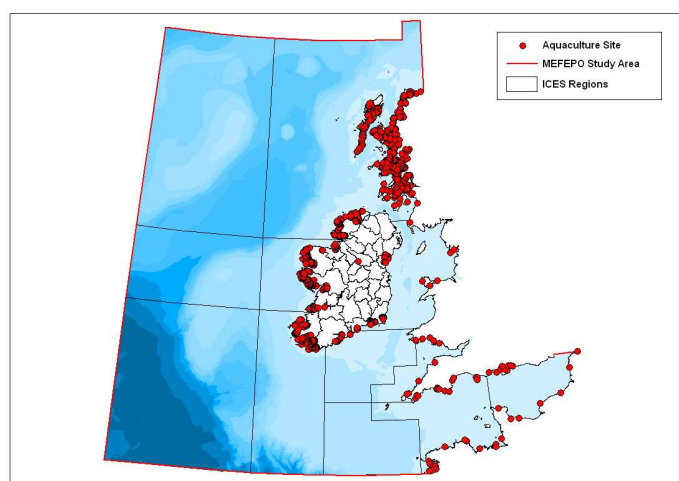
Parasites: Densely populated fish farms have ideal conditions for the proliferation of parasites, such as fish lice. These can be transmitted to passing wild fish unless effective management is in place. The use of preventative chemical treatments, in turn, brings its own concerns.

Pathogens: Similar to parasites but with less research evidence behind it.

Fish Feed: A significant proportion of the feed used in finfish farms is made from meal and oil derived from wild captured, small pelagic fish. Although this proportion is dropping, the overall amount used is growing due to the expansion of the mariculture sector. These meal fish may be sourced locally or as far away as the Peruvian anchoveta. In European waters they include: sandeel, blue whiting, sprat, pout and capelin. These types of schooling fish are prone to large annual fluctuations in the populations and sometimes dip below reference limits.

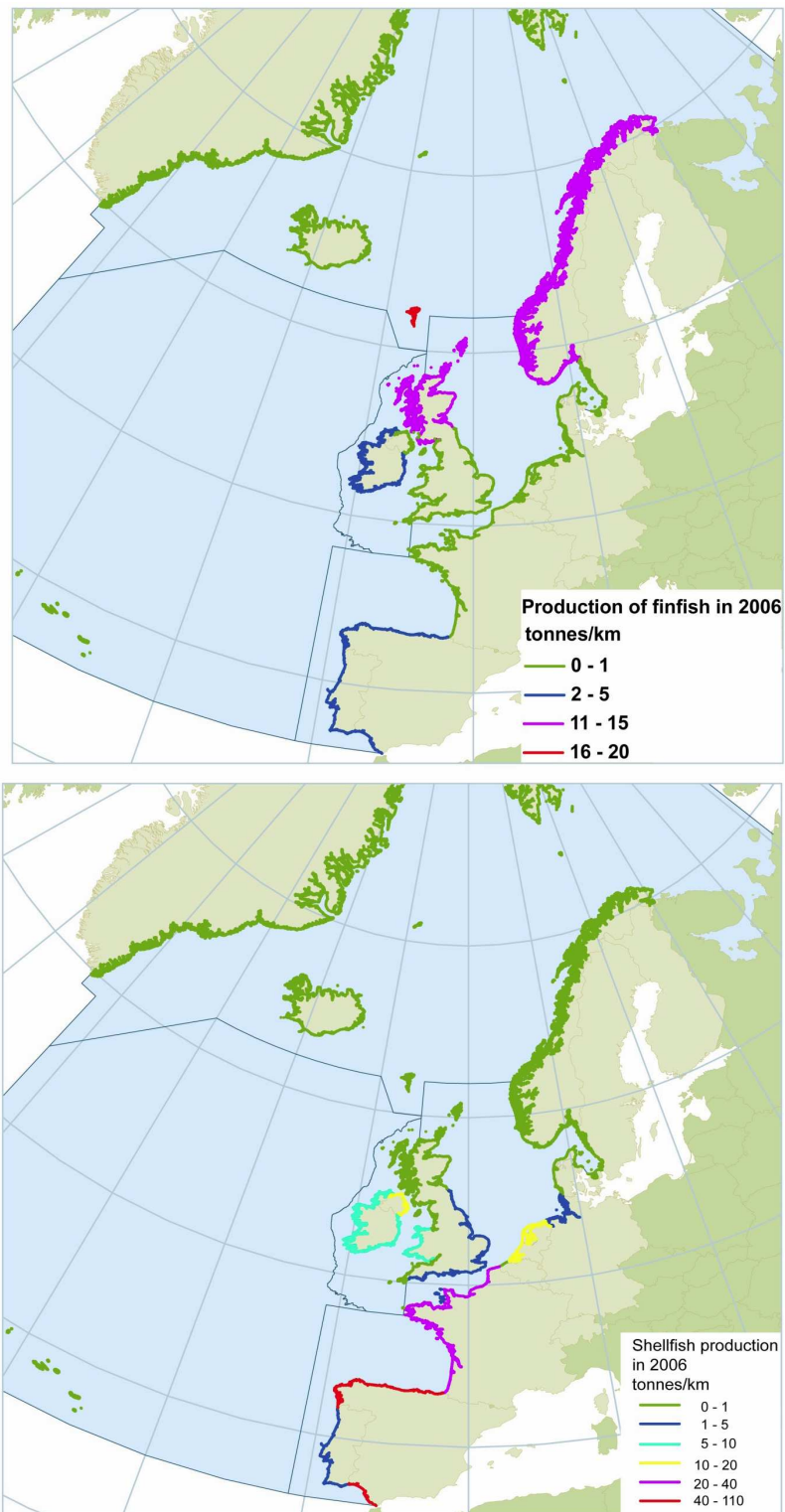
In a risk analysis, ICES identified the impact of producing fish feed as the greatest risk posed by farmed fish (salmon and cod) to wild fish populations. Parasites and pathogens were considered a low risk and reproductive competition by escapees was moderate.

(Source: ICES advice, 2010)



Aquaculture licence sites in NWW.

(Source: BIM, FRS, UK SEA6, UKSEA7, OFIMER, 2008)



Production of Finfish and Shellfish per Km of Coastline in 2006.
(Source: OSPAR, 2009)



19

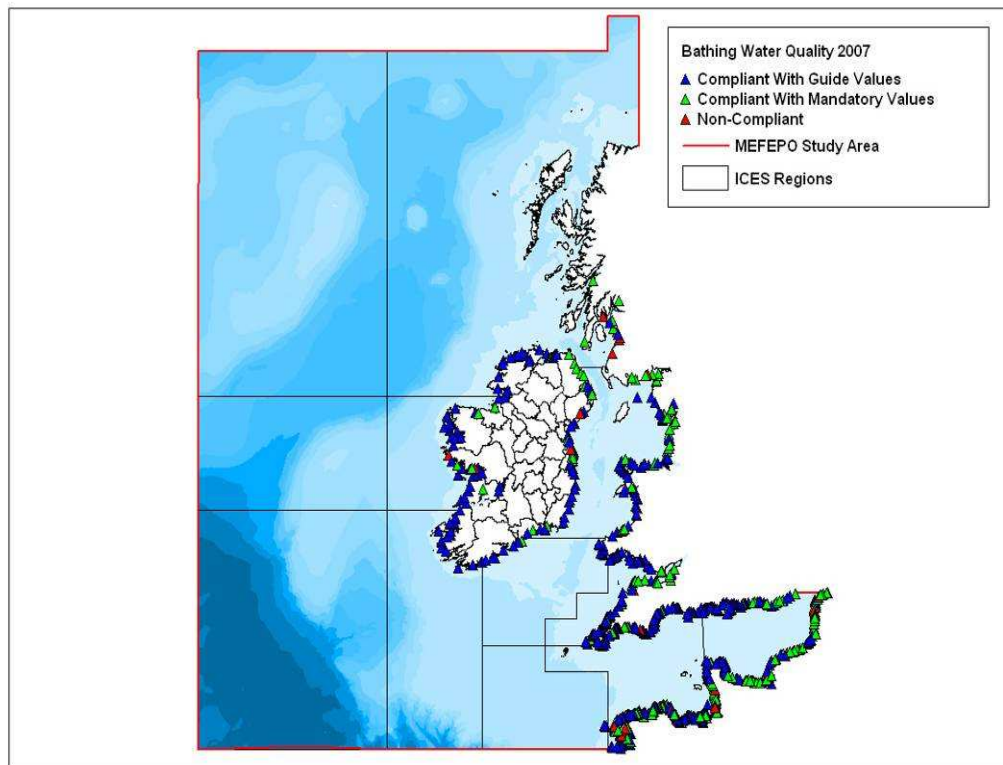


DISTRIBUTION OF OTHER HUMAN ACTIVITIES

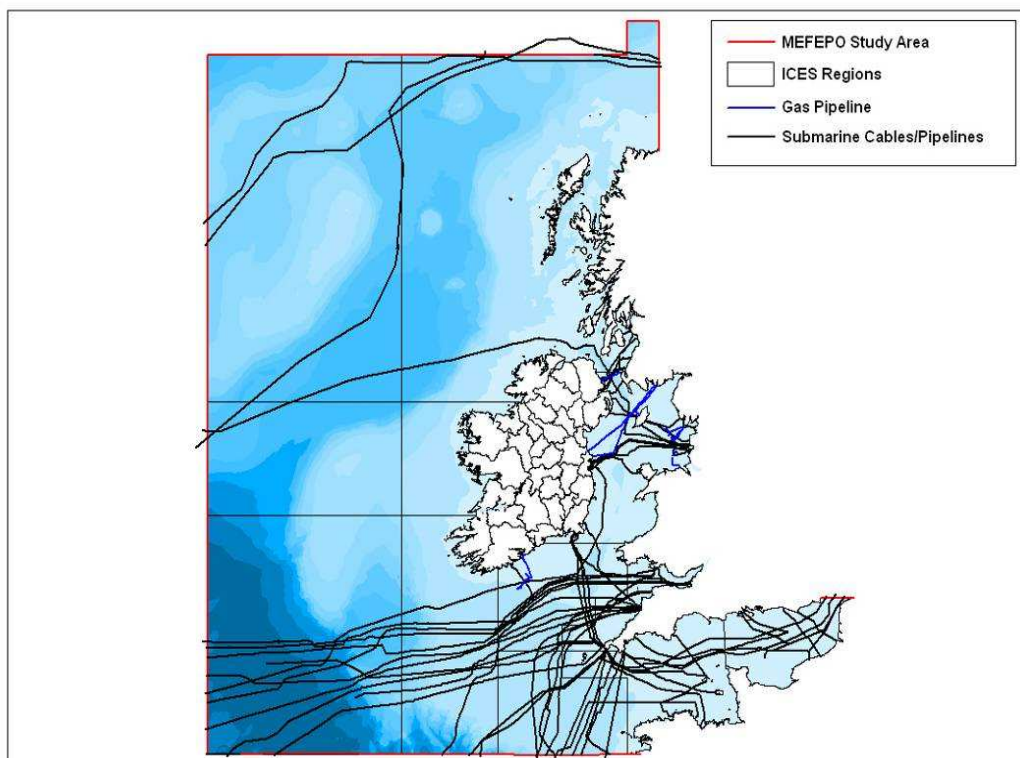
NWW are subject to a broad range of human activities. There are extensive submarine cable networks in the north Irish Sea, Celtic Sea and English Channel. The coastal areas of NWW have many fishing ports, commercial ports and leisure ports. There are several large cities and towns on the NWW coast, although they are not on the same scale as the large industrial cities associated with the North Sea. There are busy shipping lanes in the western approaches to the UK and France and in the English Channel. The Channel and the northern part of NWW are also busy oil tanker traffic routes. There are aggregate extraction sites in the English Channel and off the Welsh coast. Extensive oil and gas drilling and license activity exists in the NWW area. Military activity sites are mostly confined to UK waters. There are many power stations around the coasts of UK, Ireland and France.

The following maps are intended to give “an eagle eye view” of the various other human activities taking place in the NWW area.

