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Conservation Plan for Cetaceans in Irish waters

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Cover image: Bottlenose dolphins in the Lower River Shannon candidate SAC (© Simon Berrow/SDWF)

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Preface

In Council Directive 92/43/EEC of 21 May 1992 on the conservation of natural habitats and of wild fauna and flora (i.e. the EU Habitats Directive), Article 12 requires:

1. *Member States shall take the requisite measures to establish a system of strict protection for the animal species listed in Annex IV (a) in their natural range, prohibiting:*

   (a) all forms of deliberate capture or killing of specimens of these species in the wild;
   (b) deliberate disturbance of these species, particularly during the period of breeding, rearing, hibernation and migration;
   (c) deliberate destruction or taking of eggs from the wild;
   (d) deterioration or destruction of breeding sites or resting places.

2. *For these species, Member States shall prohibit the keeping, transport and sale or exchange, and offering for sale or exchange, of specimens taken from the wild, except for those taken legally before this Directive is implemented.*

3. *The prohibition referred to in paragraph 1 (a) and (b) and paragraph 2 shall apply to all stages of life of the animals to which this Article applies.*

4. *Member States shall establish a system to monitor the incidental capture and killing of the animal species listed in Annex IV (a). In the light of the information gathered, Member States shall take further research or conservation measures as required to ensure that incidental capture and killing does not have a significant negative impact on the species concerned.*

On 11 January 2007 the European Court of Justice ruled that Ireland had failed to fulfil its obligations in relation to *inter alia* Article 12 of the Habitats Directive (Case C-183/05). This plan was prepared as part of Ireland's response to this judgement. Its primary purpose is to identify the principal scientific, administrative and regulatory provisions that must be established in a coherent and integrated manner to ensure that strict protection is provided to all cetaceans occurring within the Irish Exclusive Economic Zone.

This plan will be further reviewed in 2013 with a view to refining a monitoring programme (including clear scientific and/or species-specific objectives where necessary) for the period 2013-2018.

1.0 Introduction

According to the International Whaling Commission (IWC), an estimated 86 cetacean (whales, dolphins and porpoises) species are recognised worldwide. These include 14 species of Mysticete or baleen whale and 72 Odontocete or toothed whale and dolphin species, among which there are six species of Phocoenidae (porpoises), 36 species of Delphinidae (dolphins) and 21 species of Ziphiidae (beaked whales).

Cetaceans account for 48% of all the native species of mammals, both marine and terrestrial, recorded in Ireland and Irish waters are thought to contain important habitats for cetaceans within the northeast Atlantic (Berrow, 2001). To date, 24 species of cetacean, or 28% of species described worldwide, have been recorded in Ireland. Irish cetaceans include six species of baleen whale and eighteen species of toothed whale, including five species of beaked whale. Twenty-two of these have been reported stranded ashore and 20 species observed at sea. Two species (Pygmy sperm whale and Gervais' beaked whale) are only known from stranded individuals and two species (Northern right whale and White whale/beluga) have only been recorded historically, with neither species occurring in the stranding record so far.

A systematic list of all species recorded in Ireland to date is shown in Table 1 together with their conservation status as determined in 2006-07 (NPWS, 2008). Individual species profiles are provided in Appendix 1.

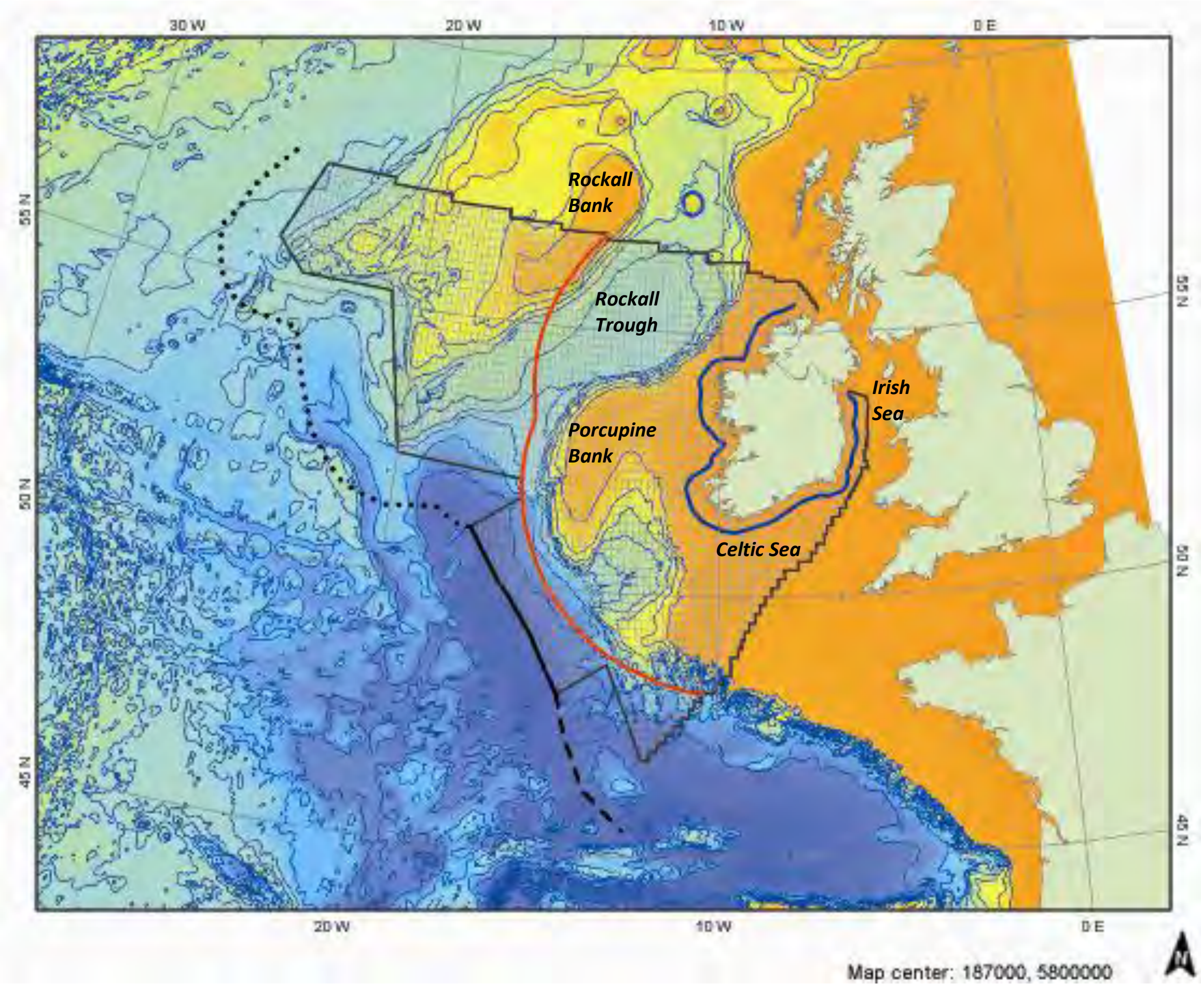

Figure 1. Map of Ireland's maritime area, including the 12 nm Territorial Sea limit (blue line), the 200 nm Exclusive Economic Zone (EEZ) limit (red line), the outer limits of the Continental Shelf (black solid line) and bathymetric features (in 500m depth contours).

Table 1. Cetacean species recorded in Irish waters listed by grouping/family and general size (Classification follows Rice, 1998). Conservation status derived from the Irish report to the EU under Article 17 of the Habitats Directive (NPWS, 2008).

Species	Latin name and Authority	Conservation Status [NPWS, 2008]
Baleen whales		
Blue whale	*Balaenoptera musculus* (Linnaeus, 1758)	Unknown
Fin whale	*Balaenoptera physalus* (Linnaeus, 1758)	Good
Sei whale	*Balaenoptera borealis* (Lesson, 1828)	Unknown
Common minke whale	*Balaenoptera acutorostrata* (Lacépède, 1804)	Good
Humpback whale	*Megaptera novaeangliae* (Borowski, 1781)	Unknown
Northern right whale	*Eubalaena glacialis* (Müller, 1776)	Vagrant
Toothed whales and dolphins		
Sperm whale	*Physeter macrocephalus* (Linnaeus, 1758)	Unknown
Northern bottlenose whale	*Hyperoodon ampullatus* (Forster, 1770)	Unknown
Sowerby's beaked whale	*Mesoplodon bidens* (Sowerby, 1904)	Unknown
Gervais' beaked whale	*Mesoplodon europaeus* (Gervais, 1855)	Vagrant
True's beaked whale	*Mesoplodon mirus* (True, 1913)	Vagrant
Cuvier's beaked whale	*Ziphius cavirostris* (G. Cuvier, 1823)	Unknown
White whale	*Delphinapterus leucas* (Pallas, 1776)	Vagrant
Long-finned pilot whale	*Globicephala melas* (Traill, 1809)	Unknown
Pygmy sperm whale	*Kogia breviceps* (Blainville, 1838)	Vagrant
Killer whale	*Orcinus orca* (Linnaeus, 1758)	Unknown
False killer whale	*Pseudorca crassidens* (Owen, 1846)	Vagrant
Risso's dolphin	*Grampus griseus* (G. Cuvier, 1812)	Unknown
Common bottlenose dolphin*	*Tursiops truncatus* (Montagu, 1821)	Good
Atlantic white-sided dolphin	*Lagenorhynchus acutus* (Gray, 1828)	Good
White-beaked dolphin	*Lagenorhynchus albirostris* (Gray, 1846)	Unknown
Common dolphin	*Delphinus delphis* (Linnaeus, 1758)	Good
Striped dolphin	*Stenella coeruleoalba* (Meyen, 1833)	Unknown
Harbour porpoise*	*Phocoena phocoena* (Linnaeus, 1758)	Good

* Included on Annex II of the EU Habitats Directive; all species are on Annex IV of the Directive

2.0 Current Knowledge

2.1 Distribution in Ireland

Of the 24 species reported in Ireland, ten species (Harbour porpoise, Atlantic white-sided dolphin, White-beaked dolphin, Bottlenose dolphin, Common dolphin, Risso's dolphin, Killer whale, Northern bottlenose whale, Long-finned pilot whale and Sperm whale) are thought to be present year-round while it is possible that Cuvier's beaked whale and Sowerby's beaked whale are also resident in deep-water gullies off the western seaboard (Berrow, 2001). Six species (Minke whale, Blue whale, Fin whale, Sei whale, Humpback whale and Striped dolphin) are thought to be seasonally present and six species (Northern right whale, White whale or beluga, False killer whale, Gervais' beaked whale, True's beaked whale and Pygmy sperm whale) are thus far classified as rarely occurring or vagrant (NPWS, 2008).

The Common dolphin and Harbour porpoise are consistently the most frequently reported species stranded on the Irish coast with Minke whale the most frequently reported stranded baleen whale species (Berrow and Rogan, 1997; O'Connell and Berrow, 2007; 2008). This pattern in stranding occurrence is relatively consistent with sighting records with Harbour porpoise, Common dolphin, Bottlenose dolphin, Minke whale and Fin whale the most frequently sighted species in Ireland (Pollock *et al.,* 1997; Berrow *et al.,* 2002a).

The Harbour porpoise is the most widespread and frequently sighted species in Ireland, occurring in continental shelf waters and around the Irish coast. It appears to be more abundant off the southwest coast and in the Irish Sea and less abundant off the northwest but this could be due to reduced recording effort (Reid *et al.,* 2003). Harbour porpoises rarely occur over deep water but have been observed over relatively shallow (<200m) offshore banks.

Common dolphins are the second most frequently sighted species in Ireland and appear to be most abundant off the southwest and west coasts and in the Celtic Sea (Reid *et al.,* 2003). They are less commonly sighted in the Irish Sea and there is some evidence of movement into the southern Irish Sea in the autumn (Brereton *et al.,* 2007). They are also observed in deep offshore waters, including those overlying the continental slope and nearby basins (e.g., Rockall Trough) (Ó Cadhla *et al.,* 2004; Cañadas *et al*., 2008).

The bottlenose dolphin shows both a coastal and offshore distribution with most sighting records off the western seaboard and in the Celtic Sea (Reid *et al.,* 2003; Ó Cadhla *et al*., 2004; SCANS-II, 2008; CODA, 2008). The species is also found in the Irish Sea and occurs in waters along the edge of the continental shelf, where it may associate with pilot whales and Atlantic white-sided dolphins. Although there is no evidence that offshore-occurring Bottlenose dolphins are of a different ecotype, which has been shown for the northwest Atlantic (Torres *et al.,* 2003),recent photo-identification and genetic evidence from the population inhabiting the Shannon Estuary suggest a degree of isolation from live and stranded animals encountered elsewhere around the Irish coast (E.Rogan, UCC; IWDG, *pers.comm*.).

Atlantic white-sided dolphin and White-beaked dolphins tend to occur offshore, with white-sided dolphins occurring mainly along the western seaboard and in waters overlying offshore banks and White-beaked dolphins more frequently sighted in the northwest (Reid *et al.,* 2003; Ó Cadhla *et al.,* 2004; Wall *et al.,* 2006) and are not commonly seen close to land. Observed Risso's dolphin distribution is more clustered with regular sightings inshore off the northwest and southeast coasts (Berrow *et al.,* 2002a; Reid *et al*., 2003). Killer whales have been observed off all coasts and in the Irish Sea but mainly in shallow continental shelf waters. Long-finned pilot whales tend to occur in waters overlying the shelf edge and continental slope, especially off the northwest and southwest coasts (Gordon *et al*., 1999; Ó Cadhla *et al.,* 2004). Deep-diving toothed whales such as Sperm whales and beaked whales tend to occur in deep Atlantic waters off the western seaboard and over deep gullies and canyons (Reid *et al.,* 2003; Aguilar de Soto *et al.,* 2004).

The Minke whale is the most widespread and most frequently seen baleen whale in Ireland. It occurs off all coasts, including the Irish Sea. Most records are from southern and southwestern coastal waters. However, this may be due to recording effort (Berrow *et al*., 2002a; Reid *et al.,* 2003). The species has also been observed over offshore banks (Wall *et al.,* 2006). Fin whales are recorded seasonally off the south coast of Ireland, with peaks in the number of animals in the autumn and early winter (Berrow *et al.,* 2002; Whooley *et al.,* 2008). Fin whales, as well as Humpback whales, Blue whales and Minke whales, are also known to migrate along the shelf edge, which is thought to be a migratory corridor (Clark and Charif, 2000; Charif *et al.,* 2001; Charif and Clark, 2009). Humpback whales have been recorded in small numbers off all coasts including the Irish Sea but records offshore are relatively scarce (Berrow *et al.,* 2002a; Ó Cadhla *et al*., 2004).

For all other species the distribution in Ireland is not well known due to low numbers of sighting records. Stranding records suggest there has been a change in distribution of Striped dolphins, which appear to be occurring more frequently in Ireland since the 1980s (O'Connell and Berrow, 2007).

2.2 Habitat

Irish waters contain an array of potential marine habitats for cetaceans, including shallow continental shelf waters (<200m deep), those overlying the continental slope, deep ocean basins off the western seaboard (c. 2,500-4000m depth), gullies and canyons along the continental slope and shallow offshore banks (<200m depth). Shallow continental shelf waters extend up to 200 km from the coast and include the Irish Sea. The edge of the continental shelf stretches up to 800km along the Atlantic seaboard and approaches to within c. 60-100km from the northwest and southwest coasts respectively. All habitats are extensive in area with approximately 297,000 km^2 of continental shelf waters, 170,000 km^2 of deep waters, 115,000 km^2 of waters overlying the continental slope and 37,500 km^2 covering offshore banks.

Shallow continental shelf waters are a habitat for Harbour porpoises, which are strongly associated with shallow water where they predominantly feed on demersal fish species (i.e. living on or near the sea floor). Sightings of this species offshore are relatively uncommon (Ó Cadhla *et al*., 2004) but this may be due in part to low sighting and acoustic survey effort in favourable sea conditions.

The margin of the continental shelf and its slope into deeper oceanic basins are particularly productive, with cold, nutrient rich waters driven to the surface by the Gulf Stream, causing them to mix with warmer surface waters. This stimulates the formation of large plankton blooms, resulting in high densities of fish and fish-eating predators such as marine mammals and seabirds. High densities of Common dolphin tend to occur in waters over the shelf edge off the southwest, west and northwest coasts (e.g., Ó Cadhla *et al*., 2001; Ó Cadhla *et al.,* 2004; Wall *et al.,* 2006) where they are thought to be feeding on schools of pelagic fish. However, no clear habitat preferences could be identified between Atlantic white-sided dolphin and Common dolphins recorded during the SIAR survey carried out off western Ireland in the summer of 2000 (Ó Cadhla *et al*., 2001; Ó Cadhla *et al.,* 2004).

Atlantic waters overlying the continental shelf and slope are thought to be important for the migratory movements of large whale species occurring seasonally in Irish waters (e.g., Blue whale, Fin whale, Humpback whale; Clark and Charif, 1998) although the mechanism and dynamics of such movement are poorly understood at present. These large baleen whales may feed on zooplankton (e.g., krill) and small schooling fish. Fin whales, Sei whales and Blue whales were historically captured in significant numbers by commercial whalers working from northwest Mayo at the turn of the 20th century (Fairley, 1981). Sei whales, Sperm whales, Humpback whales and Northern right whales were also caught. Catches are thought to have taken place predominantly in waters overlying the continental shelf edge and slope off Ireland's northwest. Offshore banks (i.e. Porcupine Bank, Rockall Bank, Hatton Bank) have also been shown to provide additional habitats of importance for cetacean diversity and abundance (Cronin and Mackey 2002; Ó Cadhla *et al*., 2004; Wall *et al*., 2006).

Along with continental slope waters, deeper abyssal waters may provide good habitat for Sperm whales and other deep-diving species such as the Northern bottlenose whale (Aguilar de Soto *et al.,* 2004; Ó Cadhla *et al*., 2004). Ireland also contains some of the most extensive deep-water canyon habitat in Europe, which are hotspots of high faunal biomass (Weaver *et al.,* 2004) and are a preferred habitat for beaked whales (MacLeod and Mitchell, 2006). Canyon systems occur intermittently along the continental slope (Fig. 1) especially off the southwestern territorial limits (e.g., Whittard Canyon), off the northwest of Ireland and in the Porcupine Seabight. Five species of beaked whale have been recorded thus far in Ireland (Table 1). However some have only been recorded via strandings and positive identification to species level of live animals at sea has been extremely rare.

Closer inshore, the lower Shannon Estuary is a very important habitat for a resident population of Bottlenose dolphins, which are found regularly in two core areas (Ingram, 2000). These preferred sites have the greatest slope and water depth, suggesting the influence of environmental heterogeneity on habitat use by this species. Analysis of the known range of individual dolphins has shown that a degree of habitat partitioning can occur within the inner estuary itself (Ingram and Rogan, 2002). Elsewhere in Ireland, groups of Bottlenose dolphins have frequently been recorded along the west and south coasts, including Donegal Bay, Broadhaven Bay, Blacksod Bay and inshore waters of northwest Co. Mayo, Killary Harbour and north Connemara, Brandon Bay, Cork Harbour and Youghal (e.g., Ingram and Rogan, 2003; Ingram *et al*., 2001, 2003; Ó Cadhla *et al*., 2003; Englund *et al*., 2006; Berrow *et al*., 2008b; Oudejans, 2008; Ryan *et al., in press*).

2.3 Abundance

Cetacean abundance in Irish waters is most commonly estimated via sighting records obtained during surveys at sea, though relative abundance of some species occurring close to the coast can also be assessed from land. A number of different methods are used to gather cetacean sightings data (Evans and Hammond, 2004). *Casual or incidental sightings* are observations made while an observer's attention is not directed solely at watching for cetaceans. *Targeted observations* include watches where survey effort is also recorded. These may be carried out from vantage points on land or from survey platforms at sea or in the air. During targeted surveys the amount of effort is quantified and relative abundance estimates can be generated. Targeted surveys using platforms of opportunity (e.g., ferries or survey vessels conducting other marine research) involve dedicated cetacean observers but the track of the vessel is not influenced by the observer or presence of animals. Therefore such surveys are not considered ideal, even though observations are quantifiable by the degree of survey effort expended (e.g., sightings per hour spent watching, per km of travel, per km^2 of area covered).

Dedicated surveys conducted from vessels and aircraft allow for the application of a pre-designed sampling regime in a chosen survey area (e.g., line-transect sampling; Buckland *et al*., 1993) in order to obtain absolute abundance estimates. During vessel-based dedicated surveys, two observation platforms may be used to help provide an estimate of (i) the proportion of animals missed along the vessel's track and (ii) the responsive movement of cetaceans to the approaching vessel (e.g., Hammond *et al*., 2002), thereby refining sighting information and estimates for individual species encountered within a given survey area.

Other abundance estimation techniques such as mark-recapture (via photo-identification) can also be carried out for particular accessible species that commonly bear individually unique markings (e.g., Bottlenose dolphin) (Evans and Hammond, 2004). Mark-recapture surveys can not only provide estimates of population size and site fidelity but can also provide a measure of population change with measures of precision if repeated over time. Bottlenose dolphins lend themselves to this technique as they often have unique and permanent marks (e.g., nicks and notches in the dorsal fin) that can be easily photographed and remain on the animal over time.

Abundance estimates for Irish cetacean species to date are from discrete areas, not from the whole population range of the species or stock. A number of large-scale dedicated cetacean surveys, designed to derive absolute abundance and density estimates, have taken place over the last 15 years. These surveys have used conventional distance sampling and double-platform survey methodology, enabling the estimation of *g(0)* (i.e. the proportion of animals on the track-line) and more accurate estimates of cetacean numbers as a result. The first such survey in Irish waters was a European-wide programme termed SCANS and it aimed to survey Harbour porpoises in the North Sea and adjacent waters including the Celtic Sea (Hammond *et al*., 1995; Hammond *et al.,* 2002). The survey was carried out in July 1994 and it produced an abundance estimate of 36,280 Harbour porpoises in the Celtic Sea (Coefficient of Variation or CV=0.57). Harbour porpoise density in this area (0.18 animals per km^2) was among the lowest recorded throughout the survey area, containing a quarter of the highest reported density (0.78) recorded in the North Sea. The total estimate of Harbour porpoises for the whole survey area was 341,366 (95% Confidence Interval or C.I.=260,000-449,000). Abundance estimates were also generated for Minke whales (n=1,195; CV=0.49) and for *Lagenorhynchus* species (Atlantic white-sided dolphins and White-beaked dolphins combined) (n=833; CV=1.02).

A second and more comprehensive pan-European survey (SCANS-II) was carried out in July 2005. This survey sought to derive the absolute abundance of small cetacean populations (particularly of Harbour porpoise, Bottlenose dolphin and Common dolphin) inhabiting the continental shelf waters of the western European Atlantic margin, the North Sea and adjacent waters. For the first time, survey effort covered all of the continental shelf waters around Ireland with shipboard surveys carried out in the Celtic Sea and aerial surveys performed off coastal Ireland and in the Irish Sea.

SCANS-II data were used to calculate abundance estimates for Harbour porpoise, White-beaked dolphin, Bottlenose dolphin, Common dolphin and Minke whale. The overall Harbour porpoise abundance estimate derived by the SCANS-II team was 386,000 (95% CI = 260,000-570,000). This was very similar to the estimate of 340,000 from 1994, suggesting little or no change in the overall population size between surveys. However there were large-scale differences observed in the distribution of Harbour porpoises with a general shift in sighting distribution from the northern North Sea to the southern North Sea and Celtic Sea (SCANS-II, 2008). The density of harbour porpoises in the Celtic Sea had doubled between SCANS (1994) and SCANS-II (2005).

It is suggested that this could reflect a change in the overall distribution of Harbour porpoises rather than an actual population increase and that this may be linked to changes in prey distribution, for example. Harbour porpoise abundance was estimated at 80,613 in the Celtic Sea (CV=0.50), 15,230 in the Irish Sea (CV=0.35) and 10,716 in coastal Ireland (CV=0.37). White-beaked dolphin abundance was estimated at 75 individuals (CV=0.80) in the Irish Sea, while Bottlenose dolphin abundance estimates were 235 in the Irish Sea (CV=0.75), 313 in coastal Ireland (CV=0.81) and 5,370 in the Celtic Sea (CV=0.49). Total abundance of this species measured in Irish waters was nearly 50% of the estimated 12,645 Bottlenose dolphins in the entire northeast Atlantic survey area. Common dolphin abundance estimates were 366 in the Irish Sea (CV=0.73), 15,327 in Atlantic coastal Ireland (CV=0.78) and 11,141 in the Celtic Sea (CV=0.61), while Minke whale abundance estimates were 1,073 in the Irish Sea (CV=0.89), 2,222 in Atlantic coastal Ireland (CV=0.84) and 1,719 in the Celtic Sea (CV=0.43).

A third dedicated large-scale survey called Cetacean Offshore Distribution and Abundance in the European Atlantic (CODA) was carried out in July 2007. This project aimed to survey all offshore waters in an area stretching from northern Spain to northern Scotland. The principal objective of CODA was to estimate cetacean abundance, especially for Common dolphin, Bottlenose dolphin, Fin whale and deep-diving species. Acoustic detections were also obtained using a towed hydrophone array. A total of 17 species were recorded throughout the survey area and full results have now become available (CODA, 2008).

A regional scale double-platform survey (SIAR) was also carried out in Ireland during July and August 2000 as part of offshore cetacean and seabird research carried out under Ireland's Petroleum Infrastructure Programme (PIP) (Ó Cadhla *et al.,* 2004). The survey area covered was 120,000 km^2 in size and stretched between southwest Ireland and the west of Scotland extending westwards to cover the Porcupine Bank and part of the Rockall Trough. A total of 126 sightings were made during the course of the survey and 15 species were recorded, consisting mainly of Atlantic white-sided dolphins and Common dolphins. Abundance derived for these two species were 5,490 (CV=0.43) Atlantic white-sided dolphins and 4,496 (CV=0.39) Common dolphins, with densities of 0.046 and 0.039 per km^2 respectively. Acoustic sampling for cetaceans was also carried out on the SIAR survey and offshore species such as Sperm whale and Long-finned pilot whale were commonly recorded (Aguilar de Soto *et al*., 2004).

A number of studies have surveyed Irish waters for cetaceans using ships of opportunity. An opportunistic survey to derive a density estimate of Harbour porpoises was carried out by Leopold *et al.* (1992) between Galway Bay and Cork in July 1989 during a fisheries cruise. A density of 0.77±0.26 harbour porpoises per km^2 was calculated, which gave an abundance estimate of 19,120 (CV=0.34) Harbour porpoises.

Pollock *et al.* (1997) recorded a total of 9,106 individual cetaceans among 13 species between August 1994 and January 1997. The method used was the European "Seabirds at Sea" (ESAS) strip-transect method, performed on board a variety of ships of opportunity, including research vessels, ferries and naval vessels. Coverage was predominantly in coastal and continental shelf waters around Ireland and Common dolphins and Harbour porpoises were the most frequently sighted species. Reid *et al.* (2003) used these data in combining three major UK based datasets to create the first cetacean atlas for northwest European waters. This mapped the distribution and relative abundance of cetaceans around the UK and Ireland from data collected up to 1997.

Thereafter Ó Cadhla *et al.* (2004) and Aguilar de Soto *et al*., 2004 surveyed Atlantic waters further offshore in a cetacean and seabird survey programme carried out under the PIP between July 1999 and September 2001, using the same ESAS visual survey method and cetacean-oriented methods including acoustic surveys. During 442 survey days at sea researchers recorded 772 sightings among 20 of the 24 known cetacean species in Ireland (six baleen whale and 14 toothed whale species). Most sighted were Common dolphins, Atlantic white-sided dolphins, Long-finned pilot whales and Bottlenose dolphins. In addition, Wall *et al.* (2006) carried out cetacean surveys on board the national research vessel the RV Celtic Explorer and survey effort on other ships of opportunity is continuing. Furthermore, Berrow *et al.* (2002a) have also used casual and effort-related sighting records submitted to the Irish Whale and Dolphin Group (IWDG) to map the distribution and relative abundance of cetaceans in Irish waters.

These data have also been incorporated into three Irish Offshore Strategic Environmental Assessments conducted over the basins west of Ireland to date, most recently in the IOSEA3 Environmental Report and Annex (DCENR, 2008). Sections 3.6.1 to 3.6.3 of the Annex include location maps for the last five years of sightings data for the major cetacean species.

On a more local scale, conventional single platform line-transect methodology was used to derive density and abundance estimates of Harbour porpoises at eight Irish coastal sites during July-September 2008. These were North County Dublin, Dublin Bay, Carnsore Point, the Cork coast, Roaringwater Bay, the Blasket Islands, Galway Bay and Donegal Bay (Berrow *et al.,* 2008a; 2008b). This research aimed to inform the National Parks and Wildlife Service (NPWS) on the sites' potential for designation as Harbour porpoise Special Areas of Conservation (SACs). The Blasket Islands candidate SAC (cSAC) was previously surveyed in 2007 using the same methodology (Berrow *et al.,* 2009).

A single-platform method was used in these surveys with *g(0)* assumed to be equal to one (i.e. that all animals occurring along the vessel's track-line were observed). This was unlikely to always be the case but it did enable the comparison of density estimates between sites. During 37 days of surveys, a total of 475 track-lines were surveyed; a total of nearly 21,000km covered in sea state ≤2. A total of 618 individual Harbour porpoises were recorded in 332 sightings. Three other species (Bottlenose dolphin, Common dolphin and Minke whale) were also recorded. Overall density estimates from each site ranged from 0.53 to 2.03 porpoises per km^2. The results from the Blasket Islands were quite consistent between 2007 and 2008 with densities of 1.33 porpoises per km^2 recorded in 2007 and 1.76 porpoises per km^2 in 2008 (Berrow *et al.,* 2008a).

Photo-identification has been used extensively in the Shannon Estuary as a means of population estimation and monitoring for Bottlenose dolphins. Its use has extended more recently to include sites elsewhere around the Irish coast (Ingram *et al.,* 2001; Ó Cadhla *et al.*, 2003; O'Brien *et al.,* 2008; Oudejans, 2008; Ryan *et al., in press*). Mark-recapture analysis has yielded abundance estimates of Bottlenose dolphins in the Shannon Estuary from four years so far:

- 113 ± 14 SE (CV=0.14) in 1997 (Ingram, 2000),
- 121 ± 14 SE (CV=0.12) in 2003 (Ingram and Rogan, 2003)
- 140 ± 12 SE (CV=0.08) in 2006 (Englund *et al.,* 2007) and
- 114 ± 17 SE (CV=0.15) in 2008 (Englund *et al*., 2008).

Englund *et al.* (2007) carried out a Population Viability Analysis to explore the viability of the Shannon Estuary bottlenose dolphin population over a 250 year period. With a current population estimate of 140 animals and using published data on reproductive parameters, the model VORTEX showed the population was unlikely to experience extinction within this time period. However if the effect of a catastrophe, which produced a 25% decline in survival in 1% of years was modelled, the population declined over the simulated period. This suggests that the population is vulnerable to decline in the event of perturbation through disease or habitat degradation (Englund *et al.,* 2007). The authors suggested that the population of Bottlenose dolphins in the lower Shannon Estuary was increasing. While this was not confirmed by results from 2008, it was noted that reduced sampling power may have influenced the results in this year (Englund *et al.*, 2008).

2.4 Migration and Movements

Information on the movement of cetaceans around the Irish coast is limited since it requires the identification and tracking of individual animals at sea. Passive acoustic monitoring (PAM) methods have however been used to monitor the movements of individual calling baleen whales via an array of seabed-based hydrophones known as the Sound Surveillance System (SOSUS). The system was originally operated by the US Navy for tracking Soviet submarines through the so-called GIUK gap between Iceland and northern Scotland. With the ending of the Cold War in the 1990s, the immediate need for SOSUS decreased and the components are now being used for various scientific projects, including tracking the vocalisations of individual whales.

Using data from the SOSUS array, Clark and Charif (1998) and Charif *et al.* (2001) analysed the occurrence of Blue whales, Fin whales and Humpback whales off western Scotland, Ireland and adjacent waters. All whale species displayed distinct seasonal patterns with Fin whale counts and vocal activity declining steadily from February to minimal levels in May through July and then increasing again during August and September, remaining steady through to March. Blue whales increased gradually from mid-July through September, peaking in October to December and were detected at higher rates in western parts of the study area. Humpback whales were the least frequently detected species overall occurring mainly between November and March. Singing Humpbacks exhibited a south-westerly movement between October and March but with no corresponding trend between April and September. These results suggest that the offshore waters west of Ireland may represent a seasonal migration route for Humpback whales (Charif *et al.,* 2001; Charif and Clark, 2009).

The most widely used method to track the movements of cetaceans is through photo-identification. The technique relies on markings on individual whales or dolphins that are unique and long-lasting and can be easily photographed and recognised again. Examples include unique markings on the ventral surface of Humpback whales or distinctive notches and nicks on the dorsal fin of Bottlenose dolphins. In Ireland, photo-identification of Fin and Humpback whales has demonstrated high site and inter-annual fidelity by some individual whales to sites off the south coast (Whooley *et al*., 2008). Fin whales were observed regularly from June to February within 15nm of the shore, with a peak in sightings in November. Humpback whales were observed in the same areas, but in smaller numbers, from July to December with a peak in November. Of the 41 individually recognisable Fin whales identifiable since 2001, 26.8% have been re-sighted. Two have been re-sighted over two years, one over three years and one in four of the last five years (Whooley *et al.,* 2008).

Of seven individually recognisable Humpback whales three have been recorded between years, two over a five-year period and one whale over six consecutive years (Whooley *et al.,* 2008). The movements of these whales outside this period or these coastal waters are not known. It is believed that Fin whales move south to the Bay of Biscay (IWDG, *pers. comm*.) but breeding grounds for this species in the north Atlantic have never been identified. The two main areas where Humpback whales breed are in the Caribbean Sea and off Cape Verde, West Africa. The majority of Humpback whales in the North Atlantic appear to use the West Indies, with the largest concentrations in the northern Antilles, especially on or near Silver Bank. A much smaller number are known to breed in the Cape Verde Islands but there have only been three photographic matches between Cape Verde and known feeding grounds around Iceland and Bear Island, Norway. It is likely that Humpback whales seen in Ireland are part of the Cape Verde breeding population but there is no hard evidence yet to support this theory (Wenzel *et al., in press*).

There have been several studies of Bottlenose dolphins in Ireland to date in which individual movements between sites have been tracked using photo-identification. Ingram *et al*. (2001), Ryan and Berrow (*in press*) recorded Bottlenose dolphins from the Shannon Estuary in Tralee Bay and Brandon Bay, Co. Kerry respectively, but Ingram *et al*. (2001) did not find any dolphins from the estuary at three other sites sampled along the west coast (Connemara, Co. Galway, Broadhaven Bay, Co. Mayo, McSwyne's Bay, Co. Donegal). However one Bottlenose dolphin recorded off North Connemara was also recorded off Co. Cork (Ingram *et al.,* 2003). More recently O'Brien *et al.* (2008) examined images of 114 individual Bottlenose dolphins from four photo-identification catalogues and found 16 re-sightings between Counties Donegal, Galway, Kerry, Cork and Dublin. Photo-identification recaptures also crossed national boundaries with a single match to Co Antrim in Northern Ireland. The duration and distances between matches ranged from 26 to 760 days (mean = 365 days) and from c. 130km to c. 650km (mean = 322km). This was a relatively high re-sighting rate (14%) given the small sample size of images used during this study and it highlighted that large-scale movements may be undertaken by Bottlenose dolphins around the Irish coast.

2.5 Life-history

Diet

The diet of most cetaceans occurring in Irish waters is quite poorly recorded. While there have been a number of studies of the diet of Harbour porpoise, Common dolphin, Atlantic white-sided dolphin and Striped dolphin, information on the diet of other species observed at sea is mostly anecdotal and more quantitative examination of diet usually refers to post-mortem examination of a few stranded animals.

