

**CETACEANS IN THE VICINITY OF THE PROPOSED
AIRD MHOR FERRY TERMINAL ON BARRA**

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INTRODUCTION The waters around the Western Isles are probably the richest of any coastal region in the UK for whales, dolphins, and porpoises, and are one of the most important regions in north-west Europe (Evans, 1998). Twenty species of cetaceans have been recorded since 1980 in nearshore waters (within 60 km of the coast). Of these, eleven species are either present throughout the year or recorded annually as seasonal visitors. Some of these are pelagic (explain) species that normally live along or west of the continental shelf edge, and they rarely come close to the coasts of the Western Isles. However, in and immediately around the Sound of Barra (including the Sea of Hebrides east of Barra), a total of nine species have been recorded live since 1980.

STATUS & ECOLOGY The status, seasonal occurrence and ecology of the nine species of cetaceans recorded in recent years in the locality are given below:

Minke Whale (*Balaenoptera acutorostrata*) Worldwide distribution in tropical, temperate and polar seas of both hemispheres. In the North Atlantic, the minke whale occurs from Baffin Bay in the west and the Greenland & Barents Seas in the east, south to the Lesser Antilles in the west and the Iberian Peninsula and Mediterranean in the east.

International protection includes Appendix II of CMS Agreement on the Conservation of Migratory Species of Wild Animals (BONN Convention, 1983); Appendix III (can be exploited so long as regulation keeps populations out of danger) of BERN Convention on the Conservation of European Wildlife and Natural Habitats (1982); and Annex IV Animal and Plant Species of Community Interest in Need of Strict Protection of the EU Habitats Directive (1992). It is listed on List C1 of Council Regulation and is treated by the European Community as if it is on CITES (in full initially) Appendix I (trade strictly controlled, and not for primarily commercial purposes, with exception of West Greenland); one of the species managed by the International Whaling Commission. Status listed by IUCN (in full initially) (1991) as vulnerable. In UK, it receives protection under The Wildlife & Countryside Act (1981) and the Wildlife (Northern Ireland) Order (1985).

The minke whale is widely distributed along the Atlantic seaboard of Britain and Ireland although it also occurs regularly in the northern and central North Sea as far south as the Yorkshire coast. It is seen in small numbers in the Irish Sea but is rare in the Channel and southernmost North Sea, as well as south of here in the Bay of Biscay.

There is some indication of an increase since the 1980's, with populations concentrated in the northern North Sea, and around North and West Scotland. Indeed, in the Minches and Sea of Hebrides, it has become the second most frequently observed species in summer months (Boran *et al.*, 1999).

Most sightings occur in July-August although the species can be seen anytime between May and October, and at least small numbers remain in coastal waters year-round (Evans, 1980, 1992; Evans *et al.*, 1986; Northridge *et al.*, 1995). In the autumn there appears to be a general offshore movement, possibly associated with breeding which occurs sometime between autumn and spring; however, breeding locations are unknown. There is no information on whether any more extensive migration takes place.

It occurs regularly in coastal waters of South Uist, Eriskay, Barra (including the Sound of Barra), Mingulay and Berneray. We do not have any records of the species adjacent to either of the proposed ferry terminal port sites at Aird Mhor, but it is likely that the species sometimes occurs in the immediate vicinity, and it has been seen within 4 km of here. On the other hand, the species rarely inhabits waters less than ten metres depth.

Although most commonly seen singly or in loose groups of up to three, in late summer feeding aggregations numbering between 5 and 15 individuals may form.

The Sea of Hebrides provides a rich feeding ground for minke whales, which prey upon a variety of fish species, notably herring, sandeel, cod, haddock, saithe, as well as euphausiids and pteropods (are these last 3 species of fish?). Feeding occurs often in areas of upwelling or strong currents around headlands and small islands, primarily during the summer. Feeding minke whales in late summer are commonly associated with flocks of manx shearwater, northern gannet, kittiwake and various *Larus* gulls.

Vocalisations involve intense, low frequency, broadband (0.5-1 kHz bandwidth) and harmonic down-sweeps with maximum source level of 165 dB re 1 μ Pa. These include short broadband downsweeps (mainly 0.13-0.06 kHz lasting 200-300 msec); 'grunts' (mainly between 0.08-0.14 kHz, but up to 2 kHz, lasting 165-320 msec); and thumps (often downsweeps; mainly 0.1-0.2 kHz, lasting 50-70 msec) (Schevill & Watkins, 1972; Winn & Perkins, 1976; Thompson *et al.*, 1979; Edds, 1988).

Northern Bottlenose Whale (*Hyperoodon ampullatus*)

The distribution of northern bottlenose whale is restricted to temperate, subpolar and polar seas of the North Atlantic. The species occurs in greatest numbers at higher latitudes, being most commonly recorded off western Norway and in the Barents Sea, though also occurring in small numbers around the Northern Isles and Western Isles of Scotland, in the northern North Sea, along the continental shelf break west of Ireland, and south as far as latitude 15°N.

International protection includes Appendix II of CMS Agreement on the Conservation of Migratory Species of Wild Animals (BONN Convention, 1983); Appendix II (strictly protected endangered and vulnerable animals) of BERN Convention on the Conservation of European Wildlife and Natural Habitats (1982; but for this species, applied from 1987); and Annex IV Animal and Plant Species of Community Interest in Need of Strict Protection of the EU Habitats Directive (1992). It is listed on List C1 of Council Regulation and is treated by the European Community as if it is on CITES Appendix I (trade strictly controlled, and not for primarily commercial purposes, with the exception of West Greenland); one of the species managed by the International Whaling Commission (completely protected). Status listed by IUCN (1991) as threatened but status is insufficiently known. In UK, it receives protection under The Wildlife & Countryside Act (1981) and the Wildlife (Northern Ireland) Order (1985). One of the species for which the Agreement on the Conservation of Small Cetaceans in the Baltic and North Seas (ASCOBANS) (1992), applies.

The distribution of northern bottlenose whales in British and Irish waters has a distinct Atlantic element, with most sightings occurring off North and West Scotland and Western Ireland, particularly in deep waters west of the continental shelf. The species is rare in the shallow waters of the Channel, Irish Sea and North Sea, becoming more common again further south in the deep waters of the Bay of Biscay where it is found mainly between May and August.

