



**ORCA** *Looking out for  
Whales and Dolphins*

# THE STATE OF EUROPEAN CETACEANS

This report has been produced by ORCA, based on marine survey data collected by its volunteer network of Marine Mammal Surveyors between 2006-2015.



**WITH  
PLYMOUTH  
UNIVERSITY**

 **IFAW**  
International Fund for Animal Welfare

# FOREWORD



I am a huge fan of ORCA. It has a critical role to play in efforts to care for whales, dolphins and porpoises in European waters and, best of all, it gets the job done. In particular, I love the fact that it relies on an outstanding and tireless army of trained volunteers. These are the kind of people, from all walks of life and of all ages, who give up their time to make a real difference. And they do just that - they make the world a better place.

**‘The State of European Cetaceans’** is testament to a decade of research undertaken by these volunteers. Quietly and methodically, they have been creating a much more complete picture of the cetaceans in our seas: which species live where, what threats they face and, most importantly, what needs to be done to protect them. This long-term monitoring is absolutely essential if we are to secure a future for our whales, dolphins and porpoises through, for example, the creation of Marine Protected Areas. But it’s also important in enabling us to identify – and tackle - problem areas and marine issues in real time.

This is a highly valuable and impressive report. I sincerely hope that it results in significantly better protection and inspires even more people to help with this important work. If we can’t look after animals as awe-inspiring, enigmatic and downright remarkable as cetaceans, what can we do?

**Mark Carwardine**

Marine wildlife expert, photographer and ORCA patron



Humpback whale



# EXECUTIVE SUMMARY

## Overview

This report provides an overview of the status of cetaceans (whales, dolphins and porpoises) within European waters and identifies marine areas and species that are of greatest importance. The insight this gives us is used to make arguments for the amending or creation of Marine Protected Areas, as well as promoting changes to human activities that occur within their habitats.

Over the past decade, the UK whale and dolphin conservation charity, ORCA, has trained thousands of volunteer Marine Mammal Surveyors, who are deployed on the European cruise and ferry network as a platform from which to monitor whales and dolphins. Thanks to the surveyors efforts, ORCA has surveyed 179,342km of European waters through 376 surveys. In total 4,340 sightings (when a cetacean or group of cetaceans is seen by observers) have been recorded, which consisted of 42,817 animals and 22 different cetacean species. These sightings occurred across nine sea regions, which are based on the OSPAR convention (North Sea, English Channel, Celtic Seas, Irish Sea, Minches and West Scotland, Bay of Biscay and Iberian Coast, Mediterranean Sea, Arctic Waters and the Wider Atlantic).

## Key Points

### Protected Marine Spaces Vital

This report underlines the vital need for protected areas for cetaceans given the increasingly wide range of threats they face. Cetacean protected areas need to be flexible and dynamic enough to respond to emerging evidence about mobility and the annual migratory nature of cetaceans. They also need to be dynamic enough to place immediate restrictions on invasive commercial activity in the zones designated for protection if deemed necessary. For instance, ORCA's research has already identified and established a clear habitat preference (Southern Bay of Biscay) for beaked whales which are particularly susceptible to low frequency sonar resulting in mass stranding. This area needs protection. The Bay of Biscay and Iberian Coast recorded the highest species diversity with 17 species recorded. This whole region needs to be internationally recognised and designated as an Important Marine Mammal Area (IMMA).



### Serious Fishing Threat to Harbour Porpoises

The harbour porpoise is one of the most threatened cetaceans in Europe due to its preference for coastal zone habitats, with its principal threat being accidental catches in fishing gear (by-catch). The harbour porpoise was recorded across all the sea regions except the Mediterranean Sea. Existing protected harbour porpoise sites must be flexible and dynamic enough to respond to emerging evidence of shifting patterns in harbour porpoise distribution, which this ORCA report highlights. Of all species recorded, the harbour porpoise was observed the most with 1,544 sightings (3,552 animals). The North Sea produced the highest number of sightings of all sea regions, with the majority occurring in southern areas. This evidence corroborates the last two Small Cetacean Abundance in the North Sea and Adjacent Waters (SCANS) surveys, which have indicated a major shift in distribution from northern to southern areas within the North Sea.

## ORCA's Top Ten Hit List

After the harbour porpoise the common dolphin recorded the second highest number of individual sightings (1,216), followed by minke whale (309), fin whale (292), white-beaked dolphin (215), bottlenose dolphin (172), striped dolphin (145), humpback whale (78), long-finned pilot whale (71) and sperm whale (68).

## Bottlenose Dolphin Sightings in North Sea

Historically bottlenose dolphin sightings in the North Sea have been uncommon, but since 2006, ORCA surveyors have recorded 105 individuals. The bottlenose dolphin was sighted across all the nine sea regions; 1,424 animals in total. The highest sightings of this species were observed in the Bay of Biscay and Iberian Coast, primarily around the southern shelf and shelf edge with 81 of the 172 sightings occurring here.

## High White-beaked Dolphin Numbers in North Sea

Over 40% of the white-beaked dolphin sightings occurred in the North Sea. White-beaked dolphins typically prefer the cool temperate climate of the North Atlantic around Iceland, Svalbard and Norway and this was reflected in ORCA's data with the highest encounters (125) being recorded in Arctic Waters. However, 87 encounters of white-beaked dolphins occurred in the North Sea with group sizes reaching up to 100 individuals.

## Minke - Most Common Whale

The minke whale was observed in all sea regions and was the most frequently sighted whale. The highest numbers were recorded in Arctic Waters followed by the North Sea. The minke whale was the third most sighted cetacean with 309 encounters (371 individuals), 85% of sightings being of a single individual. Most sightings were recorded in coastal and shelf regions and peaked in July and August in the North Sea, suggesting a seasonal migration up to the colder Arctic waters.

## Devon and Cornwall Waters Identified as Key Cetacean Area

Eight species of cetacean were recorded in the English Channel including Risso's dolphins, pilot whales and an unusual sighting of a humpback whale off Kent in March 2015. This region is the third most surveyed area with 26,739km of effort undertaken. The harbour porpoise was the most frequently sighted cetacean with 192 encounters and 396 individuals. The highest encounter rate and species diversity for all cetaceans was recorded off Devon and Cornwall.

## Bay of Biscay Top for Species Diversity

Of all the areas surveyed the Bay of Biscay showed the most diversity with 16 species recorded. ORCA and other surveys have identified that a third of all species of whale can be found in the Bay's waters. Species identified in these surveys included blue whales, sei whales, orcas, sperm whales, false killer whales and the elusive beaked whales. The common dolphin was the most frequently sighted cetacean in this region, with 740 sightings consisting of 19,779 individuals, with the highest encounter rate occurring in the outer Bay. This was followed by the fin whale, with 217 encounters comprising of 335 individuals, which peaked in the summer months of August and September.

## Elusive Beaked Whales Regularly Sighted

A total of 166 encounters of the most elusive group of whales were recorded. Beaked whales are the least studied cetacean globally. This group of cetaceans were recorded in four of the nine sea regions and included the Cuvier's beaked whale, northern bottlenose whale, Sowerby's beaked whale and True's beaked whale. A total of 350 animals were sighted. The majority of the beaked whales were observed over the southern shelf and deep-sea canyons of the Bay of Biscay and Iberian Coast, with 131 encounters consisting of 260 individuals animals recorded in the sea region.



## Super Pods of 3000 Common Dolphins Recorded

The short-beaked common dolphin was observed in all sea regions with the exception of Arctic Waters and accounted for 27.9 % of all the cetacean sightings across all sea regions (29,160 individuals). The majority of sightings occurred in the Bay of Biscay, where the average group size consisted of 24 individuals, however super pods of 3000 common dolphins were also observed.

## Threats to Cetaceans Continue to Grow

Although some may interpret these figures as an indication of a diverse population of cetaceans in European waters, significant existing and emerging threats continue to impact adversely on their habitat. There is every possibility that the minke whales we are seeing in the North Sea fall victim to commercial whaling operations in Norway and Iceland. The incidental and often fatal capture of cetaceans as by-catch is exacerbated by overfishing. Marine pollution is now recognised as being one of the most serious issues of environmental concern in modern age. Ship strikes pose a serious risk of injury and fatality to cetaceans in busy commercial waters, such as the Bay of Biscay, and ORCA is working with the shipping industry to address the issue and minimise this threat. The only way to adequately protect cetaceans is to safeguard their marine spaces.

## Ongoing Monitoring of Cetaceans is Vital

ORCA's findings in this report illustrate why ongoing monitoring of cetaceans in the field is so vital. The compilation and analysis of real-time, long-term data is critical in being able to make authoritative and informed decisions about the protection required for cetaceans. ORCA's work has conclusively shown that utilising ferry and cruise platforms for observation is a highly effective tool in determining the distribution and range of these animals. But whilst ORCA can provide an army of watchful eyes, thanks to our volunteer surveyors, we also need action from governments when the evidence gathered demonstrates the risk to cetacean populations from emerging threats to the animals themselves or to the habitat in which they live.



Striped dolphin

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# Acknowledgements

## Shipping partners

We would like to extend our overwhelming gratitude to our shipping partners without whom the survey data collection could not be possible. In particular our longstanding partners Brittany Ferries, DFDS and Saga.



## A thank you to ORCA's volunteers

ORCA's offshore monitoring programme is entirely reliant on our network of volunteer Marine Mammal Surveyors. Each one has played a role in this vital monitoring work, which can only take place thanks to their contribution – whether in the past, present or future.

This report is a testament to their skill, time, effort and dedication.



Atlantic spotted dolphin

# About ORCA

ORCA is a UK whale and dolphin conservation charity dedicated to the long-term protection of whales, dolphins and porpoises (collectively known as cetaceans) and their habitats in UK, European and adjoining waters. Founded in 2001, ORCA works to monitor vulnerable cetacean populations and helps to protect threatened marine habitats. Working with governments, research institutions and other conservation charities, we aim to create safer places for cetaceans, ultimately promoting the health and well-being of the wider marine ecosystem.

Alongside its dedication to cetaceans, ORCA is passionate about people; in fact, the charity's work is as much about people as it is about whales and dolphins. What makes ORCA unique is the way we combine accessible marine education with our conservation activities, allowing us to give people from all walks of life opportunities to take an active role in marine science and conservation. We are making science less exclusive and more accessible and tangible. We train volunteers to join our survey teams, become Wildlife Officers to inspire ferry and cruise passengers and support our educational programmes. ORCA's projects reach over 40,000 people of all ages each year providing memorable educational activities and remarkable local wildlife experiences both on and offshore. By doing so, we are enabling local communities to become stewards of local whales and dolphins and the marine environment in which they live.





## Partner organisations in this report



### International Fund for Animal Welfare (IFAW)

IFAW's mission is to rescue and protect animals around the world by rescuing individuals, safeguarding populations and preserving habitat.

Whales face more threats today than ever before and through campaigning, research and political advocacy IFAW's Whale Programme is leading the fight to save whales. Our work to protect whales straddles a range of activities, including: campaigning to end commercial whaling, using international law and conventions and working inside whaling countries to change attitudes; protecting whale habitats, by advocating the establishment of sanctuaries and protected areas for important whale feeding, breeding, and migratory areas; and reducing lethal injuries to whales from human activities such as noise pollution, entanglements in fishing gear and ship strikes.

IFAW is pleased to support the publication of the sightings data collected by ORCA in this report. By providing financial support for this undertaking, IFAW is seeking to ensure there is more data in the public domain, which can further support scientific efforts to understand distribution of whales, dolphins and porpoises in European waters. IFAW welcomes ORCA's commitment to citizen science and the benefits this brings in engendering positive attitudes towards cetaceans that share our world.



### Plymouth University

The School of Engineering and Marine Science at Plymouth University undertook the analysis work on the ORCA data using ArcGIS® and R Programming. Effort, species richness and encounter rate graphics and tables were compiled by their team for this publication.

## The report and its purpose

The State of European Cetaceans is the first in what will subsequently be ongoing annual reports summarising the distribution and range of cetacean populations in and around Europe's waters using vessels of opportunity (namely cruise ships and ferries), and commenting on matters impacting cetacean populations. Over the past decade, teams of trained ORCA volunteer Marine Mammal Surveyors have headed out to sea using the European cruise and ferry network as a platform from which to monitor whales and dolphins.

This report is the culmination of 10 years' worth of sightings and environmental data collected during the 376 ORCA surveys conducted between 2006-2015. Wherever possible, cetacean encounter rates, species richness and distribution trends have been calculated within the seven European sea regions in which ORCA operates and specific species (harbour porpoise, bottlenose dolphin, white-beaked dolphin, short-beaked common dolphin, minke whale and beaked whales). The geographical range of ORCA's surveys does however extend beyond the territorial seas of Europe with cruises journeying up into Arctic regions and embarking on trans-Atlantic crossings to North America. Therefore, analysis has also been undertaken to report on the distribution and range of cetaceans in these areas.

The sea regions are based on the OSPAR classification but some have been split into sub-regions where there is concentrated effort in those areas. Species specific information is focused on the priority cetacean species highlighted by the European Union (EU) and includes the harbour porpoise and bottlenose dolphin.

The ORCA cetacean monitoring programme, particularly in the offshore environment, provides an evidence base to justify the creation of more protected areas, and the introduction of more regulatory measures to protect cetaceans. ORCA's work is designed to better inform policy makers responsible for environmental protection by highlighting critical habitats that require urgent protection from the threats cetaceans face today, specifically habitat destruction/disruption, shipping activity, noise and marine pollution. Creating and then safeguarding habitats for cetaceans using ongoing monitoring and research is the only way to achieve long-term protection for our whales, dolphins and porpoises.



# Introduction

The world's oceans are home to approximately 90 species of cetacean of which a third can be seen in European waters. This number includes species such as the blue whale, killer whale (orca) and the more elusive beaked whales. Throughout history, cetaceans have faced numerous threats from whaling since the 1900's to the modern problems of overfishing, pollution, habitat degradation and the impacts of climate change.

Informed assessments about relative threats to, or safety of, cetacean populations can only be derived from detailed and ongoing study about their populations, range and the threats that they face. Some species of cetacean move between vast areas of ocean and across boundaries of national responsibility making legal frameworks complex and difficult to enforce.

Whales and dolphins are recognised as an "umbrella species". They need to be able to live and roam in large habitats and so by protecting their marine spaces there will be positive outcomes for the entire ecosystem within that area.

ORCA's monitoring work is vital not only in bringing about conservation benefits to cetaceans but to the wider well-being of our oceans.



## How are cetaceans protected under European law?

Various pieces of wildlife and environmental legislation are in place in the UK and Europe designed to help protect cetaceans within their marine environment. The principal legal protection for cetaceans in Europe is typically the creation of Marine Protected Areas (MPAs) or the implementation of legislation that controls third-party behaviour throughout the ocean e.g. constraints on fishing.

It is, however, debatable as to the extent that MPAs can afford cetaceans either the best possible protection, or the most legally enforceable. MPAs are typically created within a nation's territorial waters and are static in nature. In contrast cetaceans are highly mobile with the highest percentage of species found in offshore waters. Simultaneously, ORCA is observing and now reporting greater dynamism and fluctuation of observed cetacean species and populations. The oceanic habitat map is changing in front of our eyes. This is why ORCA's work is so vital, as we are one of a very few organisations monitoring cetaceans consistently on the high seas.

There are two key legal instruments relevant to cetacean protection in Europe; the Habitats Directive (Council Directive 92/43/EEC) and the Marine Strategy Framework Directive (MSFD) (2008/56/EC). The Habitats Directive is the primary basis for regulatory action for cetaceans; 11 cetacean species are listed and are subdivided across two annexes. Cetaceans listed under Annex II require the designation of Special Areas of Conservation (SAC); unfortunately only harbour porpoises and bottlenose dolphins qualify for this high level of protection. An Annex IV listing highlights the need for strict protection, with Member States having a legal requirement to ensure that all of the 11 species of cetacean listed across both annexes maintain Favourable Conservation Status (FCS) (Table 1). The overriding aim of the MSFD is to achieve 'Good Environmental Status' (GES) by 2020 across Europe's marine environment. To do this, the MSFD established four European Marine Regions based on geographical and environmental criteria, one of which is the North-East Atlantic Marine Region (NEAMR). NEAMR is further divided into five sub-regions (Figure 1), which are coordinated through the OSPAR Convention, the legislative instrument regulating the international cooperation on the

environmental protection in the north-east Atlantic. ORCA predominately surveys in the NEAMR region and for the purpose of this report OSPAR sub-region classifications have been used to describe the sea regions' surveyed across this 10 year period. Within Descriptor IV of the framework, cetaceans have been

Species	Annex
Harbour porpoise ( <i>Phocoena phocoena</i> )	II; IV
Bottlenose dolphin ( <i>Tursiops truncatus</i> )	II; IV
Atlantic white-sided dolphin ( <i>Lagenorhynchus acutus</i> )	IV
Risso's dolphin ( <i>Grampus griseus</i> )	IV
Short-beaked common dolphin ( <i>Delphinus delphis</i> )	IV
White-beaked dolphin ( <i>Lagenorhynchus albirostris</i> )	IV
Killer whale ( <i>Orcinus orca</i> )	IV
Long-finned pilot whale ( <i>Globicephala melas</i> )	IV
Fin whale ( <i>Balaenoptera physalus</i> )	IV
Minke whale ( <i>Balaenoptera acutorostrata</i> )	IV
Sperm whale ( <i>Physeter macrocephalus</i> )	IV

**Table 1** Cetacean species protected under Annex II and IV of the EU Habitats Directive.

recognised as an indicator species to assess GES. This further reinforces the significance of ORCA's ongoing data collection as a means of informing the MFS. Across EU member states, information collated from cetacean monitoring schemes is being used to assess how human activities are impacting the marine ecosystem. This is undertaken by assessing any contraction or narrowing in the range and distribution of key cetacean species.

The most recent development in the global effort to improve protection for cetaceans is the creation of International Marine Mammal Areas (IMMAs), coordinated by the International Union for Conservation of Nature and Natural Resources (IUCN) Task Force. The creation of an IMMA will be non-statutory designation, highlighting areas that



**Figure 1** North-East Atlantic Marine Region (NEAMR) - Five sub-regions coordinated through the OSPAR Convention.

are important for cetaceans using strict assessment criteria for designation. The rationale is that IMMAs could link with pre-existing conservation strategies e.g. Key Biodiversity Areas, Ecologically or Biologically Significant Areas and the Convention on Migratory Species, which will help accelerate the process of habitat protection for marine mammals and the ecosystems that support them.

In order to inform current EU policy, patterns in the range and distribution of cetacean species have been investigated and marine areas important for cetacean conservation have been identified and highlighted.

## Survey methodology

ORCA surveys utilise distance sampling through line-transect surveys, which is a widely employed sampling method for estimating cetacean density and/or abundance. Surveys are conducted by a fully trained team of three or four volunteer ORCA Marine Mammal Surveyors from the ship bridge, or forward facing platform, of ferry and cruise ships.

A standardised survey protocol is adhered to, ensuring data collection is rigorous and comparable (Appendix I).



## Data analysis

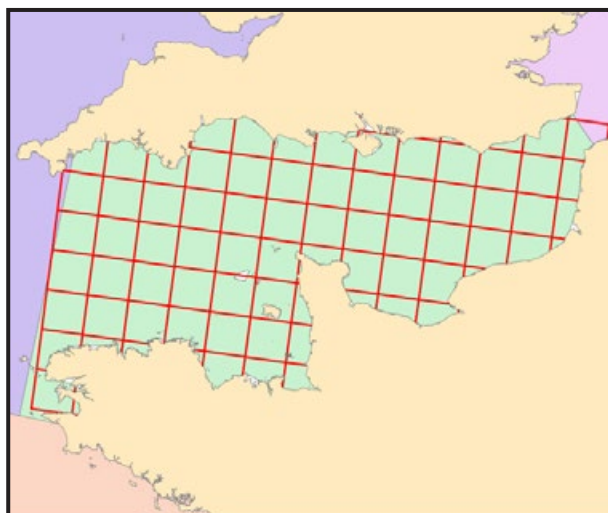


Figure 2 An example of the 20x20nm grid within the English Channel.

The data was analysed both by region and route. A 20x20nm (nautical mile) grid with an equal area projection was used for the entire dataset in ArcGIS® (Figure 2). The grid was generated in an equal area projection (Albers), for a wide region with a central meridian of 0 degrees. This grid was then cropped to the full extent of the study area and assigned to a study region based on OSPAR shapefiles, using the INTERSECT function in ArcGIS®. Cells were assigned to a region as accurately as possible whilst retaining the whole grid cells. Grid cells were omitted from subsequent analyses if no survey effort was conducted within them. For ferry route analyses, grid cells were selected from the base grid by visual selection based on the specific ferry effort transects. Where certain grid cells were shared between ferry routes, these were analysed separately for route specific statistics, but joined for overall encounter rate calculation.

Effort data was first cleaned using geographical plots to determine errant effort segments. Data that could not be corrected was removed from analyses. Over 99% of the effort data was retained for analyses. All mapping was carried out in ArcGIS®. Effort data was transformed into polylines based on the start and end GPS coordinates of each survey and then statistics were pulled for each. Effort polylines and associated metadata was then attached to the relevant grid cell, based on spatial relationships, for either display or further analyses in the R statistical coding environment.



All maps and map layers were projected in Albers equal-area conic projection. Once relevant analyses had been conducted, data was attached to each grid cell ID for display and map production.

All analyses conducted related to effort. Effort is defined as the distance (in km) travelled in a specific area during which continuous observations were carried out. The length of the transects across the grid was calculated for each month by sea region and then by route. For each sea region and route, species richness was calculated for each grid cell. Species richness (Gotelli and Colwell, 2001) is the total number of different cetacean species encountered in that grid cell over the whole time period (2006-2015). This was not corrected for effort, therefore higher effort will result in higher species richness (Piechaud and Embling, 2015).

Encounter rate was also calculated for those cetacean species or groups of species with sufficient sightings in each sea region and route. Encounter rate is defined as; the number of encounters (or sightings) when a cetacean, or group of cetaceans is sighted by the observers per 100km travelled (Silva *et al.* 2014).

Encounter rate (ER) =  $ns/L \times 100$  **ns** is the number of encounters, **L** is the total effort

For encounter rates and effort maps the value groupings have been determined using Jenks natural breaks classification method.

Species specific analyses were conducted (where sufficient data was available) for cetaceans listed under Annex II and IV of the Habitats Directive and for species that are currently data deficient. Harbour porpoise can be particularly challenging to observe in high sea states (Barlow *et al.* 2001; Teilmann, 2003), therefore encounters above a Beaufort sea state 3.5 were excluded from analyses.

# SURVEY OVERVIEW



## ORCA survey areas

ORCA's surveys traverse numerous bodies of waters in the north-east Atlantic and so have been largely defined as the designated OSPAR sea regions, although some regions have been further divided. This has resulted in the following nine survey areas, also known as sea regions; Arctic Waters (OSPAR Region I); Greater North Sea (OSPAR Region II), which has been subdivided to produce a separate region for the English Channel; Celtic Seas (OSPAR Region III), which has been subdivided to give separate regions for the Irish Sea and Minches and West Scotland; Bay of Biscay and Iberian Coast (OSPAR Region IV); Wider Atlantic (OSPAR Region V); and Mediterranean Sea (Figure 3). The routes are referred to by a specific route code (Table 2).

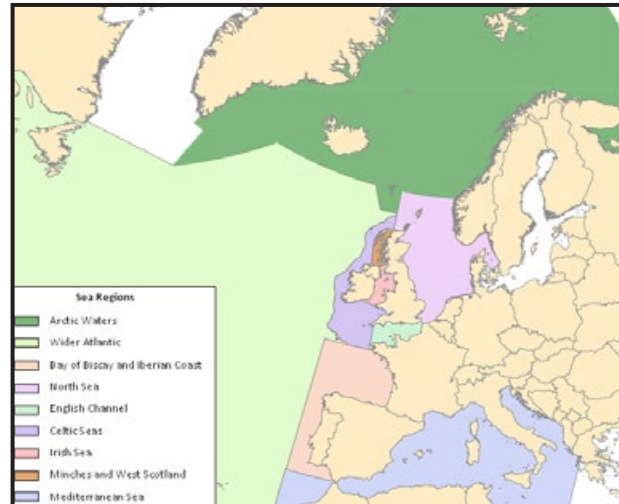


Figure 3 ORCA survey areas/sea regions

Sea region	Route code	Route	Years ran	Company
North Sea	NsId	Newcastle – Amsterdam	2009 & 2011-2015	DFDS
	NcBg	Newcastle – Bergen	2006-2008	DFDS
	HwEb	Harwich – Esbjerg	2008-2014	DFDS
	ImGoBvIm	Immingham – Gotherberg - Brevik	2015	DFDS
Irish Sea	Cruise	Various cruises	2006-2015	Saga
	HsPd	Heysham – Douglas	2011-2013 & 2015	Isle of Man Steam Packet Company
Bay of Biscay and Iberian Coast	Cruise	Various cruises	2008-2015	Saga
	PISt*	Plymouth – Santander	2006-2008	Brittany Ferries
	PIStPm*	Portsmouth – Santander – Plymouth	2009-2015	Brittany Ferries
English Channel	Cruise	Various cruises	2006-2015	Saga
	PIRc	Plymouth – Roscoff	2014-2015	Brittany Ferries
	PmCa	Portsmouth – Caen	2014-2015	Brittany Ferries
Celtic Seas	Cruise	Various cruises	2006-2015	Saga
	PzSm	Penzance – St Mary's	2009-2015	Isles of Scilly Travel
Mediterranean Sea	Cruise	Various cruises	2007-2015	Saga / Oceanwide Expeditions
Minches and West Scotland	Cruise	Various cruises	2009-2015	Saga
Wider Atlantic	Cruise	Various cruises	2008-2015	Saga
Arctic Waters	Cruise	Various cruises	2006-2015	Saga

Table 2 A table of the routes that occurred within each sea region, with the year they ran and the company which operated the route.  
\*These routes traverse through both the Bay of Biscay and Iberian Coast and the English Channel.



