Final Contract Report  
1st January 2011 to 31st December 2017  
(Contract number MB0111)  

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UK Cetacean Strandings Investigation Programme
MB0111 (and CR0364/ME6008) Marine Biodiversity Division, Defra

Information on the UK Cetacean Strandings Investigation Programme can also be found at www.ukstrandings.org. Data summarised in this report was collected in the UK under contract to Defra and the Devolved Governments of Scotland and Wales between 1st January 2011 and 31st December 2017. Data was primarily collected under contract number MB0111 (2011-2017), with additional data collected under contracts CR0364 (2006-2011) and ME6008 (2017-2020).

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www.facebook.com/pages/Cetacean-Strandings-Investigation-Programme-UK-strandings/142706582438320

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Executive Summary

Between 1st January 2011 and 31st December 2017, the UK Cetacean Strandings Investigation Programme (CSIP) received reports of 4896 cetaceans, 97 marine turtles and 21 basking sharks. The largest number of cetacean reports was received in England (n=2363), with smaller numbers in Scotland (n=1616), Wales (n=774), Northern Ireland (n=76), the Isle of Man (n=42) and the Channel Islands (n=25). The most commonly reported UK stranded cetacean species during the period of this report were the harbour porpoise (*Phocoena phocoena*, n=2686) and the short-beaked common dolphin (*Delphinus delphis*, n=860). The total number of cetacean strandings reported to the CSIP during 2011-2017 increased by approximately 15%, relative to the preceding seven-year period (n=4268, 2004-2010). This was largely driven by a recent increase in reported strandings of harbour porpoises in most regions of the UK (primarily on the northwest coast of England and in Scotland) and by a recent increase in reported strandings of short-beaked common dolphins in southwest UK. The potential driver/s of these increases are unclear.

Between 2011 and 2017, 52 stranding events involving two or more individuals (mass stranding events, MSEs) were recorded by the CSIP. Three of these were large scale MSEs involving long-finned pilot whales (*Globicephala melas*), all of which were investigated by the Scottish Marine Animal Stranding Scheme. One of the pilot whale MSEs was potentially driven by a number of factors (a potentially sick individual, the complex topography and high tidal range of the stranding site and spatial and temporal coincidence with underwater disposal of unexploded ordnance), one was possibly driven by the live stranding of an adult female with evidence of dystocia and one event remained unexplained. An unusual mortality event of Cuvier’s beaked whales (*Ziphius cavirostris*) occurred in Scotland in 2014/15 and an unusual mortality event involving sperm whales (*Physeter macrocephalus*) occurred in the southern North Sea in 2016.

During this period, 1006 post-mortem examinations of 18 cetacean species (primarily harbour porpoises and common dolphins) were conducted. The principal causes of death in 537 UK-stranded harbour porpoises examined at post mortem between 2011 and 2017 were infectious disease (n=127, primarily pneumonias due to combinations of parasitic, bacterial and fungal infections), starvation (n=112, 37 of which were starved neonates), attack from bottlenose dolphins (*Tursiops truncatus*) (n=85, two of which were witnessed attacks) and entanglement in fishing gear (by-catch) (n=77, seven of which were known bycatches). The principal causes of death in 191 common dolphins examined at post-mortem during the same period were by-catch (n=43, one of which was a known by-catch), infectious disease (n=43) and live stranding (n=40). In addition, 22 post-mortem examinations of UK stranded marine turtles and two post-mortem examinations of UK stranded basking sharks were also conducted by the CSIP during 2011-2017.

Analysis of post-mortem examinations conducted between 1991 and 2017 (n=3744, excludes known bycaught individuals) indicates that bycatch was the most common direct anthropogenic cause of mortality in UK stranded cetaceans (n=710). Other direct anthropogenic causes of death included ship-strike (n=39) and entanglement (n=28). Bycatch was most commonly diagnosed in UK stranded harbour porpoises (n=362) and short-beaked common dolphins (n=317). Diagnosis of bycatch was most common in England (primarily in the southwest), highest rates of entanglement occurred in Scotland and highest rates of ship-strike occurred in England. The proportion of diagnosed cases of bycatch in UK stranded short-beaked common dolphins examined at post-mortem appeared to decline over the contract period, concomitant with a relative increase in the diagnosis of infectious disease mortality. A relative increase in the proportion of starvation cases was also noted in harbour porpoises examined at post-mortem over the latter half of
the projects length. Low rates of marine debris ingestion (macro-debris) have been recorded in stranded cetaceans examined by the CSIP since its inception. Only one case of potentially fatal ingestion of marine debris has been recorded by the CSIP during this period and occurred in a Cuvier’s beaked whale found stranded in Scotland.

Time trends in a range of persistent organic pollutants (POPs) in UK-stranded harbour porpoises analysed by the Centre for Environment, Fisheries and Aquaculture Science (CEFAS) showed that since the 1990’s, with the marked exception of polychlorinated biphenyls (PCBs), most legacy POPs (e.g. DDTs) were either declining or occurred at tissue concentrations not thought to pose a significant health risk. However, PCBs were both stable over time and still occurred at moderately high levels in UK stranded harbour porpoises. The greatest risk from PCBs occurred in long-lived cetacean species at the apex of the food chain, specifically killer whales (Orcinus orca) and bottlenose dolphins in UK and other parts of Europe, which had the highest blubber PCB concentrations and associated toxicity risk. Severe population level impacts of PCBs in killer whales, including low or zero rates of female fecundity, have both been observed and recently predicted in the UK and other European killer whale populations. At a UK/EU policy level, renewed efforts are urgently required in the UK and across Europe to limit cetacean PCB exposure via marine food webs.

Between 2011 and 2017, 87 peer-reviewed scientific papers covering a wide range of research themes were published using data generated by the CSIP and samples held in the national tissue archive. In addition, 41 reports to government and other funders were also produced by the CSIP. The CSIP was also involved in a broad range of education and outreach events over the last seven-year period, including a large variety of demonstration necropsies, public meetings to discuss the impacts of contaminants on killer whales and other topics and a series of online and public facing demonstration necropsies (‘CSI of the Sea’).

Strandings research is by its nature inherently opportunistic. But the great strength of the UK strandings programme is its longevity, enabling it to deliver an increasing amount of collaborative science, which has wide policy relevance and helps shed light on marine species that are often difficult to study through other avenues. The research of the Defra and Devolved Government funded CSIP continues to improve our knowledge of cetaceans, informs the public about the drivers of stranding events and the wider requirement for cetacean conservation and helps to inform and shape policy decisions at a national and international level.

Key Events and Milestones (2011-2017)

- Over the seven-year period 2011-2017, 4896 cetaceans, 97 marine turtles and 21 basking sharks were reported to the CSIP. Total cetacean stranding numbers reported to the CSIP since the project began in 1990 now exceed 15300 (as of May 2017). At least twenty-one species of cetacean were recorded stranded during the 2011-2017 period, with two new additions to the regions fauna list (dwarf sperm whale and olive ridley turtle).
- The largest number of cetacean reports was received in England (n=2363), with smaller numbers in Scotland (n=1616), Wales (n=774), Northern Ireland (n=76), the Isle of Man (n=42) and the Channel Islands (n=25). The total number of strandings reported during 2011-2017 increased by approximately 15%, relative to the preceding seven-year period (n=4268, 2004-2010).
• The largest number of annual cetacean strandings recorded by the CSIP since its inception in 1990 occurred in 2016 (n=852) and 2017 (n=1011)

• During the period of this report, 1006 post-mortem examinations of 18 cetacean species (primarily harbour porpoises and common dolphins) were conducted. The principal causes of death in 537 UK-stranded harbour porpoises examined at post mortem between 2011 and 2017 were infectious disease (n=127), starvation (n=112, 37 of which were starved neonates), attack from bottlenose dolphins (n=85), and entanglement in fishing gear (by-catch) (n=77). The principal causes of death in 191 common dolphins examined at post-mortem during the same period were by-catch (n=43), infectious disease (n=43) and live stranding (n=40).

• In addition, 22 post-mortem examinations of UK stranded marine turtles and two post-mortem examinations of UK stranded basking sharks were also conducted by the CSIP during 2011-2017.

• Anthropogenic drivers of mortality investigated by the CSIP since its inception in 1990 have included by-catch/entanglement, disease related mortality driven by exposure to contaminants, mass stranding events associated with anthropogenic noise, ship strike and marine debris impacts.

• Other significant causes of mortality since 1990 have included interspecific and intraspecific aggression, starvation and live stranding. During the period of this report, grey seal predation was also revealed as a potentially significant cause of mortality in marine mammals across Europe.

• During this period, annual and quarterly reports have been submitted to the Department, acting as staged project milestones. Additional ad hoc reports have been submitted in response to specific direct requests for ministerial or departmental purposes and parliamentary questions.

• Between 2011 and 2017, 87 peer-reviewed scientific papers were published using data generated by the CSIP and samples held in the national tissue archive (Appendix 1). A range of research themes was covered, including toxicology, pathology, theoretical biology, anatomy and dietary studies as well as the potential impacts of anthropogenic noise on cetaceans. Since the inception of the CSIP in 1990, nearly 240 peer-reviewed publications have been produced1.

• During the period of this report, several peer-reviewed publications linked moderate-high blubber PCB concentrations with reproductive impairment in harbour porpoises (Murphy et al. 2015), bottlenose dolphins and killer whales (Jepson et al. 2016). These were associated with long-term population declines, contractions of range and low rates of reproduction in bottlenose dolphins and killer whales in the UK and across Europe. Additional more policy-focussed publications on the risk of PCB exposure to cetaceans in UK/Europe were also published (Jepson and Law 2016; Law and Jepson 2017; Stuart-Smith and Jepson 2017).

• Forty-one reports were also produced by the CSIP during this period and numerous presentations were given at conferences and at a wide variety of meetings.

• The CSIP conducted a broad range of education and outreach events during the last seven-year period, including a series of successful public facing post-mortem to highlight the role of strandings research in the UK (CSI of the Sea™). Several public facing meetings were also held, including Zoological Society of London Science and Conservation meetings on the PCB risk to killer whales in 20162 and one in 2016 to mark the 25th anniversary of the inception of the CSIP4.

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1 See [http://ukstrandings.org/CSIP_scientific_publications.pdf](http://ukstrandings.org/CSIP_scientific_publications.pdf)
2 [www.zsl.org/science/whats-on/csi-of-the-sea](http://www.zsl.org/science/whats-on/csi-of-the-sea), [www.youtube.com/watch?v=jX4t07BgxBY](http://www.youtube.com/watch?v=jX4t07BgxBY)
4 [https://www.zsl.org/science/whats-on/investigating-strandings-around-the-uk-coast-for-25-years-csip-anniversary-meeting](https://www.zsl.org/science/whats-on/investigating-strandings-around-the-uk-coast-for-25-years-csip-anniversary-meeting)
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2 Introduction

This report is based on research conducted under contract (primarily MB0111\(^5\), but also under CR0364\(^6\) and ME6008\(^7\)) to the Department for Environment, Food and Rural Affairs (Defra) between 1\(^{st}\) January 2011 and 31\(^{st}\) December 2017. The Institute of Zoology\(^8\) (IoZ), Scotland’s Rural College (SRUC), Natural History Museum (NHM), Marine Environmental Monitoring (MEM) and the Cornwall Wildlife Trust Marine Strandings Network/University of Exeter are responsible for the delivery of this contract.

2.1 CSIP history and background

For centuries, cetaceans (whales, dolphins and porpoises) have regularly stranded around the coasts of the UK. But the underlying drivers of these events have not always been clear and in particular, the potential role of human activity in either directly or indirectly causing them has historically been poorly understood.

In 1913, the Natural History Museum began to routinely collect data on stranded cetaceans, primarily in an effort to collect skeletal material for the museum’s collections. This dataset was one of the earliest efforts to collate data on strandings and remains a unique resource.

In 1988, an outbreak of phocine distemper virus (PDV) occurred in European seal populations, leading to the deaths of many thousands in the UK and around Europe. In response, the then Department of Environment initiated a programme in England and Wales in September 1990, which aimed to investigate causes of death in stranded marine mammals to try to establish baselines for drivers of mortality. A similar programme was initiated in Scotland in 1992 and the two programmes were amalgamated in 2000, to create what is now known as the UK Cetacean Strandings Investigation Programme (CSIP. www.ukstrandings.org). The CSIP is currently funded by Defra, Scottish Government and Welsh Government (see Section 2.4).

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\(^5\) Contract MB0111 ran from 1\(^{st}\) April 2011 to 15\(^{th}\) October 2017.

\(^6\) Contract CR0364 ran from 1\(^{st}\) April 2006 to 31\(^{st}\) March 2011

\(^7\) Contract ME6008 began on 16\(^{th}\) October 2017.

\(^8\) Main Contractor responsible for the delivery of MB0111
2.2 Project Aims

Contract number MB0111 ran from 1\textsuperscript{st} April 2011 through to 15\textsuperscript{th} October 2017. The contract objectives were to;

- collate, analyse and report data for all cetacean strandings around the coast of the UK
- determine the major causes of death in stranded cetaceans, including by-catch and physical trauma, in order to identify any substantial new threats to their conservation status
- undertake surveillance on the incidence of disease in stranded cetaceans in order to identify any substantial new threats to their conservation status
- investigate the potential interaction between feeding behaviour, fisheries and stranded cetaceans through examination of the contents of the stomach; to also record any evidence of ‘litter’
- maintain the CSIP database which brings together accurate and geo-referenced data on both strandings and post mortem data, which then allows end users to interrogate this data using the Internet.
- make information on strandings and post-mortems results available to the Department and Devolved Administrations quarterly and publicly available by annual reports.
- improve and maintain relationships with existing regional volunteer networks and local authorities.

2.3 Policy Objectives

The data generated from this programme helps to ensure that the UK complies with and contributes to a number of national and international directives and agreements, including the Habitats Directive, Marine Strategy Framework Directive (MSFD), the Agreement on the Conservation of Small Cetaceans in the Baltic, North East Atlantic, Irish and North Seas (ASCOBANS), the Convention for Migratory Species, the International Whaling Commission and the Stockholm Convention. The data generated by the CSIP also facilitates informed management decisions to maintain or restore favourable conservation status in threatened species, through the investigation of important causes of death such as accidental entrapment in commercial fishing gear (by-catch).

Stranded individuals provide a sample of the living population and a method of surveillance for the incidence of disease and causes of death to enable compliance with the agreements listed above. There remains further potential to use these data as an indicator to assess population management objectives, as well as metrics of wider marine ecosystem conservation. The collation of stranding data allows analysis of historical trends and patterns, providing a means to define a baseline for stranding rates, as well as biological and ecological metrics of the stranded population such as cause of death, nutritional condition, disease burden, diet, life history and environmental contaminant levels, which are largely impossible to determine through other means. This can reveal vital clues about the processes that generated these data and assist in identifying change, pressures and threats- both in terms of acute impacts and long-term loss of population viability.

The very longstanding collaboration between the CSIP and the Centre for Environment, Fisheries and Aquaculture Science (CEFAS) has produced one of the largest datasets in the world on chemical contaminants in a marine mammal species- the harbour porpoise. This long-term dataset also has the power to be able to demonstrate the relative success of policy decisions in the regulation or banning of such chemicals. In many cases, these UK
harbour porpoise data show that the EU bans or other forms of regulation for many POPs like DDTs, dieldrin, brominated flame retardants and butylins have been very successful – at least for reducing harmful exposures of many of these chemicals regulated under the Stockholm Convention and other Conventions.

2.4 Project consortium structure

The current organisational structure of the CSIP and the responsibilities of each organisation are given below in Figure 1. A Project Steering Group (PSG) consisting of representatives of UK government, Joint Nature Conservation Committee (JNCC; managers of the current contract) and a variety of other stakeholders, monitors progress and provides guidance on the objectives and outputs of the CSIP.

![Organisational structure of the CSIP](image)

**Figure 1** Organisational structure of the CSIP

*NB* SG- Scottish Government, WG- Welsh Government, JNCC- Joint Nature Conservation Committee
3 Materials and methods

3.1 Reporting and collection of strandings

Strandings are recorded by the CSIP when ‘an animal swims, is left by a receding tide or is deposited onto land (beach, mudflats, sandbank etc) dead or alive’. Live animals that are prevented from stranding by human interaction from the shore, but would clearly have otherwise stranded without such intervention, may also be included. In addition, the CSIP also continues to record information on the small number of dead cetaceans that are found floating at sea in and around UK territorial waters. The CSIP collates data on strandings reported in the UK and also collects additional stranding data reported on an ad hoc basis in the Isle of Man and the Channel Islands.

Figure 2 shows an outline process for the reporting of strandings in the UK, covering liaison with appropriate local authorities (primarily the Receiver of Wreck/Maritime and Coastguard Agency and local authorities) and the project steering group, along with information on post-mortem investigations and dissemination of results by the CSIP.

Stranded carcasses were assessed and decisions taken on potential recovery based on the decomposition code, accessibility and staff/project logistics in place at the time. The recovery of carcasses was undertaken across the UK under appropriate Habitats Directive national licensing (e.g. Natural England license for use in England⁹). Recoveries can sometimes prove to be drawn out and difficult processes and may involve multiple agencies, landowners and assistance from volunteer groups and members of public (e.g. Plates 3-6. Also see this link for an example of a recovery in Cornwall in 2017¹⁰). Under the terms of the contract for MB0111, funding was provided for approximately 100 post-mortem examinations/year. Funding for additional post-mortems in Scotland was provided to SRUC by Marine Scotland (e.g. Brownlow et al. 2018). CSIP annual reports contain additional details on carcass selection criteria (e.g. Deaville et al. 2018b).