No detailed population estimates exist for the North Atlantic, but following the IWC (in full) North Atlantic sightings surveys (NASS) in 1987 and 1989, an approximate estimate of 40,000 northern bottlenose whales was made (Vikingsson, 1993; NAMMCO, (in full) 1993). The species appears to be still locally abundant in at least some areas (Gunnlaugsson & Sigurjónsson, 1990; Reeves *et al.*, 1993).

Northern bottlenose whales occur regularly in coastal waters around the Isle of Skye, including the Little Minch east of Harris and North Uist. It is occasionally seen in the deeper waters of the Sea of Hebrides but there are no records of the species adjacent to either of the proposed ferry terminal port sites at Aird Mhor and the species rarely inhabits waters less than 100 metres depth.

The diet is mainly squid of a variety of species (including *Gonatus fabricii*, *Taonius* spp., *Histioteuthis* spp., *Octopoteuthis* spp., *Megalocranchia* sp., and *Teuthowenia* sp.), but also includes fish, (e.g. herring *Clupea harengus*, Greenland halibut *Rheinhardtius hippoglossoides*, lumpsucker *Cyclopterus lumpus*, redfish *Sebastes* sp., ling *Molva molva*, skate *Raja* sp., and spiny dogfish *Squalus acanthius*), large decapod crustaceans (*Pandalus* sp.), sea stars, and sea cucumbers (Ohlin, 1893; Hjort & Ruud, 1929; Benjaminsen & Christensen, 1979; Clarke & Kristensen, 1980; Bloch *et al.*, 1996; Lick & Piatkowski, 1998).

Northern bottlenose whales have long been exploited in the North Atlantic. The Scottish whalers began to shoot them in 1877, and from 1882 whaling was expanded with the participation of Norwegian whalers (Risting, 1922; Ruud, 1937). There followed two main periods of exploitation (Christensen, 1993;

Reeves *et al.*, 1993): about 50,000 were taken in the period 1882-1914 (Holt, 1977), and 5,000 between 1955-72 (JonsgErd, 1977). Hunting ended in the early 1970's and the species has been protected by the IWC since 1977, although small numbers (up to eight per year) are still killed in the Faroe Islands (Bloch *et al.*, 1993).

Preliminary results from recent line transect surveys suggest a total North Atlantic population size considerably less than the estimated initial population size before commercial exploitation intensified in the 1880's, but the estimates of pre- and post-exploitation stock size remain uncertain and have been much debated (Holt, 1977; Christensen and Ugland, 1984; —ritsland *et al.*, 1989; Gunnlaugsson and Sigurj—nsson, 1990; Sigurj—nsson *et al.*, 1990; Klinowska, 1991).

Small numbers were taken in the Scottish whaling industry early this century, although preference was given to the larger rorquals (explain). Between 1903 and 1928, a total of 25 were captured around Shetland and one in the Outer Hebrides (none in 1950-51). Most captures occurred in deep waters off the edge of the continental shelf. None was taken off Western Ireland. Between 1938-72, 5,800 were taken by Norwegian whalers, the great majority from 1955-72. Hunting of the species between the 1880's and 1970's is believed to have resulted in population declines (Klinowska, 1991).

Concerns have been expressed that human activities such as shipping and oil and gas exploration may be affecting bottlenose whales in the Gully, Nova Scotia (Faucher & Whitehead, 1991), and ship collisions have been implicated in some Irish strandings (Berrow & Rogan, 1997). The only information on pollutant levels comes from a single stranding from the North Sea, which had high levels of cadmium in the level (???) but levels of PCB's and DDT similar to other cetaceans (Harms *et al.*, 1978). Beaked whales (is the Northern bottlenose whale a beaked whale?) living in deep canyons may be specially vulnerable to underwater explosions (as produced from military activities), and some workers have linked mass strandings of various species (e.g. Cuvier's beaked whale) to low frequency active sonar.

Killer Whale or Orca (*Orcinus orca*) Worldwide distribution in tropical, temperate and polar seas in both hemispheres (with greatest abundance at higher latitudes).

International protection includes Appendix II of CMS Agreement on the Conservation of Migratory Species of Wild Animals (BONN Convention, 1983); Appendix II of BERN Convention on the Conservation of European Wildlife and Natural Habitats (applied to this species, from 1987); and Annex IV Animal and Plant Species of Community Interest in Need of Strict Protection of the EU Habitats Directive (1992). It is listed on List C1 of Council Regulation and since 1985, has been treated by the European Community as if it is on CITES Appendix II (trade controlled to prevent overexploitation). Status listed by IUCN (1991) as insufficiently known. In UK, it receives protection under The Wildlife & Countryside Act (1981) and the Wildlife (Northern Ireland) Order (1985). One of the species for which the Agreement on the Conservation of Small Cetaceans in the Baltic and North Seas (ASCOBANS) (1992), applies.

Although killer whale numbers in the North Atlantic appear to be greatest in subarctic and arctic waters, the distribution of the species extends south to the Caribbean, Azores, Madeira, Canaries and occasionally the western Mediterranean. It is widely distributed in the North Atlantic and in coastal northern European waters particularly around Iceland and western Norway. In UK, it is most common in northern and western Scotland, but rare in the Irish, central and southern North Seas, and the English Channel (Evans, 1988, 1992).

Although uncommon, killer whales are regularly observed in the Sea of Hebrides where several recognisable individuals have been seen repeatedly in the same region over a period of at least ten years. They are mostly seen in West Scotland between May and October. Like the minke whale, the species may be seen anywhere in coastal waters of South Uist, Eriskay, Barra, Mingulay and Berneray, but we have no records of it from within the Sound of Barra. However, killer whales may come into shallow coastal waters in pursuit of seals, which form part of their diet, along with a wide variety of fish species (particularly herring, cod, and mackerel) and other marine vertebrates (such as porpoises and sharks), and reports of attacks upon seals are increasing, possibly as a result of increased abundance of grey seals in the area.

Group size varies between 1 and 16, though usually between two and eight are seen, with groups (termed pods) having very stable membership. Breeding occurs between October and March, possibly mainly between October and December.

