AN IDENTIFICATION OF POTENTIAL IMPACTS OF MILITARY ACTIVITIES ON CETACEANS IN THE HEBRIDES

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ABSTRACT

The Hebrides is an important habitat for a variety of cetaceans, both resident and transient species; these valuable waters are also utilised by the military, and in particular the Navy. The Royal Navy has been training in the seas around Scotland for the past 150 years; the type of use over that period has evolved to encompass a variety of activities. Along with research, training and general usage of the area, Joint Maritime Courses (JMC) are conducted three times per annum; involving not only the RN but also NATO forces, this includes surface vessels, submarines, aircraft carriers and various weaponry.

There is increasing concern amongst residents, user groups and interested parties of the Hebrides regarding the possible negative impact that military activities may be placing on the welfare of cetaceans within these waters.

This dissertation reviews the potential impacts of military presence on cetaceans within the Hebrides, identifying both direct and indirect sources. This has been conducted by compiling a comprehensive literature review, bringing together recent research on cetaceans, both in the Hebrides and in general. Through a number of meetings and personal contacts with the Ministry of Defence (MOD), the Navy's approach to environmental policy is also discussed. Although some military information was unobtainable due to confidentiality, the paper provides an insight into the MOD, giving a positive outlook and showing its willingness to support and in some instances lead, in complying with environmental legislation.

The conclusion and recommendations brings together the research and highlights the need for a more in-depth study of the Hebrides region and cetaceans, looking not only at military activities, but at the variety of user groups that utilise the area. The report also recognises the importance of the relationship between the military, HWDT and other parties, identifying a need for improved communication and the formalisation of existing structures, otherwise there is the risk that goodwill and commitment will be lost. This would not benefit cetaceans or the Hebrides.

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1. INTRODUCTION

1.1 BACKGROUND

There has been increasing concern amongst residents, users and interested parties of the Hebrides region that military, particularly naval activities may be posing potential threats to the diverse cetacean populations within Hebridean waters.

These concerns have been highlighted via several sources:

- Incident in Loch Gairloch concerning the inappropriate behaviour of a vessel believed to be with the navy,
- Whale and dolphin watch numbers reported to have fallen by vessel operators,
- Shrimpton (1999) research recommendations,
- Enhanced media coverage and research into military activities, and in particular the use of Low Frequency Active Sonar (LFAS) in other parts of the world, has highlighted the possible impacts of these systems,
- Military concerns have been raised due to the issues identified and have resulted in the MOD Environment Policy team taking the lead in liasing with the concerned parties. The MOD has shown a willingness to co-operate with any investigation as to whether the military in the Hebrides is placing a negative impact on cetacean populations.

1.1.1 *Loch Gairloch*

Gairloch is a prime summer feeding and nursery area for Harbour Porpoises (*Phocoena phocoena*), which are a species of major conservation concern in the UK. Mr Birks of the Gairloch Marine Life Centre reported in a fax to the Ministry of Defence (MOD) and the Hebridean Whale and Dolphin Trust (HWDT) disturbances caused by the presence of the Royal Navy (RN) in Gairloch on 9th June 1998. He reported in particular, an incident involving a RIB that was seen to be speeding around the loch, passing through a group of porpoises. This generally raised the issue of RN use of Gairloch for submarine rescue training and exercises. The MOD state it is the location, shelter, weather conditions and bottom topography of Gairloch that make it an ideal place to conduct these procedures once or twice a year (MOD/SSA, pers. comm.).

1.1.2 *Hebridean Whale and Dolphin Tour Operators*

The HWDT reported several complaints from tour operators in the Mull region that sightings of whales and dolphins had suddenly ceased, at a time of year when they are normally most abundant. Operators observed that this coincided with an increase in naval activities within the area. Records indicate that a RN Joint Maritime Course (JMC) was in operation at that time. Wildlife operators and groups felt there was a lack of consultation by the MOD as to the occurrence of these exercises (Parsons, pers.comm.).

1.1.3 *Research on Hebridean Cetaceans*

Research by Shrimpton (1999) titled 'Cetacean conservation in the Hebrides: review and management recommendations' identified acoustic disturbance of marine traffic as a threat to cetaceans in the Hebrides, with military activities being a likely contributor. Shrimpton and Parsons (2000) also raised the issue of sonar and its possible connection in causing cetacean strandings. The paper recounts an incident where mass strandings of Cuvier's beaked whales in the Canary Islands and the Ionian Sea coincided with extensive sonar use, indicating a possible connection, as suggested by Frantzis and Cebrian (1999). Military explosives were also identified as potentially disturbing cetaceans, not only acoustically, but also physically.

1.1.4 *Low Frequency Active Sonar (LFAS)*

LFAS has been designed for the purpose of detecting enemy submarines. While the United States Navy has not disclosed actual sound levels, it is known through published articles that NATO has been using sound applications called 'Time Reversed Acoustics'. This system uses a playback method to make the sound extremely focused and powerful, with attenuation over hundreds of miles (O'Neal, 2000). The sound is of a low frequency (50–150 Hz), and although no specific details have been released, it is believed to be in the region of ~230dB (McNarie, 2000). This raises concerns as to its possible effect on baleen whales, as they are known to communicate within these low frequencies and may therefore be susceptible to LFAS (White, 2000), which could have major implications to their feeding, breeding and general day to day existence.

The LFAS system has triggered a storm of environmental protest based upon research that indicates sonar exposure places adverse impacts on marine mammals (O'Neal, 2000). It is claimed that LFAS has the potential to deafen and disorientate whales; with an association to several incidences of cetacean strandings (Frantzis & Cebrian, 1999).

Two recent articles in the Daily Mail (Merritt, July 2000) and The Sunday Times (Elliott, August 2000) newspapers, reported fears that LFAS was being used off the North West Coast of Scotland. Concerns were raised after the presence of six NATO vessels of the Standing Naval Force Atlantic coincided with the finding of a dead 15-foot long whale in the Inner Sounds of Skye. The MOD(N) have stated that no LFAS is used by the RN or allied forces within these waters (MOD/FOSNNI Operations, pers. comm.).

Although it is presently unclear which nations are using LFAS, it is likely that naval forces world-wide are developing systems and to truly understand the nature of LFAS thorough research is imperative (Gordon, 1999).

1.1.5 *The Ministry of Defence (MOD)*

Stemming from the incident around Loch Gairloch the MODs Naval Support Command (Environment Policy) were identified and contacted as a line of communication. The Naval Support Command are responsible for setting the policy for environmental practices within the RN, the Royal Fleet Auxiliary and marine Services – and have since become a support agency for air and land based activities (DLO). The Environmental Policy section identified the need for concerned parties to meet and raise their issues in the presence of the appropriate MOD personnel (MOD/Environment Policy, pers. comm.).

In response the Chief Environment and Safety Officer- Navy (CESO (N)) hosted an informal meeting for interested parties in Bath, England on the 17th November 1998. A second meeting took place at Scottish Natural Heritage offices in Battleby, Scotland on 19th November 1999. A summary of the main points agreed at the meetings is in Appendix 1.

1.2 AIMS AND OBJECTIVES

This study was originally initiated by HWDT as part of a MSc student dissertation into the Environmental Impact (EIA) of the military on cetaceans in the Hebrides. The original working title, through research and in response to the issues and concerns raised, has come to encompass the following aims and objectives:

1. identification of possible impacts of military activities on the cetacean populations of the waters of the Hebrides,
2. where possible a review of steps taken by the MOD to address these issues,
3. to develop an effective dialogue between NGOs and the MOD through a review of literature and existing structures for communication.

Initial concerns raised were centred on the noise and physical disturbance of military presence in the Hebrides, and the much-publicised international sonar issue. The need for a comprehensive overview of the potential effects of all military activities within these highly productive and internationally important waters has been highlighted. In light of the US Navy and NATO's controversial use of Low Frequency Active Sonar, and growing concerns of its application, this will also be discussed. For a background summary of the LFAS issue refer to Appendix 2.

Literature relating to the topic of the military and cetaceans, is again largely centred on the issues of sonar and the use of explosives. This is probably, in part, due to the fact that many other environmental impacts that may be detrimental to cetaceans are covered within generalised subject matter or fields; issues such as the discharge of substances to the marine environment, effects of climate change, and physical disturbance. However these are all issues the MOD need to be concerned with, and again identifies a need for an overall review of any potential effects of military activities.

The nature of this project and its subject matter has meant that a certain amount of information is unobtainable because of MOD confidentiality. The MOD have been contacted and where possible information has been given, but obviously a fully comprehensive report is not possible regarding certain issues.

The dissertation will attempt to identify potential impacts of military activities upon the cetacean population within these waters, examining also, the measures taken by the

MOD to address these issues. It is hoped that by identifying these points this document will provide a comprehensive review of the situation in the Hebrides, thereby giving insight to further steps that may be employed to address the situation if needed.

2. METHODOLOGY

The objectives of this project have had a great impact on the methods adopted to gather, analyse, and draw conclusions from information. The methodology for the project can be divided into two areas: primary and secondary research.

2.1 PRIMARY RESEARCH

Primary research has focused on the gathering of information directly from key people, organisations and/or sources. This has been through contact with agencies such as, HWDT, the Whale and Dolphin Conservation Society (WDCS), International Fund for Animal Welfare (IFAW), and also with the MOD. To ensure consistency in the research all correspondence has been either through e-mail, letters, or when talking directly, minutes of the conversation or meeting have been written up.

The direct contact with the MOD has been important to develop a degree of understanding and support for the project; as such all meetings were semi-structured and informal. This approach has allowed a positive working relationship to be developed, which has led to opportunities to meet with people outside the initial remit – i.e. a visit to DERA to attend a talk on future technologies in pollution control.

2.2 SECONDARY RESEARCH

The aim of secondary research has been to obtain background and specific information on the subject. Due to my base for this research the World Wide Web (WWW) has been a significant input. This has allowed the gathering of articles and papers on or related to the topic.

In addition numerous reports and correspondence have provided background information on many of the issues between the military, individuals and organisations involved in the area. Much of this information has been passed on in good faith and has only been used to reinforce observations or research gathered from other sources. Although not always valid or reliable the information does provide a valuable overview and (sometimes) subjective view of the issues.

Finally, many of the books and background papers have been obtained through the library resources of Heriot-Watt University, Sussex University, local libraries and the Hebridean Whale and Dolphin Trust.

Information related to the military was obtained from the MOD Environment Policy unit, visits to relevant departments and associated bodies, direct contact to individuals via the telephone and e-mail.

3. LITERATURE REVIEW

As discussed this project has arisen as the result of several incidences related to the military and cetacean populations in and around the Hebrides. Little information exists with regard to cetaceans and the military in the Hebrides, literature found is in large related to the US Navy and in particular is concerned with the impact of sonar on cetaceans.

To date there is not only a lack of data pertaining to the military and cetaceans but also, as Shrimpton (1999) points out, a lack of baseline data relating to the region. A paper by Berrow & Holmes (1999) entitled ‘Tour Boats and Dolphins: A note quantifying the activities of whale watching boats in the Shannon estuary, Ireland’, also reinforces the need for scientific based methodology to validate sometimes-anecdotal observations made by tour boats. Although this study is not within the Hebrides, it does reinforce the need for baseline data.

Parsons *et al.* (2001) in a paper titled ‘The possible impact of Military Activities on Cetaceans in West Scotland’ identified potential conflicts between the military and the marine environment in Western Scotland. It was the concerns highlighted by Parsons following several incidents within the region that led to the establishment of a joint agency forum, allowing key stakeholders in the area to raise concerns and issues. Parsons also acknowledged the lack of research on military activities and that this should be considered a priority in the UK.

Shrimpton and Parsons (1999) in ‘Cetacean Conservation in the Hebrides’ discuss the legal protection for cetaceans in the Hebrides region, along with the threats they face. The first section of their paper reviews the various agreements, conventions and legislative instruments relevant to cetaceans. Shrimpton and Parsons highlight that in spite of the large range of instruments relating to cetaceans, efforts in the Hebrides have no real focus and that the protection which does exist is very hard to apply specifically to cetaceans. As a result they recognise this as a “major stumbling block for the successful consultation, implementation and monitoring of marine and cetacean conservation strategies” (section 3.6, 1999).

The conservation issue is addressed in the section ‘Threats to Hebridean Cetaceans’, which identifies five main areas for discussion (Shrimpton & Parsons, 1999):

- a lack of data regarding levels of pollutants and activities,
- incomplete knowledge of full impacts,
- little understanding of how multiple threats may interact,
- a lack of information regarding habitat utilisation by Hebridean cetaceans,
- difficulty in assessing exposure levels to threats.

The paper discusses the issue of threats at length and recognises the vulnerability of cetaceans on a local and global level. It further reinforces the need for more data, due to a lack of research within the field; one of their priority research areas is the scale and intensity of military activities in the Hebrides region.

Dolman and Simmonds (interim paper: 1998) in ‘The threat posed by noise to cetaceans: preliminary considerations with particular reference to anti-predator devices’ discussed these threats. The paper talks about noise in the oceans, the structure of sound and the auditory sensitivity of cetaceans. It discusses how ambient noise has increased throughout the frequency spectrum due to human activity both in and on the marine environment. Some of these noise sources are examined and include:

- aircraft,
- vessels,
- industrial activities,
- military activities.

The paper recognises the ability of marine mammals to adapt, but due to “comparatively few data to show the effects of man-made noise”; investigation into the true impacts to cetaceans causes a number of problems. In response there is a detailed discussion of the effects of anthropogenic noise based on various research sources, in particular the use of LFAS which is described as the “most controversial source of man-made noise in the seas”.

Richardson and Würsig (1997:181) summarise “the observed behavioural reactions of cetaceans to noise and other stimuli”. In spite of research on short-term behavioural reactions, there is no long-term research to show whether or not cetaceans are being affected by human activities.

Chapter 11 (pp281-319) of 'The Conservation of Whales and Dolphins' edited by Simmonds & Hutchinson (1996) addresses underwater noise pollution and its significance for whales and dolphins. It refers to the increasing amount of marine noise from a variety of anthropogenic sources and its contribution to the overall levels of unwanted background noise in the oceans 'acoustic pollution' – as it is often termed. Again it is highlighted that although past and current research has led to a vast understanding of water acoustics "…in contrast, knowledge of the effects of underwater sound on marine life has lagged far behind" (Gordon & Moscrop, 1996:282). They also recognise the need for research into the long-term effect of noise exposure to marine mammals.

Richardson *et al.* (1995) has written a comprehensive book that examines the issue of marine mammals and noise. This work discusses in detail the effects of noise-associated environmental degradation upon marine mammals. It looks at all sources of marine noise from ambient to anthropogenic sources, also explaining how marine mammals use and relate to sound. It provides information how certain species react to particular sounds in different situations "react, strongly, react weakly, inconsistently, or do not react at all" (Richardson *et al*, 1995: 241). Again there is a case for further study of a wider variety of species, more in-depth study of anthropogenic inputs, and for more detailed investigation of the long-term impacts of chronic noise exposure.

3.1 LEGISLATION

3.1.1 *Cetaceans*

Shrimpton (1999) reviewed the legislative framework for cetacean conservation, identifying how it functions and to possible methods to increase its effectiveness. The scope of legislative protection for cetaceans involves International Law, due to migratory movement and the nature of the marine environment, through to UK specific. The relevant agreements pertaining to cetaceans discussed in Shrimpton (1999) include:

- United Nations Law of the Sea Convention (UNCLOS),
- Convention on Trade in Endangered Species of Wild Fauna & Flora (CITES),

- Bern Convention on the Conservation of Wildlife & Natural Habitats 1979 - which requires signatory states to take appropriate measures to prohibit deliberate capture, killing or disturbance of nineteen species of cetaceans listed as strictly protected. This includes most of the species commonly found in north-west European waters (DETR, 2000),
- International Union for the Conservation of Nature and Natural Resources (IUCN),
- Convention on the Conservation of Migratory Species of Wild Animals 1979 (The Bonn Convention),
- United Nations Convention on Biological Diversity 1992,
- Wildlife & Countryside Act 1981 and the Wildlife (Northern Ireland) Order 1985 - which prohibits deliberate killing, injury, or disturbance (DETR, 2000),
- All cetaceans are listed under Annex IV of the European Community Habitats and Species Directive (92/43/EEC) as species being in need of strict protection; under such protection it is an offence to deliberately disturb cetaceans (DETR, 1999),
- Marine Protected Areas (MPA's)'
- National Scenic Areas – unique to Scotland.

Other legislation:

- The UK is a Party to the Agreement on the Conservation of Small Cetaceans of the Baltic and North Seas (ASCOBANS) which requires signatory states to work towards the prevention of significant disturbances to cetaceans, especially that of an acoustic nature (DETR, 2000). This also covers the Hebrides by agreement.

Irish (1995) also discusses the range of legislation covering the marine environment, the Nature Conservancy Council (NCC – as was), for example, listed 88 Acts of direct relevance to marine conservation.

However, in spite of the range of legislation, a Government European Community Select Committee identified the requirement for better legislation to provide more efficient and workable protection (Shrimpton & Parsons, 2000).

3.1.2 *MOD - Navy*

MARPOL 73/778 appears to be one of the main legislative instruments that applies to much of the RN activities and dictates the way forward with regard to environmental standards.