In England (excluding Cornwall), the reporting, retrieval and transportation of stranded animals is co-ordinated by NHM, with IoZ providing assistance where appropriate. In Cornwall, the Cornwall Wildlife Trust Marine Strandings Network (www.cwtstrandings.org/index.html) co-ordinate stranding reporting, retrieval and transportation to the University of Exeter, Penryn campus (UoE, www.exeter.ac.uk/cornwall/) for post-mortem investigation. Strandings data collected by CWTMSN is made available to the CSIP for inclusion in the central UK database and also in the CSIP national reports. The CSIP also has a regional collaboration in the northeast of England with Dr Per Berggren at the University of Newcastle (www.ncl.ac.uk), whereby appropriate strandings are retrieved and held frozen prior to retrieval for post-mortem examination by the CSIP.

In Scotland, the reporting, retrieval and transportation of stranded animals is co-ordinated by SRUC. In Wales, the reporting, retrieval and transportation of stranded animals is co-ordinated by MEM. Stranding reports are verified wherever possible through the use of digital photographs taken on the beach. In Wales and Scotland, dedicated email addresses and mobile numbers for the provision of camera phone pictures have also been established. In addition, in Scotland SRUC run a network of trained volunteers that help with the identification, recovery, storage and transport of stranded animals¹¹.

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¹⁰https://www.youtube.com/watch?v=350IGUbEXe4
¹¹http://www.strandings.org/smass/about/volunteer/
The decision about whether to subject a carcass to post-mortem is based on the state of decomposition and whether it can be secured safely prior to collection and transportation to a laboratory for post-mortem examination. The relevant public health considerations of handling stranded cetacean carcasses are stressed to those individuals and organisations that are involved with the day-to-day reporting and recovery of stranded carcasses.

Data on strandings in Northern Ireland was collected by the Department of Agriculture, Environment and Rural Affairs (Northern Ireland Government) (DAERA, www.daera-ni.gov.uk/). Data on strandings in the Isle of Man were provided by Department of the Environment, Food and Agriculture (Isle of Man Government, www.gov.im/daff/Wildlife/species/marine.xml).

Appendix 2 gives details of the reporting mechanism for strandings of cetaceans, marine turtles, basking sharks and seals in the UK (both alive and dead).
Figure 2 Outline of strandings reporting and post-mortem examinations in the UK by the CSIP consortium. Blue highlighted sections denote CSIP actions.
3.2 Post mortem examinations

Carcasses were routinely transported to one of four pathology laboratories in the UK:

- Institute of Zoology (Zoological Society of London), Regent’s Park, London, NW1 4RY
- Scotland’s Rural College (Disease Surveillance Centre), Drummondhill, Stratherrick Road, Inverness, Scotland, IV2 4JZ
- University of Exeter, Penryn Campus, Truro, Cornwall, TR10 9EZ
- Agri-Food and Biosciences Institute, 18a Newforge Ln, Belfast BT9 5PX

(NB post-mortem carried out at the latter if conducted under contract to DAERA Marine and Fisheries Division and data is made available for inclusion within CSIP reporting).

In cases where carcasses were too large or too difficult to retrieve, post-mortem investigations were conducted in situ at the stranding site. All cetacean post-mortem investigations (and associated tissue sampling) were conducted using standard procedures (Kuiken and Garcia Hartmann 1991, Deaville and Jepson et al., 2011). Appendix 4 gives information on the cetacean post-mortem protocol employed by the CSIP during the contract period. Marine turtle post-mortem investigations and tissue sampling were also conducted using standard procedures (Work 2000 and Wyneken 2001) and basking shark strandings were investigated opportunistically. Essentially, organs were systematically examined and routine tissue samples were collected for virological, microbiological, histopathological, toxicological and other studies. Any observed lesions were also sampled for further diagnostic tests, depending on the suspected aetiology.

3.3 Assessment of causes of death

Although it is often not possible to arrive at a definitive cause of death for any individual carcass, a most probable cause of death was ascribed wherever possible based on the collective findings from post-mortem and other diagnostic investigations. Oversight of the allocation of causes of death in the UK is conducted by Dr. Paul Jepson (CSIP lead scientist and pathologist). Criteria used to establish selected causes of death are described below.

- **By-catch (entanglement in fishing gear)** was ascribed as a cause of death in cetacean carcasses using established pathological criteria for by-catch diagnosis (Kuiken et al. 1994 and Kuiken 1996)
- **Entanglement** - a cause of death category largely confined to minke whales. Denotes evidence of entanglement in rope (creel etc.) or discarded fishing gear/marine litter
- **Physical trauma (boat/ship strike)** - physical trauma consistent with impact from a boat or ship. Includes blunt trauma to dorsal/lateral aspect of body wall and/or injuries consistent with propeller strike
- **Infectious Disease** - a broad category consisting of a number of causes of death of infectious origin (Jepson 2005, Jepson et al. 2005a)
- **Live Stranding** - attributed as the cause of death in cetaceans that were known or suspected (from post-mortem examination) to have live-stranded in apparent good health and nutritional status. This category excluded severely diseased or emaciated animals that stranded alive (Jepson 2005)
- **Starvation** - given as the cause of death in animals that were severely emaciated and, following post-mortem examination, ascertained to have no other significant disease processes that could explain the poor nutritional status (Jepson 2005)
- **Starvation (neonate)** - given as the cause of death in neonates that were severely emaciated and, following post-mortem examination, ascertained to have no other
significant disease processes that could explain the poor nutritional status. Some of these animals may have become maternally separated

- **Generalised debilitation**- animals with evidence of a declining nutritional plane and with two or more chronic and significant disease processes
- **Fatal attack from one or more bottlenose dolphins**- ascribed as a cause of death in cetacean carcasses using established pathological criteria (Ross & Wilson 1996, Jepson & Baker 1998)
- **Grey seal attack**- ascribed as a cause of death in individuals presenting with pathology potentially consistent with grey seal attack, as recently described (Haelters et al., 2013 and Leopold et al., 2014).
- **Dystocia & Stillborn**- attributed as the cause of death in animals which have died during the act or process of giving birth (mothers or calves)
- **Physical trauma (unknown origin)**- where evidence of physical trauma is found at post-mortem, but no obvious origin or other significant underlying factors. This category is likely to include some undiagnosed cases of boat/ship strike, by-catch or bottlenose dolphin attack.
- **Gas embolism**- intravascular gas bubble formation that obstructs circulation and causes associated tissue injury (Jepson et al. 2003; 2005b)
- **Cold stunned**- a cause of death category specific to hard shelled species of marine turtle, resulting from exposure to cold water around the UK coast, leading to immobility, hypothermia and eventual starvation
- **Neoplasia**- where the cause of death is due to the formation of a tumour
- **Others**- a broad category covering causes of death that cannot be categorised using existing criteria
- **Not Established**- where a cause of death could not be established with any degree of certainty. Frequently a function of decomposition i.e. more decomposed carcasses are harder to assess.

### 3.4 Tissue archival and storage

Tissue specimens collected for research are stored frozen at either -20°C or -80°C and fixed in either 10% neutral buffered formalin or 70% alcohol. Long-term national tissue archives are maintained at both IoZ and SRUC Inverness (with short term storage at UoE) or sent to collaborating institutions for research purposes.

### 3.5 Data collection, storage and dissemination

The CSIP web accessed database ([http://data.ukstrandings.org/](http://data.ukstrandings.org/)) allows the entry of data on UK stranded cetaceans, marine turtles, basking sharks and seals by partners within the CSIP consortium. Strandings data and data collected during post mortem examinations are entered and stored on this integrated database, allowing cross reference with additional data resulting from research on strandings by the CSIP consortium and others (e.g. subsidiary tests and samples). Levels of access have been set such that data can be viewed by those deemed appropriate by the CSIP Project Steering Group (PSG), but data can only be entered/edited by appropriate members of the CSIP consortium.

Data entry and data validation/quality control is performed by the relevant partner organisations in the CSIP consortium. As well as enabling the CSIP consortium to collectively enter and edit data through a single web accessed portal, the database facilitates more efficient and accurate capture of data and allows stakeholders to access data as required. In addition, periodic export of relevant data to the NBN gateway
(www.nbn.org.uk/) takes place, enabling access to strandings and post-mortem data by a much wider audience than at present. Metadata on data generated as a result of this project is displayed on portals such as the Marine Environmental Data and Information Network (MEDIN, http://www.oceannet.org).

The lead CSIP scientist and pathologist Dr Paul Jepson validates causes of death of all stranded animals examined at post-mortem in the UK. Causes of death may be amended and/or altered if new test results are generated or data becomes available, with an audit trail of amendments automatically recorded on the CSIP database.

Marine turtle strandings data in the UK is collated by the UK and Republic of Ireland 'TURTLE' Database Manager (Rod Penrose) under supervision of the Turtle Implementation Group (TIG). Collation of marine turtle strandings and sightings data in UK and RoI is collectively funded by the Welsh Government, Natural England and National Parks and Wildlife Service (RoI).

Quarterly reports were submitted to the PSG during 2017 and acted as project milestones. The CSIP also provided summary reports of strandings and post-mortem data for the annual ASCOBANS national report, as well as the annual IWC national report and any ad hoc requests made during the course of the year by the Department or the Devolved Administrations.

Additional details of the data presented within this report are also available in the annual reports covering the period 2011-2017 (Deaville et al. 2012, Deaville et al. 2013, Deaville et al. 2014, Deaville et al. 2015, Deaville et al. 2016, Deaville et al. 2018a, Deaville et al. 2018b).
4 Stranding overview (2011-2017)

4.1 Cetacean, marine turtle and basking shark strandings around the UK coast (2011-2017)

In the seven-year period between 1st January 2011 and 31st December 2017, 4896 cetaceans were reported to the CSIP, comprising at least 21 species (Table 1). Of these, 4311 were reports of dead-stranded cetaceans, 399 were of live-stranded cetaceans and 186 were of dead cetaceans found at sea (including 21 which were found entangled in netting). Of the 399 live-stranded cetaceans, 132 were returned alive to sea. In addition, 97 marine turtles and 21 basking sharks were also reported to the CSIP during the same period (Table 2).

The most commonly reported UK stranded cetacean species during the period of this report were the harbour porpoise (*Phocoena phocoena*, n=2686) and the short-beaked common dolphin (*Delphinus delphis*, n=860). Another 889 stranded cetaceans were also recorded, comprising long-finned pilot whale (*Globicephala melas*, n=213), minke whale (*Balaenoptera acutorostrata*, n=126), white beaked dolphin (*Lagenorhynchus albirostris*, n=116), striped dolphin (*Stenella coeruleoalba*, n=92), bottlenose dolphin (*Tursiops truncatus*, n=78), Risso’s dolphin (*Grampus griseus*, n=70), sperm whale (*Physeter macrocephalus*, n=45), Atlantic white-sided dolphin (*Lagenorhynchus acutus*, n=38), Sowerby’s beaked whale (*Mesoplodon bidens*, n=27), fin whale (*Balaenoptera physalus*, n=22), Cuvier’s beaked whale (*Ziphius cavirostris*, n=22), killer whale (*Orcinus orca*, n=10), humpback whale (*Megaptera novaeangliae*, n=9), northern bottlenose whale (*Hyperoodon ampullatus*, n=8), pygmy sperm whale (*Kogia breviceps*, n=6), sei whale (*Balaenoptera borealis*, n=4), Blainville’s beaked whale (*Mesoplodon densirostris*, n=1), dwarf sperm whale (*Kogia sima*), n=1) and beluga whale (*Delphinapterus leucas*, n=1). The spatial distribution of these strandings (by species) is given in Table 1 and in Figures 13, 14, 17, 18, 19 and 20. A number of strandings (n=461) were too decomposed, incomplete or inaccessible to enable either accurate identification or retrieval for further investigation at post mortem (Table 1 and Section 5.22).

The largest number of cetacean strandings was reported in England (n=2363), with a smaller number in Scotland (n=1616), Wales (n=774) and Northern Ireland (n=76). In addition, a small number of cetaceans were also reported in the Isle of Man (n=42) and the Channel Islands (n=25).

Figure 3 shows the inter-annual variation in numbers of all cetaceans, harbour porpoises and common dolphins reported to the CSIP between 1990 and 2017 inclusively. Figure 4 shows the number of reported cetacean strandings in UK countries over the ten-year period 2008-2017. The number of reported strandings during the last seven year period (2011-2017) was ~15% higher than the number of reports received during the preceding seven year period (2004-2010, n=4268) (Figures 5-6). There was a general increase in reported strandings over the last two years of this contract period (2016-2017), most markedly observed in England. Analysis of regional stranding records for harbour porpoise, short-beaked common dolphins and other cetacean species (Figures 7-10) indicates that the increase in stranding numbers described above has been largely driven by an increase in reported harbour porpoise strandings in most regions of the UK (predominantly on the West Coast and also in Scotland) and an increase in reported strandings of short-beaked common dolphins in the Southwest, particularly over the last two year period of this report (2016-2017). These two years also represent the highest annual number of strandings recorded by the CSIP since its inception in 1990 (n=852 in 2016 and n=1011 in 2017).
Figure 3 Annual numbers of UK stranded cetaceans (all species), harbour porpoises and common dolphins (1990-2017)

Figure 4 Reported cetacean strandings in England, Scotland, Wales and Northern Ireland (2008-2017) 
NB greyed area outside of report period
Figure 5 Mean annual reported strandings of harbour porpoises and short-beaked common dolphins in the UK over the contract period (2011-2017) and the preceding seven-year period (2004-2010) (+/- 1SD)

Figure 6 Mean annual reported strandings of other cetacean species in the UK over the contract period (2011-2017) and the preceding seven-year period (2004-2010) (+/- 1SD)
### Table 1 Reported strandings of cetaceans (2011-2017)

<table>
<thead>
<tr>
<th>Species</th>
<th>England</th>
<th>Scotland</th>
<th>Wales</th>
<th>Northern Ireland</th>
<th>Isle of Man</th>
<th>Channel Islands</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Harbour porpoise (Phocoena phocoena)</td>
<td>1320</td>
<td>701</td>
<td>583</td>
<td>46</td>
<td>32</td>
<td>4</td>
<td>2686</td>
</tr>
<tr>
<td>Short-beaked common dolphin (Delphinus delphis)</td>
<td>588</td>
<td>160</td>
<td>89</td>
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<td>3</td>
<td>10</td>
<td>860</td>
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<tr>
<td>Long-finned pilot whale (Globicephala melas)</td>
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<td>4</td>
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<td>1</td>
<td>213</td>
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<tr>
<td>Minke whale (Balaenoptera acutorostrata)</td>
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<td>87</td>
<td>2</td>
<td>7</td>
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<td>White beaked dolphin (Lagenorhynchus albirostris)</td>
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<td>0</td>
<td>0</td>
<td>116</td>
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<tr>
<td>Striped dolphin (Stenella coeruleoalba)</td>
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<td>0</td>
<td>92</td>
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<td>Bottlenose dolphin (Tursiops truncatus)</td>
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<td>32</td>
<td>18</td>
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<td>Risso’s dolphin (Grampus griseus)</td>
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<tr>
<td>Sperm whale (Physeter macrocephalus)</td>
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<td>Atlantic white-sided dolphin (Lagenorhynchus acutus)</td>
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<td>0</td>
<td>38</td>
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<tr>
<td>Sowerby’s beaked whale (Mesoplodon bidens)</td>
<td>12</td>
<td>14</td>
<td>1</td>
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<td>0</td>
<td>0</td>
<td>27</td>
</tr>
<tr>
<td>Fin whale (Balaenoptera physalus)</td>
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<td>1</td>
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<tr>
<td>Cuvier’s beaked whale (Ziphius cavirostris)</td>
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<td>0</td>
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<td>0</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>Killer whale (Orcinus orca)</td>
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<td>0</td>
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<td>0</td>
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<td>Humpback whale (Megaptera novaeangliae)</td>
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<td>1</td>
<td>0</td>
<td>0</td>
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<td>Northern bottlenose whale (Hyperoodon ampullatus)</td>
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<td>1</td>
<td>0</td>
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<td>6</td>
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<td>Pygmy sperm whale (Kogia breviceps)</td>
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<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>4</td>
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<tr>
<td>Sei whale (Balaenoptera borealis)</td>
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<td>0</td>
<td>4</td>
</tr>
<tr>
<td>Blainville’s beaked whale (Mesoplodon densirostris)</td>
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<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Dwarf sperm whale (Kogia sima)</td>
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</tr>
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<td>Beluga whale (Delphinapterus leucas)</td>
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<td>0</td>
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<td>Cetacean (indeterminate species)</td>
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<td>133</td>
</tr>
<tr>
<td>Short beaked common/striped dolphin (indeterminate)</td>
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<td>28</td>
<td>22</td>
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<td>0</td>
<td>86</td>
</tr>
<tr>
<td>Baleen whale (indeterminate species)</td>
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<td>23</td>
</tr>
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<td>Odontocete (indeterminate species)</td>
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</tr>
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<td>Lagenorhynchus sp. (indeterminate species)</td>
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<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>Beaked whale (indeterminate species)</td>
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<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td>2363</td>
<td>1616</td>
<td>774</td>
<td>76</td>
<td>42</td>
<td>25</td>
<td>4896</td>
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</table>
### Table 2 Reported strandings of marine turtles, ‘large bodied’ sharks and seals (2011-2017)

