CETACEAN CONSERVATION IN WEST SCOTLAND

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Map courtesy of Ronnie Leckie

J.H. Shrimpton
& E.C.M. Parsons
Hebridean Whale
and Dolphin Trust

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Executive Summary

The Hebrides is home to the most diverse cetacean population in Europe, and yet this important area is poorly safeguarded against human activities. This study reviews the current state of cetacean conservation in the Hebrides with a view to making recommendations to strengthen cetacean conservation in the area.

Cetacean presence and distribution were analysed from sighting and stranding data. A total of 23 species of cetaceans have been recorded in Hebridean waters for which, broad patterns of distribution were established, and data deficient areas identified.

Legislative instruments were reviewed and Hebridean cetaceans were identified as having very little statutory protection. A number of institutional mechanisms were identified as having potential to improve conservation prospects. These are the UK Biodiversity Action Plan, ASCOBANS and also site-based frameworks including Special Areas of Conservation and National Scenic Areas. Options that have previously not been utilised in Scotland, or the UK, were also explored including a Cetacean Protection Act and Marine National Parks.

A range of threats were identified and assessed and the following have been identified as '*priority issues*' which require immediate action. The direct take of Northeast Atlantic minke whales; incidental take and injury from marine debris; pathogen pollution from human and fish-farm sewage; chemical pollutants; prey depletion and habitat destruction due to over-fishing, illegal fish catches and high by-catch rates; acoustic deterrents on fish farms and military activities.

In light of these findings the following recommendations were made:

- the establishment and adoption of an effective *management framework*;
- specific actions for *threat minimisation*;
- action for establishing *marine protected areas*;
- a programme of *prioritised research*;
- and a set of *communication and education initiatives*.

1. Introduction

1.1. THE HEBRIDES

This project focuses on cetaceans in West Scotland, an area known as the Hebrides. The area of study is illustrated in Figure 1, and is defined by the co-ordinates 55°00' - 59°00'N. to 4°30' - 9°00'W.

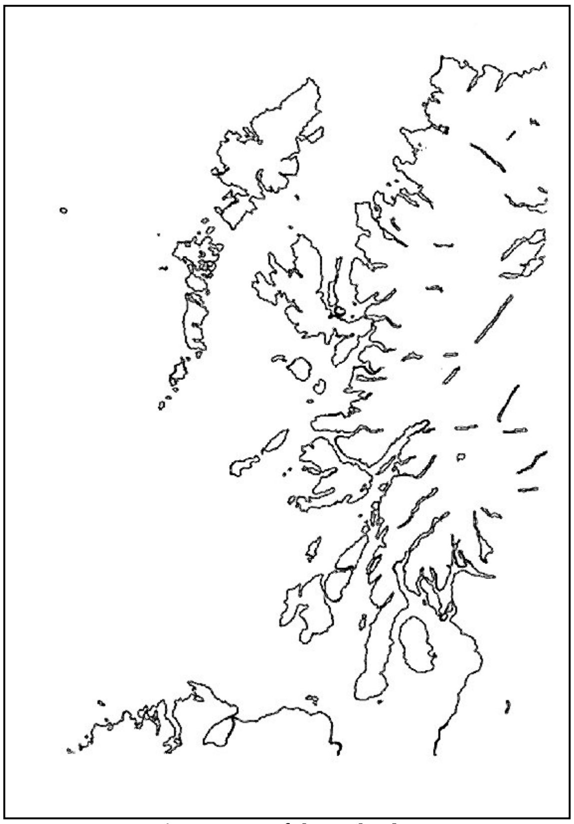


Fig. 1. Map of the Hebrides.

The Hebrides has an abundant and diverse population of cetaceans. To date, 23 cetacean species have been reported from this region. Part of the reason for this great diversity of cetaceans is the influence of the Gulf Stream and the North Atlantic Drift which bring warm water containing a high diversity and abundance of planktonic species. When these waters, travelling diagonally across the Atlantic, reach the Hebrides they encounter a complex combination of islands and submarine mountains which create bottom water upwellings and mixing zones. This replenishes surface waters with nutrients, increasing productivity of marine waters and ultimately causing high abundance of plankton, fish and, therefore, cetacean species. This great abundance and diversity of cetacean species makes the West of Scotland one of the most important habitats for cetaceans in Europe.

