

Hebridean
Whale &
Dolphin
Trust

HEBRIDEAN MARINE MAMMAL ATLAS

Part 1:

*Silurian, 15 years of marine mammal
monitoring in the Hebrides*



LOTTERY FUNDED

CONTENTS

1

INTRODUCTION

4
Foreword

5
About Us

5
*A Message from
our Patron*

6
About the Atlas

2

SILURIAN

8
*About our
Research Vessel*

10
Survey Protocol

14
Data Review

3

HEBRIDES

22
*Extraordinary
Biodiversity*

4

SPECIES

26
Harbour Porpoise

29
Minke Whale

33
Basking Shark

37
*Short-Beaked
Common Dolphin*

40
Bottlenose Dolphin

43
White-Beaked Dolphin

46
Risso's Dolphin

49
Killer Whale (Orca)

53
Humpback Whale

5

FUTURE

56
On the Horizon

6

CONTRIBUTORS

58
Acknowledgements

59
References

FOREWORD



The Hebridean Marine Mammal Atlas is a showcase of 15 years of citizen science and species monitoring in the Hebrides. It's a testament to the hundreds of dedicated volunteers who have joined HWDT to diligently survey the waters of western Scotland. It is those people who make the surveys possible, year after year.

All of these data combined have created a unique and powerful evidence base, which is making real impact by contributing to the identification and designation of Marine Protected Areas. It is an inspiring story of marine research and a staggeringly impressive public effort.

Over the years, HWDT's work has been guided by an expert panel of scientists and academics who have steered the collection and use of the data into valuable research and peer-reviewed publications. In welcoming this report, I would also like to acknowledge the steadfast commitment from the HWDT Scientific Committee and extend a heartfelt thank you for those contributions.

The continuation of HWDT's work is absolutely essential. With increased pressures on the marine environment, we must continue to monitor the distribution and abundance of cetaceans in the Hebrides, endeavour to better understand the emerging threats these animals face, and promote action to protect them. I hope this report inspires people to get involved with HWDT's work and contribute to the next 15 years of marine conservation.

JULIANA BUTLER, HWDT CHAIR

INTRODUCTION

About Us

Established in 1994, the Hebridean Whale and Dolphin Trust (HWDT) is the trusted voice and leading source of information for the conservation of Hebridean whales, dolphins and porpoises (cetaceans).

Based on the Isle of Mull, in the heart of the Hebrides, HWDT is a registered charity that has pioneered practical, locally based education and scientifically rigorous long-term monitoring programmes on cetaceans in the Hebrides.

We believe that evidence is the foundation of effective conservation. Our research has critically advanced the understanding of species that visit seasonally or are resident in the Hebrides. Data are provided to the Scottish Government to inform protection measures for minke whales, Risso's dolphins, harbour porpoises, and basking sharks across Hebridean seas.

We are dedicated to enhancing the knowledge and understanding of the Hebridean marine environment through education, research, and working within communities as a basis for the lasting conservation of local species and habitats.

A Message from our Patron

HWDT's work monitoring the waters of western Scotland plays an invaluable role in the protection of marine life here. By engaging with the public and harnessing the power of citizen science, the Trust has used the data collected on whales, dolphins and porpoises to inform policy makers and has been instrumental in the development of protected areas. I had the great pleasure of sailing on *Silurian* and experienced the dedication and passion of the Trust's researchers first-hand. I am thrilled to be able to lend my support to such an outstanding organisation.

LIZ BONNIN, SCIENCE & WILDLIFE PRESENTER, HWDT PATRON



INTRODUCTION

About the Atlas

In this first edition of the Hebridean Marine Mammal Atlas, we present an overview of the visual sightings data collected from HWDT's unique and long-term monitoring programme; a summary of 15 years of survey effort on board the dedicated research vessel, *Silurian*, from 2003 to 2017.

This Atlas celebrates the contribution hundreds of volunteer surveyors have made to our knowledge and understanding of animal distribution and behaviour in western Scotland. The report details what we have learnt about the nine most common species of cetacean and shark encountered on the west coast and highlights the potential the data holds for future analysis.



HIGHLIGHTS OF 15 YEARS SURVEY EFFORT

30,000
MARINE ANIMALS

Silurian has recorded 30,000 animals during 13,000 sightings of 15 different species. The most frequently seen species was the harbour porpoise, with 5,171 sightings.

144K HOURS

More than 700 citizen scientists have joined one of 200 *Silurian* research expeditions, between them spending over 144,000 hours on board, contributing to our long-term evidence base. This is an incredible contribution, without which our work would not be possible.

100,000
KILOMETRES ON EFFORT

Silurian has travelled more than 100,000 kilometres conducting visual and/or acoustic surveys monitoring our remarkable Hebridean seas. That's the equivalent of sailing two and half times around the world.

TRENDS AND CHANGES

FIRST
MARINE PROTECTED
AREAS (MPA)

We provide evidence to policy makers to show where the most important areas are for cetaceans and basking sharks on the west coast of Scotland. HWDT data have helped identify Marine Protected Areas for harbour porpoises (Inner Hebrides and Minches Special Area of Conservation), minke whales and basking sharks (Sea of Hebrides proposed nature conservation Marine Protected Area).

INCREASE
IN COMMON DOLPHIN
SIGHTINGS

When we first started running surveys on *Silurian*, sightings of common dolphins were infrequent. In 2004 the survey team recorded no sightings of the species at all. During 15 years of monitoring Hebridean seas, sightings of common dolphins have increased twenty-fold. Common dolphins are now the most commonly encountered dolphin species on *Silurian*.

SILURIAN

About our Research Vessel



FROM SMUGGLING TO SCIENCE

Since 2002, our research vessel, *Silurian*, has been collecting information of international importance on the marine life in the Hebrides.

Each year, she travels thousands of nautical miles to monitor whales, dolphins, porpoises and basking sharks off the west coast of Scotland. This pioneering research programme has generated one of the largest coherent databases of its kind for UK waters.

Fully equipped as a research vessel with a crow's nest for observations, computer systems for logging data, underwater microphones called 'hydrophones' for detecting cetacean vocalisations, and with space for

ten people and full facilities for life on board, *Silurian* is the perfect vessel for travelling the Hebrides and conducting our scientific monitoring work. Between April and October each year, we monitor Hebridean seas in search of cetaceans and basking sharks. On each survey, six volunteers join *Silurian's* crew for between seven and twelve days to work alongside them as marine mammal scientists, helping to collect these valuable data. Anyone can join a research expedition on board; there are even trips just for teenagers.

An 18.54 m (61') Skoochum One ketch, built in Seattle in 1981, *Silurian* was purchased by a geologist who named her after the geological period which saw the diversification of bony fish. Little is known about her early days, but she has had an interesting past. Before coming to HWDT, she had been impounded for drug smuggling in America and was also used in the filming of the original BBC Blue Planet series in 2000. Now, *Silurian* is in her 16th year as HWDT's flagship, providing the evidence needed to help conserve the Hebrides' remarkable marine megafauna.

SILURIAN

Survey Protocol

The same rigorous survey methodology has been used on *Silurian* for 15 years, ensuring that the data collected are consistent and comparable between years.

Dedicated visual and acoustic surveys are conducted using a standard line transect methodology for cetaceans (Buckland *et al.* 2001), travelling in straight, random transect lines at a constant speed (5-7 knots). For photo-identification, *Silurian* comes 'off effort', leaving the transect line to go with whales, dolphins and basking sharks. Once sufficient images have been collected, *Silurian* returns to the transect line to resume visual or acoustic effort. Effort-based survey data are important because they can be used to calculate the density of sightings in an area.

The survey protocol provides a wide scale assessment of cetacean distribution that HWDT and associate researchers are able to use to assess population size, habitat preference, site usage, and, through our photo-identification work, animal behaviour. Anthropogenic parameters (such as underwater noise, marine litter, location of fishing gear, shipping and military exercises) are also monitored to identify emerging threats and understand the conservation implications and risks. All of these data combined provide a unique and powerful body of knowledge, which is making a real impact for the protection of cetaceans in western Scotland by contributing to the identification and designation of Marine Protected Areas (MPA).



VISUAL SURVEY

During visual surveys, two observers are positioned at the mast to scan the forward 180 degrees with the naked eye and 7x50 mm binoculars. In good conditions, an observer may also be placed in the crow's nest to scan an arc from -45° to +45°. Observers scan for an hour, spending 30 minutes on both the port and starboard side.

These observers scan the surrounding area for marine wildlife (cetaceans, basking sharks and seals) as well as man-made items such as marine debris and fishing gear. When animals are spotted, the species, bearing (location in relation to the vessel), distance (from the vessel) and heading (animal's direction of travel) of the initial sighting

are recorded along with the group size, behaviour and other ancillary data. A data logging program called Logger (IFAW, Logger 2010) is used to automatically record the vessel's GPS location, boat speed and heading. The volunteer acting as the data recorder logs all sightings data in real time, along with recording environmental conditions (sea state, swell and visibility) every 15 minutes and any changes to the search status or survey effort. A third observer on deck counts sea birds (within 500 m and between 0° to 90°) and vessels (within 3 nautical miles) for the duration of their watch. Volunteers rotate between survey tasks every 30 minutes, with an hour off at the end of each rotation to ensure observers are well rested.

ACOUSTIC MONITORING

Passive Acoustic Monitoring plays a key role in HWDT's data collection. It provides an accurate and consistent way of monitoring cetacean species, such as the harbour porpoise. *Silurian* started using a towed hydrophone system to detect cetaceans back in 2002, and since then, HWDT has compiled a comprehensive acoustic dataset, spanning 15 years and comprising over 6,000 hours (250 continuous days) of underwater recordings. As well as species monitoring, these recordings are increasingly called upon to assess the changing soundscape of the west coast marine environment and the potential impacts of acoustic pollution on the population, distribution and behaviour of cetaceans in the region.

During all surveys, the hydrophone array is deployed and the passive acoustic monitoring software, PAMGuard, is run at all times. This makes a continuous broadband (up

to 250 kHz) recording while running detectors for porpoise and dolphin clicks and producing spectrograms. In addition, volunteers monitor the hydrophones for a minute every 15 minutes (the engine is throttled back to facilitate this) to make an aural assessment of natural sounds (dolphin whistles and shrimp) and man-made sounds (i.e. acoustic deterrent devices used at fish farms, vessel noise, military sonar), recording standardised assessments of these in Logger.

At the end of each survey, the recordings are re-analysed using PAMGuard. Porpoise acoustic encounters are identified and ranges of these from the boat's trackline are calculated. This allows distance analysis techniques to be used to provide absolute density estimates to be calculated for porpoises.



PHOTO-IDENTIFICATION

When cetaceans or basking sharks are encountered, animals are carefully approached to obtain good quality photographs of individual animals, which are used in our photo-identification research. HWDT holds an SNH licence, which allows animals to be approached for this purpose.

Photo-identification is a non-intrusive research method, which uses photographs to reveal natural markings or features on the animal's body, allowing individual animals to be recognised. This technique allows researchers to track the movement of individual animals, and assess site fidelity and residency patterns. The images can also provide valuable evidence that can be used to assess conservation threats; for example, by monitoring scarring caused by entanglement in marine debris or fishing gear, injuries from boat strikes, and the prevalence of disease and parasites.

HWDT has collected data on minke whales, bottlenose dolphins and killer whales in the Hebrides since the 1990's. Each year, thousands of photographs are analysed to identify the presence of identifiable individuals and added to our photo-identification catalogues. The catalogues contain left and/or right side dorsal fin images, along with other identifiable features, to aid their recognition. In addition to the data collected from dedicated research surveys on board *Silurian*, thousands of photographs are contributed each year by the Tobermory-based whale-watching company Sea Life Surveys and other contributors to our Community Sightings Network.



SILURIAN

Data Review

100,000 Kilometres on Effort

Between 2003 and 2017, *Silurian* has surveyed 105,368 kilometres of Hebridean seas. That's the equivalent of sailing two and half times around the world in search of marine life (Figure 1).

With our base in Tobermory, there is more effort around Mull, as you might expect, but we cover the whole of the west coast from the Kintyre peninsula in the south, to Cape Wrath in the north and, on occasion, out to St Kilda in the west. Each year, we aim to achieve a near-even coverage across the main survey area. *Silurian* is now traveling further than ever before, collecting more data and providing more opportunities for people to get involved. Rendezvous locations on Skye and Ullapool, provide the opportunity to cover the northern reaches of the survey area throughout the season too.



Figure 1. Fifteen years of visual and/or acoustic surveys on *Silurian* totalling 105,368 km (Base maps © OpenStreetMap Contributors, openstreetmapdata.com).

30,000 Marine Animals

Nearly 200 surveys have been conducted, thanks to help from more than 700 citizen scientists who have joined us on board to conduct this vital monitoring, collectively recording 30,389 individual marine animals during 13,131 sightings (Table 1). Of these, 11,493 sightings and 28,170 animals were identified to species level, comprising 15 different species: ten species of cetacean, two pinniped, two fish and one mustelid. The most commonly encountered species was the harbour porpoise

(*Phocoena phocoena*), which have been seen over 5,000 times and account for 45% of the sightings identified to species level, followed by grey seal (*Halichoerus grypus*, 20%), common seal (*Phoca vitulina*, 12%), basking shark (*Cetorhinus maximus*, 9%), minke whale (*Balaenoptera acutorostrata*, 7%) and common dolphin (*Delphinus delphis*, 4%). These six species account for 97% of identified sightings.

Species	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	Total
IDENTIFIED SPECIES																
<i>Cetorhinus maximus</i>	46	21	63	138	100	101	124	176	24	68	32	16	67	21	18	1015
<i>Tursiops truncatus</i>	8	5	3	3	4	3	4	4	2	4	0	1	4	7	3	55
<i>Delphinus delphis</i>	4	0	13	11	26	18	24	42	44	28	22	37	75	75	93	512
<i>Phoca vitulina</i>	37	15	63	34	48	122	110	95	62	92	116	132	160	137	166	1389
<i>Balaenoptera physalus</i>	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	2
<i>Halichoerus grypus</i>	67	32	85	125	165	155	210	100	127	111	104	352	169	285	217	2304
<i>Phocoena phocoena</i>	223	135	282	267	443	467	351	284	341	173	316	587	403	536	363	5171
<i>Megaptera novaeangliae</i>	0	1	0	1	1	0	1	0	0	0	0	0	0	2	1	7
<i>Orcinus orca</i>	1	1	1	0	4	3	1	0	0	1	1	3	0	0	0	16
<i>Balaenoptera acutorostrata</i>	73	39	25	39	48	45	61	38	67	36	34	63	66	61	62	757
<i>Lutra lutra</i>	0	0	0	0	0	0	0	5	0	0	0	2	4	2	6	19
<i>Grampus griseus</i>	13	1	5	2	6	1	1	0	2	2	1	4	5	9	8	60
<i>Mola mola</i>	2	0	7	1	5	3	2	3	2	2	0	1	1	2	2	33
<i>Lagenorhynchus albirostris</i>	1	0	0	5	16	8	17	12	27	7	6	7	13	16	14	149
<i>Lagenorhynchus acutus</i>	0	0	0	0	0	3	1	0	0	0	0	0	0	0	0	4
UNIDENTIFIED SPECIES																
Unidentified baleen whale	1	1	0	1	0	0	6	0	1	1	0	0	4	1	5	21
Unidentified beaked whale	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1
Unidentified dolphin	1	4	3	4	10	2	8	9	15	10	18	48	62	29	29	252
Unidentified seal	32	34	30	33	47	62	102	68	94	33	62	156	170	167	104	1194
Unidentified shark	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Unidentified turtle	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1
Unknown	2	2	5	10	13	10	13	9	6	6	10	25	27	5	25	168
OVERALL TOTAL	511	292	585	674	937	1004	1036	845	816	574	722	1434	1230	1355	1116	13,131

Table 1. Fifteen years of marine animal sightings from *Silurian*. 13,131 sightings of 15 species were recorded from 2003 to 2017.