<table>
<thead>
<tr>
<th>Species</th>
<th>England</th>
<th>Scotland</th>
<th>Wales</th>
<th>Northern Ireland</th>
<th>Isle of Man</th>
<th>Channel Islands</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Leatherback turtle (Dermochelys coriacea)</td>
<td>18</td>
<td>10</td>
<td>9</td>
<td>1</td>
<td>0</td>
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<td>39</td>
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<tr>
<td>Loggerhead turtle (Caretta caretta)</td>
<td>12</td>
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<td>7</td>
<td>0</td>
<td>3</td>
<td>2</td>
<td>26</td>
</tr>
<tr>
<td>Kemp’s ridley turtle (Lepidochelys kempi)</td>
<td>11</td>
<td>3</td>
<td>9</td>
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<td>24</td>
</tr>
<tr>
<td>Green turtle (Chelonia mydas)</td>
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<td>3</td>
<td>0</td>
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<td>4</td>
</tr>
<tr>
<td>Olive ridley turtle (Lepidochelys olivacea)</td>
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<td>1</td>
<td>0</td>
<td>0</td>
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<td>0</td>
<td>0</td>
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<td>3</td>
</tr>
<tr>
<td>Basking shark (Cetorhinus maximus)</td>
<td>7</td>
<td>12</td>
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<td>Porbeagle shark (Lamna nasus)</td>
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<tr>
<td>Grey seal (Halichoerus grypus)</td>
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<td>1150</td>
<td>583</td>
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<td>0</td>
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</tr>
<tr>
<td>Common seal (Phoca vitulina)</td>
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<td>0</td>
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<td>Hooded seal (Cystophora cristata)</td>
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<td>0</td>
<td>4</td>
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<tr>
<td>Bearded seal (Erignathus barbatus)</td>
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<td>762</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>1063</strong></td>
<td><strong>2163</strong></td>
<td><strong>617</strong></td>
<td><strong>2</strong></td>
<td><strong>3</strong></td>
<td><strong>5</strong></td>
<td><strong>3853</strong></td>
</tr>
</tbody>
</table>

NB although collection of data on UK stranded seals is not a formal part of the CSIP remit, summary data is presented above and in Section 5.25

![Figure 7 UK regions used for analysis of data (from Jepson et al. 2005)](image-url)
Figure 8 Inter annual variation in UK regional strandings of harbour porpoises (2008-2017)
NB greyed area outside of report period

Figure 9 Inter annual variation in UK regional strandings of short-beaked common dolphins (2008-2017)
NB greyed area outside of report period
**Figure 10** Inter annual variation in UK regional strandings of cetacean species other than harbour porpoises and common dolphins (2008-2017)

NB greyed area outside of report period. Peaks in 2011, 2012 and 2015 were in part driven by long finned pilot whale mass stranding events that occurred in these years (see below)

**Figure 11** Inter annual variation in UK regional strandings of cetacean species of indeterminate identity (2008-2017)

NB greyed area outside of report period
4.2 Mass stranding events and unusual mortality events (2011-2017)

Cetacean mass stranding events (MSEs) are commonly defined as ‘two or more cetaceans (excluding a cow-calf pair) of the same species coming ashore, usually alive, at the same time and place’ (Geraci and Lounsbury 2005). They elicit much interest from both the public and scientific community but the underlying reasons of such events often remain a mystery. Thorough investigation of these events usually requires the consideration of a wide number of potential natural and anthropogenic factors and in many cases is a process of diagnosis by exclusion.

Between 2011 and 2017, 52 stranding events involving two or more individuals (mass stranding events or MSEs) were recorded by the CSIP (Table 3). During 2011, 2012 and 2015 three MSEs of long-finned pilot whales (Globicephala melas) all resulted in large-scale mortalities. All these events occurred in Scotland and were the first significant long-finned pilot whale mortality events recorded in the UK since the inception of the strandings programme in 1990. All were forensically investigated, to try to establish any potential causal or contributory factors for these events. The investigations were coordinated by the Scottish Marine Animal Stranding Scheme (SMASS, www.strandings.org/) and undertaken using funding allocated by Marine Scotland and Defra.

Table 3 Mass stranding events in the UK (2011-2017)

<table>
<thead>
<tr>
<th>Species</th>
<th>Total number of MSEs</th>
<th>Animals involved (Range)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Long-finned pilot whale</td>
<td>6</td>
<td>2 – 39</td>
</tr>
<tr>
<td>Short-beaked common dolphin</td>
<td>11</td>
<td>2 – 14</td>
</tr>
<tr>
<td>Harbour porpoise</td>
<td>20</td>
<td>2 – 4</td>
</tr>
<tr>
<td>White-beaked dolphin</td>
<td>5</td>
<td>2 – 3</td>
</tr>
<tr>
<td>Sowerby’s beaked whale</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>Sperm whale</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Striped dolphin</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Minke whale</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Northern bottlenose whale</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Risso’s dolphin</td>
<td>1</td>
<td>2</td>
</tr>
</tbody>
</table>

The first long-finned pilot whale MSE during this period occurred on 22nd July 2011, in the Kyle of Durness, Highland (Plate 7). Over 70 long-finned pilot whales were involved in the MSE, with approximately half the pod live stranding. The efforts of rescue groups led to the refloat of a significant number of the stranded individuals, but 19 individuals died during the event. Sixteen carcases were secured by the investigating team and examined at post-mortem, with extensive follow up investigation. Samples were collected according to standard protocols and investigations into potential trigger factors of the MSE were undertaken. The investigation included detailed pathological examination to quantify overall disease burden and a number of additional diagnostic tests. These included morbillivirus (RT-PCR), quantitative analyses for algal toxins (domoic acid) and heavy metals concentration. Potential external triggers, such as unusual climatic conditions and influences of underwater anthropogenic noise were also investigated. A request was made to the then Department of Energy and Climate Change (now the Department for Business, Energy and Industrial Strategy) and the UK Ministry of Defence (MOD) to establish the temporal-spatial distribution of military and civilian sources of underwater noise preceding the MSE. The investigation concluded that a combination of factors were likely to be responsible for the mass stranding event. These included a potentially sick member of the pod, the complex topography and high tidal range of the estuarine Kyle of Durness and the...
serial detonation of several large underwater unexploded ordnance in the hours leading up to the stranding (Brownlow et al. 2015, Deaville et al. 2012).

The second long-finned pilot whale MSE occurred on Sunday 2nd September 2012, when a group of approximately 35 animals were reported as stranded or attempting to strand on the rocky coastline between Pittenweem and Anstruther, Fife. A large rescue and refloat attempt was launched and ten animals were refloated on the following tide. Twenty-one animals were either found dead by the rescue teams or died during the refloat. The carcasses were recovered to an adjacent field and necropsied by veterinary pathologists and biologists from the SMASS, CSIP, the Sea Mammal Research Unit (SMRU) and Moredun Research Institute (MRI). The proximal cause of death in all cases was live stranding and cases exhibited typical pathology. Gross and histopathological investigation of twenty-one animals did not find any indication of specific disease processes that would account for the stranding, although several animals were in poor general health. Electron microscopy examination of ears from a group of six individuals selected for on the basis of minimum decomposition condition, found evidence of significant pathology at the cochlea apex in one individual (Morrell et al. 2017). Lesions were identified in the outer hair cells that would be compatible with acoustic trauma and could affect hearing in the very low frequencies. The chronicity of this lesion did not define this to be a contributory factor to the stranding, but does serve to suggest at least one of these animals may have been acoustically 'blind' at some frequencies due to historic noise exposure. Assessment of the disease burden indicated many animals in the group were not in optimal health. Whilst this was not severe enough to account for a stranding, it may have had some bearing on the pod’s behaviour and location (Brownlow et al. 2014, Deaville et al. 2013).

The third long-finned pilot whale MSE occurred in Skye, Highland on 2nd June 2015 (Plate 10). Fourteen of the 21 whales that stranded during the event were refloated by members of rescue groups. Post-mortem examinations of the seven dead animals did not reveal any significant underlying pathology, nor did subsequent investigation indicate any abnormal intensity, duration or nature of anthropogenic noise activity in the region. Amongst the examined animals was a heavily pregnant adult female with evidence of dystocia. In the absence of any other significant intrinsic or external factors and the observed behaviour of the pod prior and subsequent to the stranding, it was concluded that social influence of the female attempting to give birth on the rest of the pod was a possible driver for the initial stranding, (Brownlow et al. 2016, Deaville et al. 2016).

A mass stranding of 14 short-beaked common dolphins occurred at Laggan Sands in Mull in July 2014 (Plate 9). Members of public in the area refloated all but two of the stranded individuals. Sampling of the two dead animals indicated that both were healthy and there appeared to be no evidence of underlying disease (Brownlow et al. 2015, Deaville et al. 2015).

An unusual mortality event involved 15 Cuvier’s beaked whales was identified in Scotland, Northern Ireland and Ireland over December 2014-January 2015. Most carcasses were in advanced state of autolysis and hence a cause of death could not be identified in any of the cases. The role of environmental factors such as wind and tide were investigated to establish if there may have been a spatial or temporal focus for the mortalities. There was indication of a reasonably persistent onshore wind prior to this UME, however given the length of time the carcasses had been at sea post mortem no other definitive conclusions could be drawn (Brownlow et al. 2015, Deaville et al. 2015).
Figure 12 Distribution of MSE’s in the UK (2011-2017) comprising fewer than 5 animals (left image) and comprising more than 5 animals (right image)

An unusual mortality event (UME) of sperm whales occurred in the southern North Sea over January-February 2016, with 30 sperm whales stranding in five different countries (Germany, Netherlands, UK, France and Denmark) over a six-week period. The six sperm whale strandings in England were all recorded around the Wash region of the east coast (Plates 11 and 12). Despite being unable to conduct a full field post-mortem in every instance, the findings were considered to be consistent with live stranding of out of habitat individuals, consequential to their presence in an unfamiliar shallow habitat. The wider question of why the sperm whales entered the North Sea in the first instance is still unclear however. Given the many uncertainties around these stranding events (i.e. when did the whales enter the North Sea, how long had they been in the region, where did they originate from) it will prove difficult to definitively ascribe potential causality for the stranding events and it’s entirely possible that the exact reasons for their entry into the North Sea will always remain unclear (Deaville et al. 2018b and IJsseldijk et al. 2018).

No epizootics or significant disease outbreaks were detected by the CSIP during the seven-year period 2011-2017.
Plate 7 Mass stranding of long-finned pilot whales at Durness, Highland in July 2011 (image credit BDMLR)

Plate 8 Mass stranding of long-finned pilot whales at Pittenweem, Fife in September 2012 (credit Sonja Heinrich, SMRU)

Plate 9 Mass stranding of short-beaked common dolphins at Laggan Sands, Mull in 2014 (image credit SWNS)

Plate 10 Mass stranding of long-finned pilot whales at Staffin, Isle of Skye in 2015 (image credit BDMLR)

Plate 11 Stranded sperm whale at Skegness in 2016 (SW2016/29, credit CSIP-ZSL)

Plate 12 Stranded sperm whales at Gibraltar Point in 2016 (SW2016/28.1 and 28.2, credit Lee Swift)

5.1 Harbour porpoise (Phocoena phocoena)

Between 2011 and 2017, 2686 stranded harbour porpoises (662 males, 587 females and 1437 of unknown sex) were reported to the CSIP. Of these, 2520 were reports of dead strandings, 101 were reported as live strandings (of which 22 were returned alive to sea) and 65 were dead cetaceans found at sea (of which nine were found entangled in netting). Of the 2686 reported harbour porpoise strandings, 1320 were reported in England, 701 in Scotland, 583 in Wales, 46 in Northern Ireland, 32 in the Isle of Man and four in the Channel Islands (Table 1 and Figure 13). The figure of 2686 strandings recorded over the seven-year period 2011-2017 was ~12% higher than the number recorded over the preceding seven-year period 2004-2010 (n=2398, data CSIP database and Figure 5). Comparison of mean monthly harbour porpoise strandings over these two periods, indicated a possible increase in early winter strandings over the period 2011-2017, relative to the preceding seven year period (2004-2010) (Figure 15).

Between 2011 and 2017, 537 stranded harbour porpoises were investigated at post mortem (226 were conducted in England, 174 in Scotland, 115 in Wales, 21 in Northern Ireland and one in the Isle of Man- Tables 4, 5, 6, 7 and 8). A cause of death was established in 516 examined individuals, of which 85 died as a result of attack from one or more bottlenose dolphins (two of which were witnessed attacks), 77 died following entanglement in fishing gear (by-catch, seven of which were known by-catch events), 75 from starvation, 53 from parasitic pneumonia, 37 were starved neonates, 33 from physical trauma of unknown origin, 26 as a consequence of live stranding, 26 from generalised bacterial infections, 18 as a result of attack from grey seals, 16 from infections of the gastrointestinal tract, ten as a result of dystocia or stillbirth, ten died as a result of impact by vessels (ship-strike), seven from gastric impactions (primarily with fish bones), five from generalised debilitation, five as a result of meningocencephalitis, four from generalised parasitism, three from generalised mycotic infections, three from parasitic and bacterial pneumonia, three from mycotic pneumonia, two were neonatal deaths, two died from bacterial pneumonia, two from neoplasia, two from pleuritis, two from proliferative/chronic cutaneous ulcers/lesions and associated blood loss, one from parasitic and mycotic pneumonia, one from generalised parasitism and debilitation, one from peritonitis and metritis, one from a vegetative endocarditis and renal abscessation (associated with Salmonella sp.), one from a systemic infection with Candida albicans, one from hepatic parasitism, one from a septic metritis, one from a septic arthritis, one from a chronic pleuritis (associated with Aspergillus fumigatus) and one from an intestinal intussusception (Table 9 and Appendix 5).

5.2 Short-beaked common dolphin (Delphinus delphis)

Between 2011 and 2017, 860 stranded short-beaked common dolphins (305 males, 214 females and 341 of unknown sex) were reported to the CSIP. Of these, 760 were reports of dead strandings, 73 were reported as live strandings (of which 33 were returned alive to sea) and 27 were dead cetaceans found at sea (of which six were found entangled in netting). Of the 860 strandings, 588 were reported in England, 160 in Scotland, 89 in Wales, ten in Northern Ireland, ten in the Channel Islands and three in the Isle of Man (Table 1 and Figure 14). The figure of 860 strandings recorded over the seven-year period 2011-2017 was ~25 % higher than the number recorded over the preceding seven-year period 2004-2010 (n=687, data CSIP database and Figure 5). Comparison of mean monthly short-beaked common dolphin strandings over these two periods, indicated an
increase in summer strandings over the period 2011-2017, relative to the preceding seven year period (2004-2010) (Figure 16).

Between 2011 and 2017, 191 stranded short-beaked common dolphins were investigated at post mortem (134 were conducted in England, 30 in Scotland, 23 in Wales and four in Northern Ireland- Tables 4, 5, 6, 7 and 8). A cause of death was established in 184 examined individuals, of which 43 were diagnosed to have died following entanglement in fishing gear (by-catch, one of which was a known by-catch event), 40 as a consequence of live stranding, 15 from infections of the gastro-intestinal tract, 15 from generalised bacterial infections, 15 from starvation, eight from physical trauma of unknown origin, seven died as a result of impact by vessels (ship-strike), seven died as a result of gastric impaction with fish bones, six as a result of meningencephalitis, four as a result of attack from one or more bottlenose dolphins, three from parasitic pneumonia, two were neonatal deaths, two died as a result of asphyxia following blockage of the larynx/nasal passage by a fish, two died from generalised debilitation, two had spinal deformities (one kyphosis and one scoliosis), two had vegetative endocarditis associated with *Brucella ceti* infections, two had possible hydrocephalus, one was a starved neonate, one died from parasitic and bacterial pneumonia, one from generalised debilitation associated with isolation of *Brucella ceti* in the CNS, one had chronic oropharyngeal and oesophageal ulceration and associated blood and nutritional condition loss (as a possible sequel to bycatch), one had a gastric perforation and associated peritonitis, one had a gastric inversion, one had extensive pulmonary abscesses, one had a skeletal (skull) abnormality and one had a hepatopathy (Table 9 and Appendix 5).
Figure 15 Mean monthly strandings of harbour porpoises over the contract report period (2011-2017) and the preceding seven-year period (2004-2010) (+/- 1SD)

Figure 16 Mean monthly strandings of short-beaked common dolphins over the contract report period (2011-2017) and the preceding seven-year period (2004-2010) (+/- 1SD)
5.3 Long-finned pilot whale (Globicephala melas)

Between 2011 and 2017, 213 stranded long-finned pilot whales (61 females, 42 males and 110 of unknown sex) were reported to the CSIP. Of these, 112 were reported as live strandings (of which 49 were returned alive to sea), 99 were reports of dead strandings and two were dead cetaceans found at sea. Of the 213 strandings, 192 were reported in Scotland, 15 in England, four in Wales, one in Northern Ireland and one in the Channel Islands (Table 1 and Figure 17). The figure of 213 strandings recorded over the seven-year period 2011-2017 was ~166% higher than the number recorded over the preceding seven-year period 2004-2010 (n=80, data CSIP database and Figure 6). This increase was primarily driven by three large-scale mass stranding events of this species that occurred in Scotland during the period of this report and involved 91 individuals (see Section 4.2).