The Hebrides is seen as one of the UK's wilder and more remote locations, and with this comes the perception of an environment that is unpolluted and free from developmental pressure. The lack of apparent conflict means that until recently the area has not received the level of statutory protection that is evident in other areas. The remote nature of the Hebrides has, in the past, provided a natural buffer and protection has been unnecessary. Consequently, although the area contains a high diversity of cetacean species, there are currently no formal measures in place offering any practical protection.

Given the sparsely distributed island communities which characterise the Hebrides, the area is unique to the UK in that it is largely economically dependent upon its marine resources (Fulton, 1999). Much of the area's revenue is derived from fisheries, aquaculture and tourism. Hebridean waters, therefore, support a wide range of human activities that, if not managed in a sustainable manner, could have detrimental effects on their very resource base. Cetaceans are just one element of the wider marine environment which are under threat from the increasing pressure of development. In order to achieve the continued diversity and health of cetacean populations in the area, these threats need to be addressed.

1.2. AIMS AND OBJECTIVES

In the development of conservation measures the objectives of conservation must be defined (Baxter & Munford, 1992; Thompson, 1992; Jones, 1998). In this case, the primary objective of recommended conservation measures is to afford greater protection to cetacean species in the Hebrides. Kenchington's (1990) conceptual model for conservation management provides a basis for formulating the approach to this current study. Kenchington's methodology entails problem identification, identification of impacts, problem solution and incorporation of controls into a management plan.

Using this as a start point, the objective of this study is addressed through the following aims:

- identification of the inherent elements which define and limit our approach to marine and cetacean conservation. These are addressed later in this chapter*;*
- the collation of existing information regarding cetacean species in the Hebrides (*Chapter 2).* Using a variety of data sources to produce an up to date and comprehensive database of distribution for each species utilising the Hebrides, therefore identifying important areas for potential conservation action. However, any assessment of abundance and ecology of individual species is beyond the scope of this current study;
- an investigation of institutional frameworks that have relevance for cetacean conservation in the region. *Chapter 3* reviews existing legislation and subsequent problems along with alternative options for implementing cetacean management strategies within the context of the Hebridean environment and community;
- identification of threats posed to cetaceans in this area. *Chapter 4* reviews these and where possible assesses the extent of these threats to Hebridean cetaceans;
- to formulate and suggest recommendations for cetacean conservation management strategies and how they could be managed. These recommendations are summarised in *Chapter 5*.

1.3. LITERATURE REVIEW

To date, there has been little work specifically focused on the conservation issues facing cetacean populations in and around the Hebrides - a factor which appears to be linked more with the lack of baseline data available for the region rather than the richness of species that are found there.

The only study with its primary focus on West Scotland is the 'Minch Project' (Bryan, 1994). Its objectives were to assess the current status of the Minch in terms of its socio-economic, environmental and biological attributes. The spatial extent of the Minch Project was from North Lewis to the Ardnamurchan Peninsula, whereas this study encompasses North Rona to Mull of Kintyre and all waters to St. Kilda. Although of a smaller scale, the Minch Project addresses many of the issues that are unique to the Hebrides that have not been addressed elsewhere and it provides a useful overview of the economic, social and ecological interactions occurring in the study area. As part of the Minch project, a review of the cetacean populations in the area was undertaken, comprising several elements. These were: to identify commonly occurring species with a spatial assessment based on regular and occasional sightings; and to identify potential threats posed to cetaceans. This assessment was limited to six species, the harbour porpoise (*Phocoena phocoena*), bottlenose dolphin (*Tursiops truncatus*), common dolphin (*Delphinus delphis*), minke whale (*Balaenoptera acutorostrata*), Risso's dolphin (*Grampus griseus)* and the white-beaked dolphin (*Lagenorhynchus albirostris*). Again, this provided a useful overview of cetaceans in the area, their relative presence and threats. No detailed assessment of cetacean distribution was made, neither was any quantification of the threats posed or recommendations for action, as this was outside the scope of the study. As a result of the Minch Project, the Minch Forum (a partnership of public bodies) was initiated. This has continued to look at the area with an issue-based approach with a view to improving the management and sustainable use of the area. Some of the reviews that have been produced in the above process have been used in this study.