Pilot whale

## Distance surveyed (effort)

### Effort by sea region

ORCA conducted 339 ferry surveys and 37 cruise surveys between 2006-2015. The total surveyed distance, across all routes was 179,342km (Figure 4). The most surveyed region was the North Sea with 76,954km of effort, with the least effort (1,304km) recorded in the Minches and West Scotland (Figure 5). Within the North Sea, Celtic Seas, English Channel and Bay of Biscay and Iberian Coast effort was conducted every year on board both cruise and ferry vessels. For the Wider Atlantic, Arctic Waters and Minches and West Scotland effort was confined to cruise surveys.

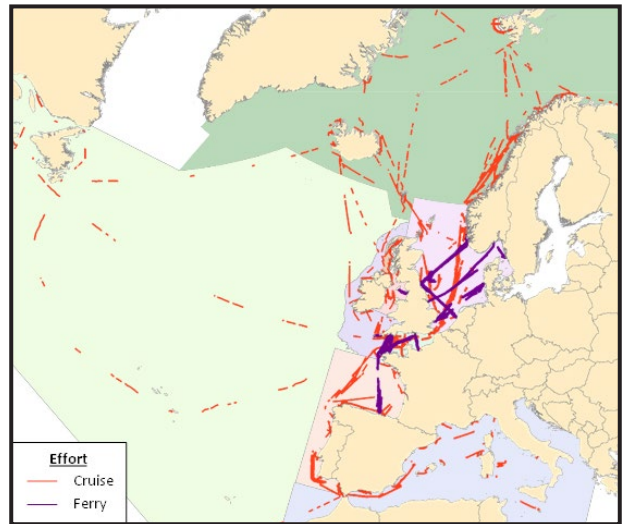


Figure 4 A map to show cruise (red) and ferry (purple) effort across ORCA sea regions.

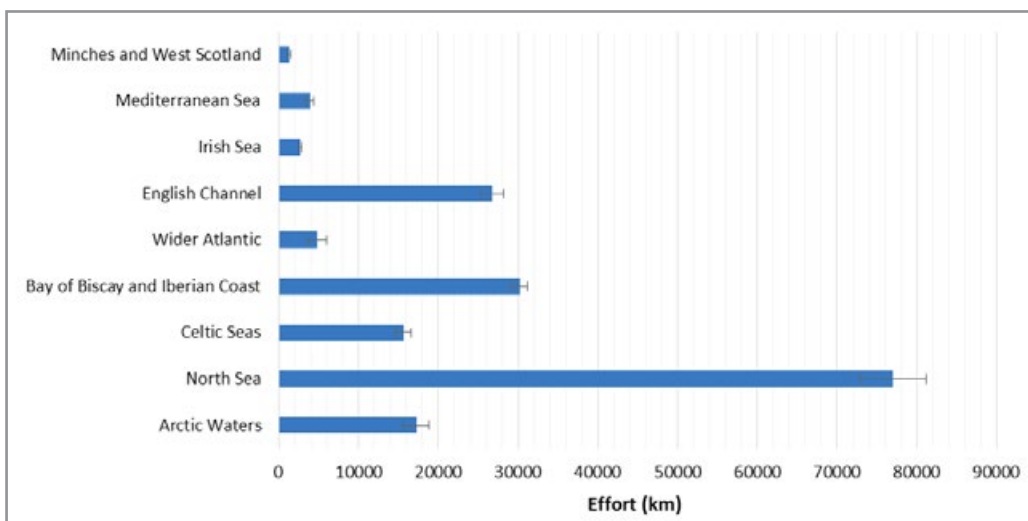


Figure 5 Graph to show the total amount of effort (km) undertaken within each sea region with error bars.

### Effort by ferry route

ORCA conducted ferry surveys on 10 routes between 2006-2015 (Table 3). The greatest amount of effort was on the Plymouth to Santander to Portsmouth (PIStPm) route, with a total of 35,294km surveyed (Figure 6); a route that has been surveyed since 2009. The least amount of effort was on the Heysham to Douglas (HsPd) and Portsmouth to Caen (PmCa) routes, with 1,674km each. This is due to the short distance travelled on these routes and surveys being conducted across fewer months. The highest average effort per month for the months surveyed was on North Shields to Ijmuiden (NsId), with the lowest average recorded on HsPd. Surveys on PIStPm, Penzance

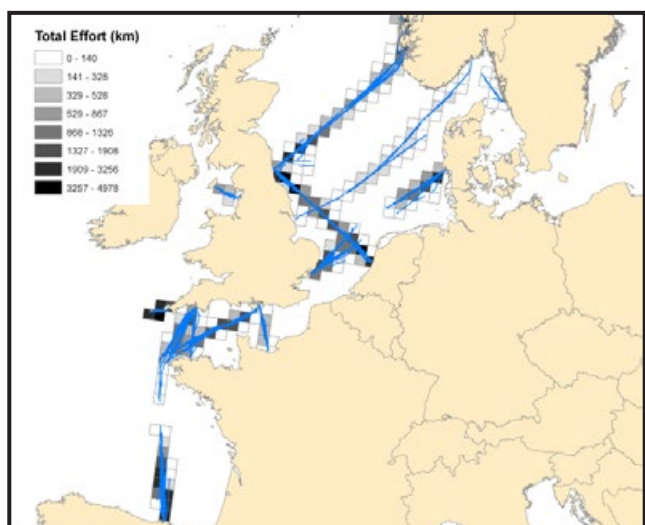


Figure 6 A map to show the amount of effort (km) undertaken on ferry routes around the UK per 20x20nm grid cell with effort lines.



to St Mary's (PzSm) and Harwich to Esbjerg (HwEb) routes have been conducted over the longest time period (seven years), with the Immingham to Gothenburg to Brevik (ImGoBvIm) route only running for a single year in 2015 (Table 3).

Year	HsPd	HwEb	ImGoBvIm	NcBg	Nsld	PIRc	PISt	PIStPm	PmCa	PzSm	Total
2006				8389			2115				10504
2007				7522			3536				11058
2008		333		7204			4453				11990
2009		1770			704			5459		512	8445
2010		163						4970		1622	6755
2011	588	2544			1855			5692		1364	12043
2012	331	2882			2210			4959		1521	11903
2013	257	2903			4087			4294		1686	13227
2014		6168			7532	1420		5270	212	1878	22480
2015	498		4297		4706	1123		4650	1462	2018	18754
<b>Total</b>	<b>1674</b>	<b>16763</b>	<b>4297</b>	<b>23115</b>	<b>21094</b>	<b>2543</b>	<b>10104</b>	<b>35294</b>	<b>1674</b>	<b>10601</b>	<b>127159</b>

Table 3 A table to show the yearly amounts of effort (km) undertaken on ferry routes ORCA surveyed around the UK.

## Sightings of animals

To define the areas where cetaceans were most frequently seen, within a region or on a route, encounter rates were calculated. These enabled important areas for cetaceans to be identified. Each sea region was split into grid cells of 20nm, with total effort (distance travelled on survey in km) and number of sightings (a group of one or more animals) calculated for each cell. The overall number of sightings for an individual cell was then divided by the total effort of that cell to determine the number of sightings per km. Sightings per 100km were then calculated to establish the encounter rate.

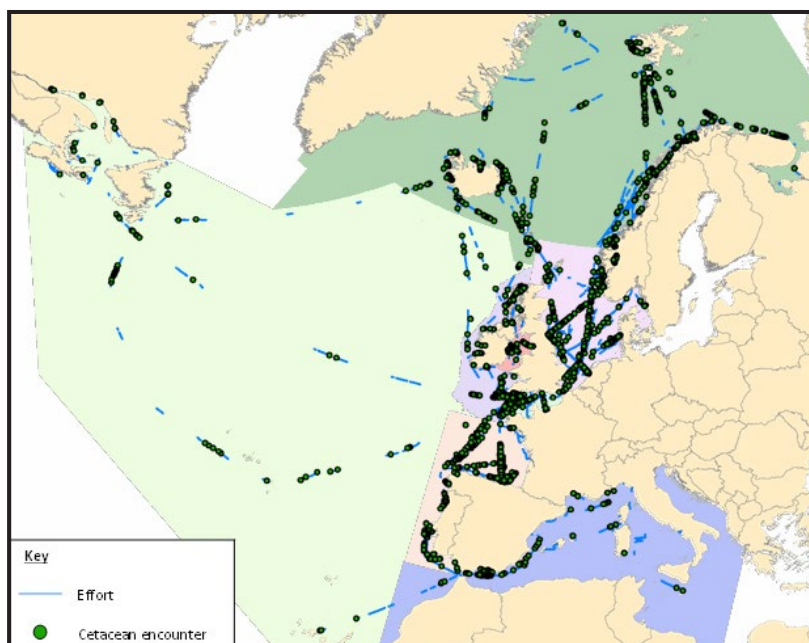


Figure 7 A map to show all sightings on routes where effort was conducted in all sea regions.

## Sightings by sea region

Between 2006-2015 ORCA surveyors recorded 4,340 encounters of cetacean species, which amounted to 42,817 individual animals (Figure 7). 22 different species of cetacean were identified, the harbour porpoise being the most commonly encountered species (Table 4) with highest recorded number of sightings around the UK, North Sea and Norwegian coastline (Figure

8). The highest number of individuals recorded was the short-beaked common dolphin with a total of 29,160 animals over the 10 years. The other most frequently sighted cetaceans included the minke whale, fin whale, white-beaked dolphin, bottlenose dolphin and striped dolphin (Table 4).

The Bay of Biscay and Iberian Coast had the highest species diversity, with 17 different cetacean species recorded. The Isles of Scilly, within the Celtic Seas, also exhibited high diversity with seven species of cetacean being recorded.

Species	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	Total											
Harbour porpoise ( <i>Phocoena phocoena</i> )	75	61	60	76	83	175	199	271	338	206	1544											
Common dolphin ( <i>Delphinus delphis</i> )	26	64	58	54	108	143	102	220	129	312	1216											
Minke whale ( <i>Balaenoptera acutorostrata</i> )	6	9	9	15	16	36	52	43	79	44	309											
Fin whale ( <i>Balaenoptera physalus</i> )	6	14	74	11	6	42	27	28	49	35	292											
White-beaked dolphin ( <i>Lagenorhynchus albirostris</i> )	4	11	3	3	1	28	19	46	79	21	215											
Bottlenose dolphin ( <i>Tursiops truncatus</i> )	8	9	19	18	8	33	12	24	25	16	172											
Striped dolphin ( <i>Stenella coeruleoalba</i> )	4	6	2	12	13	27	16	28	14	23	145											
Humpback whale ( <i>Megaptera novaeangliae</i> )			1		1	3	7	10	31	25	78											
Long-finned pilot whale ( <i>Globicephala melas</i> )	2	13	7	10		6	20	2	3	8	71											
Sperm whale ( <i>Physeter macrocephalus</i> )	3	3	2	7	5	8	2	14	11	13	68											
Cuvier's beaked whale ( <i>Ziphius cavirostris</i> )	2	2	3	8	3	10	12	6	8	12	66											
Risso's dolphin ( <i>Grampus griseus</i> )	1	2	1	2	1	5	4	6	10	3	35											
Northern bottlenose whale ( <i>Hyperoodon ampullatus</i> )	10	2	3		2	1	1		5	8	32											
Killer whale ( <i>Orcinus orca</i> )	1		1	1		2	4	2	11	9	31											
Sowerby's beaked whale ( <i>Mesoplodon bidens</i> )		1		1	1	6	1	1	1	2	14											
Atlantic white-sided dolphin ( <i>Lagenorhynchus acutus</i> )	1	1				2	1	1	2	6	14											
Sei whale ( <i>Balaenoptera borealis</i> )		1			1		2	2	6		12											
Blue whale ( <i>Balaenoptera musculus</i> )							3	4	3	1	11											
Beluga ( <i>Delphinapterus leucas</i> )							6			3	9											
Short-finned pilot whale ( <i>Globicephala macroorhynchus</i> )										3	3											
True's beaked whale ( <i>Mesoplodon mirus</i> )		1								1	2											
False killer whale ( <i>Pseudorca crassidens</i> )	1										1											
<b>Total no. of encounters/No. of cetacean species</b>	<b>150</b>	<b>15</b>	<b>200</b>	<b>16</b>	<b>243</b>	<b>14</b>	<b>218</b>	<b>13</b>	<b>249</b>	<b>14</b>	<b>527</b>	<b>16</b>	<b>490</b>	<b>19</b>	<b>708</b>	<b>17</b>	<b>804</b>	<b>18</b>	<b>751</b>	<b>20</b>	<b>4340</b>	<b>22</b>

Table 4 Number of encounters for all 22 cetacean species seen in ORCA sea regions split by year, with the total number of species (red).

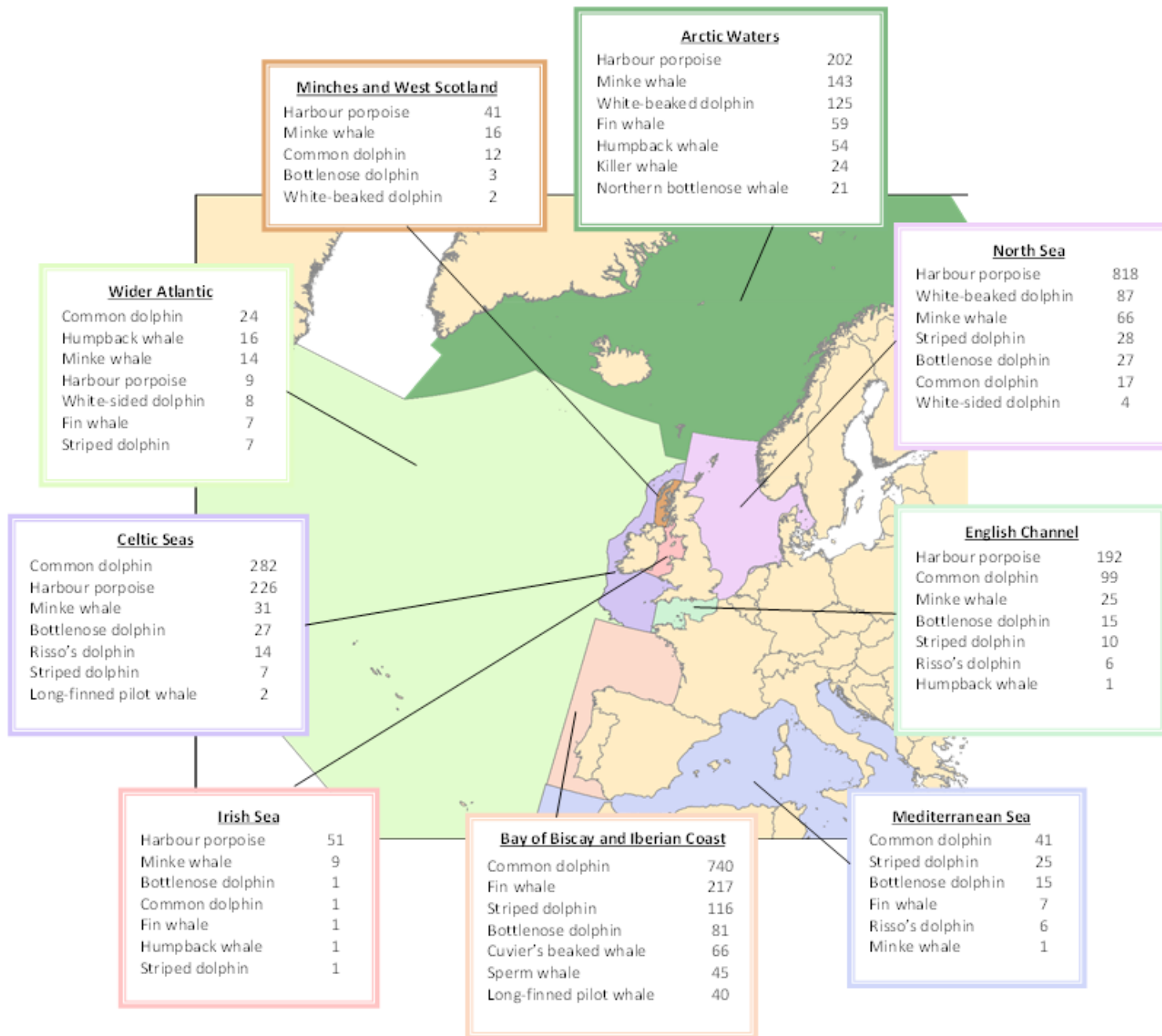


Figure 8 Map of ORCA sea regions with the number of encounters for the most frequently seen cetacean species.

## Sightings by ferry route

There have been 2,751 encounters of cetacean species on all ferry surveys consisting of 25,700 individuals. The harbour porpoise was the most commonly seen species with 1,056 sightings followed by the short-beaked common dolphin with 924 sightings (Table 5).

Species	HsPd	HwEb	ImGoBvlm	NcBg	Nsld	PIRc	PISt	PIStPm	PmCa	PzSm	Total no. of encounters
Harbour porpoise ( <i>Phocoena phocoena</i> )	20	169	11	142	343	7	50	110	6	198	1056
Common dolphin ( <i>Delphinus delphis</i> )	1	2		5	8	29	115	545	1	218	924
Fin whale ( <i>Balaenoptera physalus</i> )					1		84	94			179
Bottlenose dolphin ( <i>Tursiops truncatus</i> )	1	3	2	10	9	2	23	51		12	113
Striped dolphin ( <i>Stenella coeruleoalba</i> )					1		10	89			100
Minke whale ( <i>Balaenoptera acutorostrata</i> )	1	2	1	15	31	2	5	19		22	98
White-beaked dolphin ( <i>Lagenorhynchus albirostris</i> )		3	2	16	52						73
Cuvier's beaked whale ( <i>Ziphius cavirostris</i> )							7	59			66
Long-finned pilot whale ( <i>Globicephala melas</i> )							22	19		2	43
Sperm whale ( <i>Physeter macrocephalus</i> )							8	29			37
Risso's dolphin ( <i>Grampus griseus</i> )					1		4	10		11	26
Sowerby's beaked whale ( <i>Mesoplodon bidens</i> )							1	9			10
Northern bottlenose whale ( <i>Hyperoodon ampullatus</i> )							5	3			8
Humpback whale ( <i>Megaptera novaeangliae</i> )				1				4			5
Killer whale ( <i>Orcinus orca</i> )			1	1			1	2			5
Sei whale ( <i>Balaenoptera borealis</i> )							1	2			3
Atlantic white-sided dolphin ( <i>Lagenorhynchus acutus</i> )				2	1						3
False killer whale ( <i>Pseudorca crassidens</i> )							1				1
True's beaked whale ( <i>Mesoplodon mirus</i> )							1				1
<b>Total no. of encounters</b>	<b>23</b>	<b>179</b>	<b>17</b>	<b>192</b>	<b>447</b>	<b>40</b>	<b>338</b>	<b>1045</b>	<b>7</b>	<b>463</b>	<b>2751</b>

Table 5 Number of sightings for all cetacean species between 2006-2015, split by ferry route.



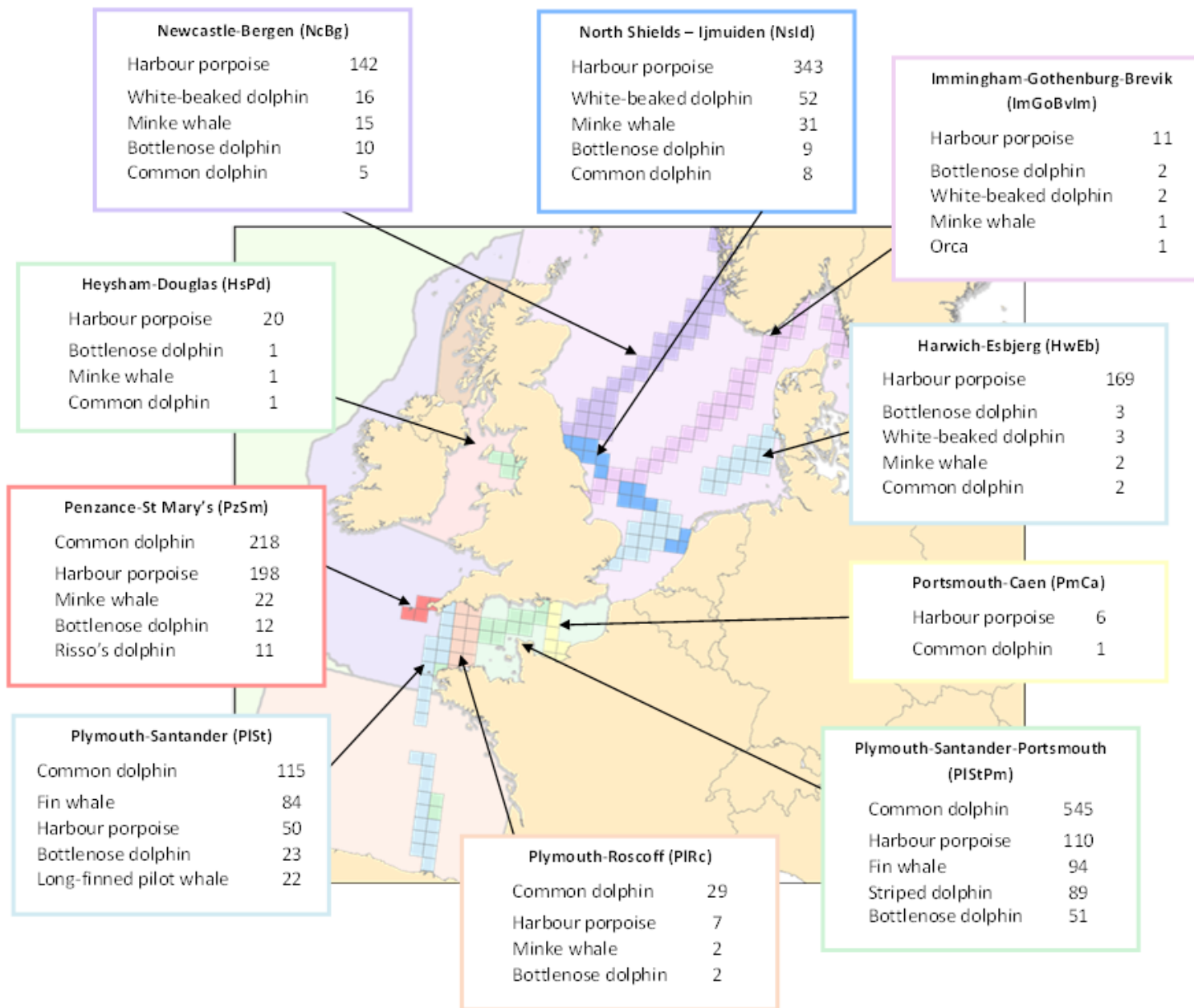
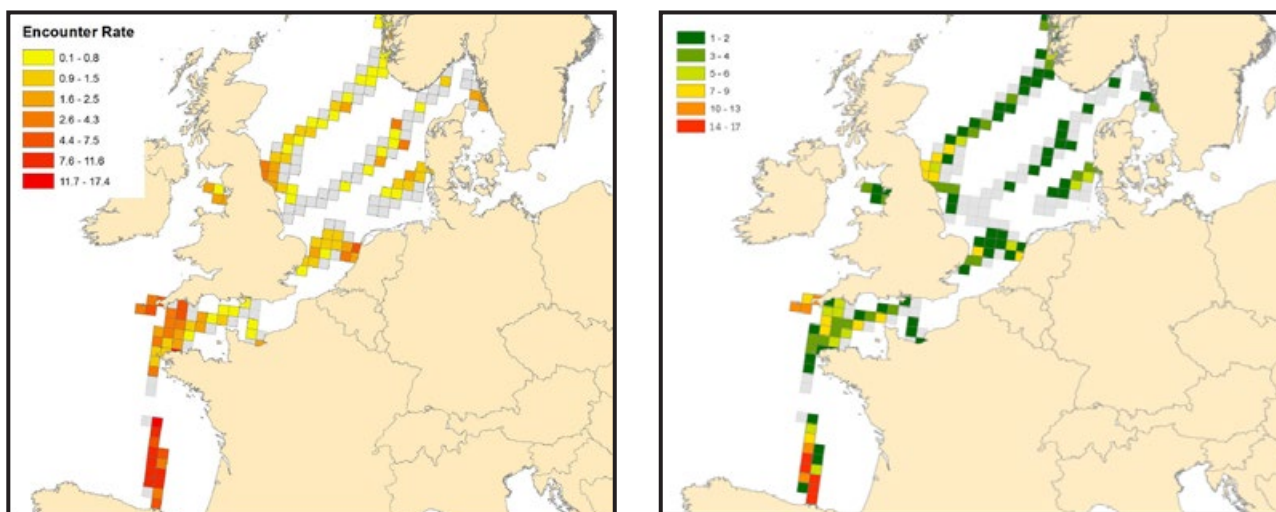


Figure 9 The most frequently encountered cetacean species split by ferry route, showing species and the number of encounters.

In UK waters, the harbour porpoise was the most frequently encountered species on six of the 10 ferry routes (NcBg, NsId, HwEb, HsPd, PmCa and ImGoBvIm) that were surveyed. For the other four survey routes (PISt, PISStPm, PzSm and PIRc) the short-beaked common dolphin was the most frequently seen (Figure 9). The overall encounter rate for cetaceans was greatest on the Plymouth to Santander (PISt) and Plymouth to Santander to Portsmouth (PISStPm) routes with 11-17 groups seen per 100km (Figure 10). The greatest diversity was on the PISt route (Table 5, Figure 10) followed by the PISStPm and PzSm route.