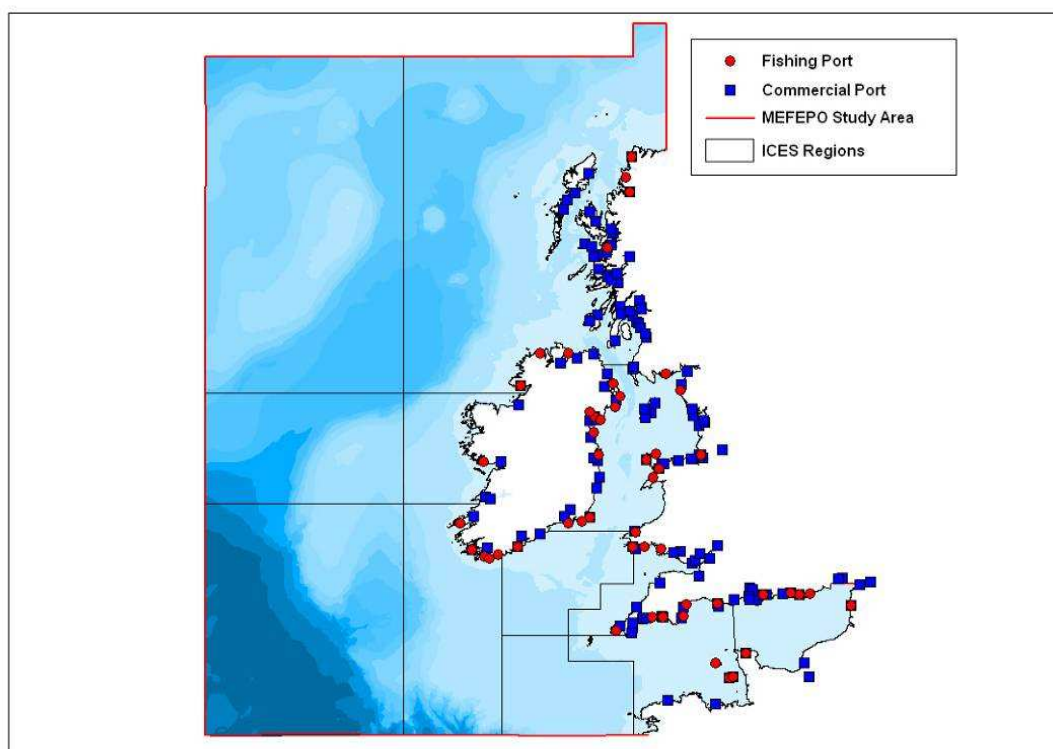
Bathing Water



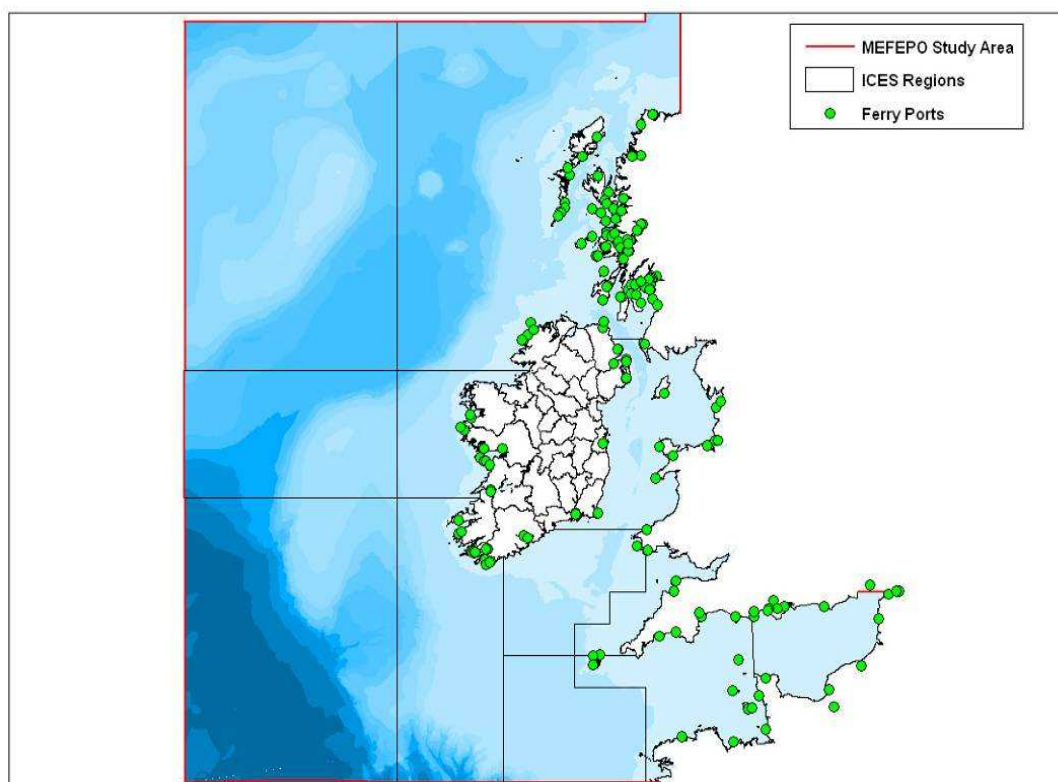
Submarine Cables and Pipelines



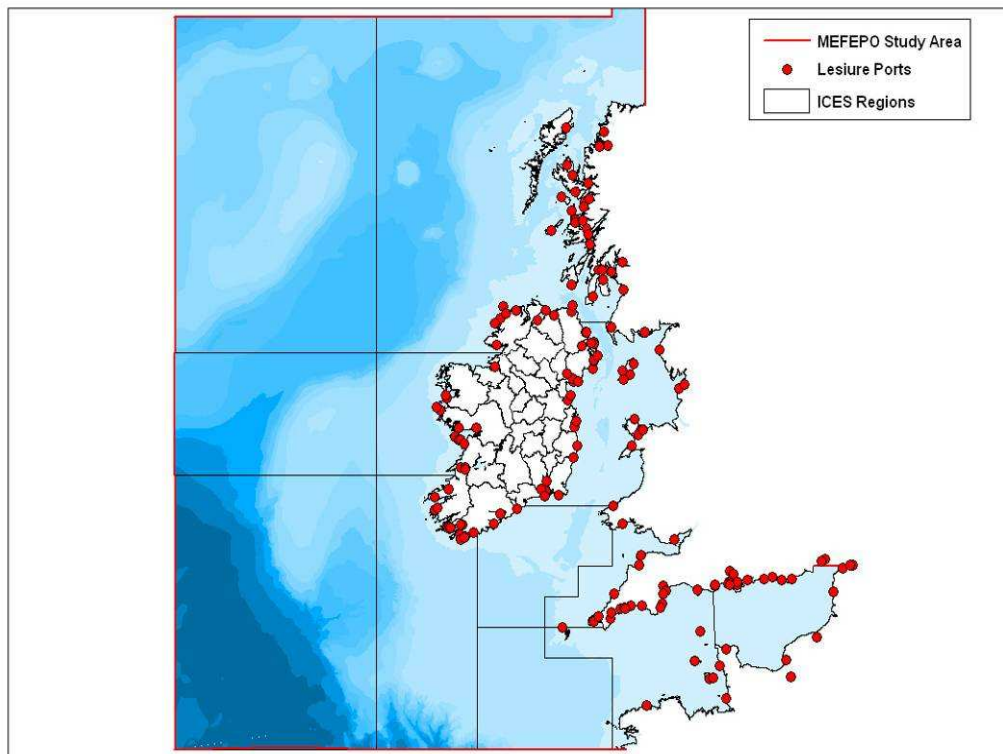
Fishing Ports and Commercial Ports



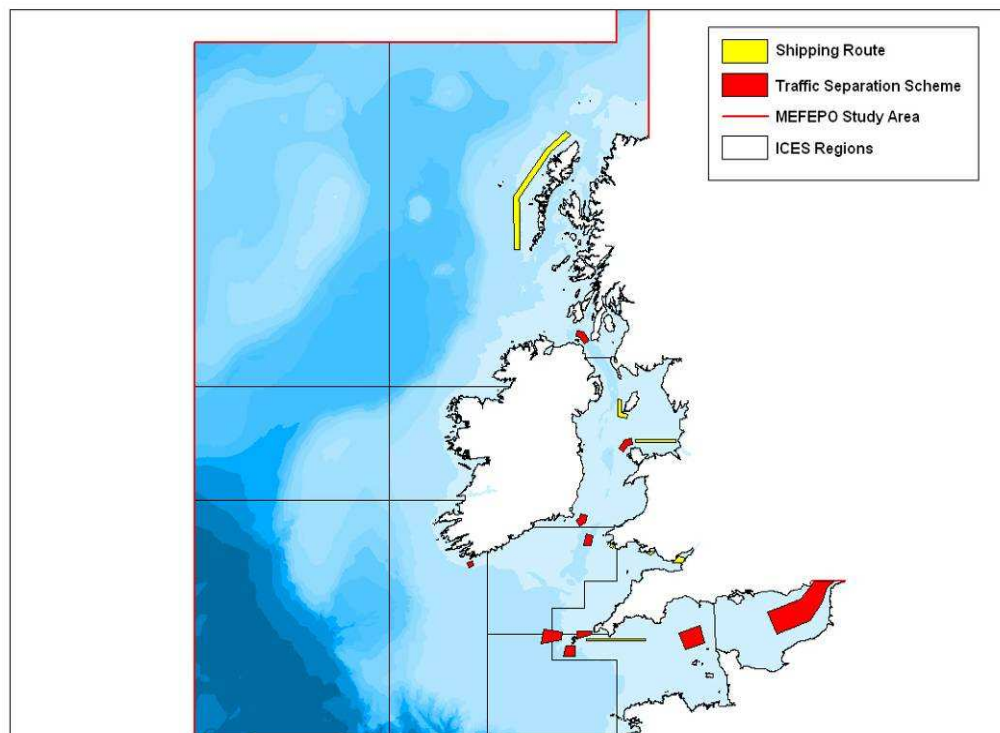
Ferry Ports



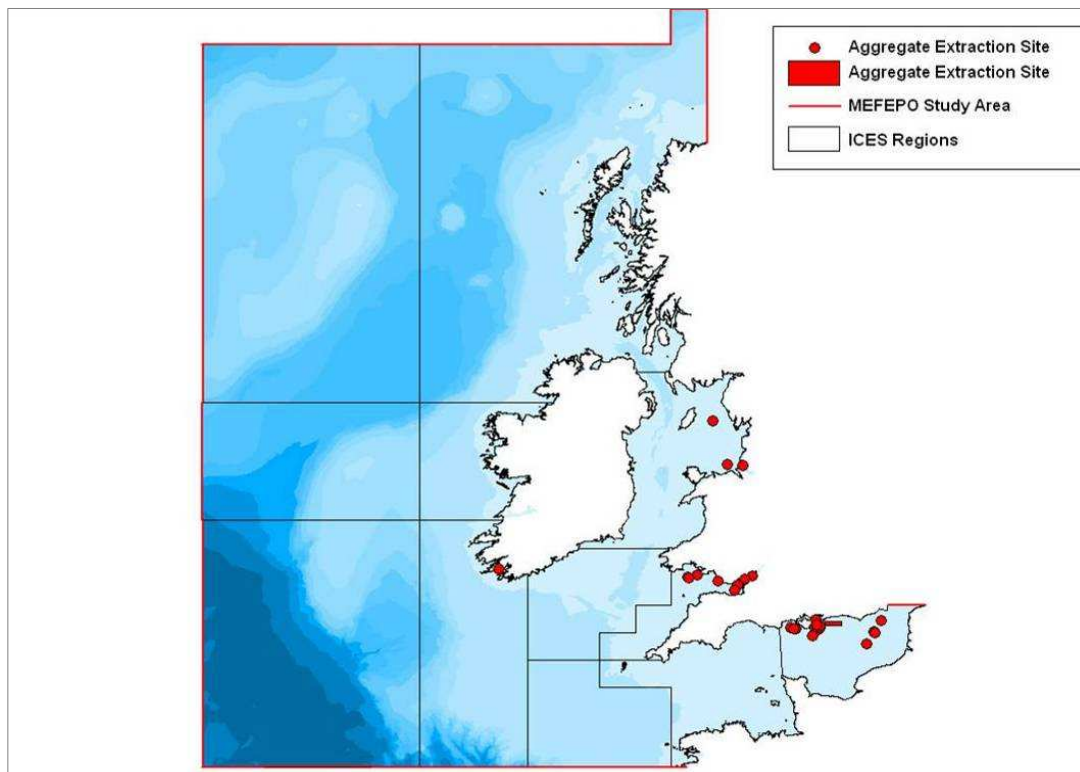
Leisure Ports



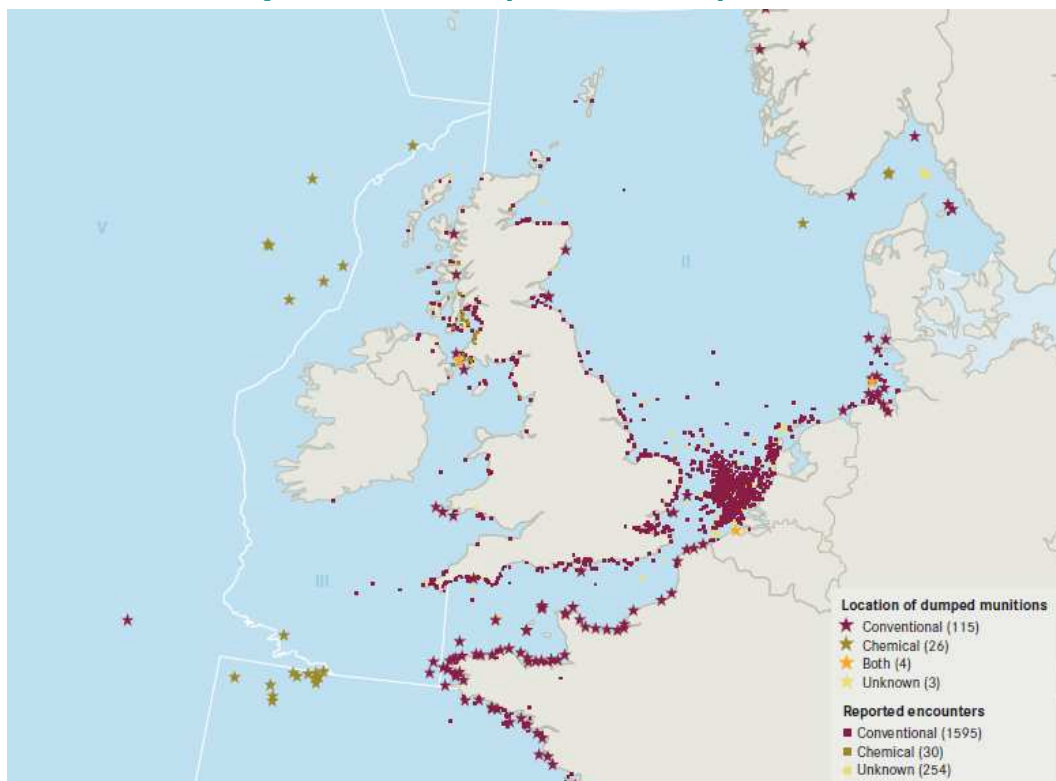
Shipping Routes and Traffic Separation schemes



Aggregate Extraction Areas

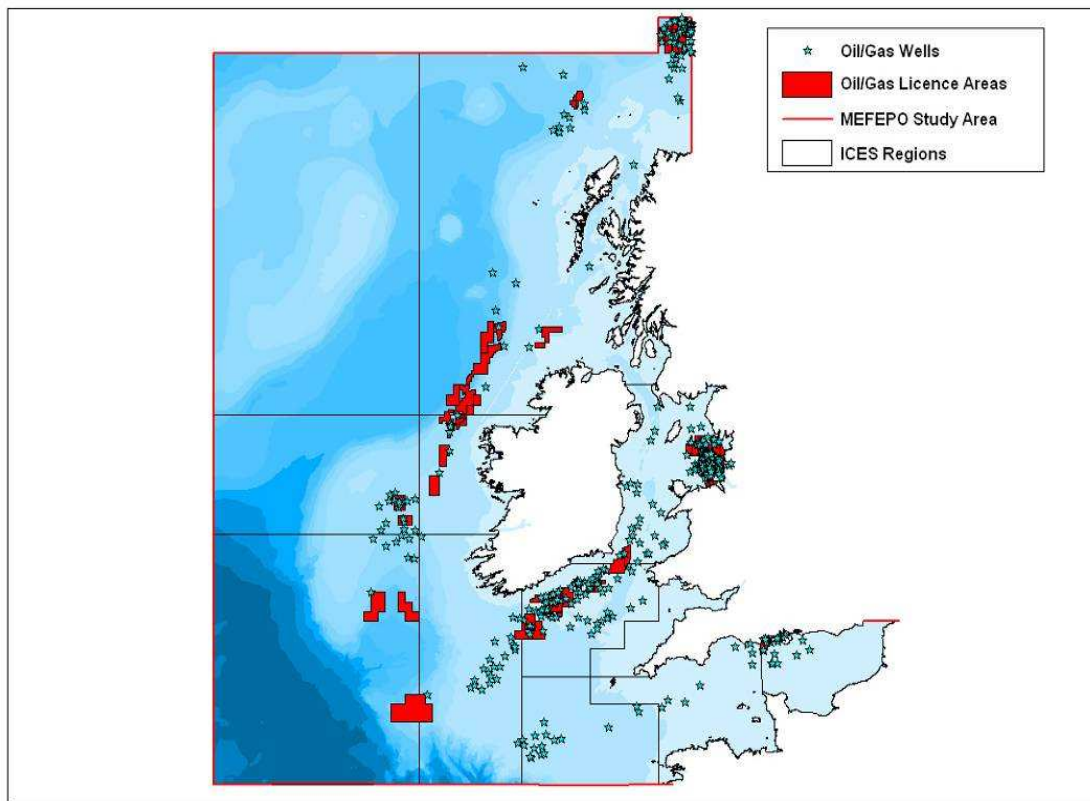


Munitions Disposal Sites (1999-2008)