On a Scotland-wide scale, there are only a limited number of papers and reports that relate to cetacean conservation. Two papers by Thompson (1992, 1994) review conservation issues for cetaceans and pinnipeds in Scottish waters. They address current information regarding distribution, abundance and status of marine mammal populations; discuss constraints; outline the threats posed; and identify future research requirements. These papers give a general overview for marine mammals in Scotland. However, information regarding cetaceans in these papers is largely focused on the east coast, with only a passing reference to the west coast, which is indicative of the levels of research undertaken in the east coast region.

On a UK wide basis, there are several papers which identify and discuss threats to cetaceans in the UK with a view to formulating management strategies (Grellier *et a*l., 1995; Curran *et al*., 1996; Hughes, 1998), each of which shall be reviewed in turn.

In preparation for the Cardigan Bay marine Special Area of Conservation (mSAC) a report to the Countryside Council for Wales was made with recommendations for management strategies for the resident bottlenose dolphins found there (Grellier *et al*., 1995). A similar report was undertaken for Scottish National Heritage in preparation for the Moray Firth mSAC, designated on the basis of its bottlenose dolphin population (Curran *et al*., 1996). Both these reports reviewed existing current ecological knowledge of the populations, going on to identify, quantify and assess the range and significance of threats posed to each dolphin population. From this point, their objectives, to make management recommendations, could be fulfilled. The similarity of their objectives to those of this current study, make both these reports relevant in their approach and treatment of the issue. However, one major difference is that management recommendations were made for these areas within the context of an established legislative framework, i.e. the SAC designation. However, the Hebrides has no such encompassing framework within which to co-ordinate conservation action.

There are other differences between Cardigan Bay, the Moray Firth and Hebridean waters, meaning the challenges of management are very different in these areas from those faced in the Hebrides. One is scale: both Cardigan Bay and Moray Firth represent smaller geographical areas than the Hebrides, meaning that a wider range of environmental, socio-economic and biological variables are encountered in the latter, requiring very different management approaches. Secondly there are ecological differences: both Cardigan Bay and the Moray Firth focus on discrete, single species populations which, consequently, have a single set of ecological requirements. This current study focuses on a range of species each with their own unique habitat requirements. For example, some species are coastal residents while others are transitory offshore species and are likely to be part of much larger Northeast Atlantic populations. Lastly there are differences in the amount of available information: the Moray Firth and Cardigan Bay dolphin populations have been the focus of much dedicated research. In comparison, research undertaken in and around the Hebrides has been limited. This lack of data is a major stumbling block for the formulation of conservation strategy recommendations. Even in the Moray Firth and Cardigan Bay, where there is a relative wealth of information, lack of data regarding threats and their significance has been a problem in the recommendation of management options.

Finally, Hughes (1998) reviewed the status of harbour porpoises in UK waters. Useful comparisons can be made with this current study due to the former study's wide geographical scale. The single focus upon harbour porpoises allowed a detailed study of ecology and biology which is not possible in this current study given the diversity of species, many of which are little understood. Hughes' study is extremely comprehensive in its review of legislation and the threats posed to harbour porpoises, much of which is applicable the Hebrides. However, when looking specifically at the Hebrides there are issues that are unique to this area and require a more localised and focused approach.

1.4. NATURE OF MARINE SYSTEMS AND CETACEANS RELEVANT TO THEIR CONSERVATION.

There are inherent features of the marine environment, and of cetaceans, which underlie, influence and limit how they can be conserved. Therefore, in the consideration and recommendation of any conservation measures for cetaceans, an understanding of the nature of the mammals themselves, and the environment in which they live, is essential. This section addresses central issues through focusing on the nature of the marine environment, and of cetaceans, and the implications that these have for conservation.

1.4.1. The Marine Environment

The marine environment has large-scale physiographic boundaries (McIntyre, 1992), meaning that it is relatively homogenous compared to terrestrial systems. This is due to its three dimensional nature, meaning that communities are mobile and more widespread in their range. These factors mean that '*rarity*' itself is very rare in the marine environment, and there are few species which are critically dependent on a specific location (Jones, 1998).