Visual Effort Summary

This report presents 15 years of visual effort and sightings data collected on board *Silurian* between April and October from 2003 to 2017. During this time, 96,821 kilometres of visual survey effort was conducted, resulting in 11,791 on effort sightings of marine animals (Figure 2).

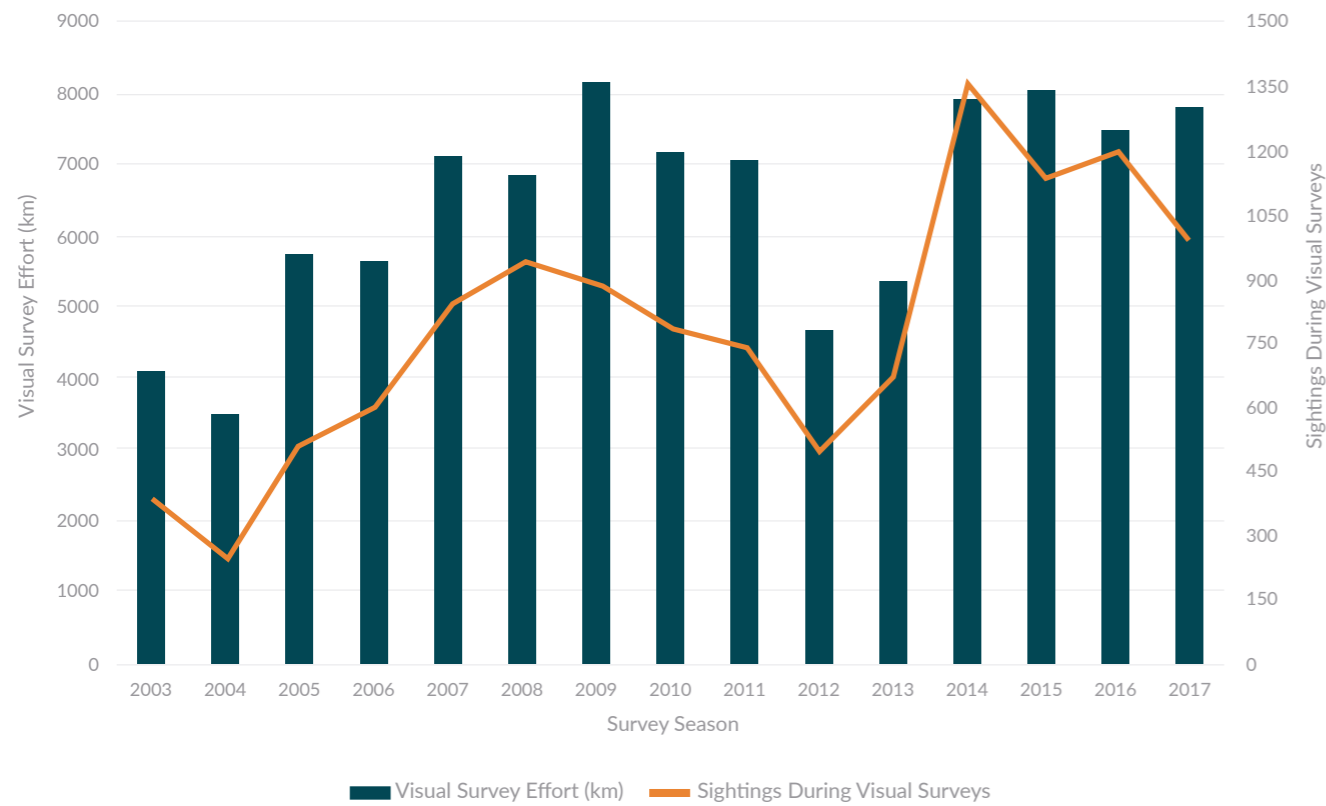


Figure 2. Total visual survey effort overlaid with total sightings during visual survey effort for each of the 15 survey seasons (2003-2017).

Survey effort varies between years reflecting the effects of poor weather conditions, volunteer numbers and occasional mechanical problems. A mean of 6,455 kilometres per year are surveyed (range 3,496-8,157 km). The effort is lower during the first four seasons (2002-2006) because fewer surveys were conducted and for 2012-2013 due to breakdowns and poor weather. For all other years, the visual survey effort is high, with between 6,800 and 8,100 kilometres surveyed per year.

Survey effort is not evenly distributed throughout the survey area (Figure 3). Locations close to our research base have inevitably been surveyed the most, with survey effort reaching a maximum of 1,242 kilometres in cells just outside of Tobermory Bay on the north coast of Mull. Areas north of Tobermory up to the Small Isles and Skye, and south to Jura, have also received more attention. There is lower effort to the west of the Outer Hebrides due to inclement sea conditions and limited weather windows to survey the area.

To account for this uneven effort, the sightings per unit effort (SPUE) was calculated for each cell as the number of encounters per kilometre travelled. A SPUE value of 1 means that there was on average one sighting per kilometre surveyed within that cell, while a SPUE of 0.01 shows one sighting per 100 kilometres surveyed.

Our ability to detect cetaceans, particularly small elusive species like harbour porpoises, is affected by sea state, and the detectability decreases rapidly especially in sea states greater than two (Teilmann 2003, Evans and Hammond 2004). Acoustic detections are much less affected by sea state. However, as only visual sightings are being presented here, all sightings and effort in sea states greater than three have been excluded.

The survey area has been divided into a grid of 50 km² hexagonal cells. A hexagonal grid has been used because it reduces sampling bias (Birch *et al.* 2007). Cells where the total survey effort was less than 19 km, (double the length of the widest part of the cell), were also excluded to reduce small sample effects. Relative encounter rates (SPUE) were calculated using data for sea states of three and under combined across all survey years. Off effort and high sea state sightings are displayed on the SPUE maps as 'off effort presence'.

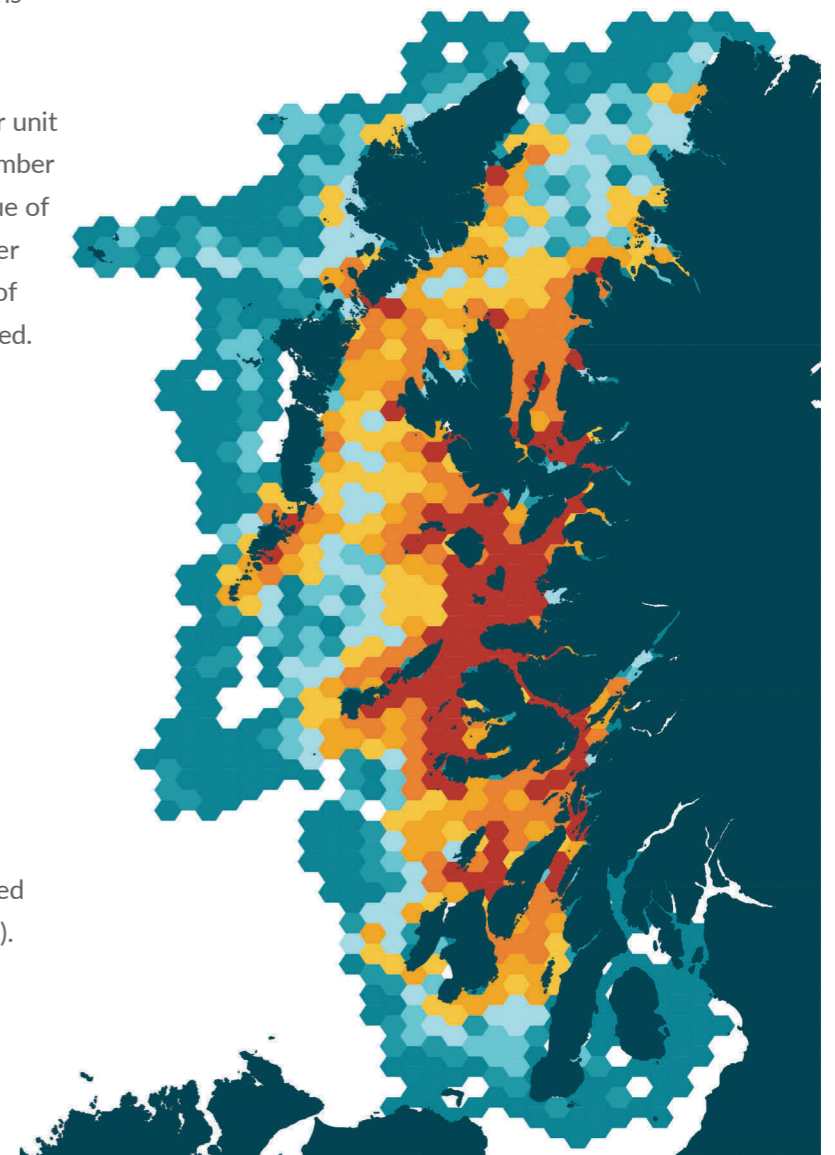
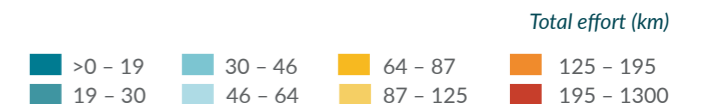


Figure 3. Fifteen years of *Silurian* visual survey effort, 2003-2017 totalling 96,821 km. Effort (km) displayed on a grid of 50 km² hexagonal cells.



Data Uses

HWDT data have been collected consistently year after year using the same methodology since 2003. Surveys cover a wide geographical area and diversity of environmental conditions (i.e. depth, slope, salinity). This long-term assessment of cetacean distribution is crucial because it provides a powerful and comparable data set that can be used to detect trends and changes in the marine environment. One such example is the increasing number of short-beaked common dolphins that have been observed over the past decade in the Hebrides.

IDENTIFYING TRENDS - COMMON DOLPHIN CASE STUDY

In 15 years of monitoring Hebridean seas, sightings of common dolphins have increased, making the species our most commonly encountered dolphin. When we first started running surveys on *Silurian*, sightings of common dolphins were infrequent, and there was even a season (2004) when we recorded no sightings at all.

The SPUE has risen from 0.05 animals per 100 kilometres surveyed in 2003 to 1.1 animals per 100 kilometres surveyed in 2017, a twenty-fold increase in fifteen years (Figure 4). The last four seasons have each seen record-breaking numbers of sightings.

The trend is evident across the whole of the survey area, with common dolphins now seen throughout the Sea of the Hebrides, the Minch, and as far north as the Butt of Lewis and Stoer Head with occasional sightings west of the Outer Hebrides (Figure 5).

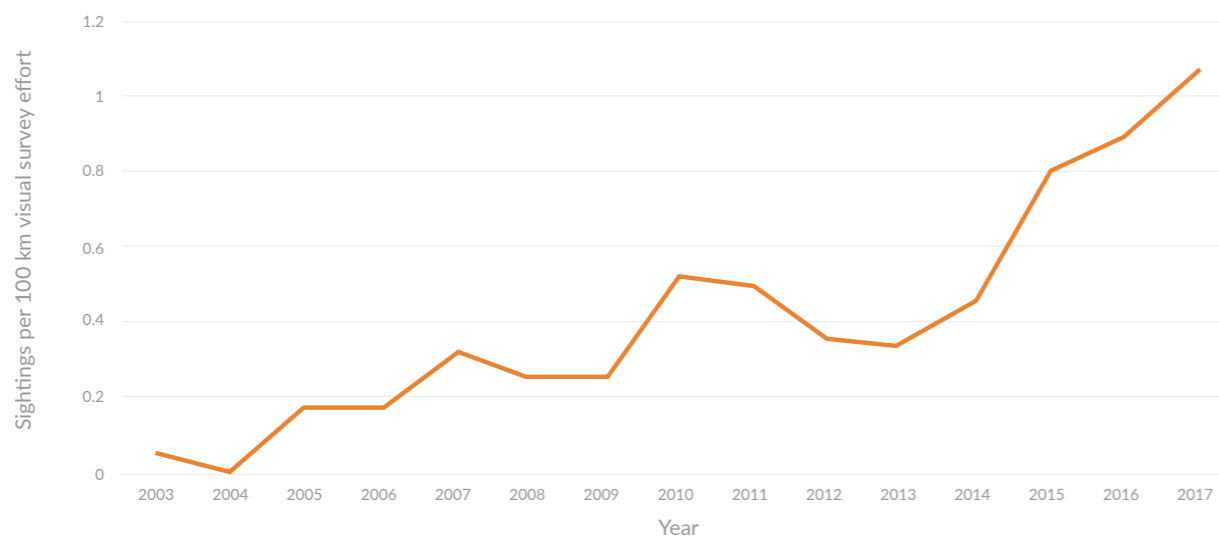


Figure 4. Common dolphin sightings per 100 km survey effort, showing a clear increase over time.

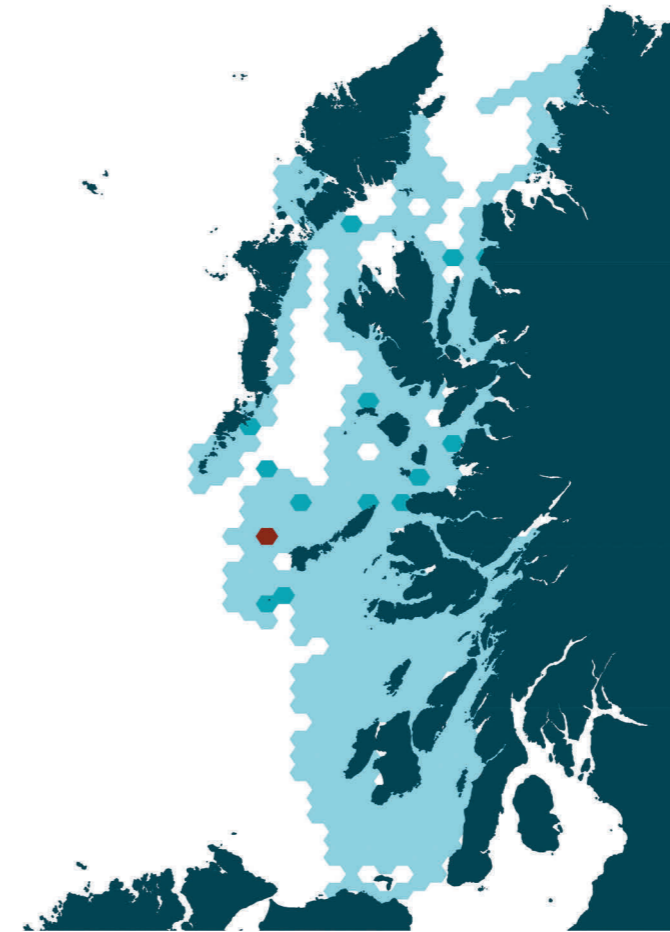


FIGURE 5
2003-2005

Common dolphin sightings per unit effort (km)

- Visual Survey Effort
- Off Effort Presence
- 0.001 - 0.006
- 0.006 - 0.011
- 0.011 - 0.021
- 0.021 - 0.036
- 0.036 - 0.095

Figure 5. Common dolphin sightings per unit effort on the west coast of Scotland between 2003 and 2017. Data shown as three-year periods (2003-2005, 2006-2008, 2009-2011, 2012-2014, 2015-2017).