The most frequent prey items recovered from the stomachs of 19 stranded and bycaught Harbour porpoise were *Trisopterus* spp. (42%), whiting (42%) and poor cod (21%) (Rogan and Berrow, 1996). Of the Clupeidae family, most common were herring (16%) and sprat (5%). More recently, stomach content analysis of 73 Harbour porpoise samples revealed that the species primarily forages on fish (98%) with the remainder of prey items consisting of cephalopods and crustaceans (Rogan, 2009). At least 16 different taxa were recorded, revealing a broad generalist diet. Whiting, *Trisopterus* species, herring and gadoids were the most frequent prey species recovered with other species such as hake, scad, sprat, silvery pout less frequent in the diet observed. These results are broadly consistent with diet analysis elsewhere in the European range (e.g., Borjesson and Berggren, 1996; Santos *et al*., 2004).

It is interesting to note that while some of the Harbour porpoise prey items are commercially fished (e.g., herring, whiting), *Trisopterus* species, which are generally not commercially targeted, are very important to this species and other Irish marine mammals including Common dolphins (Brophy *et al*., 2009), Grey seals (Kiely *et al*., 2000; McKibben, 2000) and Harbour seals (Kavanagh *et al*., in review).

Berrow and Rogan (1995) found that gadoids (38%), clupeids (7%) and cephalopods (5%) were the main prey items recovered from the stomachs of 16 stranded and 10 bycaught Common dolphins, with *Trisopterus* spp., herring, sprat and whiting the most prevalent fish species present. Of the cephalopods, Common dolphins fed primarily on *Gonatus*, *Histioteuthis* spp. *Toderopsis, Loligo forbesi* and the common octopus. Brophy *et al.* (2009) analysed the stomach contents of Common dolphins' bycaught on the edge of the continental shelf and found mackerel, horse-mackerel, hake and pearlsides (a deep-water species). Stomach contents from 129 individuals were used to examine the variation in the diet of Common dolphins in the northeast Atlantic. Samples were obtained from dolphins found stranded along the Irish coast (n=76) between 1990 and 2004, and individuals incidentally captured in the Irish albacore tuna (*Thunnus alalunga*) driftnet fishery (*n*=58) between 1996 and 1999. A total of 46 prey species were recorded consisting of 31 fish species and 15 cephalopod species. The remains of a total of 15,283 prey items were recovered from the stomachs of offshore dolphins. Teleost fish were numerically the most important prey group (95% prey numbers), with cephalopods comprising 5%. A small number of crustaceans were also recorded.

Fish representing at least six families and 16 species were identified. Myctophids dominated the fish component accounting for 54% of the fish recovered. Despite the dominance of myctophids, at a species level the carangid *Trachurus trachurus* was the most commonly recorded, followed by the myctophids *Myctophum punctatum* and *Notoscopelus kroyeri;* Combined together the three species comprised 92% of fish prey. Fish (97%) also formed the dominant portion of the stomach contents of dolphins from the neritic area (i.e. continental shelf waters, <200m depth). Gadidae comprised 59% of the fish component of the neritic dolphin diet, and the most commonly occurring fish were *Trisopterus* spp. (45%) and Gobiidae (28%). Nine dolphins from the offshore group had only milk in their stomachs (aged 0-3 months), while three (aged 3-6 months) had both milk and solid food suggesting that weaning occurs between 3 and 6 months in this species.

Mackerel accounted for 88% of fresh prey items recovered from Atlantic white-sided dolphins also bycaught on the edge of the continental shelf but silvery pout (62%), myctophids (19%) and pearlsides (7%) were among the prey identified by otoliths (Couperus, 1997). Gadoids (86%) were the most frequent prey item recovered from four Atlantic white-sided dolphins stranded on the west coast (Berrow and Rogan, 1995). Berrow and Rogan (1995) described the diet from seven stranded Striped dolphins and found that 80% of the diet was composed of gadoid species, with clupeids (13%) and cephalopods (*Illex fubei, Gonatus* sp. and *Histioteuthis* sp.) comprising the remainder. Further analysis showed that the diet of offshore Striped dolphins consisted mainly of cephalopods, myctophid fish species and crustaceans (Rogan *et al*., 1997), The prey species composition from the stomach contents of both stranded and bycaught Striped dolphins from Ireland indicate that these dolphins are opportunistic feeders, exploiting a wide range of species that occur in large dense shoals.

Couperus (1997) also carried out dietary analysis on two bycaught Bottlenose dolphins. Species identified included greater argentine, *Argentina silus*, horse-mackerel, hake, mackerel, poor cod and silvery pout. Nash (1974) described an adult female Bottlenose dolphin with a fully-grown greater-spotted dogfish *Scyliorhinus stellaris* wedged head first in its oesophagus, which he suggested caused its death after it attempted to swallow it. O'Brien and Berrow (2006) recovered otoliths from the stomach of a live-stranded Bottlenose dolphin which had also ingested a large quantity of seaweed. Otoliths could only be identified as either pollack, whiting or saithe due to their degenerative state. Bottlenose dolphins have been observed chasing and catching salmon *Salmo salar*, garfish *Belone belone* and eels *Anguilla anguilla* in the Shannon Estuary (Ingram, 2000), while salmon and mackerel were also observed prey in studies off northwest Co. Mayo (Ó Cadhla *et al.,* 2003).

Killer whales in Irish waters are thought to feed mainly on fish, including salmon and mullet *Chelon labrosus* (Wilson and Pitcher 1979; Ryan and Wilson 2003). McHugh *et al.* (2007) found salmon fish bones in the stomach of a Killer whale stranded at Roches Point, Co Cork. Food remains in the stomach of a Sperm whale stranded in Co. Donegal consisted of cephalopod beaks with *Haliphron atlanticus* being the most important prey species in the stomach of this animal (Santos *et al.,* 2002). Santos *et al*. (2006) described the diet of a Sperm whale calf that live stranded in Co. Clare and showed more than 85% of the estimated weight of prey items comprised of cephalopod species in the family *Histioteuthidae*. Notes on the diet of Pygmy sperm whales stranded in Ireland suggest they were feeding on both squid and fish (Mackey *et al*., 2001).

Reproduction

At least six species (Harbour porpoise, Common dolphin, Bottlenose dolphin, Atlantic white-sided dolphin, White-beaked dolphin, Risso's dolphin and Long-finned pilot whale) have been reported calving in Ireland with another two species (Killer whale and Cuvier's beaked whale) also most likely breeding in these waters (O'Brien *et al*.2009).

Age at sexual maturity (ASM) in Harbour porpoises has been examined during the BIOCET project, on a wider European scale, including results from Harbour porpoises recovered from stranding and bycatch programmes around Ireland. In the BIOCET study, females were found to be sexually mature at a body length of 142 – 156 cm, and approximately 4.5 years of age, although there is individual variation. The majority of neonates (animals < 90cm) were found in May and June, suggesting that most animals give birth during this period, although this is based on a very small sample size. Males appear to mature at a body size of between 144 and 157cm. As with females, there is individual variation, with some males attaining sexual maturity at 4 yrs and some later, at 8yrs (Learmonth *et al*., 2006b). In time, and with additional samples, it will be possible to determine more accurately, ASM on a finer regional scale, which is important, given the possible impact of bycatch and contaminants on this species.

Murphy *et al*. (in press) estimated female growth and reproductive parameters in Common dolphins using teeth, gonads and other biological data collected by European stranding and bycatch observer programmes (including a large sample size from Ireland) over a 16-year sampling period (between 1990 and 2006). Age was determined for 515 individuals and the maximum age in the sample was 29 years. Body lengths ranged from 91 to 239 cm. Length at physical maturity was estimated as 202cm. Sexually immature females ranged from 91 to 210 cm and 0 to 12 years of age. Sexually mature females ranged from 165 to 227 cm and 6.5 to 26 years. Average age at sexual maturity was estimated at 8.22 years. Average length at sexual maturity was calculated as 188cm. The average length at birth was 93 cm and the average weight at birth was 8.7kg.

The gestation period was estimated to be 362.7 days or 0.99 years. Previous studies by Murphy (2004) and Murphy *et al*. (2005) had suggested that the mating and calving period extends from May to September for this species in the NE Atlantic. Murphy *et al*. (in press) estimated 19 July as the average date of conception. Individual conception dates ranged from 5 April to 2 October, though 40% of individuals were conceived in July. The estimated annual pregnancy rate (APR) is 26% with a calving interval of 3.79 years, which is considered low and deserves further investigation. It should also be noted that the sample size of mature females used to estimate the pregnancy rate in European waters was 248, and it took 16 years of effort by various European stranding and bycatch observer programs to attain that size of sample. It will be important for these programs to continue so that the pregnancy rate can be monitored in the future.

In a separate analysis, Murphy *et al*. (2005) examined male Common dolphins from Ireland and France, to determine ASM. Male common dolphins ranged from 102–233 cm in length and 0–28 years of age. Sexually mature individuals were 195–233 cm in length and 8–28 years of age, and the average age of sexual maturity was 11.86 years. Reproductive seasonality was found to occur, as evidenced by marked seasonal changes in both testes weights and cellular activity in testes outside the mating period. Moderate sexual dimorphism and large testes suggest sperm competition and a promiscuous mating system, with female common dolphins mating with multiple mates.

The sample sizes for other species recovered during the stranding and bycatch programmes are much lower. For Striped dolphins, the largest proportion of the biological information comes from animals that were caught in the drift net fishery for tuna off the continental shelf. Combining this with the information from stranded animals suggests that sexual maturity in males (based on increasing testes weight and histological examination) occurs at a body length of 205cm (approx 11 yrs; Rogan *et al*., 2002). The sample size is as yet too low to determine ASM for females, but neonates have been recorded from July–September, suggesting that the calving season at least includes that time period (Rogan *et al*., 1997).

The reproductive status of a group of 19 live-stranded Atlantic white-sided dolphins in Co. Mayo showed that pregnant and lactating females and immature and sexually mature males occurred (Rogan *et al*., 1997). Neonate harbour porpoise, Atlantic white-sided dolphin, Risso's dolphin and Long-finned pilot whale have been reported stranded on the Irish coast. Five species (Harbour porpoise, Long-finned pilot whale, Risso's dolphin, White-beaked dolphin and Pygmy sperm whale) have been reported stranded with foetuses at advances stages of development. A rare twin pregnancy was reported in a Risso's dolphin found dead in Co. Donegal (Gassner and Rogan, 1997). Sexually mature male Atlantic white-sided dolphins and female Cuvier's beaked whale have also been reported.

Parasitology

Parasites are an important component in the natural history of cetaceans. For most species, cetacean parasites have evolved to be predominantly internal, perhaps due to the difficulties of external attachment and this feature has been shown to be important for the longevity and health of many cetacean species. The Harbour porpoise is considered to be one of the most heavily parasitised marine mammals (Baker and Martin, 1992). The most abundant and widespread parasites are nematode worms (*Anisakis species)*. Four species of nematode were recorded in the lungs of 98% of the animals examined and *Stenurus minor* was found in the cranial sinuses of 65% of animals. Finally parasitic cysts were recorded in the blubber of one Harbour porpoise. *Anisakis simplex* was the most widespread and abundant stomach nematode in Common dolphins. Lungworm infection by pseudaliid nematodes was recorded in Striped dolphins and Common dolphins. A comparatively high incidence of parasitism was reported in a mass stranding of Atlantic white-sided dolphins, but these were not thought to have contributed to the stranding event (Rogan *et al.,* 1997). External parasites, although uncommon, have been recorded on one dolphin and on three whale species to date (O'Brien *et al.,* 2009).

<u>Stock structure and genetic studies</u>

Cetaceans in Irish waters are likely to be part of wider North Atlantic populations but little information is available on genetic discreteness or the identities of most stocks. There have so far been a few genetic studies on cetaceans from Ireland alone. However, as part of larger comparative studies, samples from animals stranded along the coast of Ireland and/or bycaught individuals have been used in taxonomic studies (e.g. Murphy *et al*., 2006, Chivers *et al*., 2005), for species identification (e.g., Berrow and Dalebout, 2002), to elucidate stock structure (e.g. Duke, 2003, Parsons *et al*., 2002, Mirimin *et al*., 2009) and to examine familial relationships amongst groups of animals in multiple (mass) stranding events. Specific primers have also been developed for Striped dolphins and Common dolphins (Mirimin *et al*., 2006, Coughlan *et al*., 2006).

Analysis of DNA has been used for species identification. Two beaked whales stranded in Co Clare could not be identified due to their poor condition upon stranding. Berrow and Dalebout (2002) and Berrow *et al*. (2002c) used DNA analyses to show they were both Cuvier's beaked whales. This was the first time in Ireland cetaceans had been identified through genetic examination.

Walton (1997) showed that there was significant genetic difference between Harbour porpoises from the northern North Sea and the Celtic/Irish Sea, which were predominantly due to variation among females. Duke (2003) suggested that porpoises from the Celtic Sea and the North Atlantic Ocean were more similar to each other than to Irish Sea animals. This has led to a proposed population structure hypothesis of an Ireland/western British Isles sub-population separated from the North Sea population (Andersen, 2003). The ASCOBANS-HELCOM Population Structure Workshop (Evans and Teilmann, 2009) made only minor changes to earlier divisions, and suggest that within Irish waters that there might be two management units – Celtic Sea (which includes SW Ireland, Irish Sea and West Channel) and NW Ireland (including NW Ireland and West Scotland).

The status of Common dolphins has recently been reviewed by the Small Cetacean Subcommittee of the International Whaling Commission, where a number of papers relating to population structure in the North Atlantic were presented. Mirimin *et al*. (2009) examined population structure of short-beaked Common dolphins in the North Atlantic using both mitochondrial and nuclear genetic markers. A large number of samples were obtained from seasonal and spatial aggregations of Common dolphins in the western and eastern Atlantic, mostly using opportunistic sampling (stranded or bycaught individuals). Samples from the northeast Atlantic were obtained from the Irish stranding and bycatch programmes and the dolphins bycaught in the UK bass fishery. Levels of genetic diversity were relatively high in all sampled areas and no evidence of recent reduction of effective population size was detected at the nuclear loci. Population structure was detected between the two main regions (wNA and eNA) and was more pronounced at the mitochondrial ($F_{st} = 0.0018$, $p < 0.001$) than at the nuclear markers ($F_{st} = 0.005$, $p < 0.05$), suggesting at least two genetically distinct populations in this ocean basin. In contrast, no significant genetic structure was detected between temporal aggregations from within the same regions, suggesting seasonal movement at a regional scale.

Results from this study support the hypothesis of a single genetic stock in the waters off the south-western coast of Ireland and in the western English Channel and a single stock off the US Atlantic coast. However, the authors noted that due to the opportunistic nature of sampling, and the fact that large parts of the known range in the North Atlantic remain to be sampled, including along the mid-Atlantic ridge, other genetically distinct populations may exist.

In a follow up study, by Mirimin *et al*. (2009) genetic analysis was carried out on 152 Common dolphins sampled from six Atlantic areas including Portugal, France, western English Channel, Celtic Sea, Ireland and

Scotland. 25 microsatellite loci and 556 base-pairs of the mtDNA control region were used in the analysis. Analysis of molecular variance (AMOVA) found (and estimated fixation indexes indicated) no significant genetic structure among all sampled areas, *i.e.* most genetic variability resided within, rather than between, sample areas. This lack of genetic structure was observed using both microsatellite and mtDNA control region markers.

Population structure analyses indicated that Common dolphins found in the western English Channel and off the Atlantic coasts of Ireland, France and Portugal are part of the same population. These findings suggest the presence of a large neritic, panmictic (random-mating) population in the northeast Atlantic, maintained by strong gene flow. However, the possibility of a recent population split cannot be ruled out. For example, it is possible that not enough time has passed to cause significant genetic differentiation. Although the present study included a large dataset of 152 individuals, the high levels of genetic variability found at both nuclear and mtDNA control region markers may suggest that larger sample sizes are required to obtain more realistic population-wide estimates of gene frequencies. As more samples are collected each year, genetic structure should be re-assessed using a larger dataset and testing different classes of markers, to better elucidate structure. The lack of population structure using this suite of markers makes the allocation of a management or conservation unit(s) difficult. Given the taxonomic confusion within the Genus *Delphinus*, the relatively large abundance estimates for the area and the widespread distribution, the definition of management units needs further consideration, possibly with the use of additional markers and ecological tracers.

Mirimin *et al.* (2005) examined the genetic relationships within a group of Atlantic white-sided dolphins live-stranded in Co. Mayo. This work showed that genetic relatedness was observed between at least some adults and that each calf could be unambiguously assigned to an identified mother within the group. No sampled male could be identified as father and this study raised interesting questions about social structure and mating strategies in this species.

Research is also under way at present in University College Cork, investigating the genetic structure of Bottlenose dolphins inhabiting Irish coastal waters. With funding from Science Foundation Ireland (SFI), biopsy samples including skin are being collected for analysis from groups of dolphins frequenting a number of locations around the Irish coast. To date, genotypes of 14 microsatellite loci obtained from skin samples from 26 Bottlenose dolphins from the Shannon Estuary and from six stranded individuals from other locations along the west coast of Ireland have been compared (E.Rogan, UCC, *pers. comm.*). Most loci (12 out of 14) showed alleles that were unique to either inside or outside of the estuary, indicating support for the photo-identification data that the Shannon Estuary Bottlenose dolphin population may be distinct from others along the west coast of Ireland. It is expected that this research will continue to provide key information on the genetic identity of Bottlenose dolphins frequenting the Lower Shannon Estuary cSAC and other sites in Ireland.

In addition to this, there are a number of on-going collaborative studies being carried out on a larger international scale regarding the population structure of Fin whales (IWDG/GMIT), Long-finned pilot whales, Atlantic white-sided dolphins and White-beaked dolphins.

2.6 Current status

In 2006-07, an assessment of the conservation status of 18 species of cetaceans found in Irish waters was made, as part of Ireland's report to the EU under Article 17 of the Habitats Directive (NPWS, 2008). The assessments were made with the assistance of external expertise and according to guidelines drawn up by the European Topic Centre for Nature Conservation. For six species, status was considered "good" on the basis of known population size, distributional range, the availability of habitat and other criteria. These were Bottlenose, Common and Atlantic white-sided dolphin, Harbour porpoise, Minke whale and Fin whale. Twelve species however were classified as status "unknown" because of data deficiencies with regard to range, habitat condition and future prospects. The remaining six species recorded in Ireland were considered vagrant and no assessment was yet considered necessary.

In spite of its "good" status in Irish waters, the Fin whale, along with Blue whale, Sei whale and Northern right whale, are considered globally Endangered (i.e. facing a very high risk of extinction in the wild) by the International Union for the Conservation of Nature (IUCN). Four further species occurring in Ireland (Harbour porpoise, Humpback whale, Sperm whale and White whale/Beluga) are described by the IUCN as Vulnerable (facing a high risk of extinction in the wild). Six (Bottlenose dolphin, Risso's dolphin, Cuvier's beaked whale, Gervais' beaked whale, True's beaked whale and Sowerby's beaked whale) are described as Data Deficient. The latter observation indicates that there is inadequate information to make a direct or indirect assessment of a species' risk of extinction based on its present distribution and/or population status. A taxon in this category may be well studied and its biology quite well known but appropriate data on abundance and/or distribution are lacking and it is therefore not listed under a threatened category. The remaining species that occur in Ireland are classified as Lower Risk.

2.7 Legal Provisions

All cetaceans are protected under the Wildlife (Amendment) Act (1976-2005) including protection of their „resting places' and from „wilful interference' up to 12nm (20 km) offshore. Under the 1992 EC Habitats Directive (92/43/EC) and the European Communities (Natural Habitats) Regulations (1997), all Annex IV species and their habitats (including *inter alia* Cetacea) are afforded strict protection within the Irish Exclusive Fisheries Zone (EFZ). Ireland is also legally obliged therein to designate Special Areas of Conservation (SAC) for Harbour porpoise and Bottlenose dolphin.

Ireland is subject to the EU's Bycatch Regulation 812/2004, which requires the use of acoustic deterrents (pingers) on vessels greater than 12m in length fishing bottom-set or entangling gillnet in ICES sub-areas VIIg and VIIj off the south and southwest coasts. Also under this Regulation there are requirements to monitor cetacean bycatch rates in pelagic trawl fisheries in vessels over 15m in length in order to identify those fisheries with high cetacean bycatch rates.

Ireland has also ratified the Berne Convention on the Conservation of European Wildlife and Natural Habitats (1979), the Convention on Conservation of Migratory Species of Wild Animals (CMS or Bonn Convention), and the OSPAR Convention, which offer protection to cetacean species. Since 1985 Ireland has also been a Party to the international Convention for the Regulation of Whaling, which provides for the proper conservation of whale stocks.

In addition, all cetacean species are included on Appendix I of the Convention on International Trade in Endangered Species of Wild Flora and Fauna (CITES). CITES prohibits international trade in specimens of these species except for instance for scientific research. In these exceptional cases, trade may take place provided it is authorized by the granting of both an import permit and an export permit (or re-export certificate).

3.0 Monitoring

3.1 Description

The main aim of the Habitats Directive is to maintain or restore at favourable conservation status all species listed in the annexes of the Directive. The c*onservation status of a species* means the sum of the influences acting on the species concerned that may affect the long-term distribution and abundance of its populations within the territory. Ireland is required to monitor the conservation status of all cetaceans and report its findings to the EU. A standardised reporting format has been developed by the EU in conjunction with the Member States. Each Member State is required to report on changes in the range, population (abundance and dynamics), area of suitable habitat, pressures, threats and future prospects. All elements are assessed and an overall conservation status is derived.

The EU reporting guidelines recognised the fact that there is a general lack of information concerning the marine environment and therefore judgements and assessments are likely to have low confidence levels. Any conclusions should take into account these limitations in our knowledge. Substantial guidance on how to assess conservation status in the marine environment is currently being developed by the Marine Working Group set up by the Habitats Committee.

Monitoring to meet requirements for the EU Habitats Directive should not be seen in isolation, however, since much of the information generated by this research may also be useful for other purposes. Boelens *et al*. (2004) stated that the recording of cetacean abundance and distribution in Ireland is recognised as an Environmental Impact Indicator and to gain maximum benefit, monitoring programmes should consist of frequent small-scale surveys over a long period of time. Population monitoring of cetaceans in Ireland is constrained by many factors. In Ireland, there is a deficit of information and knowledge concerning the distribution and abundance of cetaceans across significant areas of its substantial jurisdiction, which makes the targeting of monitoring effort in a cost-effective manner difficult. In addition, populations of many cetaceans occurring in Ireland are not confined to Ireland but occur across a number of Member States. Thus only a proportion of a population can be monitored and changes in abundance or distribution may reflect declines or increases elsewhere in their range but affect their distribution and range within Ireland. For example, fisheries bycatch of Harbour porpoise in UK waters may affect the population of small cetaceans in Ireland since they are part of the same population (e.g., Walton, 1997). The EU reporting guidelines state that where a species may have a population which is in two or more Member States, in such instances Member States are encouraged to undertake a common assessment but to report separately. In some cases it may be necessary to take into account populations shared with non EU countries.

Cetaceans are highly mobile mammals and abundance in an area may fluctuate greatly due to large scale movements rather than changes in population. For example, climate change may lead to northern extension of a population's range that may initially appear as a population increase at sites further north (Learmonth *et al.,* 2006a). Movements of cetaceans can lead to large variability in abundance estimates and thus confound our ability to determine population status. For many species the only information available on populations and key locations are derived from sightings and although this commonly addresses only part of a species life-cycle it could be used for representing range and/or estimating population status (EC, 2006).

Events such as changes in sea surface temperature and salinity and rise in sea level could have important effects on global cetacean populations. Since the 1980's, sea surface temperatures in northwest Europe have risen at a rate of around 1ºC per decade, and are predicted to continue to increase. Learmonth *et al.* (2006a) discussed the indirect effects of such events on marine mammal populations, which included changes in prey availability impacting on prey distribution, abundance and migration patterns, community structure, susceptibility to disease and contaminants. The ability of cetaceans to adapt to such changes is largely unknown. Climate change is of particular concern to species listed as Endangered or Vulnerable, which include Fin whale, Blue whale, Sei whale, Sperm whale and the North Atlantic right whale (Simmonds and Isaac, 2007). Few studies have been carried out on the effects of climate change on cetaceans, which potentially could have profound effects on species distribution at an international scale. Studies on the effects of climate change are required to examine the consequences of such events on the migration patterns of large whales as well as a shift in the distribution of prey species. MacLeod *et al*. (2005) suggested that White-beaked dolphins were particularly vulnerable due to their northerly distribution and restricted range. There have been no studies on the potential effects of climate change on cetaceans in Ireland, though there is some evidence that Striped dolphins are stranding with increasing frequency, which might be attributed to changes in their distribution (Berrow and Rogan, 1997; O'Connell and Berrow, 2007).

3.1.1 Visual Monitoring

Monitoring spatial and temporal patterns in cetacean distribution and abundance involves a variety of approaches, depending on the target species (Evans and Hammond, 2004). As a first step, the collection of incidental sightings and strandings information aids the construction of a species list and a rough measure of status and seasonal variation in abundance. This is often carried out by volunteer networks and involves training and data quality control. More robust monitoring requires quantification of effort and environmental variables (e.g., sea state) and often an attempt to achieve equal sample coverage of the waters under study. Platforms of opportunity are often used to survey cetaceans at low cost but there is no control over where the platform goes and it is typically not possible to sample and resample defined regional areas, thus limiting the potential for abundance estimation. Line-transect surveys using dedicated platforms allow representative coverage of areas from which abundance estimates can be made. For some species mark-recapture methods can be applied using photo-identification. Measuring cetacean population change represents a particular challenge since natural changes in range may have a large impact on abundance estimates. Spatial modelling is increasingly being used to provide a better understanding of the biotic and hydrographic factors influencing cetacean distribution (Evans and Hammond, 2004).

3.1.2 Acoustic monitoring

Acoustic monitoring has advantages over visual techniques in that it is less affected by sea conditions and can obtain long-term data throughout the day and night. Acoustic monitoring can be less labour intensive and easier to standardise and automate data collection. However this technique relies on animals being vocal and methods that can relate cetacean sound occurrence to animal abundance are not well developed for most species (Evans and Hammond, 2004). The spatial extent to which some static acoustic monitoring equipment can sample can be highly dependent on the listening frequency and thus very limited to a small radius around the listening device. An exception to this are fixed submarine arrays such as the SOSUS array which has the ability to detect large baleen whales at a range of tens of kilometres (Charif and Clark, 2009). Towed hydrophone arrays are suitable for platforms of opportunity although requiring specialised data collection equipment and analysis software. These arrays are suitable for detecting mid and high frequency vocalisations including echolocation clicks of toothed whales (e.g., Sperm whale). The efficacy of towed hydrophones for detecting the low frequency sounds of baleen whales in noisy marine environments has yet to be proven.

3.2 Actions Taken to Date

3.2.1 Visual monitoring

Sighting surveys

To date the IWDG's Irish scheme for cetacean observation and public education (ISCOPE) has obtained over 14,000 sighting records. These are also available to view on-line at http://www.iwdg.ie. The broad-scale casual sighting scheme is particularly useful for recording less commonly sighted species and identifying potential areas of local or regional importance which require more detailed study. The ISCOPE programme, which is funded by the Department of the Environment, Heritage and Local Government, Northern Ireland's Environment Agency, The Marine Institute, and The Heritage Council, includes an inshore monitoring component carried out at 14 sites around the coast of Ireland (11 in the Republic, three in Northern Ireland). Standardised watches, in which visual survey effort is quantified, are carried out each month in favourable sea conditions (sea state ≤2) following a standard protocol. The data are used to identify broad differences in distribution and relative abundance and, in time, should provide quantitative data on gross changes in species' spatial and temporal distributions close to these sites.

The IWDG is also a partner in the Atlantic Research Coalition (ARC), involving ten groups in six countries that survey for cetaceans along regular ferry routes. Since 2001, Cetaceans have been surveyed monthly on three, and up to five ferry routes, (Brereton *et al.,* 2007). A total of 834 sightings have been obtained in Ireland during 671 hours of effort so far (Dave Wall, IWDG, *pers. comm.*).

Ireland has been a partner in both European SCANS surveys; SCANS (or SCANS-I) which covered the Celtic Sea in July 1994 (Hammond *et al.,* 2002) and SCANS-II which surveyed all Irish continental shelf waters, including the Irish Sea, in July 2005 (SCANS-II, 2008). Both survey programmes targeted Harbour porpoise but all cetacean species observed were recorded and abundance estimates for some additional species (e.g., Common dolphin, Minke whale) were also derived. In July 2007, an offshore survey of European Atlantic waters was also carried out (CODA, 2008). This survey targeted Common dolphin, Bottlenose dolphin, Fin whale and deep-diving species. Collectively these broad-scale international surveys have provided essential information on species abundance and distribution allowing assessment of the potential impact of bycatch and other anthropogenic influences at the population level for a number of species. Planning for the next large-scale survey (in 2015) is expected to commence shortly.

Three sites in Ireland have been designated as candidate SACs for cetaceans: Lower River Shannon cSAC for Bottlenose dolphins and the Blasket Islands cSAC and Roaringwater Bay cSAC for Harbour porpoise. Monitoring of the Bottlenose dolphin population is detailed in sections 2.3.and 2.4 above.

Monitoring for Harbour porpoise was carried out at the Blasket Islands cSAC in 2007 and 2008 (Berrow *et al.,* 2009; 2008b) and at Roaringwater Bay cSAC in 2005 and 2008 (Leeney 2007; Berrow *et al.,* 2008a). This work involved line-transect or other visual surveys to derive density and abundance estimates and additional acoustic monitoring. A density estimate derived in the Blasket Islands cSAC during 2008 (1.65 porpoises per km^2) was quite consistent with that reported in 2007 (1.33 porpoises per km^2). However there was considerable variation around these estimates, which was related to the number of surveys carried out and sighting records taken during each individual survey.

The Marine Institute's Sea Change programme and NPWS are currently funding a three-year project titled "Policy Recommendations from Cetacean Acoustics, Survey and Tracking (PReCAST)", conducted by the Galway-Mayo Institute of Technology (GMIT) and the IWDG. During this project, offshore waters are being surveyed using various Platforms of Opportunity (POPs), including Marine Institute and other state research vessels, Irish Naval Service ships and the Irish Observer Scheme. Monthly aerial surveys are also being carried out with the assistance of the Irish Air Corps' Maritime Squadron. Data from these surveys will contribute to a cetacean database that aims to map the distribution and relative abundance of cetaceans in all Irish waters.

The ISCOPE II programme, funded by NPWS, Marine Institute, the Heritage Council and the Northern Ireland Environment Agency, contains a similar survey effort carried out by the IWDG. Sea-based visual surveys are being carried out using the same methodology as in PReCAST, but are presently targeting the Irish Sea. The all-Ireland ISCOPE II scheme also collects cetacean sightings data from casual observations and during land-based watches where effort is quantified.

The NPWS also recently funded a scoping study, carried out by the National Biodiversity Data Centre (NBDC), to explore the feasibility of creating a Joint Irish Cetacean Database with datasets from the IWDG, UCC, Sea Watch Foundation and JNCC amongst others (Regan *et al*., 2008). Ongoing development of this cetacean database project would be expected to add value to existing datasets and provide some baseline information for monitoring cetaceans in all Irish waters. Ireland has also recently become a partner in the Joint Cetacean Protocol co-ordinated by the JNCC in the UK. This is developing standards for the integration of cetacean abundance and distribution data collected from European waters by a variety of methods. It is intended that data will be shared under a common agreement. The JCP initiative recently funded an exploratory analysis of selected data from the southern Irish Sea, considered representative (in contents) of the eventual JCP data resource. The aim of this pilot study was to determine how disparate data types might be integrated and what power the final data resource may have to detect trends in a species' range and abundance.

Stranded animals

Cetacean stranding records in Ireland date to the 6th century (Fairley, 1981). A cetacean stranding scheme was established by the IWDG in 1991 and records are now regularly published in the Irish Naturalists' Journal. Since 2003, the collection of stranding data has been funded under ISCOPE, an all-Ireland inter-departmental initiative organised by the IWDG. To date the stranding scheme has obtained over 2,000 records and on-line access to all records was developed. These are available on http://www.iwdg.ie.

The stranding scheme in Ireland is considered sensitive enough to identify unusual stranding events, such as those that may be caused by epizootics or fisheries bycatch (Berrow and Rogan, 1997). Some species in Ireland are only known from stranding records (e.g., Gervais' beaked whale). Records from the IWDG stranding scheme have been included in studies of stranding trends (e.g., Goold *et al.,* 2002: MacLeod *et al.,* 2004). Recently an unusually high number of deep-diving species were recorded stranded on the Irish and UK coasts, which has caused concern about increased mortalities offshore (Dolman *et al.,* 2008).

Stranded cetaceans have also been recovered for post-mortem examination, as part of a number of studies. These efforts have contributed significantly to studies on the life-history and population structure of cetaceans in

Ireland (e.g., Rogan *et al.,* 1997; Walton, 1997; Murphy *et al.,* 2005; 2006; Santos *et al.,* 2002; 2006) and to analyses of contaminant burdens (e.g., Law *et al.,* 1991; Berrow *et al.,* 1998; McKenzie *et al.,* 1998, Smyth *et al.,* 2000; Zegers *et al.,* 2005; Caurant *et al.,* 2006; McHugh *et al.,* 2007; Pierce *et al.,* 2008). In 2006, a tissue bank was established, through collaboration with the Natural History Museum (NHM) of the National Museum of Ireland, to provide samples for cetacean genetic studies. Interested parties can apply for access to these samples. A total of 125 samples have so far been submitted to the Irish Cetacean Tissue Bank from 16 different species (Ruth Carden, *pers. comm.)* and skin samples from Long-finned pilot whales have been sent to France as part of a study on genetic variability in this species throughout Europe. It is envisaged that duplicate samples of cetacean genetic tissue collected in Irish waters via state-funded projects will be lodged with the tissue bank as standard practice.

3.2.2 Acoustic monitoring

The last 15 years have seen considerable progress in the development of acoustic monitoring for cetaceans in Irish waters. Gordon *et al.* (1999) carried out a survey of former whaling grounds off the northwest coast of Ireland, incorporating acoustic detection by means of a towed hydrophone array. Aguilar de Soto *et al.* (2004) extended this passive acoustic survey method offshore between 2000 and 2001, detecting toothed cetaceans (mainly Sperm whales, Long-finned pilot whales and dolphins) in Atlantic waters to the west of Ireland and in the deeper offshore Rockall Trough. Furthermore, since 1996 remote acoustic monitoring has been conducted on large baleen whales located across twelve large overlapping areas in the deep Atlantic, west of Britain and Ireland (Charif and Clark, 2009). The bottom-mounted SOSUS array, has regularly detected Blue, Fin and Humpback whales (Clark and Charif, 1998; Charif *et al.,* 2001) and results suggest that offshore waters to the west of Ireland may contain important habitats and a seasonal migration route for these species.

Static acoustic monitoring has also been carried out at a number of coastal sites in Ireland. A fixed underwater hydrophone has been used in the lower Shannon Estuary to monitor bottlenose dolphin vocalisations, especially whistles, in order to explore their functionality and use in monitoring (Berrow *et al.,* 2006; Hickey *et al.,* 2009). Moored porpoise and dolphin detection devices known as *PODs* have also seen increased use in Ireland since 2002. A POD is a self-contained electronic device enclosed in a watertight housing, set up to log detections of dolphin/porpoise echolocation clicks at particular „listening' frequencies. Different versions of the POD (e.g., POD, TPOD 1, TPOD 2) have been used in Ireland to date, the current model being the CPOD, capable of identifying clicks from a number of dolphin species in addition to detecting Harbour porpoises.