- **MARPOL 73/78:** - The International Convention for the Prevention of Pollution from Ships 1973 (subsequently modified in 1978 – hence MARPOL 73/78). Regulations covering the various sources of ship pollution are contained in the five annexes of the Convention; these are then implemented through specific legislation, primarily the Merchant Shipping Regulations.

  The Convention designates the Antarctic, Mediterranean, Baltic, Black Seas, the Gulf of Aden, the Persian Gulf area, and north-west European waters as special areas in which oil discharge is virtually prohibited. The wider Caribbean and the North Sea are recognised as special areas subject to more stringent requirements governing the disposal of ship-generated garbage.

This and other relevant legislation is discussed in greater detail in Chapter 4.

3.2 THE HEBRIDES (Celtic Shelf)

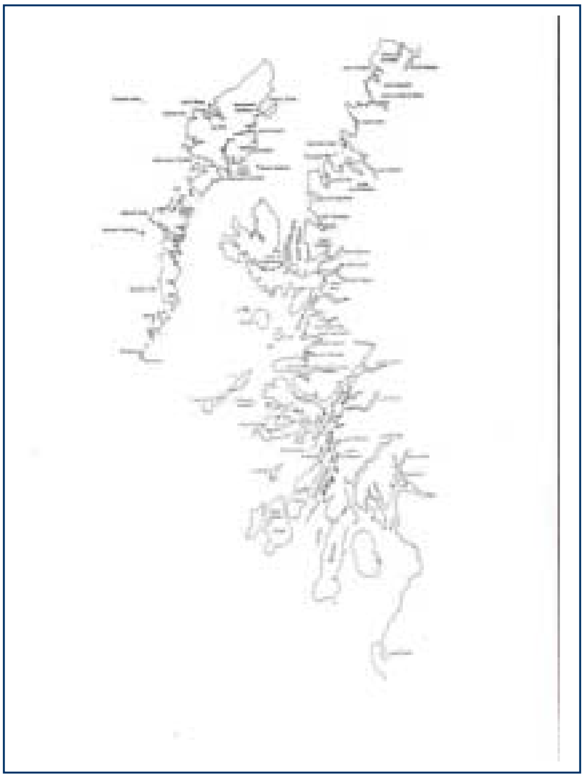
The Hebrides are situated on the west and north-west of Scotland, incorporating more than 500 islands, and are renowned for their beauty and wildlife (Figure 1). The waters surrounding the Hebrides provide a rich habitat for a variety of marine species.

The Hebrides, comprising of the Inner and Outer Hebrides, are an extremely important component of the North Atlantic ecosystem. Less than a fifth of the islands are inhabited and the seas are an essential resource to the network of small communities with the main economic activities being fishing, along with farming and sheep grazing.

In more recent years an increasing tourism industry is also proving to be valuable to the residents (www.encyclopedia.com).

3.2.1 *Hydrography*

Figure 1: *Map of the Hebrides*



The convergence of the North Atlantic Drift and the Gulf Stream, which convey warm waters sustaining a rich diversity and abundance of plankton, travel diagonally across the Atlantic. Here, they encounter the undulating submarine mountains and islands of the Hebrides where they manifest in upwellings and zones of mixing as they combine with the cooler Arctic North Sea Waters (Irish, 1995).

The water masses around the Hebrides have one of the lowest degrees of annual variation in temperature of any area around the British Isles. This is in large due to the way in which water masses mix out to the west off the continental slope. Subsurface waters of low salinity moving from the north-west into the eastern North Atlantic basin, plus deeper saline outflow from the Mediterranean, mean that the density gradient between surface and mid–depth waters is lower than normal. This means that the slightly cooled surface waters in winter descend to greater depths, resulting in the deep overturning of the water column, bringing warmer waters to the surface (Boyd & Boyd, 1996).

3.3 CETACEANS IN THE HEBRIDES

It is the hydrography of the Hebrides that leads to such high productivity; and enables a diversity of species to utilise this area both on a resident and transient basis. Twenty-seven species of cetaceans have been recorded as occurring in the coastal waters of the north-east Atlantic (DETR, 1999), twenty-three of these species have been encountered around the Hebrides (HWDT, 2000).

The order cetacea – whales, dolphins, and porpoises - are one of the oldest and most diverse group of marine mammals, inhabiting all seas, oceans, and some major rivers (Simmonds & Hutchinson, 1996). There have been around 81 species of cetaceans recorded world wide to date, these are divided into two suborders; mysticetes or baleen whales, of which there are eleven species to date, while odontocetes or toothed whales make up the remainder (Carwardine, 1999). Table 3.3 lists the twenty-three species of cetaceans that have been recorded within the Hebrides, indicating their occurrence and legislative status.

Table 3.3: *Cetacean Species Recorded in the Hebrides*

Species **Common Name** *Latin Name*	Hebridean Occurrence	Legal Protection HABITAT	BERN	BERN	CITES*	W&C	BIO-IV	IUCN
ODONTOCETES								
Harbour porpoise *Phocoena phocoena*	Common	II IV	II	II	II*	V	P	VU
White-beaked dolphin *Lagenorhynchus albirostris*	Common	IV	III	II	II*	V	C	-
Risso's dolphin *Grampus griseus*	Common	IV	II	II	II*	V	C	DD
Common dolphin *Delphinus delphis*	Common	IV	II	II	II*	V	C	-
Bottlenose dolphin *Tursiops truncatus*	Common	II IV	II	II	II*	V	C	DD
Killer Whale or Orca *Orcinus orca*	Common	IV	II	II	II*	V	C	CD
Long-finned pilot whale *Globicephala melas*	Common	IV	II	II	II*	V	C	-
Atlantic white-sided dolphin *Lagenorhynchus acutus*	Uncommon	IV	II	II	II*	V	C	-
Striped dolphin *Stenella coeruleoalba*	Uncommon	IV	II	II	II*	V	C	CD
Northern bottlenose whale *Hyperoodon ampullatus*	Uncommon	IV	II	II	I	V	P	CD
Cuvier's beaked whale *Ziphius cavirostris*	Uncommon	IV	II	II	II*	V	C	DD
Sperm whale *Physeter macrocephalus*	Uncommon	IV	III	-	I	V	P	VU
Sowerby's beaked whale *Mesoplodon bidens*	Rare	IV	II	II	II*	V	C	DD
Fraser's dolphin *Lagenodelphis hosei*	Rare	IV	III	-	II*	V	-	DD
False Killer whale *Pseudorca crassidens*	Rare	IV	II	II	II*	V	C	-
Narwhal *Monodon monoceros*	Rare	IV	III	II	II*	V	C	DD
Beluga whale *Delphinapterus leucas*	Rare	IV	III	II	II*	V	C	VU
MYSTICETES								
Minke whale *Balaenoptera acutorostrata*	Common	IV	III		I	V	P	NT
Fin whale *Balaenoptera physalus*	Uncommon	IV	III		I	V	P	EN
Sei whale *Balaenoptera borealis*	Uncommon	IV	III		I	V	P	EN

Humpback whale *Megaptera novaeangliae*	Rare	IV	II	I	I	V	P	VU
Northern right whale *Eubalaena glacialis*	Very Rare	IV	II	I	I	V	P	EN
Blue whale *Balaenoptera musculus*	Rare	IV	II	I	I	V	P	EN

Source: Shrimpton 1999

HABITAT: Directive on Conservation of Natural Habitat and Wild Fauna and Flora Appendix: II=species requiring the designation of protected areas, IV= protected species; **BERNE**: Convention on the Conservation of European Wildlife and Natural Habitats Appendix: II =strictly protected endangered and vulnerable animals, III =protected animals; **BONN**: Convention on Conservation of Migratory Species of Wild Animals appendix; **CITES**: Convention on the International Trade in Endangered Species Appendix: I= species threatened with extinction, II= vulnerable species; **W&C Act**: Wildlife and Countryside Act (1981) Schedule: V= protected species; **Bio-Div**: UK Bio-Diversity Action Plan Conservation Status : P= Priority species, i.e. globally threatened or rapidly declining in the UK (50%+ in 25 years), C= species of conservation concern; **IUCN:** IUCN Red Data List Designation: EN=endangered; VU= vulnerable; CD=conservation dependent; NT= near threatened; DD= data deficient.

* All cetaceans are listed on list C1 of Council regulation no. 3626/82. This means that all cetaceans in the UK are treated as if they are actually listed in Appendix I.

A more in-depth table, giving greater detail about the species recorded in the Hebrides can be found in Appendix 3.

Cetaceans have evolved many adaptations to marine life: streamlined body, reduced forelimbs, a powerful horizontal tail for propulsion, blow holes to facilitate respiration while travelling through water, and a variety of vocalisations (Cooke 1991). Cetaceans produce a variety of sounds, many of which are believed to have a social function, such as the song of the male humpback (*Megaptera novaeangliae*), the individual signature whistle of the bottlenose dolphin (*Tursiops truncatus*) and the 'pod identity' calls of the Killer whale (*Orcinus orca*) (Cooke, 1991).

3.3.1 *Cetacean Acoustics*

For cetaceans to be so successful within the marine environment their understanding of and ability to communicate underwater has been imperative. As light travels poorly through water cetaceans can not rely on a visual perception of their environment, and in response have developed highly skilled acoustic capabilities (Gordon & Tyack, 2000).

Sound propagates more effectively in water than in air, at least four times faster (Dolman & Simmonds, 1998; Richardson, 1995); as a result most nektonic animals show strong development of sound receiving structures; being most highly developed in cetaceans, and especially in those that use sophisticated echolocation systems (Nybakken, 1997).

Marine mammals have developed a sense of hearing with the greatest number of specialised adaptations. Cetaceans utilise sound for communication, feeding, navigation and exploration. All cetaceans have sensitive hearing and most are highly vocal, producing the widest range of sounds of any mammalian order (Gordon & Tyack, 2000). Although cetaceans have lost the typical mammalian outer ear flap, their ears are in the form of tiny holes in the skin behind the eyes; many species also receive sound via the lower jaw (Brill, 1986; Carwardine, 1999).

From earlier studies of cetaceans in captivity by scientists such as Kellogg (1962), more is understood about the communication of smaller cetaceans. There is not so much information regarding mysticetes, but it is generally believed that hearing capabilities are in the range of their own vocal sounds.

High frequency hearing ability of most small to medium sized odontocetes is exceptionally good, this is in large due to their use of high frequency sound for echolocation (Richardson, 1995). Mysticetes are more adapted to the use of low frequency sounds, and therefore are more likely to be susceptible to low frequency acoustics, such as LFAS.

3.3.2 *Echolocation*

The ability to echolocate has been proved experimentally for several odontocetes, the anatomical evidence – the presence of the melon, nasal sacs, and specialised skull structures – suggests that all dolphins have this ability (May, 1990).

The dolphin is able to transmit ultrasonic clicks, within its nasal sacs, situated behind the melon or in the larynx (Carwardine, 1999). The frequency of this click is higher than that used for communication and differs between species (May, 1990). The melon acts as a lens, which focuses the sound into a narrow beam that is projected in front of the animal. When the sound strikes an object, some of the energy of the sound wave is reflected back towards the dolphin (Nachtigall *et. al.*, 1986; May, 1990). It appears that the pan bone in the dolphin’s lower jaw receives the echo, and the fatty tissue behind it transmits the sound to the middle ear and hence to the brain (Brill, 1986; May, 1990); highly developed echolocation can vary the frequency of the sound produced.

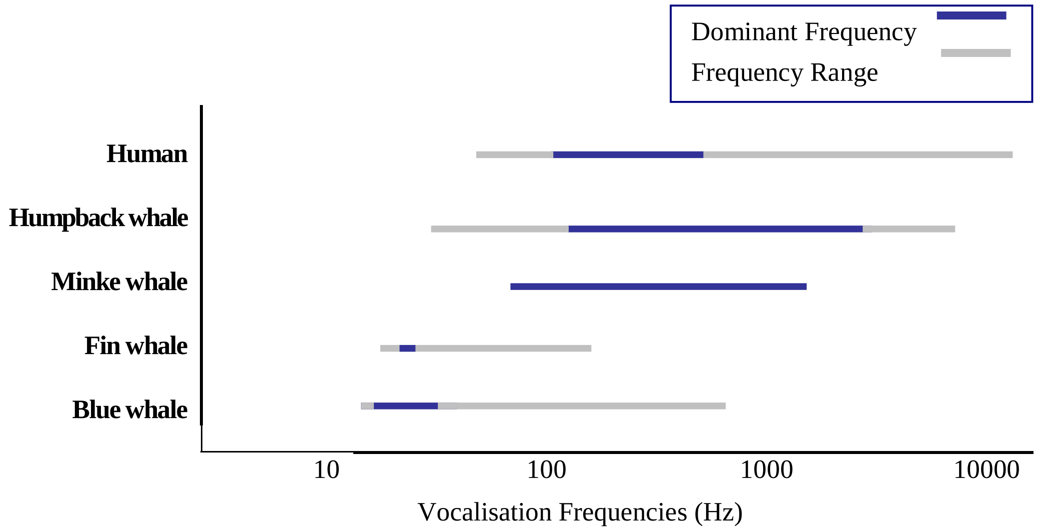
Echolocation can be used to identify prey size, shape, swimming direction, its texture, and possibly even its internal structure (Whitlow, 1986; Carwardine, 1999). Echolocation is not only used for hunting, but also navigation, keeping track of others, identifying changes, and monitoring the surroundings. It is possible that some species may be able to blast ultrasonic clicks to stun or kill prey.

3.3.3 *Low Frequency Sound*

Low frequency sound is used by cetaceans usually to communicate among themselves, such as with the 'singing' of humpback whales and the low frequencies (20 – 80Hz) produced by blue whales. Low frequency sound does not produce information as to the fine structure of objects, although it does have the potential for long range propagation, due to its low absorption coefficient (Gordon & Moscrop, 1996).

The dominant components of the 'communication' calls of most marine mammals are within the 20Hz to 20kHz range, however, sounds produced by blue and fin whales are below 20Hz, and the echolocation calls of toothed whales extend far above 20kHz (Richardson, 1995). Mysticetes produce a considerable amount of sound in the oceans and it is possible that such signals may be used as cues by other species (Nybakken, 1997).

Figure 1a: *Whale Vocalisations*



Source: NOAA, 2000.

Appendix 3 provides an insight into the acoustic capabilities of cetaceans that frequent the waters of the Hebrides.

3.3.4 *Reaction to Sound - Cetacean Vulnerability*

In the last hundred years increased use of the oceans and coastal regions for commercial, industrial and recreational purposes has led to a considerable growth in the levels of background sound (Evans, 1996). Concerns have been raised as to the impact that this, and other more intense sounds, is placing on cetaceans, which until this anthropogenic invasion had inhabited a relatively quiet environment (Patrick *et al*., 2000). It is feared that cetaceans are vulnerable to the variety and extent of this 'sound pollution', which may impinge on their existence, manifesting in an array of negative impacts. Simmonds and Dolman (1999) have comprehensively described a number of potential impacts that anthropogenic sounds may be placing on marine mammals, thereby highlighting their vulnerability. Table 3.3.4 lists the potential impacts Simmonds and Dolman discuss.

Table 3.3.4: *Potential Impact of Sound in the Marine Environment on Cetaceans*

Impact	Type of Damage Possible
Physical	
Non Auditory	- damage to body tissue - induction of the 'bends'
Auditory	- gross damage to ears - permanent hearing threshold shift - temporary hearing threshold shift
Perceptual	- masking of communication with conspecifics - masking of other biologically important noises - interference with ability to acoustically interpret environment - adaptive shifting of vocalisation
Behavioural	- interruption of normal behaviour - behaviour modified (less effective/efficient) - displacement from area (short or long term)
Chronic/Stress	- decreased viability of individual - increased vulnerability to disease - increased potential from impacts from negative cumulative effects - sensitisation to noise – exacerbating other effects - habituation to noise – causing animals to remain near noise source – although damaging
Indirect Effects	- reduced availability of prey.

Source: Simmonds & Dolman 1999.

3.3.5 *Military Acoustics and Cetaceans*

One source of acoustics which is generating a degree of debate is sonar and in particular, its use by the military.

SONAR - SOund Navigation And Ranging.

Modern echo-ranging sonar research was first stimulated by a need to detect icebergs in light of the Titanic disaster of 1912; it now covers topics as diverse as:

- Acoustic Tomography of Ocean Climate (ATOC) including ocean basin thermometry to detect global warming,
- The detection of surface, mid-water, bottom, and sub-bottom targets which may pose hazards to shipping,
- Passive detection and classification of underwater acoustic sources,
- Positioning systems for use in sub-sea oil and gas exploration,
- Non-destructive testing of metals (crack detection),
- Diver speech communication and data telemetry

(Loughborough University, 2000).