Vocalisations have been well studied and include a variety of whistles of variable duration mainly of 6-12 kHz frequency, a pulsed call primarily in the frequency range 1-6 kHz, and very short echolocation clicks mainly of 12-40 kHz (Hoelzel & Osborne, 1986; Bowles *et al.*, 1988; Moore *et al.*, 1988; Ford, 1989). Stereotyped, discrete calls have been found to vary between groups and appear to represent group-specific dialects (Ford & Fisher, 1982, 1983; Ford, 1984; Bowles *et al.*, 1988; Ford, 1989, 1991; Strager, 1995).

Risso's Dolphin (*Grampus griseus*) Worldwide distribution in tropical and temperate seas in both hemispheres.

International protection includes Appendix II of CMS Agreement on the Conservation of Migratory Species of Wild Animals (BONN Convention, 1983); Appendix II of BERN Convention on the Conservation of European Wildlife and Natural Habitats (applied to this species, from 1987); and Annex IV Animal and Plant Species of Community Interest in Need of Strict Protection of the EU Habitats Directive (1992). It is listed on List C1 of Council Regulation and since 1985, has been treated by the European Community as if it is on CITES Appendix II (trade controlled to prevent overexploitation). Status listed by IUCN (1991) as insufficiently known. In the UK, it receives protection under The Wildlife & Countryside Act (1981) and the Wildlife (Northern Ireland) Order (1985). One of the species for which the Agreement on the Conservation of Small Cetaceans in the Baltic and North Seas (ASCOBANS) (1992), applies.

In the North Atlantic, it occurs from Newfoundland to the Lesser Antilles in the west; and from the Shetland Islands to the Mediterranean in the east. The species also occurs around oceanic islands like the Azores, Canaries and Cape Verde Islands.

The major populations in the UK occur in the Hebrides but the species is regular also in the Northern Isles, the Irish Sea, and off Western Ireland (Evans, 1992). It is rare or absent in the central and southern North Sea and eastern portion of the Channel. Elsewhere, it is present in Northwest France, the Bay of Biscay, around the Iberian Peninsula, and in the Mediterranean.

The species is nowhere common but is seen most frequently between May and September, particularly the latter three months of July, August and September. The largest populations are reported from the Minches and Sea of Hebrides. Although more common in the north of this region (particularly around the Eye Peninsula), the species occurs regularly in coastal waters of South Uist, Eriskay, and Barra, and has been reported during the summer months in the Sound of Barra. In the vicinity of Aird Mhor?

Risso's dolphins feed mainly upon cephalopods (octopus, cuttlefish and small squid), and the area is important both for feeding and breeding (calving occurring mainly between April and September). Stomach content analysis of stranded animals indicate that octopus and cuttlefish are amongst important prey. Groups usually comprise 5-20 individuals although sometimes aggregations of 50-100 individuals have been recorded. Photo-ID (identification?) studies indicate that groups can be stable over the longterm with individuals associating from one year to the next (Evans, 1987; Atkinson *et al.*, 1997, 1999; Evans, unpubl. data).

Vocalisations include a variety of clicks, whistles, and pulsed calls. Whistles are rarely heard, but range over 2.5-20 kHz, usually 8-12 kHz, average duration 0.67 secs, and maximum source level of 170 dB re 1µPa @ 1 m (Watkins, *pers. comm.*). Clicks have peak frequency at 65 kHz and durations of 40-100 secs (Au, 1993). Click frequencies are between 0.2-over 100 kHz, with repetition rates of 4-200 per sec. Click-bursts last from 0.2-1.5 secs. Maximum source level is 175 dB re 1µPa @ 1 m (Watkins, *pers. comm.*). Eight different kinds of sounds in three main categories were recognised in Hebridean Risso's dolphins: clicks in discrete series (echolocation clicks, creaks, grunts) with repetition rates of 37-167 pulses per sec., fast sequences of pulses (buzzes, squeaks, squeals, moans) with high repetition rates of 187-3,750 pulses per sec, resulting in harmonics; and whistles of 9-13.2 kHz (Benoldi *et al.*, 1997, 1998).

Bottlenose Dolphin (*Tursiops truncatus*) Worldwide distribution in tropical and temperate seas in both hemispheres.

International protection includes Appendix II of CMS Agreement on the Conservation of Migratory Species of Wild Animals (BONN Convention, 1983); Appendix II of BERN Convention on the Conservation of European Wildlife and Natural Habitats (applied to this species, from 1987); and Annex II of the EU Habitats Directive (1992) (prohibiting all forms of deliberate capture, killing or disturbance,

especially during breeding, rearing or migration; bans the keeping, sale, or exchange of such species; and requiring that member states monitor the incidental capture and killing of all cetaceans, and carries out research on conservation measures to prevent such accidents). Like all cetacean species, it is also listed on Annex IV Animal and Plant Species of Community Interest in Need of Strict Protection of the EU Habitats Directive (1992). It is listed on List C1 of Council Regulation and, since 1985, has been treated by the European Community as if it is on CITES Appendix II (trade controlled to prevent overexploitation). Status listed by IUCN (1991) as insufficiently known. In the UK, it receives special protection in respect of particular methods of killing or taking under The Wildlife & Countryside Act (1981) and the Wildlife (Northern Ireland) Order (1985). One of the species for which the Agreement on the Conservation of Small Cetaceans in the Baltic and North Seas (ASCOBANS) (1992), applies.

Along the Atlantic seaboard of Europe, the species is locally fairly common nearshore off the coasts of Spain, Portugal, north-west France, western Ireland, north-east Scotland, in the Irish Sea, particularly Cardigan Bay and south-east Ireland, and in the Channel. All those localities receive influence from the Gulf Stream. The species also occurs offshore in the North Atlantic (often in association with long-finned pilot whales) as far north as the Faroe Islands. In coastal waters, bottlenose dolphins often favour river estuaries, headlands or sandbanks where there is uneven bottom relief and/or strong tidal currents (Lewis & Evans, 1993; Loret *et al.*, 1994; Wilson *et al.*, 1997).