**Figure 10** Encounter rate (no. groups per 100km) for all cetaceans within surveyed grid cells for all ferry routes (*left*). Species richness (diversity) per grid cell on all ferry routes between 2006-2015. Light grey squares indicate effort was undertaken within that cell but no encounters were recorded (*right*).



False killer whale

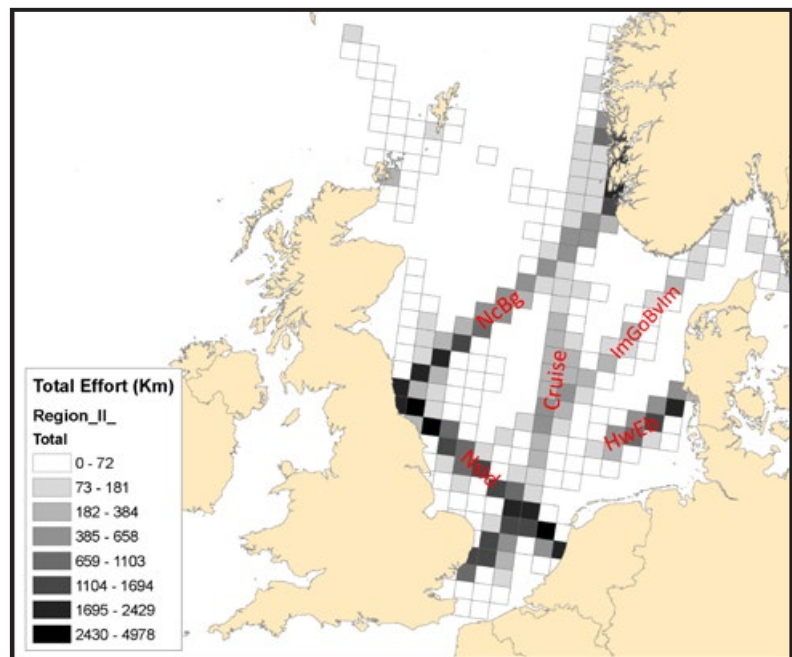
# Survey findings for each sea region

## North Sea

The North Sea is situated on the continental shelf of north-west Europe, with an opening to the Atlantic Ocean to the north and one to the English Channel at the south. It has a very shallow basin, with depths typically less than 100m throughout and not exceeding 700m. The North Sea is one of the most traversed bodies of water in the world and has considerable offshore activity and infrastructure resulting from its oil and gas reserves and wind farm developments.

### Effort

Over the last 10 years the North Sea was ORCA’s most heavily surveyed area, amounting to 76,954km of effort; 65,269km conducted through 139 ferry surveys and 11,685km conducted through 21 cruise surveys (Figure 11). In 2014 the highest annual survey effort was also recorded in the North Sea with 13,700km, due to an increased number of surveys across the region.



Year	HwEb	ImGoBvIm	NcBg	Nslid	Total
2006			8389		8389
2007			7522		7522
2008	333		7204		7537
2009	1770			704	2474
2010	163				163
2011	2544			1855	4399
2012	2882			2210	5092
2013	2903			4087	6990
2014	6168			7532	13700
2015		4297		4706	9003
<b>Total</b>	<b>16763</b>	<b>4297</b>	<b>23115</b>	<b>21094</b>	<b>65269</b>

Figure 11 Total effort (km) per grid cell for the North Sea between 2006-2015 with a table of effort for each year.

## Sightings

Within the North Sea the highest encounter rates were seen on the cruise routes around Orkney and the Shetland Islands, the east coast of Scotland and off Dover (Figure 12). Despite encounter rates being greatest in these areas the highest diversity was seen off North Shields and Ijmuiden, with six species recorded (Figure 13); minke whale, white-beaked dolphin, bottlenose dolphin, short-beaked common dolphin, Risso's dolphin and fin whale (Box 1).

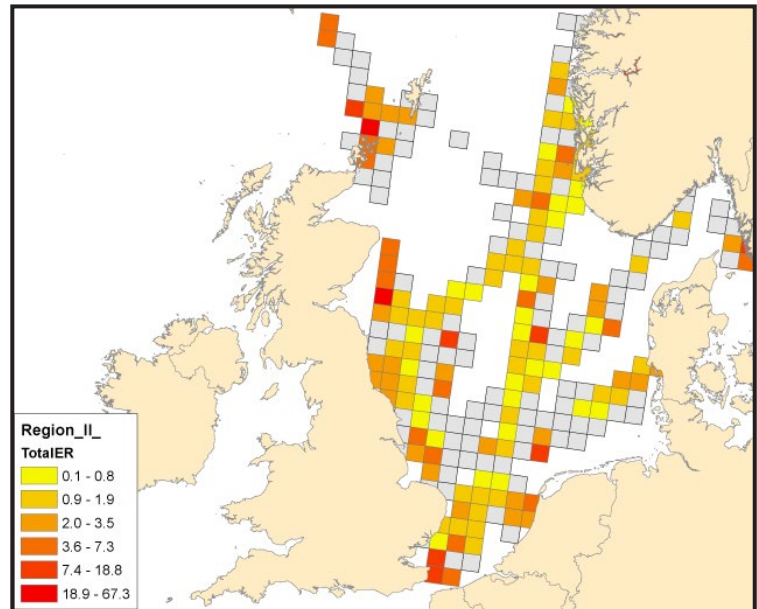


Figure 12 Encounter rate (no. groups per 100km) for the harbour porpoise within surveyed grid cells for the North Sea.

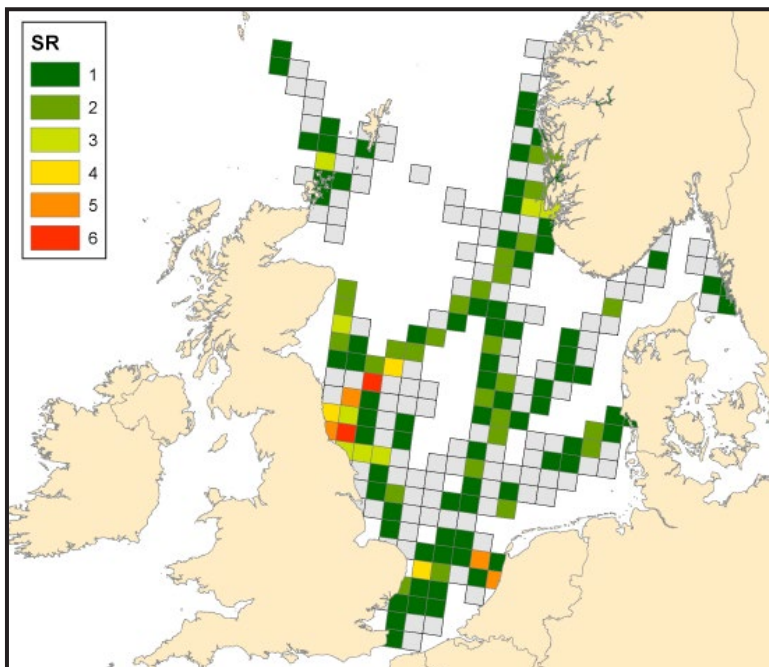


Figure 13 Species richness (diversity) per grid cell in the North Sea between 2006-2015.

In total, 1,030 sightings of identified cetacean species occurred in the North Sea, consisting of 2,342 individual animals. The greatest number of sightings occurred in 2014 (250) and the least in 2009 (19). The North Sea has the highest number of harbour porpoise sightings of all sea regions with 818 encounters (Figure 15).

## Ferry routes

Within the North Sea region, 139 ferry surveys were conducted; 52 North Shields to Ijmuiden (NslId); 42 Newcastle to Bergen (NcBg); 40 Harwich to Esbjerg (HwEb); and five Immingham to Gothenburg (ImGoBvIm).

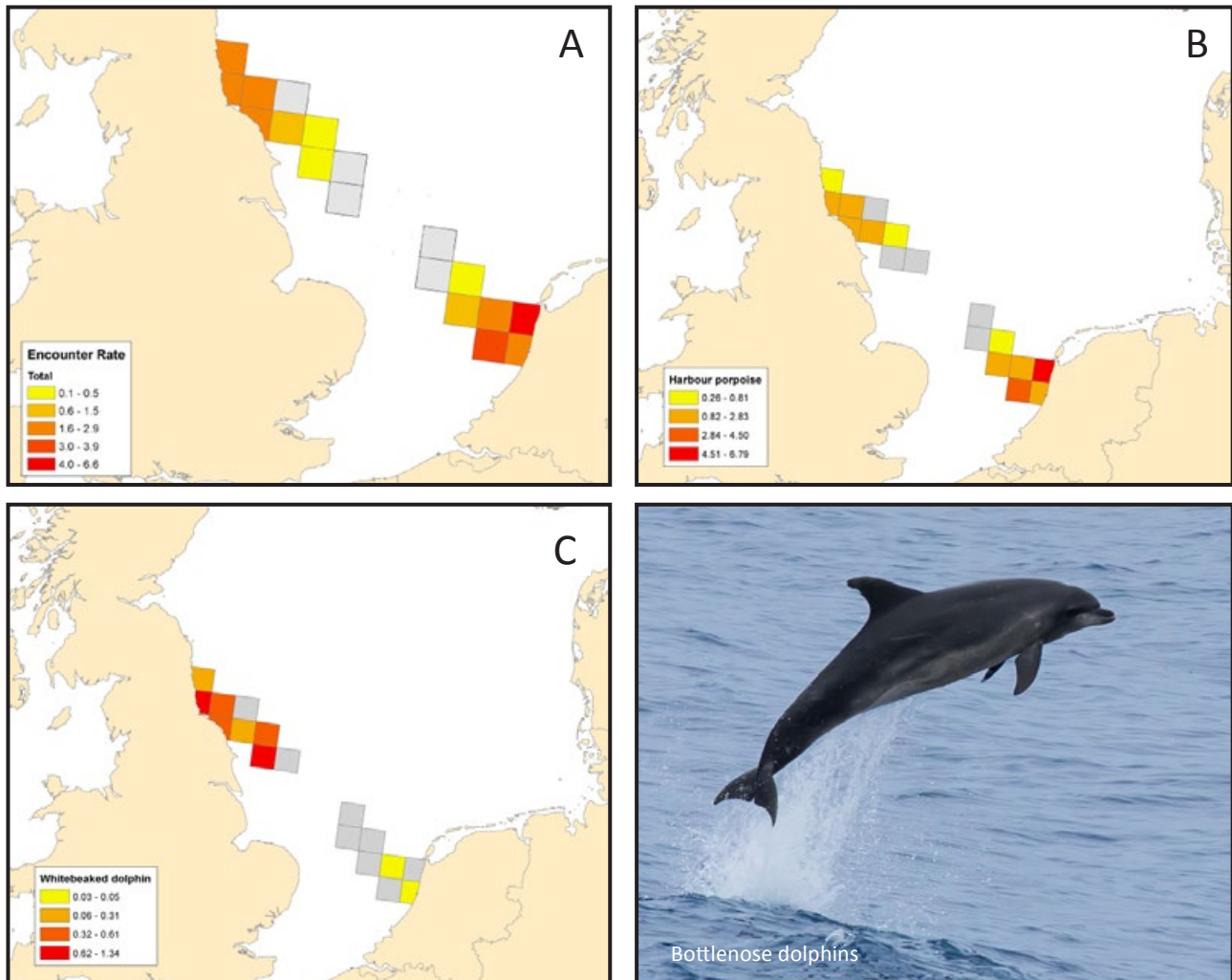


White-beaked dolphin



The North Shields to Ijmuiden (Nslid) route recorded the highest diversity of species, coupled with the highest effort per grid cell (20nm). The greatest cetacean encounter rate occurred around Ijmuiden. The harbour porpoise and white-beaked dolphin were the two most common species seen on this route. Harbour porpoises were predominantly observed off the coast of Ijmuiden (Figure 14B) whereas the white-beaked dolphin was most frequently observed off the coast of North Shields (Figure 14C).

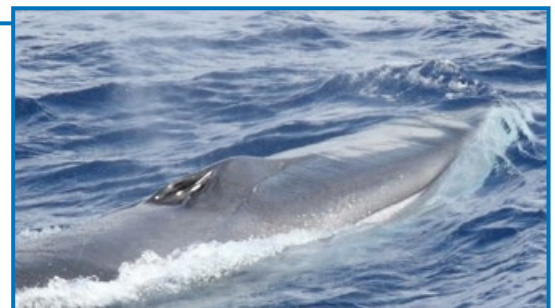
Highlights on this route include the rare sighting of a striped dolphin close to Ijmuiden, a Risso's dolphin outside of North Shields and a fin whale south-east of North Shields (Box 1).



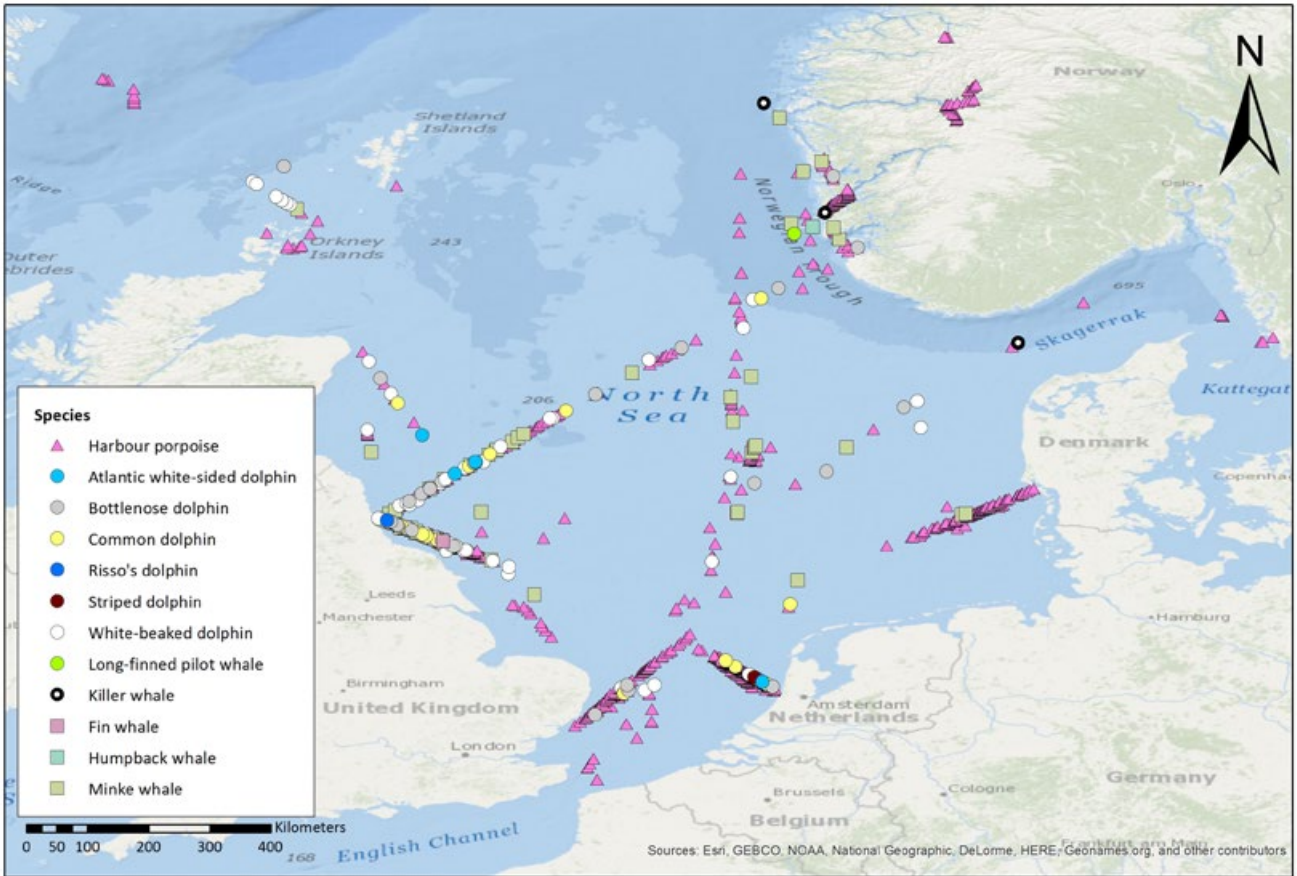
**Figure 14** The overall encounter rate (no. groups per 100km) for cetaceans in the North Shields-Ijmuiden (Nslid) route (A). The encounter rate for harbour porpoises (B) and white-beaked dolphins (C) on the Nslid route.

### Box 1 Fin whale (*Balaenoptera physalus*)

Fin whales are one of the largest animals on Earth, reaching up to 26m in length, and can be found in many temperate and polar waters. In July 2015, a fin whale was recorded in the North Sea, south-east of North Shields during an ORCA ferry survey (Figure 15). This was an unusual sighting, although not unique, as fin whales typically inhabit deep water >200m and the North Sea has an average depth of 23m. The peak season for fin whale occurrence around the UK is between July - September, where it is believed some fin whale populations exhibit a seasonal latitudinal migration (although this is poorly understood). This encounter could suggest that fin whales migrate up both the east and west coasts of the UK.



ORCA Survey sightings in the North Sea 2006-2015



www.orcaweb.org.uk

Species	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	Total
Harbour porpoise ( <i>Phocoena phocoena</i> )	71	44	28	14	35	62	89	184	201	92	818
White-beaked dolphin ( <i>Lagenorhynchus albirostris</i> )	2	11	3	2	1	6	8	18	26	11	87
Minke whale ( <i>Balaenoptera acutorostrata</i> )	4	8	3	2	3	2	6	16	12	10	66
Bottlenose dolphin ( <i>Tursiops truncatus</i> )	5	1	4			4		1	5	7	27
Common dolphin ( <i>Delphinus delphis</i> )	3		2	1		1		6	3	1	17
Atlantic white-sided dolphin ( <i>Lagenorhynchus acutus</i> )	1	1				1			1		4
Killer whale ( <i>Orcinus orca</i> )	1								1	1	3
Fin whale ( <i>Balaenoptera physalus</i> )										1	1
Humpback whale ( <i>Megaptera novaeangliae</i> )			1								1
Long-finned pilot whale ( <i>Globicephala melas</i> )								1			1
Risso's dolphin ( <i>Grampus griseus</i> )								1			1
Striped dolphin ( <i>Stenella coeruleoalba</i> )									1		1
<b>Total</b>	<b>87</b>	<b>65</b>	<b>41</b>	<b>19</b>	<b>39</b>	<b>76</b>	<b>103</b>	<b>227</b>	<b>250</b>	<b>123</b>	<b>1030</b>

Figure 15 Cetacean species map of the North Sea with species encounter table split by year.



Atlantic white-sided dolphin



# English Channel

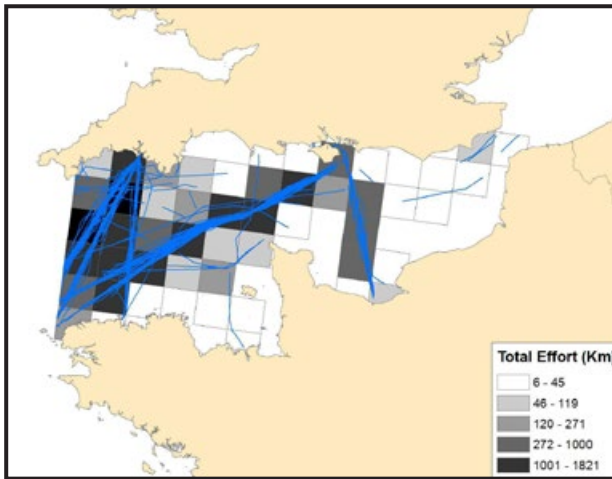


Figure 16 Total effort (km) per grid cell for the English Channel.

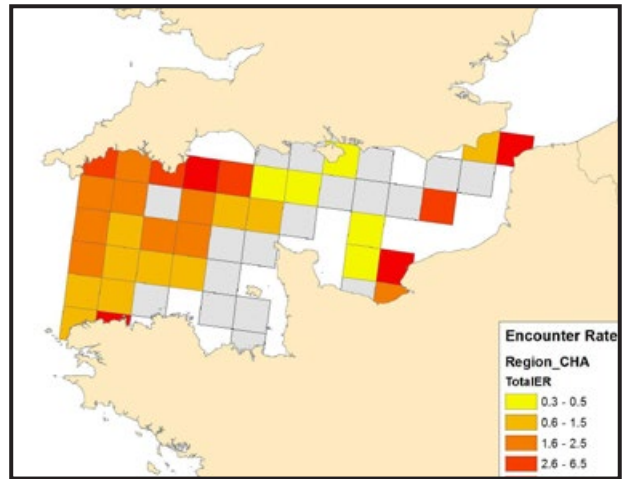
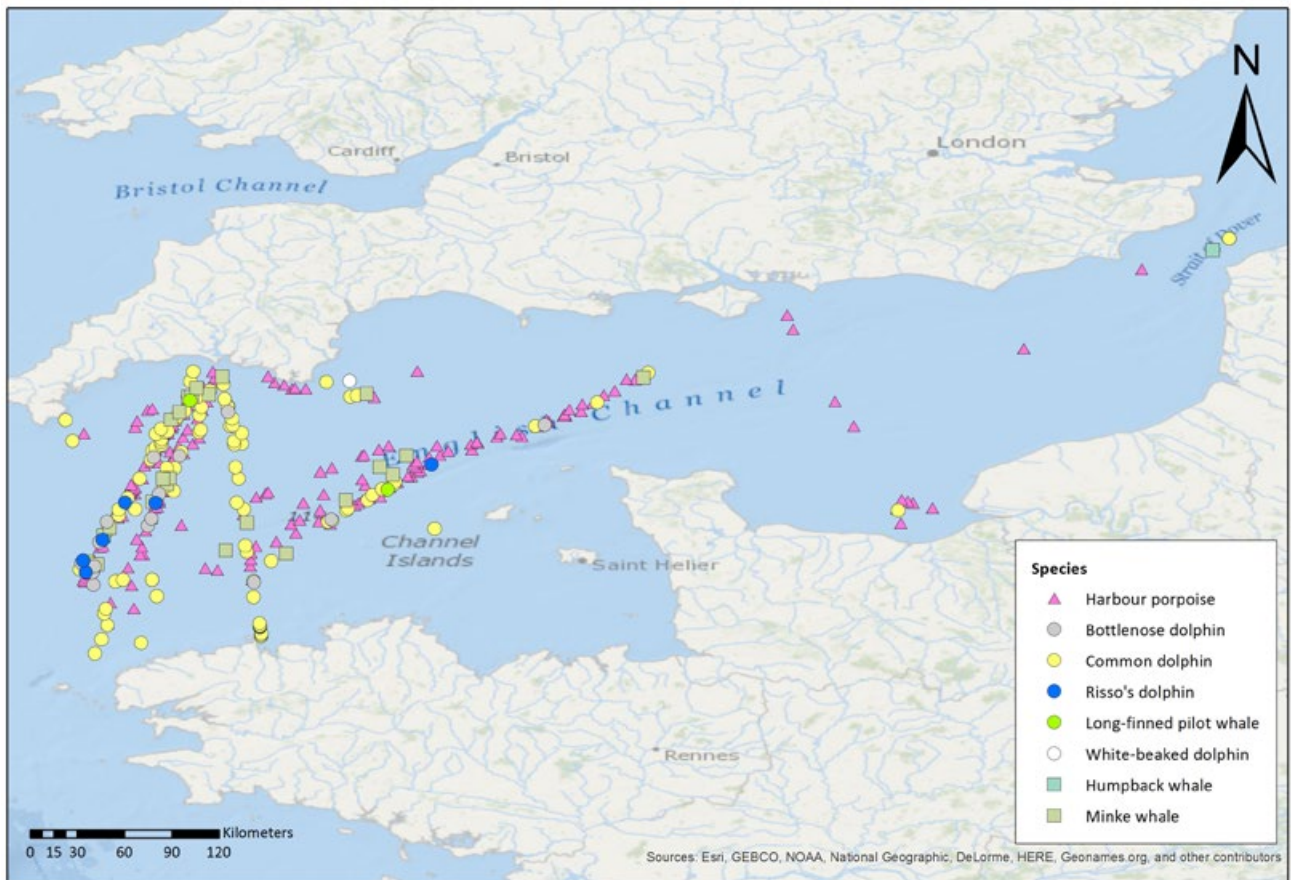


Figure 17 Encounter rate (groups per 100km) for all cetaceans within surveyed grid cells for the English Channel. Light grey squares indicate effort was undertaken within that cell but no encounters were recorded.

The English Channel is situated between the south of England and north of France. It is about 560km long, stretching from Cornwall to Dover in England and Brest to Calais in France. At its widest it is 240km and only 33.3km wide in the straits of Dover. The English Channel is ORCA's third most surveyed sea region with surveys taking place every year between 2006-2015 amounting to 26,739km of effort (Figure 16). Altogether 74 surveys have been conducted in this region consisting of 64 ferry surveys and 10 cruise surveys.

## ORCA Survey sightings in the English Channel 2006-2015



[www.orcaweb.org.uk](http://www.orcaweb.org.uk)

Figure 18 Cetacean species map of the English Channel.





Risso's dolphin

The greatest encounter rates and diversity occurred off the south coast of Devon and Cornwall (Figure 17); The five species recorded in these regions were; harbour porpoise, common dolphin, minke whale, bottlenose dolphin and Risso's dolphin (Figure 18). Harbour porpoise were the most frequently sighted species with 192 encounters and 396 individual animals observed. A rare humpback whale sighting occurred in March 2015 off the coast of Dover (Box 2).