TPODs have proven to be a useful cetacean monitoring tool in various situations (e.g., Ingram *et al*., 2004; Philpott *et al*., 2007b). The devices were used to detect Harbour porpoises and dolphins in Broadhaven Bay cSAC, Co. Mayo as part of a marine mammal monitoring programme for the Corrib Gas project and its associated coastal works (Ó Cadhla *et al.,* 2003). CPODs are currently in use at the site in an ongoing monitoring programme. TPODs have also been used for detecting Bottlenose dolphins in the Lower River Shannon cSAC (Ingram *et al*., 2004; Philpott *et al.,* 2007b), Connemara (Ingram *et al*., 2003) and in Galway Bay, Clew Bay, Dublin Bay and off the Co. Cork coast in the investigation of potential SAC sites (O'Brien *et al.,* 2008; Berrow *et al.,* 2008). The devices have also been used to detect Harbour porpoises in the Blasket Islands cSAC in 2007 (Berrow *et al.,* 2009) and Roaringwater Bay cSAC in 2005 and 2008 (Leeney, 2007; Berrow *et al.,* 2008a).

The PReCAST project is also attempting to develop acoustic monitoring techniques through the acquisition of two years of acoustic data at three sites around Ireland. Three Passive Acoustic Monitoring (PAM) systems (i.e. TPOD, CPOD and Aquaclick) are being tested and evaluated for their efficacy. PAM equipment has also been deployed in deeper waters off the continental shelf to detect deep-diving species such as beaked whales and Long-finned pilot whales. This „Deep POD' is a version of the TPOD/CPOD which has been modified to enable deployment in deep oceanic water.

3.3 Threats to their Protection

3.3.1 Visual monitoring

<u>Sighting surveys</u>
The distribution and relative abundance of cetacean species in Ireland and their movements and migration routes are poorly understood. Limited data on the temporal and spatial distribution of cetaceans, their preferred habitats and migration routes, impact on the ability to interpret monitoring information and develop targeted, cost-effective, long-term monitoring protocols. Ireland has not established a comprehensive structured approach to

monitoring cetaceans inside and outside designated areas. A structured approach to visual monitoring, with clear scientific objectives, must be developed.

Action: Conduct further research, including through the Joint Cetacean Protocol, to determine the distribution, relative abundance and habitat preferences of cetaceans. Alongside survey effort, this should also include the establishment and maintenance of an integrated national cetacean database that is compatible with the Joint Cetacean Protocol.

Action: Conduct further research to identify the breeding ecology, movements and migration routes of cetaceans.

Action: Devise a research programme with clear scientific objectives to effectively monitor cetaceans inside and outside designated areas.

Bottlenose dolphins are listed on Annex II of the Habitats Directive and require the designation of SACs for their protection. There is evidence from Ireland that the species may range over large distances. Thus individuals protected within an SAC may range outside this protected area, which may expose them to additional threats. Bottlenose dolphins are particularly suitable for monitoring using photo-identification and ID catalogues now exist from a number of locations. In order to explore ranging patterns and exposure to threats, such as pollution or fisheries bycatch, it is essential to bring together these catalogues and encourage the ongoing collection of additional images.

Action: Investigate the feasibility of establishing an integrated National Photo-identification Catalogue for Bottlenose dolphins.

Climate change, rising sea temperatures and large-scale changes in the occurrence and distribution of zooplankton and other prey have the potential to have major effects on the distribution of some cetacean populations in Irish waters. In theory, some more northerly-distributed species may disappear from Ireland while more southerly-distributed species may become more abundant as a response to such changes.

Action: Carry out a review of cetacean sightings/strandings data to detect any changes in distribution or stranding frequency that could be associated with changes in species distribution.

Stranded animals

It is envisaged that the continuation of a stranding recording scheme will complement a monitoring programme. While a number of Local Authorities are active in supporting the management of and data collection from cetacean stranding events, a clear stranding policy must also be developed in conjunction with relevant Local Authorities to ensure that valuable data are not lost through premature disposal of stranded animals.

Action: Explore the possibility of agreeing a procedure with Relevant Authorities that maximises the recovery of data from stranded animals.

Action: Maintain and develop a stranding scheme to provide data on species occurrence and seasonal distribution.

3.3.2 Acoustic monitoring

Acoustic techniques for monitoring cetaceans are relatively new to Ireland although there have been some successful large scale surveys elsewhere. Verfuss *et al.* (2007) obtained 16,318 days of PAM data on Harbour porpoise using TPODs over a four year period in the German Baltic Sea. However PAM is carried out using a range of equipment and results from these studies cannot be easily compared due to the different performances of the equipment.

With the advent of increasing capability and capacity in relation to static hydrophone networks, (e.g., SOSUS array, SMARTBAY), there are developing opportunities to use acoustic signals from offshore to monitor for the presence of cetacean species.

Action: Encourage the development of a national standard against which all appropriate Passive Acoustic Monitoring (PAM) equipment can be calibrated to allow comparisons between sites and studies.

Action: Explore the possibility of using static hydrophone networks to provide data to monitor cetaceans.

3.4 Future Actions

1. Conduct further research, including through the Joint Cetacean Protocol, to determine the distribution, relative abundance and habitat preferences of cetaceans. Alongside survey effort, this should also include the establishment and maintenance of an integrated national cetacean database that is compatible with the Joint Cetacean Protocol.
   Lead Department: DEHLG
   Other Bodies[*]: MI, EPA
   Timeframe: Ongoing

2. Conduct further research to identify the breeding ecology, movements and migration routes of cetaceans.
   Lead Department: DEHLG
   Other Bodies: MI, EPA
   Timeframe: Ongoing

3. Devise a research programme with clear scientific objectives to effectively monitor cetaceans inside and outside designated areas.
   Lead Department: DEHLG
   Other Bodies: N/a
   Timeframe: 2010-2011

4. Investigate the feasibility of establishing an integrated National Photo-identification Catalogue for Bottlenose dolphins.
   Lead Department: DEHLG
   Other Bodies: N/a
   Timeframe: Ongoing

5. Carry out a review of cetacean sightings/strandings data to detect any changes in distribution or stranding frequency that could be associated with changes in species distribution.
   Lead Department: DEHLG
   Other Bodies: N/a
   Timeframe: 2011-2012

6. Explore the possibility of agreeing a procedure with Relevant Authorities that maximises the recovery of data from stranded animals.
   Lead Department: DEHLG
   Other Bodies: Relevant Local Authorities
   Timeframe: 2011

7. Maintain and develop a stranding scheme to provide data on species occurrence and seasonal distribution.
   Lead Department: DEHLG
   Other Bodies: N/a
   Timeframe: Ongoing

8. Encourage the development of a national standard against which all appropriate Passive Acoustic Monitoring (PAM) equipment can be calibrated to allow comparisons between sites and studies.
   Lead Department: DEHLG
   Other Bodies: N/a
   Timeframe: Ongoing

9. Explore the possibility of using static hydrophone networks to provide data to monitor cetaceans.
   Lead Department: DEHLG
   Other Bodies: N/a
   Timeframe: Ongoing

[*] Other Bodies refers to public bodies that may be in a position to provide licensing and/or funding support to facilitate the implementation of an Action.

4.0 Fisheries

4.1 Description

Cetaceans may interact with fisheries both operationally (e.g., through incidental capture or *bycatch*) or biologically (e.g., through competition for prey or infection with parasites).

4.1.1 Bycatch

The most immediate threat to small cetaceans worldwide, including in Ireland, is through incidental capture in fishing nets, known as bycatch (Northridge, 1991). Probably no fishery is excluded from bycatch to some extent but it is the extent of capture and this removal in relation to the species' abundance that is important (Northridge, 1991). Kirkwood *et al.* (1997) estimated that 49% of deaths of small cetaceans washed up on the coast of England and Wales between 1990 and 1995 (including 80% of Common dolphins and 38% of Harbour porpoises) was due to bycatch. Over the period 2000-2004, fisheries bycatch was still the most common cause of death in the UK including 61% of Common dolphins and 23% of Harbour porpoises (Jepson, 2005).

Twelve species have been reported bycaught in Irish waters to date including Harbour porpoise, Common dolphin, Striped dolphin, Bottlenose dolphin, Atlantic white-sided dolphin, White-beaked dolphin, Risso's dolphin, Sperm whale, Long-finned pilot whale, Minke whale, Humpback whale and Fin whale (see Couperus, 1997; Tregenza *et al.,* 1997a; 1997b; Berrow and Rogan, 1998; Rogan and Mackey, 2007). Of the 130 Common dolphins reported stranded and examined from 1995-2003, 28% live stranded and 7.7% were diagnosed as bycatch (Murphy and Rogan, *in prep*). In the case of Harbour porpoise, 11% of stranded individuals were diagnosed as bycaught (Rogan, 2009). While various forms of fishing nets are usually implicated, whales (e.g., Humpback whale, Minke whale) may occasionally become entangled in lobster pot or crab pot lines (IWDG, *pers. comm*.).

<u>Passive gears</u>
Cetacean bycatch has been quantified for a number of fisheries in Ireland to date. The first fishery in Ireland in which cetacean bycatch was quantified was the bottom-set gillnet fishery in the Celtic Sea. Tregenza *et al.* (1997a) estimated that 2,200 Harbour porpoises and 230 Common dolphins were bycaught annually by UK and Irish vessels operating this fishery during the 1993/94 season. This amounted to 6.2% of the estimated number of Harbour porpoises in that region and there was serious concern about the ability of the population to sustain this level of mortality. A further study of the same fishery carried out by Irish vessels in 2005/06 by Cosgrove and Browne (2007) reported a similar overall bycatch rate to Tregenza *et al.* (1997a) but catch rates during March-May were over three times greater than during other periods of the year. The total fishing effort however has declined very significantly since the mid-1990s, and was estimated to be approximately seven times higher in 1993 than that reported in 2006 (An Bord Iascaigh Mhara - BIM, *pers. comm*).

Total bycatch of Harbour porpoise was estimated at 278-430 animals in 2006 (355 ± 121, 95% C.I: 108-601) depending on what unit was used to estimate effort (Cosgrove and Browne, 2007; BIM*, pers. comm.*). This equated to c.0.35-0.53% of estimated population for the Celtic Sea, based on figures provided by the SCANS-II survey. BIM (2008) has more recently estimated a total Harbour porpoise bycatch of 161 animals in 2007 and 160 animals in 2008 (BIM, 2009) suggesting that catch rates may be declining in parallel with reduced fishing effort and/or the use of pingers on gillnet gear. Bycatches of Common and Striped dolphins, although they have occurred, have been too few for impact assessment (Cosgrove and Browne, 2007). A bycatch estimate of 730 porpoises was derived for the UK gillnet and tangle net fleets operating in the Celtic Sea in 2006 (Northridge *et al*., 2007). A pilot bycatch observation study conducted on French gillnetting vessels in the Celtic Sea did not observe any bycatch (Anon., 2008). However the occurrence of incidental capture of Harbour porpoises and other small cetacean species in the Celtic Sea cannot currently be discounted for passive gears operated by any national fleet.

The cumulative impact of bycatch by fleets of all nationalities, operating in the same waters, is not known. It should be noted that bycatch data, unless independently observed and documented from a representative fleet sample size, are expected to be unreliable since carcasses may commonly fall out of nets on hauling or may go unrecorded by the crews of fishing vessels engaged in normal fishing activity.

Surface drift-nets for salmon (*Salmo salar*) are also known to accidentally capture cetaceans. Berrow and Rogan (1998) reported six species (Harbour porpoise, Atlantic white-sided dolphin, Common dolphin, Bottlenose dolphin, Striped dolphin and Minke whale) caught in surface drift-nets for salmon along the south and southwest coasts. In addition a Humpback whale also died despite rescue attempts, having been caught in a coastal driftnet for salmon (E.Rogan, UCC, *pers. comm*.).

Surface drift-nets used by the Irish albacore tuna fishery were estimated to have caught 500-600 cetaceans annually in 1996 and 1998, mainly Common and Striped dolphins but also Bottlenose dolphin, Risso's dolphin, Atlantic white-sided dolphin, Long-finned pilot whale, Minke whale and Sperm whale (Rogan and Mackey, 2007). If cetacean bycatch from the Irish, French and UK fleets are combined an estimated 1,589-2,101 Common dolphins and 1,124-1,473 Striped dolphins were caught annually between 1998 and 2000. This equated to around 0.7-4.1% of estimated abundance of Common dolphins and 1.6% of Striped dolphins.

Surface drift-net fishing for tuna and swordfish was banned by the EC in 2001 and use of this gear for salmon-fishing in Irish waters was banned in 2008.

Active gears

A relatively small number of fisheries observation trips have been carried out to date aboard Irish pelagic trawlers targeting herring, mackerel, horse mackerel and blue whiting. No cetacean bycatch was reported by pair-trawlers working in the Celtic Sea herring fishery by Berrow *et al*. (1998b) but five species (Long-finned pilot whale, Common dolphin, Atlantic white-sided dolphin, White-beaked dolphin and Bottlenose dolphin) were recorded as bycatch in Dutch mid-water trawlers off the southwest coast of Ireland (Couperus, 1997). This study also revealed that the Atlantic white-sided dolphins caught in this fishery had not been preying on the target species of the fishery but deep-water myctophid fish species.

Data gathered under the requirements of Regulation 812/2004 have been reported to the EC by BIM in a series of annual reports. Cetacean bycatch figures reported from the above fisheries so far appear comparatively low with individual Common dolphins occasionally captured. In the UK observer programme, conducted over more than 400 pelagic trawl operations in ICES Areas IV and VI (excluding paired-trawling for bass), no cetacean bycatch was observed (Northridge *et al*., 2007). This tentatively suggests that the low bycatch figures reported to date from most Irish pelagic trawl fisheries may be replicated elsewhere and this is encouraging, although greater observer coverage each year is necessary to provide statistically representative data.

During 1998/99, BIM and the Marine Institute undertook a study using paired pelagic trawling for albacore tuna *Thunnus alalunga* (Anon, 2000). During these trials a bycatch of 145 cetaceans was recorded, mainly Common dolphins, but also Striped dolphins, Atlantic white-sided dolphins and Long-finned pilot whales, particularly in waters overlying the continental slope. Most of this bycatch (68%) was taken in just 10 hauls, with one haul accounting for 30 animals. Conversely, 282 or 90% of hauls recorded no cetacean bycatch. Bycatch levels were significantly influenced by depth of water during the tow (Anon, 2000). Since this initial study, BIM has been reporting on bycatches observed in this fishery. No bycatches were observed in 2005, 2006, 2007 or 2008, which has been attributed to continued refinement and greater experience of the fishing method by vessel operators (BIM, *pers. comm*.).

There are other records of incidental capture of cetaceans in fishing gear in Ireland. Although these may be rarer incidents, they can involve some vulnerable or endangered species and may have a significant impact on comparatively small or localised populations. Common dolphin, Minke whale and Humpback whales have been recorded caught and drowned in buoy ropes (Berrow and Rogan, 1998; Philpott *et al.,* 2007a). A Fin whale was also reported washed up in Co. Waterford, wrapped in fishing rope from its head to its tail flukes (Smiddy *et al.,* 2002).

4.1.2 Resource Competition

The marine ecosystem has been modified by over-exploitation of marine resources, especially fish stocks. This has the potential to affect energy budgets, reproduction and survival, especially of Harbour porpoise and some dolphin species (MacLeod *et al.,* 2007). Although difficult to measure, competition for prey species between cetaceans and commercial fisheries is expected to have a negative impact on foraging success with consequences for reproductive fitness. Clearly where there is overlap between the species and size class removed by fishing and the preferred prey of cetaceans then there is potential for significant impact. Information on the diet of cetaceans in Ireland is relatively sparse but some commercial species (herring, mackerel, whiting, sprat, hake) have been shown to be important in the diet of Harbour porpoise (Rogan and Berrow, 1996) and Common dolphin (Couperus, 1997; Berrow and Rogan, 1995). Herring are particularly important for Harbour porpoises as they have a high calorific value (Santos and Pierce, 2003). There is evidence that species such as sandeel and whiting have become more important in the diet of Harbour porpoises in the northeast Atlantic following the decline of herring stocks since the mid-1960s. There is speculation about the consequences of prey switching if their preferred prey were depleted by over-fishing but evidence from seals suggests this could have a significant impact on their productivity and survivorship (Santos and Pierce, 2003).

Fishing activity may also degrade the seafloor and its associated demersal and benthic fauna (e.g., Piet *et al*., 2000; Rabaut *et al*., 2007). This could impact negatively on cetaceans by reducing the biomass of prey species or altering their distribution. For example, the small demersal *Trisopterus* species may currently have limited commercial interest but they are important prey species for Harbour porpoises. Therefore, unintentional removal of these non-target species by bottom trawling could impact detrimentally on this cetacean species.

Ecosystem-based management is a topical issue being widely discussed in the context of modern fisheries management (Larkin, 1996; Brodziak and Link, 2002). The review of the European Common Fisheries Policy (CFP) in January 2003 focused on this approach as the way towards a sustainable fishing industry. An Ecosystem-based Approach to Fisheries Management (EAFM) should be directed towards restoring fish stocks to levels capable of delivering optimal yields over the long-term without compromising other species or habitats. Adaptive management is a process whereby the best decisions are made on the information available, where the outcome of these decisions is monitored, and where management decisions are altered if the outcome falls short of what was intended. If there is a reasonable likelihood that an activity will cause harm to fish stocks or the marine environment, the Precautionary Principle should be applied and measures taken to exert effective control over that activity.

4.2 Actions Taken to Date

4.2.1 Bycatch

Ireland is subject to EC Council Regulation 812/2004 laying down measures concerning incidental catches of cetaceans in fisheries. This requires the use of acoustic deterrents (i.e. pingers) in some fisheries and at-sea observer studies to minimise the impact of fishing activities on marine ecosystems. Member States are required to report annually on the use of pingers and the implementation of on-board observer programmes and to include all information collected concerning the incidental capture and killing of cetaceans in fisheries.

Pingers are required on fishing vessels greater than 12m in length if fishing bottom-set or entangling gillnets in ICES sub-areas VIIg and VIIj, off the south and southwest coasts of Ireland. Currently Irish vessels over 12m are required to use pingers on gillnets, normally at a spacing of 200m or 100m depending on the specification of the device. However a temporary derogation under Article 3(2) of Regulation 812/2004 allowed for an increase in the maximum spacing between pingers to 500m for digital devices. This was in force until 12th June 2009 (Sea Fisheries Protection Authority - SFPA, *pers. comm*.). Pingers have been provided by BIM to the relevant fisheries and enforcement is the responsibility of the SFPA and Irish Naval Service. Accordingly the SFPA issued Fisheries Information Notice 02-2007 to inform the industry of the need for such devices. Up to the end of 2008 the Naval Service had conducted 69 inspections of gillnet vessels and detained seven such vessels for infringements including the failure to deploy acoustic deterrent devices in their gears (SFPA, *pers. comm*.).

In spite of concerns in some quarters on pinger reliability and effectiveness, the devices do have the potential to significantly reduce the bycatch of Harbour porpoise. Hammond *et al.* (2001) tested a number of pingers in bottom-set gillnets in the Celtic Sea, including investigations of attachment, reliability and durability, and reported a 92% reduction in Harbour porpoise bycatch despite a high rate of inoperative or damaged pingers. This work suggested that the very close spacing (100m) between pingers may have mitigated the effect of faulty pingers. It suggested that pingers were the only viable option to bring about a reduction of at least 70% in porpoise bycatch, as required to meet the maximum limit of 1.7% of the population suggested by ASCOBANS.

Further trials have been carried out by BIM since the adoption of Regulation 812/2004. Cosgrove *et al*. (2005) examined the durability and reliability of pingers on bottom-set gillnets and tangle nets, including handling time and the effect on fishing practice and costs. They concluded that the introduction of pingers in these fisheries had major implications for fishermen due to problems with pinger reliability, to the time required to attach and test pingers, to increased handling time for cleaning and sorting nets and to a potential reduction in the performance of tangle nets. The latter was resolved through the introduction of a modified attachment technique using net floats (BIM, *pers. comm*.).

Two pingers were tested by Cosgrove *et al.* (2007) who found one of the pinger types disintegrated and ceased to function soon after they were deployed. The authors recommended that fishermen should be permitted to use pingers at a spacing of approximately 585m thereby reducing Harbour porpoise bycatch to 0.12% of estimated abundance. Cosgrove and Browne (2007) provided an update on cetacean bycatch in the Celtic Sea and showed that most bycatch occurred during the months of March to May. Referring to the potentially harmful effects of pinger use, such as acoustic disturbance and reduction of available habitat, the authors suggested that a strategic approach, based on the actual seasonal impact of fishing on known porpoise populations, may be more appropriate than the blanket introduction of pingers as currently required under Regulation 812/2004. It should be remembered that this is the only such fishery studied to date. Bycatch in one such fishery cannot be considered in isolation however, since it is the cumulative impact of all fisheries on populations of cetaceans that are of concern, both via national fleets and those from other EU Member States.

Research has recently been conducted in Ireland examining the use of acoustic deterrents to reduce dolphin bycatch in pelagic trawls (Anon, 2004; Leeney *et al.,* 2007; Berrow *et al*., 2009). BIM commissioned the development of a prototype acoustic deterrent unit, which could be deployed on paired trawls (Anon, 2004). Two types of pinger have been developed: (1) a continuous pinger and (2) an interactive pinger, which is only activated when an internal hydrophone receives echolocation clicks from a dolphin. The interactive pinger was developed in order to minimise the possibility of dolphin habituation to the sound signals and to reduce the amount of noise introduced into the environment. Trials were carried out between 2002 and 2003 but since cetacean bycatch was very low in the control nets, results were not statistically robust and the efficacy of acoustic deterrents could not be fully evaluated.

A controlled exposure trial was then carried out in the Shannon Estuary in 2005 to record the effect of the acoustic deterrents on dolphin behaviour (Leeney *et al.,* 2007). Bottlenose dolphins in the estuary showed a strong evasive reaction to both types of deterrents once they were activated, immediately leaving the area in a highly directional manner. Similar trials were carried out on Common dolphins, since this is the species most frequently trapped in pelagic trawls in the Irish albacore tuna fishery (Anon, 2000). No deterrent effect was observed from either of the two pingers used in the Shannon Estuary trial nor from three other acoustic deterrent technologies, including the French *CETASAVER* and the Italian *DDD* devices which have successfully caused evasive reactions by Common dolphins during trials elsewhere (ICES, 2009). The results suggested that pingers on pelagic trawling gear, at their current state of development, may not provide a consistently failsafe deterrent signal for Common dolphins occurring in Irish waters (Berrow *et al*., 2009).

In addition, the responses of Bottlenose dolphins in the Shannon Estuary to two types of commercial pingers (Dukane NetMark™ 1000 and AQUAmark 200) was examined in an experimental setup where pingers were either active or silent for periods of time (Rogan & Philpott, 2006). Observers were unaware of whether the pingers were active (10 days observations) or not (11 days). There were no significant differences in the number of groups observed between control and either treatment, nor between the Closest Observed Approach (COA) within 600m between controls and either pinger. However, there were differences in overall COA in both active treatments and the control ($p < 0.04$ Dukane, $p = 0.056$ AQUAmark). Initially, the dolphins remained > 300m away from the pingers but within 6 days, dolphins approached to within 20m of the active pingers, suggesting that initially the dolphins responded by moving away from the pingers, but within a short period became accustomed to them. This suggests that the use of pingers in areas where Bottlenose dolphins are "resident" may not be effective deterrent in the long term.

There is a requirement in Regulation 812/2004 to monitor cetacean bycatch by vessels >15m long that are engaged in pelagic trawling in Ireland, in order to identify those fisheries with high bycatch rates. Monitoring schemes are to be designed as necessary to provide representative data for the fisheries concerned; in the case of ICES areas VI, VII and VIII 10% fleet coverage is required via observations aboard a minimum of three vessels (SFPA, *pers. comm.*). Member States are also required to collect scientific data on incidental catches of cetaceans from vessels <15m long that are fishing either single or pair trawls . This should be by means of appropriate scientific studies or pilot projects. Observers should be independent and suitably qualified to identify cetacean species and fishing practices. There has been some monitoring of albacore tuna and mackerel fisheries but fleet coverage is below that required by the Regulation. There has been limited monitoring of the gillnet fleet and of gillnet and tangle net operations by vessels under 15m. However levels of bycatch across these sectors as a whole are difficult to determine at the present time.

The EU funded project "Petracet" aimed to monitor about 5% of annual fishing effort among the main French, Irish, UK, Danish and Dutch pelagic trawl fisheries operating in the Celtic Seas and Bay of Biscay region. Dolphin bycatch was estimated in the pelagic fisheries monitored at c. 622 animals per year (489 in the bass and 133 in the albacore tuna fishery); 96% of these were Common dolphins. Other fisheries that were observed were for anchovy (371 observed tows), horse mackerel (44 tows) and mackerel (92 tows). As no cetaceans were observed in any of these operations the best estimate of the bycatch rate in these fisheries was zero. However, it is clear from previous studies that some bycatch might be expected in the horse mackerel and mackerel fisheries at least (e.g., Morizur *et al.,* 1996; Couperus, 1997).

Results on bycatch presented to the recent IWC meeting (IWC, 2009) suggest that Common dolphin bycatch is known to occur, especially in the winter months, in several UK fisheries, notably those involving large meshed static nets. Between 2005 and 2008 some 3077 static net fishing operations have been monitored on UK-based set net vessels in the Irish Sea, Celtic Sea and English Channel. A total of 22 bycaught Common dolphins has been observed, but only in those fisheries targeting hake, monkfish, turbot and pollack. A combined estimate for these four fisheries using fishery specific bycatch rates averaged over all four years of observation, together with fishery specific effort estimates for 2008, yields a total bycatch in these fleets for 2008 of 594 Common dolphins (C.I: 22-797). This estimate is a provisional one, as the variation in the observed bycatch rate from year to year warrants further investigation, as does the spatial distribution of the bycatch.

The ban on the use of surface drift-nets for salmon (since 2008), tuna and swordfish fishing (since 2001) should reduce the number of bycaught cetaceans, thus reducing this potentially significant source of cetacean mortality.

4.2.2 Resource Competition

Stranded and bycaught small cetaceans have been recovered for post-mortem examination in Ireland between 1992 and 2004. The most frequently stranded species are Harbour porpoise and Common dolphin (O'Connell and Berrow, 2008). Between 1990 and 2004, 123 Harbour porpoises and 90 Common dolphins were recovered, providing 73 stomachs for dietary analysis. At least 16 different taxa, including 11 fish and five cephalopod species have been recorded to date. This work has shown that *Trisopterus*, whiting and gadoids may be the most important prey species for Harbour porpoise (Rogan and Berrow, 1996; Rogan, 2009). *Trisopterus* species include poor cod and Norway pout, which are small demersal fish species currently of limited interest to commercial fisheries. The IWDG provides samples from stranded cetaceans to the Irish Cetacean Tissue Bank stored at the NHM. This is important for studies on cetacean stock identity and population range and it will assist in interpreting the impact of incidental mortality and resource competition due to fishing. There is also evidence of resource competition between some small cetacean species, namely Bottlenose dolphins and Harbour porpoise (Ryan, 2008) and Common dolphin (Murphy *et al*., 2005b).

The Irish government is currently funding a 7-year project using the EAFM to address issues concerning the sustainable management of Irish fisheries. A collaboration between the Marine Institute, University College Cork and Queen's University Belfast, this initiative funded under the *Beaufort* marine research awards (http://beaufort.ucc.ie) is investigating issues of resource competition between marine mammals and fisheries in Irish waters. There are many work packages in this project, and cetaceans are an important component in three of these. The project will involve extensive modelling approaches (i.e. EcoPath/EcoSIM) based on known food web and ecosystem linkages. Size spectrum modelling, GIS and bioenergetic modelling will be carried out to investigate competitive and bycatch interactions between fisheries and marine mammals, and to explore different management and mitigation scenarios.

A specific case study in this project examines the issue of cetacean bycatch. There are many hypotheses about why cetaceans get caught in fishing gear and in one work package, the research consortium will look at some of the factors influencing bycatch and at the degree of spatial and temporal overlap of cetaceans and fisheries. In addition, potential prey data will be incorporated into the models using data from fisheries and examined in the context of bycatch predictors. It is proposed to model spatial and temporal overlap of cetaceans & fisheries and use the outcomes/overlap to generate hypotheses & management strategies in relation to bycatch reduction strategies. Indices of spatial vulnerability may be developed for a number of cetacean species (using occurrence data gathered from Platforms of Opportunity (POPs) and dedicated surveys. By developing habitat maps it may also be possible to develop density maps (similar to those developed in SCANS-II and CODA) to predict likely occurrence of cetaceans in data poor areas. These can then be compared with known fishing effort in these areas. Vulnerability indices will be developed and areas of high overlap/potentially high interaction will be identified, and management measures/options such as time/area closures or gear restrictions in specific area will be examined.

The impact of prey removal from specific areas will also be examined in this project. Reconstructing food webs is a complex task, involving knowledge of species' trophic position and interactions within the food web. In addition, over the last few decades, massive removals of pelagic and demersal species, salmon, invertebrates may have altered the basic structure and function of the ecological community. The reconstruction of food webs will require knowledge of the diet of many species and a data mining exercise will be carried out to populate the models, along with re-working of published and unpublished data on cetacean and seal diet and, it is hoped, the incorporation of new additional information. Using fisheries data (landings and discards) and information on top predator abundance and distribution, the research consortium will attempt to examine the prey productivity needed to sustain top fish and marine mammal predators at various spatial scales.

As indicated in Section 3.2.1, one of the aims of the PReCAST and ISCOPE II projects is to determine the distribution and relative abundance of cetaceans within the Irish Exclusive Economic Zone (EEZ). This is expected to address significant information gaps that currently exist for a wide range of species. The PReCAST project also aims to examine potential ecosystem links between cetaceans and fisheries in the Celtic Sea using GIS (i.e. geographical information system) methods. The south coast of Ireland is known to be the site of complex coastal fronts and upwelling of cold nutrient-rich waters (Pingree and Le Cann, 1989). Exceptional blooms of planktonic algae have been recorded off the west Cork coast, especially in mid and late summer when plankton is scarce in other Irish coastal areas (Raine and McMahon, 1998). Large colonies of seabirds found in southwest Ireland and the occurrence of cetaceans, especially Fin whales and Common dolphins, off the south coast of Ireland during the autumn and early winter may be connected to this abundant plankton resource. The presence of a large biomass of schooling fish (e.g., herring and sprat) is thought to drive the seasonal foraging behaviour of cetaceans in the region (P.Whooley, IWDG, *pers. comm.*).

However the mechanisms and ecosystem links behind the presence of both cetaceans and fish are not fully understood and questions exist as to why similar fish aggregations elsewhere (e.g., northwest herring) do not appear to generate the same foraging activity by cetaceans. The PReCAST project will examine the foraging aggregations of cetaceans (especially Fin whales and Common dolphins) off the south coast to examine the potential ecosystem links that may drive this activity. A further aim of PReCAST is to track the movements of up to five Fin whales through the use of satellite telemetry, recording their position for up to 100 days. It is hoped this study will provide data on Fin whale migration and possibly identify breeding or calving grounds which currently are not known in the North Atlantic. Tagging is intended to take place along the south coast of Ireland in January/February, immediately before the whales leave inshore waters.

4.3 Threats to their Protection

While the licensing of fisheries and implementation of mechanisms for the strict protection of cetaceans is the responsibility of individual Member States, the fishing activities of multiple Member States and Third Parties overlap with these obligations. There is therefore little prospect of advancing the conservation of cetaceans through protection mechanisms operated by individual Member States alone. To ensure the required conservation success and avoid competitive discriminatory actions, it is essential that any mitigation measures that might be implemented in fishing grounds located in Ireland are progressed by regulation through the Common Fisheries Policy.

Action: Work with the European Commission to ensure that conservation actions to change fishing practices are implemented through Common Fisheries Policy regulations.

4.3.1 Bycatch

Entanglement in fishing gear is one of the most important existing and potential threats to cetaceans in Irish waters. Over the last decade or so, a number of specific and general precautionary bycatch removal targets have been discussed by various Conventions and scientific fora for some species and/or areas, e.g., 1-2% of an identified Harbour porpoise population (IWC); a maximum 1.7% of the Harbour porpoise population in the Baltic and North Seas (ASCOBANS). While clear bycatch targets for individual cetacean species in a given geographical area must be established to facilitate protection from fisheries, this can only be achieved via a multinational effort through the Common Fisheries Policy.

Action: Ireland should request advice from ICES concerning the effective mitigation of cetacean bycatch in commercial fisheries, including where relevant the steps necessary to establish species-specific bycatch targets, that will give effect to the achievement of strict protection for cetacean species occurring in the waters within Ireland's Exclusive Fishery Zone.

An integrated approach to recording, reporting and mitigating bycatch, involving all Member States fishing in Irish waters, is essential. Council Regulation 812/2004 only covers selected fisheries and areas. Fisheries off the west, north and east coasts that may present a risk to cetaceans (e.g., gill netting, tangle netting) are not covered by the Regulation at present. An assessment should be undertaken to ensure that the bycatch monitoring requirements of Council Regulation 812/2004, as they relate to Irish waters, are sufficiently robust. This would identify the gaps (if any) in protection to cetaceans from fisheries and inform discussions concerning the further development of targeted regulation and monitoring instruments, where necessary.

Action A risk assessment of existing fisheries by all fleets in waters within Ireland's Exclusive Fishery Zone should be undertaken for the purposes of identifying those that pose the greatest risk of cetacean bycatch.

Action Any fisheries and/or fleet segments that are identified as presenting a significant risk of cetacean bycatch and are not currently covered by Regulation 812/2004 should be brought to the attention of the European Commission.

The effectiveness of acoustic deterrents to repel cetaceans from fishing nets over time should be continually evaluated. Investigations to develop additional measures that mitigate cetacean bycatch by selected fisheries (including gear modifications as well as pingers) should be pursued through continued national international collaboration.

Action: Continue to contribute, nationally and/or internationally, to trials investigating the effectiveness of pingers and/or gear modifications as cetacean bycatch mitigation tools.

4.3.2 Resource Competition

The distribution and relative abundance of most cetaceans in Ireland, and their movements and migration routes are poorly understood at present. Limited data on cetacean temporal and spatial distribution, preferred habitats and life history, collectively impact on the ability to carry out informed fisheries risk assessments and to develop effective management measures. As indicated in the preceding section (3.2), surveys are currently being undertaken to address some of this information deficit.

Very little information is available on the diet or foraging behaviour of most cetaceans in Ireland, including the issue of seasonal or geographical variation in foraging. For example, recent work on Fin and Humpback whales seen off the southwest coast in the autumn and winter suggests a link between the presence of these species and seasonally abundant shoals of sprat (O'Brien *et al.,* 2009). However without quantitative data it is not possible to determine the resource or biomass required to sustain a given cetacean population and thereafter to sustain important prey species and their stocks.

Action: Initiate a cetacean post-mortem programme to determine the diet of cetaceans in Ireland, including determining size and biomass of prey species in order to explore potential competition between cetaceans and commercial fisheries.

Action: Carry out research to understand the foraging behaviour of cetaceans in Irish waters especially with regard to commercial fish species.

Cetaceans are highly mobile animals and a given population in Ireland may range in waters outside Ireland's jurisdiction. Information on the stock identity of all species is essential to ensure that mortality in areas outside Ireland is not reducing the population of cetaceans occurring in Irish waters. Information on genetic structure, variability and individual identity from an appropriate sample size can provide key information on population structure.

Action: Use a cetacean post-mortem programme to provide tissue samples to the Irish Cetacean Tissue Bank for use in population genetics studies.