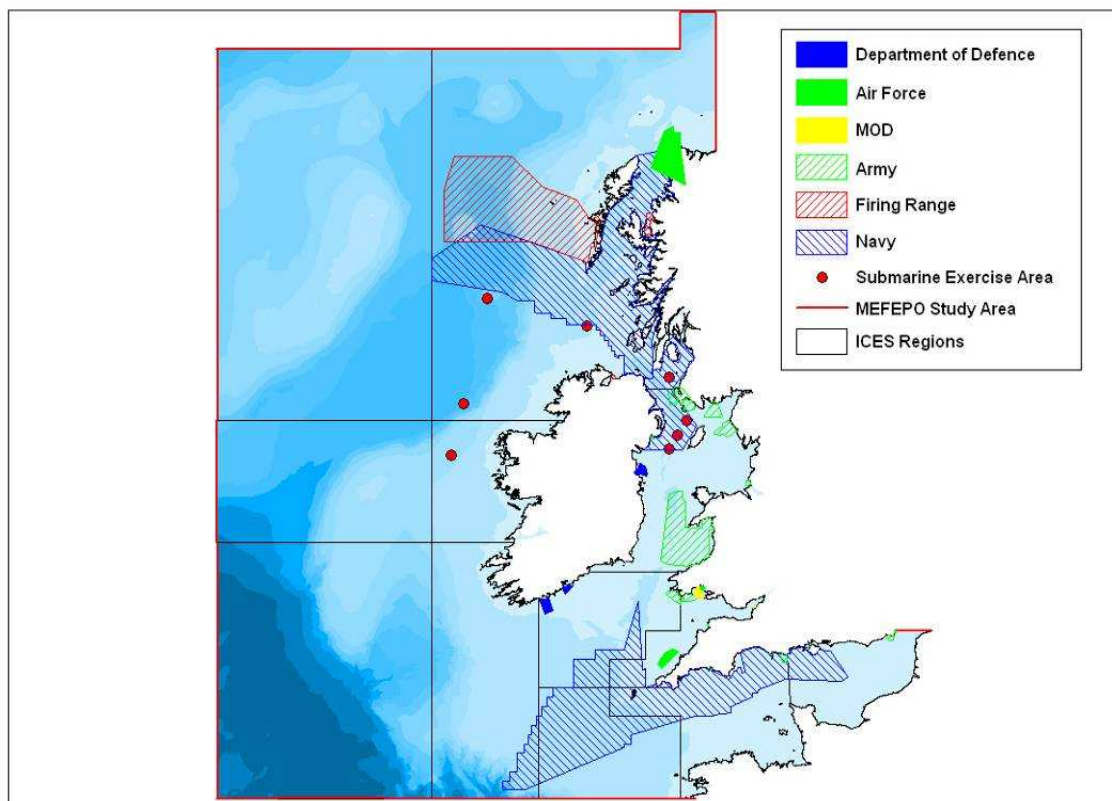


(Source: OSPAR, 2010)