In the early fifties that the word 'sonar', an American term, was finally adopted by the RN; 'sonar' was invented in 1942 by Ted Hunt an American underwater specialist. Originally the term had only related to echo ranging equipment, but later became defined as 'the science and the art of transmission and reception of underwater sound'; and has come to encompass both passive sonar – meaning listening, and active sonar – meaning echo ranging techniques (Hackmann, 1984: XXVI). Military applications of sonar include:

- Underwater Communications,
- Mine Detection,
- Sea Floor Mapping,
- Sonar Buoys,
- Torpedo Countermeasures,
- Acoustic/Trial Ranges (Neptune Sonar, 2000)

Sonar comes in a wide variety of frequencies and power ranges, from simple high frequency depth sounders (100-200 kHz), to low frequency fish-finding, charting, and military applications, Table 3.3.5 gives an idea of the properties of active sonars.

Acoustics are essential to modern-day warfare and both active and passive sonar is used extensively; this along with other military devices can contribute considerably to anthropogenic acoustic inputs to the marine environment (Gordon & Moscrop, 1996). Cetaceans also vocalise and hear over a range of frequencies and distance, which raises the issue of the capability of sonar affecting cetacean behaviour. Richardson & Würsig (1996:194) recount how 'most sonar pulses are at moderate or high frequencies, in or near the range of optimal hearing sensitivity of odontocetes'. A paper by Rendell and Gordon (1999) also examines the responses of long-finned pilot whales (*Globicephala melas*) to military sonar '…results were strongly indicative of a tendency for pilot whales to respond vocally to military sonar pulses'. The paper concludes that military sonar needs to be taken seriously with regard to acoustic disturbance of cetaceans.

Gordon and Moscrop (1996) also raise the issue that as lower frequency, long-range sonars are developed, the potential for cetacean disturbance, particularly the baleen whales, will increase.

Table 3.3.5: *Acoustic Properties of Active Sonar Systems*

Sonar Type	**Frequency Range** (kHz)	**Av. Source Level** (dB re 1 uPa/1 a)
Search & Surveillance	2 – 57	230+
Mine & Obstacle Avoidance	25 – 200	220+
Weapon Mounted Sonar	15 – 2000	200+
LFAS used by NATO	0.25 – 3.0?	230+

Source: Parsons *et al*., 2001

LFAS – Low Frequency Active Sonar

Sonars are continually evolving to detect vessels at greater distances, which due to design, span a range of frequencies that overlap the hearing sensitivities of fish and marine mammals (Dolman & Simmonds, 1998). LFAS is being developed because of its propagation capabilities, with application being aimed at submarine detection. This is an experimental technology that is being developed by the US Navy amongst others, and it has generated a high degree of controversy due to the lack of knowledge regarding the possible impacts to the marine environment (www.dreamweaving.com/lfas).

These concerns have followed a number of high profile incidents, including:

- evidence during initial testing that whales deviated from their normal course and were noted to have stopped singing in response to test broadcasts,

- reports from tests in waters around Hawaii indicated that whales left the area and a snorkeler was diagnosed with symptoms similar to a trauma patient in hospital,
- an article in 1996 by Dr Alexandros Frantzis concluded that NATO testing caused mass strandings of Cuvier's beaked whales on the Greek coast,
- 17 whales were found stranded in the Bahamas at the same time as the US Navy was using various active sonar devises (www.dreamweaving.com/lfas).

Refer to Appendix 1 for greater detail.

3.5 MINISTRY OF DEFENCE

The Ministry of Defence (MOD) is aware of increasing environmental regulations both within the UK and internationally and is committed to compliance. Not only is the MOD conscious of a 'duty of care' but is very much aware that the consequences of non-compliance are potentially extremely significant; an inability for a warship to comply with maritime legislation inhibits operational freedom and potentially reduces operational capability. This coupled with public awareness; failure to comply could have devastating consequences.

Environmental legislation impacts on all aspects of the RN; warships, amphibious forces, auxiliaries, naval aircraft, the naval estate, and its naval bases and repair facilities.

3.5.1 *Crown Immunity*

In 1990 the government decided that the presumption of Crown immunity should cease to apply to all new legislation, unless a specific exemption exists in legislation on grounds of national security (DNES, 1994).

The effect of losing Crown immunity is that the Armed services and MOD are liable to prosecution as a corporate body and/or as an employee of the MOD. For example the MOD have exemption from the provisions of the Environmental Protection Act 990 (EPA90) for noise and smoke in training/ testing activities – where this relates directly to activities involving national security.

The MOD Environmental Policy Statement makes it clear that exemptions will be invoked only where essential to maintain operational effectiveness.

3.5.2 *Environmental Management in the Royal Navy*

The Navy board has stated that positive action will be taken to ensure the continued improvement of current practices in environmental management. National and international legislation, regulations and directives, including those of maritime pollution, are to be implemented and confirmed by routine audit and inspection.

To address the combined increase in environmental legislation, the removal of Crown immunity and the general increase in public awareness, an internal review was completed which addressed the environmental challenge to the RN in 1996 (MOD/Environment Policy, pers. comm.).

In order to conceptualise the expected aims of the RN the MOD produces a 'Guide to Environmental Compliance' as a resource for Commanding Officers and Heads of Establishment within the RN, see Appendix 4. The document provides guidance on environmental legislation, awareness of issues, and action to be taken. The document states ' good environmental practice should become an integral part of good management and environmental control must become established as part of the day-to-day decision making process' (DNES, 1994:I-1).

Within the UK, operations undertaken by the Navy Department are either directly covered by environmental legislation or come within the remit of legislation in term of emissions, discharges and waste, etc.

3.5.3 *MOD Environmental Policy*

The MOD aims to further the Government's environmental strategy and set an example for the rest of the community in all activities affecting the natural environment. This involves:

- compliance with the letter and the spirit of UK environmental law regardless of any Crown or Defence immunities, which will be invoked only where essential for national Security;

- to the same extent as with UK law, compliance with international conventions to which the UK is a signatory and respect for host nation legislation overseas;
- beyond the above, action to protect and enhance the natural environment in line with the Government's environmental strategy and the principle of environmental sustainability, within overriding operational and financial constraints; and
- striving to be as good a neighbour at home and abroad as circumstances allow.

3.6 MILITARY ACTIVITIES IN THE HEBRIDES

The Hebrides is a major area for military use (Parsons, 2001), and is utilised by the Navy in particular. These activities have the potential of posing a variety of impacts on the marine environment and its inhabitants. An example of usage by the Navy between January to June 2000 is given in Appendix 5. The extent of naval military activities is presented in ship days and hours. For example, a figure such as 543 ship days recorded for a specific area may reflect that at one point a multiple ship formation (Amphibious Task Group) was operating in that area for ten days – resulting in the total of 543 ship days (MOD/FOSNNI Operations, pers. comm.). The identification of an area being used by a unit does not necessarily mean a specific activity is taking place, they may be simply transiting through that segment (MOD/FOSNNI Operations, pers. comm.).

The Royal Navy and allied navies have been training in the seas around Scotland for the past 150 years (MOD/FOSNNI Operations, pers. comm.). The types of training conducted have evolved over that period in correlation with the size and technological advancements of the fleets involved. Table 3.6 below summarises the RN fleet and sonar type. Although not all vessels are active in the Hebrides, it does highlight the scale and potential for conflict if there were no consistencies or continued adoption of policies and proceedings.

Table 3.6: *The Royal Navy Fleet – including sonar equipment onboard*

Vessel Name: No.	Active (Reserve)	Sonar Type
Strategic Missile Submarines (SSBN) **Trident Class:** Vanguard S28 Victorious S29 Vigilant S30 Vengeance S31	4	Marconi/Plessey Type 2054 composite multifrequency sonar suite, Marconi/Ferranti Type 2046 towed array. Type 2043 hull-mounted active/passive search & Type 2082 passive intercept & ranging.
Attack Submarines (SSN) Under Construction: Astute (S20), Ambush (S21), Artful (S22). **Swiftsure Class:** Sovereign S108 Superb S109 Sceptre S104 Spartan S105 Splendid S106 **Trafalgar Class:** Trafalgar Turbulent Tireless Torbay Trenchant Talent Triumph	12	Ferranti/Thomson Sintra 2076 integrated suite with reelable towed array. Marconi/Plessey Type 2074; hull-mounted; active/passive search & attack; low frequency. Marconi 2072; flank array; passive; low frequency. Ferranti Type 2046; towed array; passive search; very low frequency. Thomson Sintra Type 2019 PARIS or THORN EMI 2082; passive intercept & ranging. Marconi Type 2077; short-range classification; active; high frequency.
Aircraft Carriers (CVS) **Invincible Class:** Invincible R05 Illustrious R06 Ark Royal R07	2 (1)	Plessey Type 2016; hull-mounted; active search & attack; medium frequency.
Destroyers – Type 42 **Batch 1**: Newcastle D87 Glasgow D88 Cardiff D108 **Batch 2**: Exeter D89 Southampton D90 Nottingham D91 Liverpool D92 **Batch 3**: Manchester D95 Gloucester D96 Edinburgh D97 York D98	11	Ferranti/Thomson Type 2050 or Plessey Type 2016; hull-mounted; active search & attack; medium frequency.
Frigates (FFG) **Batch 1 -** Type 23: Norfolk F230 Westminster F237 Argyll F231 Northumberland F238 Lancaster F232 Richmond F239 Marlborough F233 Somerset F82 Iron Duke F234 Grafton F80 Monmouth F235 Sutherland F81 Montrose F236 Kent F78 Construction: Portland (F79) & St Albans (F83) **Batch 2 -** Type 22: Sheffield F96	20	**Type 23:** Ferranti/Thomson Sintra Type2050; bow-mounted; active search & attack. Dowty Type 2031Z (F229-F239); towed array; passive search; very low frequency. To be replaced by Type 2087 from late 2004; active low frequency towed body with a passive array. **Type 22** (Batch 2) Ferranti/Thomson Sintra Type 2050; hull-mounted; search &

Coventry F98 **Batch 3 -** Type 22: Cornwall F99 Cumberland F85 Campbeltown F86 Chatham F87		attack. Dowty Type 2031Z; towed array; passive search; very low frequency. **Type 22** (Batch 3)**:** Ferranti/Thomson Sintra Type2050; hull-mounted; active search & attack. Dowty Type 2031; towed array; passive search; very low frequency.
Assault Ships (LPD) **Fearless Class:** Fearless L10	1	None
Helicopter Carriers (LPH) Ocean L12	1	None
Landing Ships Logistic (RFA) **Sir Bedivere Class:** Sir Bedivere L3004 Sir Geraint L3027 Sir Percivale L3036 Sir Tristram L3505 Sir Galahad L3005	5	None
Offshore Patrol Vessels (OPV) **Castle Class**: Leeds Castle P258 Dumbarton Castle P265 **Island Class:** Anglesey P277 Alderney P278 Guernsey P297 Shetland P298 Lindisfarne P300	7	None None
Training & Patrol Craft **Archer Class Fast Training E Boat (PB/AXL):** Archer P264 Ranger P293 Biter P270 Trumpeter P294 Smiter P272 Express P163 Pursuer P273 Example P165 Blazer P279 Explorer P164 Dasher P280 Exploit P167 Puncher P291 Tracker P274 Charger P292 Raider P275 **Hong Kong Patrol Class:** Peacock P239 Plover P240 Starling P241 **Others:** x14	33	None None
Mine Warfare Forces **Hunt Class** - Minehunters (MHC)/Minesweepers (MSC): Brecon M29 Ledbury M30 Cattistock M31 Cottesmore M32 Brocklesby M33 Middleton M34 Dulverton M35 Chiddingford M37 Atherstone M38 Hurworth M39 Quorn M41	11	Plessey 193m mod 1; hull-mounted; minehunting; 100/300 kHz. Mil Cross mine avoidance sonar; hull-mounted; active; high frequency. Type 2059 to track PAP 104/105.

Minehunters (MHC/SRMH) **Sandown Class:** Sandown M101 Inverness M102 Cromer M103 Walney M104 Birdport M105 Penzance M106 Pembroke M107 Grimsby M108 Bangor M109 Ramsey M110 Construction: Blythe (M111), Shoreham (M112)	10	Marconi Type 2093; VDS; VLF-VHF multifunction with 5 arrays; mine search & classification.
Repair/Maintenance Ships (RFA) **Stena Type** – Forward repair Ship Diligence A132	1	None
Survey Ships (AGS): **Gleaner Class** (YFH): Gleaner H86 **Roebuck Class**: Roebuck H130 **Scott Class:** Scott H131 **Improved Hecla Class:** Herald H138 **Bulldog Class:** Bulldog H317 Beagle H319	6	None None None None None
Antarctic Patrol Ship (AGOB) Endurance A171	1	None
Large Fleet Tankers (RFA) **OL Class** – Large Fleet Tankers (AO): Olwen A122 Olna A123 Construction: Wave Class x 2.	2	None
Support Tankers (RFA) **Appleleaf Class** (AOT): Brambleleaf A81 Bayleaf A109 Orangeleaf A110 **Oakleaf Class** (AOT): Oakleaf A111	4	None None
Small Fleet Tankers (RFA) **Rover Class** (AOL): Grey Rover A269 Gold Rover A271 Black Rover A273	3	None
Aviation Training Ship (RFA) Argus A135	1	
Fleet Replenishment Ships (RFA) **Fort Grange Class** (AFS): Fort Rosalie A385 Fort Austin A386 **Fort Victoria Class** (AOR): Fort Victoria A387	4	None None

Fort George A388		
Transport Ro-ro (RFA) Sea Crusader A96 Sea Centurion A98	2	None
TOTAL	**141 (1)**	

RFA= Royal Fleet Auxiliary Service
The RFA are civilian manned under the command of the Commander in Chief Fleet from 1 April 1993. Its main task is to supply warships at sea with fuel, food, stores and ammunition. It also provides aviation platforms, amphibious support for the Navy and Marines, and sea transport for Army units. All ships take part in operational sea training. An order in council on 30 November 1989 changed the status of the RFA service to government-owned vessels on non-commercial service.

Source: Sharpe 2000.

The MOD utilise the Hebrides for a variety of activities, from training and research to just 'passing through'. Activities include: Joint Maritime Courses (JMC), submarine testing and exercises, torpedo testing, missile firing on South Uist, and general presence in the area. The region also houses the MOD British Underwater Test and Evaluation Centre (BUTEC) which is situated near the Kyle of Lochalsh, and test centres for DERA - the Defence Evaluation and Research Agency.

For military purposes the marine environment off the west coast of Scotland is divided into 81 sections, known as Scottish Exercise Areas (SXA) as shown in Figure 2 (MOD/FOSNNI Operations, pers. comm.).

3.6 2: *Scottish Exercise Areas within the Hebrides*

Source: MOD FOSNNI Operations

Within the SXA Naval Vessels use acoustic devices such as echo sounders and relying principally on passive sonar systems. Anti-submarine serials are conducted for the most part in the very deep water in the Atlantic (MOD/FOSNNI Operations, pers. comm.). The Navy is unable to divulge specific frequencies used by active sonar equipment, as this is highly confidential. The publication 'Jane's Fighting ships' (Sharpe, 2000) provides an understanding of the capabilities of systems carried in modern warships and submarines – refer Table 3.6.

3.6.1 *Joint Maritime Courses*

Joint Maritime Courses (JMC) have been conducted three times per year, since 1946 (MOD/FOSNNI Operations, pers. comm.). Some activity takes place in the coastal waters off the western coast, including the seas of the Hebrides and the Minches. The majority of the anti-submarine and anti-air warfare serials are conducted to the North and West of Scotland out in the Atlantic at depths of 1,000 metres plus (MOD/FOSNNI Operations, pers. comm.). The JMC often involves not only RN vessels, but also NATO, Table 3.6.1 gives the dates for JMC activities over the last twelve years.

Table 3.6.1: *Joint Maritime Courses (JMC) dates*

Year		Dates:	Year		Dates:
2000	1.	25 February – 12 March	**1994**	1.	18 February – 07 March
	2.	02 – 18 June		2.	10 – 27 June
				3.	21 October – 07 November
1999	1.	19 February – 05 March	**1993**	1.	05 – 22 February
	2.	04 – 21 June		2.	03 – 21 June
	3.	10 – 19 September		3.	29 October – 15 November
1998	1.	13 February – 02 March	**1992**	1.	07 – 24 February
	2.	12 – 29 June		2.	29 May – 15 June
	3.	23 October – 09 November		3.	30 October – 16 November
1997	1.	24 February – 10 March	**1991**	1.	15 – 28 January
	2.	06 – 23 June		2.	29 May – 08 June
	3.	27 October – 10 November		3.	08 – 25 November
1996	1.	16 February – 04 March	**1990**	1.	09 – 26 February
	2.	07 – 24 June		2.	15 June – 02 July
	3.	28 October – 11 November		3.	02 – 19 November
1995	1.	03 – 20 February	**1989**	1.	03 – 20 February
	2.	26 May – 12 June		2.	16 June – 03 July
	3.	20 October – 06 November		3.	10 – 27 November

Source: MOD/FOSNNI Operations, pers. comm.

The JMC not only represents an increased number of vessels in the areas, it also incorporates several of the identified military activities within the Hebrides.

3.6.2 *Military Traffic*

As discussed previously, usage by the RN varies throughout the year with no strict pattern. Vessels are provided with various guidelines; with regard to cetaceans each vessel is provided with 'Guidelines for Minimising Disturbance to Cetaceans', refer Appendix 6. Vessels also receive a copy of the Department of Environment Transport and Regions (DETR) booklet and card which relate to cetacean disturbance.