**Box 2 Humpback whale (*Megaptera novaeangliae*)**

Humpback whales have a wide global distribution and are highly migratory. Their seasonal migrations can exceed 8,000km each way in some instances, one of the longest migrations known for any mammal (Horton *et al.*, 2011). These whales favour waters over and along continental shelf edges and move offshore when migrating.

Sightings are not common around the UK, with most observations occurring in Scotland. Therefore, the encounter of a humpback whale in the English Channel in 2015 was rare and remarkable. This individual could have been migrating to the polar regions via the North Sea. The majority of sightings around the UK usually take place between May-September (Reid, Evans and Northbridge, 2003) but this sighting occurred in March.



# Celtic Seas

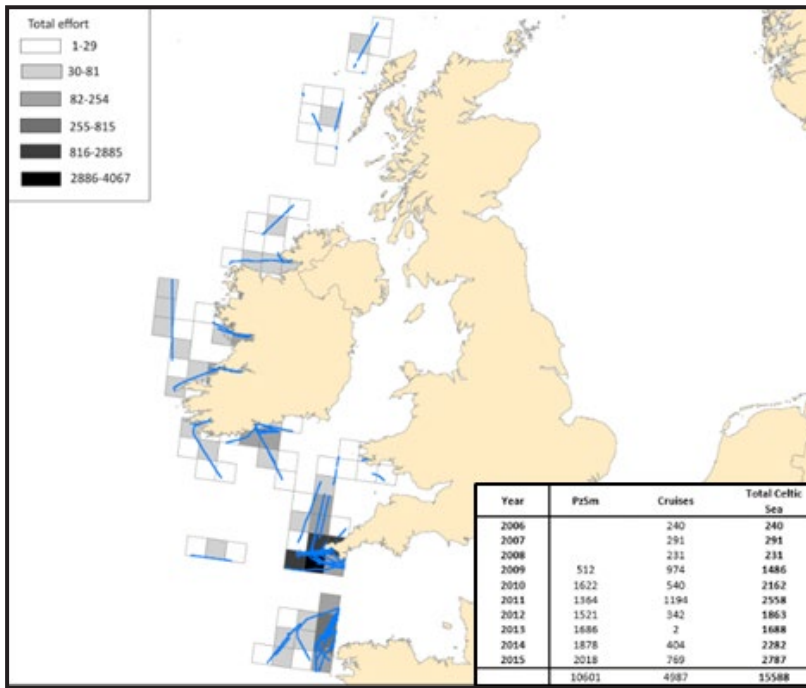


Figure 19 Total effort (km) per grid cell for the Celtic Seas with a table of effort for each year.

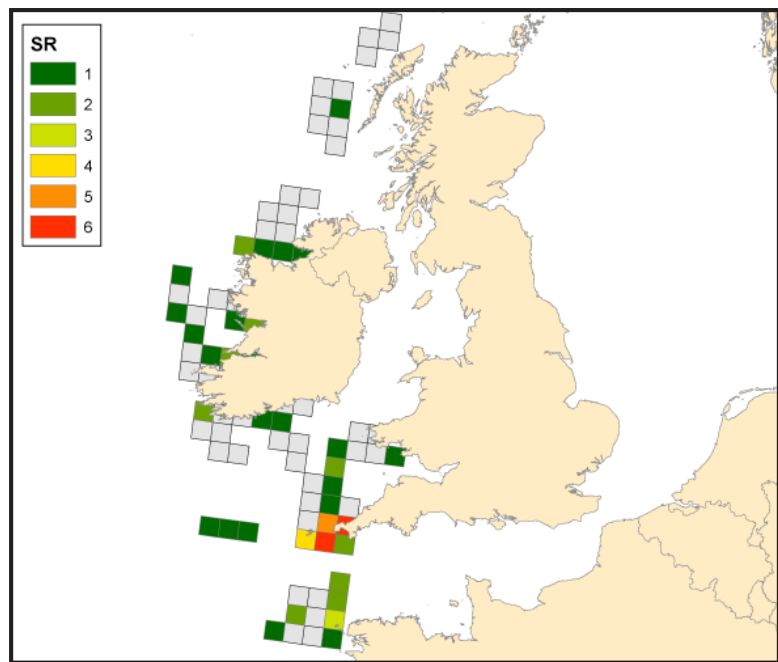
## Effort

The Celtic Seas region extends between 60°N and 48°N and the west coast of Ireland, to the 200m depth contour to the west of 6°W. ORCA has been surveying in the Celtic Seas every year from 2006-2015, through a combination of both ferry and cruise surveys. Ferry surveys only commenced in 2009 when the Isles of Scilly; Penzance to St Mary’s ferry route (PzSm) was secured. A total of 15,588km of effort has been conducted in the Celtic Seas; 10,601km was from the PzSm ferry surveys, and the remaining 4,987km was from cruises travelling through the region (Figure 19).

## Sightings

In total, 582 encounters of six cetacean species were recorded (Figure 20), consisting of 4,874 individuals. The highest cetacean encounter rate was seen off the west coast of Cornwall, Ireland and the Hebrides (Figure 21). The short-beaked common dolphin was the most encountered species in the Celtic Seas, followed by the harbour porpoise. Minke whale, bottlenose dolphin and Risso’s dolphin have also been seen in this region (Figure 20).

Diversity (Figure 20) and encounter rates (Figure 21) were highest off the west coast of the UK and Ireland, particularly around the Isles of Scilly and Penzance. Encounter rates were highest closer to the shoreline and less so in the channel between Penzance and the Isles of Scilly. Despite this, the highest species diversity was observed here, with six species being sighted; short-beaked common dolphin, harbour porpoise, minke whale, bottlenose dolphin, Risso’s dolphin and long-finned pilot whale.



Species	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	Total
Common dolphin ( <i>Delphinus delphis</i> )		1	5	8	22	30	19	55	23	119	282
Harbour porpoise ( <i>Phocoena phocoena</i> )	3			23	15	27	38	47	33	40	226
Minke whale ( <i>Balaenoptera acutorostrata</i> )				6	7	1	4	7	3	3	31
Bottlenose dolphin ( <i>Tursiops truncatus</i> )				7		6	3	2	8	1	27
Risso’s dolphin ( <i>Grampus griseus</i> )						1	2	2	8	1	14
Long-finned pilot whale ( <i>Globicephala melas</i> )										2	2
Totals	3	1	5	44	44	65	66	113	75	166	582

Figure 20 Species richness (diversity) per grid cell in the Celtic Seas between 2006-2015 and a table of species encounters. Light grey squares indicate effort was undertaken within that cell but no encounters were recorded.

The waters off Cornwall and the Isles of Scilly exhibited the highest encounter rates for harbour porpoise, short-beaked common dolphin and bottlenose dolphin in this sea region. However, each species occupied a different area along the survey route, indicating spatial segregation.

Harbour porpoises were primarily encountered in Cornish waters, followed by the waters surrounding the Isles of Scilly (Figure 22). This supports existing evidence that shallow coastal zones, such as bays, estuaries and harbours less than 200m in depth are the preferred habitats for harbour porpoise (Marubini *et al.* 2009). Conversely bottlenose dolphin encounter rates were highest around the Isles of Scilly followed by Cornish waters (Figure 22). Violent and often fatal interactions between bottlenose dolphins and harbour porpoises around the UK have been well documented in literature (Ross and Wilson, 1996; Patterson *et al.* 1998; Dunn *et al.* 2002) and even recorded on video in October 2016. Since 2001, 14 harbour porpoises have been recorded as being found dead on the coasts of Cornwall, Devon and Dorset with rake marks consistent with violent interactions with bottlenose dolphins (Barnett, 2009). This could explain the possible spatial segregation displayed by these two species in this area.

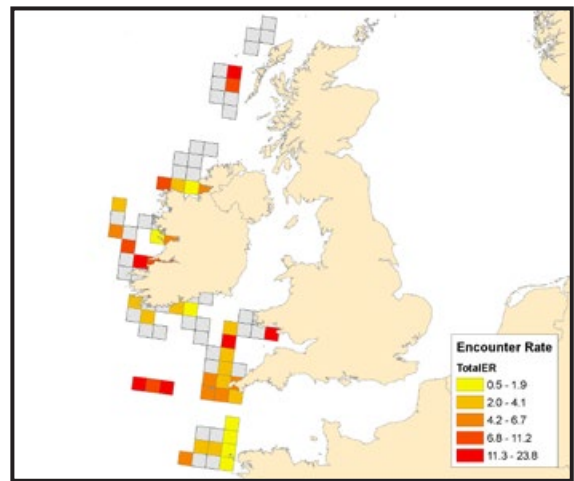


Figure 21 Encounter rate (groups per 100km) for all cetaceans in the Celtic Seas.

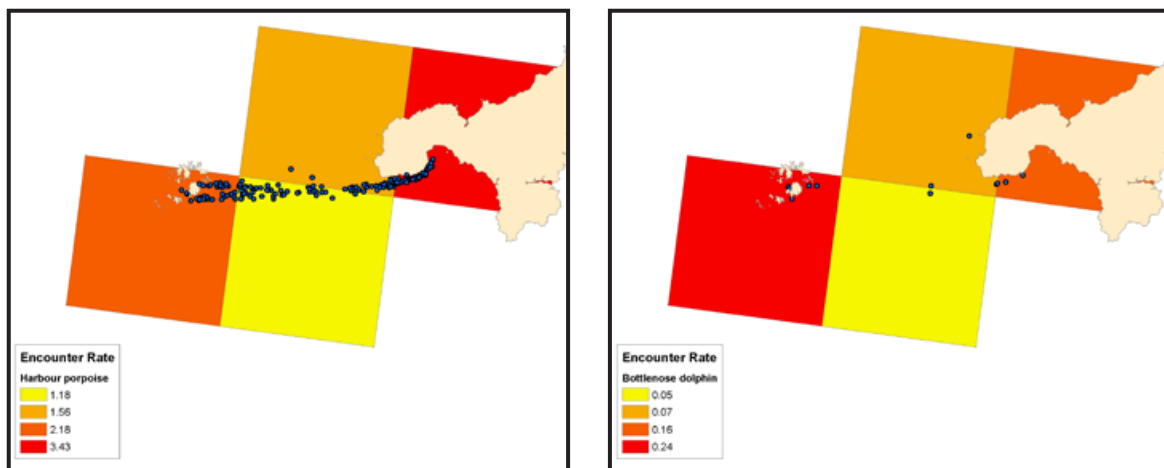


Figure 22 Encounter rate maps for the Penzance to St Mary's (PzSm) route; harbour porpoise (left), bottlenose dolphin (right).

### Box 3 Risso's dolphin (*Grampus griseus*)

Risso's dolphins have a worldwide tropical to warm temperate distribution, with their northern range limit being the Shetland Islands. They typically inhabit deep offshore waters, but are frequently seen in the western English Channel and southern Irish Sea.

In the Celtic Seas, ORCA surveyors have recorded 14 encounters with Risso's dolphins; 11 sightings from the Penzance to St Mary's (Isles of Scilly) ferry surveys and three from cruise surveys. In total, 33 individual animals were recorded, with all observations taking place in the summer months from late May to early September. This concurs with the Cetacean Atlas (Reid, Evans and Northbridge, 2003) and could suggest a seasonal distribution or migration, although further evidence is required.



# Irish Sea

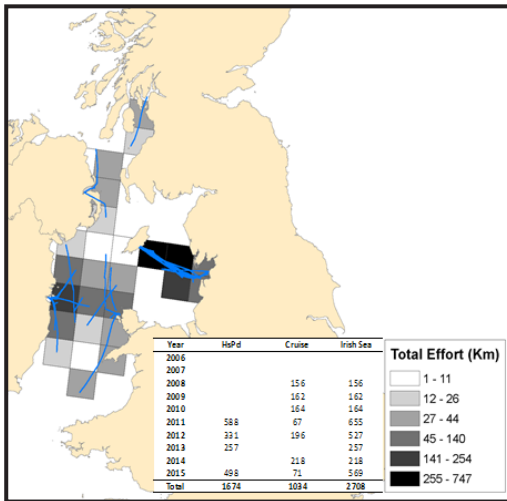


Figure 23 Total effort (km) per grid cell for Irish Sea with table of effort for each year.

The Irish Sea is situated between east Ireland and the Welsh and Cumbrian coast. ORCA commenced surveying in the Irish Sea in 2008 and between 2008-2015 13 ferry surveys (Heysham to Douglas route) and nine cruise surveys have been conducted. Effort was highest on the ferry route with 1,674km undertaken (Figure 23).

In total, six species of cetacean have been seen in the Irish Sea (Figure 24). Despite the highest effort occurring on the ferry route, the highest encounter rate and diversity was off the Irish coast near Dublin, with four of the six species recorded here (fin whale, minke whale, humpback whale and harbour porpoise) (Figure 24). The harbour porpoise is the primary cetacean found in this region making up over 75% of all sightings in the Irish Sea.

There appears to be a positive correlation between species diversity and the increasing distance from Heysham (Figure 25), which could be due to the topography of the Irish Sea. Further surveys need to be undertaken to investigate this.

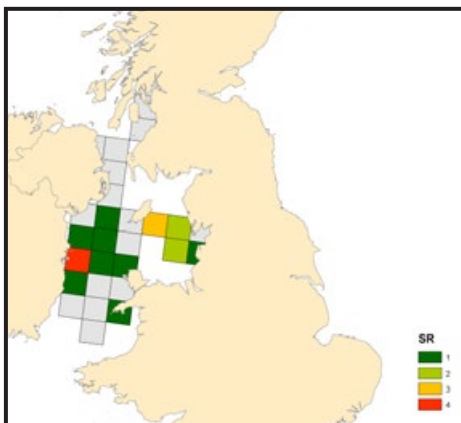
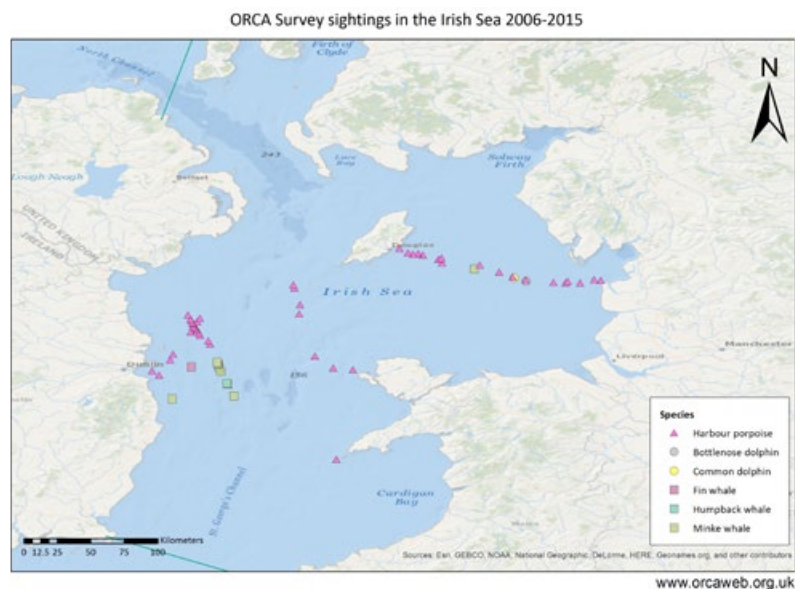
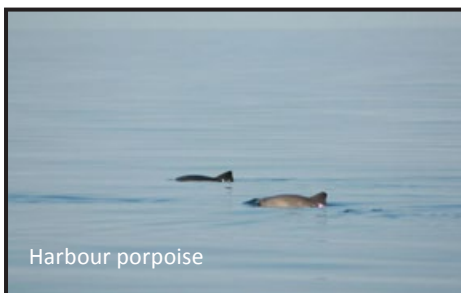


Figure 24 Species richness (diversity) in the Irish Sea.



Species	2008	2009	2010	2011	2012	2013	2014	2015	Total
Harbour porpoise ( <i>Phocoena phocoena</i> )	1		7	5	7	9	16	6	51
Minke whale ( <i>Balaenoptera acutorostrata</i> )	1						7	1	9
Fin whale ( <i>Balaenoptera physalus</i> )		1							1
Common dolphin ( <i>Delphinus delphis</i> )				1					1
Bottlenose dolphin ( <i>Tursiops truncatus</i> )						1			1
Humpback whale ( <i>Megaptera novaeangliae</i> )							1		1
<b>Total</b>	<b>2</b>	<b>1</b>	<b>7</b>	<b>6</b>	<b>7</b>	<b>10</b>	<b>24</b>	<b>7</b>	<b>64</b>

Figure 25 Cetacean species map of the Irish Sea with species encounter table split by year.

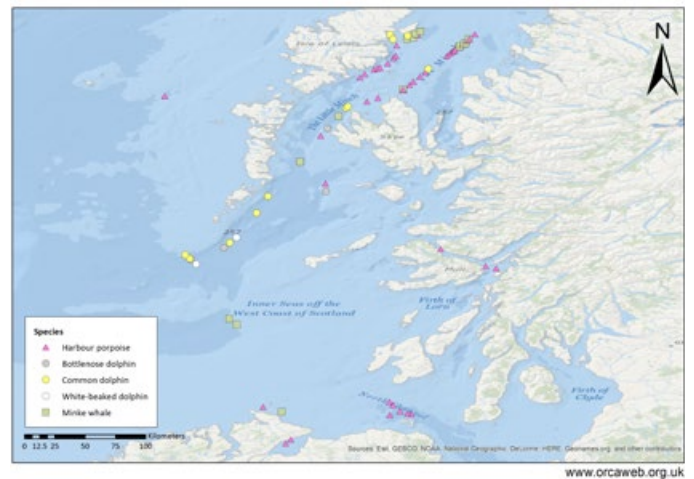


## Minches and West Scotland

The Minches and West Scotland is situated off the north-west of Scotland, stretching from Northern Ireland to the north coast of Scotland. The Minches are a strait between the Northern Highlands and the Hebrides. ORCA has surveyed this sea region intermittently since 2009 with seven cruises, totalling 1,304km of effort (the lowest effort of all sea regions).

In total five species of cetacean were observed in this region (Figure 26). Encounter rates and diversity are shown to be highest in the waters surrounding the Isle of Skye (Figure 27), with four species of cetacean being recorded; harbour porpoise, bottlenose dolphin, common dolphin and minke whale. Harbour porpoises and minke whales seem to favour the north Minch area, but this could be due to the cruise routes undertaken. Although relatively low levels of effort have been conducted within this sea region, these findings support the recent designation of this area as a Special Area of Conservation (SAC) for harbour porpoise and illustrate how continued ORCA surveys within this region could further contribute to conservation efforts.

ORCA Survey sightings in the Minches and West Scotland 2006-2015



Species	2009	2010	2011	2012	2014	2015	Total
Harbour porpoise ( <i>Phocoena phocoena</i> )	2	3	32	2	1	1	41
Minke whale ( <i>Balaenoptera acutorostrata</i> )	1	2	8	3	2		16
Common dolphin ( <i>Delphinus delphis</i> )		2	5	2		3	12
Bottlenose dolphin ( <i>Tursiops truncatus</i> )			1	2			3
White-beaked dolphin ( <i>Lagenorhynchus albirostris</i> )			1			1	2
<b>Total</b>	<b>3</b>	<b>7</b>	<b>47</b>	<b>9</b>	<b>3</b>	<b>5</b>	<b>74</b>

Figure 26 Sightings map and table of all sightings seen in the Minches and West Scotland between 2006-2015.

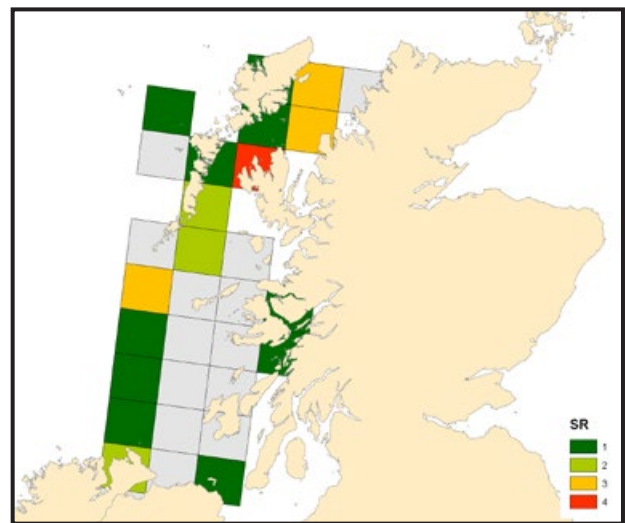
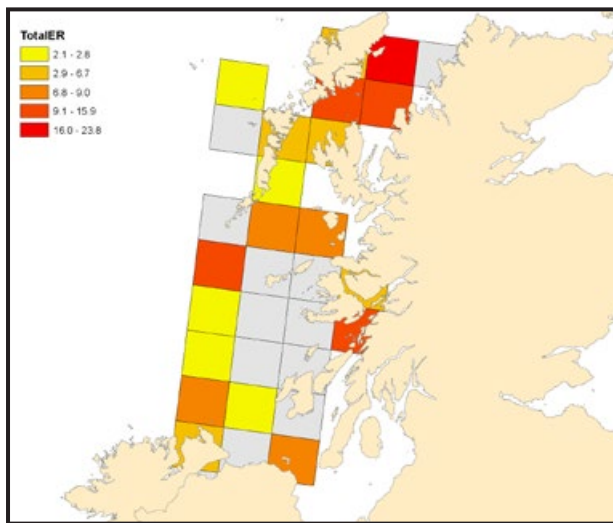


Figure 27 Encounter rate (number of groups per 100km) for all cetaceans within surveyed grid cells (Left). Species richness (diversity) per grid cell in the Minches and West Scotland (Right) between 2006-2015. Light grey squares indicate effort was undertaken within that cell but no encounters were recorded.

White-beaked dolphins have also been observed in this region with encounters occurring in 2011 and 2015 (Figure 26). Both sightings were in the same region of the south of the Hebrides and took place in July. White-beaked dolphins are usually seen in the northern Hebrides and in offshore waters. These observations might indicate an increased southern range although more surveys are required to investigate this further.



White-beaked dolphin



## Bay of Biscay and Iberian Coast

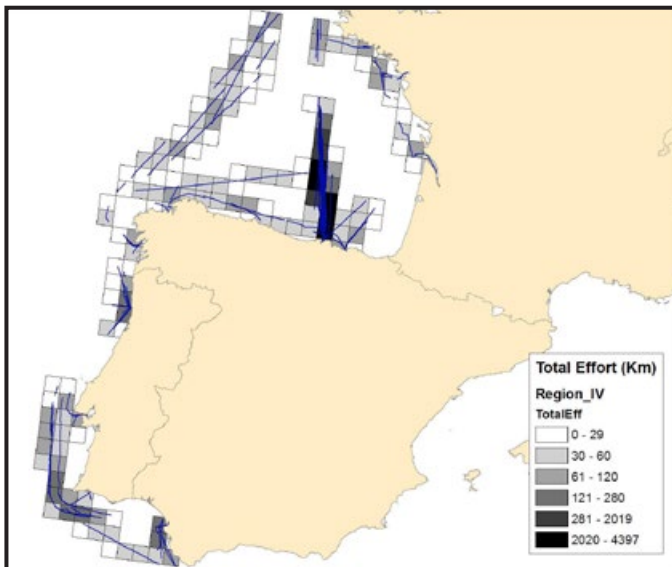
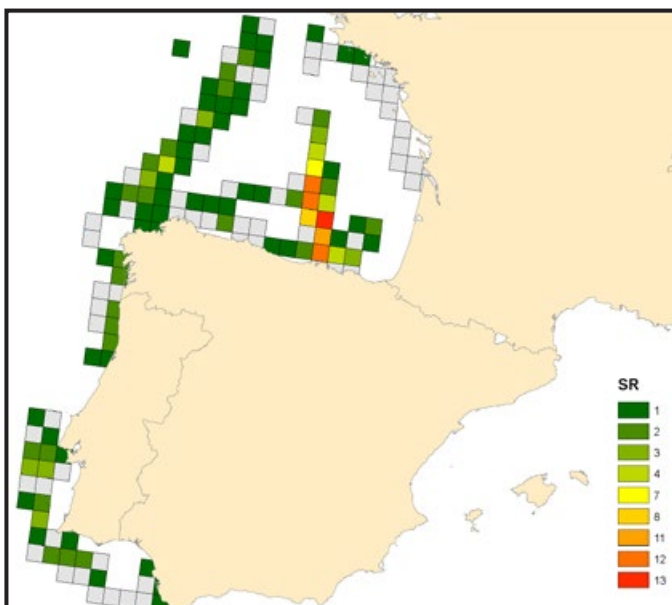


Figure 28 Total effort (km) per grid cell for the Bay of Biscay and Iberian Coast.



ORCA Survey sightings in the Bay of Biscay and Iberian Coast 2006-2015

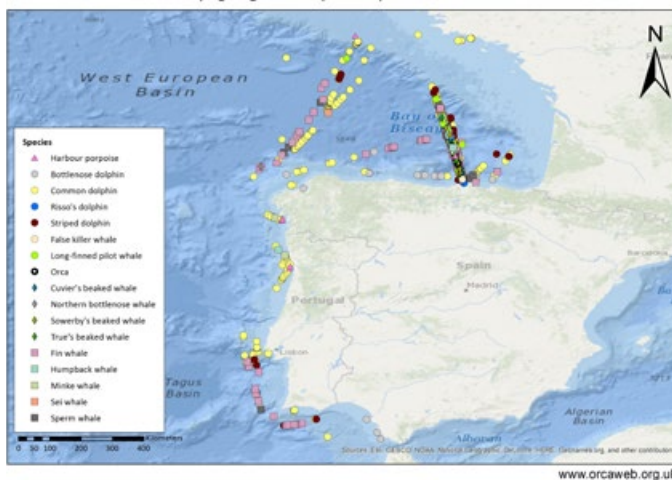


Figure 29 The species richness (diversity) (top) and the sightings map (right) for the Bay of Biscay and Iberian Coast (bottom).