In order to protect cetacean populations, it is essential to ensure that stocks of their preferred prey are also sustained. Collapses of commercial fish species due to over-exploitation may have significant effects by compromising a population's reproductive fitness. The food requirements of cetaceans as key higher trophic level predators should be considered when Total Allowable Catches are being calculated. Future fisheries management initiatives (e.g., time-area closures) could benefit cetacean species if their ecology is considered during management planning stages.

Action: Include cetacean surveys on fishery cruises to collect information on the possible relationships between fish and cetacean abundance.

Action: When sufficient data are available, carry out spatial modelling using GIS to explore the relationship between cetacean distribution and abundance and commercial fisheries to identify times or areas with increased risk of interactions.

Fishing is a dynamic industry that changes in response to diverse environmental and management factors and market forces. New fishing methods or fisheries (e.g., pair-trawling for albacore tuna) are being developed periodically, some of which might have a significant impact on one or more cetacean species. Despite the legal requirement to provide strict protection to cetaceans in Ireland's EEZ there is currently no risk assessment framework in place to ensure that no adverse impact occurs on cetaceans in Ireland as a result of fishing activities.

Action: Ensure that risk assessments are conducted on the impacts for cetaceans of any new fishing gears and/or fisheries in advance of licensing.

Commercial fishing in SACs established to protect Harbour porpoise and Bottlenose dolphin may potentially capture individuals or degrade their preferred habitats through bottom trawling or the removal of important prey species, for example. To date, no appropriate assessments have been conducted for fishing activities within SACs designated for cetaceans and no associated fishing restrictions or impact mitigation measures have been put in place.

Action: Ensure that an appropriate assessment is conducted on all commercial fishing in cetacean SACs.

4.4 Future Actions

10. Work with the European Commission to ensure that conservation actions to change fishing practices are implemented through Common Fisheries Policy regulations.
    Lead Department: DEHLG
    Other Bodies: DAFF, European Commission, All Relevant Member States, Industry
    Timeframe: Ongoing

11. Ireland should request advice from ICES concerning the effective mitigation of cetacean bycatch in commercial fisheries, including where relevant the steps necessary to establish species-specific bycatch targets, that will give effect to the achievement of strict protection for cetacean species occurring in the waters within Ireland's Exclusive Fishery Zone.
    Lead Department: DEHLG
    Other Bodies: European Commission, ICES
    Timeframe: 2011

12. A risk assessment of existing fisheries by all fleets in waters within Ireland's Exclusive Fishery Zone should be undertaken for the purposes of identifying those that pose the greatest risk of cetacean bycatch.
    Lead Department: DEHLG
    Other Bodies: European Commission, DAFF, MI, BIM
    Timeframe: 2011-2012

13. Any fisheries and/or fleet segments that are identified as presenting a significant risk of cetacean bycatch and are not currently covered by Regulation 812/2004 should be brought to the attention of the European Commission.
    Lead Department: DEHLG
    Other Bodies: DAFF, European Commission, All Relevant Member States
    Timeframe: Ongoing

14. Continue to contribute, nationally and/or internationally, to trials investigating the effectiveness of pingers and/or gear modifications as cetacean bycatch mitigation tools.
    Lead Department: DAFF
    Other Bodies: BIM, MI, DEHLG
    Timeframe: Ongoing

15. Initiate a cetacean post-mortem programme to determine the diet of cetaceans in Ireland, including determining size and biomass of prey species in order to explore potential competition between cetaceans and commercial fisheries.
    Lead Department: DEHLG
    Other Bodies: MI
    Timeframe: 2011-2012

16. Carry out research to understand the foraging behaviour of cetaceans in Irish waters especially with regard to commercial fish species.
    Lead Department: DEHLG
    Other Bodies: MI
    Timeframe: Ongoing

17. Use a cetacean post-mortem programme to provide tissue samples to the Irish Cetacean Tissue Bank for use in population genetics studies.
    Lead Department: DEHLG
    Other Bodies: MI, NHM
    Timeframe: 2011-2012

18. Include cetacean surveys on fishery cruises to collect information on the possible relationships between fish and cetacean abundance.
    Lead Department: DEHLG
    Other Bodies: MI
    Timeframe: Ongoing

19. When sufficient data are available, carry out spatial modelling using GIS to explore the relationship between cetacean distribution and abundance and commercial fisheries, to identify times or areas with increased risk of interactions.
    Lead Department: DEHLG
    Other Bodies: MI
    Timeframe: 2011-2012

20. Ensure that risk assessments are conducted on the impacts for cetaceans of any new fishing gears and/or fisheries in advance of licensing.
    Lead Department: All Relevant Member States, European Commission
    Other Bodies: N/a
    Timeframe: Ongoing

21. Ensure that an appropriate assessment is conducted on all commercial fishing in cetacean SACs.
    Lead Department: DAFF
    Other Bodies: N/a
    Timeframe: 2010-2011

5.0 Pollution

Pollution is the introduction of contaminants into an environment that causes instability, disorder, harm or discomfort to its physical systems or living organisms. For cetaceans, such pollutants include persistent pollutants such as organochlorines and Brominated Flame Retardants (BFRs), toxic heavy metals and other trace elements and plastics. Anthropogenic (i.e. manmade) noise may also be considered an acoustic pollutant.

5.1 Description

5.1.1 Persistent pollutants

Persistent pollutants are ubiquitous in the marine environment. These include organochlorines, which are chemicals that contain carbon and chlorine atoms joined together, many of which do not break down easily and thus persist in the environment and in body tissues. Persistent organochlorines include chlorinated pesticides such as dieldrin and DDT, dioxins and polychlorinated biphenyls (PCBs).

PCBs have been used since 1929 in a variety of applications and although their use has now ceased, they are still present in many older electrical installations. PCBs are very persistent in the environment since they are very resistant to biodegradation. Due to a high affinity for lipids they tend to bio-accumulate in organisms, especially those higher up the food chain. Marine mammals, with their characteristic thick blubber layer, are particularly vulnerable (Aguilar, 1985). In a study of female Common dolphins and Harbour porpoises in western European seas, Pierce et al. (2008) found that PCB levels in the blubber of sampled animals were frequently above the threshold at which effects on reproduction could be expected. Pregnancy rates for Harbour porpoise in this region were lower in comparison to western Atlantic populations and those that died from disease or parasitic infection has higher concentrations of persistent organic pollutants than porpoises dying from natural causes. High concentrations of PCBs have also been associated with an increase in disease among cetaceans in UK waters (Jepson *et al.,* 2005). Law *et al.* (1989, 2001) reported higher than expected levels of organochlorine compounds in tissues of dolphins and porpoises in west Wales, which could have serious health implications for these animals. The source of this contamination was thought to be through their diet, although analysis of their preferred prey did not show markedly elevated levels of organochlorines.

Although levels of organochlorine pesticide contamination in cetaceans in Ireland are among the lowest recorded in the northeast Atlantic (McKenzie *et al*., 1998; Smyth *et al*., 2000), no cetacean sampled in Ireland to date has been found free of these contaminants. Contaminant levels of PCBs in bycaught Harbour porpoises and Common dolphins were similar to those reported from Scotland, but levels were lower than those from Scandinavia (Smyth *et al*., 2000). Concentrations of PCBs in resident Bottlenose dolphins in the Shannon Estuary were 3-4 times higher than levels recorded from Harbour porpoises in Ireland, but these concentrations were not thought to pose a risk to their health (Berrow *et al*., 2002b). McKenzie *et al*. (1998) suggested that organochlorine contamination was ubiquitous in Atlantic white-sided dolphins from Irish and Scottish waters. Organochlorine concentrations in a Killer whale from Cork Harbour were low compared to individuals from other parts of the northeast Atlantic (McHugh *et al.,* 2007). There are currently no data available on the concentrations of organochlorines in other Irish cetacean species.

New contaminants identified in cetacean tissues include organo-tin, organo-halogens and polybrominated compounds from flame retardants. Brominated Flame Retardants are a group of chemicals added to many consumer products, including computers, TVs and household textiles, in order to reduce fire risk. Most concern has been expressed over polybrominated biphenyls (PBB), which have similar properties to PCBs, polybrominated diphenyl ethers (PBDEs) and tetrabromobisphenol-a (TBBP-A). There have been few studies of BFRs in Ireland but PBBs and PBDEs have been found to contaminate the blubber of marine mammals in the Irish Sea (Law *et al.,* 2000) and Sperm whales in the remote deep waters of the Atlantic (de Boer *et al.,* 1998). PBDEs have been found in the tissues of Long-finned pilot whales in the Atlantic (Lindstrom *et al.,* 1999). A study of hexabromocyclododecane (HBCD) flame retardants in Harbour porpoises and Common dolphins from western European seas showed that the highest total HBCD levels were measured in Harbour porpoises stranded on the Irish and Scottish coasts of the Irish Sea (Zegers *et al.,* 2005). Median levels in Common dolphins were highest from the west coast of Ireland compared to French or Spanish coasts. The implications of these HBCD concentrations are currently unknown.

A heavy metal is a member of a subset of elements that include the transition metals, some metalloids, lanthanides, and actinides. Living organisms require varying amounts of heavy metals, but excessive level of heavy metal exposure can damage the organism. Some heavy metals have no known vital or beneficial effect on organisms and their accumulation in tissues over time can cause serious illness. Environmental pollution by these metals arise from a number of sources, including lead in petrol, industrial effluents and leaching of metal ions from the soil into lakes and rivers via acid rain. Elevated concentrations of mercury and lead have been found in the livers of marine mammals in the Irish Sea, which were high enough in the case of mercury to give cause for concern (Law *et al.,* 1991, 2001). There have been very few studies of heavy metals in the tissues of cetaceans in Ireland. Current evidence suggests that lead concentrations found in small cetaceans from Ireland may not constitute a matter of concern (Caurant *et al*., 2006). Lahaye et al. (2007) measured a selection of trace elements in Harbour porpoise tissues from animals stranded along the coast of Ireland and other western European countries. Elements included in the analysis were Cadmium (Cd), Copper (Cu), Mercury (Hg), Selenium (Se) and Zinc (Zn) and the results indicated comparatively low concentrations of toxic elements in the tissues (i.e. kidney, liver) from porpoises stranded in Ireland.

Radio-nucleides may occur naturally, but can also be artificially produced. The most significant source of artificial radioactivity in the Irish environment is from the Sellafield nuclear reprocessing plant. Liquid discharges from Sellafield into the Irish Sea began in the early 1950s but have decreased during the late 1970s and early 1980s. The main contaminant is caesium-137. Radio-Caesium 137 levels have been measured in 25 Harbour porpoises stranded or bycaught along the coasts of Britain and Ireland (Berrow *et al.,* 1998). Concentrations in porpoises originating from the Irish Sea were elevated relative to those from the Celtic Sea, Atlantic seaboard and the North Sea but it was thought unlikely that this increased dose had a detrimental effect on the health of Irish Sea Harbour porpoises.

Plastics represent one of the latest contaminants in the marine environment and individual items may persist for hundreds of years. A large number of marine species are known to be harmed and/or killed by plastic debris with marine animals mostly affected through entanglement in, and ingestion of, plastic litter (Derraik, 2002). Although ingestion is believed to be less of a problem for cetaceans than entanglement, it has been reported as the cause of death for a number of species from Harbour porpoise to Pygmy sperm whale (Baird and Hooker, 2000; Stamper *et al.,* 2006). Plastic has been recovered from the stomach and oesophagus of a number of species in Irish waters including Bottlenose dolphin (O'Brien and Berrow, 2006) and Humpback whale (Berrow *et al.,* 2006b).

Cetaceans are potentially vulnerable to a wide range of human and livestock pathogens from sewage discharges, however there is a lack of data on the extent of these risks for coastal species such as Harbour porpoise and Bottlenose dolphin (Thompson, 2007).

Little is known about the effects of oil on cetaceans. Captive dolphins have been shown to avoid thick oiled areas but did not detect oil sheen (Smith *et al*., 1983; Smultea and Würsig, 1995). There have been few field studies examining the impact of oil spills on cetacean populations. Recently Matkin *et al*. (2008) indicated that the recovery of a Killer whale population to the 1989 Exxon Valdez oil spill in Alaska was unexpectedly slow due to abnormal mortalities of Killer whales following the oil spill.

5.1.2 Underwater sound

The EU Marine Strategy Framework Directive defines noise as a pollutant. The Directive describes noise as a pollutant if it "results, or is likely to result, in deleterious effects such as harm to living resources and marine ecosystems, including loss of biodiversity, the hindering of marine activities including fishing, tourism and recreational and other legitimate uses of the sea, impairment of the quality for use of sea water". This issue has particular relevance for cetaceans.

Sound propagation in water is much more effective than in air and consequently some sounds in the marine environment may travel over very long distances. Cetaceans rely heavily on sound to communicate, exploit and investigate the environment, to find and capture prey and to avoid obstacles and predators. Exposure to noise can produce a range of effects on cetaceans. A low level anthropogenic sound can be audible to animals without resulting in any visible effect. At increased levels the sound may disturb animals and induce avoidance and other behavioural changes. If animals for any reason can't avoid a noise source, they may be exposed to acoustic conditions capable of producing further negative effects, which may range from discomfort and stress to physical acoustic trauma. Exposure to very loud sound events, for example explosions at short range, can produce damage to many organs in addition to hearing (Weilgart, 2007).

Underwater noise and vibrations produced by man may come from many sources: ship traffic, marine tourism boats, seismic surveys, seabed drilling, ship sonars, oceanographic experiments, underwater explosions and vibrations propagating from the coast. Certain works on or near the shore can cause significant noise levels in adjacent waters (e.g., in enclosed harbours or estuaries), due to propagation through the water column and the seabed. Natural sources of noise in the marine environment include the movement of water, wind action, rain and earthquakes and, while they may have an impact on cetaceans, the animals are presumed to have adapted to most of them by evolving suitable schemes of acoustic and non-acoustic communication.

Richardson *et al*. (1995) provided a comprehensive summary of data on marine mammal responses to specific noise sources. A number of factors affect the response of cetaceans to sound, including the sound level and other properties of the sound including its novelty, the physical and behavioural state of the animal and its prevailing acoustic characteristics, and the ecological features of the environment in which the animal encounters the sound. Critical issues dealing with the effects of and the response of cetaceans to anthropogenic noise and the long-term effects of these sounds on individuals and populations are currently receiving significant attention yet remain to be fully explained. The indirect effects of anthropogenic sound on marine mammals via effects on their predators, prey, and other critical habitat elements are yet poorly understood.

Reviews on cetacean auditory thresholds and acoustic surveys are found in Richardson *et al.* (1995), Keevin and Hempen (1997), Gordon *et al*. (1998) and, more recently, Nowacek *et al*. (2007) and Southall *et al.* (2007). Conclusions on auditory thresholds resulting in auditory damage in marine mammals are acknowledged to be somewhat speculative due to lack of data. Richardson *et al.* (1995) and Gordon *et al.* (1998) noted that damage was more likely and thresholds lower for repeated exposure. The dominant frequencies of marine seismic surveys and lower frequency echosounders coincide more or less with the range of frequencies used by baleen whales for communication and other purposes. McCauley *et al.* (2000) concluded that animals must be able to cope physiologically with their own sounds, concluding that whales can cope with levels of 188-192dB re 1 μPa. However, this is a rapidly expanding research area (Southall & Nowacek, 2009) and more recent information suggests that lower received sound levels may be sufficient to cause temporary hearing loss (i.e. temporary threshold shift) and disruption of normal behaviour (e.g., disturbance) in a number of cetacean species studied to date (Southall *et al*., 2007; DECC, 2009). The National Marine Fisheries Service, which is the body responsible in the United States for regulating effects of human activities on cetaceans, limits the exposure of cetaceans to noise pulses based on a „do not exceed' level of 180 dB re 1 μPa (i.e. level A). Above this measure there is concern about possible risk of injury (Tyack, 2009). Levels exceeding 160 dB re 1 μPa are also regulated, under harassment level B.

Schlundt *et al*. (2000) carried out a comprehensive experimental study with five individual Bottlenose dolphins and two White whales. The hearing thresholds of the animals were measured before and after exposure to 1-second tones at 0.4, 3, 10, 20, and 75kHz. The levels required to cause a 6dB reduction in sensitivity for short exposures at these frequencies were between 192dB and 201dB. At 400Hz, where auditory sensitivity was lowest, no animals showed evidence of threshold shifts (i.e. temporary hearing loss). Richardson *et al.* (1995), in reviewing the literature, indicated that whales may react to lower frequency echosounders, sometimes showing strong avoidance behaviour. Baleen whales seem to react to frequencies up to 28kHz but do not react to pingers, acoustic tags and echosounders at 36kHz and above. For narrow-beam vertical echosounders, the highest sound pressure levels will be found in the narrow main lobe immediately below the transducer. Hence the most likely scenario for temporary or permanent injury of an animal by such acoustic equipment would be if the equipment were turned on full power while the cetacean was very close to it.

There is limited information available on the effects of blasting on cetaceans but the associated shock wave is thought to be the primary cause of damage to aquatic life (Keevin and Hempen, 1997). Blasting on land adjacent to the shore may also result in sound waves entering the sea via propagation through the bedrock. Crum and Mayo (1996) calculated that exposure of humans or marine mammals to 500Hz sounds at sound pressure levels of 210dB re. 1μPa could cause bubble growth to occur in tissues and suggested that this could theoretically induce the „bends' (i.e. decompression sickness) in marine mammals. The authors considered that this effect was unlikely at sound pressure levels below 190dB re. 1μPa. Finneran *et al.* (2000) measured the masked underwater hearing threshold of dolphins after exposure to sounds with waveforms generated to resemble those of distant explosions. Sound pulses from charges ranging from 5-500kg of Hex at ranges of 1.5 to 55.6km were simulated, with the highest exposure level generated being equivalent to 500kg @ 1.7km distance. No threshold shifts were observed after any of these exposures. Disruption of trained behaviour began to occur at exposures equivalent to 500kg of Hex @ 9.3km and 5kg of TNT @ 1.5km for the dolphins and at 500kg Hex @ 1.9km for white whales.

Pile driving noise has the potential to affect dolphin populations adversely. At 9kHz this noise is capable of masking strong vocalisations within 10-15km and weak vocalisations up to approximately 40km (David, 2006).

Carstensen *et al.,* (2006) showed an increase in waiting times between acoustic encounters with harbour porpoises during the hammering of steel sheet piles into the seabed.

Southall *et al.* (2007) used precautionary estimation and extrapolation methods to predict the exposure levels above which significant adverse effects (both temporary and permanent physical injury and behavioural disturbance) would be expected to occur in various marine mammal species (see Table 2). However for many cetacean species experimental data measuring the responses, both physical and behavioural, to known sound sources are lacking either in the wild or captive situations. Further research is required in this area to assist in more effective management of the potential threat to cetaceans from manmade noise.

Table 2. Proposed injury criteria for individual marine mammals exposed to "discrete" noise events, defined by the onset of Permanent Threshold Shift (PTS), i.e. permanent hearing loss (from Southall *et al.,* 2007).

	Sound type		
Marine mammal group	Single pulses	Multiple pulses	Nonpulses
Low-frequency cetaceans	Cell 1	Cell 2	Cell 3
Sound pressure level	230 dB re: 1 μPa (peak) (flat)	230 dB re: 1 μPa (peak) (flat)	230 dB re: 1 μPa (peak) (flat)
Sound exposure level	198 dB re: 1 μPa²-s (M_{lf})	198 dB re: 1 μPa²-s (M_{lf})	215 dB re: 1 μPa²-s (M_{lf})
Mid-frequency cetaceans	Cell 4	Cell 5	Cell 6
Sound pressure level	230 dB re: 1 μPa (peak) (flat)	230 dB re: 1 μPa (peak) (flat)	230 dB re: 1 μPa (peak) (flat)
Sound exposure level	198 dB re: 1 μPa²-s (M_{mf})	198 dB re: 1 μPa²-s (M_{mf})	215 dB re: 1 μPa²-s (M_{mf})
High-frequency cetaceans	Cell 7	Cell 8	Cell 9
Sound pressure level	230 dB re: 1 μPa (peak) (flat)	230 dB re: 1 μPa (peak) (flat)	230 dB re: 1 μPa (peak) (flat)
Sound exposure level	198 dB re: 1 μPa²-s (M_{hf})	198 dB re: 1 μPa²-s (M_{hf})	215 dB re: 1 μPa²-s (M_{hf})
Pinnipeds (in water)	Cell 10	Cell 11	Cell 12
Sound pressure level	218 dB re: 1 μPa (peak) (flat)	218 dB re: 1 μPa (peak) (flat)	218 dB re: 1 μPa (peak) (flat)
Sound exposure level	186 dB re: 1 μPa²-s (M_{pw})	186 dB re: 1 μPa²-s (M_{pw})	203 dB re: 1 μPa²-s (M_{pw})
Pinnipeds (in air)	Cell 13	Cell 14	Cell 15
Sound pressure level	149 dB re: 20 μPa (peak) (flat)	149 dB re: 20 μPa (peak) (flat)	149 dB re: 20 μPa (peak) (flat)
Sound exposure level	144 dB re: (20 μPa)²-s (M_{pa})	144 dB re: (20 μPa)²-s (M_{pa})	144.5 dB re: (20 μPa)²-s (M_{pa})

Note: All criteria in the "Sound pressure level" lines are based on the peak pressure known or assumed to elicit TTS-onset, plus 6 dB. Criteria in the "Sound exposure level" lines are based on the SEL eliciting TTS-onset plus (1) 15 dB for any type of marine mammal exposed to single or multiple pulses, (2) 20 dB for cetaceans or pinnipeds in water exposed to nonpulses, or (3) 13.5 dB for pinnipeds in air exposed to nonpulses. See text for details and derivation.

Commercial ships have been increasing in both number and size, and are producing ever-greater amounts of underwater noise as an incidental by-product of their operation. Aggregate traffic noise arising from the combined effects of all shipping at long ranges contributes to increased ambient noise levels in the sea. This traffic noise may originate from more than 10km away and in deep water may include low-frequency components from up to 4,000km distance (Richardson *et al*., 1995). An important effect of increased ambient noise on marine mammals is the potential for that noise to mask biologically significant sounds. Shipping generally dominates ambient noise at frequencies from 20 to 300Hz and the potential effect of this noise on baleen whales was first discussed by Payne and Webb (1971). Numerous studies have since examined the impacts of masking and related their findings to concerns regarding low-frequency noise from shipping (Erbe and Farmer 1998; Foote *et al.,* 2004; Nowacek *et al*., 2007). Recent data on Northern right whales indicate that members of this endangered species adjust their vocalisation (i.e. its frequency and loudness) in the presence of vessel noise (Parks and Clark, 2003). A Cuvier's beaked whale (*Ziphius carvirostris*) was found to reduce its production of sounds associated with foraging in response to a passing cargo ship (Aguilar de Soto *et al*., 2006).

One of the most immediate and well-documented sources of high level underwater sound is from geophysical surveys, especially seismic surveys. Marine geophysical surveys are conducted to study geological processes and structures and to locate submarine geological structures often associated with petroleum or gas deposits. These surveys often use high-energy sources to create sound waves that penetrate the earth's crust beneath the seabed, thereafter receiving the reflected sound information in order to produce quantitative and qualitative data (e.g., maps) describing the seabed features. High-energy low frequency sounds, usually in the form of short-duration pulses, are created along planned survey grids. Sound pulses from marine seismic surveys are often detectable in the water column tens or even hundreds of kilometres from the source (e.g., Richardson *et al*., 1995). During an acoustic survey for cetaceans off western Ireland, Aguilar de Soto *et al.* (2004) detected and recorded noise from a seismic survey off northwest Ireland 490km away from its source. Since 1965 there have been 392 seismic surveys carried out in Irish waters resulting in nearly 400,000km of seismic survey track lines being carried out (Petroleum Affairs Division on-line database). Overall, the direct and indirect impacts of this survey technique on cetaceans and other marine mammals are still unclear. A number of studies have shown that baleen whales, which are likely to be most sensitive to sounds at these lower frequencies, may react by moving away from seismic sources (Richardson *et al*., 1995; Weilgart, 2007). Even smaller toothed cetaceans like Common dolphins may react to seismic activity at least 8km from the source vessel (Goold, 1999a).

Many geophysical surveys use various acoustic techniques to assess and map the seabed's topographical contours or the nature of underlying rock formations. Methods used range from towed side-scan sonars to elucidate bottom contours, to hull-mounted multi-beam echosounders to form an accurate map with detail of the nature of sea floor or seismic surveys that use one or more airguns to form an image of underlying rock and sediment beneath the seabed surface. Despite the comparative scarcity of studies into the effect of multi-beam and other sonars on cetaceans, a number of organisations have developed best practice to minimise their potential effects on marine mammal behaviour and hearing (O'Brien *et al.,* 2005).A number of mitigation measures to minimise the impact of sound sources on cetaceans have been proposed worldwide (Weir and Dolman, 2007).

Deep-diving species such as beaked whales may be particularly susceptible to the harmful effects of seismic pulses due to the complex bathymetry of their preferred habitats, such as deep-water canyons and gullies (Barlow and Gisiner, 2006). High intensity, low and mid-frequency sonar has been implicated in some fatal beaked whale strandings to date (e.g., Frantiz, 1998; Jepson *et al*., 2003).The impact on cetaceans of mid and low frequency active sonars used in military exercises has caused great concern worldwide (Parsons *et al.,* 2008). There is now strong corroborative evidence that this equipment has caused mass strandings of cetaceans, particularly beaked whales (Cox *et al*., 2006). Gas bubble lesions in stranded cetaceans have been potentially attributed to fast surfacing due to the avoidance of active sonar (Jepson *et al.,* 2003) and these lesions have been identified in stranded cetaceans, especially deep-diving species, from the UK (Jepson *et al.,* 2005b). Atypical strandings in Ireland in early 2008 have also been linked to possible naval exercises off western Scotland (Dolmen *et al., in press*).

The expansion of renewable energy devices into the marine environment may create additional sources of underwater noise with significant effects on cetaceans (Madsen *et al.,* 2006). The construction of wind turbines offshore usually involves the excavation of material and/or pile driving to create foundations for individual turbines and further excavation of the seabed to lay the connecting power grid. Detailed studies of the impact of wind farm construction on cetaceans, mainly Harbour porpoises, were carried out in association with the Horns Reef and Nysted wind farms in Denmark. Carstensen *et al.* (2006) have shown that there was a substantial effect on Harbour porpoises during construction, with displacement from one site occurring up to two years after construction. The impact was weaker throughout the construction period at a site with higher densities, which may have been associated with higher prey availability. Once operational, wind farms may continue to impact on cetaceans via mechanical and other ongoing noise. Koschinski *et al.* (2003) simulated the underwater noise emitted by a 550MW wind turbine and showed Harbour porpoises were able to detect the low-frequency sound generated by offshore wind farms and that they may show avoidance behaviour to such introduced sound. The impact on baleen whales may be greater still since they are more sensitive to low frequency sounds. Nearly all studies on the impact of renewable energy devices on cetaceans have been on Harbour porpoises since this species is the most widespread and abundant species in the southern North Sea, where most large offshore wind farms have been built to date. There are virtually no studies on any other cetacean species to date, including baleen whales.

The impacts on cetaceans of marine turbines and other renewable energy devices placed on or below the sea surface are less well studied. since such technology is relatively new and not yet in widespread use. However a growing body of impact assessment literature is emerging which provides some initial theoretical, empirical and other guidance regarding construction of such facilities (e.g., COWRIE reports). Marine mammal collisions with submarine turbines may occur and the ability of cetaceans to detect these turbines is likely to depend on ambient noise masking the sounds from the operational devices. If ambient noise is high the detection distance is reduced and the risk of collision increases (Wilson, 2008). Ambient noise in shallow coastal waters may be quite significant depending on water depth, seabed substrate type, exposure to currents, wind and wave action.

5.2 Actions Taken to Date

5.2.1 Persistent pollutants

Ireland is a signatory to the MARPOL Convention, which is the main international convention covering prevention of pollution of the marine environment by ships from operational or accidental causes. Annex V seeks to prevent the disposal of waste, including plastic, at sea. All ships of 400 gross tonnage and above and every vessel certified to carry 15 persons is required to have to Garbage Management Plan, to include written procedures for collecting, storing, processing and disposing of garbage, including the use of equipment on board.

Both the OSPAR Convention and the EU Water Framework Directive (2000/60/EC) aim to maintain water quality by minimising or eliminating the input of persistent pollutants into the coastal or marine environment. Similarly, the EU Marine Strategy Framework Directive (2008/56/EC) will require Member States to achieve good environmental status in their marine waters. Ireland is currently conducting a pilot programme to investigate the principal sources of litter that wash up on our shores. While many aspects of this issue will require regional responses on land and at sea that will evolve through implementation of the 2008 EU Marine Strategy Framework Directive, this pilot study may offer some insight as to whether targeted actions are required at national and/or local level.

5.2.2 Underwater sound

Marine mammal observers (MMOs) are increasingly required for developments that involve blasting, dredging or pile driving in, or adjacent to, SACs. In addition, the implication of expansion of offshore exploration on cetacean populations was considered during three Irish Offshore Strategic Environmental Assessments (IOSEA 1-3). The NPWS "Code of Practice for the Protection of Marine Mammals during Acoustic Seafloor Surveys in Irish Waters" (2007) has been included in the Rules and Procedures by the Petroleum Affairs Division of the Department of Communications, Energy and Natural Resources for all new exploration licences. Implementation of the Guidelines is a condition for the granting of a licence. These guidelines provide mitigation measures including the use of MMOs on all seismic surveys and on multi-beam and side-scan sonar surveys. However, while the potential usefulness of PAM was acknowledged at a dedicated workshop organised by NPWS, the consensus was that it would be premature to rely solely on PAM as an effective mitigation tool at this time. Therefore, "soft starts" of significant sound-producing equipment are limited to daylight hours due to the requirement for visual monitoring. The existing Code of Practice is due for review and updating, via consultation with key stakeholders, in 2010.

5.3 Threats to their Protection

5.3.1 Persistent pollutants

Persistent pollutants in the marine environment constitute a serious long-term threat to cetaceans. Bio-accumulation may lead to impairment of reproductive capability or increased levels of disease. Once in the marine environment it is extremely difficult to remove these compounds, thus occurrence prevention is the most appropriate action. Persistent pollutants come from a variety of sources including run-off in rivers and through rain and can be extremely difficult to control.

Action: Monitor the concentrations of persistent organic pollutants and other toxic contaminants in cetacean species in Ireland using samples from bycatch and/or stranding programmes.

Action: Quantify the concentrations of Brominated Flame Retardants in cetacean tissues in Irish waters using samples from bycatch and/or stranding programmes.

Action: Seek to improve marine water quality to standards set in EC Directives and international conventions by reducing the discharge of substances which are toxic, infectious, persistent or liable to bio-accumulate.

Action: Continue the pilot programme to investigate the principal sources of litter that wash up on our shores and implement local and national actions to prevent this litter entering the marine environment.

Sewage discharges may potentially place human and other pathogens into the marine environment where they could come into contact with and infect cetaceans. New sewage treatment schemes in or adjacent to SACs require an appropriate assessment to assess the likely impact on the site's conservation objectives. However the lack of appropriate water quality guidelines for cetaceans and other wildlife makes it difficult to assess the risk to cetaceans from sewage discharges.

Action: Ensure that risk assessments are conducted on the potential impacts on cetaceans of sewage discharges in advance of licensing.

Oil spills in the marine environment may adversely affect cetacean populations. Oil Spill Contingency Plans have been developed in all ports and harbours in Ireland. These and any future plans should be reviewed to ensure that they include assessments on the likely effects on cetaceans.

Action: Standard guidelines should be developed to ensure that cetacean considerations are fully incorporated into oil spill contingency plans.

5.3.2 Underwater sound

Acoustic disturbance of or injury to cetaceans may arise through a range of underwater sound sources. Blasting, pile driving, the placement of rock armour, etc all have different sound characteristics and the attenuation of sound pressure levels will vary with the substrate and topography of the sea floor, among other features. The acoustic impact of these activities will depend on local factors and the cetacean species potentially affected. It is important to ensure that development applications in all areas are fully assessed for their likely impacts on cetaceans.

Action: Standard guidelines should be developed and applied in all areas for minimising the input of increased noise levels into the marine environment in consultation with key stakeholders.

Shipping is an important source of ambient noise in the oceans, which may mask the low frequency sounds produced by baleen whales for communication and navigation. Ship collisions with cetaceans may be an important threat for some species.

Action: Ensure that risk assessments are conducted in relation to the potential impact on cetaceans from any proposed intensification of shipping activity.

Action: Raise awareness of the presence of cetaceans, including important habitats and migration routes in Ireland, within the marine shipping community.

Seismic and other geophysical surveys are widely carried out in Irish waters and are likely to continue in the near future. In order to ensure that the impact on cetaceans is minimised, a precautionary approach should be adopted and the NPWS Code of Practice for the Protection of Marine Mammals during Acoustic Seafloor Surveys in Irish Waters should be implemented whenever relevant and in a systematic manner in the general marine environment. Critical habitats for cetaceans (e.g., Lower River Shannon cSAC) may require a more precautionary approach and further mitigation.

Action: All relevant Regulatory Authorities should be advised about the Code of Practice for the Protection of Marine Mammals during Acoustic Seafloor Surveys in Irish Waters and should ensure that its implementation is a standard condition on all relevant licences.

Action: Develop rigorous guidelines for use of acoustic surveys in identified critical habitats for cetaceans in consultation with key stakeholders.

There is a strong correlation between the use of certain naval sonars and cetacean mass stranding events involving beaked whales in particular (Parsons *et al.,* 2008). The Irish Government is not required to be informed or to give permission for any naval exercises outside of the Irish 12nm limit (Dept. of Defence, *pers. comm*.) despite there being considerable evidence to suggest that certain naval sonar exercises may affect a number of cetacean species. While a selection of possible mitigation measures has been identified, and is implemented in some jurisdictions, the full impact of naval sonar activity on cetaceans in Irish waters is unknown. The ongoing post-mortem examination of stranded cetaceans has been identified for action in Section 4.3.1 with respect to fisheries interactions; such examinations of deep-diving species stranded in Ireland should pay special attention to lesions associated with acoustic trauma and associated non-auditory injury.

Action: Ensure that acoustic trauma and other tissue injury are considered as a possible cause of death, particularly for deep-diving species, in post-mortem examinations.

Action: Discuss with the European Commission appropriate procedures to mitigate the possible impacts of naval sonar on cetaceans.

The expansion of renewable energy devices into the marine environment may contribute to local noise pollution both during construction and, to a lesser degree, during their operation.

Action: Ensure that a strategic assessment is conducted of the impact of renewable energy devices on cetaceans at an early stage of their development.
Action: Establish guidelines on survey requirements for the development of marine renewable energy facilities (wind, wave and tidal).