Between 2011 and 2017, 68 stranded long-finned pilot whales were investigated at post mortem (63 were conducted in Scotland, three in England, one in Wales and one in Northern Ireland - Tables 4, 5, 6, 7 and 8). A cause of death was established in all 68 examined individuals, of which 55 were diagnosed to have died as a consequence of live stranding, six as a result of meningoencephalitis, one from a generalised bacterial infection, one from intestinal parasitism, one from a pneumonia of unknown aetiology, one was a starved neonate, one died as a result of attack from one or more bottlenose dolphins, one was a neonatal death and one died as a consequence of live stranding sequential to dystocia (Table 9 and Appendix 5).

5.4 Minke whale (Balaenoptera acutorostrata)

Between 2011 and 2017, 126 stranded minke whales (34 females, 24 males and 68 of unknown sex) were reported to the CSIP. Of these, 87 were reports of dead strandings, 27 were dead cetaceans found at sea (of which three were found entangled in netting) and 12 were reported as live strandings (of which three were returned alive to sea). Of the 126 strandings, 87 were reported in Scotland, 27 in England, seven in Northern Ireland, three in the Isle of Man and two in Wales (Table 1 and Figure 18). The figure of 126 strandings recorded over the seven-year period 2011-2017 was 22% higher than the number recorded over the preceding seven-year period 2004-2010 (n=103, data CSIP database and Figure 6).

Between 2011 and 2017, 23 stranded minke whales were investigated at post mortem (15 were conducted in Scotland, seven in England and one in Wales- Tables 4, 5, 6 and 7). A cause of death was established in 23 examined individuals, of which eight were diagnosed to have died as a result of entanglement (one of which was a known entanglement event), three died as a consequence of live stranding, three from generalised bacterial infections, two as a result of meningoencephalitis, two from infections of the gastro-intestinal tracts, two died as a result of impact by vessels (ship-strike), one from a large abscess associated with Brucella ceti infection (see Plate 47), one from systemic parasitism and one as a result of liver fluke infection (Table 9 and Appendix 5).

5.5 White-beaked dolphin (Lagenorhynchus albirostris)

Between 2011 and 2017, 116 stranded white-beaked dolphins (45 males, 28 females and 43 of unknown sex) were reported to the CSIP. Of these, 98 were reports of dead strandings and 18 were reported as live strandings (of which five were returned alive to sea). Of the 116 strandings, 88 were reported in Scotland, 27 in England and one in Northern Ireland (Table 1 and Figure 17). The figure of 116 strandings recorded over the
seven-year period 2011-2017 was ~41% higher than the number recorded over the preceding seven-year period 2004-2010 (n=82, data CSIP database and Figure 6).

Between 2011 and 2017, 40 stranded white-beaked dolphins were investigated at post mortem (29 were conducted in Scotland and 11 in England- Tables 4, 5 and 6). A cause of death was established in 39 examined individuals, of which 12 died as a consequence of live stranding, six from starvation, four from generalised bacterial infections, four as a result of meningoencephalitis, two from physical trauma of unknown origin, two from bacterial pneumonias, two from parasitic pneumonias, two from gastric impactions with fish bones, one following entanglement in fishing gear (by-catch), one from a pneumonia of unknown aetiology, one was a starved neonate, one from live stranding due to generalised immunosuppression and one from a peritonitis (potentially as a sequel to dystocia) (Table 9 and Appendix 5).

5.6 Striped dolphin (*Stenella coeruleoalba*)

Between 2011 and 2017, 92 stranded striped dolphins (45 males, 24 females and 23 of unknown sex) were reported to the CSIP. Of these, 67 were reports of dead strandings, 24 were reported as live strandings (of which one was returned alive to sea) and one was a dead cetacean found at sea. Of the 92 strandings, 47 were reported in Scotland, 34 in England, ten in Wales and one in the Isle of Man (Table 1 and Figure 17). The figure of 92 strandings recorded over the seven-year period 2011-2017 was ~46% higher than the number recorded over the preceding seven-year period 2004-2010 (n=63, data CSIP database and Figure 6).

Between 2011 and 2017, 41 stranded striped dolphins were investigated at post mortem (19 were conducted in England, 17 in Scotland and five in Wales- Tables 4, 5, 6 and 7). A cause of death was established in all 41 examined individuals, of which 17 died as a result of meningoencephalitis, eight as a consequence of live stranding, four from starvation, three from physical trauma of unknown origin, two as a result of attack from one or more bottlenose dolphins, two from generalised bacterial infections, one from infection of the gastro-intestinal tract, one from a generalised mycotic infection, one from a bacterial pneumonia, one from a parasitic pneumonia and one from a possible hydrocephalus (Table 9 and Appendix 5). Meningoencephalitis associated with *Brucella* sp. infection is a relatively common finding in live stranded striped dolphins in the UK (González et al., 2002; Davison et al., 2009).

5.7 Bottlenose dolphin (*Tursiops truncatus*)

Between 2011 and 2017, 78 stranded bottlenose dolphins (28 males, 16 females and 34 of unknown sex) were reported to the CSIP. Of these, 62 were reports of dead strandings, nine were reported as live strandings (of which two were returned alive to sea) and seven were dead cetaceans found at sea. Of the 78 strandings, 32 were reported in Scotland, 21 in England, 18 in Wales, five in the Channel Islands, one in Northern Ireland and one on the Isle of Man (Table 1 and Figure 17). The figure of 78 strandings recorded over the seven-year period 2011-2017 was ~15% higher than the number recorded over the preceding seven-year period 2004-2010 (n=68, data CSIP database and Figure 6).

Between 2011 and 2017, 23 stranded bottlenose dolphins were investigated at post mortem (12 were conducted in Scotland, seven in Wales and four in England- Tables 4, 5, 6 and 7). A cause of death was established in 18 examined individuals, of which three died as a result of meningoencephalitis, three from generalised bacterial infections, two as a
consequence of live stranding, one following entanglement in fishing gear (by-catch), one from infection of the gastro-intestinal tract, one was a neonatal death, one from starvation, one was a starved neonate, one as a result of attack from one or more bottlenose dolphins, one from physical trauma of unknown origin, one from generalised debilitation, one was an aged animal with potential complications resulting from a generalised bacterial infection and one died as a result of asphyxia following blockage of the larynx/nasal passage by a fish (Table 9 and Appendix 5).

5.8 Risso’s dolphin (*Grampus griseus*)

Between 2011 and 2017, 70 stranded Risso’s dolphins (19 males, 16 females and 35 of unknown sex) were reported to the CSIP. Of these, 61 were reports of dead strandings, five were reported as live strandings (of which two were returned alive to sea) and four were dead cetaceans found at sea. Of the 70 strandings, 44 were reported in Scotland, 15 in England, nine in Wales, one in the Isle of Man and one in the Channel Islands (Table 1 and Figure 17). The figure of 70 strandings recorded over the seven-year period 2011-2017 was 25% higher than the number recorded over the preceding seven-year period 2004-2010 (n=56, data CSIP database and Figure 6).

Between 2011 and 2017, 15 stranded Risso’s dolphins were investigated at post mortem (ten were conducted in Scotland, three in England and two in Wales- Tables 4, 5, 6 and 7). A cause of death was established in 14 examined individuals, of which four died as a result of meningoencephalitis, two as a consequence of live stranding, two from infections of the gastro-intestinal tract, two were neonatal deaths, one died as a result of impact by vessels (ship-strike), one from physical trauma of unknown origin, one from a peritonitis and one from a spinal deformity (Table 9 and Appendix 5).

5.9 Sperm whale (*Physeter macrocephalus*)

Between 2011 and 2017, 45 stranded sperm whales (31 males, one female and 13 of unknown sex) were reported to the CSIP. Of these, 32 were reports of dead strandings, seven were dead cetaceans found at sea and six were reported as live strandings (none of which were returned alive to sea). Of the 45 strandings, 31 were reported in Scotland, 13 in England and one in the Channel Islands (Table 1 and Figure 20). The figure of 45 strandings recorded over the seven-year period 2011-2017 was ~36% higher than the number recorded over the preceding seven-year period 2004-2010 (n=33, data CSIP database and Figure 6). In 2016, the first ever confirmed female sperm whale was recorded stranded in the UK at Perranporth in Cornwall (Plate 21 and Deaville *et al.* 2018a).

Between 2011 and 2017, 13 stranded sperm whales were investigated at post mortem (nine were conducted in England and four in Scotland- Tables 4, 5 and 6). A cause of death was established in all 13 examined individuals, of which nine died as a consequence of live stranding, two from starvation, one as a result of impact by vessels (ship-strike) and one as a result of entanglement (Table 9 and Appendix 5).
Between 2011 and 2017, 38 stranded Atlantic white-sided dolphins (16 males, four females and 18 of unknown sex) were reported to the CSIP. Of these, 30 were reports of dead strandings and eight were reported as live strandings (of which three were returned alive to sea). Of the 38 strandings, 36 were reported in Scotland and two in England (Table 1 and Figure 17). The figure of 38 strandings recorded over the seven-year period 2011-2017 was ∼60% lower than the number recorded over the preceding seven-year period 2004-2010 (n=94, data CSIP database and Figure 6).

Between 2011 and 2017, nine Atlantic white-sided dolphins found stranded in Scotland were investigated at post mortem (Tables 4 and 6). A cause of death was established in eight examined individuals, of which two died as a consequence of live stranding, two as a result of meningoencephalitis, two from starvation, one from a generalised bacterial infection and one from impaired feeding as a result of a fused atlanto-occipital joint (Table 9 and Appendix 5).
sea). Of the 27 strandings, 14 were reported in Scotland, 12 in Scotland and one in Wales (Table 1 and Figure 19). The figure of 27 strandings recorded over the seven-year period 2011-2017 was ~17% higher than the number recorded over the preceding seven-year period 2004-2010 (n=23, data CSIP database and Figure 6).

Between 2011 and 2017, 13 stranded Sowerby’s beaked whales were investigated at post mortem (eight were conducted in Scotland, four in England and one in Wales- Tables 4, 5, 6 and 7). A cause of death was established in 12 examined individuals, of which seven died as a consequence of live stranding, three as a result of meningoencephalitis, one as a result of impact by vessels (ship-strike) and one from an infection of the gastro-intestinal tract (Table 9 and Appendix 5).

5.12 Fin whale (Balaenoptera physalus)

Between 2011 and 2017, 22 stranded fin whales (nine females, seven males and six of unknown sex) were reported to the CSIP. Of these, ten were reports of dead strandings, seven were reported as live strandings (of which one was returned alive to sea) and five were dead cetaceans found at sea. Of the 22 strandings, 15 were reported in England, five in Scotland, one in Wales and one in Northern Ireland (Table 1 and Figure 18). The figure of 22 strandings recorded over the seven-year period 2011-2017 was 22% higher than the number recorded over the preceding seven-year period 2004-2010 (n=18, data CSIP database and Figure 6).

Between 2011 and 2017, eight stranded fin whales were investigated at post mortem (four were conducted in England, three in Scotland and one in Northern Ireland- Tables 4, 5, 6 and 8). A cause of death was established in seven examined individuals, of which two died as a result of impact by vessels (ship-strike), two from starvation, one as a consequence of live stranding, one as a result of meningoencephalitis (due to morbillivirus infection) and one from heavy intestinal and renal parasitism (Table 9 and Appendix 5).

5.13 Cuvier’s beaked whale (Ziphius cavirostris)

Between 2011 and 2017, 22 stranded Cuvier’s beaked whales (six males, four females and 12 of unknown sex) were reported to the CSIP. Of these, 21 were reports of dead strandings and one was reported as a live stranding (which could not be returned alive to sea). Of the 22 strandings, 19 were reported in Scotland, two in England and one in Northern Ireland (Table 1 and Figure 19). The figure of 22 strandings recorded over the seven-year period 2011-2017 was ~15% lower than the number recorded over the preceding seven-year period 2004-2010 (n=26, data CSIP database and Figure 6).

Between 2011 and 2017, three stranded Cuvier’s beaked whales were investigated at post mortem (two were conducted in Scotland and one in England- Tables 4, 5 and 6). A cause of death was established in all three examined individuals, of which one died as a consequence of live stranding, one as a result of impact by vessels (ship-strike) and one from a gastric impaction with marine debris and generalised gastritis/enteritis and nephritis (see Appendix 3) (Table 9 and Appendix 5).

5.14 Killer whale (Orcinus orca)

Between 2011 and 2017, ten stranded killer whales (four females, three males and three of unknown sex) were reported to the CSIP. Of these, nine were reports of dead strandings
and one was reported as a live stranding (which could not be returned alive to sea). All ten strandings were reported in Scotland (Table 1 and Figure 17). The figure of ten strandings recorded over the seven-year period 2011-2017 was 150% higher than the number recorded over the preceding seven-year period 2004-2010 (n=4, data CSIP database and Figure 6).

Between 2011 and 2017, six killer whales found stranded in Scotland were investigated at post mortem (Tables 4 and 6). A cause of death was established in five examined individuals, of which one died as a result of entanglement (Plate 26), one as a consequence of live stranding, one from starvation, one from a pneumonia of unknown aetiology and one from dystocia and associated peritonitis (Table 9 and Appendix 5).

5.15 Humpback whale (*Megaptera novaeangliae*)

Between 2011 and 2017, nine stranded humpback whales (three males, two females and four of unknown sex) were reported to the CSIP. Of these, four were reports of dead strandings and five were dead cetaceans found at sea (of which two were found entangled in netting). Of the nine strandings, seven were reported in Scotland and two in England (Table 1 and Figure 18). The figure of nine strandings recorded over the seven-year period 2011-2017 was 25% lower than the number recorded over the preceding seven-year period 2004-2010 (n=12, data CSIP database and Figure 6).

Between 2011 and 2017, three stranded humpback whales were investigated at post mortem (two were conducted in Scotland and one in England- Tables 4, 5 and 6). A cause of death was established in two examined individuals, both of which were diagnosed to have died as a result of entanglement (one of which was a known entanglement event) (Table 9 and Appendix 5).

5.16 Northern bottlenose whale (*Hyperoodon ampullatus*)

Between 2011 and 2017, eight stranded northern bottlenose whales (three males, one female and four of unknown sex) were reported to the CSIP. Of these, seven were reports of dead strandings and one was a dead cetacean found at sea. Of the eight strandings, seven were reported in Scotland and one in Wales (Table 1 and Figure 19). The figure of eight strandings recorded over the seven-year period 2011-2017 was ~67% lower than the number recorded over the preceding seven-year period 2004-2010 (n=24, data CSIP database and Figure 6).

Between 2011 and 2017, four Northern bottlenose whales found stranded in Scotland were investigated at post mortem (Tables 4 and 6). A cause of death was established in three examined individuals, of which two died as a consequence of live stranding and one as a result of entanglement (Table 9 and Appendix 5).

5.17 Pygmy sperm whale (*Kogia breviceps*)

Between 2011 and 2017, six stranded pygmy sperm whales (four males, one female and one of unknown sex) were reported to the CSIP. Of these, four were reports of dead strandings and two were reported as live strandings (neither of which were returned alive to sea). Of the six strandings, four were reported in Scotland, one in England and one in Wales (Table 1 and Figure 20). The figure of six strandings recorded over the seven-year...
period 2011-2017 was 500% higher than the number recorded over the preceding seven-year period 2004-2010 (n=1, data CSIP database and Figure 6).

Between 2011 and 2017, five stranded pygmy sperm whales were investigated at post mortem (three were conducted in Scotland, one in England and one in Wales- Tables 4, 5, 6 and 7). A cause of death was established in all five examined individuals, of which four died as a consequence of live stranding and one from a generalised bacterial infection (Table 9 and Appendix 5).

5.18 Sei whale (*Balaenoptera borealis*)

Between 2011 and 2017, four stranded sei whales (three females and one male) were reported to the CSIP. Of these, three were reported as live strandings (none of which were returned alive to sea) and one was a report of a dead stranding. Of the four strandings, two were reported in England, one in Scotland and one in Northern Ireland (Table 1 and Figure 18). No sei whales were recorded by the CSIP during the preceding seven-year period 2004-2010 (data CSIP database and Figure 6).

Between 2011 and 2017, all four stranded sei whales were investigated at post mortem (two were conducted in England, one in Scotland and one in Northern Ireland - Tables 4, 5, 6 and 8). A cause of death was established in three examined individuals, of which two died as a consequence of live stranding and one from parasitic gastroenteritis and debilitation (Table 9 and Appendix 5).

5.19 Blainville’s beaked whale (*Mesoplodon densirostris*)

Between 2011 and 2017, a single male Blainville’s beaked whale, found dead stranded in England, was reported to the CSIP (Table 1 and Figure 19). No Blainville’s beaked whales were recorded by the CSIP during the preceding seven-year period 2004-2010 (data CSIP database and Figure 6). The Blainville’s beaked whale could not be investigated at post mortem due to the autolysed nature of the carcass (Plate 31), but was sampled by volunteers from the Cornwall Wildlife Trust Marine Strandings Network.

5.20 Dwarf sperm whale (*Kogia sima*)

Between 2011 and 2017, a single dwarf sperm whale of unknown sex, found live stranded in England, was reported to the CSIP (Table 1 and Figure 20). The dwarf sperm whale (Plate 32) was returned alive to sea and therefore was not sampled. No dwarf sperm whales were recorded by the CSIP during the preceding seven-year period 2004-2010 (data CSIP database and Figure 6) and this stranding event represents the first recorded stranding of this species in the UK since the Natural History Museum began routine collection of stranding data in 1913 (data courtesy NHM strandings database 1913-1989).