The Bay of Biscay and Iberian Coast extends from 48°N to 36°N and from 11°W to the coastlines of France, Spain and Portugal. It is one of the busiest shipping areas in the world, linking the northern latitudes to the southern, particularly the UK with the Mediterranean and Africa.

### Effort

Across the 10 year period, 71 surveys were conducted within this region; 62 of these were on ferry routes through the Bay of Biscay and nine on cruises which traversed the whole sea region. Overall, 30,177km of effort was conducted (Figure 28); the second highest effort for all sea regions.

### Sightings

Within the Bay of Biscay and Iberian Coast a total of 17 different species were recorded (Figure 29). Highest diversity was found where there was highest effort (281-4,397km per grid cell) on the Plymouth to Santander (PISt) and Plymouth to Santander to Portsmouth (PIStPm) routes. On these ferry routes 16 species have been seen including True's beaked whale, northern bottlenose whale, false killer whale and orca.

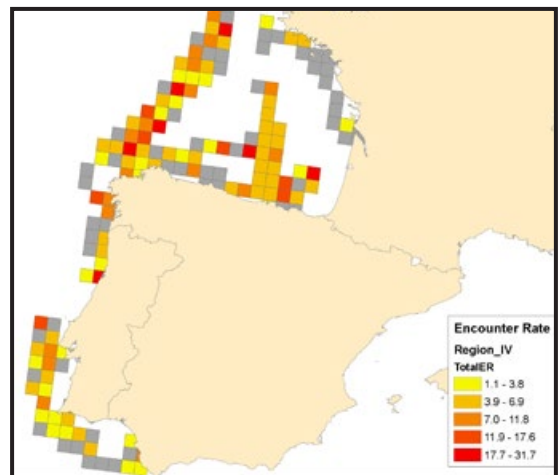
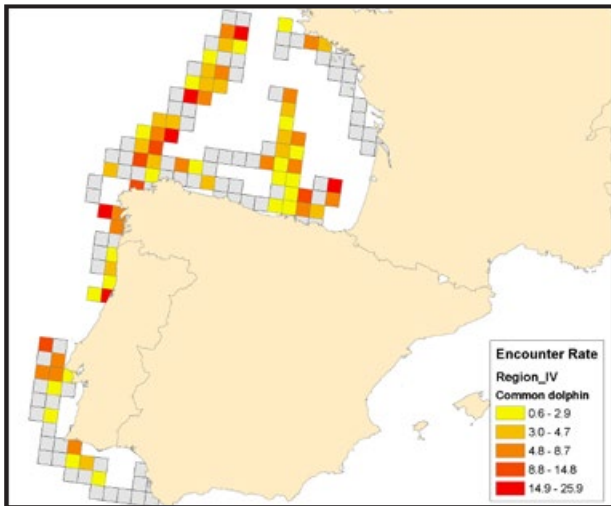
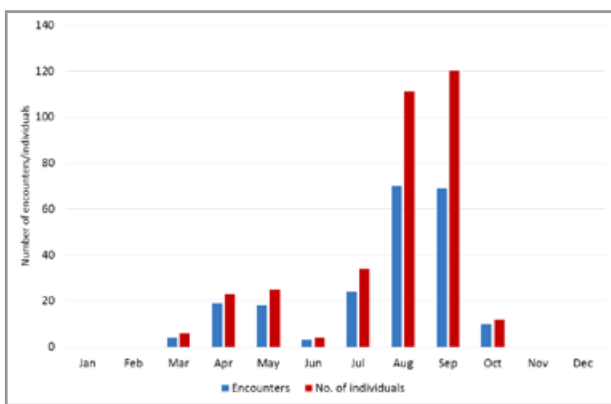


Figure 30 Encounter rate (no. groups per 100km) for all cetaceans within surveyed grid cells for the Bay of Biscay and Iberian Coast.



**Figure 31** Encounter rate (no. groups per 100km) for common dolphins in the Bay of Biscay and Iberian Coast.



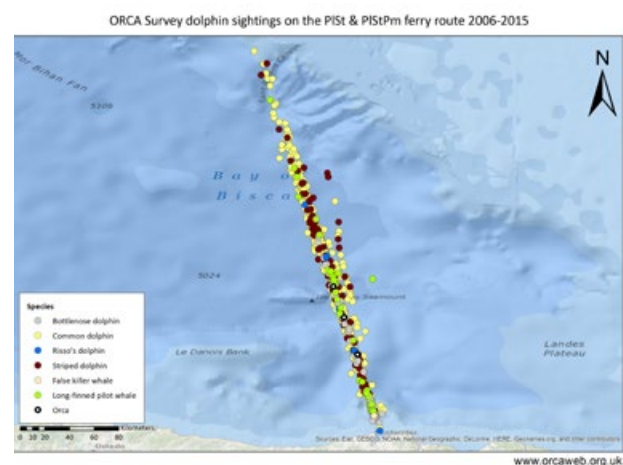
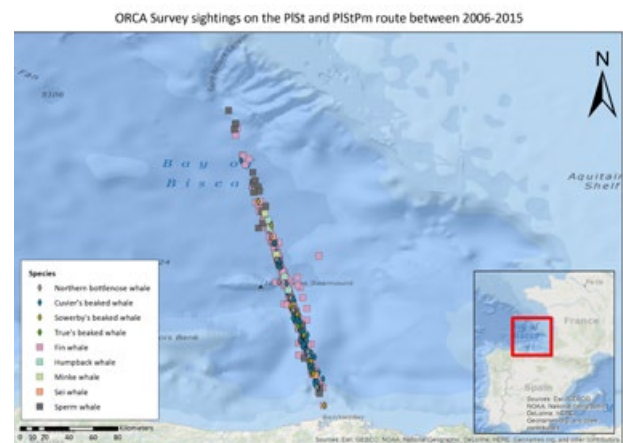
**Figure 32** Number of fin whale encounters and individuals in the Bay of Biscay and Iberian Coast between 2006-2015 by month.

## Bay of Biscay

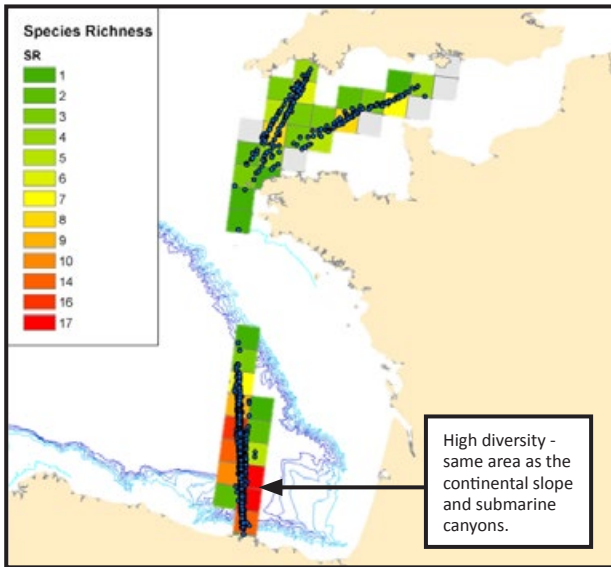
The Bay of Biscay is renowned as a cetacean rich location with a third of the world's species being recorded here. This is due to the wide range of topography in this area, from shallow coastal waters (~200m in depth) to a steep sloping continental shelf which leads to the abyssal plain (>4000m in depth). Furthermore, in the southern Bay, off the north coast of Spain, two submarine canyons are located; the Torrelevega Canyon and the Santander Canyon both extending down to ~6000m. This variety of habitats has resulted in a range of cetaceans being sighted in this area, including coastal species such as minke whale, pelagic species such as false killer whale and deep water species such as beaked whales (Figure 33).

Encounter rate for cetaceans was high throughout this sea region, particularly within the Bay of Biscay (Figure 30). The short-beaked common dolphin had the highest number of encounters (740), consisting of 19,779 individuals. This concurs with previous research carried out by Kiszka (2007). Common dolphin encounters were highest on the cruise transects in the outer Bay despite lower effort being conducted in this area (Figure 31), indicating that this may be an important area for this species.

The fin whale was the next most commonly encountered species, with 217 sightings consisting of 335 individuals. Encounters primarily occurred in the middle of the Bay and off the south-west corner of Portugal. In the northern hemisphere it is believed that fin whales breed in warm temperate waters during the winter, before migrating north to nutrient rich cooler waters, as far north as the polar seas (Reid, Evans and Northbridge, 2003). Although fin whales have been sighted throughout the year in this region, encounters peak in the summer months, August and September (Figure 32), supporting this migration theory.



**Figure 33** Species maps of whales (top) and dolphins (bottom) for the Plymouth to Santander (PISt) and Plymouth to Santander to Portsmouth (PIStPm).



**Figure 34** Species richness for all animals recorded in the Bay of Biscay and Iberian Coast.

ORCA’s data has highlighted the Bay of Biscay to have the highest cetacean diversity of all the sea regions. Within the Bay, the continental slope and deep sea canyons contained the highest species richness (Figure 34). Nutrient rich currents from the Atlantic enter the Bay and rise up the continental slope to meet surface currents, circulating nutrients within the Bay (Koutsikopoulos and Le Cann, 1996), which is why species richness is so high in this area. In addition, the canyons provide prime habitat for squid, the preferred food source for species such as the sperm whale and Cuvier’s beaked whale. Four beaked whale species were identified in the Bay of Biscay (Cuvier’s beaked whale, northern bottlenose whale, Sowerby’s beaked whale and True’s beaked whale), with the Cuvier’s being the most commonly sighted species. The majority of observations were in the southern Bay around the Jovellanos Seamount and submarine canyons, inferring this area as important to beaked whales.

A highlight of these surveys were the humpback whale sightings in 2012 and 2014 (Figure 33). Humpback whales are rarely seen in the Bay of Biscay, but occasionally pass through the deep water as they migrate to the south coast of Ireland. These sightings could be linked to the annual movements of their preferred prey.

The variety of habitats and abundance of nutrients and food sources within the Bay of Biscay has resulted in this area being cetacean rich and diverse, highlighting this as a vitally important area for whales and dolphins.



## Mediterranean Sea

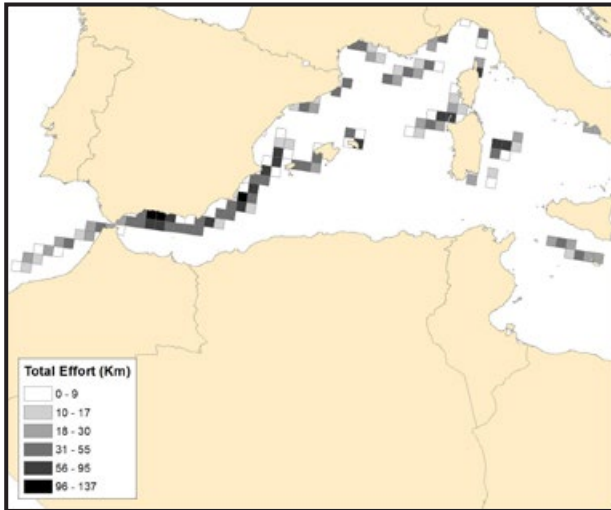


Figure 35 Total effort (km) per grid cell for Mediterranean Sea with table of effort for each year.

The Mediterranean Sea is almost completely enclosed by land, with the Strait of Gibraltar being the only opening, providing a connection to the Atlantic Ocean. This sea region is regarded as being located in one of the most heavily industrialised and populated areas worldwide, resulting in numerous threats to cetaceans inhabiting these waters. Therefore, in 2001 the Agreement on the Conservation of Cetaceans in the Black Sea Mediterranean Sea and Contiguous Atlantic Area (ACCOBAMS) commenced, which aims to assist international conservation efforts and scientific research within this area.

Effort in the Mediterranean Sea has been variable since surveys started in 2007 (Figure 35), with the highest effort conducted in 2013 (1,542km). The areas most surveyed were east of Gibraltar and off the south-eastern coast of Spain. Encounter rates

were highest in the coastal zone off southern Spain, France and Sardinia (Figure 36B), with the highest diversity occurring off Gibraltar and the south coast of Spain (Figure 36A).

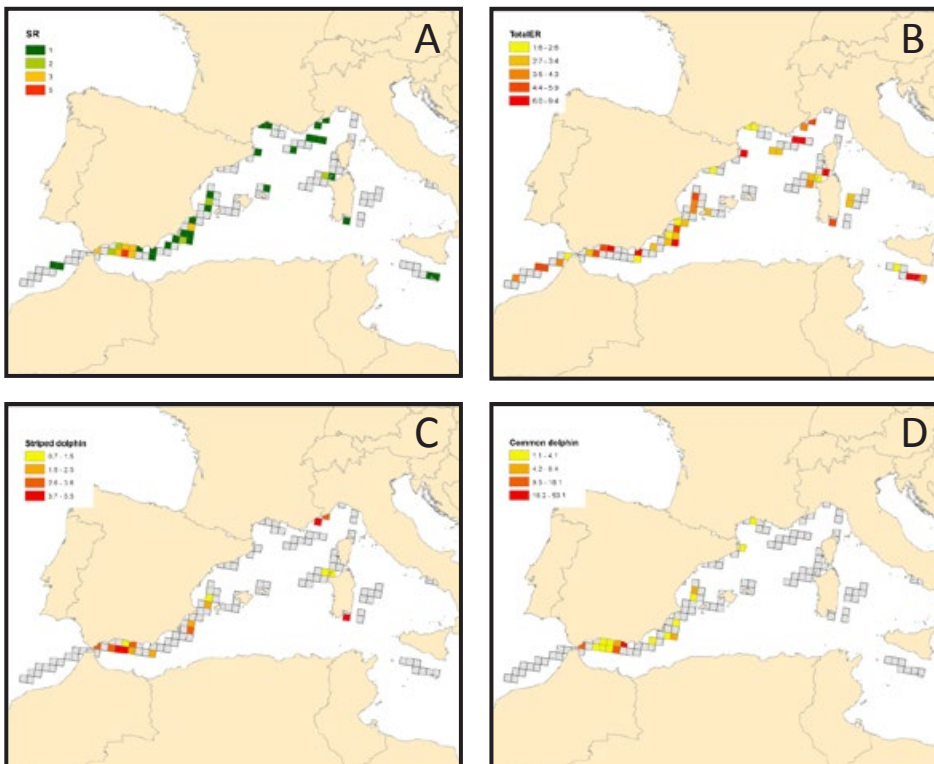


Figure 36 Species diversity (A), total encounter rate (B), striped dolphin encounter rate (C) and common dolphin encounter rate (D) per grid cell in the Mediterranean Sea between 2006-2015. Light grey squares indicate effort was undertaken within that cell but no encounters were recorded.

The most frequently observed species were the short-beaked common dolphin and the striped dolphin. Short-beaked common dolphins were sighted more frequently than striped dolphins, with encounters more readily occurring in the west of the Mediterranean Sea (Figure 36D). However, striped dolphins had a wider distribution, being seen throughout the sea region (Figure 36C). This supports ACCOBAMS conclusions, which report the striped dolphin to be the most abundant cetacean in the Mediterranean Sea.

Although they are the most abundant cetacean in the Mediterranean Sea, striped dolphins are declared as vulnerable under ACCOBAMS due to this species being subjected to multiple threats, such as drift nets, noise and pollution (Fossi *et al.*, 2013). It is perceived that the combined effects of such threats could result in a reduction in total population size of at least 30% over three generations (Aguilar, 2006). ORCA data confirms the distribution of striped dolphins reported by ACCOBAMS, however this in part could be due to the cruise routes undertaken. More effort needs to be conducted to truly understand population and distribution patterns of this vulnerable species.

# Arctic Waters

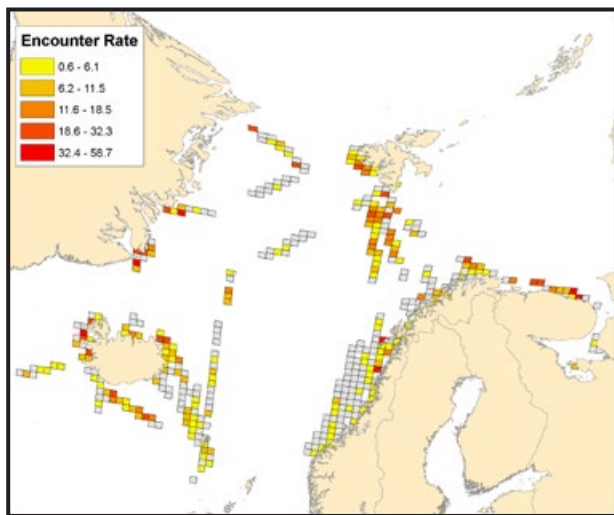


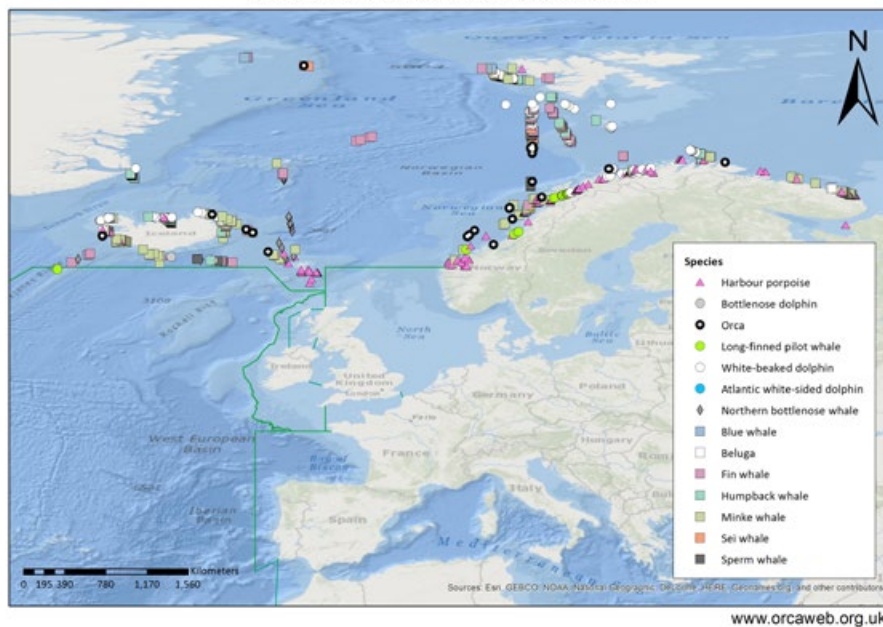
Figure 37 Encounter rate (no. groups per 100km) for all cetaceans within surveyed grid cells for Arctic Waters.

Despite effort being highest around the Norwegian coast, the highest encounter rates occurred along the coastline of Iceland and on route to Svalbard (Figure 37); species diversity was also highest in these areas (Figure 39). In total, 14 species of cetacean were seen in Arctic Waters (Figure 38), with the harbour porpoise being the most frequently sighted (212 encounters consisting of 1,133 animals). The majority of harbour porpoise sightings occurred along the Norwegian coast (Figure 38), which could be due to Norway’s fjord dominated coastline providing shallow, enclosed coastal zones, the preferred habitat for harbour porpoise.

Arctic Waters comprise almost 40% of the OSPAR maritime area. The primary current flowing through the region is the ‘Global Conveyor Belt’; a deep-water ocean current that travels around the entire globe. This current is driven by changes in salinity and temperature and is nutrient rich, supporting the growth of algae, the base of the food chain in the oceans.

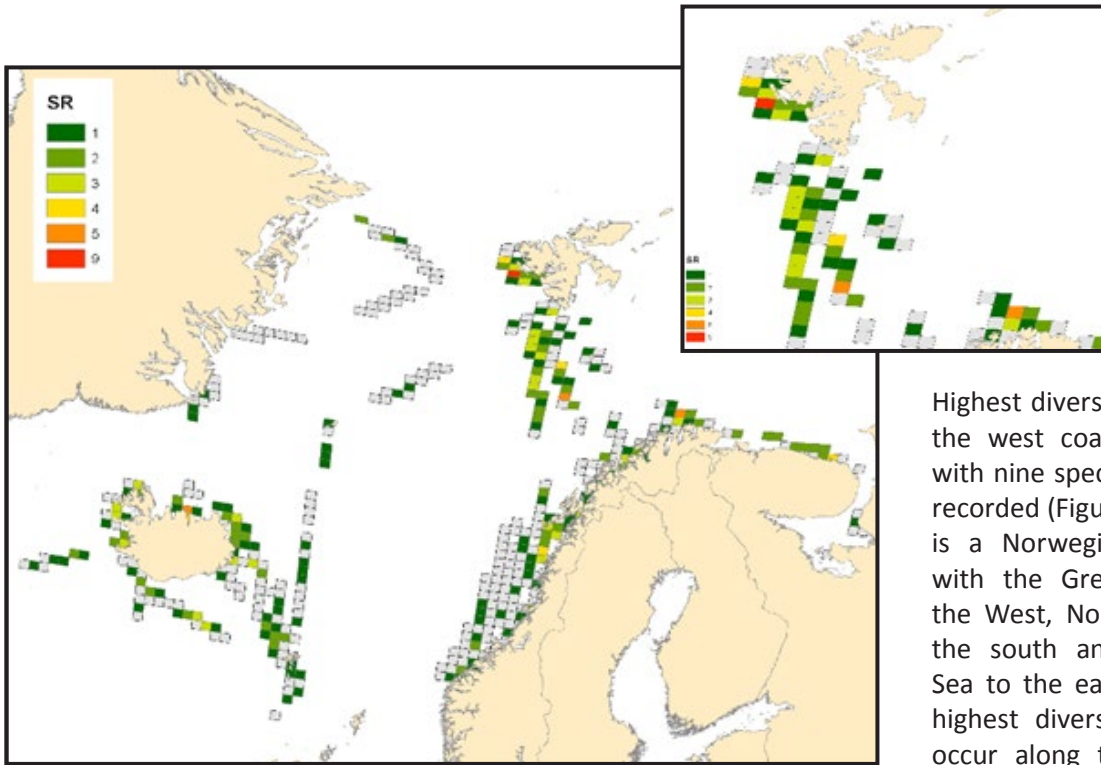
Cruise surveys commenced in this region in 2006 with increased effort from 2011 onwards; 2014 showed the greatest amount of effort conducted. The highest effort occurred along the Norwegian coast with the least around Greenland. In total, 20 cruises have been surveyed in Arctic Waters between 2006-2015.

ORCA Survey sightings in Arctic Waters 2006-2015



Species	2006	2009	2010	2011	2012	2013	2014	2015	Total
Harbour porpoise ( <i>Phocoena phocoena</i> )		19	12	16	49	20	53	43	212
Minke whale ( <i>Balaenoptera acutorostrata</i> )	2	3		20	35	17	50	16	143
White-beaked dolphin ( <i>Lagenorhynchus albirostris</i> )	2	1		21	11	28	52	12	127
Fin whale ( <i>Balaenoptera physalus</i> )	6			1	3	8	35	6	59
Humpback whale ( <i>Megaptera noveangliae</i> )				3	5	10	28	9	55
Killer whale ( <i>Orcinus orca</i> )				2	2	2	10	9	25
Northern bottlenose whale ( <i>Hyperoodon ampullatus</i> )	10				1		5	5	21
Sperm whale ( <i>Physeter macrocephalus</i> )						11	6	4	21
Long-finned pilot whale ( <i>Globicephala melas</i> )		6			9	1	2	1	19
Blue whale ( <i>Balaenoptera musculus</i> )					2	4	3		9
Sei whale ( <i>Balaenoptera borealis</i> )						1	6		7
Beluga ( <i>Delphinapterus leucas</i> )					6				6
Bottlenose dolphin ( <i>Tursiops truncatus</i> )								2	2
Atlantic white-sided dolphin ( <i>Lagenorhynchus acutus</i> )				1		1			2
<b>Total</b>	<b>20</b>	<b>29</b>	<b>12</b>	<b>64</b>	<b>123</b>	<b>103</b>	<b>250</b>	<b>107</b>	<b>708</b>

Figure 38 Cetacean species map of the Arctic Waters with species encounter table split by year.



**Figure 39** Species richness (diversity) per grid cell in the Arctic waters between 2006-2015. Light grey squares indicate effort was undertaken within that cell but no encounters were recorded.

Highest diversity occurred off the west coast of Svalbard, with nine species of cetacean recorded (Figure 39). Svalbard is a Norwegian archipelago with the Greenland Sea to the West, Norwegian Sea to the south and the Barents Sea to the east. The area of highest diversity appears to occur along the continental slope of Svalbard on the edge of the East Greenland Rift Basin. This is an area of great depth (maximum 4,846m) and significant currents, providing a rich feeding ground for cetaceans.



Killer whale (orca)

## Wider Atlantic

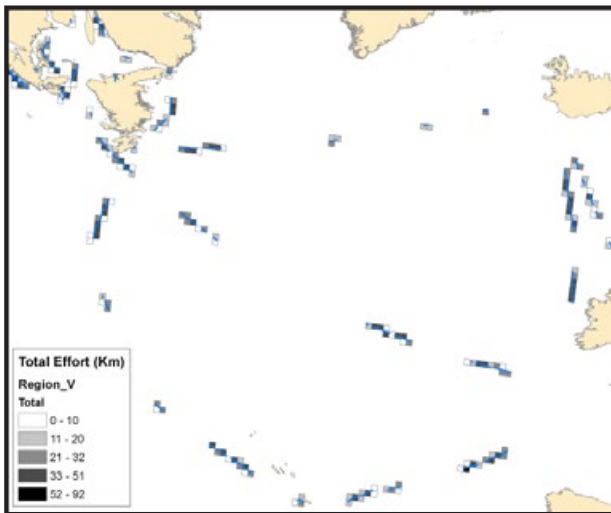
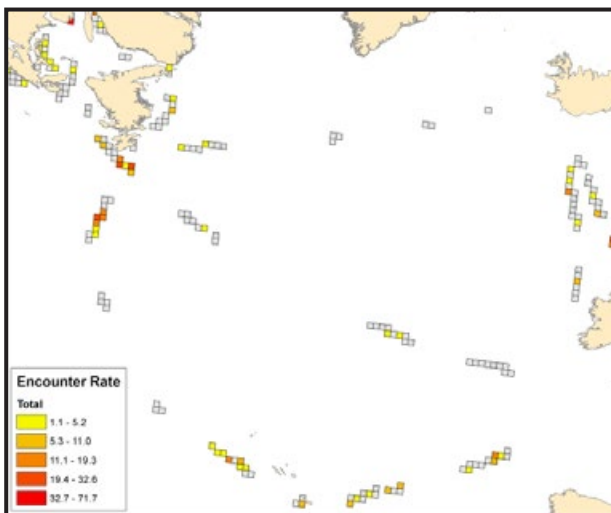


Figure 40 Total effort (km) per grid cell for the Wider Atlantic.