5.4 Future Actions

22. Monitor the concentrations of persistent organic pollutants and other toxic contaminants in cetacean species in Ireland using samples from bycatch and/or stranding programmes.
    Lead Department: DEHLG
    Other Bodies: MI, EPA
    Timeframe: Ongoing

23. Quantify the concentrations of Brominated Flame Retardants in cetacean tissues in Irish waters using samples from bycatch and/or stranding programmes.
    Lead Department: DEHLG
    Other Bodies: MI, EPA
    Timeframe: Ongoing

24. Seek to improve coastal water quality to standards set in EC Directives and international conventions by reducing the discharge of substances which are toxic, infectious, persistent or liable to bio-accumulate.
    Lead Department: DEHLG
    Other Bodies: EPA
    Timeframe: Ongoing

25. Continue the pilot programme to investigate the principal sources of litter that wash up on our shores and implement local and national actions to prevent this litter entering the marine environment.
    Lead Department: DEHLG
    Other Bodies: DAFF, DoT
    Timeframe: 2011-2012

26. Ensure that risk assessments are conducted on the potential impacts on cetaceans of sewage discharges in advance of licensing.
    Lead Department: DEHLG
    Other Bodies: Local Authorities, An Bord Pleanála
    Timeframe: Ongoing

27. Standard guidelines should be developed to ensure that cetacean considerations are fully incorporated into oil spill contingency plans.
    Lead Department: DEHLG
    Other Bodies: DAFF, DoT, DCENR
    Timeframe: 2010-2011

28. Standard guidelines should be developed and applied in all areas for minimising the input of increased noise levels into the marine environment in consultation with key stakeholders.
    Lead Department: DEHLG
    Other Bodies: DoT, DCENR, DAFF, Local Authorities, An Bord Pleanála
    Timeframe: 2010

29. Ensure that risk assessments are conducted in relation to the potential impact on cetaceans from any proposed intensification of shipping activity.
    Lead Department: DEHLG
    Other Bodies: DoT, DCENR, Local Authorities, An Bord Pleanála
    Timeframe: 2011-2012

30. Raise awareness of the presence of cetaceans, including important habitats and migration routes in Ireland, within the marine shipping community.
    Lead Department: DEHLG
    Other Bodies: DoT
    Timeframe: 2011-2012

31. All relevant Regulatory Authorities should be advised about the Code of Practice for the Protection of Marine Mammals during Acoustic Seafloor Surveys in Irish Waters and should ensure that its implementation is a standard condition on all relevant licences.
    Lead Department: DEHLG
    Other Bodies: DCENR, Local Authorities, An Bord Pleanála
    Timeframe: 2010-2011

32. Develop rigorous guidelines for use of acoustic surveys in identified critical habitats for cetaceans in consultation with key stakeholders.
    Lead Department: DEHLG
    Other Bodies: N/a
    Timeframe: 2010-2011

33. Ensure that acoustic trauma and other tissue injury are considered as a possible cause of death, particularly for deep-diving species, in post-mortem examinations.
    Lead Department: DEHLG
    Other Bodies: N/a
    Timeframe: 2011-2012

34. Discuss with the European Commission appropriate procedures to mitigate the possible impacts of naval sonar on cetaceans.
    Lead Department: DEHLG
    Other Bodies: N/a
    Timeframe: 2010-2011

35. Ensure that a strategic assessment is conducted of the impact of renewable energy devices on cetaceans at an early stage of their development.
    Lead Department: DEHLG
    Other Bodies: DCENR
    Timeframe: 2010-2011

36. Establish guidelines on survey requirements for the development of marine renewable energy facilities (wind, wave and tidal).
    Lead Department: DEHLG
    Other Bodies: DCENR
    Timeframe: 2010-2011

6.0 Vessel Use

The shipping and maritime transport industry is the largest sub-sector of the marine industry in Ireland with major ports on the east, the south and the west coasts.

6.1 Description

6.1.1 Shipping

Vessel activities, especially merchant shipping in coastal waters, pose a threat to cetaceans by their potential direct physical damage to individuals via collisions and propeller damage. Collisions with fast ferries are of increasing concern due to their expanding use in the marine environment, particularly in the case of baleen whales which do not use echolocation as a sensory tool, are relatively slow-moving and whose hearing is low frequency. Collisions between ships and cetaceans are relatively common, even though the former produce noise at considerable intensity and the latter possess good hearing capabilities. Laist *et al.* (2001) documented collisions dating to the 1890's, although reports have increased in recent years. While cetaceans are quite capable of reacting rapidly to a perceived danger, in certain situations (e.g., when they are resting at the surface, feeding, nursing or mating) they may be less alert to an imminent threat, particularly if its sound is not distinguishable from background or ambient noise levels.

Ship strikes are a known cause of cetacean mortality worldwide, yet comparatively little information is available on the subject and its management. Therefore, it is currently difficult to evaluate the existing or potential scale and repercussions of collisions on cetacean populations in Ireland. There are, however, some examples of ship strikes with Fin whales in Irish waters (e.g., Smiddy, 1990; Whooley *et al.,* 2008). A container ship arrived into Liverpool Docks in July 2004 with a Fin whale across its bow that was hit off the west coast of Ireland. The Irish Sea fast ferry *Jonathan Swift* has recorded two strikes with whales (April 2004 and July 2006). The extent and impact of these collisions is unknown but could be significant for some of the less abundant species.

Clapham *et al*. (1999) reviewed the status of baleen whale stocks with an emphasis on those that were critically endangered. The authors suggested that, of the various threats potentially affecting baleen whales, only entanglement in fishing gear and ship strikes may be significant at the population level. The impact of other known threats such as vessel "harassment" and commercial or aboriginal whaling was considered minor. Knowlton and Kraus (2001) showed that ship collisions are a significant impediment to the population recovery of the endangered Northern right whale. Laist *et al*. (2001) suggested that collisions which took place at vessel speeds of >13knots were far more likely to be fatal than those that took place at lesser speeds. Ships strikes are not only a conservation concern, they also have serious economic and safety implications. In the Canary Islands, a real-time whale position reporting network for merchant ships (REPCET) has been developed in an attempt to minimise ship collisions with cetaceans.

6.1.2 Marine tourism

Whale watching is defined by the International Whaling Commission as any commercial enterprise which provides for the public to see cetaceans in their natural habitat (IWC, 1994). It is one of the fastest growing tourism activities in the world with annual growth rates of 7% per annum (Hoyt, 2001) and is carried out in 87 countries with three countries attracting over a million whale watchers per annum. Whale watching has the potential not only to provide socio-economic benefits to coastal communities but to enhance conservation objectives by increasing awareness and supporting research activity. However, whale watching, if not properly regulated or controlled, can degrade cetacean habitats and cause excessive disturbance to some populations.

There have been a number of short-term studies on the effect of whale watching on cetaceans but fewer long-term studies. Long-term studies on Bottlenose dolphins have however reported the avoidance of whale watching areas and declines in relative abundance where whale watching occurs (Lusseau, 2004; Bejder *et al.,* 2006). Whale watching vessels have been shown to affect vocalisation rates in dolphins, to increase dive intervals and aerial behaviours, to increase horizontal avoidance and to decrease normal resting behaviour (Corkeron, 1995; Constantine *et al*., 2004; Lusseau, 2003). Foraging and resting activity by Common dolphins were significantly disrupted by whale watching boats in the Hauraki Gulf, New Zealand to levels that raised concern about the sustainability of this impact (Stockin *et al.,* 2008). Disturbance has in some cases been shown to be acoustic in nature, caused by the noise from whale watching craft (Erbe, 2002; Foote *et al.,* 2004). Holt *et al*. (2008) have shown that Killer whales increased their call amplitude by 1dB for every 1dB increase in background noise levels and nearby whale watching vessel counts were positively correlated with these observed background noise levels. However Au and Green (2000) thought it unlikely that sound produced by small vessels, inflatable boats or large coastal boats would have any grave effects on the auditory system of Humpback whales in the study area.

Whale watching is an expanding tourism activity in Ireland at a number of coastal locations (Hoyt, 2001; Berrow, 2003). It is reported to have begun in 1984 when people started visiting the solitary Bottlenose dolphin known as “Fungie” in Dingle Harbour, Co Kerry (Hoyt, 2001). Over a million people are likely to have visited the Dingle dolphin, at rates of up to 150,000 per year. This industry is not sustainable, since it is based on one dolphin.

Whale watching centred on a population of Bottlenose dolphins inhabiting the lower Shannon Estuary began in earnest in 1995 (Berrow and Holmes, 1999) and it has expanded rapidly since 1999 (Berrow, 2003). Whale watching off the south coast began in 1992 and two dedicated whale watching tour operators have been conducting passenger trips from west Cork since 2001. Hoyt (2001) estimated whale watching in Ireland to be worth $1,322,000 in direct revenues and $7,119,000 in indirect revenues in 1998. In addition to dedicated whale watching operators there is also a larger number of marine wildlife tourism operators in Ireland who seek out cetaceans, seals and other wildlife during their trips to sea. These tourism operators are now distributed along all coasts from Co. Dublin to Co. Donegal.

6.2 Actions Taken to date

6.2.1 Marine Tourism

Marine wildlife tourism is increasing in Ireland, in part due to incentives through the marine diversification programme, which seeks to reduce the number of fishing vessels and develop alternative employment for those employed in the sector. Some are turning to marine wildlife and other boat-based tourism products. In an attempt to assist in species identification and promote best practice a Marine Wildlife Tour Operators Course was piloted on Clear Island, Co Cork in May 2008.

Whale watching is now well established in several coastal areas in Ireland (e.g., west Cork, the lower River Shannon and Killary Harbour). Since 2000, when the Lower River Shannon was designated as an SAC for Bottlenose dolphins, tour boats have required permission from the Minister of the Environment, Heritage and Local Government to conduct whale watching in the Shannon Estuary. Operators are required to abide by a Conservation Plan and Code of Conduct and to provide dolphin monitoring data. This monitoring involves the collection of eight monitoring indices including photo-identification of the individual dolphins being watched by tour boats. Around 400 trips are carried out each year from Kilrush and Carrigaholt in Co. Clare (Berrow, 2003). Most trips take place during the summer months.

The Shannon Dolphin and Wildlife Foundation (SDWF) was established in west Clare in 2000 to provide educational awareness and to promote the conservation of the dolphins in the Shannon Estuary. It also provides a forum for stakeholders to contribute towards management decisions. Miller (2008) analysed the long-term monitoring dataset collected by the SDWF from the Shannon Estuary (nine years of tour boat data). Results suggested that the monitoring data showed no strong relationships between the cumulative exposure of dolphins to tour boats and four variables chosen as impact indicators. The distribution of boat trips also appeared to have shifted from one primary concentration to two separate areas of concentration, which may reflect changes in dolphin distribution. Shore-based observations were performed of dolphin behaviour when a tour boat was, and was not, in close proximity to Bottlenose dolphins.

This study showed that, from immediately prior to and after both tour boat arrival and departure, the group surfacing rate changed significantly. Mean group surfacing rates measured for more extended periods prior to and after tour boat arrival and departure, however, were not significantly different from each other. Nor were significant differences detected in the consistency of behaviour data, when extended observation periods with and without tour boats present were compared. Overall, the results from this study suggested that the presence of tour boats in the estuary can have short-term behavioural effects on the Bottlenose dolphins present, but these effects do not appear to be having a substantial long-term influence on the natural behaviour of the population.

In 2005, the Marine Safety Directorate of the Department of Transport (DoT) issued Marine Notice 15 on the “Guidelines for Correct Procedures when encountering Whales and Dolphins in Irish coastal waters”. This provides good advice and best practice guidance for operating both commercial and recreational vessels around cetaceans and is applicable to waters out to the 12nm limit.

6.3 Threats to their protection

6.3.1 Shipping

The distribution and relative abundance of most cetaceans in Ireland and their movements and migration routes are poorly understood at present. Limited data on cetacean temporal and spatial distribution, preferred habitats and life history, collectively impact on the ability to carry out informed fisheries risk assessments and to develop effective management measures. Increased ambient noise due to shipping and the effects of masking, especially on baleen whales, may be significant in their long-term impacts on cetacean populations. Areas where a cetacean species' distribution overlaps with shipping channels or the approach to major ports are particularly sensitive, especially if these areas are important feeding or breeding grounds or play a role in annual migration. As indicated in the preceding section (3.2), surveys are currently being undertaken to address some of this information deficit.

The presence of cetaceans, especially large whales, which are at greatest risk from ship collision and acoustic masking may be quite low within the main shipping lanes around Ireland. Yet a greater understanding and appreciation of the importance of Ireland for many species may help to minimise the impact of shipping in the future. Ship collisions with cetaceans are very poorly documented in Ireland at present. Under the Department of Defence, the Irish Naval Service policy is to report any ship strikes when they do occur. However in practice such events may not always be detected and the potential threat, particularly to some of the more rare species, cannot currently be quantified.

This issue is currently being examined by the International Whaling Commission. Raising awareness has already been actioned in this report (see Action 30). It may be possible to develop systems that allow the logging and provision of data on ship strikes in real time via worldwide web access, thereby eliminating losses of data from vessels in transit to other jurisdictions, for example.

Action: Explore the possibility of developing a system with merchant vessel operators and other large vessel operators (Irish Naval Service) for reporting cetacean ship strikes in Ireland.

6.3.2 Marine tourism

There is considerable potential for the disturbance of cetacean species by whale watching vessels since operators are deliberately attempting to get close to cetaceans for extended periods of time. The emerging whale watching industry should be proactively managed to ensure that the intensification of activities proceeds in a sustainable manner and does not diminish the conservation status of cetaceans.

Action: Work with marine wildlife tour operators to agree best practice standards for their operations, including promotion of Marine Notice 15 of 2005.

Action: Investigate the feasibility of a permit system that is based on risk assessments for whale watching operations and/or marine tourism operators who focus on cetaceans.

Action: Ensure that effective pressure monitoring indices for the whale watching and/or relevant marine tourism sectors are developed and implemented.

Acoustic disturbance from whale watching may arise due to the production of noise from the vessels' engines. Noise production by wildlife tour vessels can be reduced by reducing vessel velocity as well as by the design of the vessel itself. As new vessels are built for this emerging industry, active encouragement should be provided to those vessels carrying quieter engines and protection around their propellers.

Action: Encourage the use of engines meeting high international standards for noise emissions in whale watching vessels.

6.4 Future Actions

37. Explore the possibility of developing a system with merchant vessel operators and other large vessel operators (Irish Naval Service) for reporting cetacean ship strikes in Ireland.
    Lead Department: DEHLG
    Other Bodies: Irish Naval Service, DoT
    Timeframe: 2010-2011

38. Work with marine wildlife tour operators to agree best practice standards for their operations, including promotion of Marine Notice 15 of 2005.
    Lead Department: DEHLG
    Other Bodies: Industry
    Timeframe: 2010-2011

39. Investigate the feasibility of a permit system that is based on risk assessments for whale watching operations and/or marine tourism operators who focus on cetaceans.
    Lead Department: DEHLG
    Other Bodies: Industry
    Timeframe: 2010-2011

40. Ensure that effective pressure monitoring indices for the whale watching and/or relevant marine tourism sectors are developed and implemented.
    Lead Department: DEHLG
    Other Bodies: Industry
    Timeframe: 2010-2011

41. Encourage the use of engines meeting high international standards for noise emissions in whale watching vessels.
    Lead Department: DEHLG
    Other Bodies: N/a
    Timeframe: 2010-2011

7.0 Conservation Plan

The following actions summarise those listed in order of appearance in the document above. They are not listed in a prioritised manner.

I. Research Programme

- ☐ Conduct further research, including through the Joint Cetacean Protocol, to determine the distribution, relative abundance and habitat preferences of cetaceans. Alongside survey effort, this should also include the establishment and maintenance of an integrated national cetacean database that is compatible with the Joint Cetacean Protocol. (Action 1)
  Lead Department: DEHLG
  Other Bodies[†]: MI, EPA
  Timeframe: Ongoing

- ☐ Conduct further research to identify the breeding ecology, movements and migration routes of cetaceans. (Action 2)
  Lead Department: DEHLG
  Other Bodies: MI, EPA
  Timeframe: Ongoing

- ☐ Devise a research programme with clear scientific objectives to effectively monitor cetaceans inside and outside designated areas. (Action 3)
  Lead Department: DEHLG
  Other Bodies: N/a
  Timeframe: 2010-2011

- ☐ Investigate the feasibility of establishing an integrated National Photo-identification Catalogue for bottlenose dolphins. (Action 4)
  Lead Department: DEHLG
  Other Bodies: N/a
  Timeframe: Ongoing

- ☐ Encourage the development of a national standard against which all appropriate Passive Acoustic Monitoring (PAM) equipment can be calibrated to allow comparisons between sites and studies. (Action 8)
  Lead Department: DEHLG
  Other Bodies: N/a
  Timeframe: Ongoing

- ☐ Explore the possibility of using static hydrophone networks to provide data to monitor cetaceans. (Action 9)
  Lead Department: DEHLG
  Other Bodies: N/a
  Timeframe: Ongoing

- ☐ Carry out research to understand the foraging behaviour of cetaceans in Irish waters especially with regard to commercial fish species. (Action 16)
  Lead Department: DEHLG
  Other Bodies: MI
  Timeframe: Ongoing

- ☐ Include cetacean surveys on fishery cruises to collect information on the possible relationships between fish and cetacean abundance. (Action 18)
  Lead Department: DEHLG
  Other Bodies: MI
  Timeframe: Ongoing

[†] Other Bodies refers to public bodies that may be in a position to provide licensing and/or funding support to facilitate the implementation of an Action.

- When sufficient data are available, carry out spatial modelling using GIS to explore the relationship between cetacean distribution and abundance and commercial fisheries, to identify times or areas with increased risk of interactions. (Action 19)
  Lead Department: DEHLG
  Other Bodies: MI
  Timeframe: 2011-2012

- Monitor the concentrations of persistent organic pollutants and other toxic contaminants in cetacean species in Ireland using samples from bycatch and/or stranding programmes. (Action 22)
  Lead Department: DEHLG
  Other Bodies: MI, EPA
  Timeframe: Ongoing

- Quantify the concentrations of Brominated Flame Retardants in cetacean tissues in Irish waters using samples from bycatch and/or stranding programmes. (Action 23)
  Lead Department: DEHLG
  Other Bodies: MI, EPA
  Timeframe: Ongoing

II. By-Catch Programme

- Ireland should request advice from ICES concerning the effective mitigation of cetacean bycatch in commercial fisheries, including where relevant the steps necessary to establish species-specific bycatch targets, that will give effect to the achievement of strict protection for cetacean species occurring in the waters within Ireland's Exclusive Fishery Zone. (Action 11)
  Lead Department: DEHLG
  Other Bodies: European Commission, ICES
  Timeframe: 2011

- A risk assessment of existing fisheries by all fleets in waters within Ireland's Exclusive Fishery Zone should be undertaken for the purposes of identifying those that pose the greatest risk of cetacean bycatch. (Action 12)
  Lead Department: DEHLG
  Other Bodies: European Commission, DAFF, MI, BIM
  Timeframe: 2011-2012

- Continue to contribute, nationally and/or internationally, to trials investigating the effectiveness of pingers and/or gear modifications as cetacean bycatch mitigation tools. (Action 14)
  Lead Department: DAFF
  Other Bodies: BIM, MI, DEHLG
  Timeframe: Ongoing

III. Stranding Programme

- Carry out a review of cetacean sightings/strandings data to detect any changes in distribution or stranding frequency that could be associated with changes in species distribution. (Action 5)
  Lead Department: DEHLG
  Other Bodies: N/a
  Timeframe: 2011-2012

- Explore the possibility of agreeing a procedure with Relevant Authorities that maximises the recovery of data from stranded animals. (Action 6)
  Lead Department: DEHLG
  Other Bodies: Relevant Local Authorities
  Timeframe: 2011

- Maintain and develop a stranding scheme to provide data on species occurrence and seasonal distribution. (Action 7)
  Lead Department: DEHLG
  Other Bodies: N/a
  Timeframe: Ongoing

IV. Post Mortem Programme

- Initiate a cetacean post-mortem programme to determine the diet of cetaceans in Ireland, including determining size and biomass of prey species in order to explore potential competition between cetaceans and commercial fisheries. (Action 15)
  Lead Department: DEHLG
  Other Bodies: MI
  Timeframe: 2011-2012

- Use a cetacean post-mortem programme to provide tissue samples to the Irish Cetacean Tissue Bank for use in population genetics studies. (Action 17)
  Lead Department: DEHLG
  Other Bodies: MI, NHM
  Timeframe: 2011-2012

- Ensure that acoustic trauma and other tissue injury are considered as a possible cause of death, particularly for deep-diving species, in post-mortem examinations. (Action 33)
  Lead Department: DEHLG
  Other Bodies: N/a
  Timeframe: 2011-2012

V. Regulatory Programme

- Work with the European Commission to ensure that conservation actions to change fishing practices are implemented through Common Fisheries Policy regulations. (Action 10)
  Lead Department: DEHLG
  Other Bodies: DAFF, European Commission, All Relevant Member States, Industry
  Timeframe: Ongoing

- Any fisheries and/or fleet segments that are identified as presenting a significant risk of cetacean bycatch and are not currently covered by Regulation 812/2004 should be brought to the attention of the European Commission. (Action 13)
  Lead Department: DEHLG
  Other Bodies: DAFF, European Commission, All Relevant Member States
  Timeframe: Ongoing

- Ensure that risk assessments are conducted on the impacts for cetaceans of any new fishing gears and/or fisheries in advance of licensing. (Action 20)
  Lead Department: All Relevant Member States, European Commission
  Other Bodies: N/a
  Timeframe: Ongoing

- Ensure that an appropriate assessment is conducted on all commercial fishing in cetacean SACs. (Action 21)
  Lead Department: DAFF
  Other Bodies: N/a
  Timeframe: 2010-2011

- Seek to improve marine water quality to standards set in EC Directives and international conventions by reducing the discharge of substances which are toxic, infectious, persistent or liable to bio-accumulate. (Action 24)
  Lead Department: DEHLG
  Other Bodies: EPA
  Timeframe: Ongoing

- Continue the pilot programme to investigate the principal sources of litter that wash up on our shores and implement local and national actions to prevent this litter entering the marine environment. (Action 25)
  Lead Department: DEHLG
  Other Bodies: DAFF, DoT
  Timeframe: 2011-2012

- Ensure that risk assessments are conducted on the potential impacts on cetaceans of sewage discharges in advance of licensing. (Action 26)
  Lead Department: DEHLG
  Other Bodies: Local Authorities, An Bord Pleanála
  Timeframe: Ongoing

- Standard guidelines should be developed to ensure that cetacean considerations are fully incorporated into oil spill contingency plans. (Action 27)
  Lead Department: DEHLG
  Other Bodies: DAFF, DoT, DCENR
  Timeframe: 2010-2011

- Standard guidelines should be developed and applied in all areas for minimising the input of increased noise levels into the marine environment in consultation with key stakeholders. (Action 28)
  Lead Department: DEHLG
  Other Bodies: DoT, DCENR, DAFF, Local Authorities, An Bord Pleanála
  Timeframe: 2010

- Ensure that risk assessments are conducted in relation to the potential impact on cetaceans from any proposed intensification of shipping activity. (Action 29)
  Lead Department: DEHLG
  Other Bodies: DoT, DCENR, Local Authorities, An Bord Pleanála
  Timeframe: 2011-2012

- Raise awareness of the presence of cetaceans, including important habitats and migration routes in Ireland, within the marine shipping community. (Action 30)
  Lead Department: DEHLG
  Other Bodies: DoT
  Timeframe: 2011-2012

- All relevant Regulatory Authorities should be advised about the Code of Practice for the Protection of Marine Mammals during Acoustic Seafloor Surveys in Irish Waters and should ensure that its implementation is a standard condition on all relevant licences. (Action 31)
  Lead Department: DEHLG
  Other Bodies: DCENR, Local Authorities, An Bord Pleanála
  Timeframe: 2010-2011

- Develop rigorous guidelines for use of acoustic surveys in identified critical habitats for cetaceans in consultation with key stakeholders. (Action 32)
  Lead Department: DEHLG
  Other Bodies: N/a
  Timeframe: 2010-2011

- Discuss with the European Commission appropriate procedures to mitigate the possible impacts of naval sonar on cetaceans. (Action 34)
  Lead Department: DEHLG
  Other Bodies: N/a
  Timeframe: 2010-2011

- Ensure that a strategic assessment is conducted of the impact of renewable energy devices on cetaceans at an early stage of their development. (Action 35)
  Lead Department: DEHLG

Other Bodies: DCENR
Timeframe: 2010-2011

- Establish guidelines on survey requirements for the development of marine renewable energy facilities (wind, wave and tidal). (Action 36)
  Lead Department: DEHLG
  Other Bodies: DCENR
  Timeframe: 2010-2011

- Explore the possibility of developing a system with merchant vessel operators and other large vessel operators (Irish Naval Service) for reporting cetacean ship strikes in Ireland. (Action 37)
  Lead Department: DEHLG
  Other Bodies: Irish Naval Service, DoT
  Timeframe: 2010-2011

- Work with marine wildlife tour operators to agree best practice standards for their operations, including promotion of Marine Notice 15 of 2005. (Action 38)
  Lead Department: DEHLG
  Other Bodies: Industry
  Timeframe: 2010-2011

- Investigate the feasibility of a permit system that is based on risk assessments for whale watching operations and/or marine tourism operators who focus on cetaceans. (Action 39)
  Lead Department: DEHLG
  Other Bodies: Industry
  Timeframe: 2010-2011

- Ensure that effective pressure monitoring indices for the whale watching and/or relevant marine tourism sectors are developed and implemented. (Action 40)
  Lead Department: DEHLG
  Other Bodies: Industry
  Timeframe: 2010-2011

- Encourage the use of engines meeting high international standards for noise emissions in whale watching vessels. (Action 41)
  Lead Department: DEHLG
  Other Bodies: N/a
  Timeframe: 2010-2011

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Appendix I: Species Profiles

Blue Whale (*Balaenoptera musculus*)

Status: Migratory

IUCN: Endangered

Conservation Status in Ireland: Unknown

Range and distribution

The Blue whale is a migratory species that has a worldwide distribution in tropical, temperate and polar seas. In the North Atlantic, Blue whales occur in waters off western Africa, ranging as far as southern Greenland. In Irish waters, the most recent report was of two sightings in September 2008 off southwestern Ireland (Wall *et al*., 2009). This is one of a few contemporary sightings of this species in Irish waters. A single individual was recorded in May 2001 in deep waters overlying the Rockall Trough (Ó Cadhla *et al*., 2004) and a number of further sightings were reported by Reid *et al*., (2003). Acoustic monitoring using the SOSUS array in Atlantic regions west of Ireland has recorded Blue whale occurrence in deep water off the west of Ireland during all months of the year, with consistent peaks in acoustic detections during November and December and a degree of inter-annual variation(Clark and Charif, 2000; Charif and Clark, 2009).

Abundance

As is the case from Irish waters, sightings of Blue whales are still very rare in Norway, Svalbard and the UK where substantial whaling industry catches were made in the past. In the North Atlantic, about 400 whales have been photo-identified from the Gulf of St Lawrence while there is a rough estimate of 1,000-2,000 Blue whales occurring in the central North Atlantic (covering the waters of Iceland, Denmark Strait, east Greenland, Jan Mayen I., the Faroe Islands and the British Isles) (Reilly *et al.,* 2008). There are currently no more precise abundance estimates for the North Atlantic.

Habitat

Blue whales usually occur in deep oceanic waters, from 100-1000m although in some areas, for example Iceland and the Gulf of St Lawrence, they regularly occur close to land. In Ireland, they are believed to occur seasonally in deep offshore waters of the Rockall Trough and perhaps those overlying the continental slope.

Migration and movements

The migration patterns of Blue whales in the North Atlantic are very poorly known but they are thought to migrate northwards in the spring to spend the summer foraging in cold temperate and polar seas. A total of 97 Blue whales were caught by whalers operating out of Co. Mayo between 1908 and 1920, indicating that they regularly passed along the edge of the continental shelf during the summer (Fairley, 1981). Recent acoustic monitoring off the western seaboard of Ireland and Scotland suggests that some individual whales remain in high northern latitudes throughout the winter months (Charif and Clark, 2000). The Faroe-Shetland Channel to the northwest of Scotland may be an important feeding ground or form part of the migration path of this species (MacLeod *et al.,* 2003).

Breeding ecology

Like Sei whales and Fin whales, Blue whales probably breed mainly in warm temperate and sub-tropical waters during winter months but the location of these breeding areas are not currently known.

Feeding ecology

Blue whales feed almost exclusively on krill, although they also take small numbers of copepods but species of this zooplankton varies between oceans (Christensen *et al.,* 1992). Wall *et al*. (2009) suggested the individual Blue whales recently observed off southwest Ireland were feeding on northern krill *Meganyctiphanes norvegica*.

Fin Whale **(*Balaenoptera physalus*)**

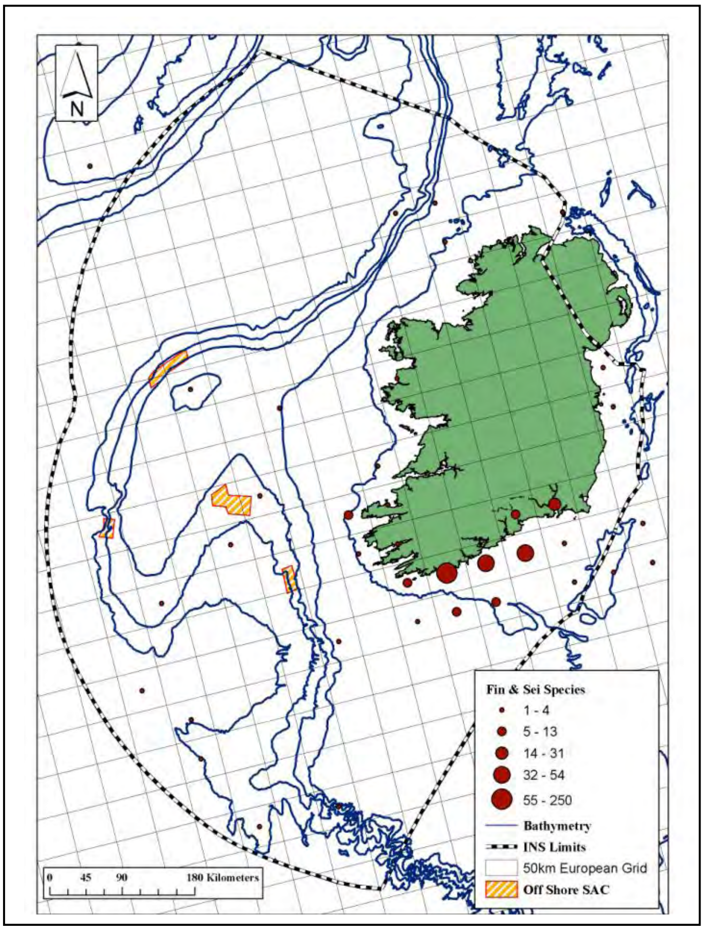
Status: Migratory

IUCN: Endangered

Conservation Status in Ireland: Good

Range and distribution

The Fin whale has a worldwide distribution in mainly temperate and polar seas. In the North Atlantic, its range extends northwards as far as Svalbard in the northeast Atlantic, to the Davis Strait and Baffin Bay in the northwest Atlantic. Fin whales in Irish waters are frequently recorded inshore off the south and southwest coasts (Whooley *et al.,* 2008) and very rarely in the Irish Sea (Berrow *et al.,* 2002a), while the relatively few offshore records of this species to date (e.g. Ó Cadhla *et al*., 2004; Wall *et al.,* 2006) are likely to be due to comparatively low observer effort. Acoustic monitoring using the SOSUS array (Clark and Charif, 2000; Charif *et al.,* 2001; Charif and Clark, 2009) has suggested that the waters off western Ireland may be important for Fin whales Inshore occurrence off the south and southwest coasts has recently been highlighted, especially in the winter months and this has resulted in the growth of a local whale-watching industry in the region.



Map of Fin whale sightings submitted to the IWDG (1991-2007).

Abundance

Based mainly on historical whaling operations, the IWC lists seven management areas for Fin whales in the North Atlantic: Nova Scotia; Newfoundland-Labrador; west Greenland; east Greenland-Iceland; north Norway; west Norway-Faroe Islands; and British Isles-Spain-Portugal. Based on genetic evidence, the IWC has concluded that current data makes it impossible to discern between one or several breeding stocks of Fin whales in the North Atlantic, and the results from genetic analyses in different studies are somewhat contradictory (IWC, 2007). Recent estimates of abundance are: 25,800 (CV=0.12) in 2001 for the central North Atlantic (East

Greenland-Iceland, Jan Mayen I. and the Faroe Islands); 4,100 (CV=0.21) in 1996-2001 for the northeast North Atlantic (North and West Norway); 17,355 (CV=0.27) in 1989 for the Spain-Portugal-British Isles area and 1,722 (CV=0.37) for West Greenland in 2005 (Reilly *et al.,* 2008). No significant population trends were found in the total abundance for any of the above areas, but when the area west and southwest of Iceland was singled out, a significant increasing trend was found (IWC, 2007). More recently the CODA survey resulted in estimates of 248 (CV=0.45) and 3,668 (CV=0.34) Fin whales from offshore waters to the north/northwest of Ireland (including Scotland) and west/south of Ireland (including part of UK and French waters) respectively (CODA, 2008).

Habitat

Fin whales may favour areas with high topographic variation such as underwater sills or ledges and upwellings, and frontal zones between mixed and thermally-stratified waters with high zooplankton concentrations (Valcroze *et al.,* 2007). In Ireland, favoured Fin whale habitats are currently difficult to determine, based on a very wide distribution of sightings in continental shelf and deeper oceanic waters (e.g. Reid *et al*., 2003; Ó Cadhla *et al*., 2004), . An exception may be the waters off the south coast of Ireland, which in the autumn and winter months, sees regular occurrence of the species (Berrow *et al*. 2002a) and the return of individual whales to the same area in successive years (Whooley *et al*., 2008).

Migration and movements

The migration patterns of Fin whales in the North Atlantic are poorly known but it is thought that they may migrate northwards in the spring to spend the summer foraging in cold temperate and polar seas. A total of 435 Fin whales were caught by whalers operating out of Co. Mayo between 1908 and 1920, indicating that they frequently passed along the edge of the continental shelf during the summer (Fairley, 1981). Recent SOSUS acoustic monitoring off the western seaboard of Ireland and Scotland recorded vocalising animals west of the Irish continental shelf in all months (Charif and Clark, 2000) with highest detection densities in December and January declining steadily into the summer months, yet no clear evidence of large-scale seasonal migratory movement (Charif and Clark, 2009). Whooley *et al*. (2008) have shown that Fin whales exhibit high site and inter-annual fidelity along the south coast of Ireland. Of the 41 Fin whales photo-identified between 2001 and 2008, 26.8% have been re-sighted. Two of these have been re-sighted over two years, one over three years and one in four of the last five years (Whooley *et al.,* 2008).

Breeding ecology

Like Sei whales and Blue whales, Fin whales are thought to breed in warm temperate and sub-tropical waters during winter months. Their breeding grounds in the North Atlantic are not known, however. The time between generations for a non-depleted Fin whale population is estimated to be 26 years (Reilly *et al.,* 2008). The average age is estimated at of 8.9 years from catches off Iceland during 1967-89, but with some indication of an increase over time from 7.5 years during 1967-78 to 9.25 years during 1979-89 (Reilly *et al.,* 2008).

Feeding ecology

Fin whales are known to eat small schooling fish species as well as krill and other crustaceans and they can be quite opportunistic in dietary terms depending on the prey type available. In Iceland, 96% of captured Fin whales contained krill with 2.5% containing a mixture of krill and fish and 1.6% fish alone (Reilly *et al.,* 2008). Fin whales have been reported to be feeding on American sand lance (sand eel) *Ammodytes americanus* in the northwest Atlantic, and Mitchell (1975) found that capelin comprised 80-90% of the prey of Fin whales caught off Newfoundland. Capelin abundance is extremely variable over time, and Fin whales may feed opportunistically on capelin in high-capelin years. In Ireland, Wall *et al.* (2009) reported Fin whales off the southwest coast possibly feeding on northern krill, while Berrow *et al.* (2004) found a high association between Fin whales and shoals of herring/sprat off the south coast of Ireland in autumn and winter.

Sei Whale (*Balaenoptera borealis*)

Status: Migratory

IUCN: Vulnerable

Conservation Status in Ireland: Unknown

Range and distribution

The Sei whale has a worldwide distribution in temperate and polar seas in all oceans and in virtually all latitudes, from 65°S to 80°N. It is more abundant in some parts of its range than others. Sei whale sightings in Irish waters have been predominantly recorded in offshore waters overlying the contintental slope off the southwest coast (Berrow *et al.,* 2002; Ó Cadhla *et al.,* 2004) and over the Rockall and Hatton Banks (Ó Cadhla *et al*., 2004). An immature Sei whale entered Larne Lough, Co. Antrim in 2005 before live stranding (Whooley and Steele, 2006), representing an unusual shallow water occurrence for this species..