Essentially an inshore species, in British and Irish waters the bottlenose dolphin is most frequently sighted within 10 km of land, although it also occurs in offshore waters, often associated with other cetaceans such as long-finned pilot whales (repeated from paragraph above). Bottlenose dolphins are present throughout the year in various bays in Western Ireland; in the Irish Sea (particularly Cardigan Bay); and the Moray Firth. Elsewhere in Britain, the species has been scarce in the central and southern North Sea, but it occurs seasonally along the south coast of England at particular localities (e.g. Durlston Head & Lyme Bay in Dorset, and Tor Bay in Devon).

Although generally rare in Northwest Scotland and the Northern Isles, there is a small resident community of bottlenose dolphins that live in the Sound of Barra and these come very close to Aird Mhor and the island of Barra where they may occur in very shallow waters (probably making use of those shallows to capture fish). They have been seen in all months of the year though most frequently between April and September, with groups usually varying between two and ten individuals including young. Elsewhere in the UK, group sizes tend to increase in late summer and may number tens of individuals. A small group also lives around Coll, Tiree, and Mull, whilst individuals have been recorded within schools of other dolphin species in the northern part of the Minches, and offshore groups are sometimes seen west of the Outer Hebrides.

The species has an extended breeding season, but with births peaking between May and November (Evans 1980; Wilson, 1995). Bottlenose dolphins feed upon a variety of benthic (e.g. eels, flounder, dab, sole, turbot, haddock, hake, and cod) and midwater fish (e.g. salmon, trout, bass, mullet, herring, blue whiting) as well as marine invertebrates (cephalopods and shellfish).

The bottlenose dolphin makes a wide range of vocalisations. Echolocation clicks (used for orientation and foraging) are composed of intense short duration broadband clicks (40-130 kHz) (Au, 1993). Clicks are broadcast in episodic trains that can continue for the duration of a dive and culminate in buzzes and whines as targets are approached. Burst pulse vocalisations (barks, yelps and donkey-like brays) may have a variety of social functions (0.2-16 kHz). Whistles are pure tone frequency modulated calls ranging from 2-20 kHz. Clicks and whistle vocalisations can be made simultaneously.

White-beaked Dolphin (*Lagenorhynchus albirostris*) Distribution restricted to temperate and subpolar seas of the North Atlantic.

International protection includes Appendix II of CMS Agreement on the Conservation of Migratory Species of Wild Animals (BONN Convention, 1983); Appendix II of BERN Convention on the Conservation of European Wildlife and Natural Habitats (applied to this species, from 1987); and Annex IV Animal and Plant Species of Community Interest in Need of Strict Protection of the EU Habitats Directive (1992). It is listed on List C1 of Council Regulation and since 1985, has been treated by the European Community as if it is on CITES Appendix II (trade controlled to prevent overexploitation). Status listed by IUCN (1991) as insufficiently known.

In the UK, it receives protection under The Wildlife & Countryside Act (1981) and the Wildlife (Northern Ireland) Order (1985). One of the species for which the Agreement on the Conservation of Small Cetaceans in the Baltic and North Seas (ASCOBANS) (1992), applies.

The distribution of the white-beaked dolphin extends northwards to central W west Greenland, the Greenland Sea and the southern Barents Sea, and south to Newfoundland, Cape Cod and SW south west Ireland. It occurs over a large part of the northern European continental shelf and is common in British and Irish waters, with a similar distribution to the Atlantic white-sided dolphin though less pelagic and apparently more abundant at least in coastal waters. Its distribution is centred mainly upon the central and northern North Sea, but extending westwards to Nnorth and nNorth-west Scotland, and southwards towards Ssouth-west Britain and Ireland (Evans, 1990, 1992; Northridge *et al.*, 1995). It is occasionally observed in the western Channel south to the Bay of Biscay, in the Irish Sea, and southernmost parts of the North Sea.

White-beaked dolphins are common in the Hebrides, particularly in the north Minches, but they also occur regularly in the Little Minch and Sea of Hebrides (mainly along the east coast of the Western Isles). The species has been seen in coastal waters of South Uist, Eriskay, and Barra but it has not been observed (according to our records) within the Sound of Barra itself where the waters are largely too shallow for them to occur more than occasionally. In UK waters, the species is most common between June and October) although it is present in northern Britain year-round (Evans, 1992; Northridge *et al.*, 1995).

White-beaked dolphins feed upon mackerel, herring, cod, poor-cod, sandeels, bib, whiting, haddock, and hake, as well as squid, octopus, and benthic crustaceans. The region is used both for feeding and breeding. They breed mainly between May and August, although some may occur also in September and October.

Vocalisations poorly known but include whistles of 6.5 to at least 15 khz frequency (often around 8 kHz), with maximum source levels of 180 db re 1 μ pa @ 1 m, and echolocation clicks of up to at least 325 khz, with click bursts of 100-750 pulses per second, and maximum source levels of 207 db re 1 μ pa @ 1 m (Watkins, *pers. comm.*, Mitson & Morris, 1988; Mitson, 1990; Reeves *et al.*, 1999b).

Atlantic White-sided Dolphin (*Lagenorhynchus acutus*) Distribution restricted to temperate and subpolar seas of the North Atlantic.

International protection includes Appendix II of CMS Agreement on the Conservation of Migratory Species of Wild Animals (BONN Convention, 1983); Appendix II of BERN Convention on the Conservation of European Wildlife and Natural Habitats (applied to this species, from 1987); and Annex IV Animal and Plant Species of Community Interest in Need of Strict Protection of the EU Habitats Directive (1992). It is listed on List C1 of Council Regulation and, since 1985, has been treated by the European Community as if it is on CITES Appendix II (trade controlled to prevent overexploitation). Status listed by IUCN (1991) as insufficiently known. In UK, it receives protection under The Wildlife & Countryside Act (1981) and the Wildlife (Northern Ireland) Order (1985). One of the species for which the Agreement on the Conservation of Small Cetaceans in the Baltic and North Seas (ASCOBANS) (1992), applies.