Vessel noise is another factor of their presence; modern military vessels by nature are designed to be as quiet and unobtrusive as possible to ensure that enemy bodies are unable to identify their location (MOD/SSA pers. Com,). Although older vessels, vessels not involved in warfare and large ship operating at high speed are likely to be noisy (Richardson, 1995).

3.6.3 *Submarine Usage*

Submarine exercise areas exist in and around the waters of the Hebrides, activities include: search and rescue, testing, and warfare techniques which may entail tracking 'enemy' vessels and playing 'cat and mouse' (Harrison, pers. comm.). For much of the time submarines and surface vessels rely on passive sonar, as active sonar is tactically of little benefit. Submarines use passive sonar to interpret what is 'out there' (MOD(A) HQ, pers. comm.), sitting static for up to 12 hours listening to the 'signatures' of other vessels. Identifying the sounds (or signatures) of vessels, cetaceans and other marine noises enables the MOD to distinguish sounds for future reference.

3.6.4 *High Frequency Mine Hunting*

Takes place for 3-4 days of the JMC.

3.6.5 *Aircraft Carriers*

Take part in the JMC, mainly operating in deeper, offshore waters, but are sometimes within the Minches (MOD/FOSNNI Operations, pers. comm.).

3.6.6 *Live Firing*

All live firing serials conducted by naval forces are carried out by surface ships and are only permitted in certain areas located in the southern approaches to the Firth of Clyde, Cape Wrath (~70 days per year) and to the east of the Firth of Forth. Any live firing within the waters of the Hebrides is conducted from vessel - towards land targets. Any other firing exercises onshore are conducted using blank ammunition (MOD(A) HQ, pers. comm.).

3.6.7 *Underwater Explosives*

Underwater weapons are not detonated within the SXA other than old ordnance discovered by Coast Guard, fishermen, and others; these are made safe by Naval Explosive Ordnance Disposal (EOD) teams or Royal Navy Mine Countermeasures Vessels (MCMV) (MOD/FOSNNI Operations, pers. comm.).

3.6.8 *Re-fuelling Station*

There is a fuelling station at Loch Ewe.

3.6.9 *Torpedo Range*

Waters adjacent to BUTEC are used as a torpedo testing rage, the area is protected and constantly monitored by UK Hydrographic Office (DERA, pers. comm.). Torpedoes are programmed with the signature of the target, which they then silently track down (Harrison, pers. comm.).

3.7 MOD RESEARCH

3.7.1 *Defence Evaluation and Research Agency (DERA)*

DERA is an agency of the UK Ministry of Defence (MOD), incorporating the bulk of the MOD’s non-nuclear research, technology and test evaluation establishments. It offers a range of services from, operational studies and analysis, applied research, through to consultancy advice on the procurement process and the test and evaluation of specific equipment in both the development and operational phase. Test facilities include indoor and outdoor ranges for weapon effectiveness trials, underwater target ranges and marine testing facilities (DERA, 2000).

As part of DERA’s testing regimes for acoustic ranging (control of noise signature) it requires the use of topographically favourable acoustic measurement ranges which are subject to low ambient noise. Two deep Scottish lochs meet the criteria because of their soft, low reflectivity seabed and sheltered position from distant noise:

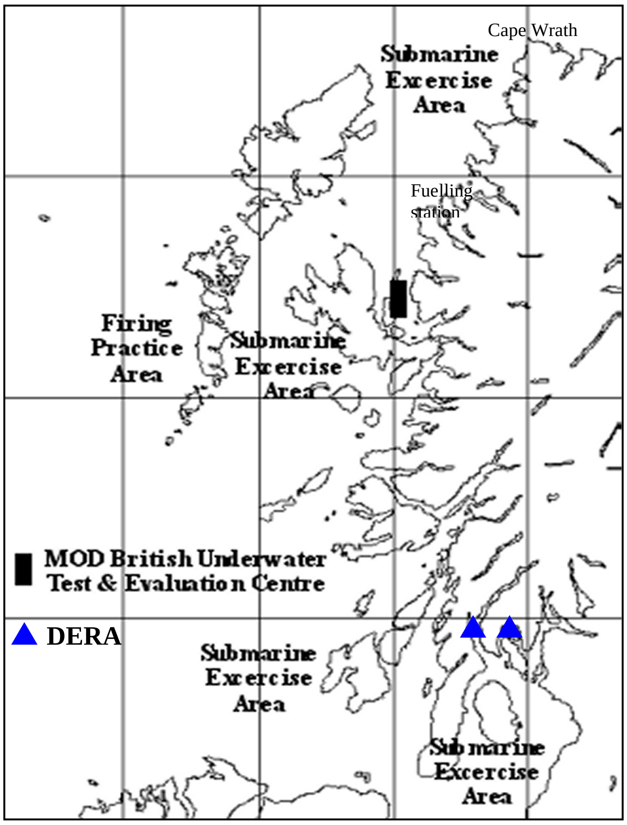
- Loch Goil - 8km long, and 80m deep is used for static trials,
- Loch Fyne – 140m deep, is used as a dynamic range.

DERA state that the lochs are 'the world's foremost facilities for measuring radiated noise'. The lochs are used to trial surface ships and submarines while static and at speed. Static trials, with ships or submarines moored to buoys, enable the acoustic contributions of particular machinery systems to be assessed. Facilities also permit full assessments of active and passive sonar, including their effectiveness against specific targets (DERA, 2000).

Access to the deepest usable waters around the UK off the Scottish islands, allows for trials on fast, deep diving nuclear submarines; submerged vessels can be run at speeds and depth. Trials may also involve surface ships, which have no manoeuvring limitations within the 10km by 2km range area.

Figure 3 identifies areas used by the MOD within the Hebrides region.

Figure 3: *Military Presence in the Hebrdes*



Source: Shrimpton, 1999.

3.8 SUMMARY

This chapter has identified and reviewed relevant literature and background information regarding the issue, providing a picture of the Hebrides, encompassing both the scope of military activities and, giving an insight to the variety of cetaceans that utilise the waters. Despite the historical presence of the military in the Hebrides, changes in attitudes, technologies and economic activities coupled with a greater understanding of the marine environment have all aided in identifying possible areas of conflict.

4. ANALYSIS OF THE POTENTIAL IMPACTS OF MILITARY ACTIVITIES ON CETACEANS

The presence of the RN in the Hebrides has the potential to place impacts on cetaceans in a variety of ways, from direct actions, as discussed below in Table 4, to associated or indirect impacts that may arise. This chapter will examine the array of associated impacts that may have the potential to harm cetacean populations, looking in particular at MOD(N) policy and its implementation of the legislative frameworks through which it address these issues.

Table 4: *Potential Impacts to Cetaceans from Military Presence*

Direct Impacts
Military Traffic
• **Physical Disturbance:** The presence of vessels may cause cetaceans to move from that area, possibly upsetting feeding and behavioural patterns. There is little data regarding reactions to repeated disturbance, however some mysticetes have shown reductions in use of some areas of heavy marine traffic and other human activities (Richardson & Würsig, 1996).
• **Collision:** Has the potential to cause death or injury, especially in areas of high marine traffic density (Parsons & Jefferson, 2000).   To date there have been no reports of cetacean collisions, however, badly cut dorsal fins on a Risso's and Common dolphin have been observed and may be attributed to propeller damage (Shrimpton, 1999). Although it is not uncommon for some species to approach vessels.
• **Vessel Noise:** All vessels produce underwater noise, a major contributor to the overall background noise in the oceans; produced by propeller cavitation, propeller singing, and propulsion or other machinery. These sounds are a combination of narrowband 'tonal' sounds at specific frequencies and 'broadband' sounds with energy spread continuously over a range of frequencies (Richardson, 1995). This range of noise may have the potential to negatively effect cetaceans in a variety of ways – refer Table 3.3.4, reactions to vessel noise vary depending on species and the type of noise (Richardson & Würsig, 1996).
• **Vessel Coatings:** Tributyltin (TBT) is a constituent of many anti-fouling and anti-corrosive paints that are applied to the hulls of vessels. The MOD no longer uses paints that contain TBT. Those older vessels, which had previously been treated with paint containing TBT, have since been re-painted - sealing in the old paint until suitable means of disposal are established (MOD/ Environment Policy. Pers. comm.). This is one of the many research areas of DERA.
• **Vessel Ballast:** Ballast water is removed to compensated tanks, to later be discharged into a collection barge, from where it is taken ashore for processing (MOD/SSA, pers. comm.).

Submarine Usage • **Marine Traffic:** As above. • **Sonar:** Types and frequencies vary considerably, as highlighted earlier, passive sonar is predominantly used in the Hebrides, active sonars, have the potential to disrupt cetaceans. It has been suggested that echo-sounders and side-scan sonar could disrupt the echolocation of smaller cetaceans (Irish, 1996). **Note:** Table 3.6 lists some RN vessels which are expected to be fitted with active low frequency sonar in 2004, this will be subject to research (MOD Environment Policy pers. comm.) • **LFAS:** LFAS is not used in the waters of the Hebrides by the RN or NATO (MOD/FOSNNI Operations, pers. comm.).
Aircraft Carriers • **Aircraft:** Sound energy is generally transmitted poorly from air to water, although, low-flying fixed-wing aircraft and helicopter have the potential to cause acoustic disturbance (Irish, 1996).
High Frequency Mine Hunting • **Refer - sonar.** • Mine sweeping cable does not get retrieved from the seabed (MOD/SSA, pers. comm.) – this has the potential to entangle and injure cetaceans.
Live Firing • Has the potential to inflict direct physical damage to cetaceans, while also producing a substantial amount of noise of broadband frequencies at source levels in excess of 270dB. These sound source types have the capability of causing disturbance, but also auditory damage to cetaceans within several kilometres from the source point (Parsons *et al.*, 2001). The regions identified are areas of high cetacean abundance.
Underwater Explosives • Any underwater explosion would be harmful to marine life causing possible physical injury, yet again there is the potential of trauma from an explosion and via the noise generated from it (Richardson, 1995).

Torpedo Range

- The torpedo testing area is an important habitat for cetaceans, notably the northern bottlenose whale and the harbour porpoise, torpedoes have the potential to disturb and possibly injure these animals (Parsons et al, 2000). It was reported in the book 'Anti-Submarine Warfare' (Gardner, 1996:52), that during the British – Argentinean conflict, 1982 a high expenditure of ASW ordnance, resulted in no sunken vessels "…but it has been reported that a number of whales were attacked by torpedoes and depth chargers". This was obviously in an area of high conflict, but it is unclear whether the cetaceans were caught 'accidentally' in the path of these weapons or whether acoustics (signature type) played a part!

Re-fuelling Station at Loch Ewe

- Possible potential of oil spills, accidental spillage.

The effects of hydrocarbons on the marine environment depend on several factors such as: type of hydrocarbon (toxicity), weather conditions, and sea-state. However, the potential impacts on cetaceans are in the form of inhalation, ingestion, and direct contact:

Inhalation: may result in lethargy, intoxication, and irritation of the respiratory membrane,

Ingestion: cetaceans are thought to effectively metabolise hydrocarbons, although they are toxic to many mammals,

Direct contact: little impact observed other than slight behavioural changes in some species, although there is a lack of data regarding the toxic and long term effects of chronic oil pollution (Shrimpton, 1999).

All MOD vessels carry and are trained to use oil clean-up equipment.

4.1 ASSOCIATED IMPACTS

To establish a greater understanding of the potential impacts of military presence the associated or indirect impacts will be examined. For example a variety of pollutants are introduced to the marine environment via many sources including atmospheric inputs and discharges from marine vessels. Organochlorines have for example become ubiquitous throughout the marine environment; other potential pollutants include pathogens, hydrocarbons and marine debris. These may have the potential to injure, cause sickness or result in the death of cetaceans.

This section will address MOD(N) policy and the legislative framework through which it regulates and implements the necessary actions to ensure compliance with regional, national and international stipulations. The MOD is very much aware of issues concerning the maritime environment and to ensure compliance, vessels and crew are provided with the appropriate information, training and guidelines.

4.2 AIR POLLUTION

There are several sources of air emissions from naval vessels - these include exhausts from incinerators, boilers, aircraft, propulsion plant, generators and auxiliary machinery. The MOD expect that the emissions would be largely controlled by equipment design. For the UK the 1993 Clean Air Act regulated the discharge of dark smoke from any source, along with any form of smoke, grit, dust or fumes from furnaces. The Act also allows local authorities to declare smoke control areas.

4.2.1 *Boiler and Funnel Emissions*

Relevant Legislation
UK - vessels within the seaward limits of UK territorial waters and within waters which are not navigable to sea going ships**:** • Clean Air Act (1993) Section 2 – regulates the emissions of dark smoke. **International Waters:** • Arrangements with international treaties prevail, principally MARPOL 73/78.

Source: DNES 1994 & Draft 1999.

The RN requires that dark smoke is not emitted from the funnel, except during lighting up. The MOD recognises that it is imperative that equipment is well maintained and that Port Guides of relevant national legislation is fully understood.

4.2.2 *Incineration*

Relevant Legislation
• Food & Environment Protection Act 1985 Part II which complies with the requirements of the Oslo & London Conventions on Dumping; • Environmental Protection Act 1990 (EPA 90); • MARPOL 73/78 Annex V; • National Legislation.

Source: DNES - Draft 1999.

RN Policy is based on the premises that incineration of waste at sea will gradually be phased out. At present the MOD reiterates that permission may be required from port authority prior to incinerating waste in either a port or within territorial waters.

MOD(N) vessels do not require licences to operate on-board incineration equipment for the purpose of processing general waste produced on-board. Special precautions are required for the incineration of hazardous wastes. Ashes produced from incineration that may contain heavy metals, and residues defined as toxic, should not be discharged at sea (DNES, 1999).

4.2.3 *Ozone Depleting Substances*

Relevant Legislation
• EC Regulation 594/91; • EC Regulation 3093/94 - implements the Montreal Protocol; • EPA 990; • Environmental Protection (Controls on Substances that Deplete the Ozone Layer) Regulations 1996; • Montreal Protocol on Substances that Deplete the Ozone Layer.

Source: DNES - Draft 1999.

The production and import of new CFCs in the EU was banned from the beginning of 1995; new supplies of HCFCS are to be completely phased out by 2015, a date likely to be brought forward (DNES, 1999).

The Montreal Protocol is implemented by EC Regulation; although the provisions of the EC Regulation apply directly to UK law, some aspects have been implemented in the UK by the Environmental Protection Regulations 1996. The RN policy is to comply with these Regulations which set down the phase out deadlines for the production and consumption (not use) of ozone depleting substances. The RN has established an essential use status/bank facility for certain applications of these controlled substances, until a time when suitable alternatives can be found (DNES, 1999).

Table 4.2.3: *The Phase Out Programme*

SUBSTANCE	**PHASE OUT SCHEDULE** - EC Regulation 3952/92 -
Chlorofluorocarbon (CFCs)	**Phase out by 01:01:1995**
Carbon tetrachloride	**Phase out by 01:01:1995**
Halons	**Phase out by 01:01:1995**
1,1,1 Trichloroethan	**Phase out by 01:01:1996**
Hydrochlorofluorocarbons (HCFCs)	Freeze at 1989 levels of HCFCs & at 2.6% of the 1989 levels for CFCs from 01:01:1995. **Phase out by 2015**
Hydrobromofluorocarbons (HBFCs)	**Phase out by 01:01:1996**
Methyl bromide	**25% cut on 1991 levels by 01:01:1998**

Note: Phase out refers to manufacture of the substance.

Source: DNES - Draft 1999.

Section 33 of the EPA sets down conditions classifying ozone depleting substances as controlled waste and therefore suitably licensed facilities should be used. The RN is to follow appropriate waste disposal procedures.

4.2.4 *Aircraft Emissions*

Relevant Legislation
• The air Navigation (Aircraft & Aircraft Engine Emissions) Order 1986; • The Air Navigation (Aeroplane & Aeroplane Engine Emission of unburned hydrocarbons) Order 1988.

Note: Control on emissions is exercised through the Convention on International Civil Aviation administered by the International Civil Aviation Organisation (ICAO), Montreal, Canada.

Source: DNES 1994.

Annex 16 of the Convention sets down international standards and recommended practices for environmental protection. Additionally, the Aircraft Engine Emissions (1990) document contains prescribed particulars for aircraft engine emissions and rules relating to vented fuel and emissions certification.

There is no Crown immunity from the Air Navigation Orders; however, military aircraft are exempt; refer to Military Flying Regulations (DNES, 1994).

4.3 LIQUID EFFLUENT DISCHARGES

4.3.1 *Oil and Mixtures*

Relevant Legislation
Of most relevance within 3nm of the shore and in harbour: • WRA 91; • EA 95; • Food and Environmental Protection Act 1985; • EPA 90, Schedule 14.
Of most relevance at sea >3nm from shore: • Prevention of Oil Pollution Act 1971; • Merchant Shipping Acts 1971, 1974, 1979, 1988, & 1995; • Merchant Shipping (Prevention of Oil Pollution) regulations 1983 prepared under the remit of MARPOL 73/78; • Merchant Shipping (Dangerous or Noxious Liquid Substances in Bulk) Regulations 1996; • Merchant Shipping (Prevention of Oil Pollution) Regulations 1996; • Oil in Navigable Waters (Records) Regulations 1972 &19996.
International legislation includes: • London Convention on Dumping in the Sea 1972;

- International Convention for the Prevention of Pollution from Ships (MARPOL) 73/78, Annex 1.