Abundance

The IWC lists three stock divisions for Sei whales in the North Atlantic: Nova Scotia; Iceland-Denmark Strait; and Eastern (including the waters of Spain, Portugal, British Isles, Faroe Islands and Norway), but the divisions were chosen on largely arbitrary grounds (Donovan, 1991). The only survey in the North Atlantic designed specifically for the purpose of estimating Sei whale abundance, and with reasonably complete coverage, occurred in 1989. This yielded a population estimate of 10,300 Sei whales (CV=0.27) (Reilly *et al.,* 2008). Areas of abundance for this species appear to shift markedly between years relative to the northern extent of the distribution, more so than for other baleen whale species. There are no abundance estimates for Ireland and the CODA survey (CODA, 2008) did not record the species in the Irish/UK offshore Atlantic area.

Habitat

Sei whales appear to favour deeper oceanic waters between 500-3000m in depth and display a more pronounced offshore distribution than Fin whales. Reid *et al.* (2003) reported that most sightings from the UK and Ireland were in waters >200m particularly in the vicinity of the Faroe-Shetland Channel. They have been recorded relatively rarely in Irish waters with <70 confirmed sightings over the past 15 years, 44 of which were recorded offshore during 1999-2001 (Ó Cadhla *et al*., 2004). Therefore the relatively lower occurrence in the sighting record to date may be due to comparatively low observer effort in deeper offshore waters. However Sei whales can also be difficult to distinguish from Fin whales unless seen at closer sighting ranges. A live stranding in Larne Lough, Co. Antrim in July 2006 was the first record of this species stranded in Ireland since 1914 (Whooley and Steele, 2006).

Migration and movements

The migration patterns of Sei whales in the North Atlantic are poorly known but, in the Northern Hemisphere, they are thought to migrate north from their breeding grounds in warm temperate and sub-tropical waters. Two Sei whales satellite-tracked from the Azores were shown to follow the Mid-Atlantic Ridge as they moved north over a period of 55 days before moving west/northwest between Newfoundland and Greenland within the Labrador Sea (Lars Kleivan *pers. comm*.). A total of 88 Sei whales were caught by whalers operating out of Co Mayo off the northwest coast of Ireland between 1908 and 1920, indicating that the species regularly passed along the edge of the continental shelf during the summer months (Fairley, 1981).

Breeding ecology

Sei whales in the North Atlantic are thought to breed in warm temperate waters and sub-tropical waters during winter months and then migrate northwards to foraging areas. The time span between generations is estimated to be 23 years (Reilly *et al.,* 2008).

Feeding ecology

Sei whales show a greater variety in their diet than Blue whales, but tend to feed on only one type of prey at a time. The stomachs of Sei whales examined in the northeast Atlantic contained copepods and euphausiid crustaceans (Reilly *et al.,* 2008). Sei whales are noted for their erratic appearance in specific feeding grounds, being very plentiful in some years and absent (sometimes for years or even decades) in others (Reilly *et al.,* 2008). There is no information on the diet of Sei whales in Irish waters.

Minke Whale (*Balaenoptera acutorostrata*)

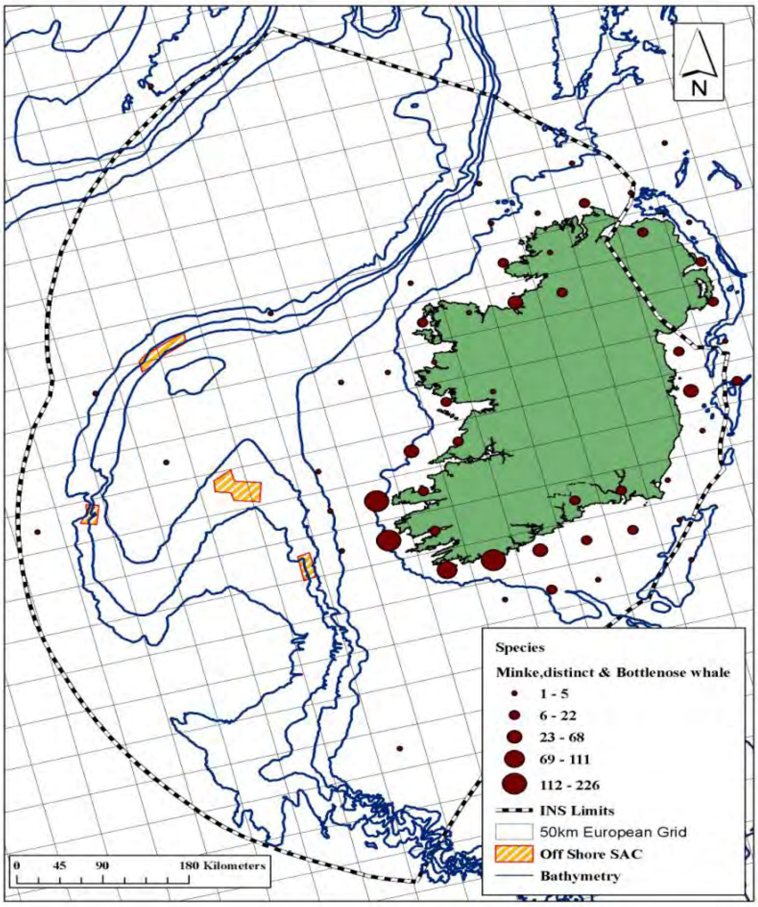
Status: Migratory

IUCN: Least concern

Conservation Status in Ireland: Good

Range and distribution

The Minke whale is a global cetacean species found in all the world's oceans and at virtually all latitudes, from 65°S to 80°N, though it is more abundant in some parts of its range than others. Minke whales are common throughout the northern North Atlantic during summer months. Sightings have occurred off all Irish coasts including the Irish Sea, but mainly off the south, southwest and west coasts (Berrow *et al.,* 2002a; Ó Cadhla *et al*., 2004). Sightings have also occurred offshore, including over the Rockall and Hatton Banks (Ó Cadhla *et al*., 2004; Wall *et al.,* 2006).



Map of Minke whale sightings submitted to the IWDG (1991-2007).

Abundance

The IWC lists four stocks of Minke whales in the North Atlantic: northeast Atlantic, central North Atlantic, west Greenland, and Canadian East Coast. Population estimates from 1997-2001 indicated that 80,487 (CV=0.15) Minke whales occurred in the Northeast Atlantic (IWC, 2004). In July 2005, Minke whale abundance in Ireland was estimated as 1,073 (CV=0.89) in the Irish Sea 1,719 (CV=1.24) in the Celtic Sea, 2,222 (CV=0.84) and 10,002 (CV=1.24) in offshore Ireland and Scotland (SCANS-II, 2008). This yields a crude estimate of approximately 10,000 Minke whales in Irish waters. A survey in July 1994 estimated that 1,195 Minke whales (CV=0.49) occurred in the Celtic Sea (Hammond *et al.,* 2002). The two surveys covered slightly different areas but density estimates were 0.006 whales per km^2 in 1994 and 0.009 per km^2 in 2005 which would equate to an annual increase of c. 3%. However there may be other factors attributed to this difference in density such as inter and intra-annual variations and migration/immigration between areas surveyed. Using conventional line transect estimation, the CODA survey (CODA, 2008) estimated a total of 6,765 animals (5,547, CV=1.03 + 1,218, CV=1.04) from the offshore Atlantic waters of the UK and Ireland.

Habitat

The Minke whale occurs in both coastal and offshore waters and exploits a variety of prey species in different areas according to availability. Tetley *et al*. (2008) explored the fine-scale distribution of Minke whales off northeast Scotland and suggested that highest densities were associated with high densities of phytoplankton which attracted sandeels, a preferred prey of Minke whales. In Ireland the species tends to be more frequently reported in continental shelf waters and especially along the coast, though this may be due in part to land-based observer effort. Highest densities during SCANS-II (2008) were recorded inshore along the western seaboard.

Migration and movements

The migration patterns of Minke whales are poorly known in the Northern Hemisphere but some populations are thought to migrate to higher latitudes in summer (Heide-Jørgensen *et al*., 2001). In the mid-Atlantic, Minke whales were found year-round but there has been very little observation effort in winter to confirm this finding (Sigurjónsson *et al*., 1991). In Ireland sightings have occurred in all months except January but they do show a distinct peak from June through to October (Berrow *et al.,* 2002a). Records from ferry routes also suggest a strong seasonal occurrence in the central Irish Sea with records from May through to July.

Breeding ecology

Conception is thought to occur when Minke whales are lactating in the warmer waters at low latitudes and before migration to higher latitudes occurs. The gestation period is estimated to be c. 10 months with the calf born near the surface of warm, shallow waters. Lactation lasts for 4-6 months and this short lactation period usually means that the calves are weaned before they arrive on summer feeding grounds. As a result, calves accompanying adult females are rarely documented. Sexual maturity usually occurs at the ages of 6-8 years in females and 5-8 years for males (Martin *et al.,* 1990). In Ireland, adults with calves have occasionally been observed during the summer months but most smaller animals are observed alone (Berrow *et al.,* 2002a).

Feeding ecology

There is no information on the diet of Minke whales in Irish waters. In the North Atlantic, studies in the Barents and Norwegian Seas showed that Minke whale diet varied greatly between areas and years. Krill dominated the diet in the northern areas, but herring or capelin dominated in southern areas according to what prey species was most abundant that year, with gadoids being taken when herring and capelin were scarce (Lindstrøm *et al.,* 2002). Dietary analysis of samples from Minke whales stranded on the Scottish coast suggested that sandeels (Ammodytidae), herring and sprat (clupeids) comprised the major prey species in the diet (Pierce *et al.,* 2004).

Humpback Whale **(*Megaptera novaeangliae*)**

Status: Migratory

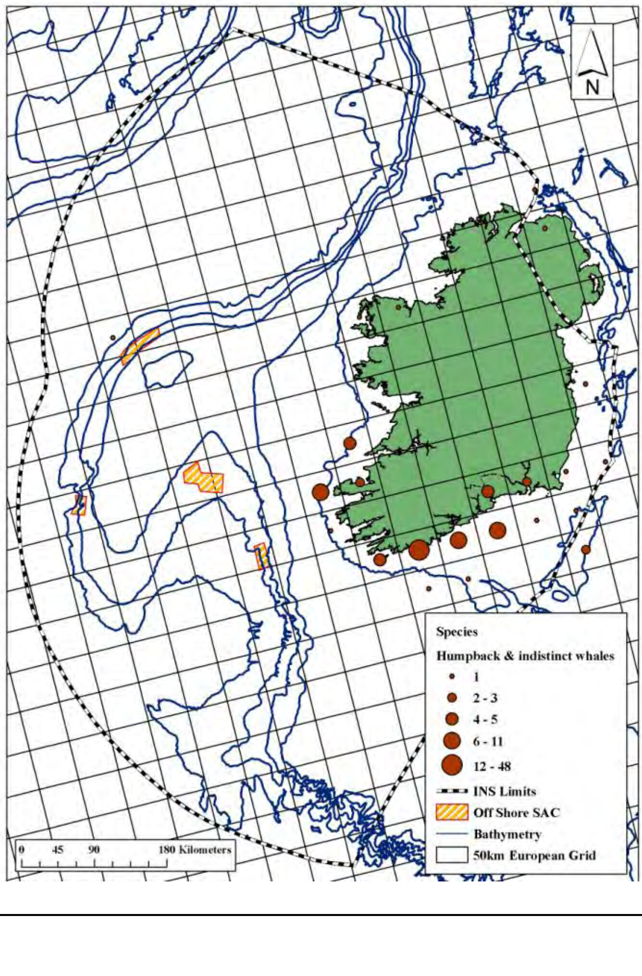
IUCN: Endangered

Conservation Status in Ireland: Unknown

Range and distribution

The Humpback whale is a global species found in all the major ocean basins (Clapham and Mead, 1999). It migrates between mating and calving grounds in tropical waters, usually near continental coastlines or island groups, and productive colder waters in temperate and high latitudes. Humpback whales in the North Atlantic range in summer from the Gulf of Maine in the northwest Atlantic and from Ireland in the northeast Atlantic northwards to the pack ice in the Arctic. The northern extent of the species' range includes the Barents Sea, Greenland Sea and Davis Strait, but not the Canadian Arctic. Humpback whales occur mainly in six distinct feeding areas: the Gulf of Maine, Gulf of St Lawrence, Newfoundland/Labrador, West Greenland, Iceland, northern Norway. Genetic and photo-identification data indicate that the six feeding areas represent relatively discrete sub-populations, fidelity to which is determined along maternal l lines. In the winter the majority of Humpback whales migrate to wintering grounds in the West Indies, and an apparently small number use breeding areas around the Cape Verde Islands.

In Ireland Humpback whales are regularly recorded in small numbers close inshore off the south and southwest coasts with offshore records (e.g. Ó Cadhla *et al*., 2004) likely to be under-reported due to reduced observer effort. Acoustic monitoring has suggested that the western seaboard of Ireland is considered a migratory corridor for humpback whales (Clark and Charif, 2000; Charif *et al.,* 2001; Charif and Clark, 2009).



Map of humpback whale sightings submitted to the IWDG (1991-2007).

Abundance
A comprehensive assessment of North Atlantic Humpback whales was completed by the IWC Scientific Committee in 2002 (IWC, 2002; 2003). The best available abundance estimate for the West Indies group of breeding aggregations was 10,752 in 1992-93 (CV=0.07) with an estimated annual rate of increase of 3.1% (Stevick *et al*., 2003). There is no estimate of abundance for the Cape Verde Islands breeding aggregation. Wenzel *et al*. (in press) estimate that there could be less than 200 humpback whales breeding in the Cape Verde Islands. Acoustic monitoring in the Irish offshore Atlantic using the SOSUS array (Charif and Clark, 2009) indicated that the species was the least recorded of the larger baleen whales with a very distinct seasonal southward migration in the autumn-winter months but no corresponding northward one.

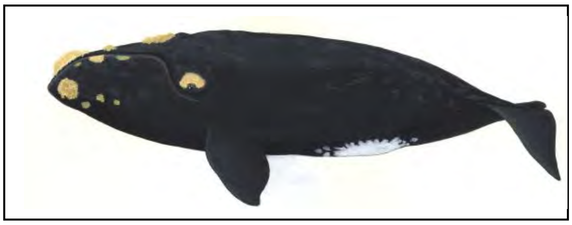
Habitat
Humpback whales appear to favour waters overlying the continental shelf and slope and those around oceanic islands. In winter Humpback whales give birth over shallow banks in tropical waters, typically 15-60m depth. In summer, they tend to have a coastal distribution that is largely dependent on local prey availability. In Ireland, favoured Humpback whale habitat includes waters overlying the continental slope and shallow waters off the south and west coasts of Ireland in the summer and autumn. Offshore sightings of this species have been relatively rare to date (Ó Cadhla *et al*., 2004).

Migration and movements
The migration pattern of Humpback whales is well known in some parts of the North Atlantic. Most photographic matches of whales from feeding grounds at high latitudes on both sides of the Atlantic match to breeding grounds in the Caribbean Sea. There are three photographic matches between Cape Verde Islands and feeding grounds off Iceland and Norway and none to the West Indies. This supports the hypothesis that Humpback whales breeding in the Cape Verde Islands may constitute a distinct breeding population and use other feeding grounds in the eastern North Atlantic, such as Ireland (Wenzel *et al.,* in press). Recent acoustic monitoring off the western seaboard of Ireland and Scotland recorded vocalising animals west of the continental shelf in all months with no obvious trends in peak annual detection densities (Charif and Clark, 2000; Charif and Clark, 2009). Only six humpback whales were caught by whalers operating out of Co. Mayo off the northwest coast of Ireland between 1908 and 1920, suggesting that the population was already severely depleted (Fairley, 1981). Whooley *et al*. (2008) showed that Humpback whales may demonstrate high site-related and inter-annual fidelity to coastal waters of the south and west of Ireland. Of seven individually recognisable Humpback whales recorded in Irish waters, three have been recorded between years, two over a five-year period and one over six consecutive years.

Breeding ecology
Humpback whales are thought to all breed and calve in warm temperate and sub-tropical waters during the winter months. However a more recent discovery of singing Humpback whales in the southern Norwegian Sea during the winter months has challenged this assumption (Charif *et al.,* 2001). Ingebrigten (1929) used whaling records to suggest that it was not improbable that Humpback whale breeding grounds historically occurred to the south of Ireland.

Feeding ecology
The diet of Humpback whales consists mainly of small schooling fish such as sandeels, herring, mackerel, capelin, pollack, cod and anchovy and large zooplankton (mainly euphausiid crustaceans) but also invertebrates such as mysids and copepods (Winn and Reichley, 1985). The type and amount of fish taken vary regionally, while euphausiids tend to be taken in greater quantities in polar regions.

Northern Right Whale (*Eubalaena glacialis*)



Status: Migratory

IUCN: Endangered

Conservation Status in Ireland: Vagrant

Range and distribution

The Right whale was formerly widespread on both sides of the North Atlantic. It appears to be close to extinction in the eastern North Atlantic but in the past the species probably ranged from calving grounds in the Golfo de Cintra (23°N) off Western Sahara, through the Azores, Bay of Biscay, western UK and Ireland and the Norwegian Sea to the North Cape.

Abundance

The Right whale was formerly common on both sides of the North Atlantic. The first records of Basque whaling in the Bay of Biscay are from the 11th century with a marked decline in catches already reported by 1650. Right whaling in the northeast Atlantic seems to have declined from the mid-17th century and all but disappeared by the mid-18th century (Brown, 1976). Only 18 Right whales were caught by whalers operating out of Co. Mayo between 1908 and 1920, perhaps indicating that their population was already severely depleted (Fairley, 1981). It is unclear whether in the past the animals in the northern part of the range (off Iceland and Norway) belonged mainly to the western or eastern breeding stocks. The current North Atlantic population is around 300–350 individuals and is centred off the east coast of North America. There have been a few sightings in recent years in the Gulf of St Lawrence, two off Iceland in 2003, and one in the former whaling ground off Cape Farewell in 2004 (IWC, 2005). A recent sighting in May 2000 was also reported by Ó Cadhla *et al.* (2004) from international waters overlying the Hatton Bank, several hundred kilometres to the northwest of Ireland.

Habitat

The Right whale is confined to temperate and sub-polar waters in the summer and thought to calve near coastal areas in relatively warmer waters. It is found closer to land than are most large whales, especially during the breeding season. Calves may be born in the protected waters of a shallow bay.

Migration and movements

The migration patterns of Right whales in the northwest Atlantic are poorly known with whales thought to migrate from calving grounds off Florida to feeding grounds off Bay of Fundy and southern Nova Scotia in Canada. A sighting off Norway in 1999 was identified as a well-known animal from the western North Atlantic population (Reilly *et al.,* 2008). A recent sighting of a Right whale from the Azores in January 2009 was the first sighting in this region since 1888 photo-identification showed and it was last seen in the Bay of Fundy in the US in September 2008 (WhaleWatch Azores *pers. comm*.).

Breeding ecology

Calving grounds in the northeast Atlantic were probably off northwest Africa and the Bay of Biscay. Most calves are born in winter. Since gestation lasts approximately one year, it is assumed that mating leading to conception also takes place in winter, although sexual activity has been observed year-round. Females give birth every 3-4 years. Estimates of the age at sexual maturity range from 5-10 years. Males are sexually mature at a length of 15 m and females at a length of 15.5 m (Wilson and Ruff, 1999).

Feeding ecology

Right whales feed on calanoid copepods and other small invertebrates (smaller copepods, krill, pteropods, and larval barnacles), generally by slowly skimming through patches of concentrated prey at or below the surface. The most common prey species is the copepod *Calanus finmarchicus* (Perry *et al.,* 1999).

Sperm Whale (*Physeter macrocephalus*)

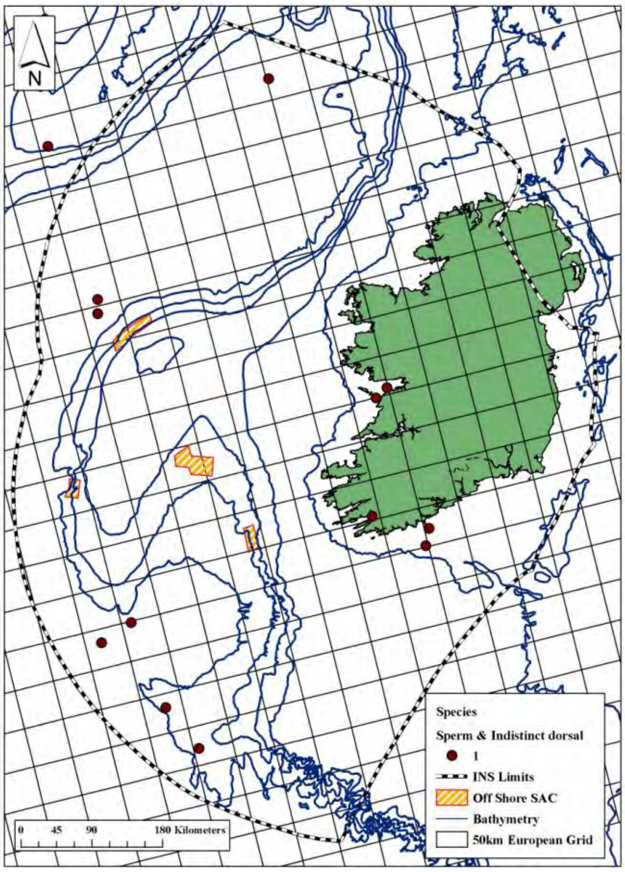
Status: Migratory

IUCN: Vulnerable

Conservation Status in Ireland: Unknown

Range and distribution

The Sperm whale has a large geographic range (Reilly *et al.,* 2008). It can be seen in nearly all marine regions, from the equator to high latitudes, but is generally found in continental slope or deeper waters. In the northeast Atlantic it is widespread in deep oceanic waters to the west of the European continental shelf, over sub-marine canyons and close to volcanic islands in waters > 200m depth. Sperm whales have unique vocalisation characteristics which facilitate their detection via acoustic surveys. Recent surveys off the west coast of Scotland and Ireland have shown that despite relatively fewer sightings, , individual whales were detected acoustically in all deep sea areas, both continental slope and deeper troughs (Goold, 1999; Aguilar de Soto *et al*., 2004). It is assumed that the majority of Sperm whales occurring off Ireland are adult males as females are very rarely reported stranded (Berrow and Rogan, 1997). A stranding of a neonate calf in Co. Clare in May 2004 was the second smallest sperm whale recorded stranded in the North Atlantic (Berrow and O'Brien, 2005) and must be considered an atypical event.



Map of sperm whale sightings submitted to the IWDG (1991-2007).

Abundance

This species has a global population size estimated in the 100,000's (Whitehead, 2002). A total of 48 Sperm whales were caught by whalers operating out of Co. Mayo between 1908 and 1920, indicating that they frequently occurred along the edge of the continental shelf during the summer (Fairley, 1981). This is supported by recent offshore studies which recorded individuals and groups of whales throughout the Rockall Trough, and over the Hatton and Rockall Banks in spring and summer months (Ó Cadhla *et al*., 2004). The CODA survey

(CODA, 2008) estimated a total of 1,122 animals (363, CV=0.46 + 759, CV=0.52) from the offshore Atlantic waters of the UK and Ireland.

Habitat

Sperm whales can be found in almost all marine waters deeper than 1000 m that are not covered by ice. In some areas, particularly in the western North Atlantic, Sperm whales, especially males, can occur in shallower waters. Females and young are thought to be restricted in distribution to waters at latitudes lower than about 40-50º and to areas where sea surface temperatures are greater than about 15ºC (Reilly *et al.,* 2008). Sperm whales are generally more numerous in areas of relatively high primary productivity (Reilly *et al.,* 2008). In Ireland, sightings have nearly all occurred offshore to the west of the continental shelf (Ó Cadhla *et al*., 2004) while Aguilar de Soto *et al*. (2004) detected Sperm whale acoustically on all surveys in deep sea areas. Recently Dunlop and Mellor (in press) reported acoustic detections of Sperm whales off the north Antrim coast which would not be considered typical habitat.

Migration and movements

Sperm whale distribution is different for non-breeding males and females. Seasonal movements may occur in some segments of the population, with those groups moving to higher latitudes in summer and lower latitudes in winter. However rigid annual migrations are not well documented. Sexually mature males travel to lower latitudes to breed but return to higher latitudes after a short period.

Breeding ecology

The breeding ecology of Sperm whales is complex but well understood. Calves are born at about 4 m in length after a gestation period of 15-15.5 months during summer and autumn at low latitudes (minimum 15ºC surface water temperature). Lactation may last from 1.6-3.5 years and calves may still suckle up to 10 years of age. Females become sexually mature at about 10 years of age (8.3-9.2 m in length) and males at about 18-21 years of age (11-12 m in length). Males usually leave their natal group at the onset of puberty and join “bachelor pods”. As they grow older they tend to become solitary and move to higher latitudes. At the onset of breeding these males travel to lower latitudes searching for females but only join female groups for short periods before returning to higher latitudes.

Feeding ecology

Sperm whales feed primarily on large-sized mesopelagic squid. Mendes *et al.* (2007) examined stable isotope profiles in sperm whale teeth and showed that females from the Atlantic had different carbon ratios compared to males reflecting their distribution at lower latitudes. In the North Atlantic the diet comprises mainly members of the Onychoteuthidae and Omnastrephidae. A live stranded sperm whale from Co. Donegal had mainly *Histioteuthis bonnellii* in its stomach as well as smaller numbers of *Haliphron atlanticus, Teuthowenia megalops* and *Gonatus* sp. (Santos *et al.* 2002). Santos *et al.* (2006) reported squid from the family *Histioteuthidae* in the diet of a sperm whale calf live stranded in Co. Clare.

Northern Bottlenose Whale (*Hyperoodon ampullatus*)

Status: Resident ?

IUCN: Data Deficient

Conservation Status in Ireland: Unknown

Range and distribution

Northern bottlenose whales are found only in the North Atlantic, from New England, USA to Baffin Island and southern Greenland in the west and from the Strait of Gibraltar to Svalbard, northern Norway in the northeast Atlantic (Reilly *et al.,* 2008). Northern bottlenose whales are rarely sighted in Irish waters. Ó Cadhla *et al.* (2004) reported one sighting off the Hatton Bank in August 2001, with two other records off the Co. Mayo coast and in the Rockall Trough in 2000.Reid *et al.* (2003) reported four sightings to the west the edge of the continental shelf.

Abundance

The overall abundance of Northern bottlenose whales has not been estimated. A rough estimate of around 40,000 in the eastern North Atlantic was presented by NAMMCO (1995), including an estimated 5,827 (CV=0.16) in the high latitudes of the eastern North Atlantic (Reilly *et al.,* 2008). Most sub-populations of the species are probably still depleted due to large kills in the past; over 65,000 animals were killed in a multinational hunt that operated in the North Atlantic from c. 1850 to the early 1970's (Reilly *et al.,* 2008). The population size by the mid-1980s was said to be about 54,000, roughly 60% of the initial stock size. Northern bottlenose whales were killed in Irish waters up to 1976 (Evans, 1987), when hunting of all cetaceans in Ireland was banned under the Wildlife Act (1976).

Habitat

These members of the beaked whale group are predominantly found in deep cold temperate to sub-arctic waters >500-1,500 m deep, mostly seaward of the continental shelf and near submarine canyons. They sometimes travel several kilometres into broken ice fields, but are more common in open water. Few whales were caught in shallow waters over the continental shelf off Labrador and in waters less than 1000 m deep off the west coast of Norway. In Irish waters, all sightings are rare and usually in deep waters to the west of the shelf edge, although they may occasionally occur closer to the coast. Sightings near the coast are usually animals about to live strand however one apparently healthy whale was observed in a small harbour near Castletownbere, Co Cork for five days in August 2005 (Ryan and Lyne, 2009).

Migration and movements

There is no information to suggest that Northern bottlenose whales carry out seasonal migrations..

Breeding ecology

The peak calving season for this species is April to June after a gestation period of one year. Lactation lasts for at least a year. Females are thought to become sexually mature at 6.9 m and males at 7.5 m, which equates to around 11 years (females) and 7-11 years (males). Calves are born at around 3.5 m in length. Although there is yet no evidence of its occurrence, Northern bottlenose whales are quite likely to calve in Irish waters.

Feeding ecology

This species occupies a comparatively narrow ecological niche; the primary food source is thought to be squid of the Genus *Gonatus* (Hooker *et al*., 2001; Whitehead *et al*., 2003). Northern bottlenose whales may also occasionally eat fish (such as herring and redfish), sea cucumbers, starfish, and prawns. They do much of their feeding on or near the bottom in very deep water (> 800 m, and as deep as 1,400 m; Hooker and Baird, 1999).

Sowerby's Beaked Whale (*Mesoplodon bidens*)

Status: Resident ?

IUCN: Data Deficient

Conservation Status in Ireland: Unknown

Range and distribution

Sowerby's beaked whales are confined to the North Atlantic Ocean. The species has the most northerly distribution of all species of the Genus *Mesoplodon* in the Atlantic. It is also the most frequently observed and frequently stranded *Mesoplodon* species Genus in the northeast Atlantic, including the North Sea, which may not be part of its' normal range (MacLeod, 2000). There are 13 stranding records from Ireland, including in the Irish Sea and at least two live strandings. Few definite sightings have been recorded in Irish waters to date, one of which occurred during the SIAR survey off western Ireland in 2000 (Ó Cadhla *et al*., 2004), and it is likely that some of the unidentified beaked whales observed in waters off the northwest coast overlying the continental slope were Sowerby's beaked whales.

Abundance

There are no abundance estimates for Sowerby's beaked whales.

Habitat

As with other members of the Genus *Mesoplodon*, Sowerby's beaked whales occur almost exclusively in deep waters beyond the continental shelf edge (MacLeod, 2000). The habitat preferences of this species are poorly known.

Migration and movements

There is some evidence of a migration of Sowerby's beaked whale in the northeast Atlantic with stranding records from the UK peaking in the summer months between July and September (MacLeod *et al*., 2004).

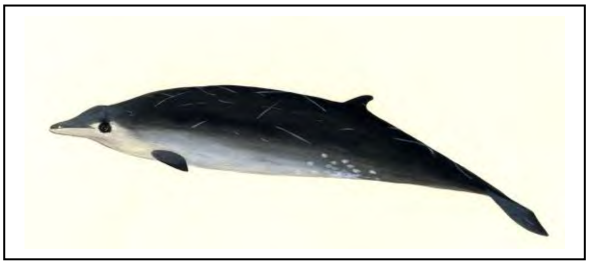
Breeding ecology

There is little information on this species' breeding ecology. There is some evidence that mating and calving may occur in late winter and spring.

Feeding ecology

The diet is thought to consist mainly of squid and fish, including Atlantic cod (*Gadus morhua*).

Gervais' Beaked Whale (*Mesoplodon europaeus*)



Status: Vagrant

IUCN: Data Deficient

Conservation Status in Ireland: Vagrant

Range and distribution

Although sometimes reported as confined to the North Atlantic, Gervais' beaked whales are probably continuously distributed in deep waters across the tropical and temperate Atlantic Ocean, both north and south of the equator (MacLeod and Mitchell*,* 2006). There is one stranding record for Ireland from Co. Sligo in 1989 (Berrow and Rogan, 1997).

Abundance

There are no abundance estimates available for Gervais' beaked whales.

Habitat

The favoured habitat of Gervais' beaked whales appears to be warm temperate and tropical waters. Like other members of the Genus *Mesoplodon*, the species is believed to prefer deep waters, based on the presence of prey from such habitats in stomach contents and a lack of sightings near shore (Mead, 1989). Their habitat in Ireland is not known.

Migration and movements

There is no information concerning migration of Gervais' beaked whale in the northeast Atlantic.

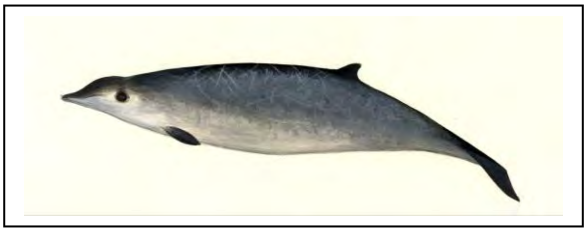
Breeding ecology

There is no information on this species' breeding ecology.

Feeding ecology

Like other members of the Genus *Mesoplodon*, Gervais' beaked whales are known to feed primarily on squid, although some fish may be taken as well. There is also a record of a mysid shrimp found in the stomach of a stranded specimen. Stable isotope analysis has found that this species feeds at a similar trophic level to other *Mesoplodon* species with which it is sympatric, but at a lower trophic level than Cuvier's beaked whale. This suggests that it feeds on smaller prey than the latter species (MacLeod *et al*., 2006).

True's Beaked Whale (*Mesoplodon mirus*)



Status: Resident ?

IUCN: Data Deficient

Conservation Status in Ireland: Vagrant

Range and distribution

True's beaked whales appear to have a disjunct distribution, being absent from tropical waters (MacLeod *et al*. 2006). In the Northern Hemisphere, they are known only in the North Atlantic from records in eastern North America (Nova Scotia to Florida), Bermuda, and Europe to the Canary Islands, the Bay of Biscay, and the Azores. They also occur at least in the southern Indian Ocean, from South Africa, Madagascar, southern Australia and the Atlantic coast of Brazil (MacLeod *et al*., 2006). There are nine stranding records from Ireland, all along the western seaboard and at least one live stranding (Berrow and Rogan, 1997). These records account for almost all strandings of this species in the Northeast Atlantic (McLeod, 2000). A probable sighting of a single group of five True’s beaked whales was reported by Ó Cadhla *et al.* (2004) in deep waters to the west of the Porcupine Bank.

Abundance

There are currently no abundance estimates for True’s beaked whales, however, the species is not believed to be rare in the North Atlantic (MacLeod *et al*. 2006).

Habitat

True’s beaked whale is believed to be a deep water pelagic species, like other Ziphiids.

Migration and movements

There is no information on migration of True’s beaked whale in the northeast Atlantic (MacLeod *et al.* 2004).

Breeding ecology

There is no information on their breeding ecology.

Feeding ecology

Like other members of the Genus *Mesoplodon*, stranded animals have had squid (mostly *Loligo* spp.) in their stomachs. They may also take fish, at least occasionally. Stable isotope analysis has found that this species feeds at a similar trophic level to other *Mesoplodon* species with which it is sympatric, but at a lower trophic level than the Cuvier’s beaked whale and the Northern bottlenose whale. This suggests that it feeds on smaller prey than these species (MacLeod, 2005).

Cuvier's Beaked Whale (*Ziphius cavirostris*)

Status: Migratory

IUCN: Least concern

Conservation Status in Ireland: Unknown

Range and distribution

Cuvier's beaked whales may have the most extensive range of any known beaked whale species (Reilly *et al.,* 2008). They are widely distributed in offshore waters of all oceans, from the tropics to the polar regions, in both hemispheres. Their range covers most marine waters of the world, with the exception of shallow water areas, and very high-latitude polar regions. This is the only species of beaked whale regularly found in the Mediterranean Sea (Reilly *et al.,* 2008). MacLeod *et al*. (2004) suggested around 60º30' was the northern range limit of this species. Cuvier's beaked whales are by far the most frequently stranded Ziphiid on the Irish coast with 45 records to date gathered from all coasts except those along the Irish Sea. They have occasionally been observed off the west coast of Ireland and in the deep waters of the Porcupine Seabight (Berrow *et al.,* 2002a; Ó Cadhla *et al.,* 2004).