The Wider Atlantic extends between 62°N and 36°N and from 42°W to 10°W off Iberia and France. It consists of a variety of topography from continental slopes and seamounts, to the mid-Atlantic ridge and the abyssal plain. Survey effort in this sea region has been intermittent (Figure 40) with the highest effort of 3,000km recorded in 2015.

Cetaceans were encountered throughout the sea region, with the majority occurring around Canada and to the south of the region (Figure 41). The most common species seen was the short-beaked common dolphin with 24 encounters consisting of 174 individuals. Other species included; humpback whale, minke whale and beaked whales (Sowerby's, True's and northern bottlenose whales) (Table 6).

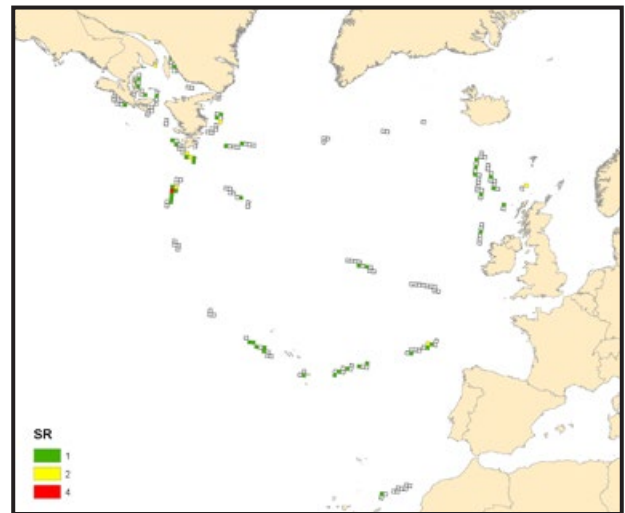


Figure 41 Encounter rate (number of groups per 100km) for all cetaceans within surveyed grid cells (Left). Species richness (diversity) per grid cell in the Wider Atlantic between 2006-2015 (Right). Light grey squares indicate effort was undertaken within that cell but no encounters were recorded.

Species	2008	2011	2012	2014	2015	Total
Common dolphin ( <i>Delphinus delphis</i> )	1				23	24
Humpback whale ( <i>Megaptera novaeangliae</i> )					16	16
Minke whale ( <i>Balaenoptera acutorostrata</i> )			3		11	14
Harbour porpoise ( <i>Phocoena phocoena</i> )			1		8	9
Atlantic white-sided dolphin ( <i>Lagenorhynchus acutus</i> )			1	1	6	8
Fin whale ( <i>Balaenoptera physalus</i> )	2	1			4	7
Striped dolphin ( <i>Stenella coeruleoalba</i> )			1		6	7
Long-finned pilot whale ( <i>Globicephala melas</i> )		1	1		3	5
Sowerby's beaked whale ( <i>Mesoplodon bidens</i> )		3			1	4
Beluga ( <i>Delphinapterus leucas</i> )					3	3
Blue whale ( <i>Balaenoptera musculus</i> )			1		1	2
Northern bottlenose whale ( <i>Hyperoodon ampullatus</i> )					2	2
Sperm whale ( <i>Physeter macrocephalus</i> )		1		1		2
Bottlenose dolphin ( <i>Tursiops truncatus</i> )				1		1
Killer whale ( <i>Orcinus orca</i> )			1			1
Sei whale ( <i>Balaenoptera borealis</i> )			1			1
True's beaked whale ( <i>Mesoplodon mirus</i> )					1	1
Risso's dolphin ( <i>Grampus griseus</i> )						0

Table 6 The number of encounters and individuals for the species seen in the Wider Atlantic.



Species diversity was highest off the coast of Canada (Figure 41) with four species being seen; common dolphin, minke whale, blue whale and humpback whale (Figure 42 pop-out). This area is on the continental slope, where nutrient rich currents rise up, creating an abundant food source for cetaceans. One of the most interesting sightings were the beluga seen in the St Lawrence River (Box 4).

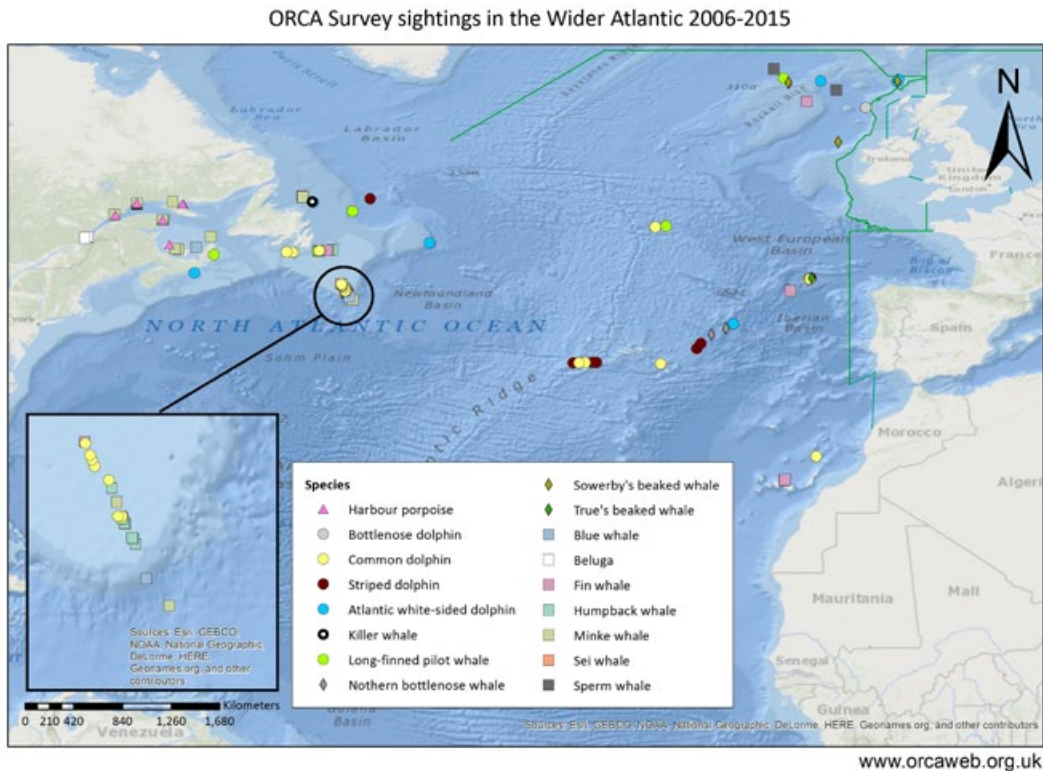


Figure 42 Cetacean species map of the Wider Atlantic between 2006-2015, with pop-out showing area of highest diversity.

#### Box 4 Beluga (*Delphinapterus leucas*)

Beluga are commonly found in the high latitudes of the northern hemisphere, with resident populations found in the St Lawrence River (Canada). At the end of the 19th century, belugas were abundant in the St Lawrence, with 7,800-10,000 individuals inhabiting these waters. Commercial hunting in the early 20th century resulted in a significant decline in their numbers and the population is now estimated to be at ~889 individuals.

The Saguenay – St Lawrence Marine Park covers a 1,245km<sup>2</sup> area of the St Lawrence River, offering protection to all species living there, including the resident belugas. Over the last 30 years, long-term research and data collection has been instrumental in protecting these populations. Continued ORCA surveys could contribute to conservation efforts.





# SURVEY FINDINGS FOR SPECIFIC SPECIES

Harbour porpoise (*Phocoena phocoena*)



## Harbour porpoise

The harbour porpoise is widespread in the northern hemisphere, inhabiting cold temperate to sub-polar waters, typically <200m in depth, in coastal zones over much of the European continental shelf (Gaskin, 1992; Read, 1999). It is the smallest cetacean (reaching 1.3-1.5m in length) and the only porpoise to be found in European waters. The IUCN have classified the harbour porpoise as 'least concern' because it is widespread and abundant across all the regions. However, such a classification is misleading, since populations have declined regionally (Hammond *et al.* 2008) and nowhere more so than in Europe.

The harbour porpoise is one of the most threatened cetaceans in Europe. This is due to its preferred habitat of shallow, coastal zones, which are frequently impacted by high levels of chemical pollution, vessel traffic, underwater noise and the depletion of prey by overfishing. However, the main threat to the harbour porpoise is that of incidental catches in fishing gear. It is estimated that ~4,600 individuals are caught each year in the North Sea, and ~1,500 individuals on the Celtic shelf (Sea Watch Foundation, 2016).

The harbour porpoise is listed under Annex II of the EU Habitats Directive, meaning participating countries of the EU are required to designate Special Areas of Conservation (SACs) for this species. In September 2016 the Inner Hebrides and Minches was designated a SAC. This is the largest protected area for harbour porpoise in Europe, covering over 13,800km<sup>2</sup> and supporting a population of over 5,000 individuals. Five more sites are currently being considered in England, Wales and Northern Ireland.

Harbour porpoise were observed in all sea regions except the Mediterranean Sea (Figure 43), with the highest number of sightings of all species recorded over the 10 year period; 1,544 encounters consisting of 3,552 individuals. The harbour porpoise was the most encountered species in five out of the nine sea regions (North Sea, Arctic Waters, English Channel, Irish Sea and the Minches and West Scotland), with the highest number of sightings (Table 7) and encounter rate (Figure 44) within the North Sea.

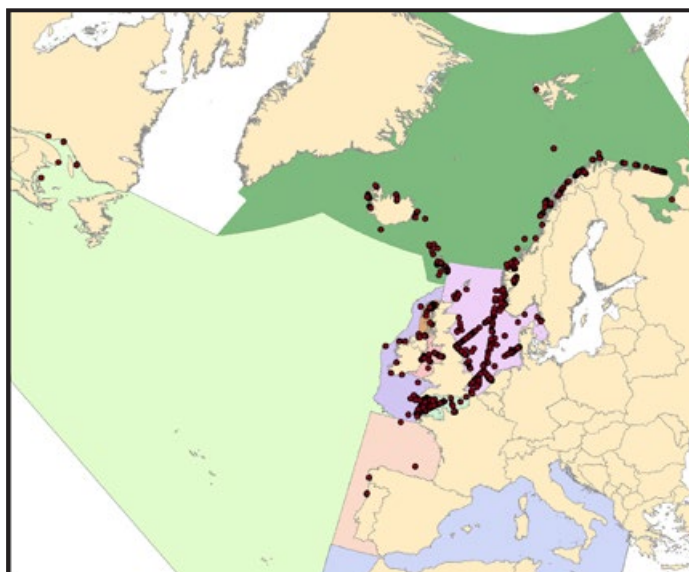


Figure 43 Harbour porpoise sightings in all sea regions between 2006-2015.

Sea Region	No. of encounters	No. of animals
North Sea	818	1498
Celtic Seas	226	465
Arctic Waters	202	1001
English Channel	191	396
Irish Sea	51	76
Minches and West Scotland	41	82
Wider Atlantic	9	22
Bay of Biscay and Iberian Coast	6	12
Mediterranean Sea	0	0
<b>Total</b>	<b>1544</b>	<b>3552</b>

Table 7 Number of harbour porpoise encounters and individuals seen per sea region between 2006-2015.

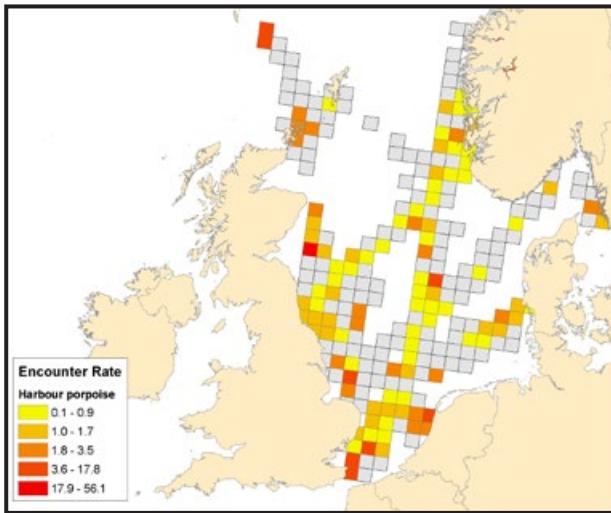


Figure 44 Encounter rate (no. groups per 100km) for the harbour porpoise within surveyed grid cells for the North Sea.

The encounter rate maps indicate that harbour porpoise are mainly sighted around coastal areas (Appendix II). The highest encounter rates were in the southern North Sea off Dover and IJmuiden (Figure 44). These results support the last two Small Cetacean Abundance in the North Sea and Adjacent Waters (SCANS) surveys, conducted in 1994 and 2005, which indicate a major shift in distribution from northern to southern areas within the North Sea (Hammond *et al.* 2008).

Harbour porpoise feed predominantly on small shoaling fish, such as whiting and sand eels (Santos and Pierce, 2003). It is documented that within the North Sea, harbour porpoise historically predate on herring, but this species has been declining since the 1960's due to overfishing, which in turn has resulted in a dietary shift

from herring to sand eels (Santos and Pierce, 2003). With numerous sand eel spawning grounds in the southern North Sea, especially in the shallower waters towards the English Channel, ORCA's data suggests that harbour porpoise are shifting their distribution to be closer to their primary food source.

Within the North Sea and Celtic Seas, harbour porpoise sightings appear to peak in July and August (Figure 45), suggesting a seasonal distribution. However, this could be due to favourable weather conditions at this time of year, with a sea state typically less than three making it easier to observe and identify the harbour porpoise. Further analysis is therefore required to investigate this.

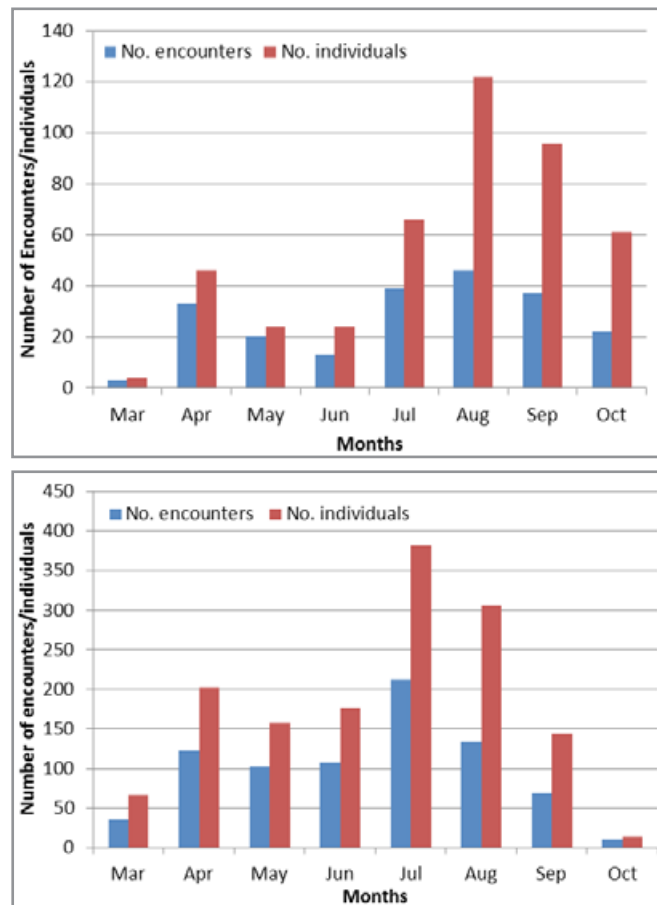


Figure 45 Harbour porpoise sightings in the Celtic Seas (Top) and North Sea (Bottom).

**Bottlenose dolphin (*Tursiops truncatus*)**

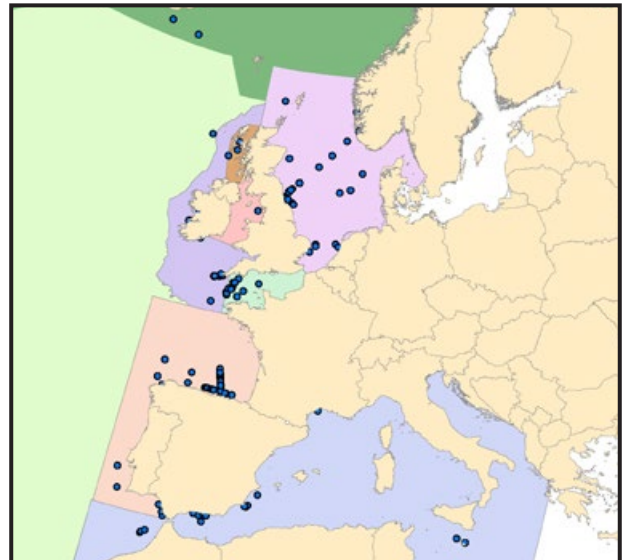


## Bottlenose dolphin

The bottlenose dolphin has a global distribution in temperate and tropical waters, with coastal populations occupying bays and estuaries, and offshore populations inhabiting pelagic waters along continental shelf edges. Bottlenose dolphins in higher latitudes are typically larger than those in warmer climates, and those located in the UK are some of the largest reaching four metres in length.

Bottlenose dolphins are one of only two species (the other being harbour porpoise) to be protected under Annex II of the EU Habitats Directive. Around the UK and Ireland, four SACs have been designated to protect the bottlenose dolphin; Cardigan Bay and the Moray Firth in the UK and the Shannon Estuary and West Connacht Coast in Ireland. All four SACs are home to what are believed to be semi-resident populations of bottlenose dolphins.

ORCA's surveys have shown bottlenose dolphins to be present in all sea regions (Figure 46). Overall, 172 encounters were recorded consisting of 1,424 individuals. Bottlenose dolphins were in the top five most encountered species for seven of the nine sea regions; Minches and West Scotland, Wider Atlantic, Celtic Sea, Irish Sea, Bay of Biscay and Iberian Coast, English Channel and North Sea.



Sea Region	No. of encounters	No. of animals
Bay of Biscay and Iberian Coast	81	786
Celtic Seas	27	172
North Sea	27	105
English Channel	15	126
Mediterranean Sea	15	180
Minches and West Scotland	3	7
Arctic Waters	2	40
Irish Sea	1	2
Wider Atlantic	1	6
<b>Total</b>	<b>172</b>	<b>1424</b>

Figure 46 Bottlenose dolphin sightings in all sea regions between 2006-2015, with a table of the numbers of sightings and individuals seen.

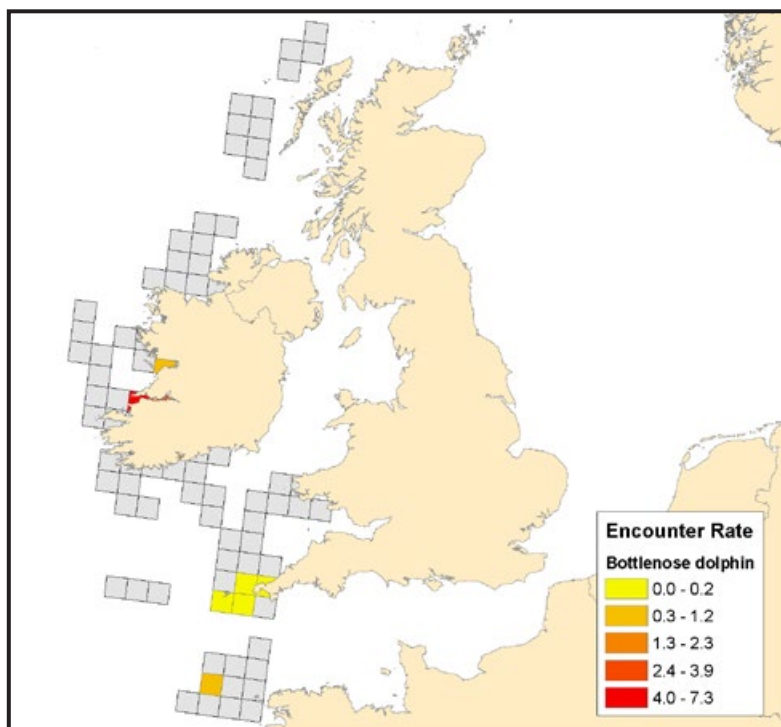


Figure 47 Encounter rate (no. groups per 100km) for the bottlenose dolphin within surveyed grid cells for the Celtic Seas.

There were 27 sightings in the Celtic Seas (Figure 46), with the highest encounter rate occurring in and around the Shannon Estuary (Figure 47). This is to be expected as there is a semi-resident population of bottlenose dolphins inhabiting these waters. Interestingly, two encounters of bottlenose dolphin occurred in Arctic Waters off the south coast of Iceland in 2015. This is further north than their documented range and could indicate a distributional northward shift.

Over the past century, bottlenose dolphins have been viewed as uncommon within the North Sea (Sea Watch Foundation, 2016). However, between 2006-2015, ORCA has recorded 27 encounters of bottlenose dolphins consisting of 105 individuals, with the majority of sightings occurring just off

the North Shields coastline. ORCA's data suggests there might be a seasonal distribution in this area, with a peak in sightings in the month of June (Figure 48); further analysis will need to be conducted to confirm this.

The highest number of sightings and number of individuals occurred in the Bay of Biscay and Iberian Coast (Figure 46), with 74 out of the 81 encounters (91%) occurring on the PISt/ PIStPm routes. No seasonal pattern was identified, but a preference was shown for the southern shelf and shelf edge in the Bay of Biscay (Figure 49), supporting the research conducted by Kiszka (2007).

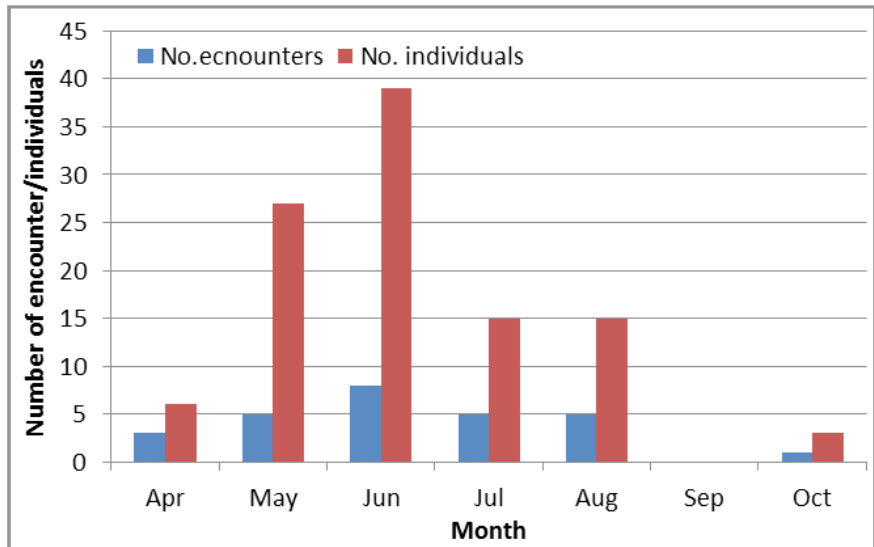


Figure 48 Bottlenose dolphin sightings in the North Sea.

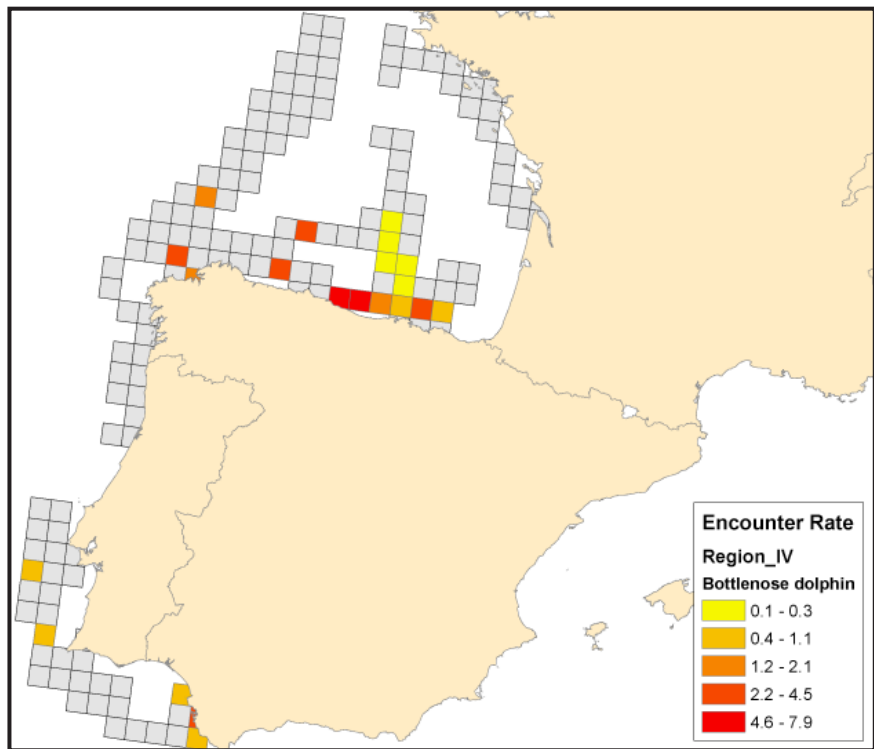


Figure 49 Encounter rate (no. groups per 100km) for the bottlenose dolphin within surveyed grid cells for the Bay of Biscay and Iberian Coast.