FIGURE 5
2006-2008

Common dolphin sightings per unit effort (km)

- Visual Survey Effort
- Off Effort Presence
- 0.001 - 0.006
- 0.006 - 0.011
- 0.011 - 0.021
- 0.021 - 0.036
- 0.036 - 0.095

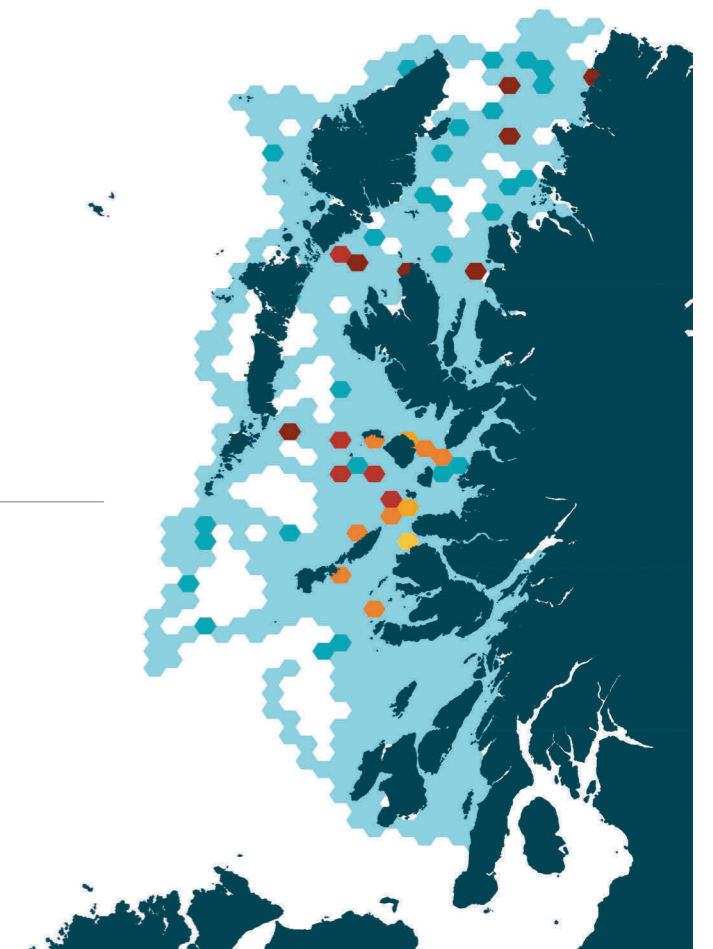


FIGURE 5
2009-2011

Common dolphin sightings per unit effort (km)

- Visual Survey Effort
- Off Effort Presence
- 0.001 - 0.006
- 0.006 - 0.011
- 0.011 - 0.021
- 0.021 - 0.036
- 0.036 - 0.095

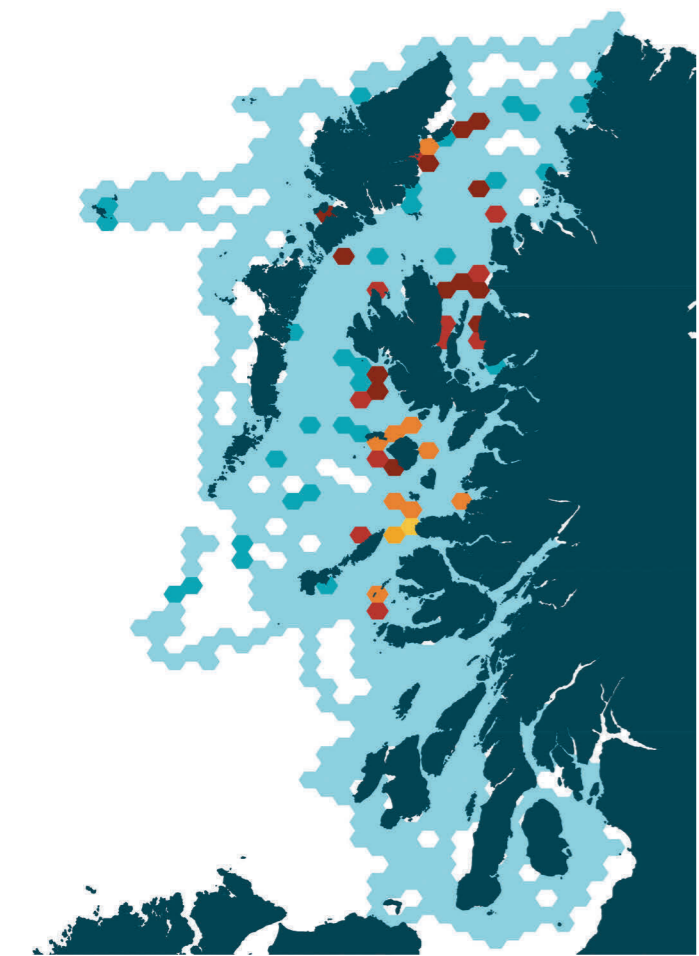
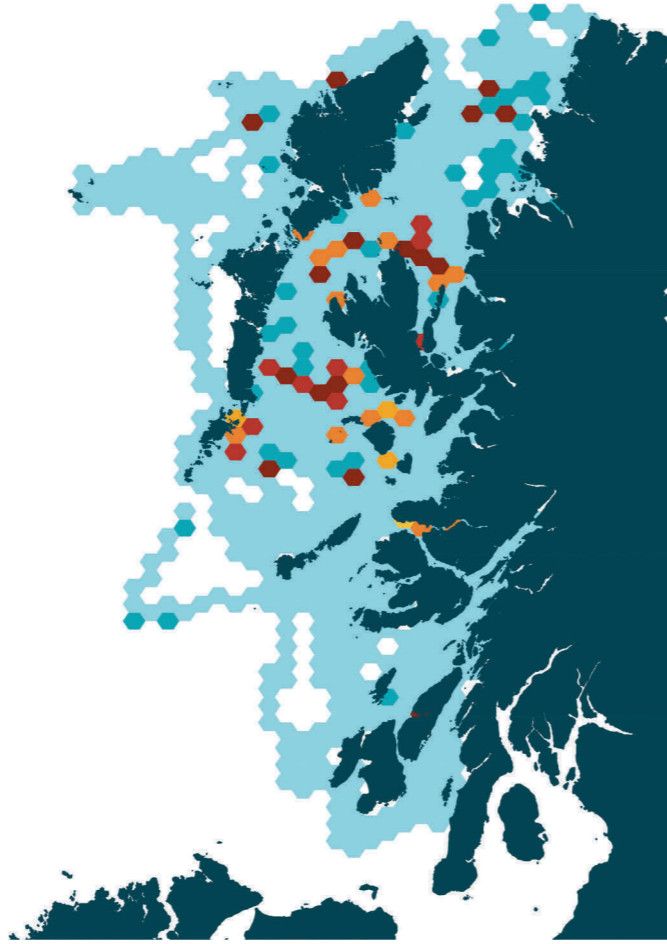


FIGURE 5
2012-2014

Common dolphin sightings per unit effort (km)

- Visual Survey Effort
- Off Effort Presence
- 0.001 - 0.006
- 0.006 - 0.011
- 0.011 - 0.021
- 0.021 - 0.036
- 0.036 - 0.095

FIGURE 5
2015-2017

Common dolphin sightings per unit effort (km)

- Visual Survey Effort
- Off Effort Presence
- 0.001 - 0.006
- 0.006 - 0.011
- 0.011 - 0.021
- 0.021 - 0.036
- 0.036 - 0.095

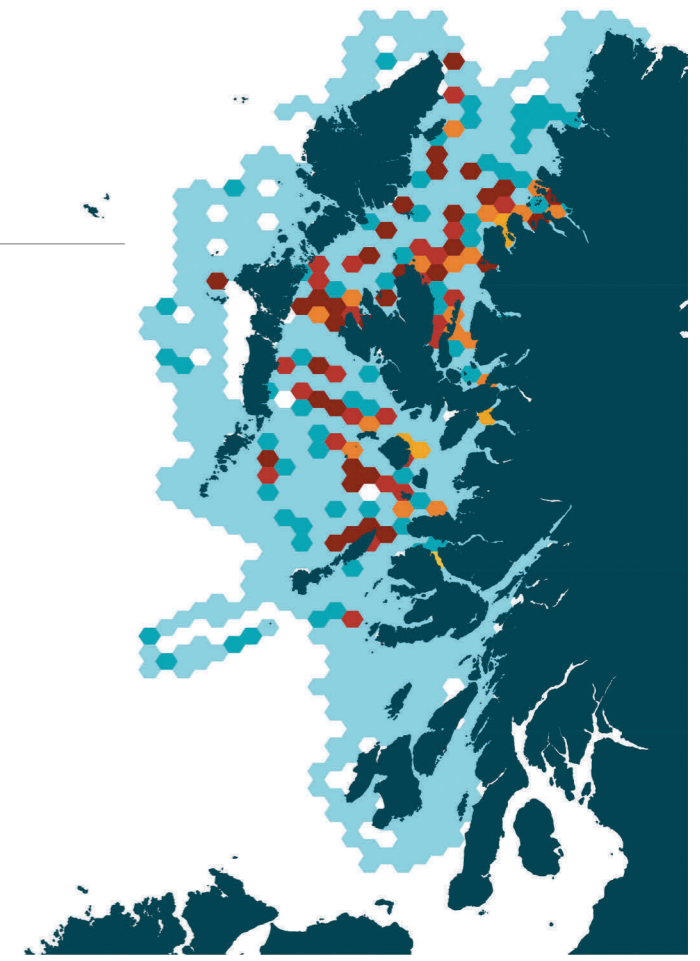


Figure 5. Common dolphin sightings per unit effort on the west coast of Scotland between 2003 and 2017. Data shown as three year periods (2003-2005, 2006-2008, 2009-2011, 2012-2014, 2015-2017).

The reason for this increase is not entirely clear, but we do know that sea temperatures are rising by 0.5 degrees every decade in the Hebrides, and it has been suggested that climate change may impact the cetacean populations on the west coast of Scotland (MacLeod *et al.* 2005). The Hebrides is towards the northern limit of the range for common dolphins in the North Atlantic. Ongoing research and continued monitoring is imperative to monitor trends like this and identify any future changes in the cetacean community due to climate change or other emerging threats. Consistent long-term monitoring is also important so that the benefits of protective measures (such as MPA's) can be evaluated.

BIODIVERSITY

Extraordinary Biodiversity

Twenty-three species of whale, dolphin and porpoise, collectively known as cetaceans, have been recorded in Hebridean waters. That's more than a quarter of all known cetacean species found worldwide.

The Hebrides is also an important area for other marine megafauna like basking sharks, seals and otters (Figure 6). Some of these species live here year-round whilst others migrate into our waters year after year. Rare and elusive species have been seen here too, which has included arctic visitors like a beluga.

The west coast of Scotland is extraordinarily biodiverse but why?

The coastline is long and complex, and the Hebrides is a diverse and widespread archipelago. Divided into the Inner Hebrides and the Outer Hebrides by the Minch and the Sea of the Hebrides, the Inner Hebrides consists of 79 islands and the Outer Hebrides over 100 islands and skerries. Habitats in this area vary from protected sea lochs, through to coastal tidal seas and out to the open ocean of the Atlantic.

To the west of the Outer Hebrides and extending down off the west of Ireland is the Rockall Trough, a deep-water basin with depths in excess of 2,000 m, and a 'migration highway' for large baleen whales, like blue whales, and deep-diving species such as sperm and northern bottlenose whales (Figure 7).

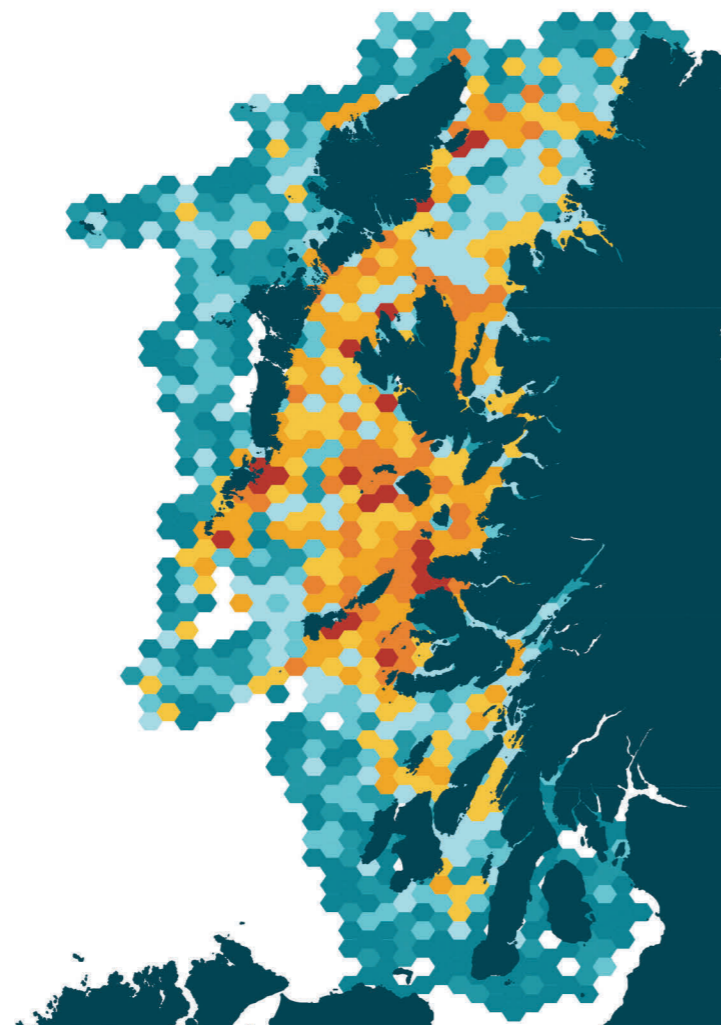


Figure 6. Marine mammal and shark species diversity recorded during 15 years of surveys on board *Silurian*.
Number of species

0	2	4	6
1	3	5	7-8

Figure 7. Rockall Trough, a deep-water basin to the west of the Outer Hebrides and a migration highway for large, deep-diving cetaceans*.

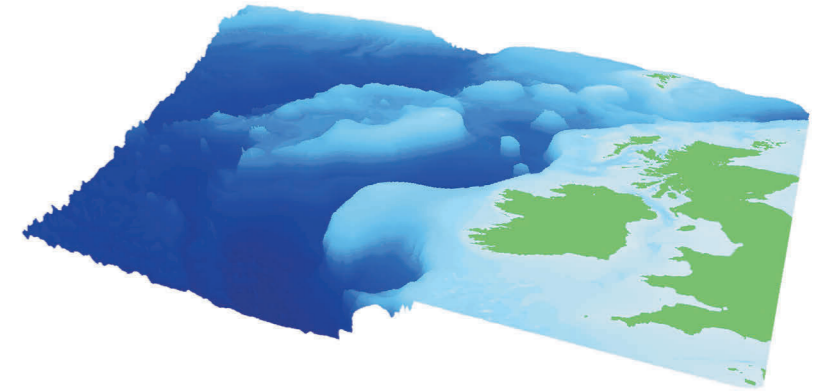
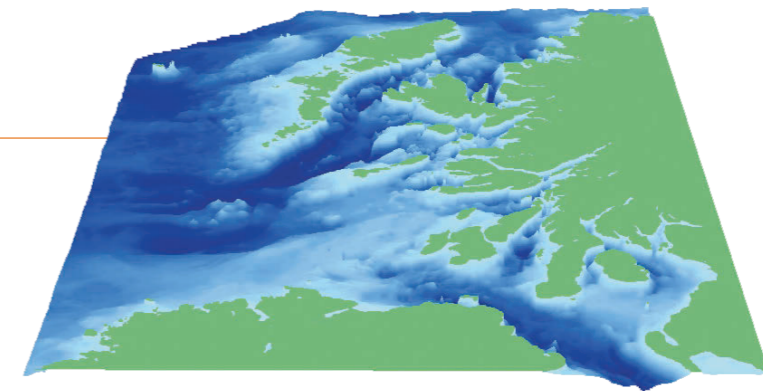


Figure 8. Under the sea in the Hebrides, showing the complex coastline and bathymetry*.



*Data accessed under a general user licence agreement. General Bathymetric Chart of the Oceans - GEBCO 2014, version 20150318, www.gebco.net (from Weatherall et al. 2015).