In addition, there is a great connectivity between different marine ecosystems (Jones, 1998). Intertidal areas, coastal waters and open seas are all linked and, given the migratory nature of many marine species, means that areas which are geographically distant can be closely connected in terms of their management and conservation. For example, large oceanic whales utilise a huge range for feeding and breeding. The marine environment also has a high degree of connectivity with terrestrial areas (Baxter & Munford, 1992). This is important to consider in pollution control, as many polluting substances found in the marine environment are originally land-based.

The marine environment is a dynamic one, both physically and ecologically (Baxter & Munford, 1992). Its features and populations are subject to a large degree of natural variation, especially in coastal areas. This constant state of flux can make detection of anthropogenic change very difficult.

As well as its physical nature, there are social elements that affect the application of conservation measures. The ocean is viewed as a wilderness, a common space, where freedoms of access, navigation and fishing are seen as rights, i.e., the principle of *res communis* is applied. Subsequently, our relationship with the sea is largely based around the resources that it supplies to us, not as a spatial entity. As a common resource the sea supports many user groups all of which have different requirements and interests. Reconciling these is perhaps one of the most difficult tasks for marine conservation.

Implications for marine conservation

The lack of rarity in the marine environment and its homogenous character has historically inhibited the development of marine conservation measures. The impetus to conserve has been quoshed in the absence of '*critical*' or '*endangered*' habitats and species that have traditionally driven terrestrial conservation. Progress in marine conservation has also been hampered by the connected nature of the marine environment that makes the delineation of effective boundaries virtually impossible. The limits that have been are administrative in nature as opposed to ecological. The terrestrial '*protected area*' approach to conservation is, therefore, not easily transcribed to the sea, except for sedentary ecosystems such as coral reefs. The strong linkage between land and sea means measures taken to conserve marine elements must take land-based activities into account which, historically, have not been addressed. This is because traditionally marine and terrestrial conservation measures begin and end at the low water mark. Also, due to the complex administrative system in the coastal zone, whereby the responsibilities of different bodies and agencies are not clearly defined, overlap and omission in management is common. A more holistic approach that straddles both environments is required, an idea that is recognised and pursued through the concept of integrated coastal zone management.

The ocean's dynamism creates difficulty in distinguishing between natural variation and induced change, meaning that the simple identification of a threat can be problematic. This is further aggravated by sparse baseline information for marine communities. This information deficit largely stems from the fact that the marine environment is an alien one and presents many practical obstacles to research and monitoring.

To date, attempts at marine conservation unlike terrestrial ones, have tended to be species or activity based, or where a harmful effect can be demonstrated. In general, where Marine Protected Areas (MPAs) have been implemented their strength is on paper rather than in practical protection. This is because many people are reluctant to accept any restrictions on use of their common marine resource. The designation of MPAs needs voluntary agreements to provide effective protection. Achieving this requires a long process of consultation and negotiation (e.g. The United Nations Law of the Sea Convention (UNCLOS) took eighteen years of negotiation just for members to agree on the text of the convention). For these reasons, marine conservation has lagged far behind terrestrial efforts.

1.4.2. The Nature of Cetaceans

Cetaceans are by nature long-lived, mobile, wide-ranging marine mammals. In addition, they spend a majority of their time underwater, during which they are largely undetectable to observers. There are, therefore, logistical limitations in undertaking direct field investigations of cetaceans, including the large financial input that is required, and dependence upon fair weather for gathering reliable data. This is particularly relevant in West Scotland, data are temporally limited to the summer months as a result of unpredictable weather. For these reasons there is a general lack of scientific knowledge about cetaceans (Mayer & Simmonds, 1996) and basic information about many cetacean species, in particular offshore ones, is limited. This has major implications for their conservation and management, as it reduces our power to make effective conservation decisions. The longevity of cetaceans means that it is very difficult to detect any population trends that may be occurring. It was estimated that it would take 11 years of annual surveys to detect a decline of 5% per annum in the population of the Moray Firth bottlenose dolphins (Wilson *et al*., 1999). The wide ranging nature of cetaceans means they are subject to many different sources of disturbance and pollution at different times of their lifetime, making the assessment of potential threats difficult as causal links rarely exist, instead threats are often interactive. Their mobility also means cetaceans have requirements and vulnerabilities that change over time and space. Consequently their management and conservation needs may not be constant over time (Kenchington, 1990). Cetaceans occupy the upper echelons of the food chain. By conserving these top predators, the protection enacted will also indirectly benefit species of lower trophic levels and cetacean-associated marine habitats.