5.21 Beluga whale (*Delphinapterus leucas*)

Between 2011 and 2017, a single stranded beluga whale of indeterminate sex was reported in Scotland (Table 1 and Figure 17). Given the autolysed nature of the carcass, species identification was confirmed by the National Museum of Scotland as a beluga whale through examination of the skull (Plate 33) and comparison with museum specimens.
No beluga whales were recorded by the CSIP during the preceding seven-year period 2004-2010 (data CSIP database and Figure 6). The last beluga whale to be recorded stranded in the UK was found in October 1932 in Stirling, Scotland (data courtesy NHM strandings database 1913-1989).

Figure 19 Distribution of Ziphiidae strandings in the UK (2011-2017)

Figure 20 Distribution of Physeteridae and Kogiidae strandings in the UK (2011-2017)

### 5.22 Indeterminate cetacean species

Once decomposition or scavenging has destroyed identifiable external characteristics, distinguishing between morphologically similar species (such as short-beaked common dolphins and striped dolphins) can be difficult. Consequently, between 2011-2017 there were 461 strandings of cetaceans that were too decomposed, incomplete or inaccessible to enable either accurate identification or retrieval for further investigation at post mortem (Table 1). These consisted of indeterminate cetaceans \((n=186)\), indeterminate dolphin species \((n=133)\), short beaked common dolphins/striped dolphins \((n=86)\), indeterminate baleen whale species \((n=23)\), indeterminate odontocetes \((n=19)\), indeterminate mysticete species \((n=10)\), indeterminate *Lagenorhynchus* species \((n=3)\) and indeterminate beaked whale species \((n=1)\).

The figure of 460 strandings of indeterminate identity cetaceans recorded over the seven-year period 2011-2017 is ~7% lower than the number recorded over the preceding seven-year period 2004-2010 \((n=496)\), data CSIP database).
5.23 Marine turtles

Between 2011 and 2017, 97 marine turtles were reported to Marine Environmental Monitoring (MEM)\(^\text{12}\), the UK and Republic of Ireland co-ordinator for marine turtle strandings (\url{www.strandings.com}). The reports consisted of 39 leatherback turtles (*Dermochelys coriacea*), 26 loggerhead turtles (*Caretta caretta*), 24 Kemp’s ridley turtles (*Lepidochelys kempi*), four green turtles (*Chelonia mydas*), one olive ridley turtle (*Lepidochelys olivacea*) and three unidentified marine turtle species. Of these, 65 were reports of dead strandings (25 leatherback turtles, 18 loggerhead turtles, 17 Kemp’s ridley turtles, four green turtles and one indeterminate identity marine turtle), 16 were reported as live strandings (eight loggerhead turtles, seven Kemp’s ridley turtles and one olive ridley turtle) and 16 were dead turtles found at sea (14 leatherback turtles and two indeterminate identity marine turtles). Of the latter, four leatherback turtles were found entangled in netting. Of the 16 live stranded turtles, seven loggerheads, six Kemp’s ridley turtle and one olive ridley turtle were taken to rehabilitation centres, where eleven subsequently died (seven Kemp’s ridley turtles and four loggerhead turtles). Of the successfully rehabilitated animals, four loggerhead turtles were either flown to the Canaries for release or transported by the Irish Navy further south, where environmental conditions are more appropriate for hardshell species of marine turtle (pers. comm. Marine Environmental Monitoring). The live-stranded olive ridley turtle was the first ever record of this species in the UK and the Republic of Ireland (data ‘TURTLE’ database; records from 1748).

Of the 39 leatherback turtles, 18 were reported in England, ten in Scotland, nine in Wales, one in Northern Ireland and one was reported in the Channel Islands. Of the 26 loggerhead turtles, 12 were reported in England, seven in Wales, three in the Isle of Man, two in Scotland and two in the Channel Islands. Of the four green turtles three were reported in Wales and one in Scotland. Of the 24 Kemp’s ridley turtles, eleven were reported in England, nine in Wales, three in Scotland and one in the Channel Islands. The olive ridley was reported in Wales. Two unidentified marine turtles were reported in England and one in Scotland. (Table 2 and Figure 22).

The figure of 97 marine turtles recorded over the seven-year period 2011-2017 was \(~27\%\) higher/ than the number recorded over the preceding seven-year period 2004-2010 (\(n=76\), data MEM).

Of the 97 reported marine turtles, 22 were investigated at post mortem (ten were conducted in England, seven in Wales and five in Scotland- Tables 4, 5, 6 and 7). A cause of death was established in all examined individuals, of which 17 died as a result of cold stunning (associated with starvation/hypothermia), two from entanglement, one from a generalised bacterial infection, one from a bacterial pneumonia and one from lung abscessation (Table 9 and Appendix 5).

\(^{12}\) Marine turtle stranding information in this section and in Table 2 is provided courtesy of *Marine Environmental Monitoring* (MEM).
5.24 Basking sharks and other large bodied shark species

Between 2011 and 2017, 21 basking sharks (seven males, one female and 13 of unknown sex) were reported to the CSIP. Of these, 15 were reports of dead strandings and six were dead sharks found at sea (of which one was found entangled in netting). Of the 21 strandings, 12 were reported in Scotland, seven in England, one in Northern Ireland and one in the Channel Islands (Table 2 and Figure 23). The figure of 21 strandings recorded over the seven-year period 2011-2017 is ~35% lower than the number recorded over the preceding seven-year period 2004-2010 (n=32, data CSIP database).

Between 2011 and 2017, two stranded basking sharks were investigated at post mortem (one was conducted in Scotland and one in Northern Ireland - Tables 4, 6 and 8). A cause of death of starvation was established in one individual and a cause of death could not be established in the other examined individual (Table 9, Appendix 5 and Plate 39).

Under contract ME6008, the CSIP was tasked with the collation of data on strandings of ‘large bodied shark species’. A stranded juvenile porbeagle shark (Lamna nasus) was found at Hayle beach, Cornwall on 5th December 2017 (Plate 40; Deaville et al. 2018b).

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2017-2020, commenced on 16th October 2017. See Section 2.2 for further detail.
5.25 Seals

Although seals are no longer a formal part of the UK wide CSIP remit, funding for the investigation of seal mortality in Scotland is provided by Marine Scotland and conducted by the Scottish Marine Animal Strandings Scheme (www.strandings.org). In addition, data on dead stranded seals are also collected on an ad hoc basis in the rest of the UK by the CSIP and in Cornwall by the Cornwall Wildlife Trust Marine Strandings Network. Between 2011 and 2017, 3735 dead stranded seals were reported in the UK, consisting of grey seals (Halichoerus grypus, n=2562), common seals (Phoca vitulina, n=406), hooded seals (Cystophora cristata, n=4), bearded seal (Erignathus barbatus, n=1) and seals of indeterminate identity (n=762). The majority were reported in Scotland (n=2134), with smaller numbers in England (n=1013) and Wales (n=588). Limited data on seals found stranded in Northern Ireland is available to the CSIP - data in this region is managed by DAREA Marine and Fisheries Division. Previous annual reports (e.g. Deaville et al. 2012-2018) have indicated that there is a good reporting network in Scotland, Wales and Cornwall, but coverage in the rest of England appears patchy. This is possibly consequential to a reduction in effort since the last systematic period of UK wide funding for seal mortality investigation during the phocine distemper virus outbreak of 2002-03 (Lawson and Jepson, 2003).

Between 2011-2017, 167 seals were investigated at post-mortem in Scotland under contract to Marine Scotland. A number of additional opportunistic seal post-mortem examinations were also carried out in England (n=89) and Wales (n=6) under ad hoc funding, primarily under the APHA Diseases of Wildlife Scheme (carried out by University of
Exeter staff in Cornwall) and by ZSL under contract to Natural England during a one-off period of funding (November 2015-March 2016; Deaville, 2016b).

Further information on seal mortality investigation in Scotland can be found at www.strandings.org.

Figure 24 Interannual variation in seal strandings in the UK (2008-2017)
Plate 13 Harbour porpoise stranding at Aberaeron (SW2015/62, credit CSIP-MEM)

Plate 14 Short-beaked common dolphin stranding at South Milton, Devon (SW2017/126, credit National Trust)

Plate 15 Long-finned pilot whale stranding at Durness, Highland in 2011 (SW2011/303.1, credit CSIP-ZSL)

Plate 16 Minke whale stranding at Oxwich Bay, Swansea (SW2017/283, credit Ben Boreham)

Plate 17 White-beaked dolphin stranding at Magilligan Point, Derry, Northern Ireland (SW2015/12, credit DOE Marine Division)

Plate 18 Striped dolphin live stranding at Port Talbot, Wales (SW2012/68, credit CSIP-MEM)
Plate 19 Bottlenose dolphin stranded at Hells Mouth, Gwynedd prior to necropsy (SW2014/135, credit CSIP-ZSL)

Plate 20 Risso’s dolphin stranding at Birsay, Orkney (SW2016/152, credit Colin Bird)

Plate 21 Female sperm whale stranding at Perranporth, Cornwall (SW2016/340, credit CSIP-ZSL)

Plate 22 Atlantic white-sided dolphin stranding at Dunnet Bay, Highland (SW2016/328, credit BDMLR)

Plate 23 Sowerby’s beaked whale stranding on St. Kilda, Western Isles (SW2013/478.1, credit Gina Prior)

Plate 24 Fin whale stranding at Holkham, Norfolk (SW2016/546, credit CSIP-ZSL)
Plate 25 Cuvier’s beaked whale stranding at Portballintrae, Northern Ireland (SW2014/480, credit Gary Burrows, DOE Marine Division)

Plate 26 Killer whale stranding at Tiree, Hebrides (SW2016/2, credit CSIP-SRUC)

Plate 27 Humpback whale found floating dead in Salmon pens in Mull (SW2014/196, credit CSIP-SRUC)

Plate 28 Northern bottlenose whale stranding at Kenfig, Wales (SW2016/481, credit CSIP-MEM)

Plate 29 Pygmy sperm whale stranding at Banff, Aberdeenshire (SW2013/473, credit CSIP-SRUC)

Plate 30 Sei whale stranding at Red Bay, Antrim Northern Ireland (SW2013/501, credit NIEA)
Plate 31 Blainville’s beaked whale stranding at Keneggy Sands, Cornwall (SW2013/626, credit CWTMSN)

Plate 32 Dwarf sperm whale after stranding in Penzance, Cornwall (SW2011/455, credit Kimara McCrindle and CWTMSN)

Plate 33 Ventral view of beluga whale skull (SW2014/137, left hand skull) compared with museum specimen (credit National Museum of Scotland)

Plate 34 Leatherback turtle found entangled in creel fishery off Dunbar, East Lothian (T2014/34, credit Dunbar inshore lifeboat)

Plate 35 Loggerhead turtle found stranded at Worthing (T2013/28, credit Adur and Worthing Council)

Plate 36 Satellite tagged Kemp’s ridley turtle found stranded in Pembrokeshire (T2016/6, credit CSIP-MEM)
Plate 37 Green turtle stranding at Hell’s Mouth, Gwynedd (T2016/11, credit CSIP-MEM)

Plate 38 Olive ridley turtle in rehabilitation at Anglesey Sea Zoo (T2016/30, credit CSIP-MEM)

Plate 39 Juvenile basking shark stranding at Ballywalter, Northern Ireland (SBS2014/1, credit DOE Marine Division)

Plate 40 Porbeagle shark stranding at Holywell, Cornwall, December 2017 (credit CWTMSN)
6 Post mortem investigations and cause of death data (2011-2017)

Table 4 Post-mortem investigations conducted on UK stranded cetaceans, marine turtles and basking sharks (2011-2017)

<table>
<thead>
<tr>
<th>Species</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Harbour porpoise (Phocoena phocoena)</td>
<td>536</td>
</tr>
<tr>
<td>Short-beaked common dolphin (Delphinus delphis)</td>
<td>191</td>
</tr>
<tr>
<td>Long-finned pilot whale (Globicephala melas)</td>
<td>68</td>
</tr>
<tr>
<td>Striped dolphin (Stenella coeruleoalba)</td>
<td>41</td>
</tr>
<tr>
<td>White beaked dolphin (Lagenorhynchus albirostris)</td>
<td>40</td>
</tr>
<tr>
<td>Minke whale (Balaenoptera acutorostrata)</td>
<td>23</td>
</tr>
<tr>
<td>Bottlenose dolphin (Tursiops truncatus)</td>
<td>23</td>
</tr>
<tr>
<td>Risso’s dolphin (Grampus griseus)</td>
<td>15</td>
</tr>
<tr>
<td>Sperm whale ( Physeter macrocephalus)</td>
<td>13</td>
</tr>
<tr>
<td>Sowerby’s beaked whale (Mesoplodon bidens)</td>
<td>13</td>
</tr>
<tr>
<td>Atlantic white-sided dolphin (Lagenorhynchus acutus)</td>
<td>9</td>
</tr>
<tr>
<td>Fin whale (Balaenoptera physalus)</td>
<td>8</td>
</tr>
<tr>
<td>Killer whale (Orcinus orca)</td>
<td>6</td>
</tr>
<tr>
<td>Pygmy sperm whale (Kogia breviceps)</td>
<td>5</td>
</tr>
<tr>
<td>Northern bottlenose whale (Hyperoodon ampullatus)</td>
<td>4</td>
</tr>
<tr>
<td>Sei whale (Balaenoptera borealis)</td>
<td>4</td>
</tr>
<tr>
<td>Humpback whale (Megaptera novaeangliae)</td>
<td>3</td>
</tr>
<tr>
<td>Cuvier’s beaked whale (Ziphius cavirostris)</td>
<td>3</td>
</tr>
<tr>
<td>Loggerhead turtle (Caretta caretta)</td>
<td>10</td>
</tr>
<tr>
<td>Kemp’s ridley turtle (Lepidochelys kempii)</td>
<td>7</td>
</tr>
<tr>
<td>Leatherback turtle (Dermochelys coriacea)</td>
<td>3</td>
</tr>
<tr>
<td>Green turtle (Chelonia mydas)</td>
<td>2</td>
</tr>
<tr>
<td>Basking shark (Cetorhinus maximus)</td>
<td>2</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>1029</strong></td>
</tr>
</tbody>
</table>

NB One porpoise examined at post-mortem in the Isle of Man in 2013 is not shown in the above table
### Table 5 Post-mortem investigations conducted in England (2011-2017)

<table>
<thead>
<tr>
<th>Species</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Harbour porpoise (Phocoena phocoena)</td>
<td>226</td>
</tr>
<tr>
<td>Short-beaked common dolphin (Delphinus delphis)</td>
<td>134</td>
</tr>
<tr>
<td>Striped dolphin (Stenella coeruleoalba)</td>
<td>19</td>
</tr>
<tr>
<td>White beaked dolphin (Lagenorhynchus albirostris)</td>
<td>11</td>
</tr>
<tr>
<td>Sperm whale (Physeter macrocephalus)</td>
<td>9</td>
</tr>
<tr>
<td>Minke whale (Balaenoptera acutorostrata)</td>
<td>7</td>
</tr>
<tr>
<td>Bottlenose dolphin (Tursiops truncatus)</td>
<td>4</td>
</tr>
<tr>
<td>Sowerby’s beaked whale (Mesoplodon bidens)</td>
<td>4</td>
</tr>
<tr>
<td>Fin whale (Balaenoptera physalus)</td>
<td>4</td>
</tr>
<tr>
<td>Risso’s dolphin (Grampus griseus)</td>
<td>3</td>
</tr>
<tr>
<td>Long-finned pilot whale (Globicephala melas)</td>
<td>3</td>
</tr>
<tr>
<td>Sei whale (Balaenoptera borealis)</td>
<td>2</td>
</tr>
<tr>
<td>Humpback whale (Megaptera novaeangliae)</td>
<td>1</td>
</tr>
<tr>
<td>Pygmy sperm whale (Kogia breviceps)</td>
<td>1</td>
</tr>
<tr>
<td>Cuvier’s beaked whale (Ziphius cavirostris)</td>
<td>1</td>
</tr>
<tr>
<td>Loggerhead turtle (Caretta caretta)</td>
<td>6</td>
</tr>
<tr>
<td>Kemp’s ridley turtle (Lepidochelys kempii)</td>
<td>4</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>439</strong></td>
</tr>
</tbody>
</table>