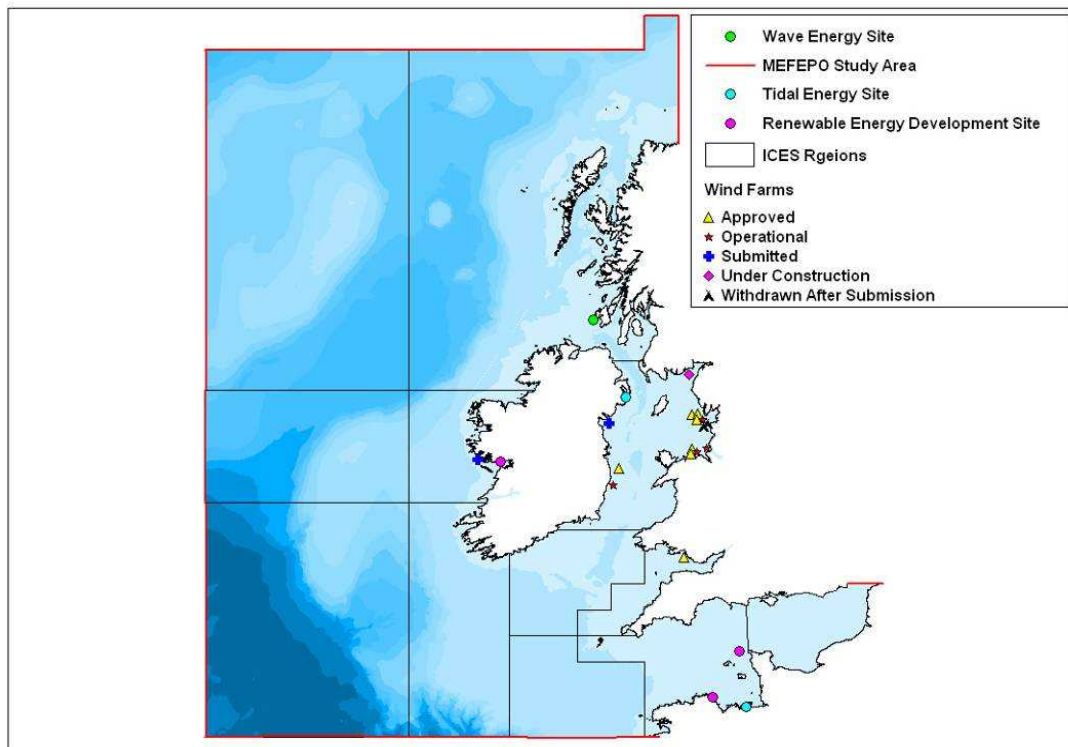
Oil and Gas



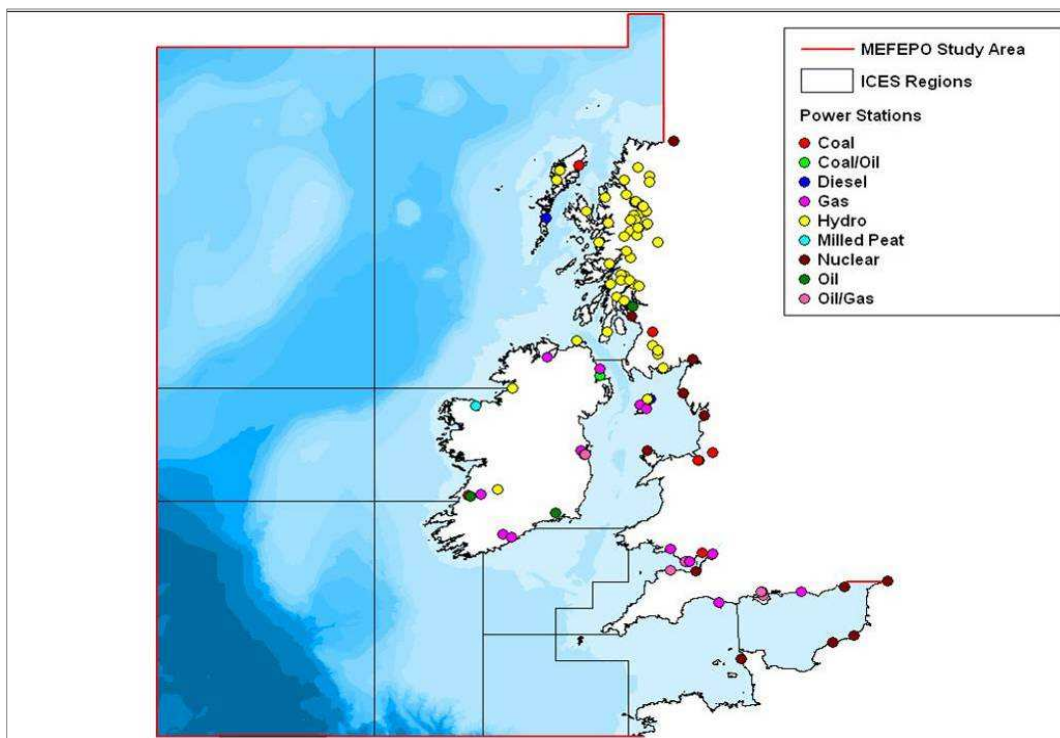
Military Activity



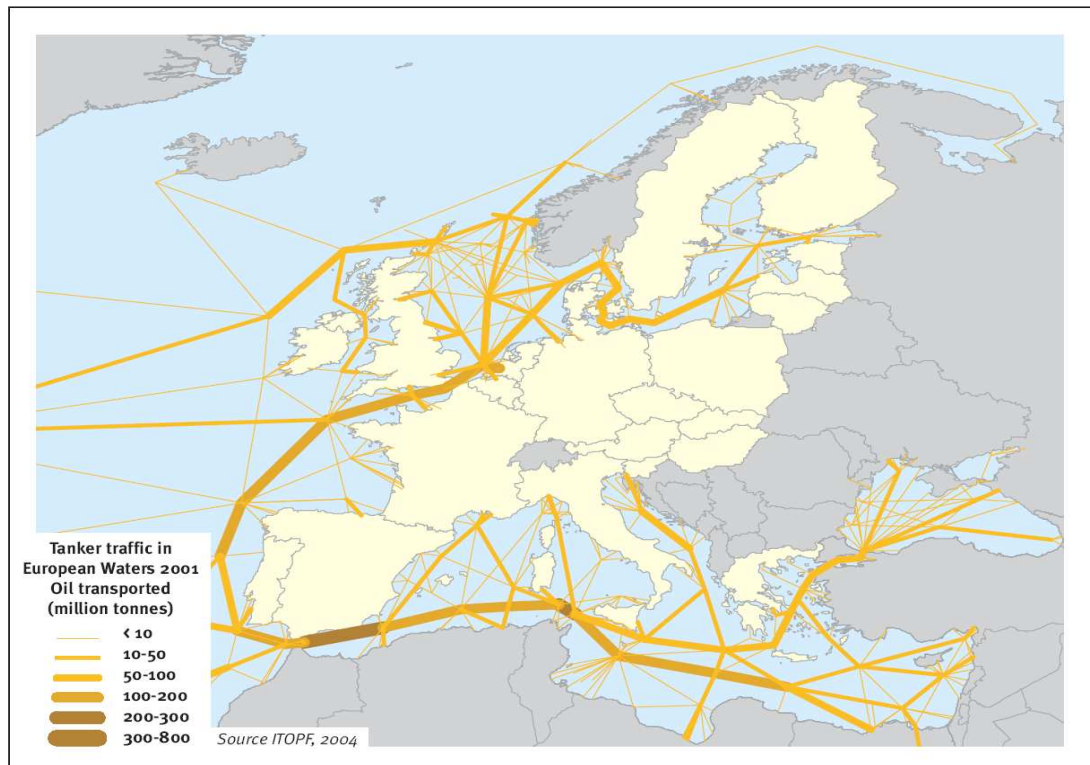
Wave Energy Sites



Power Stations

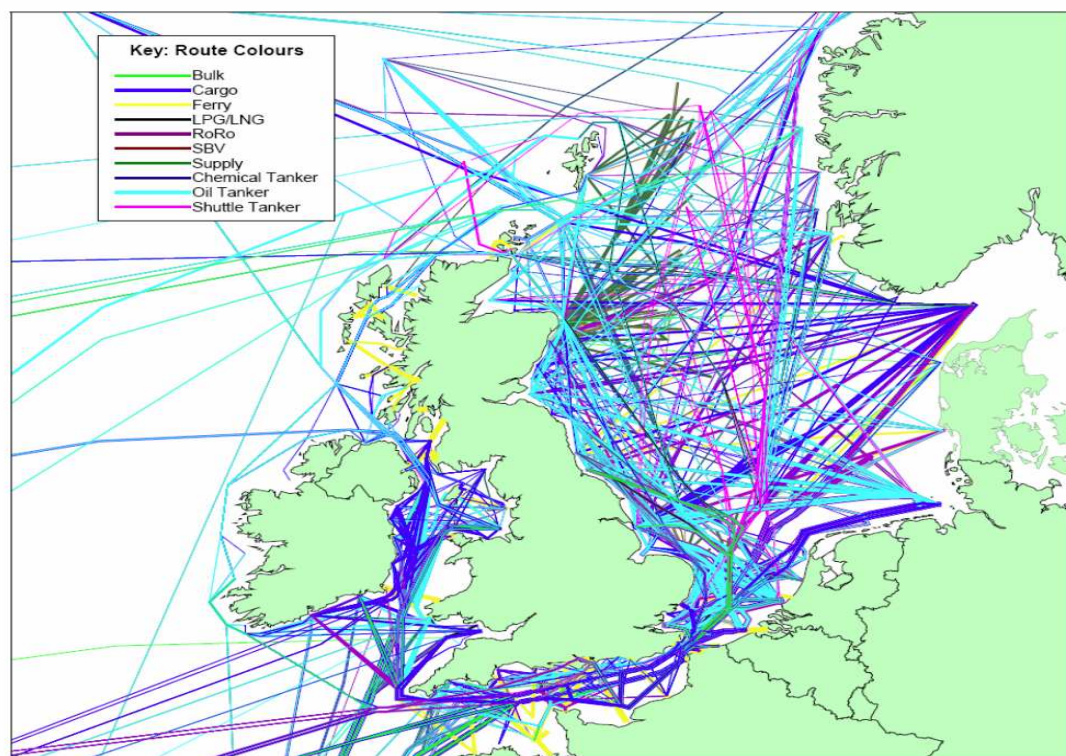


Oil Tanker Traffic



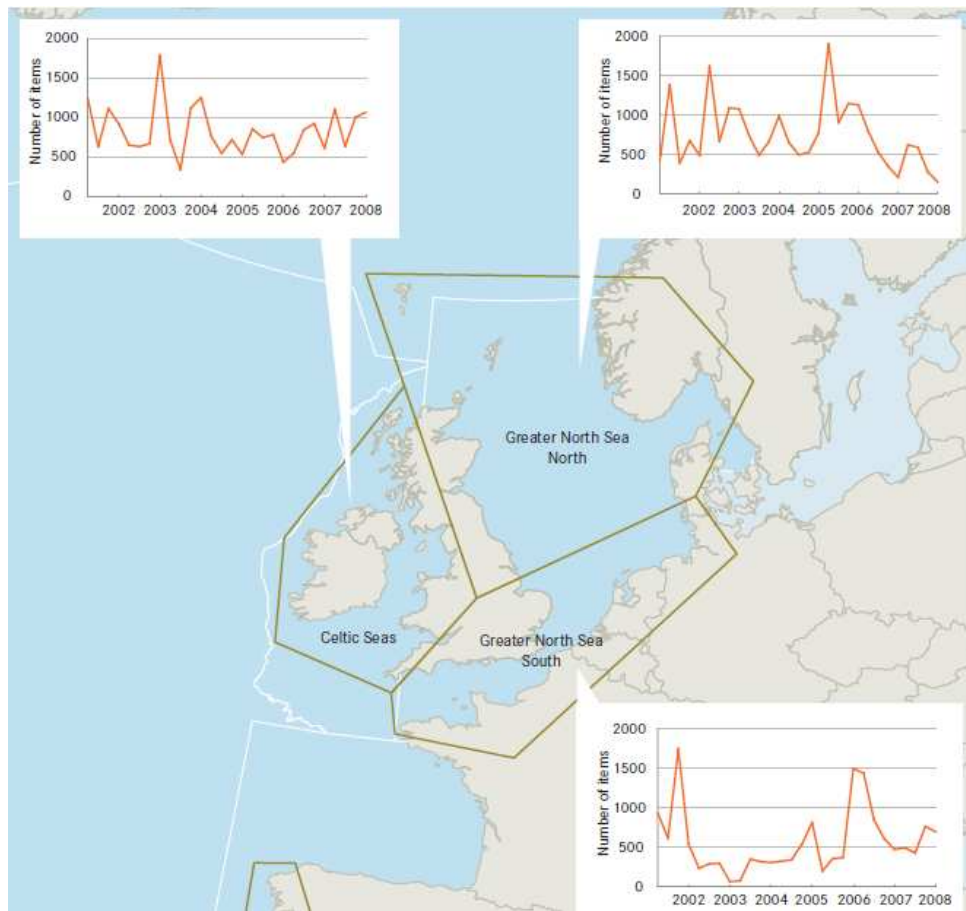
(Source: EU Green Paper on Maritime Policy)

Shipping Routes



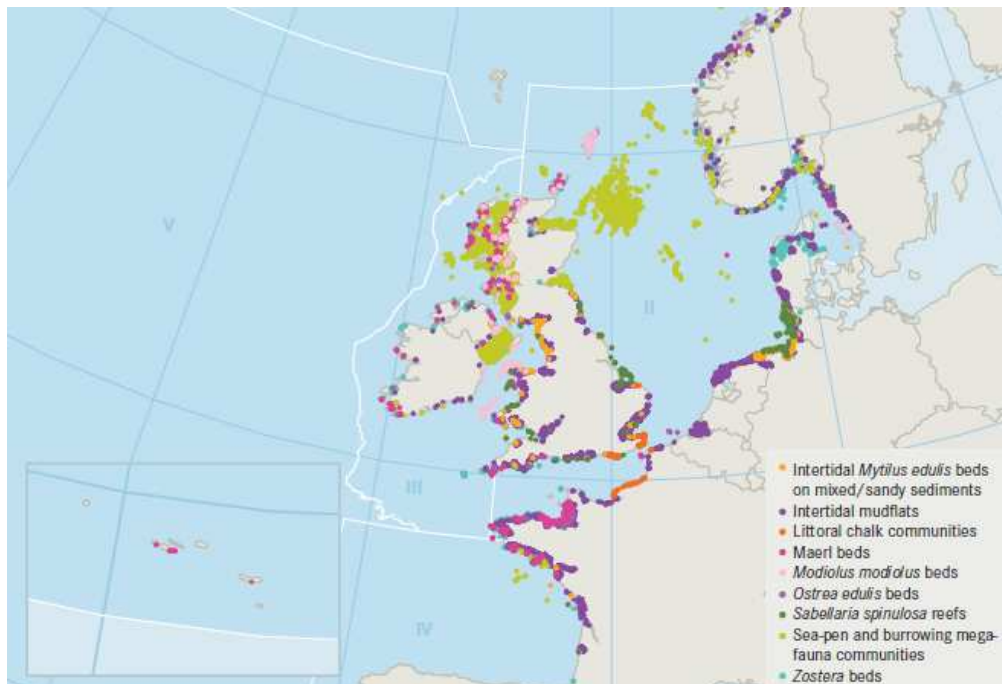
(Source: OSPAR, 2009)

Litter



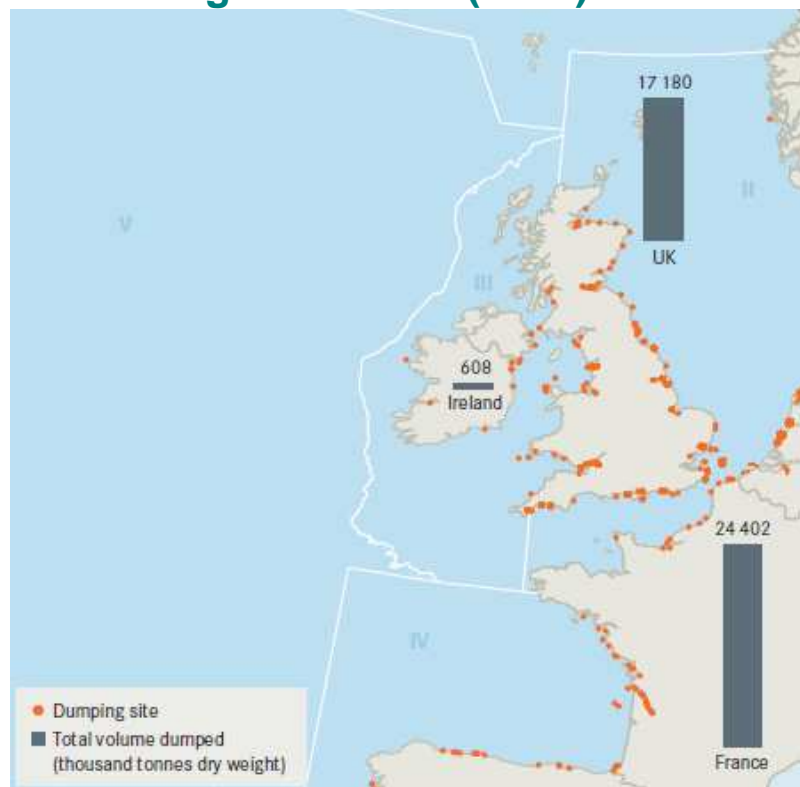
(Source: OSPAR QSR, 2010)

Threatened Coastal and Shelf-sea Habitats



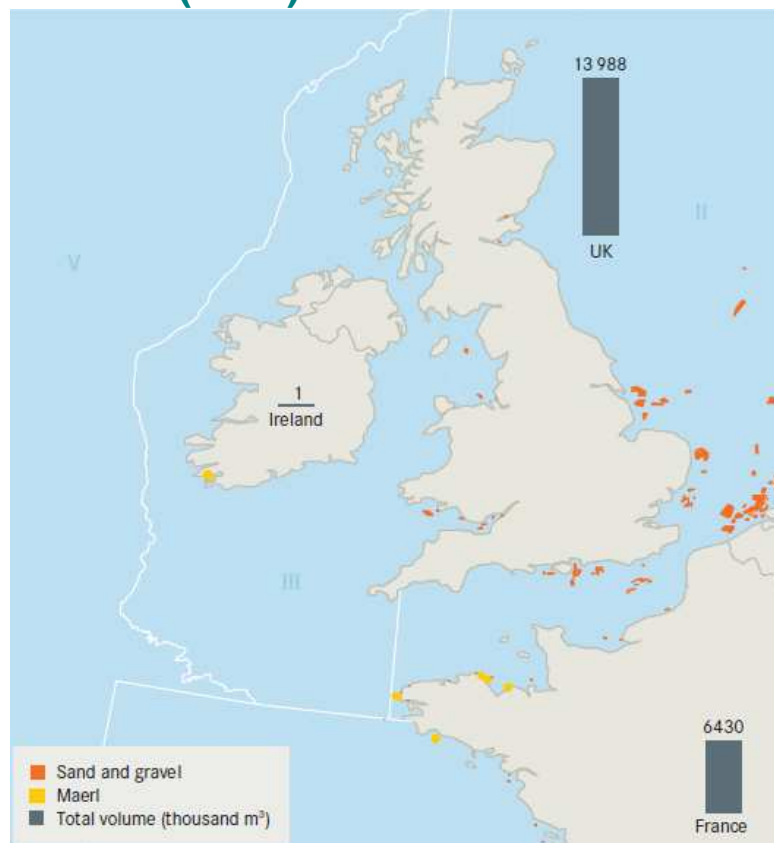
(Source: OSPAR QSR, 2010)

Dumpsites for Dredged Material (2007)



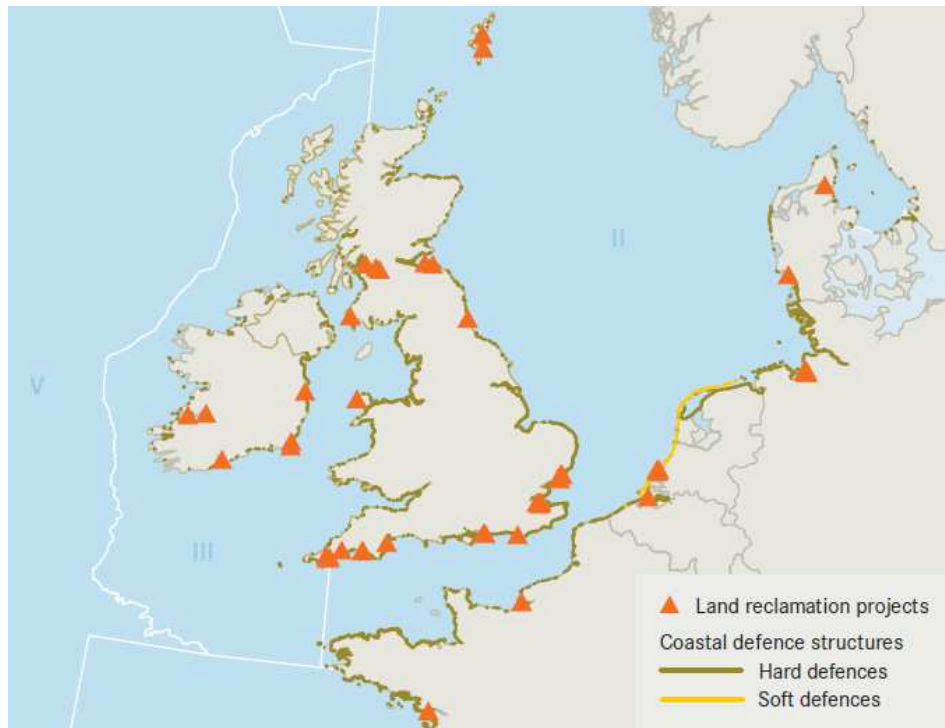
(Source: OSPAR QSR, 2010)

Mineral Extraction (2007)



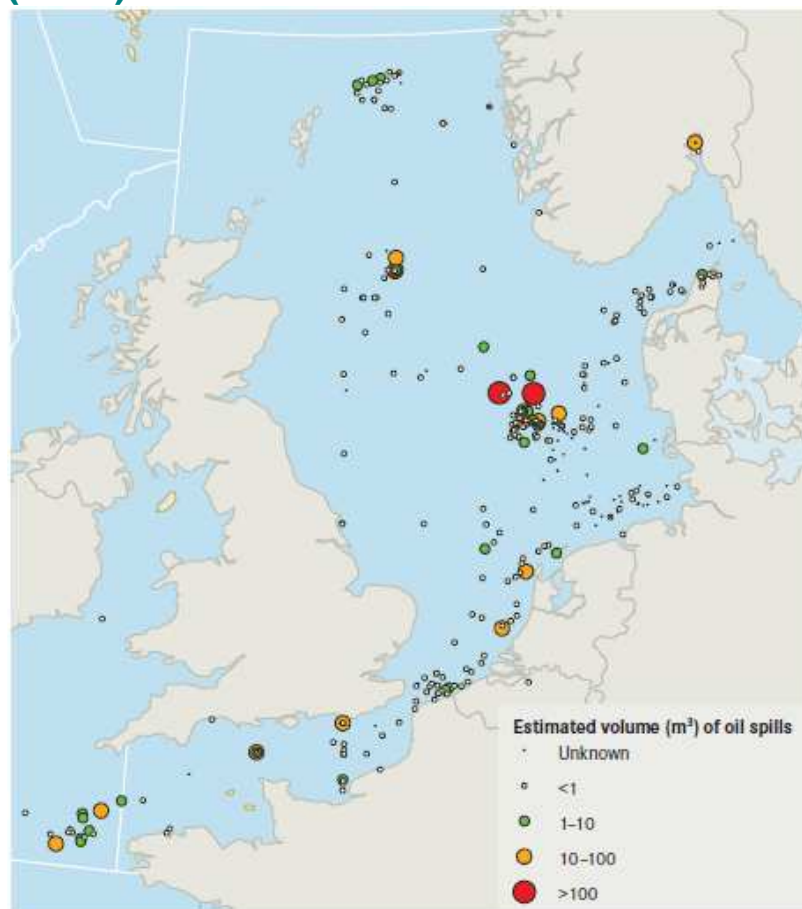
(Source: OSPAR QSR, 2010)

Land Reclamation and Coastal Defenses



(Source: OSPAR QSR, 2010)

Oil Spills (2008)



(Source: OSPAR QSR, 2010)



20

ECOSYSTEM OVERVIEWS

The NWW area consists of a large and diverse ocean area. In the NWW Atlas we have used 5 broad ecosystem overviews; Irish Sea, Celtic Seas, West of Scotland and Rockall, Deep Seas, and Widely Distributed and Migratory Stocks.