Within the Hebrides, warm oceanic currents from the south and west, and offshoots from the Gulf Stream, mix with cool coastal currents. This, in combination with the bathymetry (Figure 8), encourages mixing, forcing cold nutrient-rich waters up into the euphotic zone, where photosynthesis can occur, creating areas of high productivity. The plankton blooms off the west coast of Scotland are so extensive they can be seen from space (Figure 9).

The complex coastline also means there are a variety of habitats, from sheltered areas in the long sea lochs to fast tidal currents between islands, coastal and shelf waters and the open ocean of the Atlantic. Deep water close to the coast, such as in the Sound of Raasay at a depth of 300 m, brings offshore and deep-diving species close to the coast too.

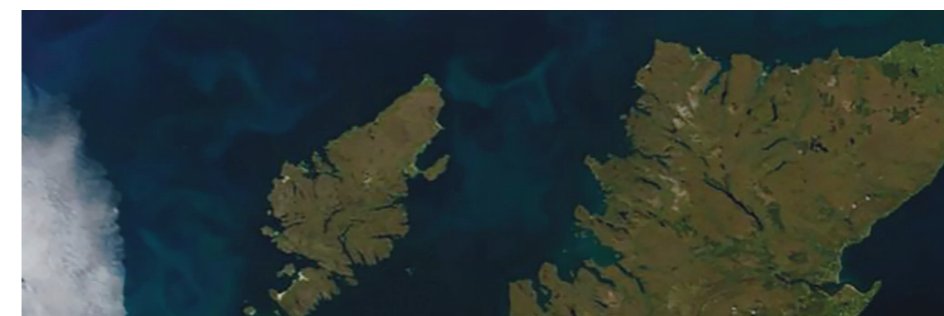
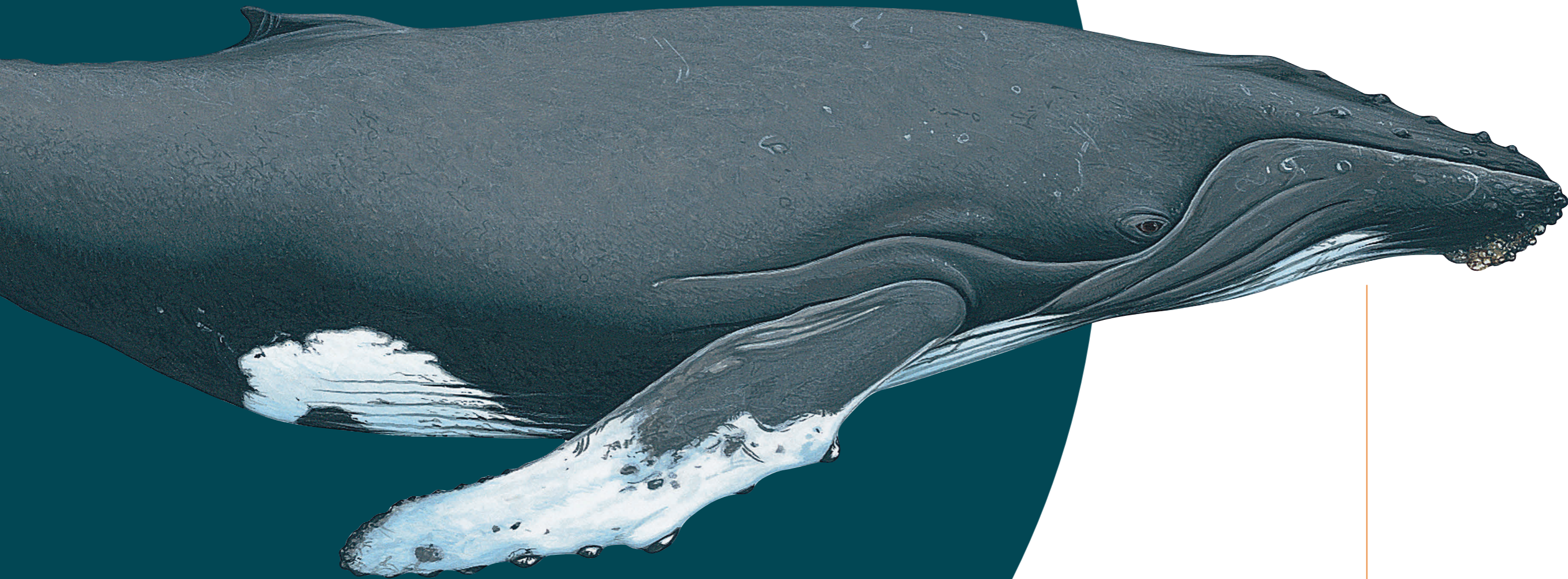


Figure 9. Plankton bloom off the west of Scotland as seen from space, NASA.

SPECIES

Species Profiles



Twenty-three species of cetacean have been recorded in Hebridean waters, over one quarter of all cetaceans known worldwide. Here, we focus on nine species: the eight most frequently seen species of cetacean from *Silurian* and the basking shark.

SPECIES

Harbour Porpoise

Latin: *Phocoena phocoena*

Gaelic: *Peileag* – In Gaelic, this is also used to describe somebody who is ‘small and lively’, like a porpoise!



HOW TO SPOT THEM

With an average length, when fully grown, of around 1.5 m and weighing about 50 kg, the harbour porpoise is the smallest cetacean found in the Hebrides and the only porpoise species in Scottish waters.

They have a stocky body, which is dark grey on the back and pectoral fins, with light grey sides and a white underside that extends up to the throat. The head is blunt with no discernible beak. A triangular dorsal fin, positioned in the middle of the body, is a key identification feature to distinguish between porpoises and dolphins, which have a more falcate-shaped fin.

Harbour porpoises are normally seen only briefly when they surface to breathe, rolling through the water

with the back and distinctive triangular dorsal fin visible. Their blow is not normally visible but can often be heard, earning this animal its nickname of ‘puffing pig’ and in another of its Gaelic names, *putthag* which means ‘little puffing one’.

They are usually seen alone or in small groups of up to five animals, although occasionally large aggregations of up to 100 animals can be seen in the Hebrides.

Harbour porpoises are generally quite elusive. Often seen briefly before diving or swimming away from vessels, they rarely approach or bow-ride on vessels or display any aerial activity, but have been seen to surf in the waves in some places in the Hebrides.



FACT FILE

Size	The smallest cetacean in the Hebrides, 1.4 - 1.9 m
Weight	50-70 kg
Teeth	Small spade-shaped teeth, used to catch prey but not for chewing
Diet	Over 20 species of fish, squid, octopus and shellfish
Habitat	Coastal waters
Life Span	Up to 24 years, but usually no more than 12

WHERE TO SEE THEM

Harbour porpoises can be found in inshore waters throughout the Northern Hemisphere, but the density of porpoises in Hebridean waters is amongst the highest in Europe. They are the most frequently seen cetacean, accounting for almost half of our sightings from *Silurian*. They are widespread and can be seen in most coastal areas of the Hebrides, with the highest encounter rates occurring around the Small Isles (Figure 10).

WHEN TO SEE THEM

With sightings all year round, harbour porpoises are one of the resident cetacean species on the west coast of Scotland.

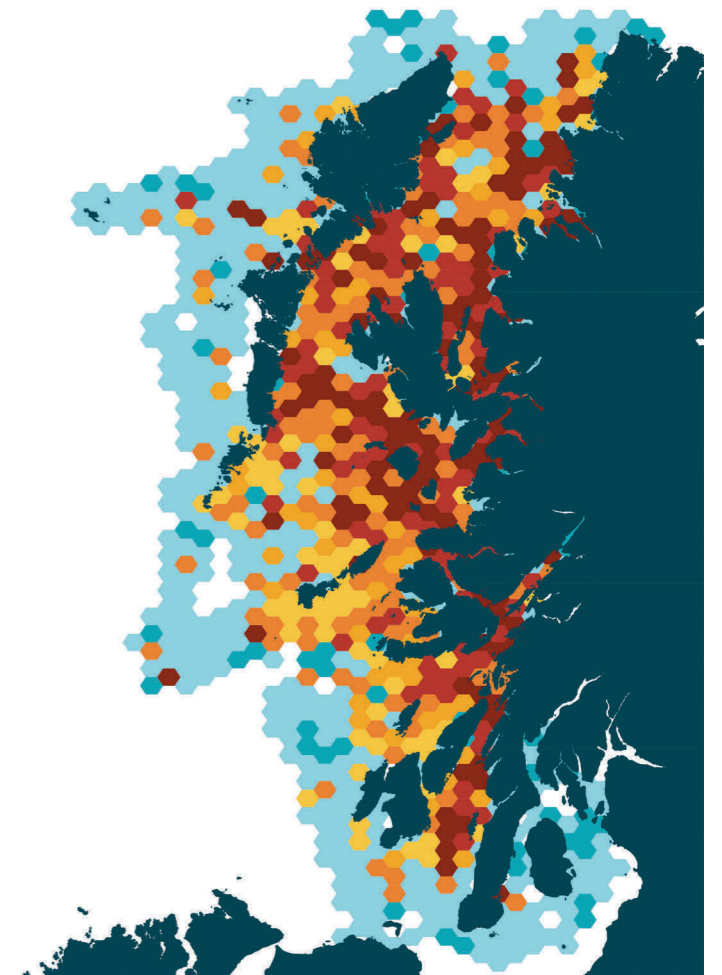
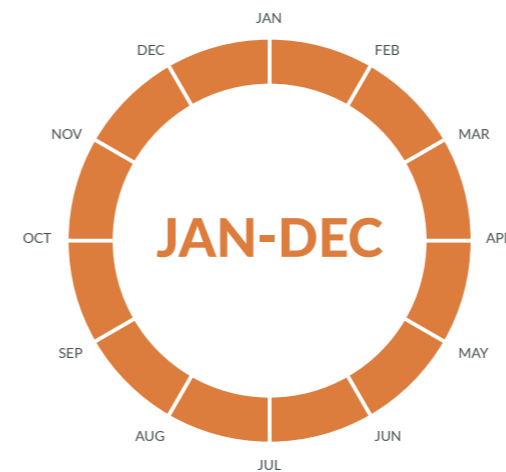


Figure 10. *Silurian* harbour porpoise sighting rates, 2003 to 2017. Species sightings per unit effort (km)



CONCERNS

Harbour porpoises are susceptible to disturbance and mortality from many human activities. Because of their feeding habits, they are at risk of entanglement in fishing gear, primarily gill nets. Some thousands are thought to become entangled and drown each year in UK waters.

On the west coast of Scotland, their distribution overlaps with coastal areas, which are also most heavily used by people. Therefore, they are exposed to high levels of shipping traffic, coastal developments, and other sources of anthropogenic (man-made) disturbances, particularly from loud underwater noises caused by vessels, military activity, and other developments such as fish-farms, which use seal-scarers (referred to as acoustic deterrent devices, ADDs). HWDT data shows the widespread and increasing use of ADDs on the west coast of Scotland, highlighting this as a significant and chronic source of underwater noise (Findlay *et al.* 2018). Harbour porpoises use sound in the form of echolocation clicks to explore the underwater environment and search for food. Porpoises have extremely sensitive hearing, and loud underwater sounds can lead to hearing damage, disturbance, and displacement from foraging grounds, impacting the local distribution and overall fitness of the species.



WHAT WE HAVE LEARNT

HWDT's long-term visual and acoustic data set shows that the west coast of Scotland is one of the most important areas for harbour porpoises in Europe (Embling *et al.* 2010, Booth *et al.* 2013). The significance of this area was recognised in 2016 when the Scottish Government approved the designation of the first protected area for harbour porpoises in Scotland, the Inner Hebrides and Minches Special Area of Conservation (SAC). HWDT's data set provided the primary evidence needed to inform the boundary for this area. This is one of the largest SAC's for harbour porpoises in Europe.

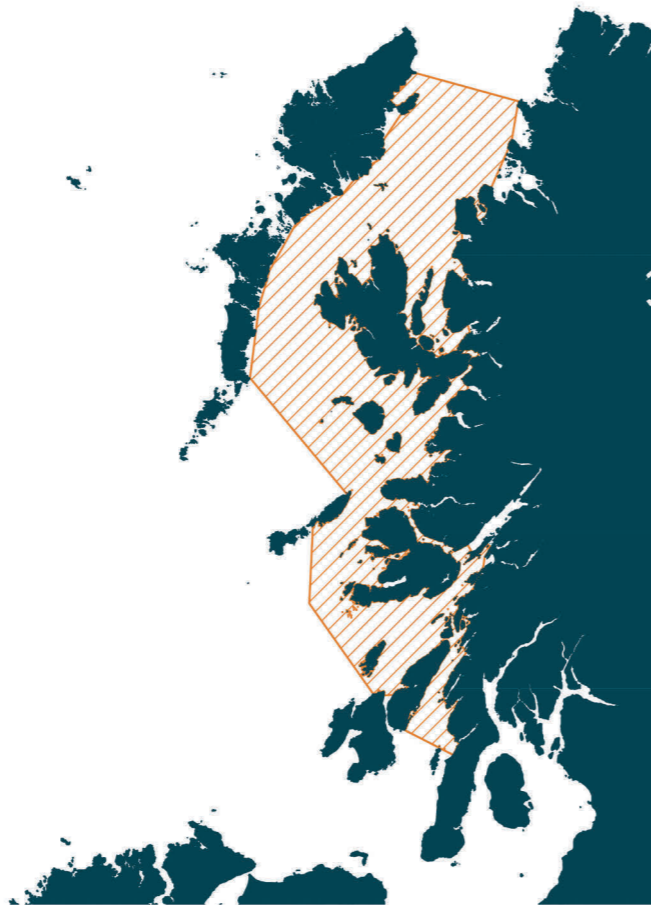


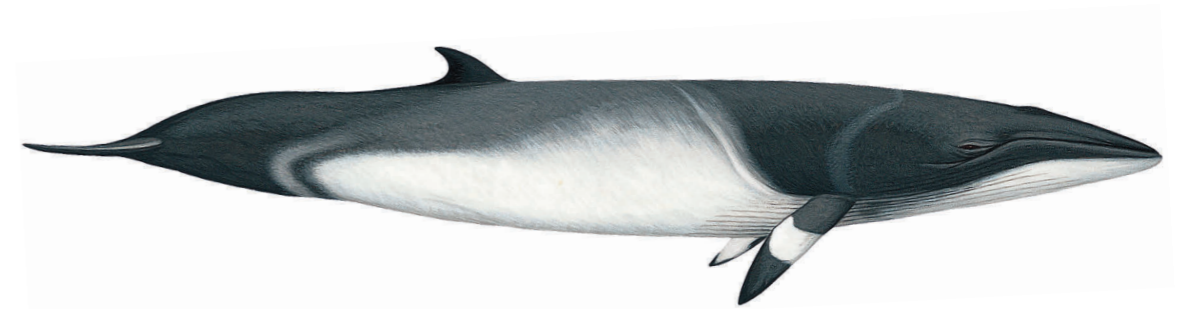
Figure 11. The Inner Hebrides and Minches Special Area of Conservation covering 13,801 km².

SPECIES

Minke Whale

Latin: Balaenoptera acutorostrata

Gaelic: Muc-mhara-mhionc - Muc-mhara is Gaelic for whale and literally translates as 'sea-pig'.



HOW TO SPOT THEM

With a body length of between 7 and 10 metres when fully grown, minke whales are the smallest baleen whales found in Scottish waters. Females are usually slightly longer than males. Minke whales have a slender, streamlined body, with a narrow, pointed head, which has a single central ridge running down it.

The dorsal fin and back are dark grey, but the underside is bright white and a paler area ('chevrons') rises up behind the pectoral fins. Bright white bands extend across each pectoral fin, known as 'minke mittens', which are thought to be used to corral fish into a ball when feeding.

The sickle-shaped dorsal fin, two thirds of the way down the body, is visible at the same time as the blowhole when surfacing. Unlike that of most other baleen whales, the minke whales blow is rarely visible at sea. Before diving, minke whales arch their back exposing the tailstock, but they do not lift their fluke out of the water ('fluking').