This species is relatively abundant in mainly offshore waters from central West Greenland, Iceland and the southern Barents Sea south to Cape Cod (United States) and SW Ireland. In European waters, it is widely distributed mainly offshore from Iceland and the western Barents Sea south to the Bay of Biscay. It is less common on the continental shelf than on the slope and in deeper waters, and is more abundant north of 56°N than south of this latitude. In coastal waters of Britain and Ireland, it is less commonly recorded than the closely related white-beaked dolphin, where its distribution is concentrated around the Hebrides, the Northern Isles and northern North Sea. It also occurs regularly off western Ireland, and in the southwest approaches to the Channel and in the central North Sea, but is rare in the Irish Sea, the eastern Channel, and southernmost North Sea.

Although less commonly encountered in the Sea of Hebrides than the white-beaked dolphin, Atlantic white-sided dolphins usually occur in large schools numbering in the tens up to around 500 individuals. Most sightings occur at the southern end of the Sea of Hebrides in July and August. Although not recorded from the Sound of Barra, the species is recorded regularly in summer due east of Barra.

The diet reflects its more oceanic ecology, with species like blue whiting, herring, mackerel, horse mackerel, cod, hake, and silvery pout being important. Squid are also taken. Breeding occurs between February and September, probably mainly between May and August.

Vocalisations include whistles of 7-16 kHz frequency, with mean peak frequencies of 8-12 khz, and mean duration 0.5 sec, and broadband echolocation clicks at 0.2-180 khz with peak frequencies of 60-80 khz and single pulse duration 0.25-1 msec (Watkins, *pers comm.*).

Common Dolphin (*Delphinus delphis*) Worldwide distribution in tropical, subtropical and temperate seas in both hemispheres.

International protection includes Appendix II of CMS Agreement on the Conservation of Migratory Species of Wild Animals (BONN Convention, 1983); Appendix II of BERN Convention on the Conservation of European Wildlife and Natural Habitats (applied to this species, from 1987); and Annex IV Animal and Plant Species of Community Interest in Need of Strict Protection of the EU Habitats Directive (1992). It is listed on List C1 of Council Regulation and since 1985, has been treated by the European Community as if it is on CITES Appendix II (trade controlled to prevent overexploitation). Status is listed by IUCN (1991) as insufficiently known. In the UK, it receives protection in respect of particular methods of killing or taking under The Wildlife & Countryside Act (1981) and the Wildlife (Northern Ireland) Order (1985). One of the species for which the Agreement on the Conservation of Small Cetaceans in the Baltic and North Seas (ASCOBANS) (1992), applies.

The common dolphin is widely distributed in the eastern North Atlantic, mainly in deeper waters from the Iberian Peninsula north to west Scotland. In British and Irish coastal waters, its distribution has a mainly western and southern component. It is common in the western approaches to the Channel and the southern Irish Sea, off the west coast of Ireland, and around the Inner Hebrides north to the Isle of Skye (Evans, 1992; Northridge *et al.*, 1995). In some years, the species occurs further north and east, around Shetland and Orkney, and in the northern North Sea. It is generally rare in the southern North Sea and the eastern portion of the English Channel. In recent years, there have been a number of sightings of common dolphins off Northern Scotland, in the Northern Isles, and well into the North Sea.

Common dolphins have been seen off the east coast of South Uist and Barra in June and July, with group sizes numbering up to 200 animals. However, the species has not been recorded in the Sound of Barra itself, and since it favours deep waters, it is unlikely that locality is used to any extent.

The diet of the common dolphin includes a wide variety of fish and squid. Pelagic fish species are most common - blue whiting, mackerel, poor cod, hake, sardine, anchovy, silvery pout, scad, hake, and whiting, as well as small squid, octopus, cuttlefish, and crustaceans. The region is used both for feeding and breeding, with calves born mainly between June and September.

Vocalisations vary from whistles of 1-50 kHz frequency (mainly 6-12 kHz, max. source level 172 dB) to echolocation clicks which have not been adequately described but may reach 150 kHz (max. source levels 170 dB) at repetition rates of 30-200 clicks/sec. and pulsed calls such as “buzzes” and “barks” (Evans, 1973; Watkins, *pers. comm.*; Sturtivant *et al.*, 1994; Moore & Ridgway, 1995). Clicks and whistles may be given simultaneously.

Harbour Porpoise (*Phocoena phocoena*) Distribution restricted to temperate and subarctic seas of the northern hemisphere.

International protection includes Appendix II of CMS Agreement on the Conservation of Migratory Species of Wild Animals (BONN Convention, 1983); Appendix II of BERN Convention on the Conservation of European Wildlife and Natural Habitats (applied to this species, from 1987); and Annex II of the EU Habitats Directive (1992) (prohibiting all forms of deliberate capture, killing or disturbance, especially during breeding, rearing or migration; banning the keeping, sale, or exchange of such species; and requiring that member states monitor the incidental capture and killing of all cetaceans, and carries out research on conservation measures to prevent such accidents). Like all cetacean species, it is also listed on Annex IV Animal and Plant Species of Community Interest in Need of Strict Protection of the EU Habitats Directive (1992). It is listed on List C1 of Council Regulation and, since 1985, has been treated by the European Community as if it is on CITES Appendix II (trade controlled to prevent overexploitation). Status listed by IUCN (1991) as insufficiently known. In the UK, it receives special protection in respect of particular methods of killing or taking under The Wildlife & Countryside Act

(1981) and the Wildlife (Northern Ireland) Order (1985). One of the species for which the Agreement on the Conservation of Small Cetaceans in the Baltic and North Seas (ASCOBANS) (1992), applies.

In the eastern North Atlantic, the harbour porpoise is widely distributed on the continental shelf from the Barents Sea south to the coast of France and Spain, although in the last thirty years it has become scarce in the southernmost North Sea, English Channel, and Bay of Biscay. Nevertheless, it is the commonest cetacean recorded in British and Irish waters, though most abundant along the south and west coasts of Ireland, western and northern Scotland including the Hebrides and Northern Isles, in East Scotland and Northeast England, and in some coastal areas within the Irish Sea (mainly off SW south west Wales). Only small numbers occur in Ssouthwest England, and the species becomes scarce eastwards along the south coast of England, in the Thames estuary and off East Anglia. General declines were noted in coastal areas of the southern North Sea during the 1970's, extending and including some more northern and Atlantic sites during the early 1980's, with some indication of a reversal in this trend in the late 1980's to the present (Evans, 1992; Sea Watch unpubl. data).