Abundance

Global abundance of Cuvier's beaked whales has not been estimated, but they are among the most common and abundant of all the beaked whales and worldwide abundance is likely to be well over 100,000 (Reilly *et al.,* 2008).

Habitat

Although Cuvier's beaked whales can be found nearly anywhere in deep waters, they seem to prefer waters overlying the continental slope (> 200-2,000m depth), especially those with a steep seafloor gradient. The species has been commonly recorded around oceanic islands (e.g. Azores, Canary Is.) and in some enclosed seas. It is rarely found close to mainland shores, except those associated with submarine canyons or in areas where coastal waters are notably deep. It is mostly a pelagic species that appears to be confined by the 10°C isotherm and the 1000 m bathymetric contour (Reilly *et al.,* 2008).

Migration and movements

This is the only widely-distributed beaked whale species for which a global assessment of genetic diversity has been conducted. The results of this study suggest that there is probably little movement of Cuvier's beaked whales among the different ocean basins and that there may even be a distinct subpopulation in the Mediterranean Sea (Dalebout *et al*., 2005). MacLeod *et al*. (2004) examined stranding data from Britain and Ireland and suggested Cuvier's beaked whale has a different pattern of seasonal distribution than other beaked whales in the area. The authors suggested that Cuvier's beaked whales move north during January to March before moving south from June onwards, but that the extent of this movement may vary between years depending on oceanographic conditions.

Breeding ecology

Little is known about the reproductive biology of Cuvier's beaked whales. Females are sexually mature at 5.1m in length and males at 5.5 m. Calves are commonly c. 2.7 m in length at birth.

Feeding ecology

Cuvier's beaked whales, like all beaked whales, appear to prefer deep waters for foraging. Dives of up to 40 minutes have been documented. Although few stomach contents have been examined, they appear to feed mostly on deep-sea squid, but also sometimes take fish and crustaceans (MacLeod *et al*., 2003). They apparently feed near the seafloor and also in the water column. As with other beaked whales, suction appears to be used to draw prey items into the mouth at close range (Heyning and Mead, 1996).

White whale *or* Beluga (*Delphinapterus leucas*)

Status: Vagrant

IUCN: Near Threatened

Conservation Status in Ireland: Vagrant

Range and distribution

White whales (*a.k.a.* Beluga) are distributed in high latitudes of the Northern Hemisphere from the west coast of Greenland westwards to Svalbard in Northern Norway (Reilly *et al.,* 2008). They are certainly a vagrant species in Ireland with only two sighting recorded to date, one off Co. Mayo and one in Cork Harbour (Carmody, 1988).

Abundance

Total numbers worldwide are well above 150,000 animals, with many portions of the species' range not yet surveyed.

Habitat

Belugas occur seasonally, mainly in summer, in coastal waters as shallow as 1-3m deep but also in deep offshore waters (>800 m). They occupy continental shelf and slope waters, and deep ocean basins in conditions of open water, loose ice, and heavy pack ice. Groups of this species typically enter estuaries and sometimes move upstream into rivers; there are records of individuals or small groups ranging hundreds of kilometres from the open sea. Belugas generally prefer to overwinter in shallow or coastal areas, usually with light or highly moveable ice cover. The species may occur as fully Arctic or sub-Arctic populations (Reilly *et al.,* 2008).

Migration and movements

Some Belugas undertake large-scale annual migrations between summering and wintering sites, while others remain in the same area year-round, shifting offshore only when excluded from coastal habitat by fast-ice formation (Reilly *et al.,* 2008).

Breeding ecology

Calves are born at 1.6m in length in spring or summer after a 14-14.5 month gestation period. Lactation is thought to last 20-24 months and the interval between births is c. three years. Females become sexually mature at about five years of age and males at around eight years of age (Martin *et al.,* 1990).

Feeding ecology

Belugas have a diverse diet, which varies greatly from one area to the next. Although various species of fish are considered to be the primary prey items (including salmon, herring, and Arctic cod), Belugas also feed on a wide variety of molluscs, such as squid and octopus, and benthic crustaceans such as shrimps and crabs.

Long–finned Pilot Whale (*Globicephala melas*)

Status: Resident

IUCN: Data Deficient

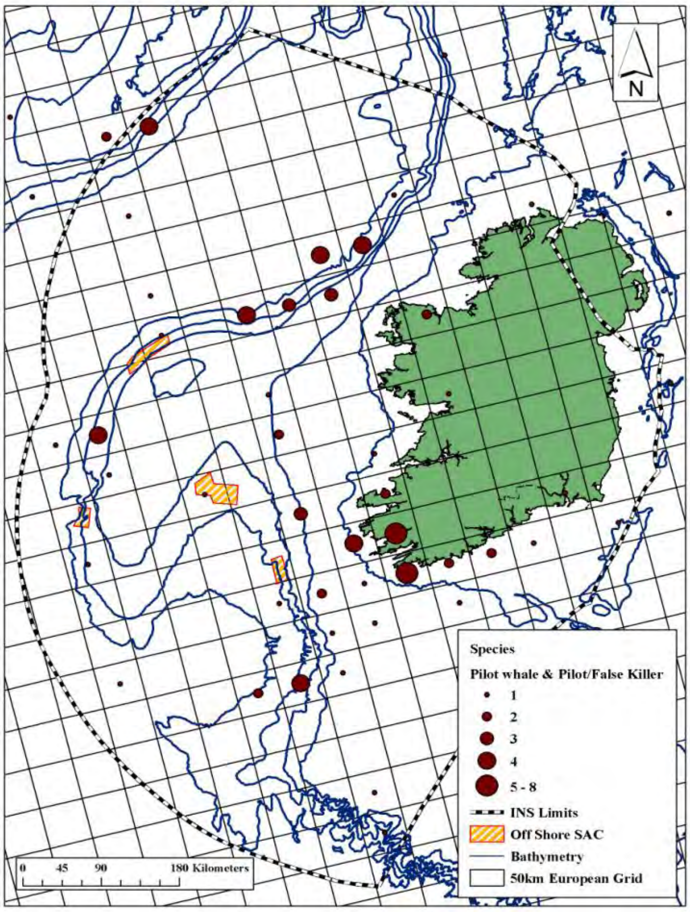
Conservation Status in Ireland: Unknown

Range and distribution

Long-finned pilot whales occur in temperate and sub-polar zones (Reilly *et al.,* 2008). They are found in oceanic waters and some coastal waters of the North Atlantic Ocean, including the Mediterranean Sea and North Sea. In the North Atlantic, the species occurs in deep offshore waters and along the edge of the continental shelf. In Irish waters Long-finned pilot whales have been reported off the southwest coast and in waters overlying the continental slope, especially off the southwest and northwest coasts and over the Rockall and Hatton Banks (Ó Cadhla *et al.,* 2004; Wall *et al.,* 2006). Recent acoustic surveys off the west coast of Scotland and Ireland have shown that Long-finned pilot whales were frequently detected along the edge of the continental shelf off the northwest coasts (Gordon *et al*., 1997; Aguilar de Soto *et al.,* 2004).

Abundance

Sighting surveys in 1987 and 1989 generated an abundance estimate of more than 750,000 Long-finned pilot whales in the central and northeast North Atlantic (Reilly *et al.,* 2008). There are no abundance estimates specifically from Ireland. However the CODA survey (CODA, 2008) estimated a total of 24,275 animals (18709, CV=0.37 + 5,566, CV=0.75) from the offshore Atlantic waters of the UK and Ireland.



Map of Long-finned pilot whale sightings submitted to the IWDG (1991-2007).

Habitat

Essentially an oceanic species, Long-finned pilot whales will enter coastal and shallower waters on a regular basis, presumably while foraging. In Ireland, they are particularly abundant in waters overlying the continental slope (Gordon *et al.,* 1997; Ó Cadhla *et al.,* 2004). The species appears to be vulnerable to live stranding and a number of mass strandings have occurred on the Irish coast especially in the southwest of Ireland (Berrow and Rogan, 1997).

Migration and movements

Long-finned pilot whales are not thought to migrate but will move with the availability of prey and remain there while prey stocks last. Reilly *et al.* (2008) reported that Long-finned pilot whales tend to follow their squid and mackerel prey inshore into continental shelf waters during the summer and autumn. O'Riordan (1975) reported on historical drive fisheries off all Irish coasts for Long-finned pilot whales from 1800 and suggested that whalers took advantage of inshore movements of whales to bring them closer to the shore for harvesting.

Breeding ecology

The peak calving period for Long-finned pilot whales occurs in July-August after a 14-15 month gestation. Mating occurs in April-May in the North Atlantic. Calves are around 1.75-1.8 m in length at birth. Males reach sexual maturity at 12-20 years of age, at a body length of c. 5m while females reach sexual maturity at a younger age (6-10 years) and shorter length (3.8 m). Calves are born to a female every 3.5 years (Reilly *et al.,* 2008).

Feeding ecology

Primarily squid eaters, Long-finned pilot whales will also take small and medium-sized fish such as mackerel when available (Reilly *et al.,* 2008). Other fish species taken include cod, turbot, herring, hake and dogfish. They will sometimes also ingest shrimp. There are no data on the diet of Long-finned pilot whales in Irish waters.

Pygmy Sperm Whale (*Kogia breviceps*)

Status: Vagrant

IUCN: Data Deficient

Conservation Status in Ireland: Vagrant

<u>Range and distribution</u>
Pygmy sperm whales are known from deep waters in tropical to warm temperate zones of all oceans (Reilly *et al.,* 2008). The range of *Kogia breviceps* is poorly known, though a lack of records of live animals may be attributed to inconspicuous behaviour rather than their rarity. Most information stems from strandings (especially females with calves), which may give an inaccurate picture of the actual distribution at sea (Reilly *et al.,* 2008). In Ireland, Pygmy sperm whales have only been reported stranded and never observed, suggesting an exclusively offshore Atlantic distribution. There are seven stranding records, all along the west coast between Co. Kerry and Co. Mayo and five since 1999.

<u>Abundance</u>
There are no abundance estimates for this species in the North Atlantic or in Irish waters.

<u>Habitat</u>
Pygmy sperm whales are rarely observed at sea but the species is believed to live a long distance from shore, in oceanic waters beyond the edge of the continental shelf. Its inconspicuous habits and small size may contribute to its rarity in sighting records to date.

<u>Migration and movements</u>
There is no information on the movements of Pygmy sperm whales.

<u>Breeding ecology</u>
The breeding ecology is only known from stranded animals. Calves are born at 1.2m in length after a gestation period of 11 months and females reach sexual maturity at 2.7-2.8m in length. Females have been reported simultaneously pregnant and lactating suggesting the potential for annual birthing. A female stranded in June 2000 had a near-term foetus suggesting they may calve in Irish waters (O'Brien *et al*. 2009).

<u>Feeding ecology</u>
Studies of feeding habits, based on stomach contents of stranded animals, suggest that this species feeds in deep water, primarily on cephalopods and less often on deep-sea fishes and shrimps (Reilly *et al.,* 2008). Examination of the stomachs of Pygmy sperm whales stranded in Ireland suggests they feed on both squid and fish (O'Brien *et al*., 2009).

Killer Whale (***Orcinus orca***)

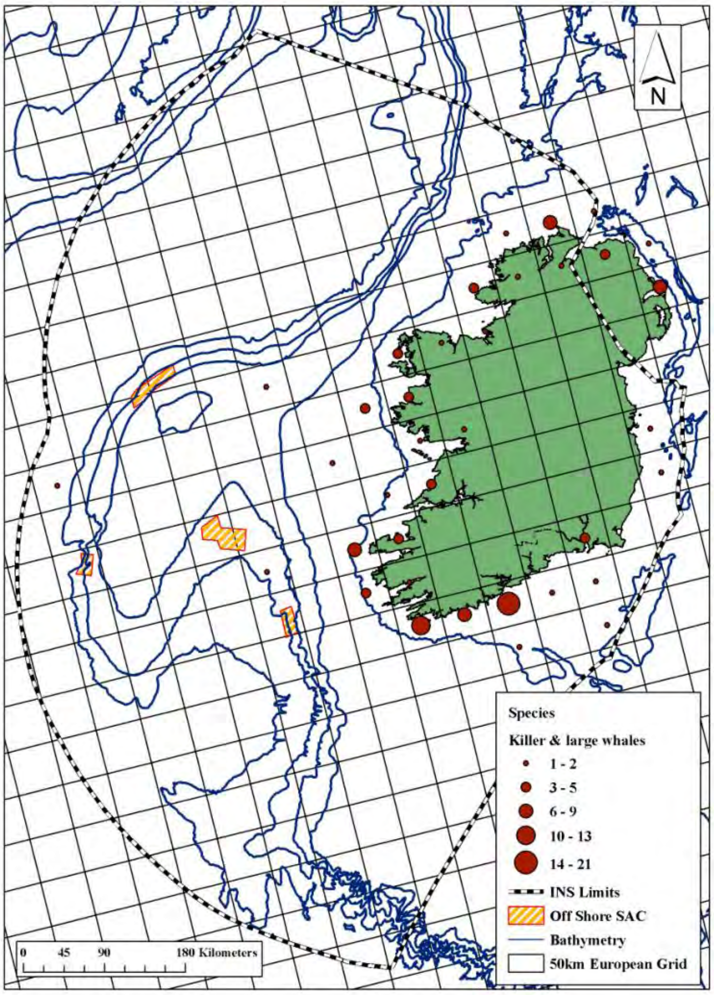
Status: Resident ?

IUCN: Data Deficient

Conservation Status in Ireland: Unknown

Range and distribution

The Killer whale is the most widely distributed of all cetaceans and it may be the second-most widely-ranging mammal species on the planet after humans (Rice, 1998). Killer whales can be seen in virtually any marine region, from equatorial to polar waters. Although they are generally more common inshore and in areas of high productivity and higher latitudes, there appear to be consistent restrictions of water temperature or depth on their range. They have been recorded throughout the year in Ireland and off all coasts, including the Irish Sea (Evans, 1988; Berrow *et al.* 2002; Ó Cadhla *et al*., 2004) and individual groups may occasionally enter harbours and estuaries (Wilson and Pitcher, 1979; Ryan and Wilson, 2003).



Map of Killer whale sightings submitted to the IWDG (1991-2007).

Abundance

Although the available data are far from complete, abundance estimates for the areas that have been sampled provide a minimum worldwide abundance estimate of around 50,000 Killer whales. It is likely that the total abundance is higher because estimates are not available for many high-latitude areas of the northern hemisphere and for large areas of the South Pacific, South Atlantic and Indian Ocean. However, this population abundance refers to several forms of Killer whales that may be recognised as different species or subspecies in the future (Reilly *et al.,* 2008). There are no abundance estimates from Irish waters.

Habitat

Although Killer whales occur worldwide, densities increase by 1-2 orders of magnitude between the tropics and the highest-sampled latitudes in the Arctic and Antarctic (Forney and Wade, 2006). Killer whales tend to be more common along continental margins; however, there is some variation in this general pattern that appears linked to ocean productivity. In Ireland, they have been recorded over shallow, continental shelf and coastal waters and in deeper water to the west of the continental shelf and in the Irish Sea (Berrow *et al.,* 2002a; Reid *et al*., 2003; Ó Cadhla *et al*., 2004).

Migration and movements

There is little evidence of migration in the northeast Atlantic but Killer whales will occur seasonally in areas of high prey abundance (e.g., seal breeding colonies, habitats for overwintering herring). Some individuals may undergo an inshore movement in summer (Evans, 1988). A Killer whale observed off Co. Donegal in 2004 was also photographed off Shetland 12 years earlier, suggesting that Killer whales range widely between the UK and Ireland (IWDG News, 2005).

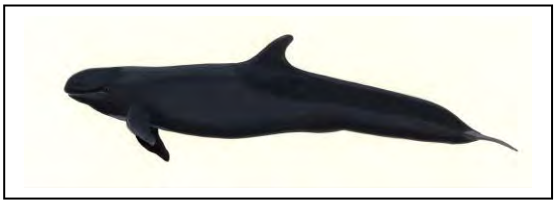
Breeding ecology

Calves are born in Norwegian waters in late autumn and winter at around 2.1m in length, with mating occurring throughout the year (Evans 1988).The gestation period is approximately 12-15 months. Sexual maturity in the northeast Atlantic is reached at a length of about 5.8m and 12-16 years (males) and 4.6-4.9m and 6-10 years (females). The calving interval may vary greatly depending on location.

Feeding ecology

Killer whales are known to feed on a wide array of prey, including most marine mammal species (except river dolphins and manatees), seabirds, sea turtles, many species of fish (including sharks and rays) and cephalopods (Martin *et al.,* 1990). Studies in the Pacific Ocean suggest that transient pods feed primarily on marine mammals and resident pods mainly on fish. In Norway, Killer whales seasonally feed on overwintering herring in deep fjords. Killer whales in Irish waters have been reported chasing harbour porpoises (Evans, 1988) and fish such as salmon and mullet (Ryan and Wilson, 2003). McHugh *et al.* (2007) found salmon fish bones in the stomach of a killer whale stranded at Roches point, Co Cork.

False Killer Whale (***Pseudorca crassidens***)



Status: Vagrant

IUCN: Data Deficient

Conservation Status in Ireland: Vagrant

Range and distribution

False killer whales are found in tropical to warm temperate zones, generally in relatively deep, offshore waters of all three major oceans. They are not generally thought to range into latitudes higher than 50° in either hemisphere. There is one unconfirmed stranding of this species in Ireland (O'Riordan, 1972). During offshore surveys between 1999 and 2001, seven sightings of False killer whale groups were recorded, in the deep waters of the Porcupine Seabight or at the northern margins of the Rockall and Hatton Banks (Ó Cadhla *et al.,* 2004); these were the first confirmed sightings of this species in Irish waters.

Abundance

There are no abundance estimates for False killer whales in the North Atlantic.

Habitat

False killer whales occur in tropical and temperate waters worldwide (Reilly *et al.,* 2008), generally in relatively deep, offshore warm temperate waters. However, some animals may move into shallow and higher latitude waters, on occasion including some semi-enclosed seas such as the Red Sea and the Mediterranean Sea.

Migration and movements

There is no information on migration of False killer whales in the North Atlantic.

Breeding ecology

Information on the breeding ecology of False killer whales is scarce. Calves are born at a length of 1.8m and sexual maturity is reached at 3.96-4.57m (males) and 3.66-4.27m (females). Examination of two stranded pods suggested they have a long reproductive cycle.

Feeding ecology

Although False killer whales eat primarily fish and cephalopods, they also have been known to attack small cetaceans, Humpback whales, and Sperm whales. They eat some large species of fish, such as dorado, tunas and sailfish (Reilly *et al.,* 2008).

Risso's Dolphin (*Grampus griseus*)

Status: Resident

IUCN: Least concern

Conservation Status in Ireland: Unknown

Range and distribution

Risso's dolphins are a widely-distributed species, inhabiting primarily deep waters overlying the continental slope and outer shelf, especially those with a steep seafloor gradient, from the tropics through the temperate regions in both hemispheres (Kruse *et al.,* 1999). Most records of Risso's dolphins in the UK and Ireland reported by Reid *et al*. (2003) were recorded within 11km of the coast. In certain areas, such as in the southwestern English Channel, Risso's dolphins are known to occur seasonally in shallow coastal waters and feed on cuttlefish *Sepia officinalis*. Although Risso's dolphins have been reported off all coasts in Ireland their distribution is clumped with concentrations of sightings off the east, southeast and west coasts (Berrow *et al*., 2002a). High sighting rates and interannual recurrences of Risso's dolphins have been recorded in Broadhaven Bay, Co Mayo (Ó Cadhla *et al.,* 2003; Oudejans, 2008).

Abundance

There are no abundance estimates for Risso's dolphins in the North Atlantic or in Ireland.

Habitat

Risso's dolphins inhabit deep oceanic and continental slope waters, generally 400-1,000 m deep (Jefferson *et al*., 1993), mostly occurring seaward of the continental slope. They frequent subsurface seamounts and escarpments, where they are thought to feed on vertically migrant and mesopelagic cephalopods. Water temperature appears to be a factor that affects the distribution of Risso's dolphins, the acceptable temperature range for the species being 7.5°C - 35°C (Kruse *et al.,* 1999).

Migration and movements

Risso's dolphins are not thought to migrate but will move with the availability of prey and remain there while prey stocks last. There may be an onshore movement in the summer associated with the movement of their preferred prey (Kruse *et al.,* 1999). Sightings from Broadhaven Bay, Co. Mayo (Ó Cadhla *et al*., 2003; Oudejans, 2008) have recently shown that groups of this species return to the area each summer and indicate the potential for seasonal residency in this coastal Irish region.

Breeding ecology

Risso's dolphin calves have been reported in Irish waters. A twin pregnancy in a Risso's dolphin stranded in Co. Donegal was reported (O'Brien *et al.,* 2009).

Feeding ecology

Risso's dolphins feed on crustaceans and cephalopods, but appear to prefer squid prey. Squid bites may be the cause of at least some of the scars found on the bodies of these animals. In the few areas where feeding habits have been studied, they appear to feed mainly at night.

Common Bottlenose Dolphin (*Tursiops truncatus*)

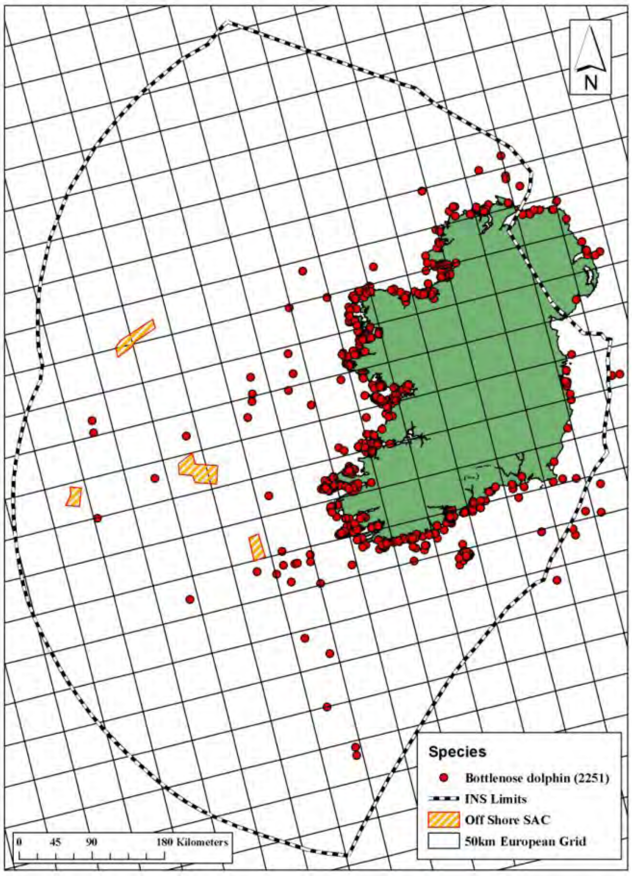
Status: Resident

IUCN: Least concern

Conservation Status in Ireland: Good

Range and distribution

Common bottlenose dolphins are distributed worldwide through tropical and temperate inshore, coastal, continental shelf, and oceanic waters (Reilly *et al.,* 2008). In the North Atlantic, Bottlenose dolphins may range as far as the Faroe Islands. The species is vagrant to Newfoundland and Norway. In Ireland, most sighting records are coastal or are distributed in waters overlying the continental shelf or continental slope (Reid *et al.,* 2003; Ó Cadhla *et al.,* 2004; CODA, 2008). Bottlenose dolphins frequently enter harbours and estuaries and a resident group occurs in the Shannon Estuary (Berrow *et al.,* 1996; Ingram, 2000). A recent study by O'Brien *et al.* (2008, 2009b) suggests some Bottlenose dolphins in Ireland are highly mobile, travelling extensively between sites off all Irish coasts including the Irish Sea.



Map of Bottlenose dolphin sightings submitted to the IWDG (1991-2007).

Abundance

Abundance has been estimated for several parts of the species' range. Summing available estimates, a minimum world-wide estimate is 600,000 (Reilly *et al.,* 2008). A broad-scale survey in 2005 of western European continental shelf waters including the western Baltic, North Sea and Atlantic margin as far as southern Spain (SCANS-II, 2008) estimated that there were 12,600 bottlenose dolphins in this area (CV=0.27). Using conventional line transect estimation, the CODA survey (CODA, 2008) estimated a total of 17,245 animals (5709, CV=0.35 + 11,536, CV=0.33) from the offshore Atlantic waters of the UK and Ireland.

Abundance estimates were generated for four areas in Ireland during the SCANS-II survey programme (SCANS-II, 2008). Around 235 dolphins (CV=0.75) were estimated to occur in the Irish Sea and 313 in coastal Ireland (CV=0.81). The largest abundance estimate was from the Celtic Sea with 5,370 dolphins (CV=0.49) and 1,128 dolphins (CV=0.87) from western Scotland and the Irish outer shelf. Thus around 6,500 bottlenose dolphins occur in Ireland, which is around one-half of the estimated abundance for all western European continental shelf waters (SCANS-II, 2008). Abundance estimates in the Shannon Estuary cSAC were 113±16 in 1997 (Ingram, 2000), 121±14 in 2003 (Ingram and Rogan, 2003), 140±12 in 2006 (Englund *et al.,* 2007) and 114±16.9 in 2008 (Englund *et al*., 2008), which suggests that the population of dolphins in the Shannon Estuary is comparatively stable.

Habitat

Common bottlenose dolphins tend to be primarily coastal worldwide, but they can also be found in deeper offshore waters (Reilly *et al.,* 2008). Where distinct ecotypes are known, the inshore form frequents estuaries, bays, lagoons and other shallow coastal regions, occasionally ranging far up into rivers. The offshore form is apparently less restricted in range and movement. Some offshore dolphins are resident around oceanic islands. In Ireland, Bottlenose dolphins are frequently observed in bays and estuaries and enter harbours where they may occur for extended periods. The Shannon Estuary is a very important habitat for Bottlenose dolphins which are found regularly in two core areas. These sites have the greatest slope and water depth demonstrating the influence of environmental heterogeneity on habitat use by this species. Minimum convex polygons of known ranges for individual dolphins showed that a degree of habitat partitioning occurred in the inner Shannon Estuary (Ingram 2000; Ingram and Rogan, 2002).

Migration and movements

Information on the movement of Bottlenose dolphins around the Irish coast is limited. Ingram *et al.* (2001) recorded Bottlenose dolphins from the Shannon Estuary in Tralee Bay, Co. Kerry but did not find any dolphins from the estuary at three other sites along the west coast (Connemara, Co. Galway, Broadhaven Bay, Co. Mayo, and McSwyne's Bay, Co. Donegal). One dolphin recorded off North Connemara was also recorded off Co. Cork (Ingram *et al.,* 2003). More recently O'Brien *et al.* (2008, 2009b) examined images of 114 individual bottlenose dolphins from four photo-identification catalogues and found 16 re-sightings between Cos. Donegal, Galway, Kerry, Cork and Dublin and one match to Co. Antrim in Northern Ireland. The duration and distances between matches ranged from 26 to 760 days and from c. 130km to c. 650km. A relatively high re-sighting rate (14%) was shown, which suggests that Bottlenose dolphin individuals undertake large movements around Ireland.

Breeding ecology

Bottlenose dolphins may live up to 30-50 years and reach sexual maturity at 9-10 years of age (females) and 10-13 years of age (males). Calves are born in the summer at a length of 1.0-1.3 m after a gestation period of 12 months. Calves may suckle for up to 18 months although take fish from 6 months of age. The breeding interval is estimated at 2-3 years in length. In Ireland, the Shannon Estuary is an important calving area with calves born from May to September (Berrow *et al.,* 1996; Ingram, 2000).

Feeding ecology

Bottlenose dolphins consume a wide variety of prey species, mostly fish and squid (Reilly *et al.* 2008). They sometimes eat shrimps and other crustaceans. Couperus (1995) identified a number of fish species including greater argentine, *Argentina silus,* horse-mackerel, hake, mackerel, poor cod and silvery pout in the stomachs of Bottlenose dolphins bycaught off southwestern Ireland. Nash (1974) described an adult female Bottlenose dolphin with a fully grown greater-spotted dogfish *Scyliorhinus stellaris* wedged head first in its oesophagus, which he suggested caused its death after it attempted to swallow it. Bottlenose dolphins have been observed chasing and catching salmon *Salmo salar*, garfish *Belone belone* and eels *Anguilla anguilla* in the Shannon Estuary (Ingram, 2000), while salmon and mackerel were also observed prey in studies in Co. Mayo (Ó Cadhla *et al.,* 2003).

Atlantic White-Sided Dolphin (*Lagenorhynchus acutus*)

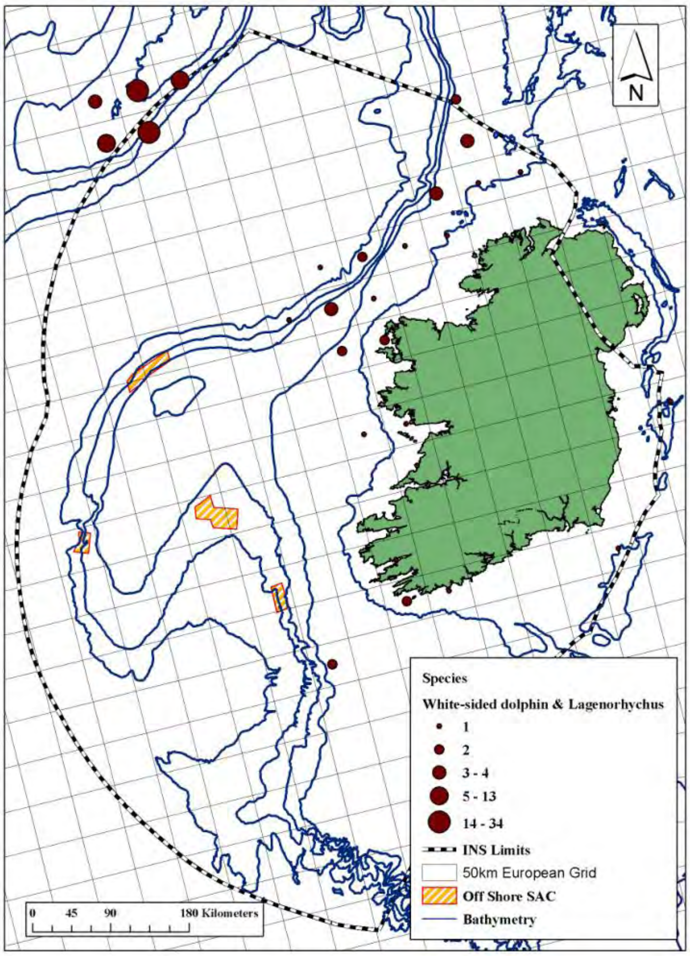
Status: Resident

IUCN: Least concern

Conservation Status in Ireland: Good

Range and distribution

Atlantic white-sided dolphins are confined to the North Atlantic Ocean. They are found in cold temperate to sub-polar waters of the North Atlantic, from about 38°N (south of Cape Cod) in the west and the Brittany coast of France in the east, north to southern Greenland, Iceland and to the south of Svalbard, northern Norway (Reilly *et al.,* 2008). In Ireland they have been mainly reported off the northwest coasts, especially in waters overlying the continental slope (Reid *et al*. 2003; Ó Cadhla *et al.,* 2004). Leopold and Couperus (1995) suggested that large groups off southwest Ireland could represent a concentration zone for this species. Wall *et al.* (2006) also reported large concentrations over the Hatton Bank.



Map of Atlantic white-sided dolphin sightings submitted to the IWDG (1991-2007).

Abundance

This species is quite abundant throughout its range. There are an estimated 51,640 (CV=0.38) Atlantic white-sided dolphins off the eastern North American shoreline (Reilly *et al.,* 2008) and about 96,000 (CV=0.54) off the west coast of Scotland (MacLeod, 2004). Results obtained during the SIAR survey in July and August 2000 (Ó Cadhla *et al*.,2001, 2004) yielded an abundance estimate of 5,490 Atlantic white-sided dolphins within an offshore Atlantic survey area of 120,000 km^2 .

Habitat
The Atlantic white-sided dolphin is found primarily in cool waters (7-12ºC) overlying the continental shelf and slope, but it also occurs in oceanic waters across the North Atlantic. Along the continental slope of North America, it seems to associate with high sea-bed relief (Reilly *et al.,* 2008). Individual White-sided dolphins frequently live strand along the Irish coast, and these have included mass strandings (Berrow and Rogan, 1997; Rogan *et al.,* 1997).

Migration and movements
There is no information to suggest Atlantic white-sided dolphins carry out seasonal migrations, though they are likely to move in response to the distribution of their preferred prey.

Breeding ecology
Atlantic white-sided dolphins reach sexual maturity at 2.3-2.4m (males) and 2.0-2.2m (females), which corresponds to an age of 6-12 years. Calves are born at 1.08-1.22 m in length after 10-12 months gestation. Lactation lasts around 18 months (Sergeant *et al.,* 1980). Females have been found to be simultaneously pregnant and lactating suggesting annual births (Addink *et al.,* 1997). The reproductive status of 19 Atlantic white-sided dolphins live-stranded in Co. Mayo showed that both pregnant and lactating females and immature and sexually mature males occurred in the same group (Rogan *et al*., 1997).

Feeding ecology
These dolphins often associate and feed in the same areas as large baleen whales or form mixed groups with Long-finned pilot whales and a number of other dolphin species (including Bottlenose and White-beaked dolphins). Atlantic white-sided dolphins feed mostly on small schooling fish such as herring, mackerel, cod, smelt, hake, and sandlance, and also shrimp and squid. In Irish waters, a study by Couperus (1995) on 46 White-sided dolphins bycaught off southwestern Ireland showed that mackerel accounted for 88% of fresh prey items but silvery pout *Trisopterus luscus* (62%), myctophids (19%) and pearlsides (7%) were also among the prey identified by otoliths. Gadoids (86%) were the most frequent prey item recovered from four White-sided dolphins stranded on the west coast (Berrow and Rogan, 1995). Mackerel and herring have also been found to be important prey of Atlantic white-sided dolphins in other studies (O'Brien *et al.,* 2009).

White-Beaked Dolphin (*Lagenorhynchus albirostris*)

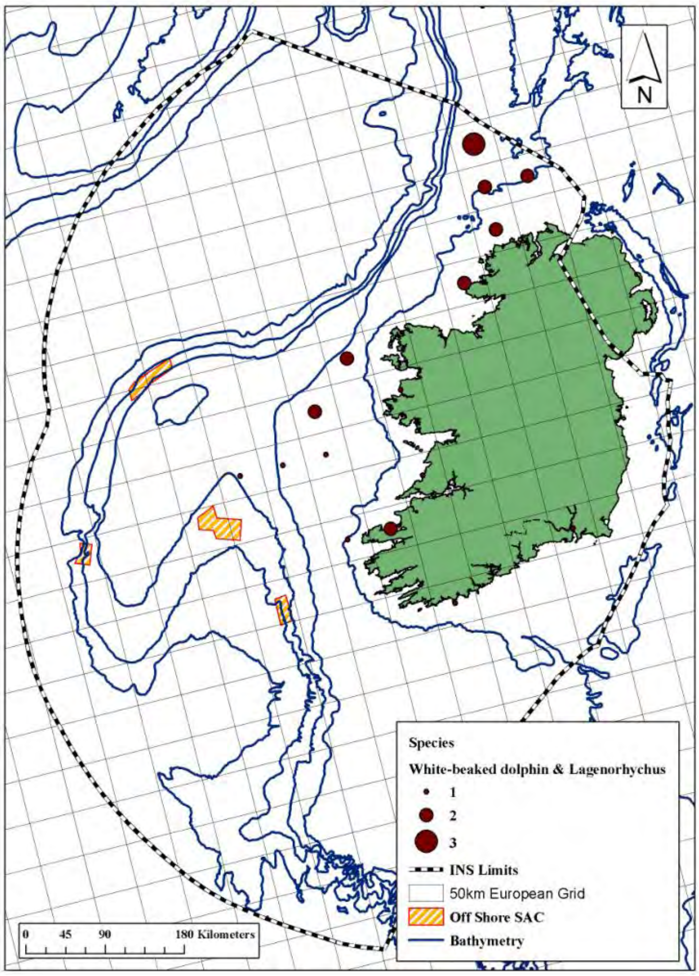
Status: Resident

IUCN: Least concern

Conservation Status in Ireland: Unknown

Range and distribution

White-beaked dolphins are confined to the North Atlantic. This is the most northerly member of the Genus *Lagenorhynchus*, and it has a wide distribution (Kinze, 2002). White-beaked dolphins inhabit cold temperate to sub-polar waters of the North Atlantic, from a line between Cape Cod and France, north to southern Greenland, Svalbard in northern Norway and east to Novaya Zemlya, off Russia. They are the most abundant dolphin in the North Sea. In European waters the species typically prefers water depth less than 200m (Reilly *et al.,* 2008). Sightings in Irish waters are mainly off the west and northwest coasts (Northridge *et al.,* 1995; Reid *et al.,* 2003; Ó Cadhla *et al*., 2003; Ó Cadhla *et al.,* 2004) and Irish waters are probably at the southern edge of their range in the northeast Atlantic.