Source: DNES - Draft 1999.

Under the Prevention of Oil Pollution Act 1971, it is an offence to contaminate navigable waters anywhere within the UK territorial waters. MOD vessels are exempt from this legislation, but it is MOD policy to comply at all times unless operational requirements would be unacceptably affected. The MOD comply with MARPOL 73/78 - Annex 1, which makes it an offence to contaminate UK territorial waters, therefore spill clearing training is undertaken and the appropriate equipment is available on RN vessels (DNES, 1999).

It is a requirement of all Royal Fleet Auxiliary's (RFAs) that an 'Oil Pollution Prevention' Certificate, an Oil Emergency Plan and an Oil Record Book are maintained within accordance with MARPOL; warships will also carry an Oil Pollution Emergency Plan (DNES, 1999).

In addition, it is MOD policy to deal with MOD generated oil pollution and oil pollution in waters under their control from non-MOD sources and to ensure that risk of oil spillage into MOD waters is minimised (DNES, 1999). MOD is also responsible for cleaning shorelines of MOD owned or controlled land – without public access (Local Authorities are responsible for land with public access). The MOD has a contractor to deal with oil spills (DNES, 1999).

4.3.2 *Liquid Chemical Discharges*

Relevant Legislation

- Merchant Shipping (Dangerous & Noxious Liquid Substances in Bulk) Regulations (1996) – applies to tankers specifically;
- Merchant Shipping (Prevention & Control of Pollution) Order (1987 & 1990);
- Merchant Shipping (Dangerous Goods & Marine Pollutants) Regulations 1990 – entered force in January 1991;
- Dangerous Substances in Harbour Regulations (1987);
- MARPOL 73/78.

Note: Regulations are defined in MARPOL and include largely alkaline and acidic solutions. The IMO have developed guidelines for vessels. The BCH & IBC Codes, MEPC resolutions 40 & 41 provide the appropriate guidelines.

Source: DNES - Draft 1999.

The RN are required to conduct regular surveys of vessels and an International Oil Pollution Prevention Certificate for the Carriage of Noxious Liquid Substances in Bulk must be held for those vessels within defined categories. Vessels carry a Cargo Record Book to be maintained on a tank-to-tank basis. The MOD state that all procedures used meet the relevant MARPOL requirements, there are set down standards for the procedures and arrangements for carrying and the discharge of noxious substances (DNES, 1999).

4.3.3 *Sewage*

Relevant Legislation
Blackwater: • Sewage discharge is controlled under conditions within Annex IV of MARPOL 73/78. **MARPOL 73/78 discharge of sewage requirements:** a) Within 4nm of the coast – if an IMO certificated Sewage Treatment Plant is in operation, b) Between 4nm & 12nm of the coast – as above or if an IMO certificated system to comminute & disinfect the sewage is in operation, c) Over 12nm from the coast – no treatment necessary; • within harbours & dock areas controls are enforced by the relevant harbour authority (national variations exist).
Within the UK – ships operating alongside, in harbour or in controlled waters within 3 mile limit: • EA 95; • COPA 74; • WRA 91.
Greywater (dishwater, showers, laundry etc.)**:** • Some nations have introduced specific restrictions preventing the discharge of grey waters in ports – the MOD have developed & installed removal equipment on board vessels.

Source: DNES - Draft 1999.

At present a typical RN vessels (Type 23 / ~180 persons) can hold up to 7 days worth of black-water treated sewage, vessels avoid discharging sewage at sea when possible. If the vessel is at sea longer than 7 days a tanker may collect the sewage for land treatment and/or disposal (DERA pers. comm. 2000).

4.4 WASTE DISPOSAL

In the past disposal of land and ship waste at sea has been seen as an acceptable practice; this is becoming increasingly restricted by legislation and obligations under international conventions (DNES, 1999).

The majority of the waste generated by the RN is controlled waste rather than special waste.

Table 4.4: *Waste Categories*

Garbage Category	**All Ships* Outside Special Areas**	**All Ships* Inside Special Areas****	**Within 500m of Offshore Platforms & Ships**
Category 1: Plastics - includes synthetic ropes, fishing nets & plastic garbage bags	**PROHIBITED**	**PROHIBITED**	**PROHIBITED**
Category 2: Dunnage, lining & packaging materials that will float.	**PROHIBITED** **Unless** >25nm offshore	**PROHIBITED**	**PROHIBITED**
Category 3: Paper, glass, metal, bottles, rags, crockery & similar refuse which is comminuted or ground.	**PROHIBITED** **Unless** >2nm offshore	**PROHIBITED**	**PROHIBITED**
Category 4: Paper, glass, metal, bottles, rags, crockery & similar refuse which is **not** comminuted or ground.	**PROHIBITED** **Unless** >12nm offshore	**PROHIBITED**	**PROHIBITED**
Category 5: Food wastes **not** comminuted or ground. Food wastes comminuted or ground***.	**PROHIBITED** **Unless** 2nm offshore **PROHIBITED** **Unless** >3nm offshore	**PROHIBITED** **Unless** >12nm offshore **PROHIBITED** **Unless** >3nm offshore inside Wider Caribbean region only; >12nm offshore for all other Special Areas	**PROHIBITED** **PROHIBITED** **Unless** >12nm offshore
Category 6: Incinerator ash - if **no** residue grater than 25mm. Incinerator ash - if residue grater than 25mm.	**PROHIBITED** **Unless** >3nm offshore **PROHIBITED** **Unless** >12nm offshore	**PROHIBITED** **PROHIBITED**	**PROHIBITED** **PROHIBITED**
Other: Mixed refuse types.	The more stringent requirements apply.	The more stringent requirements apply.	The more stringent requirements apply.

Note: * Discharge of garbage to the sea is permitted when necessary to secure safety of the ship or those on board or saving life at sea or from damage to the ship or equipment.

** Special Areas include: Mediterranean Sea, Baltic Sea, Black Sea, The "Gulfs" area, North Sea, Antarctic and the Wider Caribbean Area.

*** Comminuted or ground garbage shall be capable of passing through a 25mm screen.

Source: DNES - Draft 1999.

Guidance on these issues is provided to all vessels, for quick, decisive information, crew refer to a 'Prevention of Pollution at Sea' chart.

4.4.1 *Garbage*

Relevant Legislation
Marine pollution legislation in the UK includes: • MARPOL 73/78 Annex V – significant discharge restrictions which came into force on 31:12:1988 can be seen in Table 4.4; • Food & Environment Protection Act 1985 Part II (as amended by Part II of EPA 90); • Transfrontier Shipment of Waste Regulations 1994; • Merchant Shipping Act 1995; • Merchant Shipping (Prevention of Pollution by Garbage) Regulations 1998.

Source: DNES - Draft 1999.

The types of waste classified as garbage within MARPOL and the Merchant Shipping Regulations 1998 include domestic and operational waste (not that defined as hazardous), also included are ash and clinker from shipboard incinerators and coal fired boilers as long as they do not contain heavy metals or toxic components (DNES, 1999).

RN policy is that where possible garbage should be retained on board for disposal to shore reception facilities. Waste that is disposed at sea, should be in waters greater than 50m to prevent possible wave and tidal damage. MARPOL 73/78 Annex V Regulation 9 requires that vessels over 12m long must display placards to notify passengers and crew of disposal requirements. Regulation 9 also stipulates that vessels of or greater than 400 gross registered tonnes – certified to carry 15+ people, and every fixed or floating installation must carry a Garbage Management Plan (GMP) (DNES, 1999).

Rubbish (non-food waste) is segregated at sea; plastics are melted down to form a ‘plastic slug’, non-plastic materials are shredded and discharged at sea or go to landfill (MOD/SSA pers. comm.).

4.4.2 *Industrial and Hazardous Waste*

Relevant Legislation
Main legislation covering industrial & hazardous waste at sea: • Food and Environment Protection Act 1985; • Environmental Protection (Duty of Care) Regulations 1991; • Merchant Shipping Act 1995; • Special Waste Regulations 1996; • Merchant Shipping (Prevention of Oil Pollution) Regulations 1996.

Source: DNES - Draft 1999.

Industrial Waste: The MOD defines industrial wastes as oil and oily waters, greywaters, and sanitary wastes.

Hazardous Waste: Definition includes waste containing substances such as chromium compounds or possess toxic, corrosive or flammable properties, including clinical waste. Hazardous waste disposal at sea – including ports and harbours is prohibited by MARPOL 73/78, various conventions, and domestic legislation (DNES, 1999).

Under the Oslo and London Dumping Conventions, the sea dumping of hazardous and industrial wastes and ammunition ceased at the end of 1992. The dumping of radioactive waste and incineration at sea was banned under the 1972 London Convention (DNES, 1999).

It is MOD policy that 'no industrial waste, ammunition or pyrotechnics will be dumped at sea' (DNES, 1999). Hazardous waste is to be held on board ship until appropriate onshore waste disposal facilities are available.

4.4.3 *Transfrontier Shipment of Hazardous Substances*

Relevant Legislation
• Merchant Shipping (Tankers) (EEC Requirements) Regulations 1981 – as amended in 1882; • Merchant Shipping (Dangerous or Noxious Liquid Substances in Bulk) Regulations 1996 - + amended Regulations 1998.

Source: DNES - Draft 1999.

EC legislation controls the sea transport of dangerous and polluting goods by oil, gas and chemical tankers; it is implemented in the UK through the Merchant Shipping (Tankers) (EEC Requirements) Regulations 1981, as amended in 1882. The Regulations relate to sea going tankers entering or leaving Community ports; all tankers of 1600 gross registered tonnes +, that are carrying or have carried such goods.

MOD(N) vessels must specify all relevant information detailing the vessel and its cargo; appropriate certification, where required must be obtained. Harbour masters must be notified where necessary.

4.5 SUMMARY

This chapter has identified a wide range of threats posed to cetaceans from anthropogenic sources, not all of them related strictly to the military, but encompass a variety of maritime users.

The chapter identifies how important legislative frameworks are in implementing change and environmental protection; organisations such as the MOD can not afford to take these regulations lightly and are therefore often at the forefront in facilitating compliance. This highlights the importance of legislative protection for cetaceans and the way forward in securing their existence in waters such as that of the Hebrides.

5. CONCLUSION AND RECOMMENDATIONS

The uniqueness of the Hebrides as an important cetacean habitat and recognised location for military research and exercise, along with a growing tourism industry, and conservation interests has inevitably resulted in some degree of conflict.

This dissertation, through a comprehensive literature review, discussion and meetings with MOD personnel, HWDT and others, has acknowledged the range of potential impacts the military may pose on cetacean populations.

In the past the military has been able to move and operate with relative freedom within the Hebrides without little reported incident. However, increased tourism and recreational use of remote areas like the Hebrides coupled with growing environmental understanding and awareness, brings issues to the forefront. Growth in tourism in the Hebrides is dictating changes in the local economy, bringing income to the area and for its inhabitants a reliance on the tourism trade. Consequently issues relating to possible impacts due to military presence, as highlighted by the HWDT in reports received from tour operators, indicating a fall in cetacean numbers - coinciding with JMC activities, are raised and must be addressed.

The possibility of links between naval activities and a drop in cetacean sightings, for example, during JMC, may be credible, but there is no strong evidence to support these observations. Further more a possible cause of conflict with the military may be attributed to the actuality that they are recognised as an ‘easy target’ at which to direct anger and frustration. The MOD are not unfamiliar with this concept and are committed to building a positive image through innovative public relations, for example: open days, attending public events and by making the MOD more accessible through vehicles such as the world-wide-web.

In establishing greater public perception the MOD are aware that their remit for pioneering new technologies and programmes may facilitate the ‘positive image’ process, while leading the way and often surpassing legislative requirements. Examples of MOD research and development are discussed in the following section. It can be hoped that these new technologies and developments will contribute positively to conservation issues.

5.1 CURRENT MOD RESEARCH AND OBJECTIVES

5.1.1 *Ship Support Agency (SSA)*

Another arm of the DLO is the SSA, which is responsible for several fields, including the development of pollution control equipment. One of the main aims of SSA is to work in accordance with MARPOL 73/78 Regulations and other relevant legislation to produce the Environmentally Sound Warship Design (ESWD). SSA's goal is to 'enable sustained unrestricted world-wide operations including port access, littoral areas, MARPOL special and restricted areas, free from constraints of national or international environmental legislation' (MOD/SSA pers. comm.). To achieve the set goals SSA is developing an integrated waste treatment system, this requires the identification and assessment of potential technologies, both existing and new. The SSA aim to have an environmentally compliant fleet by 2005, with an environmentally sound design established for new ships entering service by 2015.

The SSA is aware that Greenpeace have launched a campaign for the UK government to apply the EU Habitats Directive up to 200nm from shore (http://www.greenpeace.org.uk, 2000), this may have implications on present legislative requirements and may require a review of current practices (MOD/SSA, pers. comm.).

5.1.2 *DERA – sewage system design*

A majority of technological development for the MOD is conducted by DERA, an example of this is currently being undertaken by the Environmental Science Department, which has for the past 18 months, evaluated and conducted research into waste treatment systems suitable for RN vessels. This is in compliance with MARPOL 73/78 Regulations and the anticipated MARPOL 73/78 year 2005 guidelines.

Evaluation of the RN's waste stream and identification of suitable technologies (COTS – commercially available technology) has resulted in the construction of a life-sized technical demonstrator, using submerged bio-membrane technology, which will require little manpower or maintenance and can be incorporated into the existing system. The prototype is suitable for installation onto a Type 23 Frigate (commonly used RN vessel), fitting into a space of about $3m^3$. The system has undergone successful land-based trials and is soon to be tested at sea.

The system is designed to deal with 30m^3 (a crew of around 180 individuals) of a combined influent of black and grey water per day and to endure 45 days between de-sludging.

At present the prototype has reached all proposed goals and beyond – possibly reaching the proposed MARPOL 73/78 year 2015 guidelines (half of the 2005 requirements). RN vessels generally receive a re-fit every five years – it is hoped that the new system will be installed where possible as part of this.

Further research goals for DERA include:

- identification/development of system friendly cleaning products (i.e. less foaming, eco-friendly products);
- feasibility of including additional waste streams;
- incorporation of the design into integrated waste handling system i.e. to handle mashed food waste;
- adapting the system to fit all vessels, including submarines.

The research is funded and therefore owned by the MOD (DERA, pers. comm.).

5.1.3 *MOD Environmental Impact Assessment*

The European Community introduced the requirement for the Environmental Impact Assessment (EIA) for major land based projects through EC Directive in 1985 (EU Directive 85/337 EEC 1985), revised in 1997 (EU Directive 97/11 EC 1997), which was introduced into UK legislation in 1999 (MOD/Environment Policy, pers. comm.). Despite exemption of military projects and activities from this legislation, MOD Environmental Statement 'ensures compliance with the letter and spirit of…environmental legislation' (DLO/EIAPM, 1999).

In accordance the Defence Estates (DE) are developing EIA and Environmental impact Statement (EIS) guidelines to apply to major land based projects only. However, it was observed that this did not 'reflect the uniqueness of the maritime domain'. In response MOD Director Safety in conjunction with DERA have developed an EIA Process Model (EIAPM) that will be suitable for all types of assessment need, using the 'best practice' approach (DLO/EIAPM, 1999).

The introduction of the EIAPM is seen as a key element in identifying those Service activities that may have a significant impact on the environment and therefore by implication require formal mitigation measures to be instigated. The paper provides a three-tier EIAPM that includes an Environmental Impact Scoping Study (EISS), an EIA and EIS; this covers the process from the initial proposal through to the final decision (mitigation measures of or the issuing of an environmental statement).

The EIAPM is intended to apply to all Service activities whether, ashore, afloat, or in the air. It will cover the six main stages of MOD business:

- Concept
- Assessment
- Demonstration
- Manufacture
- In-service
- Disposal.

The aim is that the EIAPM will be an aid in environmental decision making, raising issues such as: economic verses environmental considerations, long-term sustainability of actions and the implications of actions to be taken (DLO/EIAPM, 1999).

5.1.4 *UK Hydrographic Office*

The UK Hydrographic Office (HO), Maritime Environment Information Centre is compiling a data base of marine information, oceanographic data is collected by RN survey vessels. In addition the HO is cataloguing 'Marine Life Reports' of all types, including cetacean sightings/occurrences. The HO obtains cetacean data from a variety of sources, from agencies such as the Meteorological Office, to observations by merchant vessels. Within the MOD(N) the HO is keen to encourage information gathering by crew members, and would like to see marine life reports made an obligatory function when and where possible (HO, pers. comm.).

At present all vessels are provided with Marine Life Report forms and cetacean Identification Guides. The report form requests information such as: location, description, and number of animals; the HO is aware of the difficulties in collecting this information and encourages reports, however detailed.