Minke whales are generally seen alone or in small groups (2-3), but they do aggregate at productive feeding grounds.

In the Hebrides, minke whales can occasionally be seen breaching and some, particularly young animals, are inquisitive around boats, approaching vessels to take a closer look, rolling on their sides, showing their bright white underside, and swimming under and around the boat to have a closer look, a behaviour known as 'associating'.

Minke whales feed by engulfing large volumes of water, which they sieve over their baleen plates, trapping their prey against the hair-like baleen, before they swallow it all whole. A commonly seen feeding behaviour, known as lunge feeding, involves the whale lunging at its prey at high speed from below and erupting at the surface with the throat grooves extended. Minke whales in the Hebrides are commonly seen feeding in association with sea birds, such as kittiwakes, Manx shearwaters and young gulls.



FACT FILE

Size	Smallest baleen whale in the Hebrides, up to 10 m
Weight	Up to 10,000 kg
Baleen	460-720 baleen plates, coarse hair-like structures formed of keratin, hang from the upper jaw to filter small schooling fish
Diet	Sandeels, herring, sprat and whiting, along with some plankton
Habitat	Coastal waters
Life Span	Up to 50 years

WHERE TO SEE THEM

Minke whales are one of the most widely distributed baleen whales and can be found from the subtropics to polar waters in the Northern Hemisphere. Their migration patterns are not fully understood, although they are thought to make a general migration between winter breeding grounds to the south of the British Isles and feeding grounds in the cooler, more productive waters during the summer.

The second most frequently seen cetacean from *Silurian*, minke whales account for 7% of all marine animal sightings. The highest encounter rates and most frequent sightings are around the Small Isles and east of the Outer Hebrides throughout the Minch and Sea of the Hebrides (Figure 12).

WHEN TO SEE THEM

Minke whales are one of the migratory species seen on the west coast and can be frequently seen in coastal waters around the Hebrides between April and October each year. The majority of the population are believed to migrate to breeding grounds to the south, although a few remain in the region through the winter.

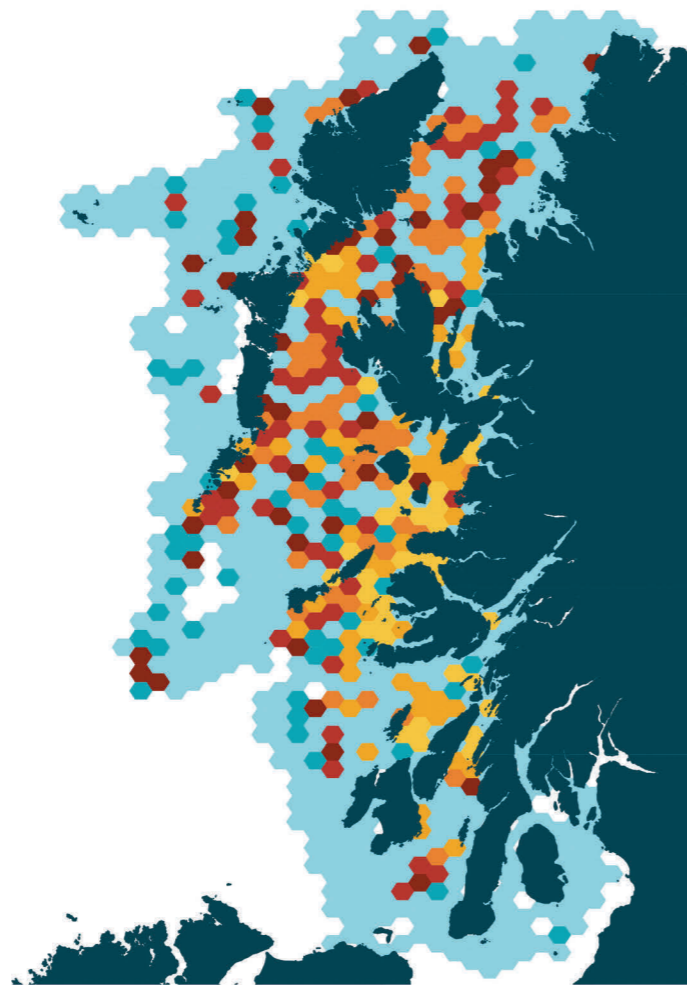
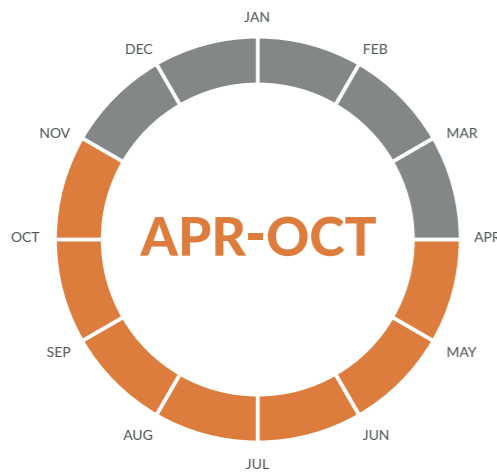


Figure 12. *Silurian* minke whale sighting rates, 2003 to 2017.

Species sightings per unit effort (km)

- Visual Survey Effort
- Off Effort Presence
- 0.001 - 0.006
- 0.006 - 0.011
- 0.011 - 0.018
- 0.018 - 0.031
- 0.031 - 0.310

MINKE WHALES ARE GENERALLY SEEN ALONE OR IN SMALL GROUPS, BUT THEY DO AGGREGATE AT PRODUCTIVE FEEDING GROUNDS



Figure 13. The Sea of the Hebrides proposed nature conservation Marine Protected Area (ncMPA) for minke whales and basking sharks.

WHAT WE HAVE LEARNT

HWDT catalogues thousands of minke whale photographs each year that have been captured during dedicated surveys on *Silurian*, along with a significant contribution from Sea Life Surveys, Tobermory-based whale-watching company. Analysis of these photographs has identified 235 individual minke whales in Hebridean waters. Thirty-eight percent of individuals have been recaptured on more than one occasion. These data have provided information on the movements of individual minke whales and the frequency at which they return to their important feeding grounds in the Hebrides. Some individuals have returned every year for over a decade.

HWDT, working with colleagues from Whale and Dolphin Conservation (WDC) and Cetacean Research and Rescue Unit (CRRU), first proposed the Sea of the Hebrides as a potential nature conservation Marine Protected Area (ncMPA) for minke whales back in 2011. Data collected from *Silurian* helped to demonstrate the importance of this area for these species (Paxton *et al.* 2014). The Scottish Government are expected to hold a public consultation for the Sea of the Hebrides ncMPA for minke whales and basking sharks late in 2018 (Figure 13).

CONCERNS

Entanglement in static fishing gear is a global threat for minke whales. They are also exposed to marine litter, which can be ingested or result in entanglement, causing injury and problems with mobility.

Minke whales, believed to be from the same population as those we monitor in the Hebrides, are a target for commercial whaling in the northern North Atlantic pursued by Norway, Iceland and Greenland.

Collisions with ships may also pose a threat, with some reports of minke whales being killed by ship strikes in UK waters. Seismic surveys during gas and oil exploration may cause cetaceans, including minke whales, physical harm at close ranges.

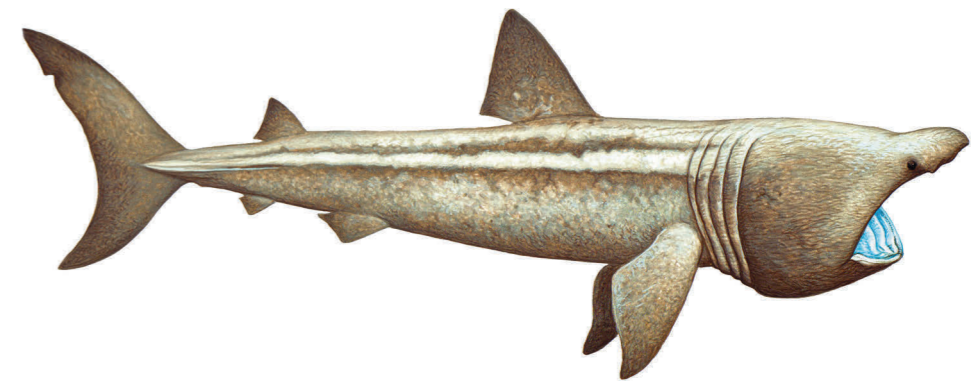


SPECIES

Basking Shark

Latin: Cetorhinus maximus

Gaelic: Cearban – means shark but will always be used to refer to a basking shark in Gaelic, unless otherwise specified. A less common name is Cearban-grèine meaning ‘sun-shark’ reflecting their propensity to ‘bask’ in the sun at the surface.



HOW TO SPOT THEM

Growing up to 10 metres, basking sharks are the second largest fish in the world, second only to the whale shark. They are dark, slate grey with a large triangular dorsal fin that can be as tall as one metre and may flop to the side in particularly large animals. They have large angular pectoral fins, with a long caudal (tail) fin, which is crescent-shaped with a notch in it.

Basking sharks have a narrow, pointed, upturned nose and a big mouth that can measure up to one metre across. Swimming slowly with its huge mouth wide open, zooplankton are caught on comb-like gill rakers as they filter the water and are swallowed when the mouth closes.

Basking sharks don't need to come to the surface for air but can be seen swimming and feeding near the surface. When at the surface, the dorsal fin, tip of the nose, and tip of the tail fin can be visible above the water. Basking sharks normally swim slowly, but they are capable of greater speeds, which allows them to leap clear of the water (breach), a behaviour that we see in the Hebrides.

They can be seen alone or in small groups but can form much larger aggregations, consisting of hundreds of animals, in areas where plankton is plentiful.





THE WAY THEY SWIM SILENTLY THROUGH THE WATER GAVE RISE TO A GAELIC SAYING: 'CHO SÀMHACH RI CEARBAN GRÈINE' - AS QUIET AS A BASKING SHARK

FACT FILE

Size	Second largest fish in the world, up to 10 m
Weight	Around 4,500 kg
Teeth	Comb-like gill rakers sift plankton from the water column
Diet	Zooplankton
Habitat	Coastal
Life Span	Up to 50 years

WHERE TO SEE THEM

Basking sharks are found globally in the cold to temperate waters of all the oceans. During spring and summer they favour coastal waters and move into deeper waters during the winter. Their distribution is related to prey availability.

Most sightings of basking sharks are within the Sea of the Hebrides. Highest numbers can be seen off the south of Tiree as well as the Gunna Sound (between Coll and Tiree) up to the Small Isles and Hyskier, as well as along the west of Mull (Figure 14).

WHEN TO SEE THEM

Basking sharks are most frequently seen in the Hebrides between May and October, with sightings peaking at the height of summer in July and August.

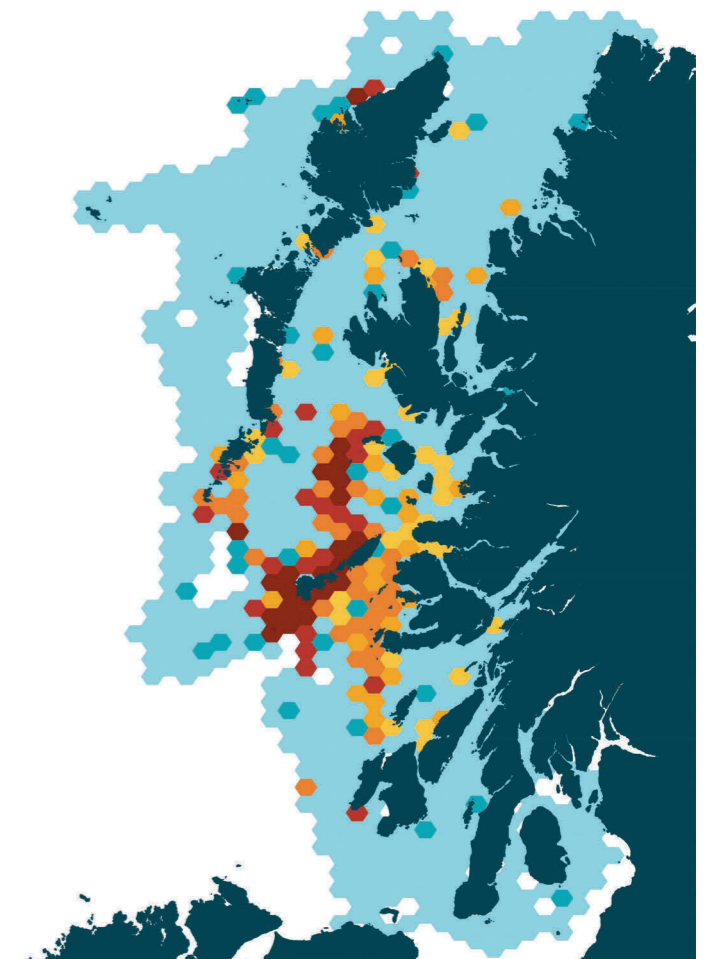
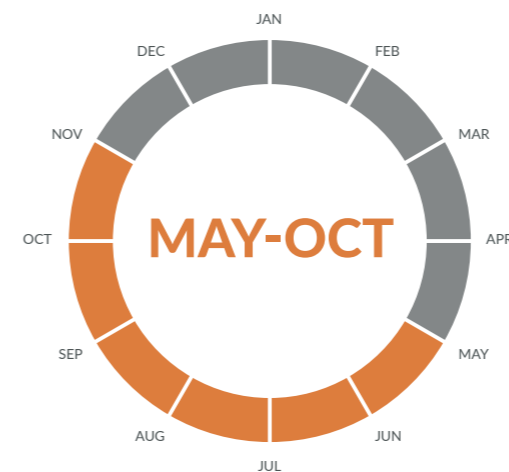
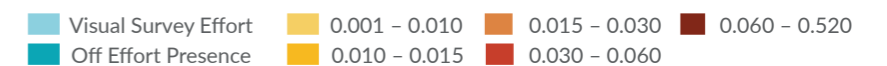


Figure 14. *Silurian* basking shark sighting rates, 2003 to 2017. Species sightings per unit effort (km)



CONCERNS

Basking sharks have been hunted around the globe for their fins and valuable liver oil for centuries. Comprising as much as a quarter of their total body weight, the liver is full of an oil known as squalene, which was used as an efficient industrial lubricant and for lamp oil, but now has uses in cosmetics. Basking sharks were hunted in Scotland, and the last of these fisheries (based in the Firth of Clyde) closed down as recently as 1995. They continue to be hunted in some countries, mainly for their dorsal fins, which are considered a delicacy in Asian countries. Basking sharks are slow to mature and have a long gestation period, which means the species is slow to recover if populations are rapidly depleted. It is now illegal to take basking sharks in the Hebrides, but other threats are harassment by, and collision with, boats and entanglement in fishing gear, which can cause injury from nets cutting into skin or cause damage to the dorsal fin, and may result in death if the animal cannot free itself. A growing concern for filter feeders, like basking sharks, is ingestion of marine debris. We do not yet understand the scale of this issue.

A BASKING SHARK'S MOUTH OPENS UP TO 1 METRE WIDE AND CAN FILTER THE EQUIVALENT OF A 50-METRE OLYMPIC-SIZED SWIMMING POOL IN ONE HOUR; THAT'S 2.5 MILLION LITRES OF SEAWATER!

WHAT WE HAVE LEARNT

The Sea of the Hebrides, where most of our basking shark sightings occur (Figure 14), is an important feeding and breeding area, which some animals return to year after year. The importance of this site has been recognised by the Scottish Government who have identified it as a potential nature conservation Marine Protected Area (ncMPA) for basking sharks (Figure 15). Data collected by HWDT from *Silurian* helped to demonstrate the importance of this area for basking sharks (Paxton *et al.* 2014). The Scottish Government are expected to hold a public consultation for the Sea of the Hebrides ncMPA for basking sharks and minke whales late in 2018.