Another important aspect of the nature of cetaceans is that they have come to enjoy a high public profile, this has significant implications for what conservation actions are called for.

Implications for cetacean conservation

The wide-ranging nature of cetaceans, across international boundaries, can create barriers to conservation. Therefore, there is little point in protecting a species in one area only to have it under threat in another location. This issue has long been recognised and has catalysed international cooperation for cetacean conservation. If conservation is to be successful, countries must act together. This is a trend which is becoming increasingly common, reflected in global agreements such as UNCLOS, the Biodiversity Convention and the Bonn Convention (*Chapter 3*).

As stated previously, ecological data available for cetaceans are limited, and often what is available is subject to large levels of variance. This means that it is very difficult to establish causal links with cetacean mortalities and decline and considerable scientific uncertainty arises, especially when considering the synergistic functioning of many threats posed. Due to this conservation action is often not undertaken. This is mainly because of institutional preference for the provision of causative proof (Thompson, 1992, 1994; Mayer & Simmonds, 1996). In the absence of such proof the decision-making body has two options: either take no action until the science is certain, which as the Moray Firth example illustrates may be too late; or, take a precautionary approach to conservation. The precautionary principle is an increasingly common basis for decision making since the ratification of the Biodiversity Convention. The UK Government, and its respective bodies, have yet to take this onboard with respect to the marine environment.

The diversity of threats posed to cetaceans means that regulation and management is the responsibility of a wide range of bodies. None of which have cetacean conservation as a primary objective, nor take into account the interactive nature of many threats. Acceptable levels of an individual threat are very different from the acceptable levels of combined threats. Integrative management of threats is rare and traditional sectorial management may not be sufficient to provide the level of protection needed for cetaceans.

Before conservation action can be initiated its objectives need to be defined, this can be heavily influenced by public perception. There is strong public feeling when it comes to cetaceans and this can demand rigorous conservation measures to be implemented, often entailing complete protection. Such an objective, which requires control of a diverse set of interests, is difficult to fulfil because restrictions are not easily accepted, especially when there is little scientific basis. However, the high profile afforded to cetaceans and their broad appeal may help the implementation and promotion of such conservation measures.

2. Cetacean Species in the Hebrides

2.1. INTRODUCTION

To date, twenty-three species of cetaceans have been reported in Hebridean waters, these are listed below in Table 1. This section reviews the data sources currently available regarding the different cetacean species found in the study area and assesses their distribution. The aim of this review is to identify which areas are important habitats for each species, and for areas where information is lacking.

Table 1. Diversity and occurrence of cetacean species in the Hebrides.

COMMON NAME	*LATIN NAME*	GAELIC NAME	OCCURRENCE
ODONTOCETES			
Harbour porpoise	*Phocoena phocoena*	Peileag	Common
White-beaked dolphin	*Lagenorhynchus albirostris*	Deilf-gheal-ghobach	Common
Risso's dolphin	*Grampus griseus*	Deilf-risso	Common
Common dolphin	*Delphinus delphis*	Deilf	Common
Bottlenose dolphin	*Tursiops truncatus*	Muc-bhiorach	Common
Killer whale	*Orcinus orca*	Mada-chuain	Common
Long-finned pilot whale	*Globicephla melaena*	Muc-mhara-chinn-mhoir	Common
Atlantic white-sided dolphin	*Lagenorhynchus acutus*	Deilf-chliathaich-ghil	Uncommon
Striped dolphin	*Stenella coeruleoalba*	--	Uncommon
Northern bottlenose whale	*Hyperoodon ampullatus*	--	Uncommon
Cuvier's beaked whale	*Ziphius cavirostris*	--	Uncommon
Sperm whale	*Physeter macrocephalus*	Muc-mhara-sputach	Uncommon
Sowerby's beaked whale	*Mespplodon bidens*	--	Rare
Fraser's dolphin	*Lagenodelphis hosei*	--	Very Rare
False killer whale	*Pseudorca crassidens*	--	Very Rare
Narwhal	*Monodon monoceros*	Bian-na-agroguig	Very Rare
Beluga whale	*Delphinapterus leucas*	--	Very Rare
MYSTICETES			
Minke whale	*Balaenoptera acutorostrata*	Muc-mhara-mionc	Common
Fin whale	*Balaenoptera physalus*	Muc-an-sgadain	Uncommon
Sei whale	*Balaenoptera borealis*	Muc-mhara-sei	Uncommon
Humpback whale	*Megaptera novaeangliae*	Muc-mhara-crotach	Rare
Blue whale	*Balaenoptera musculus*	Muc-mhara-mhor	Rare
Northern right whale	*Eubalaena glacialis*	--	Very Rare