**Short-beaked common dolphin**  
*(Delphinus delphis)*



## Short-beaked common dolphin

The short-beaked common dolphin is one of the smallest dolphins, measuring 2-2.5m in length and is located in most temperate and tropical regions of the Pacific and Atlantic Oceans. In Europe it is listed under Annex IV of the EU Habitats Directive.

As the name suggests, this is a very common dolphin species in Europe, and the most widely distributed (Reid, Evans and Northbridge, 2003). Between 2006-2015, the common dolphin was observed in eight out of the nine sea regions, with the majority of sightings occurring in European waters. Arctic Waters was the only sea region where this species was not sighted (Figure 50). In total, across all sea regions, ORCA surveyors recorded 1,216 sightings of common dolphin, consisting of 29,160 individuals making up 27.9% of all cetacean sightings in all sea regions. Group size was highly variable, ranging between 1 and 3,000 animals with an average group size of 24.

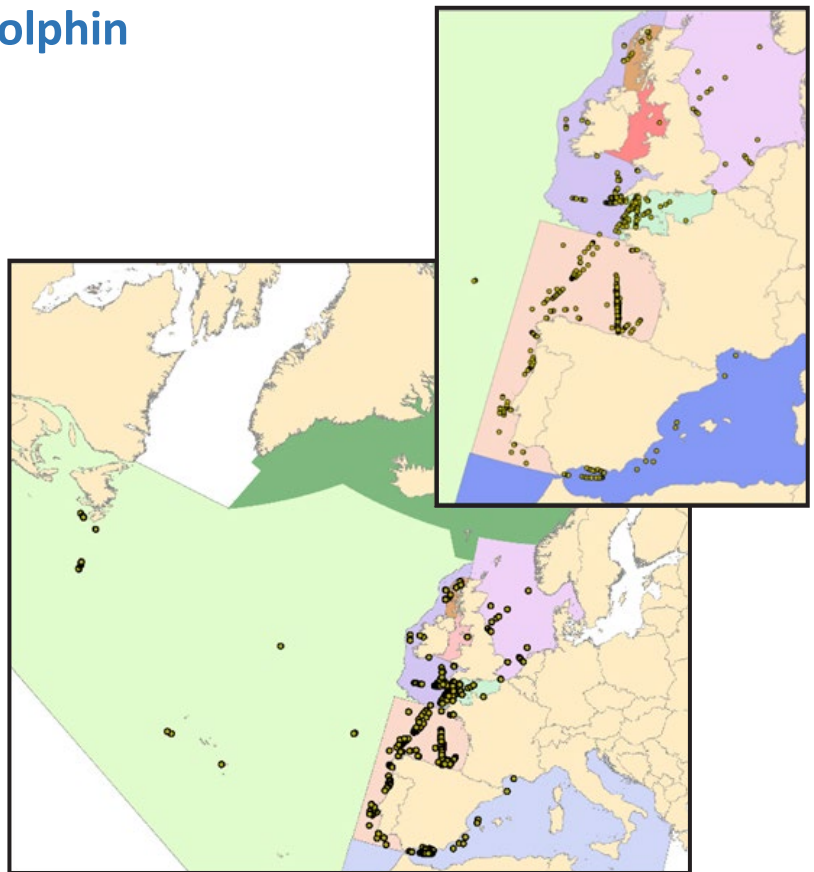


Figure 50 Common dolphin sightings within all sea regions between 2006-2015, with a focus around Europe.

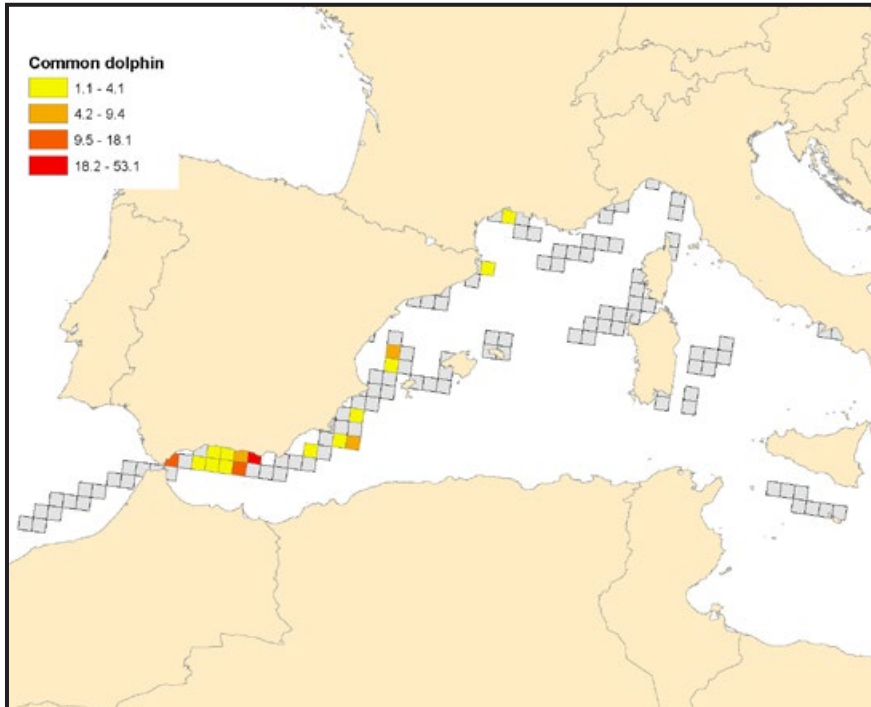
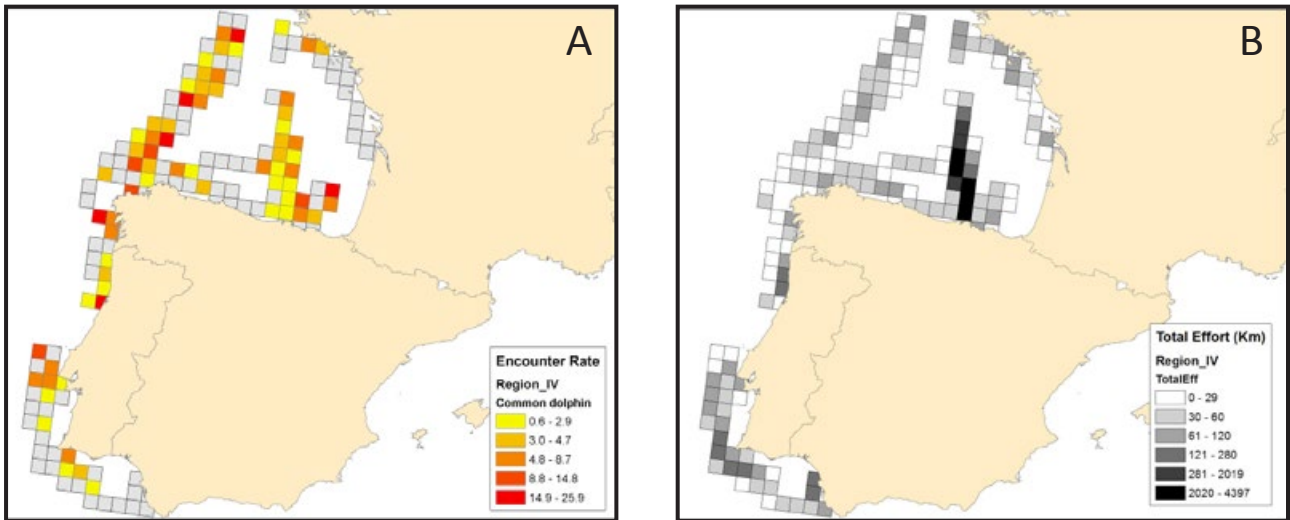


Figure 51 Encounter rate (no. groups per 100km) for the common dolphin within surveyed grid cells for the Mediterranean Sea.

Common dolphins were the most frequently seen species in four of the nine sea regions; Celtic Seas, Bay of Biscay and Iberian Coast, Mediterranean Sea and Wider Atlantic. The highest encounter rate occurred off the south coast of Spain in the Mediterranean Sea (Figure 51). The population within the Mediterranean Sea is classified as endangered by the IUCN, therefore this data could help inform conservation efforts. However, the highest number of sightings was in the Bay of Biscay and Iberian Coast.

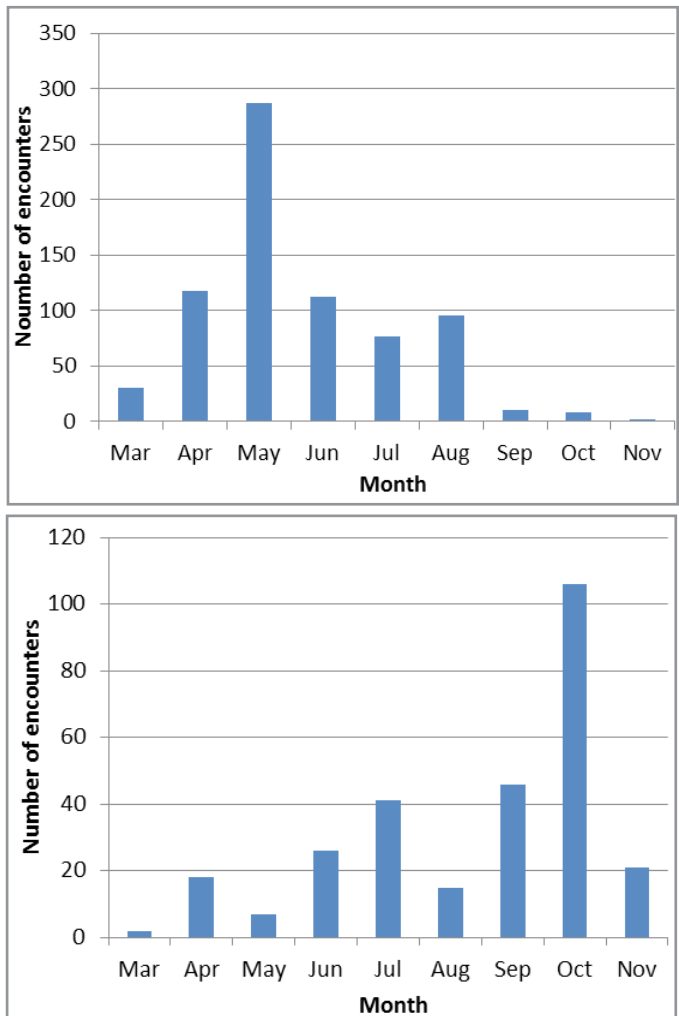




**Figure 52** Encounter rate (no. groups per 100km) for the common dolphin within surveyed grid cells for the Bay of Biscay and Iberian Coast (*Left*). Effort conducted within the Bay of Biscay and Iberian Coast sea region (*Right*).

In the Bay of Biscay and Iberian Coast, encounter rates were highest in the outer and south-east of the Bay (Figure 52), despite there being reduced effort conducted in these areas when compared to the centre of the Bay (Figure 52). This suggests that the outer Bay is the preferential habitat for common dolphins. Although the common dolphin was seen throughout the year in the Bay of Biscay and Iberian Coast, sightings peaked in May (Figure 53).

It is believed that the occurrence of common dolphins is strongly associated with the presence of prey species, particularly European pilchard and Atlantic horse mackerel, which are most abundant in the Bay of Biscay in spring and the Celtic Seas in autumn and winter (Santos *et al.* 2004; Kiszka, 2007; Meynier, 2008). Furthermore, Saunders (*et al.* 2010) stated that the Celtic Seas is a seasonal foraging ground for common dolphins due to the large presence of pelagic schooling fish. Encounters of common dolphin in the Bay of Biscay and Iberian Coast, and Celtic Seas could therefore suggest a seasonal pattern, as encounters peak in May and October respectively (Figure 53). This supports the theory that common dolphin distribution is a consequence of prey movements.



**Figure 53** Common dolphin sightings in the Bay of Biscay and Iberian Coast (*Top*) and Celtic Sea (*Bottom*).

**White-beaked dolphin**  
**(*Lagenorhynchus albirostris*)**



# White-beaked dolphin

White-beaked dolphins are found in the cool temperate and sub-arctic waters of the North Atlantic, preferring shelf waters around Iceland, Svalbard, Norway and the east coast of the UK (Figure 54). Pod size is generally reported to consist of 5-50 individuals (WDC, 2016a). However, ORCA surveyors have observed pods of 80-100 animals in the North Sea. This species was also sighted regularly in the southern North Sea, although the majority of sightings occurred in the northern North Sea. There has only been one sighting in the English Channel, which occurred in May 2014 off the Salcombe coastline. There is a well-studied population of white-beaked dolphins in Lyme Bay, off the south coast of England. The sighting off Salcombe could suggest that this species range is increasing through the English Channel.

ORCA surveyors have sighted white-beaked dolphins 215 times (5% of total sightings from all species) with a total of 1,263 individuals. 71 of the sightings were on ferry routes, all of which were in the North Sea. Overall, the highest number of encounters were in Arctic Waters (125 sightings), with the highest encounter rate off the northern coast of Iceland and south of Svalbard (Figure 55).

Within the North Sea, ORCA's data suggests a seasonal occurrence of white-beaked dolphins, with encounters peaking in July (Figure 56) and being seen more commonly inshore than offshore. This concurs with findings by Weir (2007). Research suggests that white-beaked dolphins give birth in the summer months offshore in the North Sea followed by an inshore movement to what are believed to be nursery areas, although further evidence is required (Reid Evans and Northbridge. 2003; Canning *et al.* 2008). Therefore, with the majority of white-beaked dolphin sightings occurring in the inshore waters around North Shields in July, this could infer these waters to be important nursery areas.

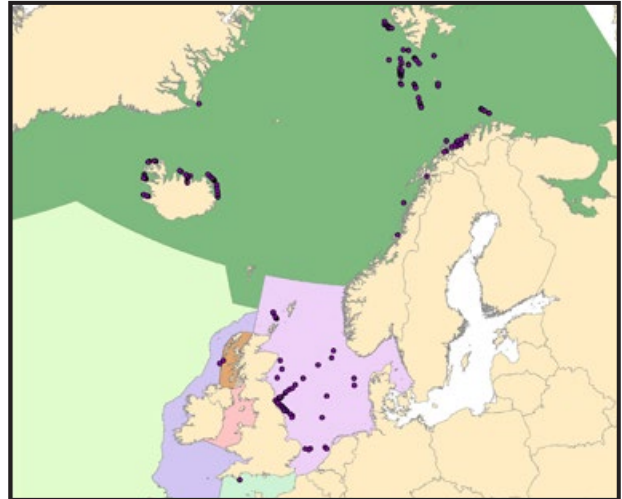


Figure 54 White-beaked dolphin sightings in all sea regions between 2006-2015.

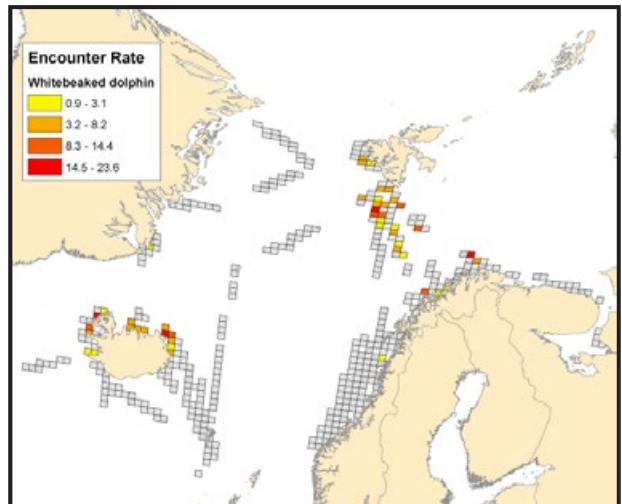


Figure 55 Encounter rate (no. groups per 100km) for the white-beaked dolphin within surveyed grid cells for Arctic Waters.

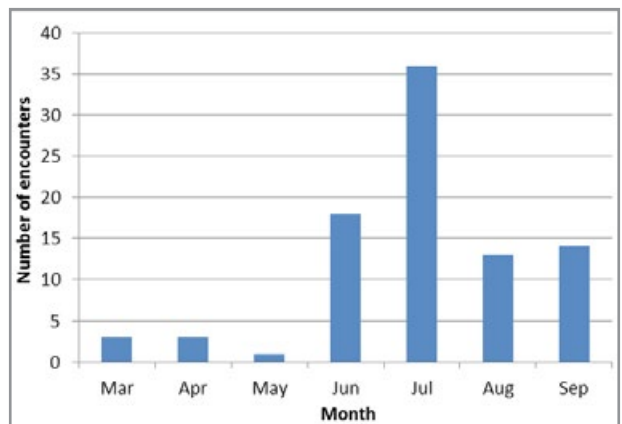
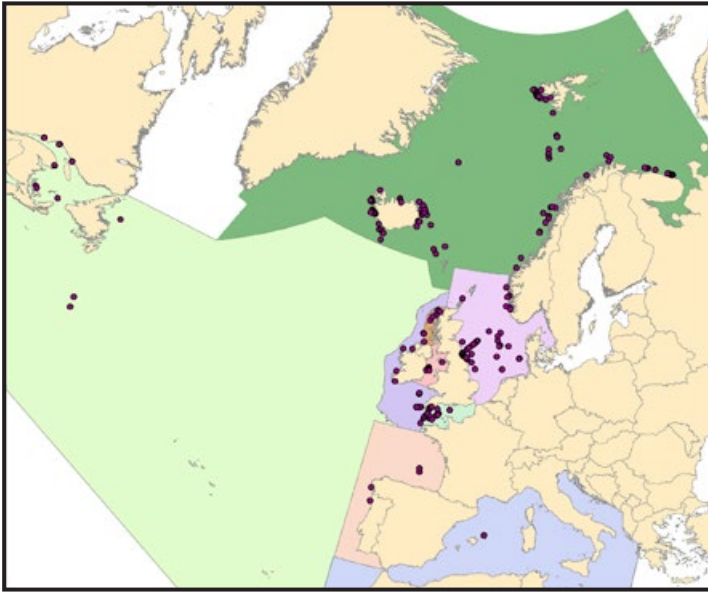


Figure 56 White-beaked dolphin sightings in the North Sea.

**Minke whale**  
**(*Balaenoptera acutorostrata*)**



# Minke whale



Sea Region	No. of encounters	No. of animals
Arctic Waters	143	189
North Sea	66	74
Celtic Seas	31	32
English Channel	25	26
Minches and West Scotland	16	20
Wider Atlantic	14	16
Irish Sea	9	9
Bay of Biscay and Iberian Coast	4	4
Mediterranean Sea	1	1
<b>Total</b>	<b>309</b>	<b>371</b>

Figure 57 Minke whale sightings in all sea regions between 2006-2015, with a table of the numbers of sightings and individuals seen.

of encounters of minke whales with 66 sightings (Figure 57). Nearly half of these were on the North Shields to Ijmuiden survey. ORCA’s data infers a seasonal distribution of minke whales in the North Sea with peak numbers in July and August (Figure 58). Research has shown that minke whales undergo a seasonal migration from high latitude feeding grounds in the summer to temperate winter breeding grounds (Stewart and Leatherwood, 1985; Glover *et al.* 2010). Anderwald and Evans (2007) reported that most sightings around the UK occur between May and September with peak numbers from July to September, supporting ORCA’s findings. The concept of a seasonal northern migration in the summer months is further supported by the seasonal pattern also seen within the English Channel and Celtic Seas, with peak encounters occurring in July and September respectively (Figure 58). This could suggest that minke whales migrate through the English Channel into the North Sea and Celtic Seas on their way to polar feeding grounds. However, due to the number of sightings in these areas further analysis is required to confirm this.

Minke whales can be found in all oceans across the world and are the smallest baleen whale in European waters with an average length of 7-10m. They are protected under Annex IV of the EU Habitats Directive.

ORCA surveys detected minke whales in all sea regions (Figure 57), with the highest number of encounters and individual animals seen in Arctic Waters (Figure 57). The majority of sightings throughout all sea regions occurred in coastal or shelf regions where depths were <200m. Minke whales were the third most frequently sighted species, with 309 sightings (7% of all encounters for all species) consisting of 371 individuals. More than 85% of sightings were of only one individual, which concurs with research that this is primarily a solitary species. The North Sea displayed the second highest number

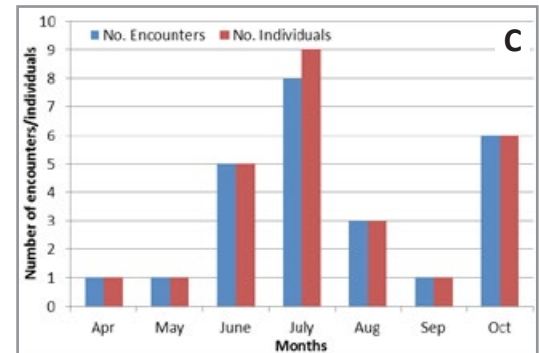
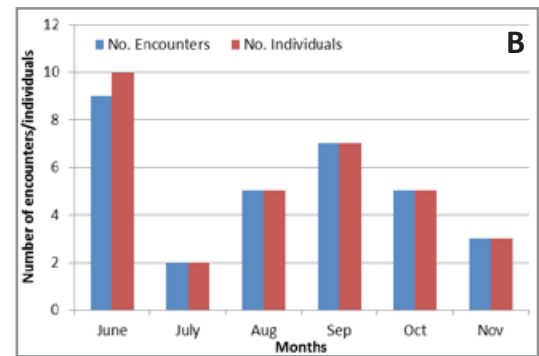
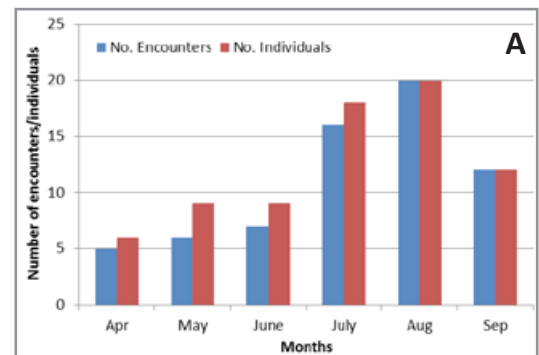


Figure 58 Minke whale sightings in the North Sea (A), Celtic Seas (B) and English Channel (C).



**Beaked whales**  
*(Ziphiidae spp.)*



## Beaked whales

Beaked whales are members of the *Ziphiidae* family, the second largest group of cetaceans after the *Delphinidae* family (dolphins) (Rice, 1998). The *Ziphiidae* consist of six genera and 21 species; 14 in the genus *Mesoplodon*, two in the *Hyperoodon*, two in the *Berardius* and three non-specific genera (*Ziphius*, *Tasmacetus* and *Indopacetus*) (Smith, 2010). These are extraordinarily elusive toothed cetaceans and most of what we know about the genus is derived from stranded animals. Few species have been studied at sea and some have never been seen alive at all, the new species of beaked whales are still being discovered. Efforts in recent years continue to reveal fresh but frustratingly incomplete knowledge about their habitat and distribution and all species, with the exception of the Cuvier's beaked whale, are deemed data deficient. Ongoing research programmes such as that undertaken by ORCA will be critical in finding out more about these elusive and mysterious animals. Our long-term dataset and observations of beaked whales could make a significant contribution to the understanding of these understudied and enigmatic species.

Beaked whales were observed in four of the nine sea regions (Figure 59); Bay of Biscay and Iberian Coast, Arctic Waters, Wider Atlantic and English Channel. All beaked whales were found in relatively deep water areas, with the exception of an unidentified beaked whale observed in the English Channel in August 2010.

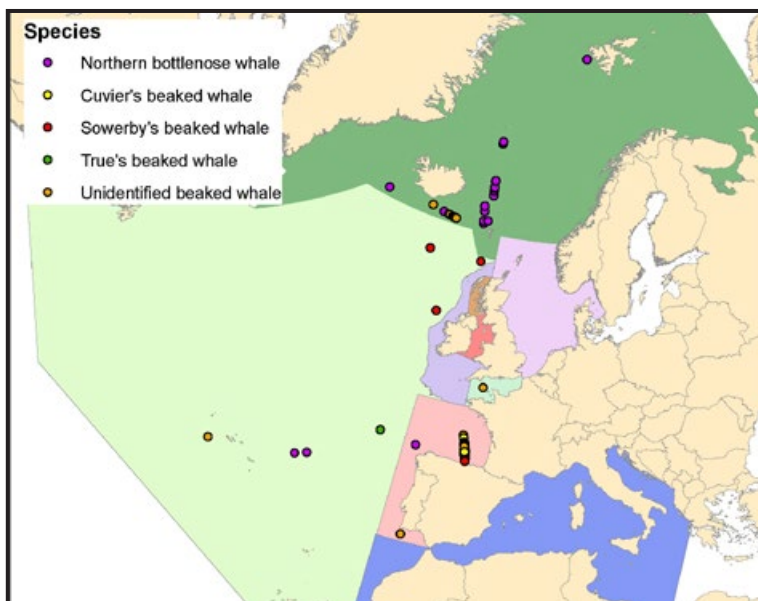


Figure 59 Beaked whale sightings in all sea regions between 2006-2015.