In the Irish Sea there are a number of severely depleted stocks e.g. cod, whiting and sole. A significant proportion of the catch of the demersal fleets is discarded.

In the Celtic Sea, the size structure of the fish community has changed significantly over time, and a decrease in the relative abundance of larger fish has been accompanied by an increase in smaller fish.

Surface waters of the Rockall trough have been steadily warming for some years and are currently at an all time high. The general and continuing reduction of copepod abundance and recent changes in zooplankton composition throughout the region are also causes of major concern given the key role that these organisms play in the food web.

Deepwater trawling can damage deep sea benthic communities, impacting particularly on structurally complex habitats such as coral (*Lophelia* spp.) reefs.

Most fishing for widely distributed and migratory stocks is pelagic in nature and there is little or no direct effect on the benthic community.

This section provides a series of five ecosystem overviews that represent the main areas within the NWW RAC area. They are for the Irish Sea (ICES Division VIIa): the Celtic Sea Area (ICES Divisions VIIe-k), the shelf areas to West of Scotland and Rockall (ICES Divisions VIa and VIb); the deep waters areas to the west of Ireland and Scotland (ICES Divisions VII and VI) and the pelagic waters to the west of Ireland and Scotland (ICES Divisions VII and VI). These summary tables have been sourced from the Marine Institutes annual Stock Book (2010) and are compiled using information from ICES WGRED, 2008; WGCSE, 2009; WGWIDE 2009, WGOH, 2009 and Hughes *et al.*, 2008.

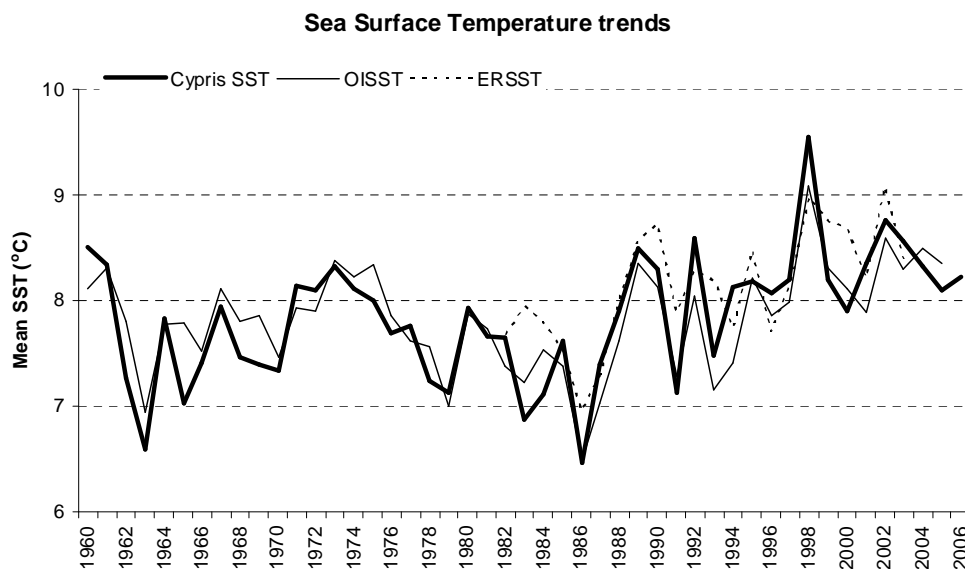
(1) Ecosystem overview for the Irish Sea

Physics	
Bathymetry	Shallow sea (less than 100m deep in most places), largely sheltered from the winds and currents of the North Atlantic.
Circulation	An inshore coastal current carries water from the Celtic Sea and St. Georges' Channel northwards through the North Channel, mixing with water from the outer Clyde. A seasonal gyre operates as a local retention mechanism in the western Irish Sea.
Fronts	The Celtic Sea front is situated at the southern entrance to the Irish Sea and the Islay Front is found between Islay and the Malin Shelf.
Temperature Salinity	Time series from the SW coast of the Isle of Man (the Cypris station), western Irish Sea (Gowen, AFBI, Belfast), and two series of combined satellite and ship-records indicate a general warming trend in the Irish Sea since 1960, with particularly high temperatures in 1998. Temperature does not seem to have further increased in the last two years (see figures on following page).
Biology	
Phytoplankton	Phytoplankton biomass tends to be greatest in the eastern Irish Sea and elevated production esp. in the bays compared to adjacent seas suggests anthropogenic enrichment. Species of <i>Phaeocystis</i> are found throughout the region in most years and together with other microflagellates can dominate the spring bloom, however diatoms are still an important component of the community. Red tides of dinoflagellates are rare events in the Irish Sea but toxin-producing dinoflagellates are recorded (Gowen and Stewart, 2005; Gowen <i>et al.</i> 2008).
Zooplankton	Copepods form the greatest proportion of the zooplankton community with smaller species of <i>P. elongatus</i> , <i>T. longicornis</i> and <i>A. clausi</i> dominating. The zooplankton community of the Irish Sea has undergone significant change over the last thirty years with a significant decrease in abundance of most of the species recorded. Some species distributions and abundances have been shown to be influenced by climate, specifically the North Atlantic Oscillation (Kennington and Rowlands, 2005).
Benthos, larger invertebrate, biogenic habitats	The main commercial invertebrate species is Norway-lobster (<i>Nephrops norvegicus</i>). There are distinct benthic assemblages with plaice and dab on fine substrates in inshore waters and sea urchins and sun-stars on coarser substrates further offshore. Thickback sole (<i>Microchirus variegatus</i>) and hermit crabs dominate the transitional zone, while Norway-lobster and Witch (<i>Glyptocephalus cynoglossus</i>) dominate on the muddy sediments in the central Irish Sea. Beds of <i>Alcyonium digitatum</i> (Dead man's fingers) occur on coarse substrates throughout. Biogenic reefs of horse mussels <i>Modiolus modiolus</i> , maerl and Serpulid worms occur in specific locations.
Fish Community	There are commercial fisheries for cod (<i>Gadus morhua</i>), plaice (<i>Pleuronectes platessa</i>) and sole (<i>Solea solea</i>). The most abundant species in trawl surveys are dab (<i>Limanda limanda</i>), plaice (<i>Pleuronectes platessa</i>), solenette (<i>Buglossidium luteum</i>) and common dragonet (<i>Callionymus lyra</i>) along with large numbers of poor-cod, whiting and sole. Lesser

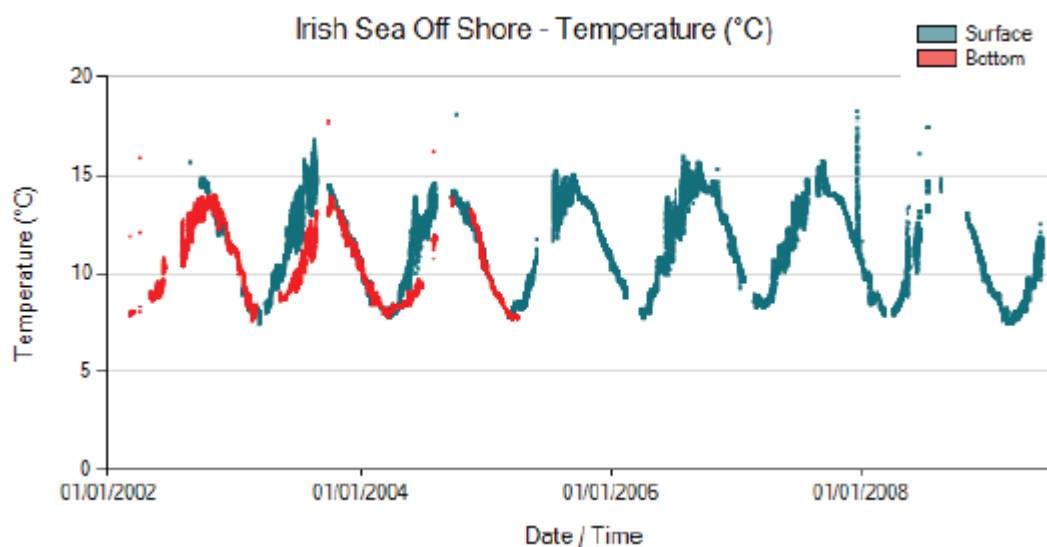
	spotted dogfish <i>Scyliorhinus canicula</i> is abundant throughout. There are also ray assemblage on sand hills in the Southern Irish Sea and Cardigan Bay. Herring and sprat are the main pelagic species in the eco-region, with important spawning grounds for herring in the south.
Birds, Mammals & Elasmobranches	Grey seals (<i>Halichoerus grypus</i>) are common and 5000-7000 individuals are thought to exist in the Irish and Celtic Seas. Gulls predominate the seabird populations, in particular black-headed, lesser black-backed and herring gulls as well as guillemots.
Environmental signals & implications	There has been a steady warming of sea surface temperatures (SSTs) in the area in the last 25 years and this can potentially affect the recruitment and productivity of stocks. Herring recruitment has fluctuated widely, however studies to date have not been able to demonstrate any relationship to environmental changes. Irish Sea cod recruitment exhibited a decline in the 1990s. There is some indication that this reduction in cod recruitment may be due to a combination of small spawning-stock biomass and poor environmental conditions, coinciding with a shift towards above-average sea temperatures. Recruitment of plaice stocks in waters around the UK (Irish Sea, Celtic Sea, western and eastern Channel, North Sea) is negatively correlated with sea surface temperature (ICES, 2010). For Nephrops stocks, increasing water temperature leading to shorter larval development times is thought to improve recruitment in areas such as the Irish Sea (ICES, 2010). There has been a northward shift in the distribution of some fish such as an increase of seabass <i>Dicentrarchus labrax</i> and red mullet <i>Mullus surmuletus</i> populations around British coasts.
Fishery effects on benthos and fish communities	<p>This area has a number of severely depleted stocks e.g. cod, whiting and sole. Trawling for Nephrops results in bycatch and discards of other commercial species, including cod, haddock, whiting, hake, monkfish, and megrim. Given that 80 mm is the predominant mesh size used in Nephrops fisheries the resulting discard rates of small Nephrops and fish can be high. Discarding is a serious problem for the cod and whiting stocks. The discard rate by fleet in 2009 for cod was 100% for one-year-olds and almost all whiting caught were discarded. Although a number of gear selectivity devices such as square mesh panels are mandatory, their effectiveness is variable.</p> <p>Sole and plaice are primarily targeted by beam trawl fisheries. Beam trawling, especially using chain-mat gear, is known to have a significant impact on the benthic communities, although less so on soft substrates and in areas which have been historically exploited by this fishing method.</p> <p>The high mud content and soft nature of Nephrops grounds means that trawling readily marks the seabed, trawl marks remaining visible for some time. Despite the high intensity of fishing (some areas are impacted >7 times/year) burrowing fauna can be seen re-emerging from freshly trawled grounds, implying that there is some resilience to trawling.</p>

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Sea surface temperature in the Irish Sea (1960 – 2006).
(Source: ICES 2006)



Variation of sea temperatures at Cypris station, Irish Sea (53° 47' N / 05° 38' W).
(Agri-Food & Biosciences Institute (AFBI) Northern Ireland: www.afbini.gov.uk)

(2) Ecosystem overview for the Celtic Sea Area

Physics	
Bathymetry	Shelf sea south of Ireland, limited to the west by the slope of the Porcupine seabight and the Goban Spur.
Circulation	Along the shelf edge, there is a poleward flowing 'slope current'; on the shelf a weaker current flows north from Brittany across the mouth of the English Channel. Thermal stratification and tidal mixing generates the Irish coastal current which runs westwards in the Celtic Sea and northwards along the west coast of Ireland. Several rivers discharge freshwater into the ecoregion and influence the circulation patterns. These are notably the River Loire, the Severn and the Irish rivers Lee and Blackwater.
Fronts	The Irish Shelf Front is located to the south and west of Ireland (at c. 11°W), and consists of a tidal mixing front existing all year-round. On the shelf, there are the Ushant Front in the English Channel and the Celtic Sea front at the southern entrance to the Irish Sea.
Temperature	Sea surface temperatures measured in coastal stations northwest of Ireland since the 1960s show a trend of sustained positive temperature anomalies from 1990 with a decrease in the last year (see figure). Temperature variations correspond closely to the Atlantic Multidecadal Oscillation (AMO) (ICES, 2010). An offshore weather buoy maintained off the southwest coast of Ireland (51.22°N 10.55°W) since mid 2002, indicated that temperatures in 2009 started below the time-series mean (2003–2009), remained generally below the time series mean in August and September and similar to the time series mean for the remainder of the year (see figure, ICES, 2010).
Biology	
Phytoplankton	Productivity is reasonably high on the shelf with a rapid decrease west of the shelf break. Continuous Plankton Recorder (CPR) data suggests a steady increase in phytoplankton over at least the last 20 years. Toxic algal blooms occur around Irish coasts esp. along the southwest of Ireland.
Zooplankton	CPR data suggest an overall decline in the abundance of zooplankton in recent years. <i>Calanus</i> abundance is now below the long term mean.
Benthos, larger invertebrate, biogenic habitats	The major commercial invertebrate species is Norway lobster (<i>Nephrops norvegicus</i>). Two epibenthic assemblages predominate in the Celtic Sea: one along the shelf edge and the slope, dominated by the anemone <i>Actinauge richardi</i> and a more widely distributed assemblage on the continental shelf, dominated by <i>Pagurus prideaux</i> and other mobile invertebrates (shrimps and echinoderms).
Fish Community	The area is a spawning area for key migratory fish species, notably mackerel <i>Scomber scombrus</i> and horse mackerel <i>Trachurus trachurus</i> . On the continental shelf the main pelagic species are herring <i>Clupea harengus</i> , sardine <i>Sardina pilchardus</i> and sprat <i>Sprattus sprattus</i> . The groundfish community consists of over a hundred species with the most abundant 25 making up 99% of the total biomass. Surveys revealed a downward trend in the biomass and abundance of cod, whiting and hake. Basking shark (<i>Cetorhinus maximus</i>) is seen throughout the area but the stock seems to be severely depleted. Blue sharks (<i>Prionace glauca</i>) are found during the summer.
Birds & Mammals	The Harbour porpoise <i>Phocoena phocoena</i> is the most numerous cetacean in the region. Bottlenosed dolphins (<i>Tursiops truncatus</i>) occur in large numbers while the common dolphin (<i>Delphinus delphis</i>) is also widely distributed in the area. White-beaked dolphin and White-sided dolphin (<i>Lagenorhynchus albirostris</i> and <i>L. acutus</i>) occur over much of the shelf area. Grey seals (<i>Halichoerus grypus</i>) are common in many parts of the area. Petrels (fulmar and storm-petrel) dominate the seabird populations in the west of Ireland and Celtic Sea region but there are also large breeding colonies of kittiwake, guillemot and gannet.