### Table 6 Post-mortem investigations conducted in Scotland (2011-2017)

<table>
<thead>
<tr>
<th>Species</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Harbour porpoise (Phocoena phocoena)</td>
<td>174</td>
</tr>
<tr>
<td>Long-finned pilot whale (Globicephala melas)</td>
<td>63</td>
</tr>
<tr>
<td>Short-beaked common dolphin (Delphinus delphis)</td>
<td>30</td>
</tr>
<tr>
<td>White beaked dolphin (Lagenorhynchus albirostris)</td>
<td>29</td>
</tr>
<tr>
<td>Striped dolphin (Stenella coeruleoalba)</td>
<td>17</td>
</tr>
<tr>
<td>Minke whale (Balaenoptera acutorostrata)</td>
<td>15</td>
</tr>
<tr>
<td>Bottlenose dolphin (Tursiops truncatus)</td>
<td>12</td>
</tr>
<tr>
<td>Risso’s dolphin (Grampus griseus)</td>
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<tr>
<td>Atlantic white-sided dolphin (Lagenorhynchus acutus)</td>
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<tr>
<td>Sowerby’s beaked whale (Mesoplodon bidens)</td>
<td>8</td>
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<tr>
<td>Killer whale (Orcinus orca)</td>
<td>6</td>
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<tr>
<td>Sperm whale (Physeter macrocephalus)</td>
<td>4</td>
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<tr>
<td>Northern bottlenose whale (Hyperoodon ampullatus)</td>
<td>4</td>
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<tr>
<td>Pygmy sperm whale (Kogia breviceps)</td>
<td>3</td>
</tr>
<tr>
<td>Fin whale (Balaenoptera physalus)</td>
<td>3</td>
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<tr>
<td>Cuvier’s beaked whale (Ziphius cavirostris)</td>
<td>2</td>
</tr>
<tr>
<td>Humpback whale (Megaptera novaeangliae)</td>
<td>2</td>
</tr>
<tr>
<td>Sei whale (Balaenoptera borealis)</td>
<td>1</td>
</tr>
<tr>
<td>Leatherback turtle (Dermochelys coriacea)</td>
<td>3</td>
</tr>
<tr>
<td>Loggerhead turtle (Caretta caretta)</td>
<td>1</td>
</tr>
<tr>
<td>Green turtle (Chelonia mydas)</td>
<td>1</td>
</tr>
<tr>
<td>Basking shark (Cetorhinus maximus)</td>
<td>1</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>398</strong></td>
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Table 7 Post-mortem investigations conducted in Wales (2011-2017)

<table>
<thead>
<tr>
<th>Species</th>
<th>Number</th>
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<tbody>
<tr>
<td>Harbour porpoise (<em>Phocoena phocoena</em>)</td>
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<tr>
<td>Short-beaked common dolphin (<em>Delphinus delphis</em>)</td>
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<tr>
<td>Bottlenose dolphin (<em>Tursiops truncatus</em>)</td>
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<tr>
<td>Striped dolphin (<em>Stenella coeruleoalba</em>)</td>
<td>5</td>
</tr>
<tr>
<td>Risso’s dolphin (<em>Grampus griseus</em>)</td>
<td>2</td>
</tr>
<tr>
<td>Long-finned pilot whale (<em>Globicephala melas</em>)</td>
<td>1</td>
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<tr>
<td>Minke whale (<em>Balaenoptera acutorostrata</em>)</td>
<td>1</td>
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<td>Sowerby's beaked whale (<em>Mesoplodon bidens</em>)</td>
<td>1</td>
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<tr>
<td>Pygmy sperm whale (<em>Kogia breviceps</em>)</td>
<td>1</td>
</tr>
<tr>
<td>Loggerhead turtle (<em>Caretta caretta</em>)</td>
<td>3</td>
</tr>
<tr>
<td>Kemp’s ridley turtle (<em>Lepidochelys kempii</em>)</td>
<td>3</td>
</tr>
<tr>
<td>Green turtle (<em>Chelonia mydas</em>)</td>
<td>1</td>
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<tr>
<td><strong>Total</strong></td>
<td><strong>163</strong></td>
</tr>
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</table>

Table 8 Post-mortem investigations conducted in Northern Ireland (2011-2017)

<table>
<thead>
<tr>
<th>Species</th>
<th>Number</th>
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<tbody>
<tr>
<td>Harbour porpoise (<em>Phocoena phocoena</em>)</td>
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<tr>
<td>Short-beaked common dolphin (<em>Delphinus delphis</em>)</td>
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<tr>
<td>Long-finned pilot whale (<em>Globicephala melas</em>)</td>
<td>1</td>
</tr>
<tr>
<td>Fin whale (<em>Balaenoptera physalus</em>)</td>
<td>1</td>
</tr>
<tr>
<td>Sei whale (<em>Balaenoptera borealis</em>)</td>
<td>1</td>
</tr>
<tr>
<td>Basking shark (<em>Cetorhinus maximus</em>)</td>
<td>1</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>29</strong></td>
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</tbody>
</table>

NB Post-mortem examinations in Northern Ireland were carried out by the Agri-Food and Biosciences Institute, under contract to Northern Ireland Environment Agency and more recently, under contract to DAERA Marine and Fisheries Division.
Table 9 Causes of death of cetaceans, marine turtles and basking sharks examined at post mortem in the UK (2011-2017)

<table>
<thead>
<tr>
<th>Species</th>
<th>Cause of death category</th>
<th>No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Harbour porpoise (Phocoena phocoena, n=537)</td>
<td>Bottlelenose Dolphin Attack</td>
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</tr>
<tr>
<td></td>
<td>Starvation</td>
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</tr>
<tr>
<td></td>
<td>By-catch</td>
<td>70</td>
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<tr>
<td></td>
<td>Pneumonia, Parasitic</td>
<td>52</td>
</tr>
<tr>
<td></td>
<td>Starvation (neonate)</td>
<td>37</td>
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<td>Bottlelenose Dolphin Attack</td>
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<td>-------------------------------------------------------------</td>
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<td><strong>White-beaked dolphin</strong></td>
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<td>Generalised Bacterial Infection</td>
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<td>Others</td>
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<tr>
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</tr>
<tr>
<td></td>
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</tr>
<tr>
<td></td>
<td>Others</td>
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<td>Gastritis &amp;/or Enteritis</td>
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<td>Physical Trauma, Boat/Ship Strike</td>
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<tr>
<td></td>
<td>By-catch</td>
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<td>Gastritis &amp;/or Enteritis</td>
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<tr>
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<td>Neonatal death</td>
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</tr>
<tr>
<td></td>
<td>Starvation</td>
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<tr>
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<tr>
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<td><strong>Risso’s dolphin</strong></td>
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<td>Gastritis &amp;/or Enteritis</td>
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<tr>
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<td>Physical Trauma, Boat/Ship Strike</td>
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<td>Starvation</td>
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<td>Others</td>
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<tr>
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<td>Not Established</td>
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<td>Species</td>
<td>Cause of death category</td>
<td>No.</td>
</tr>
<tr>
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<td>-----------------------------------------</td>
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<td>Starvation</td>
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<td>Killer whale (Orcinus orca, n=6)</td>
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<tr>
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<td>Starvation</td>
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<tr>
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<td>Pneumonia (unknown aetiology)</td>
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<td>Entanglement</td>
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<td>Sei whale (Balaenoptera borealis, n=4)</td>
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<td>Others</td>
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<td>Humpback whale (Megaptera novaeangliae, n=3)</td>
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<tr>
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<td>Others</td>
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<tr>
<td>Loggerhead turtle (Caretta caretta, n=10)</td>
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<td></td>
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</tr>
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<td>Leatherback turtle (Dermochelys coriacea, n=3)</td>
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<tr>
<td></td>
<td>Cold Stunned</td>
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<td>Green turtle (Chelonia mydas, n=2)</td>
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<tr>
<td>Basking shark (Cetorhinus maximus, n=2)</td>
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</table>

Spatial distribution of six selected cause of death categories (infectious disease, live-stranding, starvation, by-catch/entanglement, interspecific and intraspecific aggression and boat/ship strike) between 2011-2017 are given in the figures overleaf (Figures 25a-25f).

a) infectious disease (n=255);
b) live stranding (n=178);
c) starvation (n=149, includes 41 neonates);
d) by-catch or entanglement (n=135, includes ten known bycatch cases);
e) interspecific aggression (n=113)-violent interactions with bottlenose dolphins (n=93, including two known attacks), grey seal predation (n=18, cross hatched symbol) and common dolphin-harbour porpoise interspecific aggression (n=1) and a possible white-beaked dolphin infanticide case (n=1);
f) boat/ship strike (n=25)
Figure 25 Spatial distribution of selected cause of death categories (2011-2017)
NB Crossed circles denote cases of grey seal predation

The following section reviews selected cause of death categories in cetaceans examined at post-mortem by the CSIP during the 27-year period 1991-2017. Data from 1990 has been excluded from this section, as funding for post-mortem examinations in the UK began in September 1990. Cases of known by-catch (n=91) or known entanglements recorded by the CSIP during this period (n=3) were also excluded.

Table 10 Species examined at post-mortem by the CSIP (1991-2017)

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<th>Species</th>
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<tr>
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<tr>
<td>Striped dolphin</td>
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<tr>
<td>White-beaked dolphin</td>
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<td>Long-finned pilot whale</td>
<td>101</td>
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<td>93</td>
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<tr>
<td>Bottlenose dolphin</td>
<td>85</td>
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<tr>
<td>Minke whale</td>
<td>64</td>
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<td>Risso's dolphin</td>
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<td>Sowerby's beaked whale</td>
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<td>Sperm whale</td>
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<td>Northern bottlenose whale</td>
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<td>Fin whale</td>
<td>13</td>
</tr>
<tr>
<td>Killer whale</td>
<td>11</td>
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<td>Pygmy sperm whale</td>
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<td>Humpback whale</td>
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<td>Sei whale</td>
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<td>Blainville's beaked whale</td>
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<tr>
<td><strong>TOTAL</strong></td>
<td><strong>3744</strong></td>
</tr>
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</table>

Table 11 Cause of death categories in UK stranded cetaceans (1991-2017)

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<th>Cause of death category</th>
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<td>Infectious Disease</td>
<td>753</td>
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<tr>
<td>Bycatch and Entanglement</td>
<td>738</td>
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<tr>
<td>Live Stranding</td>
<td>527</td>
</tr>
<tr>
<td>Inter and intra specific aggression</td>
<td>437</td>
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<tr>
<td>Starvation</td>
<td>339</td>
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<tr>
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<td>Others</td>
<td>114</td>
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<tr>
<td>Dystocia &amp; Stillborn</td>
<td>53</td>
</tr>
<tr>
<td>Shipstrike</td>
<td>39</td>
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<tr>
<td>Neoplasia</td>
<td>11</td>
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<tr>
<td>Gas Embolism</td>
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<td><strong>TOTAL</strong></td>
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</tbody>
</table>

NB Known by-catch/entanglement cases (n=94) are excluded from the above two tables.
7.1 By-catch

Incidental entanglement in fishing gear (or by-catch) was ascribed as a cause of death in cetacean carcasses using established pathological criteria for by-catch diagnosis (Kuiken et al. 1994 and Kuiken 1996). These include (but are not limited to), netmarks (Plate 41), penetrating wounds to the body wall, excised fins and/or flukes (Plate 42), good nutritive condition, evidence of recent feeding and the elimination of any other significant underlying pathology.

Between 1991 and 2017, 710 cetaceans were diagnosed to have died as a result of by-catch. Highest numbers were recorded in harbour porpoises (n=362) and short-beaked common dolphins (n=317) examined at post-mortem, although proportionally more of the latter were diagnosed as cases of by-catch (Table 12).

Table 12 Diagnosed cases of by-catch in the UK (1991-2017)

<table>
<thead>
<tr>
<th>Species</th>
<th>Necropsies</th>
<th>Number</th>
<th>Proportion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Harbour porpoise</td>
<td>2221</td>
<td>362</td>
<td>16.3%</td>
</tr>
<tr>
<td>Short-beaked common dolphin</td>
<td>725</td>
<td>317</td>
<td>43.7%</td>
</tr>
<tr>
<td>Striped dolphin</td>
<td>149</td>
<td>8</td>
<td>5.4%</td>
</tr>
<tr>
<td>White-beaked dolphin</td>
<td>123</td>
<td>8</td>
<td>6.5%</td>
</tr>
<tr>
<td>Risso’s dolphin</td>
<td>50</td>
<td>6</td>
<td>12.0%</td>
</tr>
<tr>
<td>Bottlenose dolphin</td>
<td>85</td>
<td>5</td>
<td>5.9%</td>
</tr>
<tr>
<td>Atlantic white-sided dolphin</td>
<td>93</td>
<td>3</td>
<td>3.2%</td>
</tr>
<tr>
<td>Long-finned pilot whale</td>
<td>101</td>
<td>1</td>
<td>1.0%</td>
</tr>
</tbody>
</table>

The spatial distribution of by-caught harbour porpoises and short-beaked common dolphins in the UK are shown in Figures 26 and 27. By-catch was recorded most frequently in cetaceans found stranded in England (n=539), with smaller numbers in Wales (n=104) and Scotland (n=67). By-caught short-beaked common dolphins were primarily recorded stranded in southwest UK (n=278) and surrounding regions, with very low numbers recorded in Scotland (n=2). By-caught harbour porpoises were recorded UK wide, with highest numbers in the southwest (n=125) and high numbers also recorded around the Welsh coast and to a lesser extent, the northeast coasts of England. Relatively lower numbers of diagnosed harbour porpoise by-catch cases were recorded in Scotland (n=58). There was also a strong temporal component in short-beaked common dolphin by-catch, with a majority (n=227) stranding between January and March. There was less pronounced seasonality with harbour porpoise by-catch.

Inter-annual variation in numbers of by-caught harbour porpoises and short-beaked common dolphins are shown in Figures 34 and 36 respectively, with annual proportions of by-catch given in Figures 35 and 37 respectively. By-catch has been a consistent finding in each species over the majority of the study, although the number of diagnosed cases and the relative annual proportion appears to have declined somewhat in stranded short-beaked common dolphins examined at post-mortem during recent years.

7.2 Entanglement

Entanglement is a form of by-catch that is specific to larger whales. It denotes cases where evidence of rope entanglement is found (e.g. Plate 44) and is thought to be primarily associated with entanglement in creel type fisheries. It may potentially also involve entanglement in Abandoned, Lost or Otherwise Discarded Fishing Gear (ALDFG) or other forms of marine debris. Entanglements can be either acute or chronic in nature.
Between 1991 and 2017, 28 cetaceans were diagnosed to have died as a result of entanglement (Table 13). A high incidence of entanglement was recorded in minke whales (~36% of all examined cases) and the majority of the entanglements were recorded in cetaceans found stranded in Scotland (n=25, Figure 28).

**Table 13** Diagnosed cases of entanglement in the UK (1991-2017)

<table>
<thead>
<tr>
<th>Species</th>
<th>Necropsies</th>
<th>Number</th>
<th>Proportion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minke whale</td>
<td>64</td>
<td>23</td>
<td>35.9%</td>
</tr>
<tr>
<td>Fin whale</td>
<td>13</td>
<td>1</td>
<td>7.7%</td>
</tr>
<tr>
<td>Humpback whale</td>
<td>5</td>
<td>1</td>
<td>20.0%</td>
</tr>
<tr>
<td>Killer whale</td>
<td>11</td>
<td>1</td>
<td>9.1%</td>
</tr>
<tr>
<td>Northern bottlenose whale</td>
<td>19</td>
<td>1</td>
<td>5.3%</td>
</tr>
<tr>
<td>Sperm whale</td>
<td>30</td>
<td>1</td>
<td>3.3%</td>
</tr>
</tbody>
</table>

This therefore appears to be an issue that predominantly affects minke whales in Scottish waters, potentially reflecting creel fishery effort in this region. This also correlates with previous work (e.g. Northridge et al. 2010). Entanglement is also an issue that appears to be increasing globally⁴, potentially sequential to increased population density in some species of baleen whale, as some populations begin to increase following the moratorium on commercial whaling convened through the International Whaling Commission in 1986.

⁴ https://iwc.int/entanglement
number of chronic entanglement cases have also been recorded by the CSIP (e.g. Appendix 3), highlighting the significant welfare impact of this issue.

7.3 Ship-strike

Ship-strike is diagnosed by the CSIP when observed pathology in examined animals is considered to be consistent with impact from a vessel. This can include multiple, linear, parallel incisions on the body wall (e.g. Plates 45 and 46) and/or evidence of blunt force trauma on the dorsal or lateral body wall.

Between 1991 and 2017, 39 cetaceans were diagnosed to have died as a result of ship-strike (Table 14).

Table 14 Diagnosed cases of ship-strike in the UK (1991-2017)

<table>
<thead>
<tr>
<th>Species</th>
<th>Necropsies</th>
<th>Number</th>
<th>Proportion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Harbour porpoise</td>
<td>2221</td>
<td>17</td>
<td>0.8%</td>
</tr>
<tr>
<td>Short-beaked common dolphin</td>
<td>725</td>
<td>11</td>
<td>1.5%</td>
</tr>
<tr>
<td>Fin whale</td>
<td>13</td>
<td>3</td>
<td>23.1%</td>
</tr>
<tr>
<td>Minke whale</td>
<td>64</td>
<td>3</td>
<td>4.7%</td>
</tr>
<tr>
<td>Risso's dolphin</td>
<td>50</td>
<td>1</td>
<td>2.0%</td>
</tr>
<tr>
<td>Cuvier's beaked whale</td>
<td>5</td>
<td>1</td>
<td>20.0%</td>
</tr>
<tr>
<td>Sowerby's beaked whale</td>
<td>36</td>
<td>2</td>
<td>5.6%</td>
</tr>
<tr>
<td>Sperm whale</td>
<td>30</td>
<td>1</td>
<td>3.3%</td>
</tr>
</tbody>
</table>

Relatively low numbers of ship-strike cases have therefore been diagnosed in the UK since the inception of the CSIP in 1990. Numbers of cases were highest however in England (n=27, Figure 29) relative to the rest of the UK, perhaps reflecting regions of more intense shipping/vessel activity. Interestingly, a potential cluster of ship-strike cases has also been observed in short-beaked common dolphins on the south Devon coast (Figure 29 and Plate 45).

Analysis of trends in ship-strike cases in the UK between 1991 and 2017 (Figures 34-37) indicates that although occurring at a low incidence, numbers and proportions of these cases were higher in UK stranded harbour porpoises and short-beaked common dolphins examined at post-mortem over the last decade.