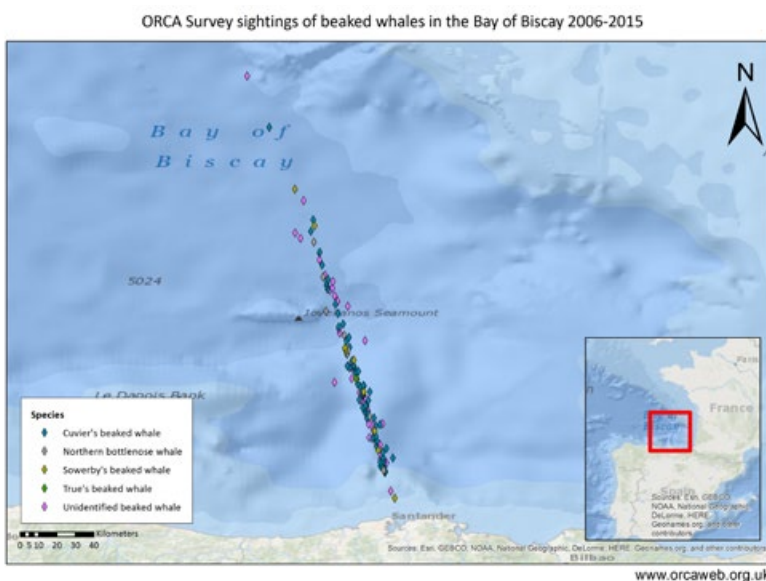


Figure 60 ORCA survey sightings of beaked whales in the Bay of Biscay between 2006-2015.

In total, 166 beaked whale sightings were recorded consisting of 350 individuals. This included 52 encounters (89 individuals) of unidentified beaked whale due to the difficulties in identifying these species in the field. A positive identification of many beaked whale species can only be determined by the position and shape of a single pair of teeth on the outer lower jaw, which are only present in the males. Despite this, four species of beaked whale were identified around Europe; Cuvier's beaked whale, northern bottlenose whale, Sowerby's beaked whale and True's beaked whale.

The highest number of encounters occurred in the Bay of Biscay and Iberian Coast with 131 sightings (260 individuals), all of which occurred in the southern Bay (Figure 60). The southern Bay is a nutrient rich area of steeply sloping continental shelf which separates the coastal and pelagic regions and contains two deep sea canyons home to squid, the preferred food source for beaked whales. This topographical feature is a likely explanation for the high number of beaked whale sightings in this area, all of the four identified species were observed here and therefore, indicates this as a hotspot in Europe.

The two most frequently sighted beaked whales were the Cuvier's beaked whale and the northern bottlenose whale respectively, therefore further detail will be provided on these species.

## Cuvier's beaked whale (*Ziphius cavirostris*)

The Cuvier's beaked whale is believed to have the most extensive range of any beaked whale species (Heyning, 2002), extending from the offshore waters of the tropics to the polar regions in both hemispheres. It is the only known beaked whale to be regularly seen in the Mediterranean Sea (Podesta *et al.* 2005).

The Cuvier's was the most frequently observed beaked whale species with 66 sightings consisting of 143 individuals. Despite this, all sightings occurred within one sea region, the Bay of Biscay and Iberian Coast, specifically within the southern Bay of Biscay, signifying this to be an important area for Cuvier's (Figure 61).

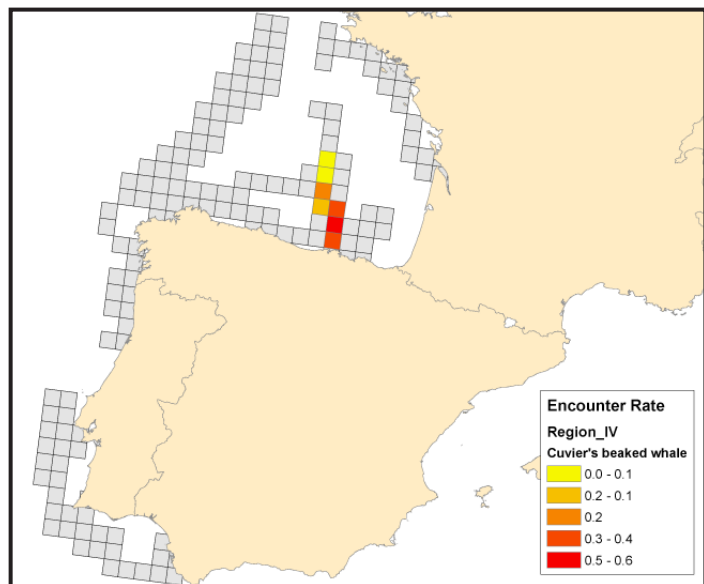


Figure 61 Encounter rate (no. groups per 100km) for the Cuvier's beaked whale within surveyed grid cells for Bay of Biscay and Iberian Coast.



One of the biggest threats to beaked whales is the use of active sonar and noise created by seismic operations (Malakoff, 2002), and military sonar has been implicated in a number of large mass strandings of Cuvier's beaked whales in the Mediterranean Sea (Frantzis and Cebrian, 1998; Podesta *et al.* 2005), Madeira (Freitas, 2004) and the Canaries (Jepson *et al.* 2003). This is due to their foraging behaviour. All beaked whales are understood to be deep divers and the Cuvier's is thought to be one of the deepest diving reaching depths of 2,992m and remaining submerged for 138 minutes (Schorr *et al.* 2014). It is thought that sonar acutely distresses the whales when they are at extreme depth, causing them to rush to the surface, resulting in a similar physiological condition to the bends (Hooker, 2009). Within the Mediterranean Sea, ACCOBAMS has implemented measures to limit or avoid the use of military sonar in areas known to contain habitat suited to the Cuvier's beaked whale.

As ORCA's data has highlighted the southern Bay of Biscay to be a possible area of importance for Cuvier's, similar measures to reduce the impact of known threats to this species may need to be considered.



## Northern bottlenose whale

### *(Hyperoodon ampullatus)*

The northern bottlenose whale is endemic to the North Atlantic Ocean and is the largest species of beaked whale in the European Atlantic, reaching up to 11m in length (MacLeod *et al.* 2005). It is the only beaked whale known to have been hunted commercially in the North Atlantic, where over 65,000 whales were killed by whalers in the 19th and 20th Century (WDC, 2016b). Since 1977 the species has been protected from commercial whaling (Reeves, Mitchell and Whitehead, 1993).

The northern bottlenose whale was the second most frequently encountered beaked whale species from ORCA's surveys, with 32 sightings in total consisting of 80 individuals.

Encounters were highest in Arctic Waters, followed by the Bay of Biscay and Iberian Coast and Wider Atlantic (Figure 62). This is the only beaked whale to be positively identified in Arctic Waters and it is reported that only mature males migrate up to the high Arctic, with female and juvenile animals remaining much further south (Kovacs and Lydersen, 2016). Therefore, the northern bottlenose whales ORCA observed in Svalbard were likely to have been male.

This species occupies a very narrow niche, feeding primarily on squid of the genus *Gonatus* (Hooker *et al.* 2001) and is therefore even more susceptible to the numerous threats and pressures facing beaked whales. This further stresses the importance of long-term data, such as that collected by ORCA, in contributing to the conservation efforts of this species.

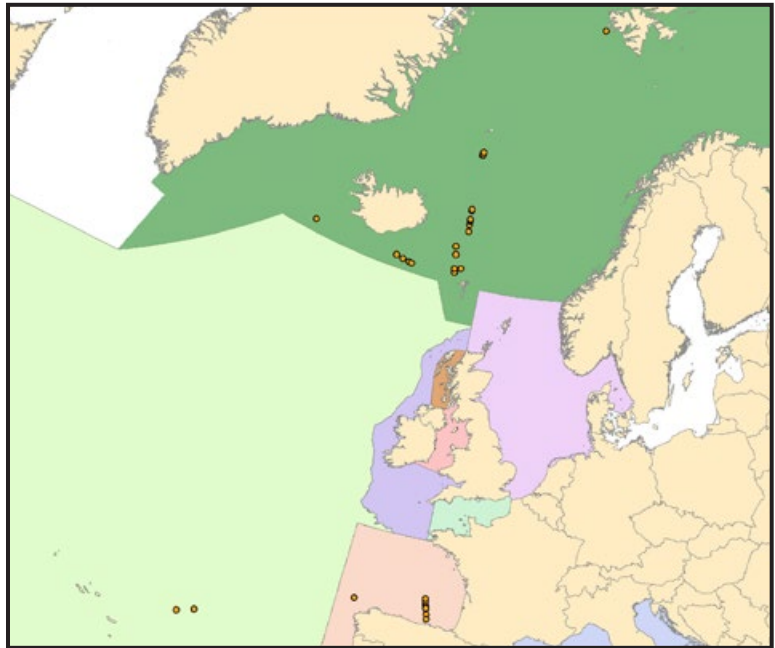


Figure 62 Northern bottlenose whale sightings in all sea regions between 2006-2015.



# Summary of findings

- For the last 10 years, ORCA has built positive relations with operators of the ferry and cruise network across Europe in order to survey for cetaceans in its waters. The geographical scope of the survey areas included five OSPAR sea regions of the Arctic Waters, Greater North Sea, Celtic Seas, Bay of Biscay and Iberian Coast, Wider Atlantic and includes the Mediterranean Sea. From 2006-2015, 376 surveys were undertaken; 339 on board ferries and 37 on cruise ships, amounting to 179,342km of effort.
- Sightings of cetacean species totalled 4,340 which consisted of 42,817 animals, with 22 different species identified. The most commonly sighted cetacean was the harbour porpoise (1,544 sightings), which was observed predominantly around the coast of the UK, North Sea and along the Norwegian coastline. The Bay of Biscay and Iberian Coast was the region that showed the highest species diversity with 17 species seen overall and 13 seen in one 20nm cell. Overall the common dolphin recorded the second highest number of sightings (1,216) followed by fin whale (309) minke whale (292), white-beaked dolphin (215), bottlenose dolphin (172) and striped dolphin (145).
- The North Sea region recorded the highest effort of 65,269km with the highest cetacean encounter rates recorded off Dover, Orkney, Shetland, and the east coast of Scotland from cruise ships. The highest diversity in the North Sea, six species in total, was observed along the ferry route from North Shields to Ijmuiden. Harbour porpoises and white-beaked dolphins were the most commonly sighted cetaceans for this region.
- Eight species of cetacean were recorded in the English Channel. This sea region was the third most surveyed area with 26,739km of effort. The harbour porpoise was the most frequently sighted cetacean with 192 encounters and 396 individuals. The highest encounter rate and species diversity for all cetaceans was recorded off Devon and Cornwall. There was also an unusual sighting of a humpback whale in March 2015 off Kent.
- In the Celtic Seas, the encounter rates and diversity were highest around the west coast of Cornwall, particularly around the coastline of Penzance and the Isles of Scilly. Six species were recorded including Risso's dolphins and pilot whales.
- The Bay of Biscay observed the highest species diversity of all areas surveyed with 16 species recorded, including blue whales, sei whales, orcas, sperm whales, false killer whales and the elusive beaked whales. The common dolphin was the most frequently sighted cetacean, with 740 sightings consisting of 19,779 individuals, with the highest encounter rate in the outer Bay. This was followed by the fin whale, with 217 encounters comprising of 335 individuals, which peaked in the summer months of August and September.
- Since 2006, Arctic Waters have only been surveyed via the cruise network (20 cruises in total) with increasing effort recorded from 2011 onwards. Despite the highest effort being recorded off the Norwegian coastline the highest encounter rates were seen off Iceland and on route to Svalbard. In total, 14 species of cetacean were seen in Arctic Waters, including blue whale, sei whale and beluga, with harbour porpoise being the most frequently sighted species (212 encounters consisting of 1,133 animals).
- The harbour porpoise was recorded across all the sea regions except the Mediterranean Sea and registered the highest sightings number of 1,544 (3,552 animals). It was the most encountered cetacean in five of the nine sea regions listed. The highest encounter rates for this species overall was registered in the southern North Sea with numbers peaking in July (although this may be attributable to improved weather conditions).

- The bottlenose dolphin was sighted across all the nine sea regions, 1,424 animals in total. The highest sightings of this species were observed in the Bay of Biscay and Iberian Coast, primarily around the southern shelf and shelf edge with 81 of the 172 encounters. Historically bottlenose dolphin sightings in the North Sea have been uncommon, but since 2006, ORCA surveyors have recorded 105 individuals.
- The short-beaked common dolphin accounted for 27.9% of all the cetacean sightings (29,160 individuals). It was observed in all sea regions with the exception of Arctic Waters and most of the sightings occurred in the Bay of Biscay and Iberian Coast. Group size varied from 1-3,000 animals with an average group size of 24.
- White-beaked dolphins typically prefer the cool temperate climate of the North Atlantic around Iceland, Svalbard and Norway and this was reflected in the highest encounters for this species with 125 being recorded in Arctic Waters. However, out of 215 sightings, 87 encounters of white-beaked dolphins occurred in the North Sea with group sizes reaching up to 100 individuals.
- The minke whale was observed in all sea regions with the highest numbers being recorded in Arctic Waters followed by the North Sea. The minke whale was the third most sighted cetacean with 309 encounters (371 individuals) and with 85% of sightings being of a single individual. Most sightings were recorded in coastal and shelf regions.
- Beaked whales are the least studied cetacean globally. This group of cetaceans were recorded in four of the nine sea regions and included the Cuvier's beaked whale, northern bottlenose whale, Sowerby's beaked whale and True's beaked whale, totalling 166 sightings consisting of 350 animals. The majority of the beaked whales were observed in the Bay of Biscay and Iberian Coast sea region over the southern shelf and deep-sea canyons with 131 encounters recorded.



Humpback whale

# Comments on the State of European Cetaceans

ORCA volunteers have freely given their time and effort to generate the citizen science which is the foundation of this report. They have all done so with the selfless objective of creating a more complete picture of our whales, dolphins and porpoises, so that they can be afforded greater protection and conservation where this is required.

One of the notable findings of their research has been the fluid and transitory nature of whale and dolphin populations, in terms of geography, the seasons, location of prey species and so on. We anticipate just as much change and movement in the future, and look forward to welcoming new generations of volunteers to map the mercurial habits and life cycles of these mysterious animals.

For now, our findings have given us some clear indications for future necessary steps to protect whales, dolphins and porpoises.

## The Bay of Biscay

As outlined previously, the Bay of Biscay is a recognised hotspot for cetacean species, with up to a third of the world's cetaceans found there. Unsurprisingly, our evidence has shown that this area recorded the highest species diversity.

ORCA's research, added to previous efforts, is helping to identify the Bay as a globally important marine mammal area which requires designated protection such as the proposed IMMAs.

Copious and compelling scientific information and research now exists to back the Bay's designation as an offshore marine protected area, shielding its cetaceans from the harmful effects of commercial or invasive activity. We neither need to wait or should tolerate waiting for yet more information or research before decisions are made. The Bay of Biscay should become a top priority site for designation for the new proposed IMMA systems. These types of frameworks have the potential to overcome the largely meaningless boundaries by which open seas are subdivided into territories. It would also reflect the perpetual mobility and annual migratory nature of cetaceans and ultimately result in a statutory designation that mirrors and addresses the nature of the animals themselves.

## Threats to European cetaceans

Although some may interpret this report as being an indication of a thriving and diverse population of cetaceans in European waters, significant existing and emerging threats continue to impact adversely on these animals and their habitat.

The incidental and often fatal capture of cetaceans as by-catch in commercial fishing operations is having a serious impact on populations, and is recognised as being the biggest threat to vulnerable harbour porpoise populations. Despite obligations to EU governments under the Agreement on the Conservation of Small Cetaceans of the Baltic, North East Atlantic, Irish and North Seas (ASCOBANS) and the EU Habitats Directive, the level of by-catch monitoring is poor. By-catch itself is exacerbated by over-fishing which is now being addressed at a global level due to its impact on many marine species.

Marine pollution is now recognised as being one of the most serious issues of environmental concern in the modern age. Cetaceans are extremely vulnerable to the adverse effects of human impact on the oceans, whether in the form of unnatural noise from naval operations or commercial activity. Within European waters, which are some of the busiest in the world, this manifests itself as a major threat. Marine debris such as plastic-based material is frequently ingested by cetaceans. Lost or abandoned fishing gear, known colloquially as "ghost gear", is also being recognised as a major threat to a wide range of marine species particularly marine mammals.



## Protecting beaked whales

Evidence about the enigmatic and vulnerable beaked whale is poor, but ORCA's research has identified and established a clear habitat preference and presence in the southern Bay of Biscay, particularly around the deep sea canyons and seamounts. From the little evidence we do have about this species, we know that it is very susceptible to low frequency sonar, which can result in mass strandings. We would urge authorities to avoid the use of military sonar and other sonar pollution in this specific location and allow fishing to take place only outside this restricted zone and follow the example of ACCOBAMs who have implemented such measures in the Mediterranean Sea to protect beaked whales.

## Fin whales and ship strikes

Evidenced by our findings and supported by other research, we know that fin whale populations peak in the summer months as they migrate through the Bay of Biscay. Of all the baleen whales, fin whales are the most susceptible to ship strike, as they tend to spend longer on the ocean surface. This region has some of the busiest shipping lanes in the world and with the associated high fin whale numbers, there is a high risk of ship strikes.

Through ORCA's OceanWatch programme, we are working with the shipping industry to address this issue. Since 2015 we have been providing awareness training to bridge crews, which has already resulted in greater understanding of the vulnerability of fin whales to ship strikes and the mitigating steps they can take to avoid collisions.

## Minke whales and whaling

The minke whale was the third highest encountered cetacean overall with numbers peaking in July and August in the North Sea. This strongly suggests that these animals are seasonally migrating up to the colder Arctic Waters. There is every possibility that the whales we are seeing in UK waters then fall victim to commercial whaling operations in Norway and Iceland. Whaling is banned by the International Whaling Commission, but these countries continue to slaughter large numbers. Continued opposition to this cruel and wasteful trade should be maintained and hopefully those countries defying worldwide opposition will eventually be forced by the global opposition to their cruelty to end such commercial whaling.

## The harbour porpoise, white-beaked dolphin and the North Sea

The North Sea remains an incredibly important habitat for harbour porpoise. With by-catch estimates as high as 4,600 per year in the North Sea, urgent action needs to be taken to reduce the impact of fishing on this vulnerable species.

In addition, the current harbour porpoise marine protected sites under consultation should be implemented regardless of the UK's decision to leave the EU. This is even more pertinent given the EU Commission's fining of the UK for its failure to adequately protect its harbour porpoise populations, which are being decimated by overfishing, dredging and pollution.

Harbour porpoise sites must be capable of expanding in response to emerging evidence, with the ability to place immediate restrictions on invasive commercial activity in the zones designated for protection if deemed necessary. Our findings revealed a diversity of cetaceans in the southern North Sea with six species recorded; this diversity must be maintained by protecting habitats important to all these species.



## Ongoing Monitoring Backbone to Cetacean Protection

ORCA's ongoing work is so crucial because unlike the statutory obligation on the UK Government to monitor cetacean populations for one month approximately every 10 years, which at best can only provide an incomplete species snapshot, ORCA provides real-time, long-term data. Survey teams are on board ships most months of every year and ORCA recognise and record changes in distribution and range as they happen. But whilst ORCA can provide an army of watchful eyes thanks to our volunteers, we need action from Government when our evidence indicates an emerging threat or problem.

One of ORCA's key objectives is to engage people from all walks of life as active participants in the collection of scientific data. In doing so, ORCA want to demystify wildlife conservation and to make it accessible, tangible and engaging for people who might see it as the exclusive preserve of academics. By doing this, by providing a platform for citizens to participate as scientists, awareness is raised about the threats facing our marine wildlife. And with that awareness comes recognition about what steps governments can take to improve marine habitats for cetaceans and indignation when they do not. As well as being citizen-scientists, ORCA's supporters are articulate, informed citizen-advocates and campaigners.

Our volunteers will continue to work tirelessly, year round, collecting data and giving up their time to create a more complete picture of our whale, dolphin and porpoise populations. But like ORCA, they have expectations of action resulting from the conclusions and recommendations in this report.



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# Appendix

## ORCA Distance Sampling survey protocol

Each surveyor in the team rotates through each of the following positions/role every thirty minutes; port observer, data recorder, starboard observer, rest. This ensures surveyor fatigue does not impact the data.

Two surveyors are on effort (watch) at any given time; one on the starboard and one on the port side of the observation platform. The starboard observer scans a 100° area of the sea (from 90° off the starboard side to 10°) and the port observer scans a 100° area of the sea (from 90° off the port side to 10° to starboard). Surveyors scan the area for cetacean presence by eye and using reticle binoculars (7x50 Opticron Marine-2®). Distance to the animal sighted is measured with the reticle binoculars and an angle reading is taken from the front of the ship to the animal using an angle board.

Sightings are identified to species level where possible and classified as definite, probable or possible. When species identification cannot be confirmed sightings are downgraded to the lowest taxonomic certainty (e.g. unidentified dolphin / unidentified beaked whale / medium cetacean etc.).

The data recorder collects environmental data every thirty minutes or when environmental conditions alter, including vessel position, course and speed (obtained from the ships instruments), and records all sightings data. Survey effort is conducted up to Beaufort sea state six.

On surveys with a duration >3 hours the team consists of four surveyors and this fourth individual is on rest.

As of 2014 all ORCA cruise surveys utilised a different surveying protocol; the ORCA Observation Protocol. Public engagement is an important role in ORCA cruise surveys, resulting in surveyors not being able to continuously observe the sea for cetaceans without distractions and the Observation Protocol takes this into account. The only alteration to the Distance Sampling Protocol is that when an animal is sighted no angle reading is taken. Although data collected via the Observation Protocol cannot be used to inform abundance estimates, cetacean density and distribution trends can still be reported.



## Harbour porpoise encounter rate maps

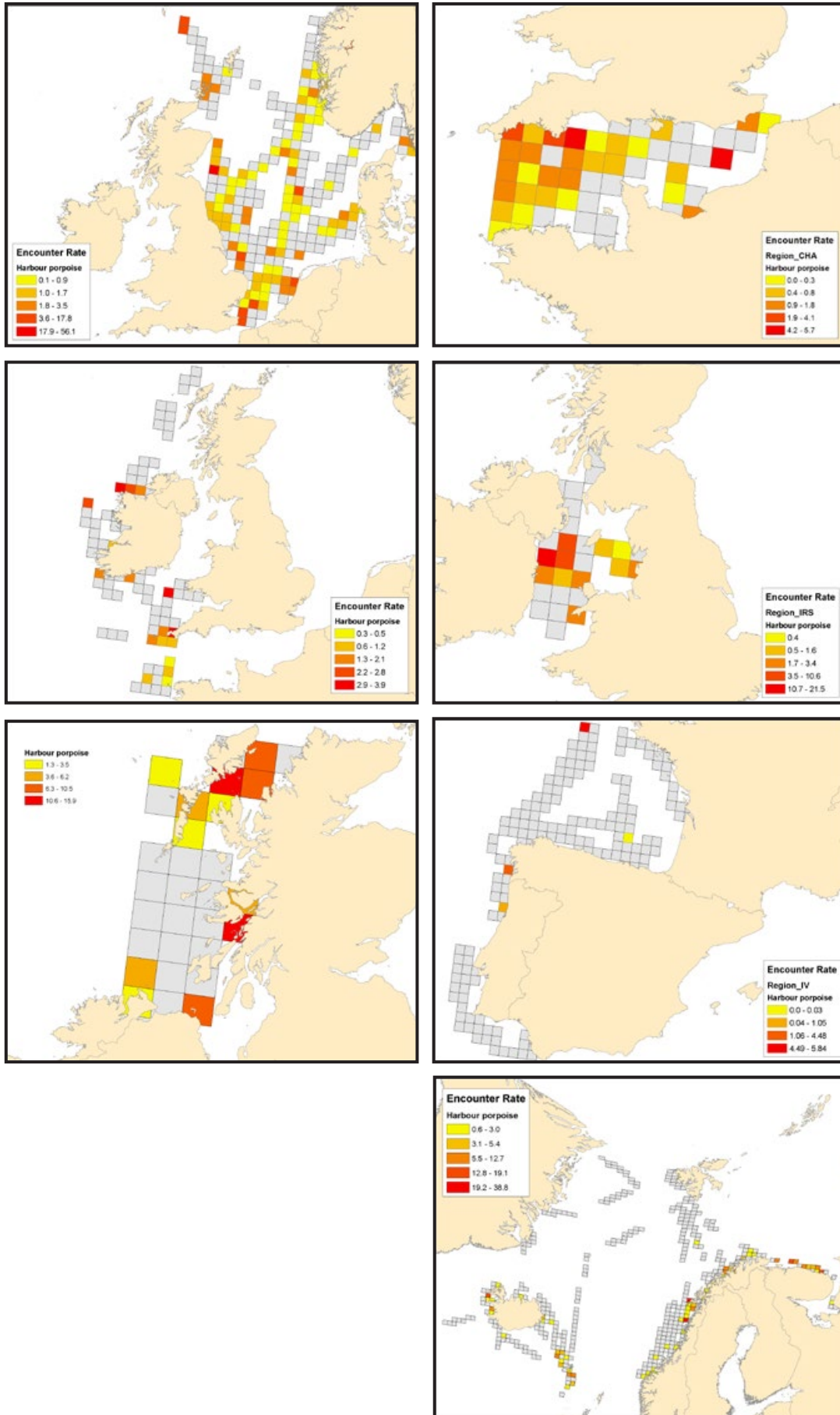


Figure 63 Encounter rate maps for all regions in which the harbour porpoise was found.

**“If we can’t look after  
animals as awe-inspiring,  
enigmatic and downright  
remarkable as cetaceans,  
what can we do?”**

**Mark Carwardine**

Marine wildlife expert, photographer and ORCA patron



We would like to acknowledge all our ORCA surveyors, Mark Carwardine, Dr Mike Tetley and Juan Carlos Calvin for use of their images in this publication.



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