Environmental signals & implications	<p>Increasing temperature and changes in zooplankton communities are likely to have an impact on the life histories of many species. Cod in the Celtic Sea are at the southern limit of the range of the species in the Northeast Atlantic. It is known that at the southern limits of their range, recruitment tends to decrease in warmer waters (above 8.5°C), and that cod are not found in waters warmer than 12°C. Celtic Sea cod has higher growth rates and mature earlier than other cod stocks. Other species where recruitment appears to be linked with temperature is Celtic Sea plaice (ICES, 2010b). A northward shift in the distribution of some fish has occurred with an increase of seabass <i>Dicentrarchus labrax</i> and red mullet <i>Mullus surmuletus</i> populations around British coasts. Abundance of herring <i>Clupea harengus</i> and pilchard <i>Sardina pilchardus</i> occurring off the south-west of England, has been shown to correspond closely with fluctuations in water temperature. Sardines were generally more abundant and their distribution extended further to the east when the climate was warmer, whilst herring were generally more abundant in cooler times.</p> <p>Zooplankton abundance has declined in the region in recent years and the overall substantial decline in <i>Calanus</i> abundance, which is currently below the longterm mean, may have longer term consequences given the fish community shift towards smaller pelagic species feeding on zooplankton.</p>
Fishery effects on benthos and fish communities	<p>Temporal analyses of the effects of fishing and climate variation suggest that fishing has had a stronger effect on size-structure than changes in temperature. A marked decline in the mean trophic level of the fish community over time has been documented and this has resulted from a reduction in the abundance of large piscivorous fishes such as cod and hake, and an increase in <i>Nephrops</i> and smaller pelagic species such as boarfish (<i>Capros aper</i>) which feed at a lower trophic level.</p> <p>In the Celtic Seas, discarding levels differ between the different fleets but can be as high as two thirds of the total catch with increasing trends in recent years. Discarding of undersized fish is a problem in several fisheries (e.g. cod, haddock, <i>Nephrops</i> and megrim).</p> <p>Sole and plaice are predominantly caught by beam trawl fisheries. Beam trawling, especially using chain-mat gear, is known to have a significant impact on the benthic communities, although less so on soft substrates and in areas which have been historically exploited by this fishing method.</p> <p>The high mud content and soft nature of <i>Nephrops</i> grounds means that trawling readily marks the seabed, trawl marks remaining visible for some time. Despite the high intensity of fishing (some areas are impacted >7 times/year) burrowing fauna can be seen re-emerging from freshly trawled grounds, implying that there is some resilience to trawling.</p> <p>Cetacean bycatch has been noted in some fisheries, including the pelagic trawl fishery for mackerel and horse mackerel in the SW of Ireland, although the numbers caught were low.</p>

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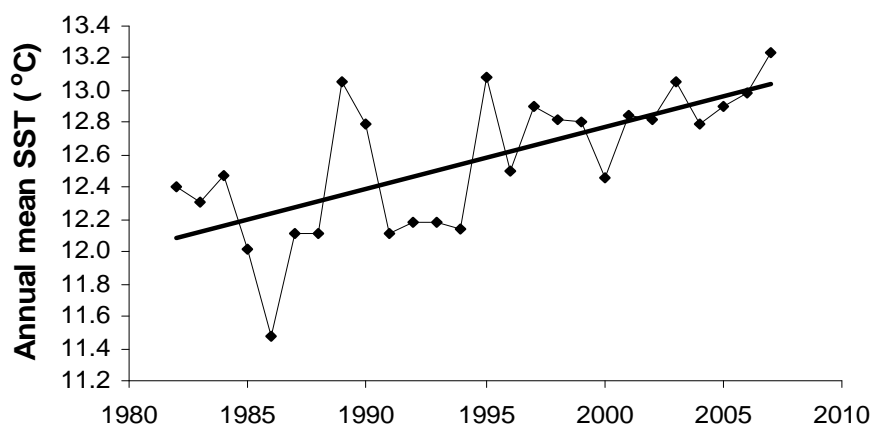
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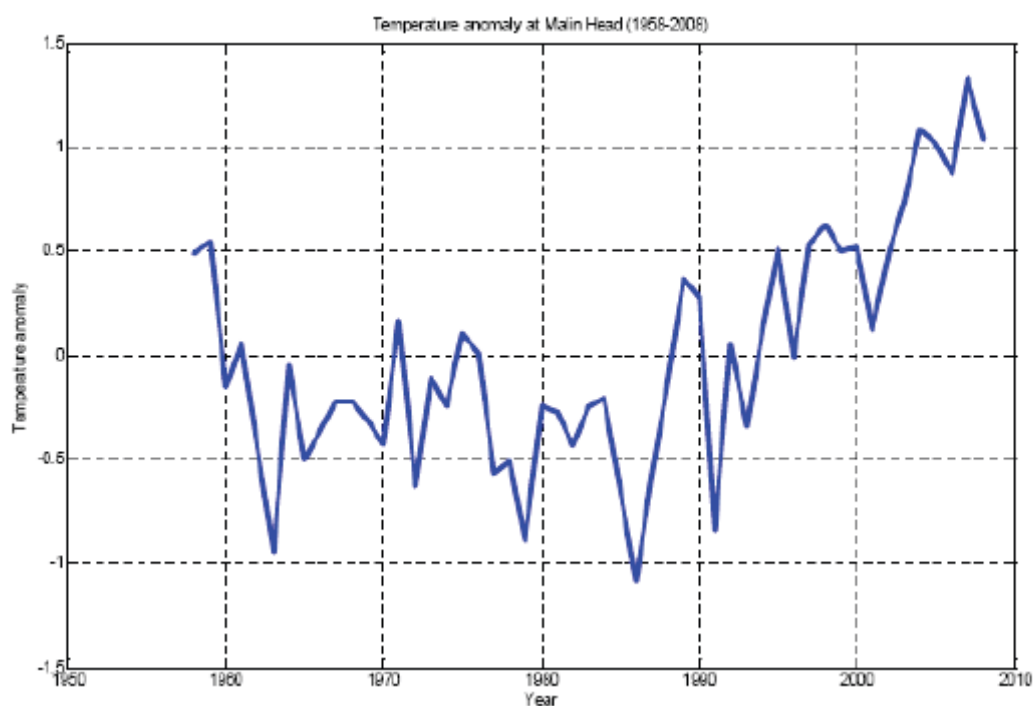
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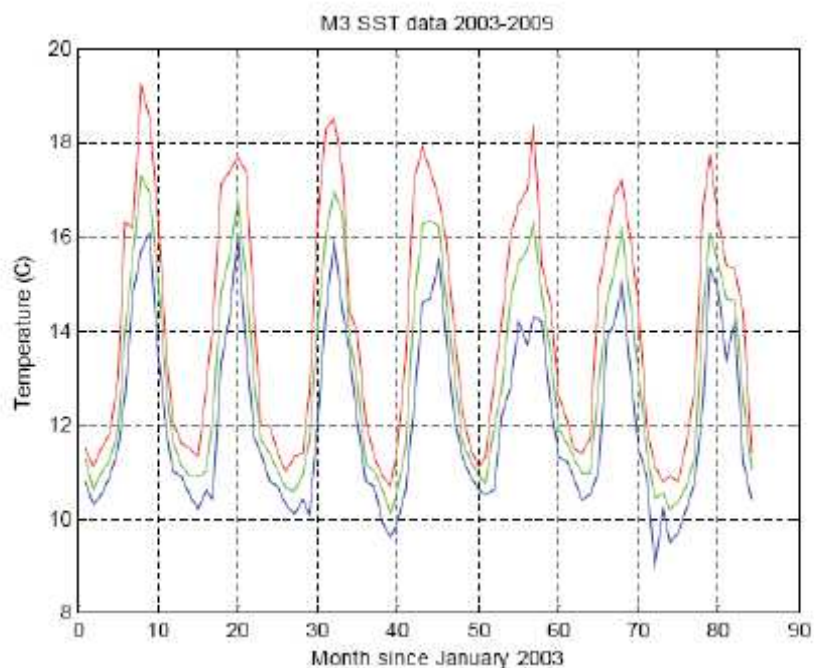
Celtic Sea



Annual mean sea surface temperature in the Celtic Sea (50.0 to 52.5 N and 12 to 3 W) showing positive linear trend.



Sea surface temperature anomaly from Malin Head (Ireland) 1960–2008 (55.39°N 7.38°W).

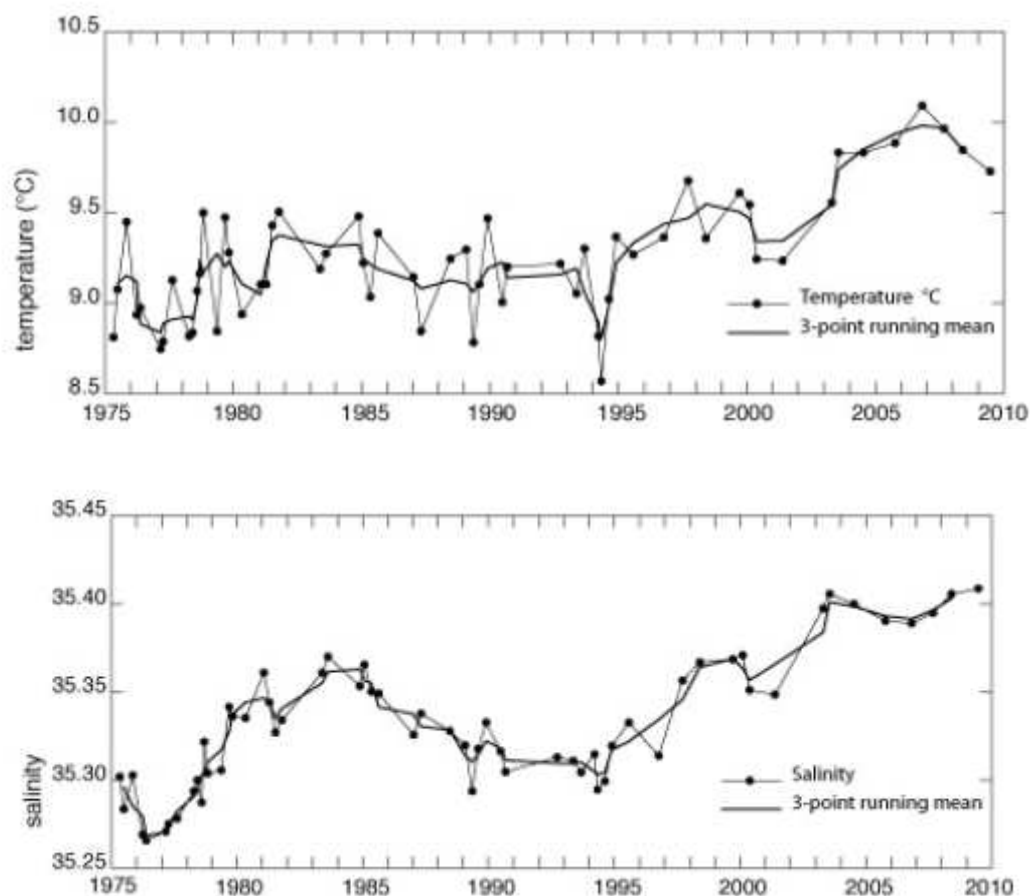


SST at the M3 weather buoy (51.22°N 10.55°W) since its deployment in 2003 (blue is minimum, green is mean and red is maximum monthly values).

(3) Ecosystem overview for West of Scotland and Rockall

Physics	
Bathymetry	This area is limited to the southwest by the Rockall Trough, where the transition between the Porcupine Bank and the trough is a steep and rocky slope with reefs of deepwater corals. Further north, the slope of the Rockall Trough is closer to the coast line. West of the shelf break is the Rockall Plateau with depths of less than 200m. The shelf area consists of mixed substrates, with soft sediments (sand and mud) in the west and rockier pinnacle areas to the east. The area has several seamounts: the Rosemary Bank, the Anton Dohrn sea mount and the Hebrides, which have soft sediments on top and rocky slopes.
Circulation	The shelf circulation is influenced by the poleward flowing 'slope current', which persists throughout the year north of the Porcupine Bank, but is stronger in the summer. Over the Rockall plateau, domes of cold water are associated with retentive circulation. Thermal stratification and tidal mixing generate a northwards running coastal current.
Fronts	The Islay Front is situated between Islay and the Malin shelf.
Temperature	Temperature and salinity in the upper layers of the Rockall Trough during the last 5 years have been high compared to the long-term (30 year) mean. In the deeper waters, the Labrador Sea Water (LSW) is presently cool and fresh compared to the long-term mean. Inshore waters off the west of Scotland also continue to warm with more rapid warming taking place since the mid 1990s.
Biology	
Phytoplankton	The productivity is reasonably high on the shelf but drops rapidly west of the shelf break.
Zooplankton	As is true of the adjacent North Sea, the overall abundance of zooplankton in this region has declined in recent years. Continuous Plankton Recorder (CPR) data in the area show substantial drops in <i>Calanus</i> abundance and these are now below the long term mean. <i>Calanus finmarchicus</i> is known to overwinter in the Faroe-Shetland channel and the abundance of these is known to have been