Porpoises are common all along the eastern (and western) seaboard of the Outer Hebrides including South Uist, Eriskay, Barra, Mingulay and Berneray, and the species occurs in Sound of Barra including close to both of the sites on Aird Mhor that are proposed for a ferry terminal port. As elsewhere, porpoises can be found sometimes in very shallow waters. The species is apparently resident throughout the year in the region, although peak numbers are recorded between July and September. The area is used both for feeding and breeding.

The main diet of porpoises is small fish (usually less than 40 cm length) such as young herring, sprats, sand-eels, whiting, saithe, and pollack, although particularly in winter months, prey such as dab, flounder, sole, and cod are taken. Breeding occurs mainly between May and August, with a peak in June, though some can be as early as March.

Harbour porpoises produce high-frequency sounds used for echolocation and communication, but do not make frequency-modulated whistles typical of many delphinids. The high frequency sounds are comprised entirely of click trains, produced in two narrow band frequency components, one weaker one of longer duration (c. 0.2 msec) at between 1-20 kHz (Schevill *et al.*, 1969; Goodson *et al.*, 1995) and the other between 120-160 kHz (peaking around 125-130 kHz) of shorter duration (c. 0.02 msec) (Mohl & Andersen, 1973; Kamminga, 1990; Amundin, 1991; Goodson *et al.*, 1995). Repetition rates of pulses range between 0.5-1,000 clicks per sec (Amundin, 1991). Maximum source level is estimated at between 149 and 177 dB re 1 μ Pa at 1 m (Akamatsu *et al.*, 1992). The contexts in which these click trains are used are not well understood.

EFFECTS OF ANTHROPOGENIC SOUND UPON CETACEANS

Sound characteristics produced by human activities Animals such as cetaceans which live entirely within an aquatic environment rely heavily on sound both to acquire information about their environment and for communication (Evans, 1987; Richardson *et al.*, 1995). Additional sounds may therefore cause disruptions to the lives of cetaceans, distracting, annoying or even frightening them, as well as providing the potential for causing behavioural and physiological upset.

Since the industrial era, humans have developed a number of highly intense sources of sound (Ross, 1976; Urlick, 1983, 1986). Indeed, Ross (1976) estimated that between 1950 and 1975, ambient noise had risen by 10 dB in areas where shipping noise dominates, and he predicted it would rise a further 5 dB by the end of the 20th century as shipping traffic increased. The more powerful the engine that a vessel possesses, the greater the amount of sound (at least at low frequencies) it will produce. Supertankers, in particular, produce sound intensities of between 187 dB (at 50 Hz) and 232 dB (at 2 Hz) re 1 μ Pa, at very low (particularly <10 Hz) frequencies (Cybulski, 1977; Leggat, *et al.*, 1981).

Besides propeller and engine sound generated by vessels during commercial, military and recreational activities, surface vessels and submarines employ active sonar which uses sonic or ultrasonic waves to locate submerged objects, at the same time introducing brief, high-intensity pulses into the marine environment that sometimes may be transmitted over great distances. Source levels of sound are c. 200-250 dB re 1 μ Pa at frequencies up to 200 kHz. High resolution sidescan sonar (generally below 14 kHz) is also used in geophysical seismic surveys particularly during oil and gas exploration, along with lower resolution explosive techniques (airguns, sleeve exploders, etc.) mainly at frequencies below 500 Hz (Richardson *et al.*, 1995; Evans & Nice, 1996).

Most of the sounds generated from maritime activities referred to above (with the exception of sonar) are produced at frequencies lower than 1 kHz. However, when a surface vessel travels at high speed, the propeller may cavitate and produce much higher frequency sound (between 2 and 20 kHz) (Evans *et al.*, 1992). Measurements of various small craft (up to 15 m length, 240 hp engine) indicated source levels ranging from 100-125 dB re μPa at 2 kHz and 60-105 dB re μPa at 20 kHz. Cavitation (explain) is also more likely to occur when the propeller is damaged.

Cetacean Sound Production and Hearing The auditory sensitivities of porpoises, dolphins and the smaller toothed whales are greatest at very high frequencies - between 10 and 150 kHz, with a hearing threshold of about 40 dB at those frequencies, increasing to around 100 dB at 1 kHz and 120 dB at 100 Hz, at least for those species for which data are available (Richardson *et al.*, 1995). Although there is no quantitative information on the auditory sensitivities of baleen (explain?) whales (such as the minke whale), results of recent investigations suggest that greatest hearing sensitivities occur between 100 Hz and 5 kHz, on the assumption that whales will hear approximately over the same frequency range as the sounds they produce. Using this argument, we would expect minke whales to be most sensitive to frequencies of between 60-140 Hz.

The sounds produced by toothed whales and dolphins may conveniently be divided into: (1) pure tone whistles generally in the frequency range 500 Hz - 20 kHz, used mainly for communication; and (2) pulsed sounds or clicks varying from 500 Hz to 150 kHz, used mainly for echolocation. Source levels for both types of sound are estimated usually to be between 150 and 200 decibels, although pulsed sounds for non-echolocatory purposes may be produced at source levels of 115 dB, mainly in the frequency range below 20 kHz. Most of these measurements were made in captivity and it should be noted that animals can modify their sound production (particularly its intensity) in confined situations, and indeed do so also in open water.

The sounds produced by baleen whales may be classified into four types: (1) low-frequency moans, typically with frequencies of 12-500 Hz and of 0.4 to 36 seconds duration; (2) gruntlike thumps and knocks with most sound energy concentrated between 40 and 200 Hz; (3) chirps, cries and whistles at frequencies between 1 and 10 kHz; and (4) clicks or pulses at frequencies up to 20-30 kHz and lasting from 0.5 to 5 msec. Sound source levels range between 150 and 200 decibels, at frequencies of 500 Hz or less.