2.2. SOURCES OF DATA

Information on the distribution of cetaceans in the Hebrides is derived from two main sources: sighting and stranding data that are discussed below. Limited offshore information is also available (Clark & Chariff, 1998; Lewis *et al.*, 1998).

2.2.1. Sightings Data

Standard methods for recording cetacean sightings were introduced in 1973 when the UK Mammal Society Cetacean Group set up a national sightings database. Prior to this, sightings, going back to 1946, were largely opportunistic, scant, with very patchy coverage. Today a national network of observers regularly report cetacean sightings throughout the UK. The problems of unreliable species identification have been addressed through the development of standardised sightings forms and identification guides. The database is an ongoing scheme maintained and periodically analysed by the Sea Watch Foundation (SWF) to produce seasonal distribution maps. For this current study information has been obtained from this database from 1979 to 1999, throughout the study area. The database incorporates data from the regional SWF co-ordinator, the Hebridean Whale and Dolphin Trust (HWDT), who since 1989 have been collecting cetacean sightings data in conjunction with local whale-watching operations. In 1997, HWDT set up '*Operations Sightings*', a scheme to expand the number of sources of cetacean sightings data, which included data collected by fishermen, yachtsmen, wildlife tour operators and the general public, therefore increasing cetacean reporting coverage in the Hebrides. The majority of sightings are centred in the waters around Mull, Coll and Muck due to higher levels of observer effort in these areas, and this may skew distribution patterns observed. The SWF database also includes data from dedicated cruises in the Minches and the Sea of Hebrides which have been undertaken every summer from 1992 to the present by SWF (Boran *et al*., 2000). The entire SWF database comprises over 10,000 sightings in the Hebridean region.

The sightings data was plotted using DMAP for Windows (© Andrew Morton). Distribution maps were then produced for each species and are fully discussed in *Section 2.3*. Although providing a good idea of distribution of different species throughout the area such information does has its limitations. No estimate of abundance can be made from the data as the majority of the sightings are not accompanied by an indication of search effort. Although the region is well covered, its sightings records for some areas are sparse and the distribution of sightings effort is not even.

2.2.2. Strandings data

The Natural History Museum has maintained cetacean stranding records since 1913. In 1992 the responsibility in Scotland was passed to the Scottish strandings co-ordinator operating from the Scottish Agricultural College Veterinary Investigation Centre (SACVIC). Data prior to 1992 is scant and largely opportunistic. After 1992, a formal national strandings scheme was implemented and since this point, strandings in West Scotland have increased from 17 in 1990 to an average of 150 per year (R. Reid, pers. comm.). Results derived from this national scheme, from 1992 to the present, are due to be published in the near future.

All published strandings data for the Hebrides have been collated from 1913 up to 1992 (Harmer, 1914, 1915, 1916, 1917, 1918, 1919, 1921, 1923, 1925, 1927; Fraser, 1934, 1946, 1953, 1974; Sheldrick, 1989; Sheldrick *et al.*, 1994). Maps have been produced for each species using DMAP. Strandings information provides a useful historic baseline that indicates the general distribution of species. Strandings also provide definite identification for species occurring in the region, whereas the identification of live animals can be subject to error, especially when identifying rare or offshore species. The Scottish strandings co-ordinator is informed of all known strandings but it is likely that a large number go unreported, especially in the remote, inaccessible and unpopulated areas of the Hebrides.