	reduced in recent years (Edwards <i>et al.</i> , 2008)
Benthos, larger invertebrate, biogenic habitats	The main commercial invertebrate species is Norway-lobster (<i>Nephrops norvegicus</i>), which is targeted on the continental shelf west of Scotland and on the Rockall plateau. Fisheries dredging for scallops and some smaller bivalves exist west of Scotland, as well as pot fisheries exploiting lobster (<i>Homarus gammarus</i>) and brown crab (<i>Cancer pagurus</i>). Biogenic reefs of horse mussels (<i>Modiolus modiolus</i>), maerl and Serpulid worms occur in specific locations.
Fish Community	The shelf edge is a spawning area for mackerel <i>Scomber scombrus</i> and blue whiting <i>Micromesistius potassou</i> . Historically, there were important commercial fisheries for cod, haddock and whiting and a number of flatfish species. Hake <i>Merluccius merluccius</i> and angler fish <i>Lophius</i> spp. are also fished across the whole area. The Rockall plateau has important haddock <i>Melanogrammus aeglefinus</i> and angler fish fisheries. On the shelf, the main resident pelagic species is herring <i>Clupea harengus</i> . Basking shark (<i>Cetorhinus maximus</i>) appears from April through to October.
Birds, Mammals & Elasmobranches	The harbour porpoise (<i>Phocoena phocoena</i>) is the most numerous cetacean and minke whale (<i>Balaenoptera acutorostrata</i>) is found throughout the region. In this area, the Grey seals (<i>Halichoerus grypus</i>) have their largest population in the Northeast Atlantic with the majority of individuals found in the Hebrides. Common seals (<i>Phoca vitulina</i>) are also widespread. There is a high abundance of breeding seabirds, predominantly the common guillemot (<i>Uria aalge</i>), razorbill (<i>Alca torda</i>) and the Atlantic puffin (<i>Fratercula arctica</i>) as well as petrels (including fulmar, <i>Fulmarus glacialis</i>), storm petrel, <i>Hydrobates pelagicus</i> ; Manx shearwater, (<i>Puffinus puffinus</i>); northern gannets (<i>Morus bassanus</i>) and gulls (Laridae).
Environmental signals & implications	Surface waters of the Rockall trough have been steadily warming for some years. The general and continuing reduction of copepod abundance and recent changes in zooplankton composition throughout the region are also causes of major concern given the key role that these organisms play in the food web. Increasing temperature and changes in zooplankton communities are likely to have an impact on the life histories of many species. It is known that similar environmental changes have affected the North Sea herring. There is evidence that there have been recent changes of the productivity of the Division VIaN stock. A negative impact on recruitment with rising sea temperature has been shown for cod in the warmer waters of this species' range, including cod west of Scotland (Brunel and Boucher, 2007).
Fishery effects on benthos and fish communities	There are several depleted stocks e.g. cod and whiting. Furthermore, the level of discarding in some fisheries is significant. Approximately half of the annual catch weight of whiting and haddock are discarded. The effect of fishing on benthic communities is not yet fully understood. The high mud content and soft nature of <i>Nephrops</i> grounds means that trawling readily marks the seabed, trawl marks remaining visible for some time. Burrowing fauna can be seen re-emerging from freshly trawled grounds, implying that there is some resilience to trawling. Some deepwater fisheries on the continental shelves take place in areas where cold water corals (<i>Lophelia</i> spp.) occur, particularly at Rockall. In order to protect cold water corals, four areas (North West Rockall, Logachev Mounds and West Rockall Mounds, Empress of British Banks) are closed since 2007. Ghost fishing and discarding of fish not suitable for consumption due to long soaking times are considered to be problems within some offshore gillnetting carried out by "flag-vessels" which target anglerfish in Subareas IV, VI, and VII. How effective the regulations (Council Regulation (EC) No 43/2009) on gear length and soak time have been in mitigating this phenomenon is unknown.



Temperature and salinity anomalies for the upper ocean (0–800m) of the northern Rockall Trough.

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(4) Ecosystem overview for Deepwater Area

This description covers the benthic deepwater ecosystem and its associated species; for a description of the oceanic water column habitat, please refer to the section of widely distributed and migratory species.

Physics	
Bathymetry	Most of the surface is abyssal plain with an average depth >ca 4 000 m. The continental slope is rocky hard substrate from Ireland southwards and covered with sediment west of the British Isles. Two offshore banks, the Rockall and Hatton Banks are separated from the continental shelf by the Rockall Trough. The north of this advisory region is marked by the Wyville Thomson and Iceland-Faroe Ridges and the south by the Azores. To the west is the mid-Atlantic Ridge (MAR), stretching from Iceland to the Azores. Isolated seamounts occur over the whole basin.
Circulation	The general circulation in the epipelagic zone (0-200m) is a warm current flow from the south-west North Atlantic towards the European coast with several side branches. Cold currents flow south from the Labrador Sea and Irminger Sea and also as a strong deep water flow between Shetland and the Faeroes.
Temperature Salinity	Below about 700m there is little seasonal variation in temperature, average temperatures are 7°C to 8°C at 1000m depth and less than 4°C below 2000m.
Biology	
Phytoplankton	Photosynthetic primary production at the surface is limited in many areas by nutrient availability, except near seamounts and other topographical features that cause upwelling. The depth of primary production is limited to the euphotic zone which reaches a maximum depth of 200m and only a small proportion (1%-3%) may arrive in deeper waters as 'planktonic snow'. Descents of carcasses down the slopes also bring organic matter to the deep environments.
Benthos, larger invertebrate, biogenic habitats	There is little commercial exploitation of large invertebrates in this region. Some bycatch of cephalopods and crabs (<i>Chaceon affinis</i>) occurs in deep-water fisheries. Biogenic habitats occur along the slope, such as those formed by the scleractinian <i>Lophelia pertusa</i> a colonial coral, forming large reefs along the slope, on the offshore banks, on the mid-Atlantic Ridge and on seamounts. Dense and diverse fauna associated with such reefs include fixed (e.g. anthipatarians, gorgonians) and mobile invertebrates (e.g. echinoderms, crustaceans) and has species richness up to three times higher than on the surrounding sedimentary seabed.
Fish Community	The midwater pelagic or <i>mesopelagic</i> zone (200-1000m) has a high diversity and abundance of small fish species, notably Myctophidae, Gonostomatidae and Stomiidae, most of which migrate diurnally and thus bring nutrients into deeper water layers. Fish communities above the abyssal plane in the bathypelagic zone (1000-3000m) include Bathylagidae, Platytroctidae and Searsidae. The species composition of demersal deep water fish community depends on depth. Dominant commercial species at 200-2000m include species such as ling, tusk, roundnose grenadier, orange roughy, deepwater sharks, chimaeriforms and other species such as redfish, monkfish and Greenland halibut. All deepwater shark species and larger deepwater demersal fish are assumed to be highly vulnerable to overexploitation, having a low reproductive capacity. Most fisheries are occurring on the continental slopes, the seamounts and the MAR.
Elasmobranches	Amongst sharks, <i>Centroscyrmnus coelolepis</i> and <i>Centrophorus squamosus</i> , are the two main commercial species (1 - 1.5 m long) are seriously depleted. The status of a number of smaller or less common species (<i>Centroscyrmnus crepidater</i> , <i>Deania calcea</i> , <i>Dalatias licha</i> , <i>Scymnodon ringens</i> , <i>Etmopterus</i> spp. <i>Galeus</i> spp. <i>Apristurus</i> spp.) is less clear.
Environmental signals	The deep sea environment is considered to be less variable than surface

& implications	systems. Moreover, due to the long life span of exploited species, variations in annual recruitment have a relatively minor effect on the standing biomass so short-term variability in the environment is unlikely to have great effects on stocks. Abundance of some deepwater invertebrate species has been linked to the North Atlantic Oscillation but overall it is not known how climate change might change the deep seas in the longer term.
Fishery effects on benthos and fish communities	Modern fishing fleets have caused significant reduction in demersal deepwater fish biomass in just a few years; resulting in the collapse of several fisheries. In addition to catching target species, deepwater fisheries by-catch unwanted species that are either too small or currently unmarketable and discarding rates are often high (up to 50%). Deepwater trawling can also damage deep sea benthic communities, impacting particularly on structurally complex habitats such as <i>Lophelia</i> reefs. Deep-water set nets can also have a negative impact, both on the fish community due to ghost fishing and targeting vulnerable species such as sharks. Long-line fishing can also have negative effects on the ecosystem through breaking off branches of coral, overturning large sponges and may also have some bycatch of seabirds. The degree of perturbation and damage caused by deepwater fisheries depends on their spatial extend and the frequency of their activities.



(5) Ecosystem overview for Widely Distributed and Migratory Stocks

Physics	
Bathymetry	Widely distributed and migratory stocks are considered here in terms of pelagic stocks, generally in waters < 400m depth.
Circulation	The circulation of the North Atlantic Ocean is characterized by two large gyres: the subpolar and subtropical gyres. The anticyclonic subtropical gyre owes its existence to the low-latitude trade winds and mid-latitude westerlies. Some of the water in the subtropical gyre is re-circulated to the west of the Mid Atlantic Ridge (MAR) and some water continues east and crosses the MAR in the Azores Current and the remainder forms the North Atlantic Current (NAC). The NAC loses its jet signature as it turns east and the waters are transported eastward in the Sub Polar Front (SPF). It crosses the MAR in 2 to 4 branches between 45°N and the Charlie Gibbs Fracture Zone. The northern branch that is the main pathway for waters crossing the MAR from the western to the eastern North Atlantic. East of the MAR the SPF makes a sharp turn toward the north.
Fronts	In the northern part of the Barents Sea fresh and cold Arctic water flows from the northeast to southwest. The Atlantic and Arctic water masses are separated by the Polar Front, which is characterized by strong gradients in both temperature and salinity. In the western Barents Sea the position of the front is relatively stable, although it seems to be pushed northwards during warm climatic periods.
Temperature	Overall, the upper layers of the northern North Atlantic and the Nordic seas were warm and saline in 2009 compared with the long-term average. A strong, cold anomaly developed in the surface of the central North Atlantic during summer. In Biscay and the eastern north Atlantic, cold temperatures and strong freshwater input in winter 2009 reduced upper ocean heat content and salinity. Sea surface temperature of the Rockall Trough peaked in October 2006 and has demonstrated a decrease of ca. 0.3°C since then. Conversely, salinity has remained high. In the Faeroe Channel in 2009, record-high values of both temperature and salinity have been observed, while sea surface temperature in the Norwegian Sea, Skagerrak, and Kattegat have been above-average in 2009 (Hughes <i>et al.</i> , 2010).
Biology	
Phytoplankton	Phytoplankton abundance in the NE Atlantic increased in cooler regions (north of 55°N) and decreased in warmer regions (south of 50°N). The effects propagate up through herbivores to carnivores in the plankton food web (bottom-up control), because of tight trophic coupling.
Zooplankton	Broad scale changes have occurred showing that over the last decade there has been a progressive increase in the presence of warm-water/sub-tropical species into the more temperate areas of the northeast Atlantic. This trend seems to be accelerating over the last five years (Edwards <i>et al.</i> 2010). In terms of a productive environment this change is currently considered detrimental because the warmer-water species are not replacing the colder-water species in similar abundances which may negatively impact other trophic levels including fish larvae.
Fish Community	The Blue whiting stock is distributed in European waters from the western Mediterranean Sea to the Barents Sea, around the Canary Islands and the Azores, in the North Sea, west of the British Isles, around the Faeroes, east and south of Iceland, and westwards beyond Cape Farewell. The main spawning area extends from southwest of Ireland, over the Porcupine Bank and further north along the slope to north of the Hebrides. Spawning also takes place in the Rockall Bank area, in the Bay of Biscay and off the Iberian coast, and on a minor scale off the Norwegian coast, in Faroese waters and off the southern

	<p>coast of Iceland.</p> <p>The Norwegian Spring Spawning Herring (NSS Herring) has its distribution area in the Norwegian Sea, the Barents Sea and along the Norwegian coast south to 59°N. During long periods it has also been found north of Iceland during the summer. It is potentially the largest of the herring stocks in the northeast Atlantic.</p> <p>The North East Atlantic mackerel stock ranges between the Iberian Peninsula and the Norwegian Sea and changes with life history stage and migration patterns. NEA Mackerel is divided into three spawning components depending on location of their spawning grounds. Spawning of the North Sea component is concentrated in the western and central part of the North Sea in June. The southern component spawns along the coast of the Iberian peninsula between January to May, while the western component spawns along the European shelf between the Bay of Biscay and the west of Scotland. Timing of spawning is between March and July with peak spawning usually occurring in April to May. Spawning on the shelf is concentrated along the 200 m contour line whereby mackerel are migrating northwards and progressively releasing their eggs.</p> <p>The western horse mackerel stock is distributed along the Bay of Biscay, south and west off the British Isles, in the western Channel, the northern North Sea, the Norwegian Sea and the western part of Skagerrak. Like NEA mackerel, western horse mackerel are closely connected to the shelf contour, and shows distinct areas for spawning, feeding and over-wintering.</p> <p>The southern horse mackerel stock is distributed within the West Iberian Atlantic.</p>
Birds, Mammals & Elasmobranches	<p>The bottlenosed dolphin (<i>Tursiops truncatus</i>) occurs in large numbers in the area, while the common dolphin (<i>Delphinus delphis</i>) is also widely distributed. White-beaked dolphin and white-sided dolphin (<i>Lagenorhynchus albirostris</i> and <i>L. acutus</i>) occur over much of the shelf area. Large baleen whales are found offshore throughout the area and several species have migration routes through these areas. Beaked whales are found in the deep canyons along the continental edge. Seabirds are less common offshore, but closer to land petrels (fulmar and storm-petrel) dominate the seabird populations in the west of Ireland and Celtic Sea region but there are also large breeding colonies of kittiwake, guillemot and gannet.</p>
Environmental signals & implications	<p>Increasing temperature and changes in zooplankton communities are likely to have an impact on the life histories of many species, but particularly on the migratory pelagic species; mackerel, horse mackerel and blue whiting.</p> <p>The position and strength of the North Atlantic sub-polar gyre (SPG) appears to influence the spawning distribution of blue whiting (ICES, 2009a). This could impact on recruitment success through food availability and predation levels. However, these mechanisms are not yet fully understood. Catch and survey data from recent years indicate that the NEA mackerel stock has expanded North-westwards during the summer feeding migration. The change could be a consequence of change in food availability, linked to increased water temperature, and/or increased stock size. For horse mackerel, since 1987, when the strong 1982 year class of the western stock started to appear in the North Sea, there has been a good correspondence in most years between the influx of Atlantic water to the North Sea in the first quarter and the horse mackerel catches taken by Norwegian purse seiners in the Norwegian EEZ (NEZ) during the late (October-November) period of the same year (Iversen <i>et al.</i>, 2002; Iversen, 2007). Norwegian spring spawning herring migrations have been linked to changes in climate and in zooplankton distribution. During 1995-2005, a weak relationship existed between zooplankton biomass in May and</p>

	herring condition in the autumn. The average biomass of zooplankton in the Norwegian Sea in May has been decreasing since 2002 and, measurements of herring fat content from the 2010 summer fishery show much lower values than in recent years.
Fishery effects on benthos and fish communities	As most fishing for widely distributed and migratory stocks is pelagic in nature, there is little or no effect on the benthic community. There is relatively little by-catch of non-target species in these fisheries, which tends to operate with pelagic trawl gear, purse seine nets and handlines. Cetacean bycatch has been noted in some fisheries.