Figure 15. The Sea of the Hebrides proposed nature conservation Marine Protected Area for basking sharks and minke whales.

SPECIES

Short-Beaked Common Dolphin

Latin: *Delphinus delphis*

Gaelic: *Leumadair cumanta* – *Leumadair* means 'one who leaps' and *cumanta* means 'common'.



HOW TO SPOT THEM

With a distinctive creamy yellow, hourglass pattern along their sides and a dark grey back, tail and pectoral fins, common dolphins are easily identified from other dolphins seen in the Hebrides. They are also well known for being very acrobatic and playful, and can often be seen porpoising, jumping clear of the water in shallow arches to swim faster, breaching or leaping. These inquisitive animals often join vessels to bow-ride, and they are fast swimmers, capable of travelling considerable distances in a short time.

In the Hebrides, common dolphins generally travel in groups of up to 30 individuals, but during the peak summer months "super-pods", hundreds of animals strong, can be seen too. These groups are often very active, and their leaping and splashing makes them easy to see from several kilometres away. This behaviour is reflected in their Gaelic name, 'leumadair' which means 'one who leaps'. Individuals will cooperate to herd fish in order to catch them more easily, and they can be seen in association with diving gannets feeding on the same fish in the Hebrides.



FACT FILE

Size	Small dolphins measuring up to 2.5 m
Weight	Around 150 kg
Teeth	Up to 216 sharp pointed teeth to grasp prey
Diet	Varied diet of squid and fish, like herring and mackerel
Habitat	Coastal and offshore
Life Span	Up to 35 years

WHERE TO SEE THEM

Short-beaked common dolphins are widespread in coastal and offshore waters in subtropical and warm temperate seas. They are now the most commonly seen dolphin species during *Silurian* surveys, accounting for 4% of all marine animal sightings. Common dolphins can be seen throughout the west coast, with most sightings east of the Outer Hebrides in the Minch, Little Minch and Sea of the Hebrides (Figure 16). They can often be seen from the shore in coastal areas too.

WHEN TO SEE THEM

Sightings of common dolphins peak between April and October each year, and although they are generally considered a summer visitor, some animals now remain in the area throughout the winter months too.

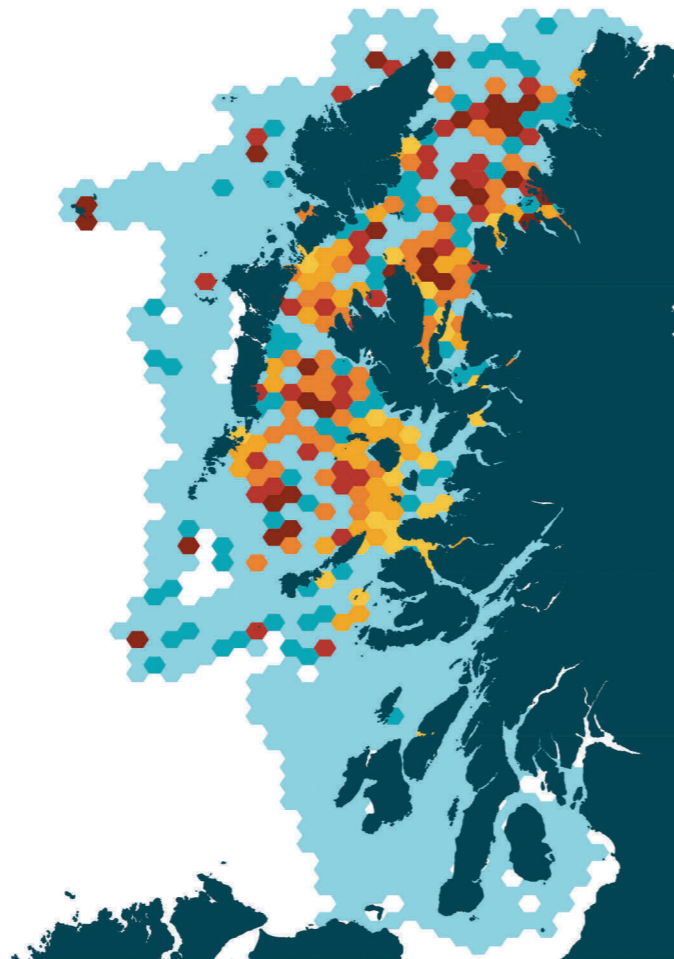
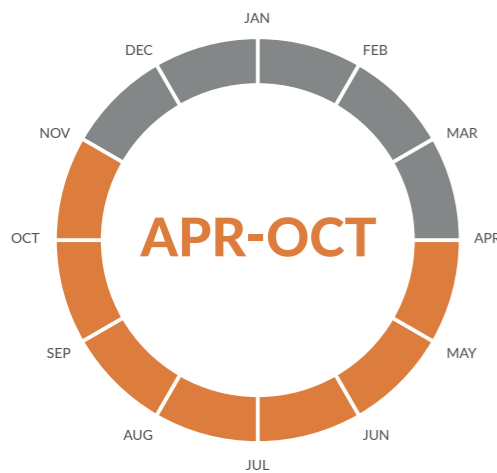
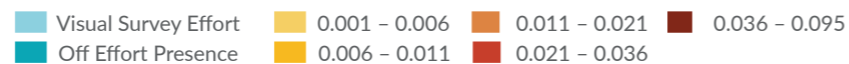


Figure 16. *Silurian* short-beaked common dolphin sighting rates, 2003 to 2017. Species sightings per unit effort (km)



WHAT WE HAVE LEARNT

Once a rare sight, common dolphins are becoming increasingly common in the waters of western Scotland. During the early years of *Silurian* surveys, common dolphins were rarely seen; there is even a season (2004) where they were not seen at all. In recent years, they have become the most frequently encountered dolphin species from *Silurian*, and each year the number of sightings is increasing. To learn more about this increase, see Identifying Trends in Section 2.

CONCERNS

Common dolphins are thought to be one of the most abundant cetacean species, with population estimates suggesting that there are several hundred thousand animals globally. Yet significant numbers of common dolphins are accidentally caught in open sea trawl and drift nets. Common dolphins are also subject to the same threats as other cetacean species, including the pollution and degradation of the marine environment, injury and disturbance from vessels, and decreasing food resources due to overfishing.

SPECIES

Bottlenose Dolphin

Latin: *Tursiops truncatus*

Gaelic: *Muc-bhiorach* – ‘pointed pig’, *bhiorach* means pointed in Gaelic, referring to the dolphin’s prominent beak or bottlenose.



HOW TO SPOT THEM

A large, robust dolphin noticeably ‘chunky’ in shape. It is mostly dark grey in colour with a pale, near-white belly and lower jaw. On some animals you will see pale scratches or scars caused by other dolphins’ teeth. The jaws form a stubby beak, giving it the characteristic ‘bottle-shaped’ nose.

Famously inquisitive, active and playful, they are often seen bow-riding and leaping clear of the water.

In the Hebrides, bottlenose dolphins travel in small, social groups of between three and ten individuals, but larger group sizes are not unusual.

Bottlenose dolphins have up to 100 teeth, which they use to catch a wide variety of fish, squid, cuttlefish and crustaceans. Individuals can sometimes be seen working together to herd fish to the surface, and they are known to use their powerful tails to strike fish in order to stun and catch their prey. They have also been seen to attack and kill harbour porpoise on the west coast of Scotland.



FACT FILE

Size	Growing up to 3.9 metres, Scottish bottlenose dolphins are some of the largest in the world
Weight	Around 400 kg
Teeth	Up to 100 sharp pointed teeth to grasp and kill prey
Diet	Variety of fish, squid, cuttlefish and crustaceans
Habitat	Close to shore, around headlands and bays
Life Span	Up to 52 years

WHERE TO SEE THEM

The bottlenose dolphins encountered in the Hebrides are near the northernmost extreme of the species’ global range. They generally stay close to shore, following the coastline as they travel throughout the area, and can be seen around headlands and bays. This preference for inshore habitats means they are infrequently seen during *Silurian* surveys, which tend to cover areas further offshore. Sightings of bottlenose account for just 0.5% of all *Silurian* sightings, but they are most often seen in and around the Sound of Barra and throughout the Inner Hebrides, with most sightings around Mull, the Small Isles and Skye (Figure 17).

WHEN TO SEE THEM

With sightings all year round, bottlenose dolphins are one of the resident species off the west coast.

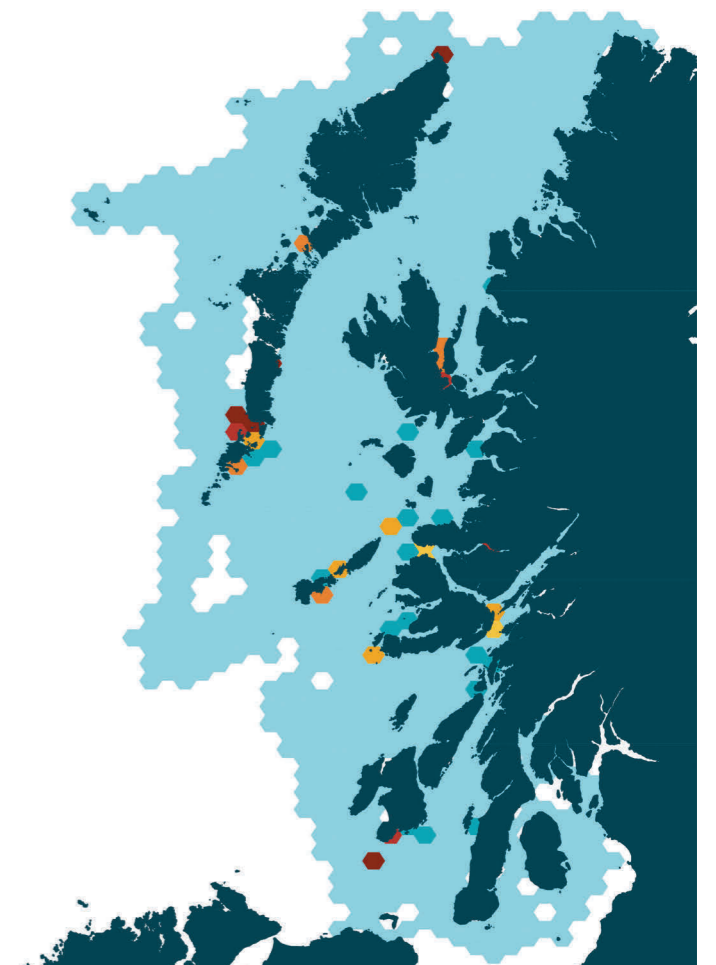
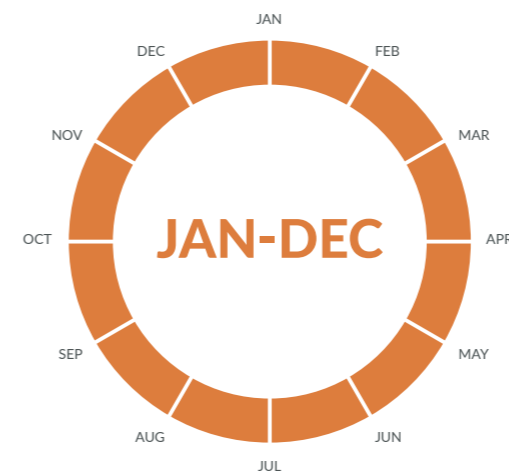


Figure 17. *Silurian* bottlenose dolphin sighting rates, 2003 to 2017. Species sightings per unit effort (km)

Visual Survey Effort 0.001 – 0.002 0.004 – 0.008 0.016 – 0.040
 Off Effort Presence 0.002 – 0.004 0.008 – 0.016

CONCERNS

Like most cetaceans, bottlenose dolphins may be affected by human activities. They are vulnerable to the degradation of the marine environment, the bioaccumulation of chemical contaminants, and shipping activities, which may lead to injury from collisions, interference with navigation, foraging and communication from loud noises produced by seismic and military vessels, as well as physical damage depending on the sound level. They may be accidentally caught in fishing gear. As a resident species in coastal areas, bottlenose dolphins are susceptible to disturbance from marine tourism and recreational activities.



WHAT WE HAVE LEARNT

HWDT has been tracking individual bottlenose dolphins in the Hebrides since 2001. In 2006, Hebridean Whale and Dolphin Trust researchers were the first to suggest that groups of bottlenose dolphins were resident year round on the Scottish west coast (Mandelberg 2006). Since then, our data have revealed the west of Scotland is home to two separate groups of bottlenose dolphins, which live in the area all year round: the Inner Hebrides community, consisting of 30 to 40 animals, and a smaller group of around 15 dolphins, the Sound of Barra community (van Geel 2016). The Sound of Barra dolphins have a restricted range, staying close to the Sound of Barra all year. In contrast, the Inner Hebrides community travel large distances throughout the Inner Hebrides and mainland coasts mainly from the Kintyre peninsula to the south of Skye (Mandelberg 2006, Cheney *et al.* 2013, van Geel 2016).



SPECIES

White-Beaked Dolphin

Latin: Lagenorhynchus albirostris

Gaelic: Leumadair bàn-ghobach - Leumadair means 'one who leaps' and bàn-ghobach literally translates as 'white-beaked'.



HOW TO SPOT THEM

White-beaked dolphins are distinctive robust-bodied animals with a stubby, mostly white beak and a tall falcate (sickle-shaped) dorsal fin. They have a dark grey back, tail and pectoral fins, with greyish-white flashes along the flanks, and a pale grey patch behind the dorsal fin (known as the saddle-patch) which extends down around their tailstock.

Fast, powerful swimmers, white-beaked dolphins are acrobatic and frequently breach and leap out of the water, and 'porpoise' when travelling at speed. They are often attracted to boats to bow-ride, where they will swim in the pressure wave at the front of the boat. Usually seen in groups of five to 20 animals, they occasionally form larger groups of several hundred individuals and are rarely seen alone.



FACT FILE

Size	Around 2.8 m
Weight	Up to 350 kg
Teeth	Up to 112 teeth to grasp prey
Diet	Varied diet including small schooling fish like sandeels and herring to larger fish like cod, whiting and haddock, as well as squid and crustaceans
Habitat	Open water
Life Span	Life expectancy of white-beaked dolphins is unknown

WHERE TO SEE THEM

White-beaked dolphins have a relatively restricted range and are only found in the temperate and subarctic waters of the North Atlantic. Rising sea temperatures caused by climate change may affect the future distribution of white-beaked dolphins. The Hebrides are towards the southern extreme of their range. Here, they are usually seen in open waters further from the coast and favour the waters around the Outer Hebrides and the north Minch (Figure 18).

WHEN TO SEE THEM

White-beaked dolphins are one of the species that are present in Hebridean waters all year round.