Collected information is put onto a 'Grided Physical Properties Database', with a 1° grid, which allows the HO to pull together potential and actual data for given locations. This allows them to produce among other things, 'probability' information, i.e. probable species occurrence in a given location – for example; knowledge of cetacean abundance may be useful for acoustic purposes to submarines. The HO is conscious of validity downfalls, factors such as 'effort', accuracy and participant knowledge; data are categorised where possible. Collected data have allowed the HO to make observations such as – tiger sharks prefer to frequent a certain water mass type and salinity (HO, pers. comm.).

The HO is enthusiastic to obtain and share as much data as is possible, although restrictions may apply due to MOD confidentiality.

5.2 FURTHER CONCERNS

5.2.1 *Cetacean Research*

Despite an increase in cetacean research, generally little is know about most species (Cooke, 19991). There are logistical constraints on the estimation of abundance and no feasible level of monitoring to detect changes in populations. Furthermore, the majority of existing research only addresses short-term behavioural changes, with a lack of understanding of long-term impacts. This is especially the case with acoustic issues, particularly anthropogenic sound and its potential to affect behaviour, well-being, reproduction and overall fitness of individuals and the health of populations (Würsig & Evans, 2000). As discussed by Würsig and Evans (2000), cetaceans can mitigate against noise disturbance by displacing themselves from the sources, but this is not always a possibility or an ideal resolution to the problem. If moving is an option for the animal, in areas like the Hebrides this could have negative outcomes for the residents that rely financially on industries such as whale-watching.

The most rational way froward appears to be a reduction of anthropogenic noise allowing both sensible practices and policies that benefit all. Richardson and Würsig

(1995) outline changes in technologies, responsible behaviour, education and enforcement as tools to address this issue.

5.2.2 *Marine Traffic*

The increase in tourism including, charter boats, recreation vessels and scheduled ferry's, all have the potential to impact Hebridean cetacean populations, many of which can not be distinguished from military inputs. However very little or anecdotal research exists, which does not allow for conclusive data to be drawn.

5.3 SUMMARY

In spite of the lack of baseline data there is a need to adopt the 'precautionary principle' to the Hebrides, due to its diversity and uniqueness. This will ensure that conservation of cetaceans is the prime objective of all users who have the potential to impact the area. It is for this reason that the paper makes the following recommendations:

1. **More Research:** The lack of baseline data limits the ability of agencies to make strong arguments and develop strategies for the conservation of cetaceans. Research needs to address the abundance of cetaceans, along with the potential impacts on the area as a whole – not merely from military presence. For example increases in tourism and associated businesses, such as whale-watching, need to be better understood. The MOD is currently initiating the collection of sightings data, but this needs to be validated through other scientific research methods and possibly opens the door to some form of collaborative work.

2. **Greater Communication:** A co-operative relationship is being established between the MOD and interested parties to address issues concerning the Hebrides. The MOD facilitated two meetings in November of 1998 and 1999. However, to maintain this line of communication and the goodwill of those involved, it is imperative that links are sustained and the forum does not lose momentum. Tour operators, private companies, such as fishermen and ferry operators should also take the opportunity to participate in the organised meetings.

This dissertation has encouraged positive links with the MOD, these needs to be reinforced by those parties concerned to develop and facilitate a greater degree of openness and willingness of information sharing.

ACRONYMS & ABBREVIATIONS

ASCOBANS	**Agreement on the Conservation of Small Cetaceans of the Baltic & North Seas**
dB	**Decibel**
CCW	**Countryside Council for Wales**
CITES	**Convention on trade in Endangered Species of Wild Fauna & Flora**
COPA	**Control of Pollution Act**
DE	**Defence Estates**
DERA	**Defence Evaluation and Research Agency**
DETR	**Department of the Environment, Transport & the Regions**
DLO	**Defence Logistics Organisation**
DNES	**Directorate of Naval Environment & Safety**
EC	**European Commission**
EHS	**Environment & Heritage Service (Northern Ireland)**
EIS	**Environmental Impact Statement**
EN	**English Nature**
EOD	**Explosive Ordnance Disposal**
ESWD	**Environmentally Sound Warship Design**
FOSNNI	**Office of the Flag Officer Scotland, Northern England & Northern Ireland**
HO	**UK Hydrographic Office**
HWDT	**Hebridean Whale & Dolphin Trust**
Hz	**Hertz**
IMO	**International Maritime Organisation**
JMC	**Joint Maritime Courses (Naval)**
JNCC	**Joint Nature Conservation Committee**
kHz	**Kilohertz**
MARPOL	**International Convention for the Prevention of Pollution from Ships**
MCMV	**Mine Countermeasures Vessel (Royal Navy)**
MEPC	**Marine Environment Protection Committee**
MOD	**Ministry of Defence**
NATO	**North Atlantic Treaty Organisation**
nm	**Nautical Miles**
RMAS	**Royal Maritime Auxiliary Services**
SNH	**Scottish Natural Heritage**
SSA	**Ship Support Agency**
SXA	**Scottish Exercise Areas**
WDCS	**Whale & Dolphin Conservation Society**
WRA	**Waste Regulatory Authority**

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APPENDIX 1

MOD FORUM MEETINGS

The following notes are taken from the minutes of the two forum meetings held between the MOD, HWDT, Scottish Natural Heritage and other parties on the 17th November 1998 and 19th November 1999 to discuss issues regarding the Hebrides, the RN and the variety of cetaceans that utilise the area.

Main points of meetings between MOD and other parties:

<u>Meeting – 17th November 1998:</u>

1. Consideration will be given by MOD(N)/RN to provide wider distribution of the JMC Bulletin – possibly to include distribution via Internet. In the meantime a hard copy provided to Scottish Natural Heritage (SNH).
   Non-Government Organisations (NGOs) to provide additional information for inclusion through MOD(N)/CESO(N).

2. MOD to discuss with FOSNNI Operations the feasibility of providing NGOs with Notices to Fishermen and other public notices of RN activity.

3. Suggested that it would be useful to have data in the JMC Bulletin relevant to sonar emission characteristics in shallow water of participating classes of surface warships, HM submarines and sonobuoys, applicable to the Hebridean littoral. MOD and DERA to investigate what is releasable to the Public Domain.

Post meeting: Sonar data not to be released due to security considerations.

4. The wildlife NGOs to provide MOD(N) Hydrographic Office comments on the format of the data-collecting sheet used by Her Majesties (HM) ships to report cetacean sightings, offering form modifications and guidance note texts to aid Service mariner-observers.

Post meeting: Comments on forms made at 1999 meeting.

5. Hydrographic Office to evaluate releasability to NGOs of access to their cetacean sightings database – possibility of data exchange.

6. SNH to provide MOD with names and addresses of other known interested NGOs.

7. CESO(N) to be provided with a list of ‘sensitive’ sea areas, detailing species and relevant geographic information – characteristic habitation areas/depths, known breeding and feeding areas, relevant species vulnerable sound frequency/ies.

8. CESO(N) to be provided with NGOs current ‘Codes of Practice’ document for release to HM vessels operating within sensitive areas.

Post meeting: RN ships issued with guidance notes on avoiding cetaceans.

<u>Meeting – 19th November 1999</u>

1. Recognition that positive PR is more effective in communicating actions of the RN.

2. Grid reference of areas the NGOs consider to be sensitive to be provided to MOD. This would allow the MOD to give better notice of activities and the scale.

3. List of 'sensitive' sea areas to be provided to the MOD, detailing species and relevant geographical information. This will allow the RN to take this into consideration where operationally possible. The HO were also asked to share similar information.

4. NGOs provided statistics that aimed to show the variance in cetacean sightings around times of naval exercise – more research needed.

5. Terms of reference for meetings were identified to address local Hebridean enviroemtnal issues and specific species.

6. MOD stated it could be mutually beneficial to set up some collaborative unclassified research between the NGOs and DERA.

7. Meeting closed with exchange of general information.

Summary

Although only two meetings have been held between the various parties to date, there appears to be a positive framework for developing stronger links. This is evident in the exchange of information and the willingness to look at solutions and alternatives. The next meeting is scheduled for the 16th November 2000, it appears that additional parties will be attending, such as the Whale and Dolphin Conservation Society (WDCS), this reinforces the importance of this forum. At this stage no formal agenda has been set, this needs to be done, to ensure all parties benefit from the meeting - if not, the risk may be that with no clear terms of reference or agenda the forum will lose momentum and fail to attain its original purpose.

APPENDIX 2

LOW FREQUENCY ACTIVE SONAR
AND THE US NAVY

Background

Without preparing an Environmental Impact Statement (EIS), initiating a formal consultation process, or securing permits pursuant to the Marine Mammal Protection Act (MMPA) or endangered Species Act (ESA), the US Navy committed to a development program for Low Frequency Active Sonar (LFAS), running tests in various locations of international waters. US Navy claims that laws do not apply in the Exclusive Economic Zone of foreign nations (EEZ). **This is a chronological list of events to date:**

1995: NRDC call attention to the environmental laws violated during the development and testing process.

1996: Navy commit to the preparation of an EIS and a Scientific Research Program (SRP) to test effects of low level LFAS broadcasts on limited numbers of whale species – permit for testing received from NMFS.

1996 – 1998: Evidence emerges from tests that cetacean behaviour is altered and a snorkeler is injured- suspension of the testing is required. US Navy refuses to stop testing - against conditions of the permit. A lawsuit is files by Hawaii County Green Party – navy ends testing and amends the permit to expire before the judge can rule on the Green Party's motion for a preliminary injunction – the navy represents to the court that testing and research is complete – the judge dismisses the case.

1999: US Navy issue draft EIS with no mention of the established effects on cetaceans or the snorkeler, these inadequacy call for withdrawal of the dEIS. The US Navy sent a letter to attorney, acknowledging receipt of this letter – no consideration is given to withdrawing the dEIS.
Navy files permit application with NMFS for five year deployment of SURTASS LFA based on the dEIS – the permit can not be issued until the EIS is finalised.

2000:

February: Ten environmental organisations and an elected official file suit in Honolulu Federal Court challenging the Navy plans to deploy SURTASS LFA. The Suit alleges illegal commitments of resources, lack of objectivity in the EIS process, and improper consideration of permit application by NMFS given Navy violations of NEPA and EIS.

March 02: Navy detail plans to conduct further testing of LFAS in an email to the President of Ocean Mammal Institute. Hawaii County Green Party file motion to re-open 1998 case based on new Navy plans – motion discusses Navy position that permits are not required for testing in foreign EEZs. The Marine Mammal Commission reported to US Congress in 1998 that LFAS could affect all marine species worldwide, possibly disrupting feeding, breeding, nursing, and hearing, causing physiological stress, making animals more vulnerable to disease, parasites, and predators.

March 13 to 17: Seventeen whales (four species) strand in the Bahamas at time of Navy conducting active sonar tests, including high intensity broadcasts (200dB), know as Littoral Warfare Advances Development (LWAD) Sea Tests – navy claim it is coincidence.

March 22: Attorney for plaintiffs sends a formal notice to Secretaries of Commerce and US Navy that Bahamian test violated environmental laws. Notice of violation expired and no response from either the Secretary of Commerce or the Secretary of the Navy, the attorney for plaintiffs in the new Hawaii case files amended complaint to include three new counts of direct violations of the MMPA and ESA. Amended complaint now alleges pattern of illegal testing by Navy to include the Bahamian tests and includes request for order that Navy requires permits under MMPA and ESA for testing in international waters.

March 24: Humane Society of the US (HSUS), the nation's largest animal protection organisation, demands that the US Navy suspend upcoming tests involving active sonar systems.

March 31: Attorney for plaintiffs sends letter to Secretary of Commerce calling upon the Secretary to notify the Navy that further LWAD testing without formal consultation and permits from National Marine Fisheries Service would be a criminal violation of the Endangered Species Act.

April 6: After less than thirty days of analysis, US Navy concludes that testing in the Bahamas did not cause strandings and deaths of whales. (Note Scientists conducting 1998 studies of affects of LFAS on whales are still analysing the data two years later).

May 26: US Navy cancelled planned LWAD tests.

Reports that US Navy scientists have held meetings to discuss LFAS testing in the Azores – an island group a thousand miles west of Portugal.

June: Hearing has been set for June 13th to consider the defendants motion (US Navy) to dismiss the case (www.dreamweaving.com/lfas, 2000).

June 14: The US Navy will not proceed with further underwater sonar testing in Hawaiian waters until it completes an environmental impact statement. This pledge was made in a federal court (Hardie, pers. comm.)

Summary

The issue of LFAS and the concerns it has raised highlight the potential pressures on the marine environment. The lack of long-term data or openness about activities being undertaken by the US Navy and its disregard of legislative frameworks and the EIA process has highlighted the sensitivities of the marine environment to such actions. The need for research and long term data is imperative to enable comprehensive conclusions to be drawn between naval activities and reported incidents. With issues as important as these the precautionary principle must be applied to avoid any potential negative effects.

APPENDIX 3

LIST OF CETACEAN SPECIES FOUND IN AND AROUND THE WATERS OF THE HEBRIDES

Species found within the waters of the Hebrides:

Species	Information
ODONTOCETES	
Harbour porpoise *Phocoena phocoena* **Size:** 1.4 – 1.9 m; 55 – 65 kg. (Carwardine, 1999) **Longevity:** Not usually beyond 9 years. **Sexual Maturity:** Females ~6 years Males ~5 years **Gestation:** ~11 months **Births:** May to November **Calving interval:** ~1 – 2 years	**Distribution:** Widely distributed within cool temperate and sub-arctic coastal waters, with concentrated population on the Atlantic coasts of South and West Ireland and Western Scotland. Most sightings are within 10km off land and peak between July and October. **Hebrides –** found throughout the area. **Behaviour:** Harbour porpoises are found singularly or in pairs, although aggregations of up to 50 do occur for (possibly) feeding/migrating. Basic social unit is probably mother-calf, sometimes with a yearling; male – female during mating season. Activity pattern for 24 hours suggests time spent 76% feeding, 21% travelling, 3% resting. **Sound:** ***Type*** / ***Frequency Range*** *(kHz)* / ***Dominant Frequency*** *(kHz)* / ***Source level*** *(db re 1 uPa/1 a)* Pulses / 41.0 / -- / 149-188 Clicks / <100-160 / 125-140 / -- **Diet:** Schooling, non-spiny fish, also cephalopods and crustaceans. **Status:** Locally common within its range, eleven strandings have been recorded within the Hebrides, this is relatively low considering abundance. General threats to populations include drowning in gill nets, herring weirs and other fishing equipment. Its coastal habitat is probably to blame for high levels of pollutants found in the body tissues of harbour porpoises in many parts of the world (Carwardine, 1999).
White-beaked dolphin *Lagenorhynchus albirostris* **Size:** 2.5 – 2.8 m; 180 – 275 kg. (Carwardine, 1999) **Longevity:** Unknown. **Sexual Maturity:-** **Gestation:** Probably ~10 months. **Births:** Late spring to summer (May – August). **Calving interval:** unknown	**Distribution:** Common – widely distributed in the north North Sea, north and north-west Scotland, extending south to south-west Britain and Ireland. **Hebrides** – distributed throughout the coastal waters of the North Minch and down the west of the Sea of Hebrides near Barra, as well as in deeper offshore waters. **Behaviour:** Usually in groups of less than 10 individuals - of mixed age and sex, although larger aggregations are not uncommon. Peak numbers occur in August to early September. They are found in association with seasonal concentrations of mackerel. **Sound:** ***Type*** / ***Frequency Range*** *(kHz)* / ***Dominant Frequency*** *(kHz)* / ***Source level*** *(db re 1 uPa/1 a)* Squeals / -- / 8.0-12.0 / -- **Diet:** Mainly cod, herring, and mackerel as well as cephalopods and crustaceans. **Status:** Appear to be common throughout much of its range. Nine strandings have been recorded in the Outer Hebrides correlating with predominantly northerly distribution.

Risso's dolphin

Grampus griseus

Size: 2.6 – 3.8 m;
300 – 500 kg.
(Carwardine, 1999)

Longevity: Unknown

Sexual Maturity: -

Gestation: -

Births: Early spring to summer (March – June).

Calving interval: unknown

Distribution: Worldwide in deep tropical and warm temperate waters (Carwardine, 1999), reaching the northern limit of its range in the Northern Isles of Scotland.
Hebrides – common predominantly along the east of the Outer Hebrides from Butt of Lewis to Barra Head.

Behaviour: Occur in groups ranging from 7–8 individuals, commonly comprising of a mature male, four to six females and young of both sexes; although groups of up to 50 are not uncommon. Risso's inhabit coastal waters from August to September, moving offshore May to July following their main prey, octopus.

Sound:

Type	***Frequency Range*** *(kHz)*	***Dominant Frequency*** *(kHz)*	***Source level*** *(db re 1 uPa/1 a)*
Whistles	--	3.5-4.5	--
Rasp/pulse burst	0.1-8.0+	2.0-5.0	--

Diet: Mainly cephalopods, as well as fish and crustaceans.

Status: Fairly common throughout its range. Ten strandings have been recorded, largely in south Hebrides, in opposition with main distribution pattern.