7.4 Marine debris (ingestion)

Since the inception of the CSIP in 1990, only one single stranded cetacean examined at post-mortem has been recorded, where a potentially significant gastric impaction has taken place following ingestion of marine debris (a Cuvier’s beaked whale which stranded in Highland in 2015; Section 5.13). See Appendix 3 for additional detail on this case and other non-fatal evidence of marine debris ingestion recorded by the CSIP during the contract period.
Infectious disease is a broad category consisting of a number of causes of death of infectious origin (Jepson 2005, Jepson et al. 2005a). These can include (but are not limited to) pneumonias of parasitic, bacterial and/or mycotic origin, generalised infections (e.g. Plate 47), infections of the gastrointestinal tract (e.g. Plate 48) and infections of the brain/central nervous system.

Between 1991 and 2017, 753 cetaceans were diagnosed to have died as a result of infectious disease (Table 15), making it the most common driver of mortality in the UK during this period. It should be noted that the high proportion of disease mortality recorded in striped dolphins and Atlantic-white sided dolphins is consequential to the higher rates of meningoencephalitis recorded in these two species (e.g. Davison et al. 2009). The highest number of disease related mortality cases were recorded in Scotland (n=353), with smaller numbers in England (n=291), Wales (n=100) and Northern Ireland (n=9).

A significant body of work has been undertaken by the CSIP on the impact of legacy chemical contaminants (e.g. Jepson et al. 2016, Jepson and Law, 2016) and the relationship between exposure to these pollutants and disease and other health impacts (e.g. Jepson et al. 2005a and Murphy et al. 2015). See Section 8.1 for additional detail.
### Table 15 Diagnosed cases of infectious disease in the UK (1991-2017)

<table>
<thead>
<tr>
<th>Species</th>
<th>Necropsies</th>
<th>Number</th>
<th>Proportion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Harbour porpoise</td>
<td>2221</td>
<td>522</td>
<td>23.5%</td>
</tr>
<tr>
<td>Short-beaked common dolphin</td>
<td>725</td>
<td>78</td>
<td>10.8%</td>
</tr>
<tr>
<td>Striped dolphin</td>
<td>149</td>
<td>43</td>
<td>28.9%</td>
</tr>
<tr>
<td>Atlantic white-sided dolphin</td>
<td>93</td>
<td>26</td>
<td>28.0%</td>
</tr>
<tr>
<td>White-beaked dolphin</td>
<td>123</td>
<td>24</td>
<td>19.5%</td>
</tr>
<tr>
<td>Bottlenose dolphin</td>
<td>85</td>
<td>15</td>
<td>17.6%</td>
</tr>
<tr>
<td>Long-finned pilot whale</td>
<td>101</td>
<td>11</td>
<td>10.9%</td>
</tr>
<tr>
<td>Risso's dolphin</td>
<td>50</td>
<td>11</td>
<td>22.0%</td>
</tr>
<tr>
<td>Minke whale</td>
<td>64</td>
<td>10</td>
<td>15.6%</td>
</tr>
<tr>
<td>Sowerby's beaked whale</td>
<td>36</td>
<td>5</td>
<td>13.9%</td>
</tr>
<tr>
<td>Killer whale</td>
<td>11</td>
<td>3</td>
<td>27.3%</td>
</tr>
<tr>
<td>Fin whale</td>
<td>13</td>
<td>2</td>
<td>15.4%</td>
</tr>
<tr>
<td>Northern bottlenose whale</td>
<td>19</td>
<td>1</td>
<td>5.3%</td>
</tr>
<tr>
<td>Pygmy sperm whale</td>
<td>9</td>
<td>1</td>
<td>11.1%</td>
</tr>
<tr>
<td>Sei whale</td>
<td>4</td>
<td>1</td>
<td>25.0%</td>
</tr>
</tbody>
</table>

#### 7.6 Starvation

Starvation is diagnosed by the CSIP when evidence of emaciation is found, but no other significant disease processes or pathology were found during post-mortem examinations, that may otherwise explain the poor nutritional status.

Starvation can be divided into two further sub-categories in the UK, starvation (e.g. Plate 49) and neonatal starvation (e.g. Plate 50). These are two distinct categories and are therefore presented separately below. Between 1991 and 2017, 150 cetaceans were diagnosed as neonatal starvation cases and 339 cetaceans were diagnosed as starvation cases (Tables 16 and 17). The large majority of starvation cases in both categories were harbour porpoises (140 neonatal starvation cases and 233 starvation cases). Broadly proportionate numbers of harbour porpoise starvation cases were recorded in England (n=141), Scotland (n=122), Wales (n=69) and Northern Ireland (n=7). However, higher numbers of neonatal starvation cases were recorded in Wales and parts of Scotland, comparative to the rest of the UK.

Analysis of trends in starvation cases in the UK between 1991 and 2017 (Figures 34 and 35) indicates that although there was no discernible trend in harbour porpoise neonatal starvation, proportionally higher numbers of starvation cases have been diagnosed over the latter half of the period of study. However, there are many potential drivers of starvation and it is difficult to draw any firm conclusions on the potential significance of this finding.

### Table 16 Diagnosed cases of neonatal starvation in the UK (1991-2017)

<table>
<thead>
<tr>
<th>Species</th>
<th>Necropsies</th>
<th>Number</th>
<th>Proportion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Harbour porpoise</td>
<td>2221</td>
<td>140</td>
<td>6.3%</td>
</tr>
<tr>
<td>White-beaked dolphin</td>
<td>123</td>
<td>4</td>
<td>3.3%</td>
</tr>
<tr>
<td>Short-beaked common dolphin</td>
<td>725</td>
<td>3</td>
<td>0.4%</td>
</tr>
<tr>
<td>Bottlenose dolphin</td>
<td>85</td>
<td>1</td>
<td>1.2%</td>
</tr>
<tr>
<td>Long-finned pilot whale</td>
<td>101</td>
<td>1</td>
<td>1.0%</td>
</tr>
<tr>
<td>Risso’s dolphin</td>
<td>50</td>
<td>1</td>
<td>2.0%</td>
</tr>
</tbody>
</table>
### Table 17 Diagnosed cases of starvation in the UK (1991-2017)

<table>
<thead>
<tr>
<th>Species</th>
<th>Necropsies</th>
<th>Number</th>
<th>Proportion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Harbour porpoise</td>
<td>2221</td>
<td>233</td>
<td>10.5%</td>
</tr>
<tr>
<td>Short-beaked common dolphin</td>
<td>725</td>
<td>34</td>
<td>4.7%</td>
</tr>
<tr>
<td>Striped dolphin</td>
<td>149</td>
<td>16</td>
<td>10.7%</td>
</tr>
<tr>
<td>White-beaked dolphin</td>
<td>123</td>
<td>14</td>
<td>11.4%</td>
</tr>
<tr>
<td>Atlantic white-sided dolphin</td>
<td>93</td>
<td>14</td>
<td>15.1%</td>
</tr>
<tr>
<td>Minke whale</td>
<td>64</td>
<td>6</td>
<td>9.4%</td>
</tr>
<tr>
<td>Risso's dolphin</td>
<td>50</td>
<td>4</td>
<td>8.0%</td>
</tr>
<tr>
<td>Bottlenose dolphin</td>
<td>85</td>
<td>3</td>
<td>3.5%</td>
</tr>
<tr>
<td>Humpback whale</td>
<td>5</td>
<td>3</td>
<td>60.0%</td>
</tr>
<tr>
<td>Killer whale</td>
<td>11</td>
<td>3</td>
<td>27.3%</td>
</tr>
<tr>
<td>Sperm whale</td>
<td>30</td>
<td>3</td>
<td>10.0%</td>
</tr>
<tr>
<td>Fin whale</td>
<td>13</td>
<td>2</td>
<td>15.4%</td>
</tr>
<tr>
<td>Cuvier's beaked whale</td>
<td>5</td>
<td>1</td>
<td>20.0%</td>
</tr>
<tr>
<td>Long-finned pilot whale</td>
<td>101</td>
<td>1</td>
<td>1.0%</td>
</tr>
<tr>
<td>Northern bottlenose whale</td>
<td>19</td>
<td>1</td>
<td>5.3%</td>
</tr>
<tr>
<td>Sowerby's beaked whale</td>
<td>36</td>
<td>1</td>
<td>2.8%</td>
</tr>
</tbody>
</table>

**Figure 30** Distribution of harbour porpoise starvation cases in the UK (1991-2017)

**Figure 31** Distribution of harbour porpoise neonate starvation cases in the UK (1991-2017)
7.7 Interspecific and intraspecific aggression

A variety of interspecific and intraspecific aggression cases have been diagnosed by the CSIP since its inception, with 438 recorded between 1991 and 2017 (Table 17). A majority of cases were recorded in Scotland (n=255), with smaller numbers in Wales (n=130), England (n=48) and Northern Ireland (n=5). Bottlenose dolphin attack has been by far the most prevalent finding in this cohort, with 405 cases recorded in UK stranded harbour porpoises, making it the 2nd most common cause of death in this species in the UK after infectious disease related mortality. A small number of bottlenose dolphin infanticide cases have also been recorded in the UK (n=6), with the first diagnosed case in Wales recorded during this contract period (Plate 51). In addition, a number of diagnosed cases of aggressive interactions by one or more bottlenose dolphins with a range of other cetacean species have also been recorded (n=7, e.g. Barnett et al. 2009). More recently, a single potential case of white-beaked dolphin infanticide has also been recorded in Scotland (n=1, Section 5.5). Distribution of cases of cetacean interspecific and intraspecific aggression is shown in Figure 32.

In addition, recent cases of grey seal predation have also been diagnosed in harbour porpoises found stranded in various parts of the UK (n=19, Figure 33 and Plate 52), following recent research on this area (e.g. Haelters et al. 2013, Leopold et al. 2014, Stringell et al. 2015). It is likely that this issue has been under diagnosed in the UK, as findings in these cases were initially conflated with other forms of physical trauma (e.g. shipstrike, Deaville et al. 2013). It should be noted that a review of shipstrike cases was undertaken by the CSIP recently and any potential cases of grey seal predation were revised accordingly.

All cases of interspecific aggression occurred in regions of sympatric distribution between the various species.

Table 18 Diagnosed cases of interspecific and intraspecific aggression in the UK (1991-2017)

<table>
<thead>
<tr>
<th>Species</th>
<th>Necropsies</th>
<th>Number</th>
<th>Proportion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Harbour porpoise</td>
<td>2221</td>
<td>424*</td>
<td>19.1%</td>
</tr>
<tr>
<td>Bottlenose dolphin</td>
<td>85</td>
<td>6</td>
<td>7.1%</td>
</tr>
<tr>
<td>Short-beaked common dolphin</td>
<td>725</td>
<td>4</td>
<td>0.6%</td>
</tr>
<tr>
<td>Striped dolphin</td>
<td>149</td>
<td>2</td>
<td>1.3%</td>
</tr>
<tr>
<td>Long-finned pilot whale</td>
<td>101</td>
<td>1</td>
<td>1.0%</td>
</tr>
<tr>
<td>White-beaked dolphin</td>
<td>123</td>
<td>1</td>
<td>0.8%</td>
</tr>
</tbody>
</table>

* includes both bottlenose dolphin attack (n=405) and grey seal predation (n=19)
Figure 32 Distribution of cetacean interspecific and intraspecific aggression cases in the UK (1991-2017)

Figure 33 Distribution of grey seal predation cases in the UK
Plate 41 Harbour porpoise with encircling lesions consistent with entanglement in monofilament fishing gear (SW2002/265, credit CSIP-ZSL)

Plate 42 Short-beaked common dolphin with excised tail flukes at Downderry Cornwall (SW2017/138, credit CWTMSN)

Plate 43 Humpback whale found entangled off Helmsdale (SW2015/183, credit CSIP-SRUC)

Plate 44 Minke whale with characteristic ropemarks on dorsal tail flukes (SW2015/408, credit CSIP-SRUC)

Plate 45 Parallel dorsal incisions on dorsal aspect of a common dolphin stranded in Devon, consistent with shipstrike (SW2015/379, credit CSIP-ZSL)

Plate 46 Parallel incisions on Risso’s dolphin tailstock consistent with shipstrike (SW2015/419, credit CSIP-MEM)
Plate 47 Large abscess in the ventral abdomen of a minke whale stranded at Whitehills, Aberdeenshire (SW2014/321, credit CSIP-SRUC)

Plate 48 Heavy gastric parasitism in the cardiac stomach of a common dolphin stranded in Poole (SW2013/477, credit CSIP-ZSL)

Plate 49 Harbour porpoise in poor nutritional (marked hollowing of flanks), cause of death starvation (SW2002/5, credit CSIP-ZSL)

Plate 50 Starved neonate harbour porpoise-hollowed flanks and yellow tinge of blubber due to jaundice (SW2010/233, credit CSIP-ZSL)

Plate 51 Rakemarks on dorsal aspect of a bottlenose dolphin calf’s head consistent with bottlenose dolphin attack (infanticide) (SW2016/402, credit CSIP-ZSL)

Plate 52 Harbour porpoise found stranded in Suffolk with pathology consistent with grey seal predation (SW2014/29)
Figure 33 Interannual variation in selected cause of death categories in UK stranded harbour porpoises examined at post-mortem (1991-2017)

Figure 34 Interannual variation in proportions of selected cause of death categories in UK stranded harbour porpoises examined at post-mortem (1991-2017)
Figure 35 Interannual variation in selected cause of death categories in UK stranded short-beaked common dolphins examined at post-mortem (1991-2017)

Figure 36 Interannual variation in proportions of selected cause of death categories in UK stranded short-beaked common dolphins examined at post-mortem (1991-2017)

8.1 Research on pollutant exposure and potential toxic effects

Trends in Persistent Organic Pollutants (POPs) in harbour porpoises
Continued collaboration between CEFAS and the UK strandings programme reported marked and ongoing declines in tissue concentrations of organochlorine pesticides (e.g. DDTs), brominated flame retardants (Law et al. 2012a) and butyltins (Law et al. 2012b) in UK-stranded harbour porpoises. Other newer chemical compounds including the alternative brominated and chlorinated flame retardants such as tetrabromo-p-xylene (TBX), tetrabromo-o-chlorotoluene (TBCT) and 2,3-dibromopropyl-2,4,6-tribromophenyl ether (TBP-DBPE) and Dechlorane Plus (DDC-CO) isomers [Law et al. 2013a], perfluoroalkyl substances (PFASs) such as perfluorooctane sulphonate (PFOS) and perfluorooctanoic acid (PFOA) in (Law et al. 2008) and emerging organophosphorus flame retardants (PFRs) and plasticisers (Papachlimitzou et al. 2015) were detected in some UK-stranded harbour porpoise samples. With the possible exception of PFOS, the toxicological risk of all these older and newer POPs was considered to be relatively low, because they occurred at either relatively low levels or below levels of analytical detectability.

In contrast, the industrial polychlorinated biphenyl (PCB) concentrations have reached a high plateau in UK-stranded harbour porpoises since 1998 - following earlier reductions due to regulation of commercial use (Law et al. 2012a). Unlike the levels of the other POPs, PCBs levels still exceed thresholds for PCB toxicity in many individual harbour porpoises (Law et al 2012a) and other cetacean species in UK and Europe (Jepson et al. 2016). During 2013, a smaller study on organochlorine pesticides and PCBs in by-caught common dolphins was published (Law et al. 2013b).

PCB exposure and potential toxic effects in UK/European cetaceans
In UK-stranded harbour porpoises, statistical associations were found between PCB exposure and involution of lymphoid tissue in the thymus of UK-stranded harbour porpoises (n=170), consistent with PCB-induced immune-toxicity (Yap et al. 2012). Another study of 329 UK-stranded female harbour porpoises (1990-2012) found that 25/127 (19.7%) sexually mature females had evidence of reproductive failure (foetal death, aborting, dystocia or stillbirth) and a further 21/127 (16.5%) had infections or tumours of the reproductive tract that directly caused reproductive failure (Murphy et al. 2015). A much lower pregnancy rate of 50% was estimated for “healthy” female porpoises that died of traumatic causes of death, compared to other harbour porpoise populations in more pristine environments that tend to calve annually (e.g. Iceland; Greenland) (Murphy et al. 2015).

A large pan-European meta-analysis of PCBs in stranded or biopsied cetaceans (4 species)(n= >1000), demonstrated that several European species currently have markedly elevated blubber PCB concentrations (Jepson et al. 2016). The study included PCB data on harbour porpoises (n=706), bottlenose dolphins (n=138), striped dolphins (n=220) and killer whales (n=24) sampled across Europe between 1990 and 2012. PCBs concentrations in the UK-stranded harbour porpoises were moderately high (mean PCB = 10-20 mg/kg lipid) and excessively high in the dolphins (mean PCB = 50-350 mg/kg lipid). Time trend analyses also showed that PCBs stopped declining in 1998 in UK-stranded harbour porpoises. The high and stable PCB exposures were associated with small populations, long-term population declines or a contraction of range in bottlenose/striped dolphins and killer whales in the UK and other parts of Europe that were not adequately explained by other factors (e.g. bycatch or other anthropogenic causes of mortality). Excessively high PCBs were therefore considered to be the predominant driver of on-going population declines in bottlenose dolphins and killer whales across Europe (Jepson et al. 2016). An earlier study...
had found a link between high PCBs and *Brucella ceti* infection in a bottlenose dolphin from southwest England (Davison *et al.* 2011).