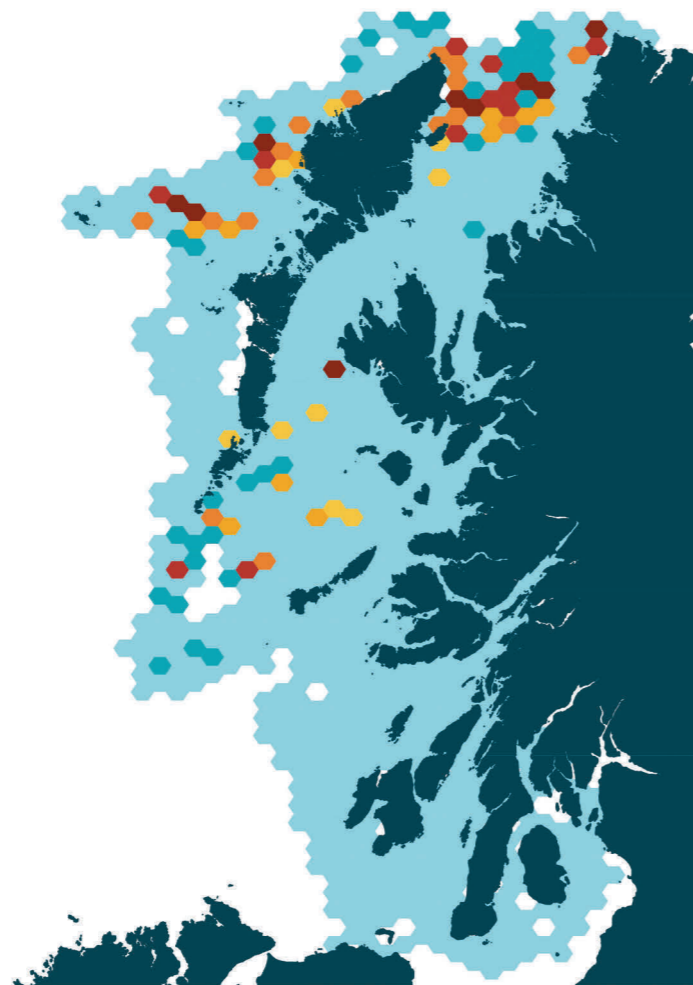
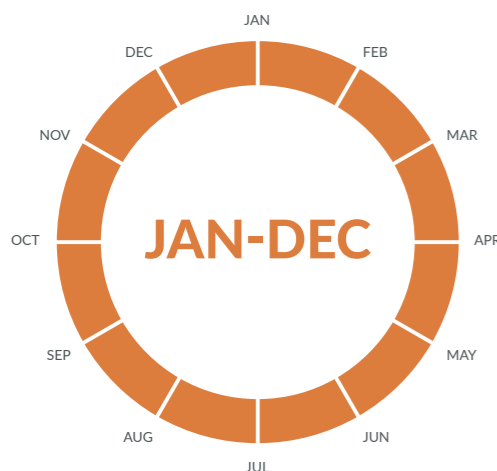


Figure 18. *Silurian* white-beaked dolphin sighting rates, 2003 to 2017. Species sightings per unit effort (km)

Visual Survey Effort 0.001 - 0.016 0.024 - 0.035 0.050 - 0.095
 Off Effort Presence 0.016 - 0.024 0.035 - 0.050



CONCERNS

One of the major threats to white-beaked dolphins is incidental capture and drowning in gill net, drift net and trawl fisheries. Like other cetacean species, the white-beaked dolphin is affected by marine pollution, habitat degradation and disturbance.

WHAT WE HAVE LEARNT

HWDT with WDC and CRRU suggested two MPA's for white-beaked dolphins in 2011. Whilst the joint proposals for Risso's dolphins and minke whales were included, the white-beaked areas were not recommended to progress as part of an ncMPA proposal at that time, largely due to a perceived lack of distribution data. Work is currently ongoing to identify the likely distribution and potential habitats for white-beaked dolphins in Scottish waters. The suggestion in previous studies of potential range shifts related to climate change (MacLeod *et al.* 2005), as well as the apparently highly dispersed distribution patterns from modelling studies (Paxton *et al.* 2014), makes the identification of hotspots for white-beaked dolphins important but challenging.

SPECIES

Risso's Dolphin

Latin: *Grampus griseus*

Gaelic: *Cana* - The diminutive 'canarag' is used to refer to a young Risso's dolphin.



HOW TO SPOT THEM

Risso's dolphins have a robust, stocky body and a tall, falcate (sickle-shaped) dorsal fin. The melon (forehead) is blunt and bulbous with a unique crease running from the upper lip to the blowhole. The colour pattern varies greatly between individuals and with age. Calves are born grey but turn darker grey to dark brown as they become juveniles. As they age, the skin tone lightens to silvery-grey and the body becomes increasingly covered with scratches and scars inflicted by other Risso's dolphins and prey species such as squid.

In the Hebrides, Risso's dolphins are usually seen singly or in groups of up to 20 animals, although in other areas they are reported in large groups of several hundred individuals. Social behaviour is gregarious and sometimes rough, possibly accounting for some of the scars and tooth rake marks seen in adult animals. Risso's can be seen breaching, tail slapping, spy-hopping, splashing, and sometimes striking one another, although they are more commonly seen travelling and surfacing slowly, rarely approaching vessels or bow-riding.



FACT FILE

Size	Up to 3.8 m
Weight	Up to 500 kg
Teeth	Risso's rarely have teeth in the upper jaw, but have 4-14 teeth at the front of the bottom jaw for grasping squid
Diet	Mainly squid, with some octopus and cuttlefish
Habitat	Deep water, sometimes coastal in the Hebrides
Life Span	At least 30 years

WHERE TO SEE THEM

Risso's dolphins are widely distributed throughout most oceans between 60° North and 55° South. The north of Scotland represents the northern limit for this species. In the Hebrides, Risso's dolphins tend to inhabit deeper waters, which may be home to their preferred prey of squid, octopus and cuttlefish. Due to the bathymetry in the Hebrides, deep water can be sometimes found close to land e.g. Tiumpán Head off the north east coast of Lewis in the Outer Hebrides. Sightings from *Silurian* are however, distributed throughout the survey area (Figure 19). Sightings have been recorded as far south as the Kintyre peninsula but are more frequent around Coll, Tiree, Mull and Skye, with some of the highest encounter rates off the Butt of Lewis.

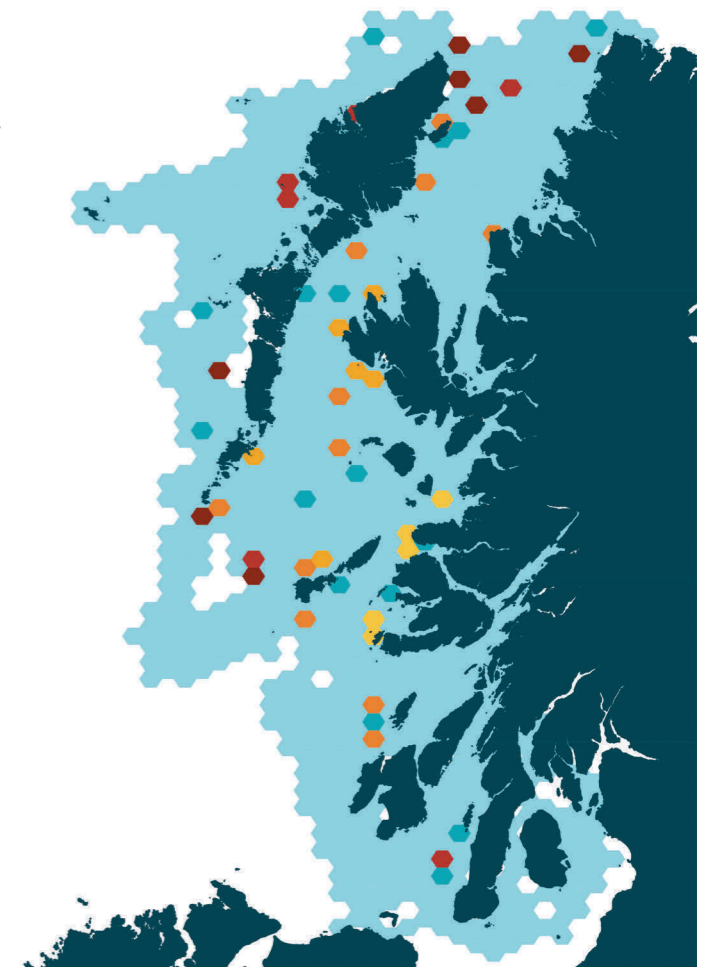
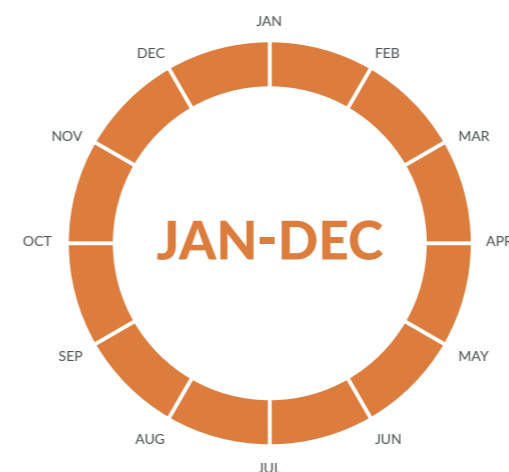


Figure 19. *Silurian* Risso's dolphin sighting rates, 2003 to 2017. Species sightings per unit effort (km)

WHEN TO SEE THEM

Risso's dolphins can be seen all year round in the Hebrides.



Visual Survey Effort 0.001 – 0.005 0.007 – 0.014 0.025 – 0.060
 Off Effort Presence 0.005 – 0.007 0.014 – 0.025



WHAT WE HAVE LEARNT

The deep water close to the north east coast of Lewis, surrounding Tiumpán Head, is an important feeding and calving area for Risso's dolphins. The importance of the North East Lewis site has been recognised by the Scottish Government who have identified it as a potential ncMPA for Risso's dolphins (Figure 20). Together with WDC and CRRU, HWDT first proposed this site in 2011. HWDT contributed to the scientific evidence needed to demonstrate the importance of this area for Risso's dolphins. The Scottish Government are expected to hold a public consultation for this site late in 2018.



Figure 20. The North East Lewis proposed nature conservation Marine Protected Area (ncMPA) for Risso's dolphins.

CONCERNS

Many squid eating marine animals, including turtles and sea birds, swallow plastic bags that they mistake for their prey. Once ingested, plastic may accumulate in the stomach of the animal, causing starvation and eventual death. It is likely that Risso's dolphins commonly encounter plastic bags in the ocean and may be affected by this. Risso's dolphins are also subject to incidental capture in fishing nets causing drowning, may be disturbed by noise produced by offshore oil and gas exploration, and are exposed to marine pollutants, including organochlorines such as pesticides and industrial chemicals.

SPECIES

Killer Whale (Orca)

Latin: Orcinus orca

Gaelic: Madadh-cuain – means Ocean Wolf in Gaelic. The word 'orca' also has a cognate in Gaelic; orc, is an archaic word for a whale.



HOW TO SPOT THEM

Killer whales have a distinctive black and white colouration: a mainly jet black body with a bright white eye patch, lower jaw, and underside which extends along the whole body to the fluke and up along the flanks. There is also a paler patch behind the dorsal fin known as a 'saddle patch' and their pectoral fins are paddle-shaped.

Male killer whales (bulls), when mature, are much larger than females, and their unmistakable large black dorsal fins can reach up to nearly two metres in height. Females have a smaller, falcate (curved)

dorsal fin, and are sometimes mistaken for juveniles due to their small size compared to bulls.

These agile, powerful swimmers are known to breach, porpoise, spy-hop, and are capable of swimming at speeds up to 35 mph, enabling them to cover large distances over short periods of time. Photo-ID images have shown that some identified individuals have travelled from Mull to Skye overnight! Generally, they travel in family groups of up to 10 animals, but individuals can sometimes be seen alone.



FACT FILE

Size	Largest member of the dolphin family, 5.5 to 9.8 m
Weight	Up to 5,500 kg
Teeth	100 pointed teeth to grasp and kill prey
Diet	Marine mammals and fish such as herring and mackerel
Habitat	Coastal sightings
Life Span	Females can live up to 90 years

WHERE TO SEE THEM

One of the most widespread cetaceans globally, killer whales' range covers the warm tropical waters near the equator through to the cool temperate seas and freezing polar waters of the Arctic and Antarctic where they are most abundant.

Killer whales can be seen throughout the west coast of Scotland and can be seen from the shore in coastal areas as well as offshore.

From *Silurian* there have been just 16 sightings over the last 15 years (Figure 21), most of which have been of a small unique group called the West Coast Community, the UK's only resident group of killer whales.

WHEN TO SEE THEM

Sightings of killer whales are infrequent, but they are present in Hebridean waters all year round.

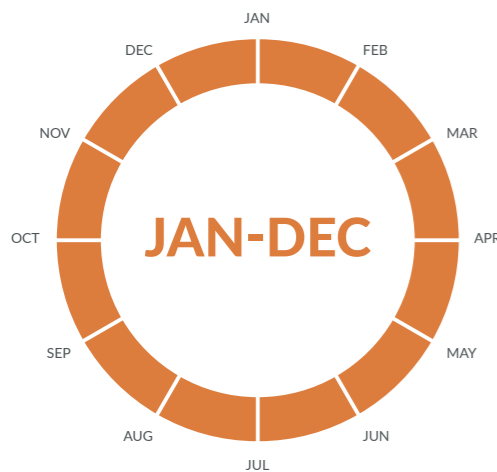


Figure 21. *Silurian* killer whale sightings, 2003 to 2017. Species presence
 ■ Visual Survey Effort ■ Presence

Introducing:
The West Coast Community



W01 - John Coe (Bull)

First seen in 1980, John Coe is the most distinct individual in the West Coast Community, identifiable by the large notch in the bottom of his dorsal fin and his fluke.



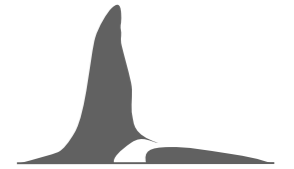
W02 - Floppy Fin (Bull)

Floppy Fin has a very distinctive dorsal fin that 'flops' over to the left. In wild killer whales, this is quite rare and is thought to be genetic.



W03 - Nicola (Female)

Nicola was first catalogued in 1992 and has a notch in her dorsal fin, which makes her distinguishable from the other females in the group.



W05 - Comet (Bull)

Comet was first catalogued by HWDT in 1998. In 2016, HWDT helped to match Comet to a whale named "Dopey Dick" who swam up the River Foyle in 1977 making him nearly 60 years old!



W07 - Moneypenny (Female)

Moneypenny was first catalogued in 2004 and has most often been seen with John Coe.



W08 - Aquarius (Bull)

Aquarius was first catalogued in 2004 and he is frequently seen with John Coe.



W09 - Puffin (Female)

Puffin was first catalogued by HWDT in 2000 and has a small, falcate dorsal fin, which is characteristic of female killer whales.



W10 - Occasus (Female)

Occasus was first catalogued by HWDT in 2005 and later named in 2011 as part of a competition run by BBC Wildlife.

DECEASED



W04 - Moon (Bull)

Moon was first catalogued by HWDT in 1992. He has a moon-shaped nick in his dorsal fin, which identifies him from the other males. Moon is believed to have perished in 2008.



W06 - Lulu (Female)

Lulu, first catalogued by HWDT in 1995. She was found dead on the island of Tiree in January 2016.



WEST COAST COMMUNITY

Numbering just eight individuals, four male and four females, members of the West Coast Community can be distinguished from other groups of killer whales seen around Scotland by their unusual sloping eye patch and large size (Makelaninen *et al.* 2014). Each individual in the group is recognisable by the unique shape of their dorsal fins as well as the shape and coloration of their saddle patch. HWDT have been collating photographs and sightings of the West Coast Community since 1992.

These animals truly are a West Coast Community, with sightings along the whole of the west coast of the UK from the Hebrides to the south of Ireland. One individual, John Coe, the most distinct member of the group, has also been seen on the east coast of Scotland (Robinson *et al.* 2017). Although the group is wide-ranging, most sightings have been within the Hebrides. Some individuals have not been seen in recent years, and there have been no calves observed since monitoring began in the 1990's (Beck *et al.* 2014). Lulu, the ninth member of the group, died after becoming entangled and stranded on Tiree, in the Hebrides, in January 2016. Lulu's death was tragic, but it provided us with a unique insight into the threats facing this small and unique group.

CONCERNS

Organic pollutants, such as pesticides and industrial chemicals like polychlorinated biphenyls (PCBs), accumulate in the bodies of all marine animals. Although PCBs have been banned since the 1980's, once in the marine environment they are difficult to remove. As an apex predator at the very top of the food chain, killer whales are at a higher risk of toxic contamination than other species.