2.3. DISTRIBUTION

General localities favoured by cetaceans in the Hebrides include the continental shelf edge; areas with uneven bottom topography (e.g. the Stanton and Shiant banks); the Sounds between islands and neighbouring islands (e.g. the Monachs, Flannans and St. Kilda); protruding headlands (e.g. Butt of Lewis, Eye Peninsula and Barra Head); and offshore fishing banks (Evans, 1997a,b). These are all areas where strong tidal streams pass over a complex seabed producing an upwelling of nutrients. Plankton concentrations increase in nutrient rich waters, acting as a food source for fish species that in turn attracts cetaceans. Spatial and temporal patterns of distribution are governed by lifecycles of prey species (Evans *et al*., 1993).

Species-specific distribution from sightings and strandings data is discussed in the following sections, in which only positively identified sightings have been mapped. This, therefore, gives an under estimate of sightings due to difficulty in identification of some species especially those which are less common.

Only published strandings from 1913-1992 are included in the study as it provides a consistent time series of the entire Hebrides. Other strandings have been published and reported since this date, but only for limited areas such as the Western Isles (Bones & Maclennan, 1994a,b). However, inclusion of this data would introduce a bias towards these areas.

2.3.1. Harbour porpoise (*Phocoena phocoena*)

Porpoises are common and widely distributed in nearshore waters (Fig. 2). Group sizes are usually 1-2, although aggregations of over 50 do occur (Evans, 1997b). Peak numbers occur from August to September (Boran *et al*., 2000). Areas where harbour porpoises are regularly observed include; Sounds of Barra, Vatersay, Sandary, Pabbay, Mingulay, Berneray, Monach, Flannans, Harris; the Shiant Isles; Lochs Roag, Tarbet, Maddy and the Little Minch (Evans, 1997b).

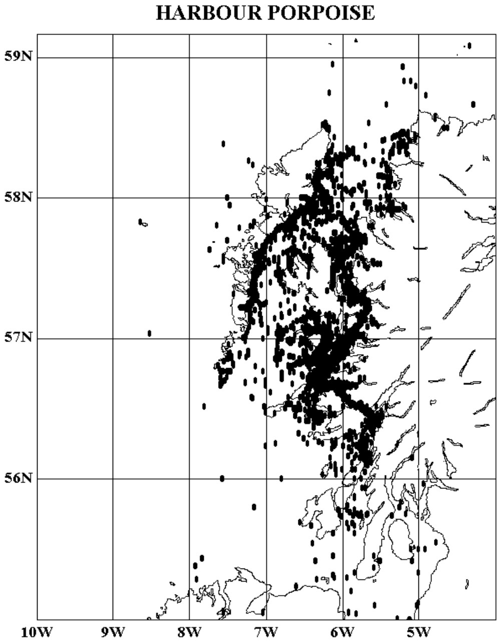


Fig. 2. Harbour porpoise sightings1979-1999.

They also occur in mainland Lochs Duich, Hourn, Nevis, Carron, Torridon, Gairloch, Ewe, Broom, Laxford and Inchard; Sea of Hebrides; North Minch; Sounds of Sleat and Raasay; the Small Isles and the coastal waters of Skye (Evans, 1997b). The Sound of Mull including Duart Point, Salen, Grasspoint and Bloody Bay has resident populations (E.C.M. Parsons pers. obs.). The coastal waters of the Firth of Lorn; Sound of Jura; Kilbrannan Sound; Kyles of Bute; Coll; Tiree; the Treshnish Isles; Colonsay; Oronsay; Islay and Arran are also inhabited by porpoises (Evans, 1997a). Acoustic surveys off the Outer Hebrides rarely detected porpoises in water deeper than 200m (Lewis *et al*., 1998). Eleven strandings of porpoises have been recorded (Fig. 3), this is a relatively low number considering their widespread abundance. Strandings are predominantly in the south, an area for which there is little corresponding distribution data.

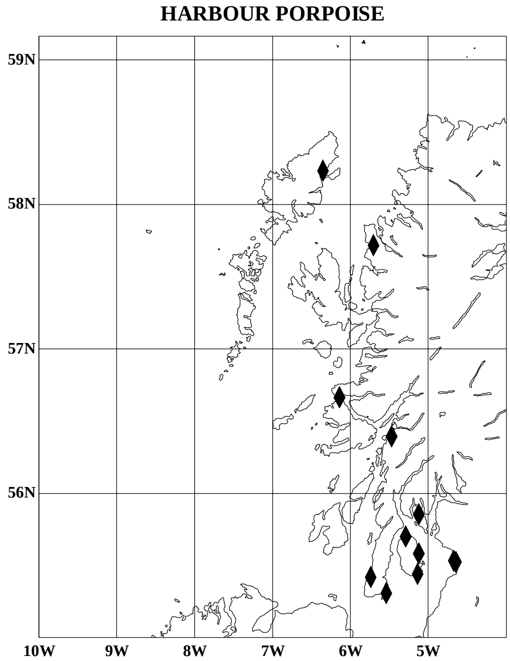


Fig. 3. Harbour porpoise strandings 1913-1992.