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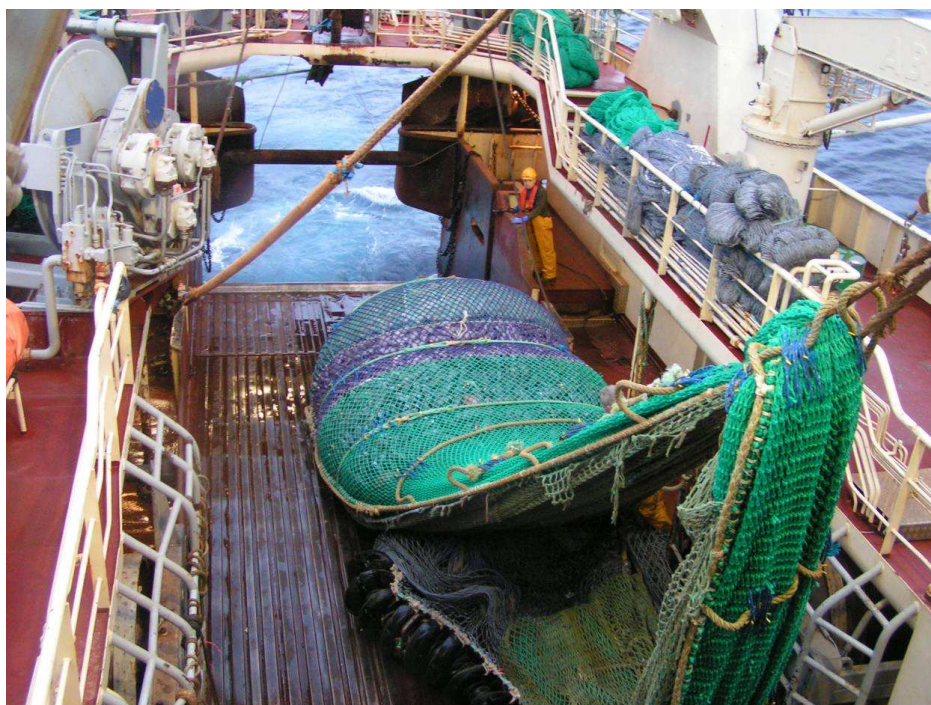
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GLOSSARY

Abundance Index Information obtained from samples or observations and used as a measure of the weight or number of fish which make up a stock.

ACOM Advisory Committee – This ICES group is responsible for compiling and analysing all available fish stock information to compile advice on stock levels and strategies for management.

Acoustic surveys Acoustic surveys use sound waves emitted from a "transducer" to estimate the density of plankton and fish shoals. The survey vessel tows the transducer under water, which is linked to an echo sounder in the vessel which records the shoals of fish as "marks" on a screen or paper trace. The density of these marks is used to calculate total biomass of a stock.

Age The number of years of life completed, here indicated by an Arabic numeral, followed by a plus sign if there is any possibility of ambiguity (age 5, age 5+) ([see http://www.efan.no](http://www.efan.no))

Annual (or seasonal) Total Mortality Rate The number of fish that die during a year (or season), divided by the initial number. Also called actual mortality rate, coefficient of mortality.

Benthic Anything living on, or in, the sea floor.

BIM An Bord Iascaigh Mhara, The Irish Sea Fisheries Board, charged with responsibility for development of the fishing and aquaculture industries in Ireland. ([see http://www.bim.ie](http://www.bim.ie))

Biomass Measure of the quantity, usually by weight in metric tons (2,205 pounds = 1 metric ton), of a stock at a given time.

Biological reference points Various reference points can be defined for fished stocks. These can be used as a management target or a management trigger (i.e. point where more stringent management action is required) Examples include fishing mortality reference points $F_{0.1}$, F_{max} , F_{med} , F_{pa} and biomass reference points B_{pa} and B_{lim} .

By-catch Refers to discarded catch (see Discards) plus incidental catch not purposely targeted by the fishermen.

CECAF Fisheries Committee for the Eastern Central Atlantic – a committee of FAO (see below) and web page http://www.fao.org/fi/body/rfb/cecaf/cecaf_home.htm

CFP / Common Fisheries Policy The instrument of fisheries management within the European community ([see http://europa.eu.int/comm/fisheries/policy_en.htm](http://europa.eu.int/comm/fisheries/policy_en.htm))

Collapse A stock is considered to have collapsed when the spawning stock biomass has been below B_{lim} for three consecutive years.

CPUE / Catch Per Unit of Effort The catch of fish, in numbers or in weight, taken by a defined unit of fishing effort. Also called catch per effort, fishing success, or availability.

Demersal Fish, such as cod, whiting, haddock, sole, plaice, skates and rays, that normally swim in mid-water at or close to the sea floor.

Discard Discards are defined as that part of the catch returned to the sea as a result of economic, legal or other considerations.

Discard rate The percentage (or proportion) of the total catch which is discarded.

Ecosystems are composed of living animals, plants and non living structures that exist together and 'interact' with each other. Ecosystems can be very small (the area around a boulder), they can be medium sized (the area around a coral reef) or they can be very large (the Irish Sea or even the eastern Atlantic).

Elasmobranchs Fish, such as skates, rays, sharks and dogfish, whose skeletons are cartilaginous rather than boney (as in the teleost species such as cod, whiting, plaice and herring).

Emergency Measures Measures adopted by the EU prior to the introduction of cod and hake as part of the recovery plan.

Exploitation pattern The distribution of fishing mortality over the age composition of the fish population determined by the type of fishing gear, area and seasonal distribution of fishing, and the growth and migration of the fish. The pattern can be changed by modifications to fishing gear, for example, increasing mesh or hook size, or by changing the ratio of harvest by gears exploiting the fish (e.g., gill net, trawl, hook and line, etc.).

Exploitation rate The proportion of a population at the beginning of a given time period that is caught during that time period (usually expressed on a yearly basis). For example, if 720,000 fish were caught during the year from a population of 1 million fish alive at the beginning of the year, the annual exploitation rate would be 0.72.

Fishing Effort The total fishing gear in use for a specified period of time. When two or more kinds of gear are used, they must be adjusted to some standard type.

Fishing Mortality Deaths in a fish stock caused by fishing.

Gadoids An important family of food fish, including cod, haddock, rocklings, hake, whiting, blue whiting and ling. Usually characterised by the presence of a barbel on the chin.

Gill nets Static nets suspended in the water column to trap fish by the gills.

Groundfish Species of demersal fish dwelling on, or close to the sea floor, as targeted in the annual FSS groundfish surveys around the Irish coast.

Fleet A physical group of vessels sharing similar characteristics in terms of technical features and/or major activity (e.g. the Irish beam trawler fleet < 300 hp, regardless of which species or species groups they are targeting).

Fishery Group of vessel voyages targeting the same (assemblage of) species and/or stocks, using similar gear, during the same period of the year and within the same area (e.g. the Irish flatfish-directed beam trawl fishery in the Irish Sea).

ICES International Council for the Exploration of the Seas –Ireland shares the Total Allowable Catches TACs for many stocks we exploit with our European Union partners. Because of this international dimension many stocks need to be assessed in an international fora such as ICES. ([see: http://www.ices.dk/](http://www.ices.dk/))

ICCAT International Commission for the Conservation of Atlantic Tuna – ([see: http://www.iccat.es/](http://www.iccat.es/))

IFREMER France's national marine research agency – (<http://www.ifremer.fr/anglais/>)

Inshore fisheries There are various definitions of inshore fisheries including those fisheries that are conducted within 12 miles of the shore, including demersal, pelagic, shellfish and sea angling fisheries.

MCS Marine Conservation Society

Management Plan is a agreed plan to manage a stock. With defined objectives, implementation measures, review processes and stakeholder agreement and involvement.

Maximum Sustainable Yield / MSY The largest average catch or yield that can continuously be taken from a stock under existing environmental conditions. (For species with fluctuating recruitment, the maximum might be obtained by taking fewer fish in some years than in others.) Also called maximum equilibrium catch, maximum sustained yield, sustainable catch.

Métier Homogeneous Subdivision of a fishery by vessel type (e.g. the Irish flatfish-directed beam trawl fishery by vessels < 300 hp in the Irish Sea).

MPA / Marine Protected Area A conservation area in the sea usually designated for the protection and maintenance of biological diversity and natural and cultural resources.

Natural Mortality Deaths in a fish stock caused by predation, illness, pollution, old age, etc., but not fishing.

OSPAR The Oslo and Paris Commissions, which have the objective of protecting the Northeast Atlantic against pollution. Member countries range from Finland to Portugal and Iceland.

Pelagic Fish that spend most of their life swimming in the water column, as opposed to resting on the bottom, are known as pelagic species.

Precautionary Approach The precautionary approach should be widely applied to conservation, management and exploitation of living aquatic resources in order to protect them and preserve the aquatic environment. The absence of adequate scientific information should not be used as a reason for postponing or failing to take conservation and management measures.

Quota A portion of a total allowable catch (TAC) allocated to an operating unit, such as a Vessel class or size, or a country.

Rate Of Exploitation The fraction, by number, of the fish in a population at a given time, which is caught and killed by man during the year immediately following. The term may also be applied to separate parts of the stock distinguished by size, sex, etc. Also called fishing coefficient.

Rebuilding Plan (See Recovery Plan)

Recovered A stock is considered to have recovered when the spawning stock biomass has been above B_{pa} for three consecutive years

Recovery Plan This is a multi-annual plan to recover a seriously depleted stock. The plans generally involve agreed Harvest control Rules, Technical Measures, effort controls and various control and enforcement measures.

Recruitment The amount of fish added to the exploitable stock each year due to growth and/or migration into the fishing area. For example, the number of fish that grow to become vulnerable to the fishing gear in one year would be the recruitment to the fishable population that year. This term is also used in referring to the number of fish from a year class reaching a certain age. For example, all fish reaching their second year would be age 2 recruits.

Recruitment overfishing The rate of fishing above which the recruitment to the exploitable stock becomes significantly reduced. This is characterised by a greatly reduced spawning stock, a decreasing proportion of older fish in the catch, and generally very low recruitment year after year.

Relative Abundance An estimate of actual or absolute abundance; usually stated as some kind of index; for example, the average catch per tow on a survey.

SACs Special Areas of Conservation, sites designated under the European Community Habitats Directive, to protect internationally important natural habitats and species.

SPAs Special Protection Areas (SPAs) are strictly protected sites classified in accordance with Article 4 of the EC Birds Directive, which came into force in April 1979. They are classified for rare and vulnerable birds, and for regularly occurring migratory species.

Sample A proportion or a segment of a fish stock which is removed for study, and is assumed to be representative of the whole. The greater the effort, in terms of both numbers and magnitude of the samples, the greater the confidence that the information obtained is a true reflection of the status of a stock (level of abundance in terms of numbers or weight, age composition, etc.)

Shellfish Fisheries Those fisheries where the target species are either crustaceans (e.g. *Nephrops*, lobsters, crabs and crayfish) or molluscs (Cephalopods, scallops, oysters etc.).

STECF The Scientific Technical and Economic Committee on Fisheries. Established by the European Commission and comprises fisheries scientists and economists from the member states. The role of STECF is to advise the European Commission on scientific, technical and economic issues related to the management of fisheries resources that are exploited worldwide by members of the European Union.

Stock A "stock" is a population of a species living in a defined geographical area with similar biological parameters (e.g. growth, size at maturity, fecundity etc.) and a shared mortality rate. A thorough understanding of the fisheries biology of any species is needed to define these biological parameters.

SSB / Spawning Stock Biomass The total weight of all sexually mature fish in the population. The size of SSB for a stock depends on abundance of year classes, the exploitation pattern, the rate of growth, fishing and natural mortality rates, the onset of sexual maturity and environmental conditions.

Sustainable yield The number or weight of fish in a stock that can be taken by fishing without reducing the stock biomass from year to year, assuming that environmental conditions remain the same.

TAC / Total Allowable Catch is the total regulated catch from a stock in a given time period, usually a year.

TCM / Technical Conservation Measures These measures take the form of closed areas, increased mesh sizes and gear modifications (such as separator panels) and are aimed at protecting specific stocks, or age-classes within that stock, from overfishing (See also Recovery Plans).

Whitefish Term used to describe demersal species such as cod, plaice, ray etc., as opposed to pelagic or salmonid species.

Year class (or cohort) Fish in a stock born in the same year. For example, the 1987 year class of cod includes all cod born in 1987, which would be age 1 in 1988. Occasionally, a stock produces a very small or very large year class which can be pivotal in determining stock abundance in later years.

Yield-per-recruit The expected lifetime yield-per-fish of a specific age (e.g., per age 2 individual). For a given exploitation pattern, rate of growth, and natural mortality, an expected equilibrium value of Y/R can be calculated for each level of F.



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“The future Common Fisheries Policy must be
set up to provide instruments to support
an ecosystem approach”

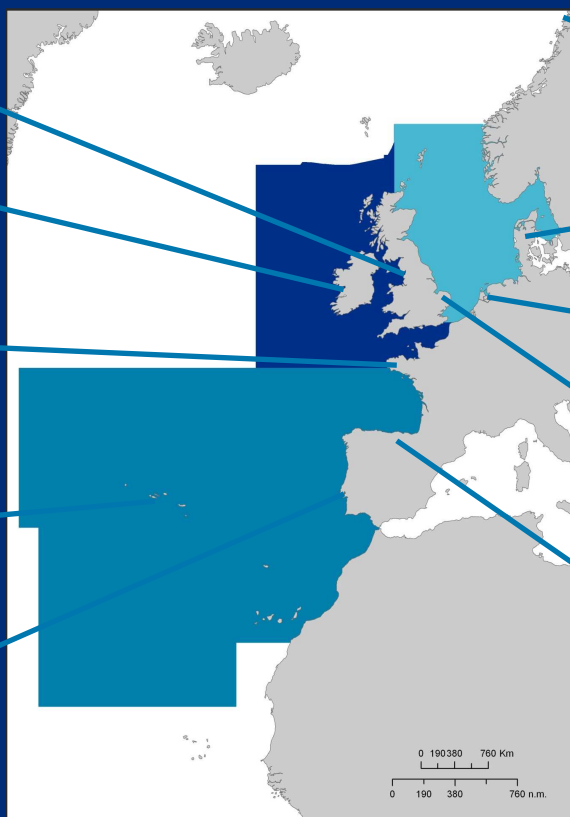
Reform of the Common Fisheries Policy
Green Paper (2009)



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