To summarise, most toothed whales, dolphins and porpoises can hear sounds over a wide range of frequencies from 75 Hz to 150 kHz, with greatest sensitivity around 20 kHz (although low frequency hearing has not been fully investigated), whereas the hearing of baleen whales probably ranges from frequencies of 10? Hz to 10 kHz, with greatest sensitivity usually below 1 kHz (this is based on sound production levels since no audiograms exist). Major differences in hearing between baleen and toothed whales are further supported by anatomical differences between the hearing organs of these two groups.

Sounds generated within the hearing range of cetacean species tend to elicit specific responses: the animal or animals move away from the sound source; they increase their dive times, remaining underwater for longer periods (possibly as a result of a rapid flee response; and social groups may bunch together. Sometimes, a cetacean species can shift the sound frequency at which it is communicating, and thus avoid or at least reduce interference with human made sounds. Longterm effects upon survival and reproduction of cetaceans have scarcely ever been demonstrated. However, because of the extreme difficulty of distinguishing from other anthropogenic factors and natural environmental changes, it is almost impossible to say whether these occur.

IMPLICATIONS FOR CETACEANS OF A FERRY TERMINAL PORT ON THE ISLAND OF BARRAFerry facilities for the Sound of Barra are being proposed by Comhairle nan Eilean Siar. Two possible sites are being considered for the location of the ferry terminal on the Aird Mhor peninsula of Barra. The scheme involves construction of a slipway and alignment structure, an approach road linking to the existing road network, a marshalling area and a rock breakwater. This report is for the EIA for Aird Mhor 1 only – Aird Mhor 2 has been dismissed through the comparative EIA process.

The slipway is likely to be c. 60 m long, constructed of rockfill with a concrete berthing slab, protected along one side by rock armour, and the other side having a vertical concrete face. Associated with the slipway will be a marshalling area, car park, waiting room/toilets/store and a fuel storage tank. The breakwater will be constructed to form a small artificial harbour. The breakwater will be crescent shaped and extend in the order of 120 m out to sea. The crest height will be approximately 3-4.5 m above Mean High Water Springs and 3 m wide, and will be constructed of rockfill protected by rock armour. The approach road will constitute a single-track road, 3.3 m wide with passing places. The alignment of the

road will be determined after the results of the environmental assessment. (the alignment will be determined as part of the detailed design process, prior to the submission of the EIA). Rock for the construction of the slipway and breakwater will be sourced from excess material from excavations associated with the approach road and marshalling area. Additional material will be available from visibility improvements which will be made along the existing approach road and on the C90 road.

These developments have two particular implications for cetacean species living in the area. They are:

- (1) increased ship traffic within the Sound of Barra generating local underwater sound disturbance which could also affect cetaceans further afield; and
- (2) noise disturbance to the local cetacean populations in the immediate vicinity of the terminal as a result of blasting operations and increased heavy transport.

From the systematic list of nine species of whales and dolphin regularly occurring in the area, detailed above, it is clear (explain why) that four species are most likely to be affected to any great extent in the immediate area by this scheme. These are minke whale, Risso's dolphin, bottlenose dolphin, and harbour porpoise. Both bottlenose dolphin and harbour porpoise are listed in Annex II of the EU Habitats Directive as species whose conservation requires the designation of Special Areas of Conservation. Both species are found regularly in the Sound of Barra and have been recorded adjacent to the Aird Mhor peninsula including both locations proposed for the ferry terminal port. They occur in the area throughout the year, and use it for giving birth and nursing their calves, for socialising, mating and feeding. Minke whales and Risso's dolphins occur regularly in the Sound of Barra and adjacent waters, and although most common during summer months, they are found in the area most months of the year, using it for feeding, socialising, and as nursery areas for their calves.

The development of a ferry terminal port on the east side of the Aird Mhor peninsula of Barra will introduce at least one large vessel into this area, in this case using the deeper waters of the Sound of Barra as the route between the terminal and the island of Eriskay.

In general, all vessels produce noise in the same ways (Richardson *et al.*, 1995). Propeller cavitation produces most of the broadband noise, with dominant tones arising from the propeller blade rate. Propellers create more noise if damaged, operating asynchronously, or operating without nozzles. Propulsion and auxiliary machinery can also radiate significant noise. Radiated noise is roughly related to ship size, speed, and mode of operation. Large ships tend to be noisier than small ones, and ships underway with a full load produce more noise than unladen vessels. Noise also increases with ship speed.

It is anticipated that Caledonian MacBrayne will operate the ferry service. The vessel which may run on the Sound of Barra sector will be similar to the "Loch Bhruisda" that currently operates in the Sound of Harris. The vessel is 44m long, 11.2m wide, 80 tonnes (dead weight) and 246 tonnes (gross) with a capacity to carry 18 cars or an equivalent, with 150 passengers. The vessel operates by "shuttle propulsion" and has a top speed of 9 knots.

Although direct measurements of sound source levels from ferries in the region have not been made, most vessels of similar size produce sounds of c. 180-190 dB re 1 μ Pa at 1 metre for sound frequencies of 30-60 Hz (Richardson *et al.*, 1995: 116; Evans, 1996). As noted above, the size of the propeller affects the dominant frequencies at which sound is generated. Strong broadband components caused by propeller cavitation were centred at 40-50 Hz for a vessel with a propeller 6.3 m in diameter, and near 100 Hz for another with a 9-m propeller. Although such sounds will be heard by any cetacean species, there is greatest overlap with the frequencies used by baleen whales like the minke whale.

In general terms, the use of such a vessel should avoid the broadband noise associated with propeller cavitation, but impacts associated with radiated noise, emanating from propulsion and auxiliary machinery and related to ship size, speed and mode of operation will remain.

Whereas local conditions of propagation will affect the actual sound levels that cetaceans are exposed to from any particular vessel, as a general rule behavioural avoidance tends to occur at sound levels of 160-170 dB re 1 μ Pa at 1 metre in the frequency range of greatest sensitivity to the species (Evans & Nice, 1996). For comparison, ambient noise in the ocean tends to be c. 60-100 dB re 1 μ Pa at 1 metre (usually nearer to the upper value of 100 dB) (Richardson *et al.*, 1995: 88-98).