Contaminant analysis of tissue taken from Lulu's necropsy, carried out by the Scottish Marine Animal Stranding Scheme, showed that she had one of the highest levels of PCBs ever recorded in the species: 100 times higher than the accepted threshold for PCB toxicity in marine mammals. High levels of PCBs cause poor health and infertility. Although she was sexually mature, Lulu's necropsy showed she had never been pregnant. This finding, linked with the fact that no calves have been recorded in the West Coast Community since monitoring began, suggests that this unique group of killer whales will die out in our lifetime.

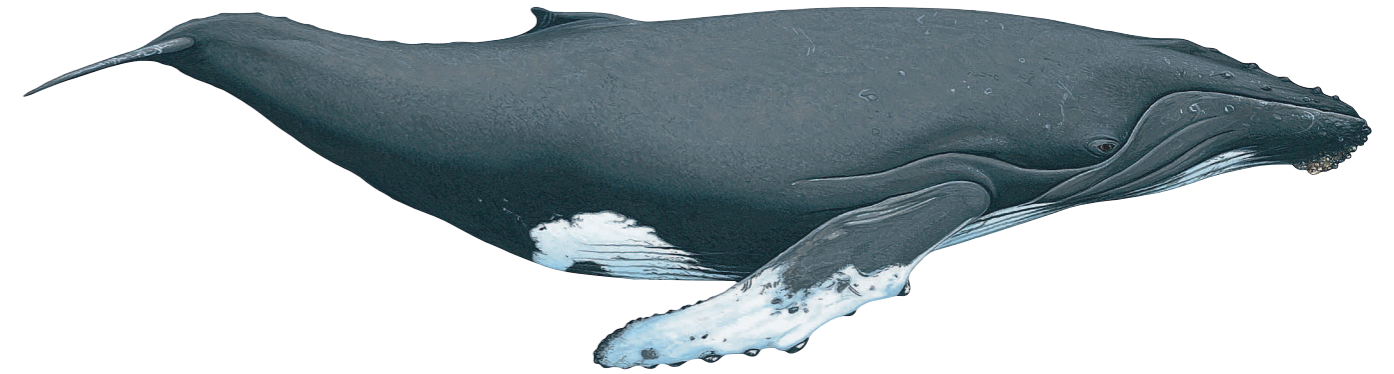
SPECIES

Humpback Whale

Latin: Megaptera novaeangliae

Gaelic: Muc-mhara-crotach – crotach means 'humpbacked'

and people can also be crotach



HOW TO SPOT THEM

Humpback whales are easy to distinguish from other baleen whales due to their distinctive appearance. The head has a number of knobby tubercles, which are enlarged hair follicles. The body is predominantly black with white patches on the underside and white ventral pleats extend from the lower jaw to midway down the belly. The dorsal fin is small and hooked, located far down the back on the "hump", and is often scarred. Their mostly white pectoral fins may be as long as five metres, which gives rise to their latin name *Megaptera* meaning "great wing". The fluke can measure up to five metres across and is raised out of the water when diving. The

colouration and serrated trailing edge are unique to each animal, which enables individual animals to be identified.

Humpbacks have a 'bushy', visible blow, which can be as tall as four metres. Despite their size, humpback whales are well-known for their energetic displays of breaching, lobtailing (fluke slapping) and flipping (smashing their long "wings" onto the water's surface). Humpback whales can also be very inquisitive and may approach boats. Humpback whales are normally seen alone or in small groups of up to seven animals. Long-term associations between individuals are rare.



FACT FILE

Size	Up to 17 metres
Weight	40,000 kg!
Baleen	540-800 stiff baleen plates filter prey from the water
Diet	Krill and small schooling fish like herring and sprat
Habitat	Coastal sightings
Life Span	Up to 50 years

WHERE TO SEE THEM

Humpback whales are widely distributed throughout all oceans of the world. They travel thousands of miles from warm-water breeding grounds in the tropics to the cold-water feeding grounds in the polar regions. They favour inshore waters and continental shelf areas, but will travel through open water during their migration.

First seen from *Silurian* in 2004, there have been just six sightings since then (2006, 2007, 2009, 2 in 2016, 2017). Humpback whales are occasionally encountered in the Hebrides travelling between breeding grounds off Africa to feeding grounds around Iceland and Norway. Sightings from *Silurian* have all occurred north of Ardnamurchan Point around Skye and Lewis (Figure 22).

WHEN TO SEE THEM

Humpbacks are migratory and sightings have been reported throughout the year in the Hebrides.

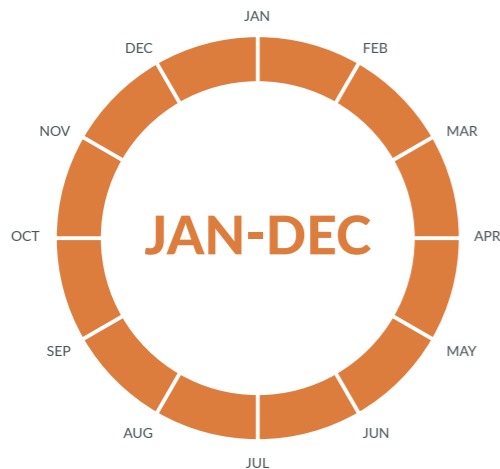


Figure 22. *Silurian* humpback whale sighting rates, 2003 to 2017.
 Species presence
 Visual Survey Effort Presence



CONCERNS

Historically, humpback whales were targeted by commercial whalers and the global population was severely depleted. Humpbacks are listed in the whaling records for the Hebrides between 1904 and 1928 along with blue, fin, sei, sperm and northern right whales (Brown 1976). There is some evidence that the North Atlantic population of humpback whales has started to recover since the whaling moratorium was established in 1982. Today, humpback whales face a range of threats including entanglement in fishing gear, collisions with vessels, pollution and reduction in prey stocks.

WHAT WE HAVE LEARNT

HWDT share sightings information and photographs of the humpbacks we encounter with other organisations and researchers across the north Atlantic to help provide a better understanding of the movements of individual animals.

FUTURE

On the Horizon

HWDT believes in a participative and community-based approach to research and conservation. Large-scale citizen science projects are the foundation of our monitoring efforts, and HWDT is extremely grateful to the volunteer citizen scientists who have joined us on board *Silurian* and contributed to the collection of every single data point that has been presented in this edition of the Hebridean Marine Mammal Atlas.

Long-term monitoring of this nature remains our main priority to ensure we can continue to provide the evidence needed to develop effective conservation measures to protect Scotland's remarkable marine wildlife for future generations.

As HWDT approaches its 25th year, we remain as committed as ever to ensuring that whales, dolphins and porpoises are valued and protected throughout the Hebrides. In our mission to achieve this, HWDT's science team will be continuing our long-term monitoring and undertaking new and innovative research in order to provide a better understanding of the animals that inhabit our remarkable seas and the threats that face them.

MARINE MAMMAL ATLAS SERIES

In this first edition of the Hebridean Marine Mammal Atlas, we have presented a straightforward showcase of our visual data set. Subsequent editions of the HWDT Atlas series will bring together 15 years of Passive Acoustic Monitoring (PAM) on board *Silurian*, analysis of our photo-identification data, and community sightings records.

PHOTO-IDENTIFICATION CATALOGUE

In 2019, HWDT will update and reissue its Hebridean minke whale photo-identification catalogue to include all of the identifiable animals that have been seen in the Hebrides since 1990. Since the last catalogue was produced, around 100 new individuals have been seen almost doubling the number of animals in the catalogue.



WINTER SURVEYS

For the first time in HWDT's history, we will be extending the *Silurian* survey programme to include winter monitoring to complement our already extensive timetable operating between April and October. Starting early in 2019, this important enhancement of our survey programme will provide critical year-round monitoring throughout Hebridean seas to expand the evidence available to inform the effective management of priority marine species (cetaceans, seals and basking sharks). Currently, no substantive winter data exist for the region, so these surveys will provide a baseline for the presence and distribution of priority marine species during the winter months, allowing us to assess the year-round presence and distribution for the first time.

SCOTTISH ENTANGLEMENT ALLIANCE

Entanglement is a global problem for cetaceans and a growing concern in Scottish waters. It is the single largest cause of death for minke whale strandings in Scotland (up to 40% of all recorded mortalities). HWDT have partnered with five other organisations (Scottish Marine Animal Stranding Scheme, Scottish Natural Heritage, Whale and Dolphin Conservation, British Divers Marine Life Rescue and Scottish Creel Fishermen's Federation) to form the Scottish Entanglement Alliance (SEA). HWDT are proud to be part of this project funded by the EU European Maritime Fisheries Fund that aims to better understand the impacts and risks of entanglement in creel lines in Scottish waters by working closely with the Scottish inshore fishing industry. HWDT will focus on assessing the interaction between large whales and manmade items in the marine environment by analysing photographs of live animals and taking new calibrated photos using photogrammetry equipment from *Silurian*. These data, and the project as a whole, should lead to a better understanding of the risks that entanglement poses to our amazing Hebridean marine life.



Acknowledgements

Our species monitoring and research programme relies entirely on volunteers, dedicated individuals who donate both time and money to join expedition surveys. At its core, *Silurian* is a citizen science project; every single data point has been collected by a volunteer. These contributions have improved our understanding of cetaceans in Hebridean seas and led to the identification and designation of Marine Protected Areas - a national and global first for some species.

This continuous monitoring effort for over 15 years has required skill, passion and a steadfast commitment from many individuals. Our experienced boat crew have kept our volunteer teams safe and smiling, and *Silurian* 'ship-shape' for her many voyages. Expert scientists and researchers of the HWDT Scientific Committee, and many others have guided the collection and use of this vital data into valuable research and peer-reviewed publications.

Over the years, a number of talented scientists have led the research programme aboard *Silurian*; Juliet Shrimpton, Susannah Calderan, Nienke van Geel, Olivia Harries, Kerry Froud, and Frazer Coomber. Collectively, they have trained hundreds of volunteers, diligently monitored thousands of miles of Hebridean seas, and checked and cleaned millions of data points.

We would also like to thank the funders who have supported our boat-based species monitoring and research programme over the past 15 years including; Heritage Lottery Fund, The Nàdair Trust, Scottish Natural Heritage, WWF-UK and Coastal Communities Fund. This inaugural report is testament to these contributions.

Base maps © OpenStreetMap Contributors. A HLF funded publication.
Species illustrations donated © Martin Camm. All other content © HWDT.
Atlas design by Pentameter.

References

- Beck, S., Foote, A.D., Kotter, S., Harries, O., Mandelberg, L., Stevick, P.T., Whooley, P., and Durban, J.W., (2014). Using opportunistic photo-identifications to detect a population decline of killer whales (*Orcinus orca*) in British and Irish waters. *Journal of the Marine Biological Association of the United Kingdom*, 94 (6), 1327–1333.
- Birch, C.P.D., Oom, S.P., and Beecham, J.A., (2007). Rectangular and hexagonal grids used for observation, experiment and simulation in ecology. *Ecological Modelling*, 206 (3–4), 347–359.
- Booth, C., (2010). *Variation in habitat preference and distribution of harbour porpoises west of Scotland*. PhD Thesis, University of St. Andrews, UK.
- Booth, C.G., Embling, C., Gordon, J., Calderan, S.V., and Hammond, P.S., (2013). Habitat preferences and distribution of the harbour porpoise *Phocoena phocoena* west of Scotland. *Marine Ecology Progress Series*, 478, 273–285.
- Brown, S.G., (1976). Modern whaling in Britain and the north-east Atlantic Ocean. *Mammal Review*, 6 (1), 25–36.
- Buckland, S.T., Anderson, D.R., Burnham, K.P., Laake, J.L., Borchers, D.L., and Thomas, L., (2001). *Introduction to distance sampling: estimating abundance of biological populations*. Oxford: Oxford University Press.
- Cheney, B., Thompson, P.M., Ingram, S.N., Hammond, P.S., Stevick, P.T., Durban, J.W., Culloch, R.M., Elwen, S.H., Mandelberg, L., Janik, V.M., Quick, N.J., Islas-Villanueva, V., Robinson, K.P., Costa, M., Eisfeld, S.M., Walters, A., Phillips, C., Weir, C.R., Evans, P.G.H., Anderwald, P., Reid, R.J., Reid, J.B., and Wilson, B., (2013). Integrating multiple data sources to assess the distribution and abundance of bottlenose dolphins *Tursiops truncatus* in Scottish waters. *Mammal Review*, 43 (1), 71–88.
- Embling, C., Gillibrand, P.A., Gordon, J., Shrimpton, J., Stevick, P.T., and Hammond, P.S., (2010) Using habitat models to identify suitable sites for marine protected areas for harbour porpoises (*Phocoena phocoena*). *Biological Conservation*, 143 (2), 267–279.
- Embling, C.B., (2007). *Predictive models of cetacean distributions off the west coast of Scotland*. PhD Thesis, University of St Andrews, UK.
- Evans, P.G.H. and Hammond, P.S., (2004). Monitoring cetaceans in European waters. *Mammal Review*, 34 (1), 131–156.
- Findlay, C.R., Ripple, H.D., Coomber, F., Froud, K., Harries, O., van Geel, N.C.F., Calderan, S. V., Benjamins, S., Risch, D., and Wilson, B., (2018). Mapping widespread and increasing underwater noise pollution from acoustic deterrent devices. *Marine Pollution Bulletin*, 135, 1042–1050.
- van Geel, N.C.F., (2016). *Predator movements in complex geography: Spatial distribution and temporal occurrence of low-density bottlenose dolphin communities off western Scotland*. PhD Thesis, University of Aberdeen, UK.
- MacLeod, C.D., Bannon, S.M., Pierce, G.J., Schweder, C., Learmonth, J.A., Herman, J.S., and Reid, R.J., (2005). Climate change and the cetacean community of north-west Scotland. *Biological Conservation*, 124, 477–483.
- Makelaninen, P., Esteban, R., Foote, A.D., Kuningas, S., Nielsen, J., Samarra, F.I.P., Simila, T., van Geel, N.C.F., and Vikingsson, G.A., (2014.) A comparison of pigmentation features among North Atlantic killer whale (*Orcinus orca*) populations. *Journal of the Marine Biological Association of the United Kingdom*, 94 (6), 1335–1341.
- Mandelberg, L., (2006). *Bottlenose dolphins of the Hebrides: A summary report of five years of research (2001-2005)*. Hebridean Whale and Dolphin Trust, Tobermory, Scotland.
- Paxton, C.G.M., Scott-Hayward, L.A.S., and Rextad, E., (2014). *Statistical approaches to aid the identification of Marine Protected Areas for minke whale, Risso's dolphin, white-beaked dolphin and basking shark*. Scottish Natural Heritage Commissioned Report No. 594.
- Robinson, K.P., Bamford, C.C.G., Airey, A., Bean, T.S., Bird, C., Haskins, G.N., Sim, T.M.C., and Evans, P.G.H., (2017). Killer whale (*Orcinus orca*) occurrence in the moray firth, Northeast Scotland: Incidental sightings, behavioural observations, and photo-identification. *Aquatic Mammals*, 43 (1), 26–32.
- Shirihai, H., (2006). *Whales, Dolphins and Seals: A field guide to the marine mammals of the world*. A&C Black Publishers Ltd, London.
- Teilmann, J., (2003). Influence of sea state on density estimates of harbour porpoises (*Phocoena phocoena*). *Journal of Cetacean Research and Management*, 5 (1), 85–92.
- Weatherall, P., Marks, K.M., Jakobsson, M., Schmitt, T., Tani, S., Arndt, J.E., Rovere, M., Chayes, D., Ferrini, V., and Wigley, R., (2015). A new digital bathymetric model of the world's oceans. *Earth and Space Science*, 2 (8), 331–345.

Follow us at
HWDT.ORG



Hebridean
Whale &
Dolphin
Trust

Hebridean Whale and Dolphin Trust,
Registered Scottish Charity SC022403, Tobermory, Isle of Mull.



LOTTERY FUNDED