Common dolphin

Delphinus delphis

Size: 1.7 – 2.4 m;
70 – 110 kg.
(Carwardine, 1999)

Longevity: ~30 years

Sexual Maturity:
Females ~5 – 7 years
Males ~6 – 7 years

Gestation: ~19 months

Births: Mainly June to September.

Calving interval: ~1-2 years.

Distribution: Worldwide in warm temperate, sub-tropical, and tropical waters. Widely distributed in west and south British and Irish waters, mainly offshore, but also close to coast, particularly associated with Gulf Stream, west of continental shelf edge.
Hebrides – mainly sighted in the Sea of Hebrides south of Skye, area of particular importance are Stanton banks, the south and east Sea of Hebrides.

Behaviour: Group size between 8-10, along with gatherings of up to 350 occurring. Form groups of mixed age and sex, often equal numbers of males and females.

Sound:

Type	***Frequency Range*** *(kHz)*	***Dominant Frequency*** *(kHz)*	***Source level*** *(db re 1 uPa/1 a)*
Barks	--	<0.5-3.0	
Whistles	4.0-16.0	--	
Chirps	--	8.0-14.0	
Clicks	10.0-110	26,90,110	

Diet: Small schooling fish and squid.

Status: Appear to be common within its range. Seven strandings recorded throughout the Hebrides.

Bottlenose dolphin

Tursiops truncatus

Size: 1.9 – 3.9 m;
150 – 650 kg.
(Carwardine, 1999)

Longevity:
Females ~45 years
Males ~35 years

Sexual Maturity:
Females ~10-11 years
Males ~10-15 years

Gestation: ~12–13 months

Births: Extended period – peak in August to September.

Calving interval: Probably ~2-3 years.

Distribution: Worldwide in tropical, sub-tropical and temperate waters, mainly close to shore. Around Britain and Ireland small populations are found in scattered localities in bays and estuaries; known resident groups are at Cardigan Bay and Moray Firth.
Hebrides – were thought to be uncommon, but recent sightings around Mull, Gunna Sound, and Barra suggests there are several resident groups in the vicinity.

Behaviour: Often in groups of 2-15 animals. Social organisation; mother-calf, sub-adult males, adult females, and less commonly, sub-adult males- sub-adult females. Most sightings are within 10 km of land, but not uncommon in offshore waters. Bottlenose dolphins' range in size, temperate waters house the larger of the species.

Sound:

Type	***Frequency Range*** *(kHz)*	***Dominant Frequency*** *(kHz)*	***Source level*** *(db re 1 uPa/1 a)*
Barks	0.20-16.0	--	--
Whistles	0.80-24.0	3.5-14.5	125-173
Clicks	0.10-300	15.-130	max. 227

Diet: Opportunistic feeders, with a wide range of feeding techniques. Will take fish, squid, crustaceans and a variety of other prey (Carwardine, 1999).

Status: Appear to be common over much of its range. Three published strandings recorded, HWDT investigated two strandings on Mull in 1999.

Killer Whale or Orca

Orcinus orca

Size: 5.5 – 9.8 m;
2.6 – 9 tonnes
(Carwardine, 1999).

Longevity:
Females 80+ years
Males 50+ years.

Sexual Maturity:
Females 8 – 10 years
Males 15–16 years

Gestation: ~12 (to possibly 16) months, 17 months observed in captivity.

Births: Probably late October to January.

Calving interval: ~3 years, maybe up to 9 years.

Distribution: Worldwide – patchy distribution, occurs in all sea and oceans, from equator to poles, inshore and offshore (Carwardine, 1999). Sightings around UK usually individual or small group (<8).
Hebrides – regular sightings throughout the area, predominantly in the Little Minch, west of Skye and in the Sea of Hebrides, around the Small Isles to as far south as the Mull of Kintyre.

Behaviour: Orca has been categorised into three distinct types – resident, transients, and other. The latter orca travels in an unpredictable movement pattern. They live in extended family groups or pods; studies have revealed a highly sophisticated social hierarchy (Moscrop, 2000). Within the Hebrides groups of 2-10 have been observed, with several individuals being re-sighted year to year. One individual *'John Coe'*, has been sighted consistently since 1982 from Islay to Northern Skye.

Sound:

Type	***Frequency Range*** *(kHz)*	***Dominant Frequency*** *(kHz)*	***Source level*** *(db re 1 uPa/1 a)*
Whistles	1.50-18.0	6.0-12.0	--
Pulsed calls	0.50-25.0	1.0-6.0	160
Clicks	0.10-80.0	12.0-25.0	180

Diet: Large fish, squid, birds and marine mammals.

Status: Appear to be common within its range. Eleven strandings have been recorded in the Hebrides.

Long-finned pilot whale

Globicephala melas

Size: 3.8-6 m;
1.8-3.5 tonnes
(Carwardine, 1999).

Longevity: Unsure.

Sexual Maturity:
Females 3 – 4 metres long
Males 4 – 5 metres long.

Gestation: ~14.5 months.

Births: July to October.

Calving interval: 3.3 – 3.5 years

Distribution: Worldwide – two distinct populations, cool southern hemisphere waters and cool North Atlantic waters (Carwardine, 1999).
Hebrides – sparse distribution near-shore and offshore.

Characteristics: Long-finned pilot whales occur in groups of between 10-50, are sociable animals living in family pods and are often found in the company of other cetaceans (Carwardine, 1999).

Sound:

Type	***Frequency Range*** *(kHz)*	***Dominant Frequency*** *(kHz)*	***Source level*** *(db re 1 uPa/1 a)*
Whistles	0.50-8.0	1.6-6.7	--
Clicks	0.10-18.0	--	180

Diet: Predominantly feed on squid.

Status: Common within its range. They are the most commonly stranded cetacean with twenty-three strandings recorded throughout the Hebrides.

Atlantic white-sided dolphin

Lagenorhynchus acutus

Size: 1.9 - 2.5 m;
160 - 200 kg
(Carwardine, 1999).

Longevity: ~27 years.

Sexual Maturity:
Uncertain, but data suggests;
Females 5 – 8 years
Males 4 –6 years.

Gestation: 10 - 12 months

Births: Mainly in summer (May – July).

Calving interval: Possibly 2-3 years.

Distribution: Cold temperate and sub-arctic waters of the northern North Atlantic, especially along the edge of the continental shelf (Carwardine, 1999). Concentrated in North Scottish waters, not particularly coastal, but will occur within 10 km of land, numbers peak between August and October.
Hebrides – uncommon with sparse distribution, occur sometimes in the Sea of Hebrides, peak times are July and August, when large aggregations of 100 –1,000 may appear.

Characteristics: Mostly less than 10 individuals, but large groups do appear, as recorded in the Hebrides. Groups are of mixed age and both sexes, possibly with some age segregation, immatures and young adults largely absent from breeding groups. Data suggests offshore breeding in northern North Sea and in the north and west of the Atlantic.

Sound:

Type	***Frequency Range*** *(kHz)*	***Dominant Frequency*** *(kHz)*	***Source level*** *(db re 1 uPa/1 a)*
Whistles	--	6.0-15.0	--

Diet: Fish, including cod, herring, and young mackerel, as well as squid and gammarid crustaceans (Carwardine, 1999).

Status: Seven strandings have been recorded.

<table>
<tr>
<td>
<u>Striped dolphin</u>
Stenella coeruleoalba

Size: 1.8 - 2.5 m;
90 - 150 kg
(Carwardine, 1999).

Longevity: ~ 30 years.

Sexual Maturity: ~ 9 years.

Gestation: ~ 12 – 13 months.

Births: Probably concentrated July to September.

Calving interval: ~ 1 – 4 years.
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Distribution: Worldwide, mainly in tropical, sub-tropical and warm temperate waters. Usually encountered in deep water (Carwardine, 1999).
Rare in British and Irish waters, recorded almost exclusively in the south-west. A few records 700 km west of Scotland, suggesting they extend northwards offshore by the Gulf Stream. Strandings on the UK suggest the striped dolphin may occur further north than previously thought.
Hebrides – only three positive sightings in inshore waters.

Behaviour: Single (sometimes mixed with common dolphins) or groups up to 30.

Sound: -

Diet: Small squid, fish and crustaceans.

Status: Six strandings have been recorded distributed throughout the Hebrides.
They are hunted in some regions of the world and large numbers have been lost via the fishing industry in the Pacific (Carwardine, 1999).
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<td>
<u>Northern bottlenose whale</u>
Hyperoodon ampullatus

Size: 7 - 9 m;
5.8 – 7.5 tonnes
(Carwardine, 1999).

Longevity: Oldest recorded females 27 years – male 37 years.

Sexual Maturity: Min. ~ 7 years.

Gestation: 12+ months

Births: Peak in April.

Calving interval: 2 years
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<td>
Distribution: Found only in the North Atlantic, including all waters around the UK. Mainly found in deep, cold, sub-arctic waters. Two main centres of distribution are ‘The Gully’ (Nova Scotia) and Davis Strait (off Northern Labrador).
Hebrides – uncommon, with a few sightings mainly in inshore waters of central Hebrides.

Behaviour: Most pods contain 1 – 4 whales with some segregation by age and sex recorded. Mixed herds seem to occur early in the spring, including newborn calves, while in autumn, solitary males are common.

Sound:
<table>
<tr><th>Type</th><th>Frequency Range (kHz)</th><th>Dominant Frequency (kHz)</th><th>Source level (db re 1 uPa/1 a)</th></tr>
<tr><td>Whistles</td><td>3.0-16.0</td><td></td><td></td></tr>
<tr><td>Clicks</td><td>0.5-26.0+</td><td></td><td></td></tr>
</table>
Diet: Mainly squid and some fish, sea cucumber, starfish and prawns, mostly feeding on or near seabed.

Status: Common within its range, uncommon to the Hebrides with one stranding reported in the area.
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Cuvier’s beaked whale
Ziphius cavirostris

Size: 5.5 – 7m;
2 – 3 tonnes
(Carwardine, 1999).

Longevity:
Females 28 g.l.gs
Males 47 g.l.gs

Sexual Maturity: 11 growth layer groups

Gestation: -

Births: -

Calving interval: -

Distribution: Widely distributed in deep tropical, sub-tropical, and temperate waters, especially around oceanic islands and in enclosed seas (Carwardine, 1999).
Hebrides – rare, with one positive sighting near Skye, although they are difficult to positively identify.

Behaviour: Cuvier's beaked whales tend to travel alone (especially older males) or in groups of about 10. They are not acrobatic animals although they have been observed breaching. Their blow is not noticeable unless they have just completed a long dive. Their dives usually last from 20 to 40 minutes. They lurch through the water with their heads above the surface and arch their backs steeply before deep dives when they may lift their flukes above the surface. Of the beaked whale family Cuvier's is the most likely to be found stranded (WDCS, 1999).

Sound: -

Diet: -

Status: Sixteen strandings in total have been recorded for the Hebrides between 1920 and 1987 along the west coast of islands; this indicated they may be more common than sightings suggest.

Sperm whale
Physeter macrocephalus

Size: 11 – 18m;
20 – 50 tonnes
(Carwardine, 1999).

Longevity: 60 – 70 years.

Sexual Maturity:
Females 7 – 13 years
Males 18 – 21 years
(IFAW, 2000).

Gestation: ~ 14.5 – 16.5 months (IFAW, 2000).

Births: Mainly in summer and autumn (IFAW, 2000).

Calving interval: ~ 3 – 6 years (IFAW, 2000).

Distribution: Patchy distribution worldwide, ranging from the tropics to the poles, although only the mature males range into the highest latitudes (IFAW, 2000). Prefer deep water, usually found offshore, but also occurs over submarine canyons at the edges of the continental shelf (Carwardine, 1999).
Hebrides – uncommon, with three positive sightings recorded, acoustic surveys indicate abundance is high in waters >500m north west of Lewis.

Behaviour: Sociable, living in groups of up to 50 individuals. The two sexes live together in breeding season, otherwise several types of schools can be recognised: matriarchal nursery schools; juvenile schools; bachelor schools; bull schools and lone bulls (IFWA, 2000).

Sound:

Type	***Frequency Range** (kHz)*	***Dominant Frequency** (kHz)*	***Source level** (db re 1 uPa/1 a)*
Clicks	0.10-30.0+	2.4, 10-16	160-180

Diet: Mainly squid, although octopuses and a wide variety of large fish are also taken (Carwardine, 1999).

Status: Uncommon in the Hebrides, thirteen stranding recorded mainly along the west coast of the Uists and Barra – the expected pattern for an offshore species

Sowerby's beaked whale
Mesoplodon bidens

Size: 4 – 5m; 1 – 1.3 tonnes (Carwardine, 1999).

Longevity: -

Sexual Maturity: -

Gestation: -

Births: -

Calving interval: -

Distribution: Mainly found in temperate and sub-arctic waters of the northern North Atlantic (Carwardine, 1999).
Hebrides – rare, not positively sighted, probably due to difficulty in identification; stranding reports indicate their presence.

Behaviour: The first of the beaked whales to be discovered – in the Moray Firth, Scotland, in 1800 (Carwardine, 1999). Rarely encountered at sea and therefore limited understanding (Carwardine, 1999).

Sound: Appear to use frequencies between 300Hz & 129kHz for echolocation and 2 – 10kHz for social communication (MacLeod, 2000).

Diet:

Status: Five stranding reports.

Fraser's dolphin
Lagenodelphis hosei

Size: 2 – 2.6m; 160 – 210kg (Carwardine, 1999).

Longevity: -

Sexual Maturity: -

Gestation

Births: No obvious peak.

Calving interval: -

Distribution: Common around the equator, also found in deep tropical Pacific and warm temperate waters, generally offshore, except in areas with narrow continental shelf (Carwardine, 1999).
Hebrides – rare, indication of presence from a fresh stranding in 1996.

Behaviour: Groups of over a thousand have been seen and these dolphins are commonly sighted in mixed herds with pan-tropical spotted dolphins, false killer whales, sperm whales, melon-headed whales, spinner dolphins, and striped dolphins. Almost nothing is known of reproduction biology or seasonal migration. This species is tropical in distribution and should be expected in pelagic waters of all oceans. In the Pacific they are considered shy and difficult to approach, however, on recent surveys in the Gulf of Mexico, Fraser's dolphins came from considerable distance to ride the bow-wave of the research vessel (Stranding web page).

Sound:

Diet: Mid and deep-water fish, squid, and crustaceans (Carwardine, 1999).

Status: One recorded, fresh stranding on South Uist, September 1996. Fairly common within its range.

False Killer whale
Pseudorca crassidens

Size: 4.3 – 6m; 1.1 – 2.2 tonnes (Carwardine, 1999).

Longevity: 30 – 40 years

Sexual Maturity: 8 – 14 years

Gestation: 15.5 months (possibly down to 11).

Births: No obvious calving peak.

Calving interval: 3 years.

Distribution: Tropical, sub-tropical, and warm temperate waters worldwide (Carwardine, 1999). Occasionally seen north of the British Isles in the North Atlantic, four sightings since 1976, between 5 – 54km off land (generally a pelagic species), three off Scotland, and one off Cornwall. One sighting off NW Scotland involved 100 – 150 animals; the others were individual sightings.
Hebrides – rare, positively sighted once, off Neist point, Skye.

Behaviour: Commonly in groups of 10 – 30 individuals although, herds of up to 300 may form. Groups are of mixed ages and sexes.

Sound:

Type	***Frequency Range** (kHz)*	***Dominant Frequency** (kHz)*	***Source level** (db re 1 uPa/1 a)*
Whistles	3.0-11.0		
Clicks		25.0-50.0, 80.0-110.0	228 (IFAW, 2000)

Diet: Squid and large fish also known to prey on dolphins.

Status: No strandings have been recorded, believed to be a transitory species to the Hebrides area.

Narwhal

Monodon monoceros

Size: 3.8 – 5m;
0.8 – 1.6 tonnes
(Carwardine, 1999).

Longevity: May extend to at least 52 years (IFAW, 2000)

Sexual Maturity:
Females ~5 to 8 years
Males ~ 11 to 13 years

Gestation: Estimated to be 14 to 15 months.

Births: June to August with a peak at the beginning of August.

Calving interval: Estimated to be 3 years.

Distribution: Mostly above Arctic Circle and right to the edge of the ice-cap (Carwardine, 1999).
Hebrides – rare, one sighting near Skye in 1976.

Behaviour: Sociable animals, usually in small groups of three to four, but as many as 20 individuals may congregate in close proximity. Smaller groups may join to form large aggregations of several hundred or even thousand animals that generally move together in dispersed herds. Pods may consist of individuals of the same sex and age, but mixed groups are also seen. During migration narwhals are segregated by sex: adult males leave first, followed by females and young. Later in the summer, narwhals are segregated into groups of immature males, mature females and calves, and groups of tusk-bearing males (IFAW, 2000).

Sound:

Type	***Frequency Range*** *(kHz)*	***Dominant Frequency*** *(kHz)*	***Source level*** *(db re 1 uPa/1 a)*
Pulsed tone	0.5-5.0		
Whistles	0.3-18.0	0.3-10.0	

Environmental concerns of the deleterious effects upon marine mammals of increased vessel traffic and oil exploration activities in the Arctic. Studies of the reactions of narwhals to ice-breaking ships in the High Arctic, revealed how narwhals moved slowly, or were motionless on the surface often huddling together near the ice edge and engaging in physical contact. Rather than diving, they were seen to sink below the surface and disperse along the ice edge in front of the advancing ships, they ceased vocalising temporarily (IFAW, 2000).