The few remaining coastal killer whale populations appear close to extinction within the industrialized regions of Europe, at least partly because they have very low or zero rates of reproduction (Jepson *et al.* 2016). An adult female killer whale (SW2016/8) found dead stranded on Tiree in the Hebrides on 1st January 2016 was diagnosed to have died due to entanglement. She was subsequently identified as 'Lulu', one of the last remaining killer whales from the Scottish resident 'west coast community' population. This group specializes in feeding on marine mammals. Her blubber PCB burden (957mg/kg lipid) was 100 times greater than a widely used marine mammal PCB toxicity threshold (Kannan *et al.* 2000). “Lulu” was at least 20 years old but, based on analysis of her ovaries, she had never reproduced.

Following this publication, a global assessment of the likely PCB risk to marine apex predators was conducted (Jepson and Law 2016). Killer whales remain the most highly PCB-contaminated mammalian species on Earth, with very high PCB concentrations found throughout their range (Arctic-Antarctic). This is mainly due to their longevity and their trophic level – with marine mammal-eating ecotypes having the very highest exposures. The relatively long lactation period in cetaceans – compared to other marine taxa such as phocid seals – facilitates considerable transmission of PCBs from mother to calf – potentially up to 90% or more of the mother’s body burden. A global PCB effects modelling paper rather grimly predicts that more than 50% of the world’s killer whale populations will collapse, solely due to their PCB exposures (Desforges *et al.*, in review). Killer whales that eat large fish or other marine mammals are predicted to suffer the greatest toxic effects.

**PCB-related policy implications (UK/EU/international)**

In 2017, two policy-focussed publications on the PCB threat to cetaceans in Europe (Law and Jepson 2017) and globally (Stuart-Smith and Jepson 2017) were published. Both papers showed that the bans on PCB manufacture/use are insufficient – on their own - to fully protect human health or to conserve wildlife in UK/Europe. The US is relatively proactive in terms of PCB mitigation nationally and at State level - including numerous US Environmental Protection Agency “Superfund sites” actively decontaminating sites contaminated with PCBs and other hazardous materials. Perhaps as a direct result, PCB levels in the US have slowly declined in humans, fish and other biota over several decades. Policy makers in Europe should consider any important science and policy lessons from the more aggressive PCB risk assessment and decontamination adopted across the US (Law and Jepson 2017).

The global progress so far to comply with the Stockholm Convention in relation to PCBs has been very poor (Stuart-Smith and Jepson 2017). A 2015 United Nations Environment Programme assessment estimates that the vast majority (>80%) of PCB-contaminated equipment and materials, around 14 million tonnes, still requires elimination. On the present rates of PCB elimination or mitigation, many countries, including some European countries, will not achieve the 2025 and 2028 targets of the Stockholm Convention. The potential human health effects of PCBs should also be considered, via eating highly PCB-contaminated fish, or from atmospheric exposures from PCB-containing joint sealants in some tower blocks. More effort is urgently needed by countries to comply with the terms of the *Stockholm Convention*, particularly in Europe. For example, only Norway, Sweden and Switzerland have established procedures for secure disposal or destruction of highly contaminated PCB in joint sealants.
8.2 Summary of additional (peer reviewed) research activity (2011-2017)

During the period 2011-2017, collaborative research activity using data or tissue samples derived from the CSIP resulted in the production of 87 publications in peer-reviewed scientific journals (see Appendix 1), some of which are summarised below. Papers referred to in the following text are available in Appendix 1. Further details of collaborations that gave rise to these publications are available within CSIP annual reports (e.g. Deaville et al. 2018b).

Anatomy

A publication on the head and neck anatomy of sea turtles (Cryptodira: Chelonioida) and skull shape in testudines (Jones et al. 2012). A paper calculating the weight of entangled right whales (Eubalaena glacialis) at sea was published in order to facilitate accurate dosing of sedatives to enable disentanglement of live whales (Barratclough et al. 2014).

Cetacean Mass Stranding Events (MSEs)

A paper investigating the most probable cause(s) of a large mass stranding of common dolphins in Falmouth Bay, Cornwall that occurred in June 2008 (Jepson et al. 2013).

Climate Change


Distribution, Abundance and Population Structure

In harbour porpoises, phenotypic and genetic divergence among different populations and was associated with habitat regions in the North Sea and adjacent seas (De Luna et al. 2012) and mixing of porpoise ecotypes in south western UK waters revealed by genetic profiling (Fontaine et al. 2017). A novel analysis of the stranding data and stranding anomalies for the harbour porpoise in the North Sea and the Bay of Biscay was conducted (Peltier et al. 2013).

For common dolphins, the contribution of stranding data to monitoring and conservation strategies was assessed by developing spatially explicit mortality indicators in the eastern North Atlantic (Peltier et al. 2014). Another paper estimated common dolphin bycatch from data from stranding schemes in the northeast Atlantic (Peltier et al. 2016).

The phylogeography and population dynamics of the Atlantic white-sided dolphin in the North Atlantic (Banguera-Hinestroza et al. 2014) was reported along with a genome-wide catalogue of single nucleotide polymorphisms in white-beaked and Atlantic white-sided dolphins (Fernández et al. 2017).

For bottlenose dolphins, a habitat-driven population structure was derived in the North-East Atlantic (Louis et al. 2014a). Another paper reported on ecological opportunities and specializations in bottlenose dolphins shaped by genetic divergence (Louis et al. 2014b).

For killer whales, the genetic differentiation among North Atlantic killer whale populations was described (Foote et al. 2011). Another publication used a multi-disciplinary approach to
identify a critically endangered killer whale management unit in the Strait of Gibraltar (Esteban et al. 2016).

For long-finned pilot whales, population diversity and structure in Atlantic waters was assessed through biogeochemical and genetic markers (Monteiro et al. 2015) and Major Histocompatibility Complex (MHC) class II sequence poly-morphism (Monteiro et al. 2016).

An assessment of killer whale rake mark occurrence in the Eastern Canada-West Greenland bowhead whale (Balaena mysticetus) population was conducted (Reinhart et al. 2013). Stable isotope analysis of baleen reveals resource partitioning among four sympatric species of rorqual and population structure in fin whales in the Northeast Atlantic (Ryan et al. 2013). Finally, for all cetaceans, methods for quantifying baseline variability in cetacean stranding rates were reported to improve the ecological value of the strandings record as a monitoring tool (ten Doeschate et al. 2017).

**Diet and Nutrition**

The regional variation in marine mammal diet was determined using IP$_{25}$ and related highly branched isoprenoid (HBI) diatom biomarkers (Brown et al. 2013). Seasonality of diet including stomach contents was described for the northern bottlenose whale in the NE Atlantic (Fernández et al. 2014). Stable isotope studies were used to assess the feeding ecology of long-finned pilot whales in the Northeast Atlantic Ocean (Monteiro et al. 2015). Finally, a study evaluated the morphometric and metabolic markers of body condition in harbour porpoises (Kershaw et al. 2017).

**Evolutionary Biology**

The evolution of promoters and enhancers active in liver across 20 mammalian species from six diverse orders was studied by profiling genomic enrichment of H3K27 acetylation and H3K4 trimethylation (Villar et al. 2015). It found that rapid evolution of enhancers is a universal feature of mammalian genomes and most of the recently evolved enhancers arise from ancestral DNA exaptation, rather than lineage-specific expansions of repeat elements. In contrast, almost all liver promoters are partially or fully conserved across these species. Our data further reveal that recently evolved enhancers can be associated with genes under positive selection, demonstrating the power of this approach for annotating regulatory adaptations in genomic sequences. These results provide an important insight into the functional genetics underpinning mammalian regulatory evolution, including marine mammals.

**Immunology**

Variation in European harbour seal immune response genes and their susceptibility to phocine distemper virus (PDV) was assessed in this immunogenetic study (McCarthy et al. 2011).

**Life History**

There were two publications on the life history of common dolphins. The first conducted a review of the distribution, ecology and conservation status of the short-beaked common dolphin in the North-east Atlantic (Murphy et al. 2013). The second examined the deposition of growth layer groups in dentine tissue of two captive common dolphins (Murphy et al. 2013). A third paper reported on the life history of harbour porpoises in Scottish (UK) waters (Learmonth et al. 2014).
Microbiology

Research on marine mammal *Brucella* sp. continues and has increased the number of species of cetacean known to harbour *Brucella ceti* in UK waters to ten. High exposure to PCB’s and infection with, *Brucella ceti* has been shown in eight bottlenose dolphins in southwest England (Davison et al. 2011). Several Brucellosis case reports have also been published during this report period. The first case of meningitis and arthritis associated with *Brucella ceti* in a short-beaked common dolphin (Davison et al. 2013). First report of *Brucella ceti* associated meningoencephalitis in a long-finned pilot whale (Davison et al. 2015). *Brucella ceti* infection in a common minke whale with associated pathology (Davison et al. 2017). *Brucella ceti* was also isolated for the first time from a Sowerby’s beaked whale (Foster et al. 2015). A survey of exposure to *Brucella pinnipedialis* in harbour seals and its role if any in their decline, found no convincing evidence (Kershaw et al. 2017). A serological study of hooded seals found age-dependent prevalence of anti-Brucella antibodies (Nymo et al. 2013). A review of both *Brucella ceti* and *B.pinnipedialis* infections marine mammals (Godfroid et al. 2013) was a chapter in New Directions in Conservation Medicine: Applied Cases of Ecological Health. The first characterisation of North American marine mammal *Brucella* sp. isolates using European isolates for comparison was also published (Whatmore et al. 2017).

A review of *Salmonella* sp. isolated from free-ranging and stranded grey seal pups and compared with strains from the same serovars isolated from human clinical cases, livestock, wild mammals and birds in Scotland (Baily et al. 2016). *Salmonella bovismorificans* was the most common isolate and was indistinguishable from isolates found in Scottish cattle. *Salmonella typhimurium* was infrequent mostly similar to isolates found in garden birds and, in one case, identical to a highly multidrug resistant strain isolated from a human child. *Salmonella haifa* was rare but isolates were indistinguishable from that of a human clinical isolate. These results suggest that *S. bovismorificans* may circulate between grey seal and cattle populations and that both *S. typhimurium* and *S. haifa* isolates are shared with humans, raising concerns of microbial marine pollution.

*Mycobacterial* infections are rare in marine mammals, however there were two cases reported during this reporting period. *Mycobacterium bovis* was isolated from a grey seal pup in Cornwall (Barnett et al. 2013) this isolate was the same spoligotype as that found in cattle and badgers in Wales suggesting the seal may have been bitten by an infected badger. The second case *Mycobacterium avium* subsp. *avium* was found in a free-ranging common seal that had been shot in Scotland. (Foster et al. 2013).

The first description of the isolation of *Helicobacter cetorum* in a striped dolphin and evidence of *H. cetorum* infection in cetaceans from European waters was also published during this period (Davison et al. 2014). Two new members of the family Pasteurellaceae were published; *Bisgaardia hudsonensis* gen. nov., sp. nov. and an additional genomospecies, isolated from seals (Foster et al. 2011). A review of *Bordetella bronchiseptica* isolates associated with respiratory disease in seals comprise unique, host-adapted and highly clonal populations (Register et al. 2015). Finally, following the isolation of *Mycoplasma phocicerebrale* from the flipper wound of a grey seal in Cornwall, UK, surveillance for *Mycoplasma* species was extended to include other seals rescued or found dead around the UK. *Mycoplasma phocicerebrale* was frequently detected from the teeth of seals and from infected wounds and respiratory tracts. *Mycoplasma phocirhinis, Mycoplasma phocidae*, and some unidentified *Mycoplasma* species were also detected. *Mycoplasma phocicerebrale* and *M. phocidae* were the only bacteria consistently identified from the wound infections, but their role in respiratory and other diseases remains unknown, as other bacteria were also isolated from respiratory sites (Ayling et al. 2011).
Pathology

In cetaceans, a novel methodology for in situ gas sampling, transport and laboratory analysis of gases from stranded cetaceans was described (Bernaldo de Quirós et al. 2011). The first evidence of ovotestis (true hermaphroditism) in a cetacean species (Murphy et al. 2011) was reported. The first evidence of chronic gas embolism in a harbour porpoise in German waters was described (Siebert et al. 2013). Criteria and case definitions for serious injury and death of marine mammals caused by anthropogenic trauma including: underwater entrapment, chronic entanglement, sharp and blunt vessel, and gunshot (Moore et al. 2013). The pathology and causes of death were described for a range of stranded cetacean species in the Canary Islands, Spain (1999-2005) (Arbelo et al. 2013). Another study considered whether dolphin morbillivirus virulent for white beaked dolphins (van Elk et al. 2014) and another reported vertebral column deformities in individuals the same species from the eastern North Atlantic (Bertulli et al. 2015). Fatal asphyxiation in two long-finned pilot whales caused by ingestion or aspiration of common soles (Solea solea) (IJsseldijk et al. 2015). A twin foetus was described in an Atlantic white-sided dolphin that stranded on the coast of Scotland, UK (Davison et al. 2016). The implementation of a method to visualize noise-induced hearing loss in mass stranded cetaceans was recently reported (Morrell et al. 2017).

In pinnipeds, unusual mortality in UK-stranded pinnipeds was reported that was associated with helical (corkscrew) injuries of suspected anthropogenic origin (Bexton et al. 2012). A later publication attributed these spiral “corkscrew” injuries to infantide and cannibalism from adult male grey seals (Halichoerus grypus) (Brownlow et al. 2012).

In marine turtles, the first report of decompression sickness (‘the bends’) in sea turtles – these cases were caused by entanglement in fishing gear (Garcia-Párraga et al. 2014).

Physiology

A review of the physiological and behavioural drivers of decompression stress in diving mammals – specifically including beaked whales - was published (Hooker et al. 2011).

Theoretical Biology

An epidemiological model was published in 2013 using network theory to identify disease outbreaks of unknown origin (Bogich et al. 2013).

Toxicology

In addition to the recent work on the exposure and effects of PCBs and other POPs (see Section 8.1), several other peer-reviewed studies on different aspects of marine mammal toxicology were published. In cetaceans, these included a possible link between Hg and Cd accumulation in the brain of long-finned pilot whales (Gajdosechova et al. 2016a) and the in vivo formation of natural HgSe nanoparticles in the liver and brain of the same species (Gajdosechova et al. 2016b). A large amount of marine debris was found in some individual sperm whales stranded along the North Sea coast in early 2016 (Unger et al. 2016). Radiocarbon (14C) uptake – as associated with nuclear reprocessing – was reported in UK marine mammals (Tierney et al. 2017).

In pinnipeds, the roles of disease epidemiology and persistent organic pollutants (POPs) in the long-term mortality patterns in Caspian seals (Pusa caspica) were reported (Wilson et al. 2014). The detection and effects of harmful algal toxins in Scottish harbour seals and the potential links to population decline were assessed (Jensen et al. 2015).
9 Glossary of terms and acronyms

Acute: Rapid onset
Aetiology: The cause of the disease
APH: Animal and Plant Health Agency
BDMLR: British Divers Marine Life Rescue
By-catch: Incidental catch of non-target species during fishing activity
Chronic: Refers to a persistent, lasting or slow developing disease.
CCW: Countryside Council for Wales
Cold stunned: When marine turtles (hard shell species only) become lethargic or comatose following exposure to a drop in temperature
CSIP: UK Cetacean Strandings Investigation Programme
CWTMSN: Cornish Wildlife Trust Marine Strandings Network
DAERA: Department of Agriculture, Environment and Rural Affairs (Northern Ireland Government)
Defra: The Department for Environment, Food and Rural Affairs
Devolved Administrations: The devolved administrations in Scotland and Wales (Scottish Government and Welsh Government)
Dystocia: Difficulty encountered during the act or process of giving birth
Encephalitis: Inflammation of the brain. Often viral in origin
Enteropathy: Disease or abnormality of the intestinal tract
Epizootic: A rapidly spreading disease which affects a large number of animals in a particular region at the same time
Gastropathy: Disease or abnormality of the stomach/s
Histology: The study of tissue sectioned as a thin slice
IoZ: Institute of Zoology
JNCC: Joint Nature Conservation Committee
Mass stranding: When two or more cetaceans (excluding mother-calf pairs) of the same species strand at the same time and location
MEM: Marine Environmental Monitoring
Meningitis: Inflammation of the meninges, the three membranes covering the brain and spinal cord
Meningoencephalitis: Infection/inflammation of the meninges and/or brain
Morphometric: The measurement of shapes or forms
MSE: Mass stranding event
Neoplasia: The formation of a tumour
NHM: Natural History Museum
OCs: Organochlorine pesticides (e.g. DDT’s, dieldrin etc)
Pathology: The science/study of the origin, nature and course of disease
PBDEs: Polybrominated diphenyl ethers, a class of compounds used predominately as flame retardants
PCBs: Polychlorinated biphenyls (organochlorine pollutants)
PMEs: Post-mortem examinations
PSG: CSIP Project Steering Group
SG: Scottish Government
SMASS: Scottish Marine Animal Strandings Scheme
SMRU: Sea Mammal Research Unit
SRUC: Scotland’s Rural College (Inverness)
Sympatric: Occupying the same/overlapping regions without interbreeding
Toxicology: The science or study of poisons
UME: Unusual Mortality Event. Defined within the US MMPA as “A stranding that is unexpected; involves a significant die-off of any marine mammal population; and demands immediate response”.
WG: Welsh Government
Zoonosis: Infectious disease of animals that can be transmitted to humans
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Plate 53 Fin whale stranded at Shingle Street, Suffolk (SW2012/420, credit Andrew Capell
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