Map of White-beaked dolphin sightings submitted to the IWDG (1991-2007).

Abundance

At least a few thousand White-beaked dolphins inhabit Icelandic waters and up to 100,000 in the northeast Atlantic including the Barents Sea, the eastern part of the Norwegian Sea and the North Sea north of 56°N (Øien 1996). A survey of the North Sea and adjacent waters in 1994 provided an estimate of 7,856 (CV=0.30) White-beaked dolphins (Hammond *et al*. 2002). In 2005 there were an estimated 22,700 (CV=0.42) in the European

Atlantic continental shelf waters, including 10,600 (CV=0.29) in the same area surveyed in 1994. The White-beaked dolphin is much more common in the North and Baltic Seas than its relative, the Atlantic white-sided dolphin. Northridge *et al*. (1995) found that White-beaked dolphins are relatively common in European waters compared to White-sided dolphins. White-beaked dolphins are only occasionally reported in Irish waters, usually off the northwest coast (e.g., Ó Cadhla et al., 2003) but also in the Irish Sea. White-beaked dolphin abundance was estimated at 75 individuals in the Irish Sea and 5,370 in the Celtic Sea during July 2005 (SCANS-II 2008). Hammond *et al.* (2002) calculated an abundance estimate of 833 *Lagenorhynchus* species (Atlantic white-sided dolphins and/or White-beaked dolphins) in the Celtic Sea in July 1994.

<u>Habitat</u>

White-beaked dolphins inhabit continental shelf and offshore waters of the cold temperate to subpolar zones. Although there is evidence suggesting that their primary habitat is in waters less than 200m deep, sightings have also commonly occurred in waters overlying the Irish continental slope (Ó Cadhla *et al*., 2004). MacLeod *et al*. (in press) suggested that habitat partitioning occurs between White-beaked and Common dolphins around the UK and Ireland, with White-beaked dolphins inhabiting water with surface temperatures below 13ºC and Common dolphins above 14ºC.

<u>Migration and movements</u>

There is no information to suggest White-beaked dolphins carry out seasonal migrations though they are likely to move in response to the distribution of their preferred prey.

<u>Breeding ecology</u>

There is limited information on the breeding ecology of White-beaked dolphins. Calves are born at 1.2-1.6m in length in the summer and early autumn (Martin *et al.,* 1990).

<u>Feeding ecology</u>

White-beaked dolphins feed on a variety of small pelagic and demersal species such as cod, haddock, poor cod, bib, hake, and whiting, squid, and crustaceans (Reeves *et al*. 1999). They sometimes associate with other species , e.g., with large whales (such as Fin and Humpback whales), and are known to form mixed groups with a number of other dolphin species including Bottlenose and Atlantic white-sided dolphins (Reeves *et al*. 1999; Ó Cadhla *et al*., 2003).

Common Dolphin (*Delphinus delphis*)

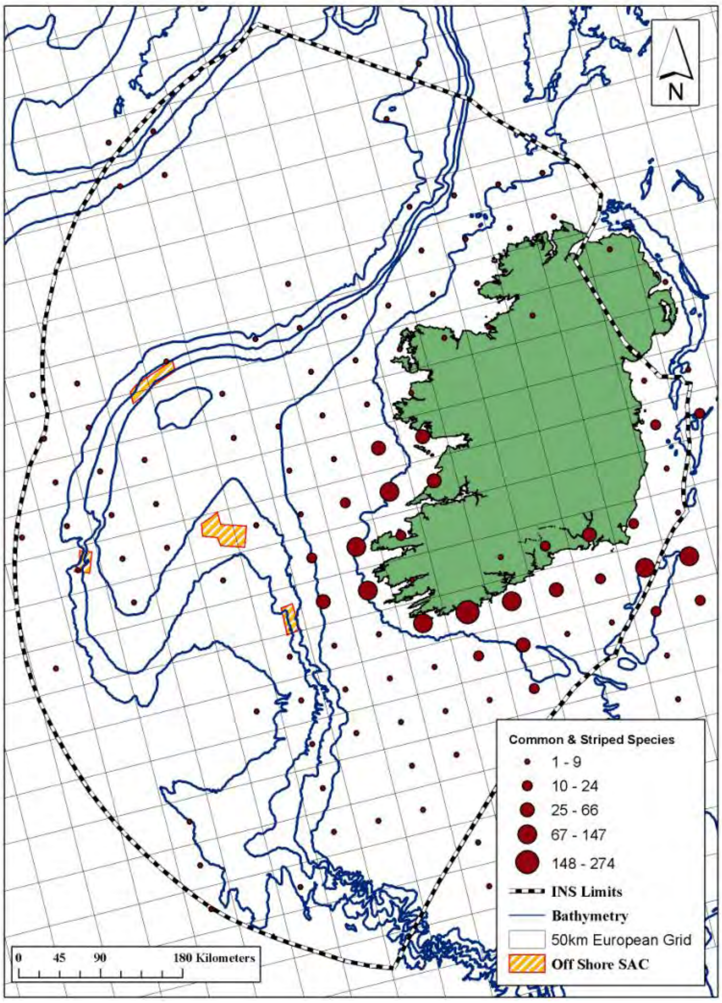
Status: Resident

IUCN: Least concern

Conservation Status in Ireland: Good

Range and distribution

The Short-beaked common dolphin is a wide-ranging oceanic and continental shelf-dwelling species that is distributed from tropical to cool temperate waters of the Atlantic Ocean (Reilly *et al.,* 2008). Common dolphins may occur inshore as well as up to thousands of kilometres offshore. In Ireland they have been recorded off all coasts and in deeper Atlantic waters but abundance appears to be highest off the south and west coasts (Berrow *et al.,* 2002a; Reid *et al.,* 2003; Ó Cadhla *et al*., 2001; Ó Cadhla *et al*., 2004). Mirmin *et al.* (*in press*) suggested that there are at least two genetically distinct populations in the North Atlantic (i.e. western and eastern North Atlantic stocks) but no genetic structure within these regions.



Map of Common dolphin sightings submitted to the IWDG (1991-2007).

Abundance

Common dolphins are a very abundant species, with many estimates available for the various areas where it occurs. Abundance in European continental shelf waters was recently estimated at 63,400 (95% CI=27,000-149,000) (SCANS-II, 2008). Common dolphins occur in all Irish waters including offshore waters and the Irish Sea, but highest concentrations appear to occur off the south and west coasts. Common dolphin abundance estimates were 366 for the Irish Sea, 15,327 on the continental shelf off the Atlantic coast and 11,141 in the Celtic Sea during July 2005 (SCANS-II, 2008). Ó Cadhla *et al*. (2001, 2004) estimated that 4,496 common dolphins occurred off western Ireland in July-August 2000, based on sightings obtained during the SIAR survey in an area of 120,000 km^2. More recently the CODA survey (CODA, 2008) estimated a total of 57,184 animals (3,546, CV=0.76 + 53,638, CV=0.54) from the offshore Atlantic waters of the UK and Ireland.

Habitat

Short-beaked common dolphins appear to have a preference for waters influenced by upwellings, areas with steep sea floor relief and extensive continental shelf areas but they are also widespread in warm temperate and tropical waters. In Ireland, most records are from the Celtic Sea and off the west coast, but mainly distributed in waters over the continental shelf and slope (e.g., Berrow *et al*., 2002a; Ó Cadhla *et al*., 2004). Wall *et al*. (2006) reported highest concentrations of Common dolphins off the southwest and northwest coasts between May and September. Deep water records of this species are fewer in number but this may be due to reduced observer effort over the deeper ocean basins.

Migration and movements

There is no evidence of long-distance migration by Common dolphins in the North Atlantic but seasonal local movements into the Celtic Sea and southern Irish Sea may occur (Brereton *et al.,* 2001).

Breeding ecology

Common dolphins calve in Irish waters during the summer months. The most comprehensive study of reproduction in an Irish cetacean species was carried out on the Common dolphin by Murphy (2004). Reproductive seasonality was found to occur with mating and calving taking place between May and September. The author reported that moderate sexual dimorphism and large testes suggested sperm competition and a promiscuous mating system. Murphy *et al*. (2005) categorised individuals into different reproductive stages by using characteristics of their gonadal morphology and found that sexually mature individuals were 1.95-2.23m in length and between 8-28 years of age, whilst the average age of sexual maturity occurred at 11.8 years.

Feeding ecology

Berrow and Rogan (1995) found that gadoids (38%), clupeids (7%) and cephalopods (5%) were the main prey items recovered from the stomachs of 16 stranded and 10 bycaught Common dolphins, with *Trisopterus* spp., herring, sprat and whiting the most prevalent fish species present. Of the cephalopods, Common dolphins fed primarily on *Gonatus*, *Histioteuthis* spp. *Toderopsis, Loligo forbesi* and the common octopus. Brophy *et al*. (2009) analysed the stomach contents of Common dolphins' bycaught on the edge of the continental shelf and found mackerel, horse-mackerel, hake and pearlsides (a deep-water species).

Stomach contents from 129 individuals obtained from dolphins found stranded along the Irish coast (*n*=76) between 1990 and 2004, and individuals incidentally captured in the Irish albacore tuna (*Thunnus alalunga*) driftnet fishery (*n*=58) between 1996 and 1999 recorded 46 prey species consisting of 31 fish species and 15 cephalopod species. Teleost fish were numerically the most important prey group (95% prey numbers), with cephalopods comprising 5%. A small number of crustaceans were also recorded. Fish representing at least six families and 16 species were identified. Myctophids dominated the fish component accounting for 54% of the fish recovered. Despite the dominance of myctophids, at a species level the carangid *Trachurus trachurus* was the most commonly recorded, followed by the myctophids *Myctophum punctatum* and *Notoscopelus kroyeri;* Combined together the three species comprised 92% of fish prey. Fish (97%) also formed the dominant portion of the stomach contents of dolphins from the neritic area (i.e. continental shelf waters, <200m depth). Gadidae comprised 59% of the fish component of the neritic dolphin diet, and the most commonly occurring fish were *Trisopterus* spp. (45%) and Gobiidae (28%).

Striped Dolphin (*Stenella coeruleoalba*)

Status: Vagrant

IUCN: Least concern

Conservation Status in Ireland: Unknown

Range and distribution

Striped dolphins are a widely-distributed species in tropical and warm-temperate waters of the Atlantic, Pacific, and Indian Oceans including the Mediterranean Sea. The northern limit of their range is thought to be approximately 50°N and the southern range limit about 40°S, although there are records in the North Atlantic from southern Greenland and the Faroe Islands (Bloch *et al.,* 1996). Though frequently reported stranded on the Irish coast (Berrow and Rogan, 1997), Striped dolphins are not commonly sighted in Irish waters. This might reflect difficulties in their identification at sea where they can resemble Common dolphins.

Abundance

Striped dolphins are the most abundant cetacean in the Mediterranean Sea. The population in the western Mediterranean, excluding the Tyrrhenian Sea, was estimated in 1991 to be 117,880 (95% CI = 68,379-214,800) (Reilly *et al.,* 2008). There is no estimate for the eastern Mediterranean Sea. Goujon *et al*. (1993) conducted a sighting survey in 1993 in the fishing grounds of the albacore tuna driftnet fishery in the Bay of Biscay and estimated the abundance of striped dolphins as 74,000. There are no specific abundance estimates available for Ireland. However the CODA survey (CODA, 2008) estimated a total of 33,773 animals (519, CV=1.05 + 33,254, CV=1.57) from the offshore Atlantic waters of the UK and Ireland.

Habitat

Striped dolphins are primarily found in warm temperate and tropical oceanic regions and are seen close to shore generally where deep water occurs close to the coast (Reilly *et al.,* 2008). In the western North Atlantic, Striped dolphins appear to prefer continental slope waters offshore. In the Mediterranean, Striped dolphins are associated with highly productive oceanic waters beyond the continental shelf (Reilly *et al.,* 2008). Striped dolphins have been recorded off the west and southwest coasts of Ireland, especially in the Porcupine Seabight and in waters over the Rockall Bank (Ó Cadhla *et al.* 2004), although sightings have also occurred in continental shelf waters off the Irish west coast (e.g., Ó Cadhla *et al.* 2004).

Migration and movements

There is no evidence of seasonal migrations of Striped dolphins in the North Atlantic but visual and acoustic surveys in the Mediterranean Sea indicate that Striped dolphins may concentrate to feed at night in waters overlying the continental slope and then move offshore during the day before returning to shallower water at dusk (Reid *et al.*, 2003).

Breeding ecology

In the Mediterranean Sea, females become sexually mature at 1.87m or 12 years of age. The calving interval was estimated as four years (Calzada *et al*., 1996). Limited data from Ireland suggests males become sexually mature at 2.01 m and 11 years of age and neonates were recorded in July and September (Rogan *et al.,* 1993). Apparent lack of sexual dimorphism and relatively small testes size suggested that Striped dolphins may have a promiscuous mating strategy.

Feeding ecology

The diet of the Striped dolphin consists primarily of a wide variety of small, midwater and pelagic or benthopelagic fish, especially lanternfish (myctophids), cod, and squids (Reilly *et al.,* 2008). Striped dolphins apparently feed in pelagic to benthopelagic zones, to depths as deep as 200-700m Berrow and Rogan (1995) described the diet from seven stranded Striped dolphins and found that 80% of the diet was composed of gadoid species, with clupeids (13%) and cephalopods (*Illex fubei, Gonatus* sp. and *Histioteuthis* sp.) comprising the remainder. Further analysis showed that the diet of offshore Striped dolphins consisted mainly of cephalopods, myctophid fish species and crustaceans (Rogan *et al*., 1997), The prey species composition from the stomach contents of both stranded and bycaught Striped dolphins from Ireland indicate that these dolphins are opportunistic feeders, exploiting a wide range of species that occur in large dense shoals.

Harbour Porpoise (*Phocoena phocoena*)

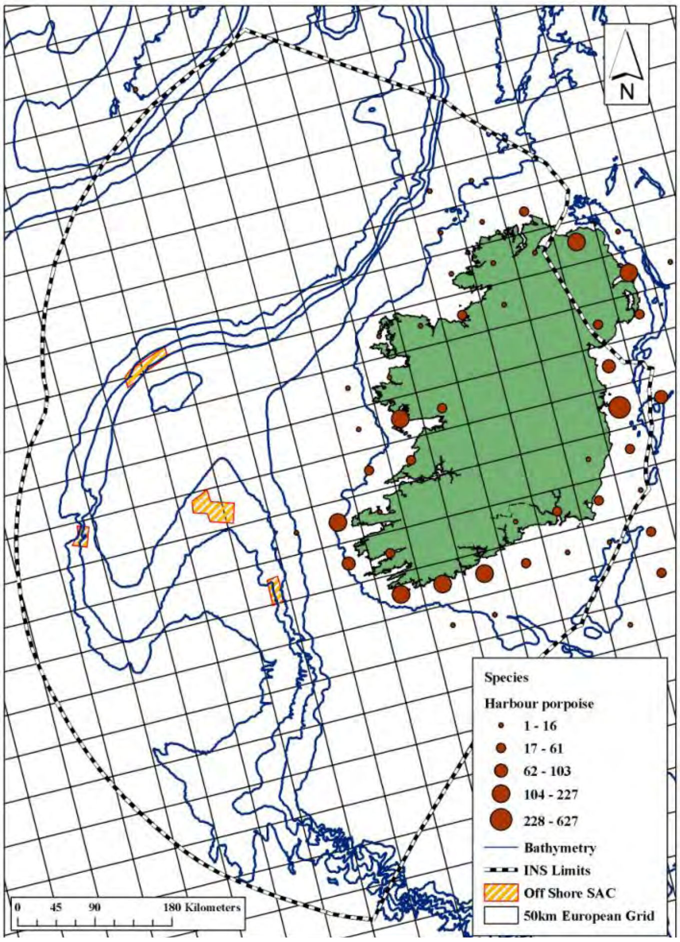
Status: Resident

IUCN: Least concern

Conservation Status in Ireland: Good

Range and distribution

Harbour porpoises are found in cold temperate to sub-polar waters of the Northern Hemisphere (Martin *et al.,* 1990). They are usually found in continental shelf waters <200m deep, although they may be recorded occasionally over deeper offshore waters. In the North Atlantic, they are found from the southeast US to Baffin Island, Canada in the west and from Senegal to Novaya Zemlya, Russia in the east. They also occur around southeast and western Greenland, Iceland, and the Faroe Islands. Surveys in 1994 and 2005 in the North Sea and adjacent waters have shown a major difference in observed sighting distribution from northern (i.e. northern North Sea) to southern (i.e. southern North Sea and Celtic Sea) areas (Hammond *et al*., 2002; SCANS-II, 2008.). This change may also be reflected by increases in shore-based sightings (Camphuysen 2004, Thomsen *et al*. 2006). Walton (1997) showed there were significant genetic differences between Harbour porpoises from the northern North Sea and the Celtic/Irish Sea, but these differences were predominantly due to genetic variation among females.



Map of Harbour porpoise sightings submitted to the IWDG (1991-2007).

Abundance

In the North Atlantic including the Black Sea and Azov Sea, fourteen population units have been proposed (Anderson, 2003). Harbour porpoise in Irish waters are thought to belong to an Irish/western British Isles stock but the whole northeast Atlantic is thought to be one population (IWC, 1996). The species is by far the most numerous of all cetaceans in the northeast Atlantic. In the waters of the European Atlantic, abundance was estimated at 385,600 (CV=0.20) in 2005 (SCANS-II, 2008). Abundance estimates in the North Sea and adjacent waters in 1994 was estimated at 341,000 (CV=0.14) (Hammond *et al*. 2002) and 335,000 (CV=0.21) in 2005 (SCANS-II, 2008).

Harbour porpoises occur throughout Irish continental shelf waters and in the Irish Sea, with highest densities reported in the Celtic Sea and off the southwest coast. Hammond *et al.* (2002) reported an abundance estimate of 36,280 Harbour porpoises in the Celtic Sea from surveys carried out in July 1994. The subsequent SCANS-II survey in July 2005 yielded abundance estimates of 80,613 in the Celtic Sea, 15,230 in the Irish Sea and 10,716 in inshore Irish coastal waters (SCANS-II, 2008). Between 1994 and 2005, therefore, the density of Harbour porpoise in the Celtic Sea was estimated to have increased by 127% from 0.18 animals per km^2 to 0.41 animals per km^2. In a regional context, Leopold *et al.* (1992) estimated that 19,210 Harbour porpoises occurred between Galway Bay and Cork in July 1989. More recently an abundance estimate of 303±76 Harbour porpoises (95% Confident Interval: 186-494) was calculated from surveys conducted in the Blasket Islands cSAC during the summer of 2007 (Berrow *et al.,* 2009) and 372±105.3 (95% Confident Interval: 216-647) in the summer of 2008 (Berrow *et al*., 2008b). Abundance at eight sites surveyed in 2008 ranged from 87 (95% CI 39-196) off Carnsore Point to 402 (84% CI=267-605) in Galway Bay (Berrow *et al.,* 2008a; 2008b).

Habitat

Throughout its range, the Harbour porpoise is largely associated with continental shelf waters and there is strong evidence that high porpoise densities are strongly associated with shallow waters and maintenance of some distance from the coast (SCANS-II, 2008). In Ireland, as is the case elsewhere in its European range, Harbour porpoises frequent relatively shallow bays, estuaries, and tidal channels and may occur in waters < 20m deep (e.g., Ó Cadhla *et al*., 2003). Foraging areas are often associated with strong tidal currents, especially off headlands or between islands.

Migration and movements

There is no evidence of migration of Harbour porpoise in the northeast Atlantic but Teilmann *et al.* (2008) showed that Harbour porpoises in Danish waters may travel thousands of kilometres over many months, including travel across the North Sea. There appears to be an offshore movement in Ireland during the months of April and May which coincides with the calving period (Berrow *et al.,* 2002a).

Breeding ecology

Calves are born in early summer at a length of 0.7-0.80m, after a gestation period of 11 months. In the northwest Atlantic, females nurse there calves for less than a year but may be simultaneously pregnant and lactating suggesting annual births in some areas (Reid and Hohn, 1995). Females reach sexual maturity at around three years of age and a length of 1.5-1.6m and males at 1.4-1.5m but a slightly older age. Although capable of reaching up to 20 years of age, most animals only live for 10 years (Reid and Hohn 1995). Rogan and Berrow (1996) suggested male Harbour porpoises in Ireland became sexually mature at a length of 1.3-1.4m (3-4 years of age).

Feeding ecology

Harbour porpoises eat a wide variety of fish and cephalopods and the main prey items vary regionally (see O'Reilly *et al.,* 2008). Although small schooling fish (e.g. herring) are important, foraging on demersal species is characteristic in many areas. The most frequent prey items recovered from the stomachs of 19 stranded and bycaught Harbour porpoise in Ireland were *Trisopterus* spp. (42%), whiting (42%) and poor cod (21%) (Rogan and Berrow, 1996). Of the Clupeidae family, most common were herring (16%) and sprat (5%). More recently, stomach content analysis of 73 Harbour porpoise samples revealed that the species primarily forages on fish (98%) with the remainder of prey items consisting of cephalopods and crustaceans (Rogan, 2009). At least 16 different taxa were recorded, revealing a broad generalist diet. Whiting, *Trisopterus* species, herring and gadoids were the most frequent prey species recovered with other species such as hake, scad, sprat, silvery pout less frequent in the diet observed. These results are broadly consistent with diet analysis elsewhere in the European range (e.g., Borjesson and Berggren, 1996; Santos *et al*., 2004).

Appendix II: List of Acronyms used in the Conservation Plan

ARC	Atlantic Research Coalition
BIOCET	Bioaccumulation of persistent organic pollutants in small cetaceans in European waters
BIM	An Bord Iascaigh Mhara
CMRC	Coastal and Marine Resources Centre, UCC
DCMNR	Department of Communications, Marine and Natural Resources
CODA	Cetacean Offshore Distribution and Abundance
DAFF	Department of Agriculture, Food and Fisheries
DEHLG	Department of the Environment, Heritage and Local Government
DoT	Department of Transport
EHS	Environment and Heritage Service (Northern Ireland)
ENFO	Environmental Information Centre
GMIT	Galway-Mayo Institute of Technology
HC	Heritage Council
IOSEA	Irish Offshore Strategic Environmental Assessment
ISCOPE	Irish Scheme for Cetacean Observation and Public Education
ISPCA	Irish Society for the Prevention of Cruelty to Animals
IWDG	Irish Whale and Dolphin Group
MI	Marine Institute
MSD	Marine Safety Directorate
NBDC	National Biodiversity Data Centre
NDP	National Development Programme
NGO	Non-Governmental Organisations
NHM	Natural History Museum
OSPAR	The Convention for the Protection of the marine Environment of the North-East Atlantic
PAD	Petroleum Affairs Division
PAM	Passive Acoustic Monitoring
POPs	Platforms of Opportunity
PReCAST	Policy Recommendations from Cetacean Acoustics, Survey and Tracking
SAM	Static Acoustic Monitoring
SCANS	Small Cetacean Abundance in the North and Baltic Seas
SDWF	Shannon Dolphin and Wildlife Foundation
SIAR	Survey in western Irish waters and the Rockall Trough
TPOD	Timed Porpoise Detector
UCC	University College Cork

Delivery Schedule for Actions listed in the Conservation Plan for Cetaceans in Irish waters – April 2010

Action No.	Action	Lead Department	Other Bodies	Timeframe	Progress to April 2010
28	Standard guidelines should be developed and applied in all areas for minimising the input of increased noise levels into the marine environment in consultation with key stakeholders.	DEHLG	DOT, DCENR, DAFF, LA, ABP	2010	A pre-consultation draft is under development
3	Devise a research programme with clear scientific objectives to effectively monitor cetaceans inside and outside designated areas.	DEHLG		2010-2011	Draft completed
21	Ensure that an appropriate assessment is conducted on all commercial fishing in cetacean SACs.	DAFF		2010-2011	A process leading to the appropriate assessment of commercial fishing operations in all Natura 2000 sites is currently being undertaken.
27	Standard guidelines should be developed to ensure that cetacean considerations are fully incorporated into oil spill contingency plans.	DEHLG	DAFF, DOT, DCENR	2010-2011	
31	All relevant Regulatory Authorities should be advised about the Code of Practice for the Protection of Marine Mammals during Acoustic Seafloor Surveys in Irish Waters and should ensure that its implementation is a standard condition on all relevant licences.	DEHLG	DCENR, LA, ABP	2010-2011	This is in place for consents under the Gas and Foreshore Acts.
32	Develop rigorous guidelines for use of acoustic surveys in identified critical habitats for cetaceans in consultation with key stakeholders.	DEHLG		2010-2011	A pre-consultation draft is under development
34	Discuss with the European Commission appropriate procedures to mitigate the possible impacts of naval sonar on cetaceans.	DEHLG		2010-2011	
35	Ensure that a strategic assessment is conducted of the impact of renewable energy devices on cetaceans at an early stage of their development.	DEHLG	DCENR	2010-2011	A Strategic Environmental Assessment (SEA) of marine renewable energy development is currently at the scoping stage. DEHLG is represented on its Steering Group.
36	Establish guidelines on survey requirements for the development of marine renewable energy facilities (wind, wave and tidal).	DEHLG	DCENR	2010-2011	A pre-consultation draft is currently being prepared.
37	Explore the possibility of developing a system with merchant vessel operators and other large vessel operators (Irish Naval Service) for	DEHLG	INS, DOT	2010-2011	Preliminary input has been received from the INS.

	reporting cetacean ship strikes in Ireland.				
38	Work with marine wildlife tour operators to agree best practice standards for their operations, including promotion of Marine Notice 15 of 2005.	DEHLG	IND	2010-2011	
39	Investigate the feasibility of a permit system that is based on risk assessments for whale watching operations and/or marine tourism operators who focus on cetaceans.	DEHLG	IND	2010-2011	
40	Ensure that effective pressure monitoring indices for the whale watching and/or relevant marine tourism sectors are developed and implemented.	DEHLG	IND	2010-2011	
41	Encourage the use of engines meeting high international standards for noise emissions in whale watching vessels.	DEHLG		2010-2011	
6	Explore the possibility of agreeing a procedure with Relevant Authorities that maximises the recovery of data from stranded animals.	DEHLG	LA	2011	
11	Ireland should request advice from ICES concerning the effective mitigation of cetacean bycatch in commercial fisheries, including where relevant the steps necessary to establish species-specific bycatch targets, that will give effect to the achievement of strict protection for cetacean species occurring in the waters within Ireland's Exclusive Fishery Zone.	DEHLG	EC, ICES	2011	
5	Carry out a review of cetacean sightings/strandings data to detect any changes in distribution or stranding frequency that could be associated with changes in species distribution.	DEHLG		2011-2012	
12	A risk assessment of existing fisheries by all fleets in waters within Ireland's Exclusive Fishery Zone should be undertaken for the purposes of identifying those that pose the greatest risk of cetacean bycatch.	DEHLG	EC, DAFF, MI, BIM	2011-2012	BIM are currently undertaking a study for the EC in conjunction with the University of St Andrews to assess EU policy on the mitigation of incidental catches of cetaceans in EU waters that will contribute to this action.
15	Initiate a cetacean post-mortem programme to determine the diet of	DEHLG	MI	2011-2012	

	cetaceans in Ireland, including determining size and biomass of prey species in order to explore potential competition between cetaceans and commercial fisheries.				
17	Use a cetacean post-mortem programme to provide tissue samples to the Irish Cetacean Tissue Bank for use in population genetics studies.	DEHLG	MI, NHM	2011-2012	
19	When sufficient data are available, carry out spatial modelling using GIS to explore the relationship between cetacean distribution and abundance and commercial fisheries, to identify times or areas with increased risk of interactions.	DEHLG	MI	2011-2012	• The Beaufort EAFM study will model trophic interactions and spatial overlap between marine top predators and selected fisheries in Irish waters. It will also assess fisheries impact risks and explore management approaches. • The PReCAST study co-funded by DEHLG is examining links and spatial overlap between observed cetaceans and selected fish stocks using GIS methods.
25	Continue the pilot programme to investigate the principal sources of litter that wash up on our shores and implement local and national actions to prevent this litter entering the marine environment.	DEHLG	DAFF, DOT	2011-2012	Pilot programme has been discontinued pending elaboration and implementation of the Marine Litter Good Environmental Status Descriptor under the Marine Strategy Framework Directive.
29	Ensure that risk assessments are conducted in relation to the potential impact on cetaceans from any proposed intensification of shipping activity.	DEHLG	DOT, DCENR, LA, ABP	2011-2012	
30	Raise awareness of the presence of cetaceans, including important habitats and migration routes in Ireland, within the marine shipping community.	DEHLG	DOT	2011-2012	
33	Ensure that acoustic trauma and other tissue injury are considered as a possible cause of death, particularly for deep-diving species, in post-mortem examinations.	DEHLG		2011-2012	
1	Conduct further research, including through the Joint Cetacean Protocol, to determine the distribution, relative abundance and habitat preferences of cetaceans. Alongside survey effort, this should also include the establishment and maintenance of an	DEHLG	MI, EPA	Ongoing	Work currently under way includes: • Development of an Irish marine species database to include the hosting of cetacean data from a variety of sources.

	integrated national cetacean database that is compatible with the Joint Cetacean Protocol.				• Continued participation in the UK Joint Cetacean Protocol project. • The PReCAST study co-funded by DEHLG & MI. • The ABCD study funded by MI. • An SFI-funded project at University College Cork concerning population genetics of Bottlenose dolphins in Irish waters. • An IRCSET-funded project at University College Cork investigating odontocete acoustics in Irish waters. • An IRCSET-funded project at Galway-Mayo Institute of Technology investigating baleen whale ecology in Irish waters. • Various research projects on Bottlenose dolphin populations and movements around Ireland. • BWPAM funded by the Petroleum Infrastructure Programme to conduct PAM of beaked whales in offshore canyonated systems.
2	Conduct further research to identify the breeding ecology, movements and migration routes of cetaceans.	DEHLG	MI, EPA	Ongoing	Studies currently under way include: • The PReCAST study co-funded by DEHLG. • An SFI-funded project at University College Cork concerning population genetics of Bottlenose dolphin in Irish waters. • An IRCSET-funded project at University College Cork investigating odontocete acoustics in Irish waters • An IRCSET-funded project at Galway-Mayo Institute of Technology investigating baleen whale ecology in Irish waters. • Various research projects on Bottlenose dolphin populations and movements around Ireland. • Population genetics of selected cetacean species via DEHLG-licenced biopsy sampling under. • In 2009 Cornell University produced a report for the UK Department of Energy and Climate Change concerning baleen whale distribution off western Ireland and Britain, using data gathered via the SOSUS array.
4	Investigate the feasibility of establishing an integrated National Photo-identification Catalogue for bottlenose dolphins.	DEHLG		Ongoing	
7	Maintain and develop a stranding scheme to provide data on	DEHLG		Ongoing	

	species occurrence and seasonal distribution.				
8	Encourage the development of a national standard against which all appropriate Passive Acoustic Monitoring (PAM) equipment can be calibrated to allow comparisons between sites and studies.	DEHLG		Ongoing	The PReCAST study co-funded by DEHLG is exploring issues of PAM equipment comparability, calibration and method standardisation.
9	Explore the possibility of using static hydrophone networks to provide data to monitor cetaceans.	DEHLG		Ongoing	DEHLG enquiries have commenced with the Bioacoustics Research Program team at Cornell University (U.S.A). DCENR has secured industry funding through PIP to carry out a passive acoustic monitoring study of beaked whales along the eastern side of the Rockall Trough.
10	Work with the European Commission to ensure that conservation actions to change fishing practices are implemented through Common Fisheries Policy regulations.	DEHLG	DAFF, EC, MS, IND	Ongoing	
13	Any fisheries and/or fleet segments that are identified as presenting a significant risk of cetacean bycatch and are not currently covered by Regulation 812/2004 should be brought to the attention of the European Commission.	DEHLG	DAFF, EC, MS	Ongoing	BIM are currently undertaking a study for the EC in conjunction with the University of St Andrews to assess EU policy on the mitigation of incidental catches of cetaceans in EU waters that will contribute to this action.
14	Continue to contribute, nationally and/or internationally, to trials investigating the effectiveness of pingers and/or gear modifications as cetacean bycatch mitigation tools.	DAFF	BIM, MI, DEHLG	Ongoing	
16	Carry out research to understand the foraging behaviour of cetaceans in Irish waters especially with regard to commercial fish species.	DEHLG	MI	Ongoing	• The PReCAST study co-funded by DEHLG and MI includes visual surveys for cetaceans aboard fishery research cruises. It will examine links between cetacean foraging and fish stocks in the Celtic Sea. • The Beaufort EAFM study is exploring trophic interactions and spatial overlap between marine top predators and selected fisheries in Irish waters.
18	Include cetacean surveys on fishery cruises to collect information on the possible relationships between fish and cetacean abundance.	DEHLG	MI	Ongoing	The PReCAST study co-funded by DEHLG and MI includes visual surveys for cetaceans aboard selected fishery research cruises.

20	Ensure that risk assessments are conducted on the impacts for cetaceans of any new fishing gears and/or fisheries in advance of licensing.	MS, EC		Ongoing	
22	Monitor the concentrations of persistent organic pollutants and other toxic contaminants in cetacean species in Ireland using samples from bycatch and/or stranding programmes.	DEHLG	MI, EPA	Ongoing	
23	Quantify the concentrations of Brominated Flame Retardants in cetacean tissues in Irish waters using samples from bycatch and/or stranding programmes.	DEHLG	MI, EPA	Ongoing	
24	Seek to improve marine water quality to standards set in EC Directives and international conventions by reducing the discharge of substances which are toxic, infectious, persistent or liable to bio-accumulate.	DEHLG	EPA	Ongoing	
26	Ensure that risk assessments are conducted on the potential impacts on cetaceans of sewage discharges in advance of licensing.	DEHLG	LA, ABP	Ongoing	

ABP – An Bord Pleanála
BIM – An Bord Iascaigh Mhara
DAFF – Department of Agriculture, Fisheries and Food
DCENR – Department of Communications, Energy and Natural Resources
DEHLG – Department of the Environment, Heritage & Local Government
DOT – Department of Transport
EC – European Commission
EPA – Environmental Protection Agency
IND – Industry
INS – Irish Naval Service
ICES – International Council for the Exploration of the Sea
LA – Relevant Local Authorities
MI – Marine Institute
MS – Relevant Member States
NBDC – National Biodiversity Data Centre
NHM – Natural History Museum, National Museum of Ireland