Assuming spherical spreading of sound according to the equation STL (sound transmission loss) = $20 \log R$ + linear range term, where R = range (a reasonable assumption in this area), the zone of negative

influence (resulting in direct avoidance) is unlikely to be more than 100 metres from the vessel, although there is potential for acoustic masking at distances of a few kilometres.

The most likely impact of the ferry terminal is through sound disturbance and local habitat modification during its construction. If marine explosives are used, then there is potential for disturbance in the area during the period of this activity. Source levels for explosions at 60 m depth gave peak values of 267 dB re 1 μ Pa at 1 metre for 0.5 kg TNT, 271 dB for 2 kg TNT, and 279 dB for 20 kg TNT (Richardson *et al.*, 1995: 156-157), likely to cause physical hearing damage at distances of up to one kilometre, and behavioural avoidance to c. 10 km. Although minke whale behaviour has not been studied in relation to industrial activities, strong behavioural changes in another baleen whale species, the bowhead whale (during migration) have been noted at received levels of 124 dB from a drilling platform (Richardson *et al.*, 1995: 286), and avoidance was recorded in bowheads exposed received sound levels of 122-131 dB from a suction dredge (Richardson *et al.*, 1995: 279). They stopped feeding and moved from within 0.8 km of the sound projector to locations more than 2 km away. If other baleen whales like the minke whale were to react similarly, this could result in displacement from preferred feeding grounds with consequent implications upon their energetics.

A general assumption exists that cetaceans will move away from an ensonified area before physiological damage is induced. However, if an animal is in the close vicinity when explosions take place, it will not have the opportunity to avoid experiencing very loud sounds. There is also recent evidence that suggests that whales will tolerate industrial sound despite experiencing physiological damage. Lien *et al.* (1995) have reported an unusually high percentage of ear damage during humpback whale post-mortem examinations from individuals found dead in the vicinity of an area (Trinity Bay, north-east Newfoundland) characterised by industrial noise (underwater drilling, blasting and dredging) of 140-150 dB between 20 and 400 Hz (which falls in the same frequency range as the fundamental frequencies from airguns - i.e. 0-120 Hz - Malme *et al.*, 1986). Two humpbacks that had died in fishing gear near blasting both had damaged ears: ruptures of round windows, ossicular chain disruption and haemorrhages, whilst two autopsied individuals similarly killed in gear from areas where there was no industrial activity, showed no signs of ear damage (Ketten *et al.*, 1993). While explosions were characterised by high energy signatures with principal energies under 1 kHz (overlapping the sound production and, presumably, hearing range of the species), humpbacks showed little behavioural reaction to the detonations, in terms of decreased residency, overall movements or general behaviour. However, entrapment in fishing gear (a common phenomenon in the area) increased significantly over the period when industrial activities were taking place, and it was concluded may therefore have been influenced by the long term effects of exposure to deleterious levels of sound - decreasing their sensitivity to acoustic stimuli (Todd *et al.*, 1996).

The operation of the ferry may also lead to long term, but localized and limited impacts on cetaceans within the Sound of Barra due to the avoidance of the ferry during transit. Four species, the minke whale, harbour porpoise, bottlenose dolphin and Risso's dolphin, all known to inhabit this part of the Sound of Barra, are most likely to be affected by this scheme to build a ferryport.

Minke whales are usually solitary with no social organisation, although they can form aggregations of up to 10-15 individuals if feeding conditions are good. There is greatest overlap between the sounds generated by the ferry and the frequencies used by baleen whales like the minke whale. Should traffic of vessels in the Sound of Barra exceed around ten movements per day, it may deter this species from using the area. At present, it is planned for 5 return trips in the summer and 3 in the winter.

Harbour porpoises do not have any strong social structure, usually feeding and travelling either singly or in loose groups of 2-4 animals. During the period of construction, activities including blasting and dredging may disrupt their behaviour. Ferries (including some of much larger size than the one proposed here) operate regularly in many locations in the Western and Northern Isles where porpoises are common. Although porpoises can react negatively to those vessels (Evans *et al.*, 1994), there is little evidence that they avoid such areas for an extended period and the species can be seen regularly at many of those locations. It is therefore considered unlikely that their behaviour will be disrupted in the longterm unless traffic increases substantially.

Bottlenose dolphins live in social units and have preferred home ranges which they use on a longterm basis. From our current knowledge of the local Barra population, the species is most commonly seen off the north-east corner of the island, and particularly in the western portion of the Sound of Barra. This means that there is some potential for disruption of family groups during the period of construction. Once the ferry terminal is built, vessel traffic could interfere with bottlenose dolphin behaviour. As with harbour porpoises, there are other locations where ferries of this type and the species coexist without any

apparent longterm impact (Richardson *et al.*, 1995; Evans, 1996), so effects may not be great unless there is a significant increase in vessel traffic.

Risso's dolphins also live in social units and although their social organisation remains poorly known, it appears to involve stable bonds which can last several years. Thus, like the bottlenose dolphin, there is some potential for disruption of family groups during the period of construction and subsequently whilst the ferry is operating, but the longterm coexistence of this species and similar ferries (notably in Stornoway Bay and off the Eye Peninsula) would suggest that impacts may not be very large unless vessel traffic increases greatly.

MITIGATION MEASURES THAT COULD BE ADOPTED TO MINIMISE POTENTIALLY ADVERSE IMPACTS

There are three main measures that could be taken to mitigate the potentially adverse effects of this scheme:

1) The construction of the ferry terminal would be best conducted between November and April when cetaceans are least in evidence in the region; On the current programme the works which will directly affect the marine environment are programmed for July to mid September for the breakwater, September for the slipway and September to mid October for the timber structure. Assumably the weather would be too bad to contemplate undertaking this work during the winter period.

2) Where possible, blasting should be confined to terrestrial situations so as to minimise waterborne sound transmission which have potentially dangerous effects on cetaceans; The intention is to minimise marine blasting.

3) Any large vessel like a ferry or tanker using the proposed terminal is likely to pass through areas used by cetaceans whatever route is taken. Minimising the length of the ferry route is therefore probably the most sensible mitigation action to take. (Since cetaceans often concentrate foraging activities close to reefs and other areas with higher bottom relief, a precautionary recommendation would be to avoid these - so long as it did not increase the length of the route unduly).

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