Diet: Variety of fish, squid, and crustaceans (Carwardine, 1999).

Status: Considered to be transitory to the Hebrides.

Beluga whale

Delphinapterus leucas

Size: 3 – 5m;
0.4 – 1.5 tonnes
(Carwardine, 1999).

Longevity: ~30-35 years

Sexual Maturity: 5 – 10 years (Carwardine, 1999).

Gestation: -

Births: -

Calving interval: -

Distribution: Found in seasonally ice-covered waters of the sub-Arctic and Arctic. Mostly in shallow coastal waters, but will enter estuaries and rivers (Carwardine, 1999).
Hebrides – rare, one sighting for 3 days in Loch Duich and coastal waters of east Raasay in April 1995.

Behaviour: Beluga whales are gregarious and rarely found alone, they congregate in large herds of hundreds or thousands around river mouths in summer. Beluga travel in herds, segregated into nursery groups of several adult females, their newborn calves and several older calves and pods of mature males comprising of 8 to 16 individuals (IFAW, 2000).

Sound:

Type	***Frequency Range*** *(kHz)*	***Dominant Frequency*** *(kHz)*	***Source level*** *(db re 1 uPa/1 a)*
Whistles	0.26-20.0	2.0-5.9	
Pulse	0.4-12.0	1.0-8.0	
Echolocation	40.0-120	variable	160-180

Diet: Variety of fish, crustaceans, cephalopods, and molluscs (Carwardine, 1999).

Status: Considered to be transitory to the Hebrides.

MYSTICETES

Minke whale

Balaenoptera acutorostrata

Size: 7 – 10m;
5 – 10 tonnes
(Carwardine, 1999).

Longevity: ~30 – 40 years

Sexual Maturity: 5 – 10 years

Gestation: ~10 months

Births: November to March

Calving interval: Mature females may give birth every year (Klinowska, 1991).

Distribution: Almost worldwide, from the tropics to polar regions, most common in cooler waters, mainly inshore (Carwardine, 1999).
Hebrides – most commonly recorded, widely distributed baleen whale in the area.

Behaviour: Usually observed singularly or in pairs but can occur in groups of up to 14 in areas of high prey abundance. Peak numbers are recorded in the Hebrides in August and September.

Sound:

Type	***Frequency Range** (kHz)*	***Dominant Frequency** (kHz)*	***Source level** (db re 1 uPa/1 a)*
Down sweeps	0.06-0.13	--	165
Moans/Grunts	0.06-0.14	0.06-0.14	151-175
Ratchet	0.85-6.00	0.85	
Clicks	3.30-20.0	<12	151
Thump trains	0.19-2.0	0.1-0.2	

Diet: Krill and small schooling fish (Carwardine, 1999).

Status: HWDT have identified 67 individuals in waters around Mull, Coll, and Muck, and are thought to have specific territories. Thirteen widely distributed strandings have been recorded in the Hebrides.
Most abundant of all baleen whales, but is now the only baleen whale being hunted commercially under the auspices of the IWC (Carwardine, 1999).

Fin whale

Balaenoptera physalus

Size: 18 – 22m;
30 – 80 tonnes
(Carwardine, 1999).

Longevity: May be 85 to 90 years (IFAW, 2000).

Sexual Maturity: Length at sexual maturity;
Females:17.7 - 19.1m
Males: 16.8 - 17.6m.

Gestation: 11.25 months.

Births: winter months.

Calving interval: ~ 3 years.

Distribution: Deep water in tropical, temperate and polar regions, but most common in cooler waters and in the southern hemisphere (Carwardine, 1999). Most commonly acoustically detected cetaceans in the Atlantic Frontier.
Hebrides – uncommon, occasional sightings in near-shore waters from Harris to Mull of Kintyre.

Behaviour: Sociable species, often gathering in small groups. The second largest animal on Earth (Carwardine, 1999).

Sound:

Type	***Frequency Range** (kHz)*	***Dominant Frequency** (kHz)*	***Source level** (db re 1 uPa/1 a)*
Moans	0.03-0.75	0.02	170-200
Chirps/Whistles	1.5-5.0	1.5-2.5	
Clicks	10-31		
Rumble	0.01-0.03		
Constant call	0.02-0.04		

Diet: Variety of schooling fish, krill, other crustaceans, and sometimes squid (Carwardine, 1999).

Status: Five strandings recorded along the west coast of Lewis, Harris, and the Uists.
Historically the most commonly caught species in commercial whaling– uncertainty as to what degree the population has recovered (Carwardine, 1999).

<u>Sei whale</u> *Balaenoptera borealis* **Size:** 12 – 16m; 20– 30 tonnes (Carwardine, 1999). **Longevity:** Up to 65 years. **Sexual Maturity:** 6 to 8 years. **Gestation:** 10.5 to 13 months. **Births:** winter **Calving interval:** 2-3 years.	**Distribution:** Deep temperate waters worldwide, most common in the southern hemisphere (Carwardine, 1999). **Hebrides** – occasional sightings in near-shore waters of eastern Hebrides, historical commercial whaling data indicates their presence. **Behaviour:** Normally found alone or in groups of 2-5 individuals, though larger aggregations are found on feeding grounds. As with some other baleen whales, there may be some segregation in the population during migration. The older and bigger sei whales tend to be found in the highest latitudes (IFAW, 2000). Do not seem to gather in the same areas year after year (Carwardine, 1999). **Sound:** ***Type*** / ***Frequency Range*** *(kHz)* / ***Dominant Frequency*** *(kHz)* / ***Source level*** *(db re 1 uPa/1 a)* Pulses / 2.5-3.5 / 3 / **Diet:** Small crustaceans, such as krill and copepods, and schooling fish (Carwardine, 1999). **Status:** Two strandings recorded along the west coast of Lewis, Harris, and North Uist. Depleted by commercial whaling in some areas of the world – uncertainty as to what degree the population has recovered (Carwardine, 1999).

Humpback whale

Megaptera novaeangliae

Size: 11.5 – 15m; 25– 30 tonnes (Carwardine, 1999).

Longevity: Between 40 and 95 years.

Sexual Maturity: 4 to 6 years

Gestation: 11 to 11.5 months

Births: They migrate annually from colder waters, where they feed in spring and summer to tropical winter breeding grounds where they mate, calve and usually do not feed (IFAW, 2000).

Calving interval: Usually 2 to 3 years - although successful post-partum ovulation in some females may occasionally result in two calves in two years (IFAW, 2000).

Distribution: Found within all oceans of the world – poles to tropics, fee in higher latitudes during spring and summer, and migrate to tropical breeding grounds in winter (Carwardine, 1999).
Hebrides – occasional sightings in near-shore waters, a humpback stayed for one week in Loch Eynort, Skye in December 1994, and an immature resided in the Firth of Clyde from January to March 1994. Offshore surveys suggest the region is important as a migration route.

Behaviour: Most sightings are of individuals or pairs and rarely exceed four or five, unless in a feeding or breeding aggregation. Group dynamics on the breeding grounds appear to be complex, but few long term associations have been observed on feeding grounds except between calves and their mothers. Social groups of up to several animals may form on breeding grounds and male escorts may accompany cow-calf pairs (IFAW, 2000).

Sound:

Type	***Frequency Range** (kHz)*	***Dominant Frequency** (kHz)*	***Source level** (db re 1 uPa/1 a)*
Song	0.03-8.0	0.12-4.0	144-174
Components	0.02-1.80	0.035-0.36	175
Moans	0.12-1.90+	--	190
Grunts	0.10-2.0	--	158

SONG - These are cyclical, hierarchically-structured sequences, they repeat at intervals of between 5 and 35 minutes. The structure, and established terminology for this is as follows: SONGS are comprised of THEMES which consist of patterns of repeated PHRASES which in turn are made up of single calls called UNITS. Themes, phrases and units follow each other in a repetitive sequence, but the structure of the song evolves slowly. It has been proposed that the songs 'rhyme', in the sense that 'phrases in adjacent themes had similar beginnings or endings', and that this rhyming might be a memory-aid for singing whales. Only males sing, and this is thought to be a courtship display. Why the population should maintain and develop a consistent song is not understood. The songs change sufficiently rapidly relative to the rate of recruitment, that genetic transmission of song types can be discounted. Song change seems unrelated also to environmental factors, and therefore must be culturally transmitted (learnt) (IFAW, 2000).

Diet: Schooling fish and crustaceans (Carwardine, 1999).

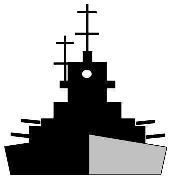
Status: Rare in the Hebrides with one stranding recorded, unusually far inshore, at the head of Loch Sunart.
95% of the worlds population were killed by the whaling industry – appear to be making a good recovery (Carwardine, 1999).

Northern right whale *Eubalaena glacialis* **Size:** 11.5 – 15m; 25– 30 tonnes (Carwardine, 1999). **Longevity: -** **Sexual Maturity:** Probably between 5 & 10 years. **Gestation:** Studies suggest 13 to 14 months (IFAW, 2000). **Births:** Winter months. **Calving interval:** ~3 to 5 years	**Distribution:** Western North Atlantic, with occasional sightings in eastern North Atlantic and eastern North Pacific (Carwardine, 1999). **Hebrides** – very rare to the region, with one sightings recorded. **Behaviour:** Mostly individual or in pairs, or small groups of less than 12 animals, larger groups may form on feeding or breeding grounds. In winter (calving), cows and newborn calves may be segregated from the rest of the population (IFAW, 2000). **Sound:** ***Type*** / ***Frequency Range** (kHz)* / ***Dominant Frequency** (kHz)* / ***Source level** (db re 1 uPa/1 a)* Tonal moans / 0.03-1.25 / 0.16-0.50 / Pulses / 0.03-2.20 / 0.05-0.50 / 172-187 **TEMPORAL VARIATION -** Greater vocal activity at, vocalisations are thought to be mainly communicative, between whales that are nearby; it is reported that 'animals in close, active (often sexually active) groups produce a much richer set of acoustic signals' (IFAW, 2000). **Diet:** Copepods and sometimes krill (Carwardine, 1999). **Status:** Rare, historical whaling data places this species within the Hebrides region. Species was heavily exploited by commercial whaling – still recovering (Carwardine, 1999).
Blue whale *Balaenoptera musculus* **Size:** 21 – 27m; 100– 120 tonnes (Carwardine, 1999). **Longevity:** Estimates range from 30 to 80-90 years. **Sexual Maturity:** 5 - 10 years **Gestation:** ~11 months **Births:** **Calving interval:** 2 or 3 years.	**Distribution:** Patchy distribution worldwide, from tropics to poles, some populations migrate, while others appear to be resident (Carwardine, 1999). Acoustically detected all year round in Atlantic Frontier and is thought to be an important habitat. **Hebrides** – no sightings recorded – historical whaling data places the species in the region. **Behaviour:** Usually encountered alone or in pairs, occasionally larger groups may gather in areas of high food concentration. Mixed schools of blue and fin whales have been reported (IFAW, 2000). **Sound:** ***Type*** / ***Frequency Range** (kHz)* / ***Dominant Frequency** (kHz)* / ***Source level** (db re 1 uPa/1 a)* Moans / 0.012-0.39 / 0.16-0.25 / 188 Clicks / 6-8, 21-31 / 6-8, 25 / 130, 159 **Diet:** Krill (Carwardine, 1999). **Status:** Rare in the Hebrides region, three strandings have been recorded. Despite protection by the International Whaling Commission in 1965, population numbers remain well below pre-exploitation levels (IFAW, 2000).

Taken from Irish (1996) and Shrimpton (1999) unless otherwise stated.

APPENDIX 4

EXTRACT FROM THE MOD(N)
'GUIDE TO ENVIRONMENTAL COMPLIANCE'
- INCLUDING ENVIRONMENTAL POLICY -



APPENDIX 5

MILITARY USAGE OF THE HEBRIDES

Scottish Area Usage January – June 2000

	AREA	TOTAL VESSEL DAYS
1.	Tiumpan	23 days 14 hours
2.	Minch North	23 days 17 hours
3.	Stoer	17 days 01 hour
4.	Shiant	28 days 01 hour
5.	Minch South	24 days 06 hours
6.	Ewe	30 days 21 hours
7.	Trodday	20 days 18 hours
8.	Rona West	14 days 17 hours
9.	Rona North	16 days 11 hours
10.	Lochmaddy	18 days 05 hours
11.	Dunvegan	20 days 02 hours
12.	Portree	Nil
13.	Rona South	67 days 23 hours
14.	Raasay	68 days 14 hours
15.	Neist	21 days 06 hours
16.	Bracadsale	18 days 23 hours
17.	Ushenish	19 days 13 hours
18.	Hebrides North	21 days 06 hours
19.	Canna	18 days 23 hours
20.	Rhum	10 days 07 hours
21.	Sleat	237 days 08 hours
22.	Barra	17 days 23 hours
23.	Hebrides Central	21 days 22 hours
24.	Hawes	19 days 17 hours
25.	Eigg	10 days 07 hours
26.	Hebrides South	21 days 13 hours
27.	Ford	21 days 10 hours
28.	Tiree	19 days 07 hours
29.	Staffa	12 days 23 hours
30.	Mackenzie	12 days 23 hours
31.	Mull	11 days 19 hours
32.	Linnhe	11 days 09 hours
33.	Jura	Nil
34.	Fyne	08 days 13 hours
35.	Minard	07 days 01 hour
36.	Tarbert	07 days 01 hour
37.	Skipness	26 days 19 hours
38.	West Kyle	70 days 01 hour
39.	Striven	Nil

40.	East Kyle	Nil
41.	Goil	12 days 23 hours
42.	Long	01 day 14 hours
43.	Cove	55 days 07 hours
44.	Gareloch	44 days 22 hours
45.	Rosneath	71 days 21 hours
46.	Cumbrae	30 days 11 hours
47.	Garroch	52 days 12 hours
48.	Laggan	28 days 22 hours
49.	Blackstone	19 days 09 hours
50.	Place	53 days 23 hours
51.	Colonsay	11 days 19 hours
52.	Boyle	43 days 10 hours
53.	Orsay	49 days 20 hours
54.	Islay	53 days 14 hours
55.	Otter	52 days 04 hours
56.	Gigha	19 days 13 hours
57.	Earadale	23 days 09 hours
58.	Lochranza	11 days 17 hours
59.	Davaar	86 days 06 hours
60.	Brodick	51 days 10 hours
61.	Irvine	23 days 08 hours
62.	Lamlash	43 days 09 hours
63.	Ayr	46 days 01 hour
64.	Skerries	41 days 15 hours
65.	Rathlin	40 days 01 hour
66.	Kintyre	52 days 04 hours
67.	Sanda	55 days 07 hours
68.	Stafnish	58 days
69.	Pladda	44 days 20 hours
70.	Turnberry	08 days 06 hours
71.	Torr	51 days 22 hours
72.	Mermaid	59 days 23 hours
73.	Ailsa	41 days 11 hours
74.	Maiden	53 days
75.	Corsewall	60 days
76.	Ballantrae	16 days 13 hours
77.	Magee	54 days
78.	Londonderry (D509)	10 days 13 hours
79.	Beaufort	54 days 11 hours
80.	Ardglass	50 days 11 hours
81.	Peel	49 days

Source: (MOD/FOSNNI Operations, pers. comm.)

APPENDIX 6

MOD GUIDELINES FOR MININIMISING DISTURBANCE TO CETACEANS

GUIDELINE FOR MINIMISING DISTURBANCE TO CETACEANS

References:
Wildlife & Countryside Act 1981
Wildlife (Northern Ireland) Order 1985
EC Habitats & Species Directive (92/43/EEC)
DETR Guidelines
CESO(N) letter dated 15 April 1999

1 27 species of whales, dolphins and porpoises have been recorded in the coastal waters of the North Eastern Atlantic. Although many are seen in offshore waters, several species are regularly seen inshore. The UK Government is committed to protecting all species of whales, dolphins and porpoises and to maintaining healthy population levels now and for the future.

2 The sea areas of the North West Scotland, the Minches and the Sea of the Hebrides are known cetacean breeding grounds, the principal mating season for these marine mammals falls within the period July – September.

3 Units operating in these areas during this period should, where possible, observe the following guidelines when encountering cetaceans:-

a. On encountering cetaceans, continue on your intended route making progress at a slow, steady, no wake speed. This will present predictable movements and thus minimise the risk of disturbance to, or collision with, the animals. Avoid erratic movements or sudden changes in course and speed.

b. To minimise the risk of disrupting mother-calf bonds give cetaceans with young a wide berth and avoid coming between a mother and calf.

c. Allow groups of cetaceans to remain together. Proceeding slowly on a steady course will enable cetaceans to remove themselves from the path of a vessel as a group. Avoid deliberately passing through, or between, groups of cetaceans.

d. On sighting cetaceans, fast planing vessels should gradually slow down to a slow, no wake speed. A suggested speed is less than 5 knots. Wait until well clear of cetaceans before resuming speed.

Source: MOD/FOSNNI Operations pers.comm.