2.3.2. Bottlenose dolphin (*Tursiops truncatus*)

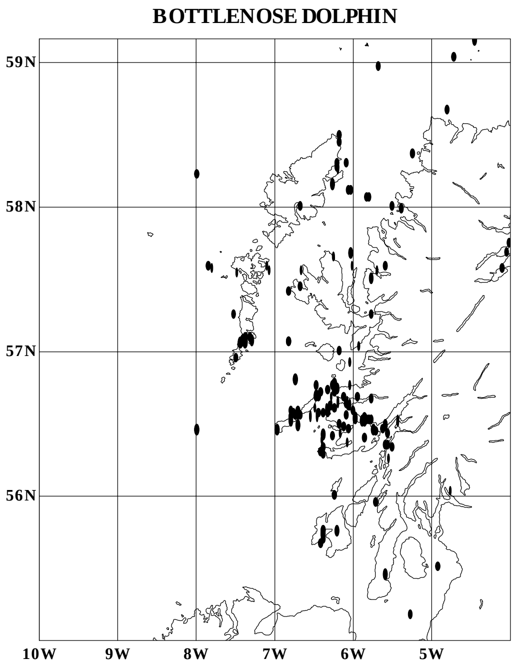


Fig. 4. Bottlenose dolphin sightings1979-1999.

Evans (1997b) describes bottlenose dolphins as being uncommon with only occasional sightings around Barra and South Uist. HWDT have since identified a group of bottlenose dolphins regularly sighted around Mull, Coll, Tiree and the Ardnamurchan peninsular. A resident group that inhabits the coastal waters of Barra has also been confirmed (Fig. 4) and another group may also be present in the coastal waters of Islay.
Sightings of bottlenose dolphins are mainly in nearshore waters and are widespread throughout the Hebrides. More survey work may highlight additional groups that are currently unknown. Three published strandings have been recorded (Fig. 5) However, HWDT have investigated two strandings on Mull in 1999 alone.

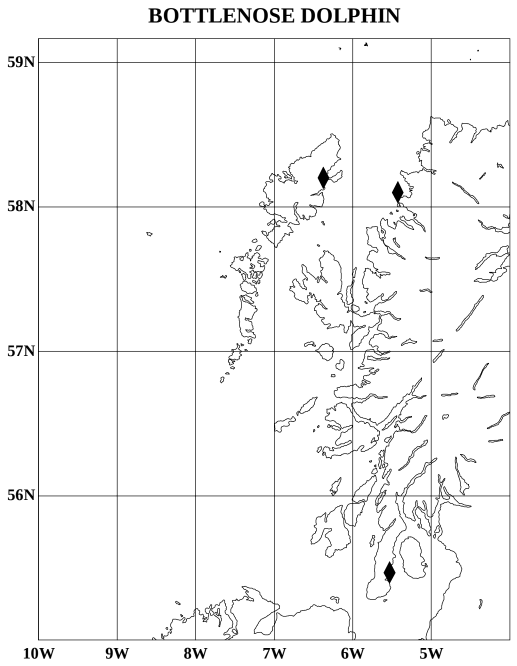


Fig. 5. Bottlenose dolphin strandings 1913-1992.

2.3.3. Common dolphin (*Delphinus delphis*)

Common dolphins are mainly sighted in the Sea of Hebrides south of Skye (Fig. 6) and utilise both inshore and offshore waters. Observations peak in June, early July, then sharply decline in August (Boran *et al*., 2000). Areas of particular importance are the Stanton banks and the south and east Sea of Hebrides (Evans, 1997b). Group sizes are usually between 8-10 but up groups of up to 350 can occur (Boran *et al*., 2000). Seven strandings have been published, (Fig. 7) widely distributed throughout the Hebrides.

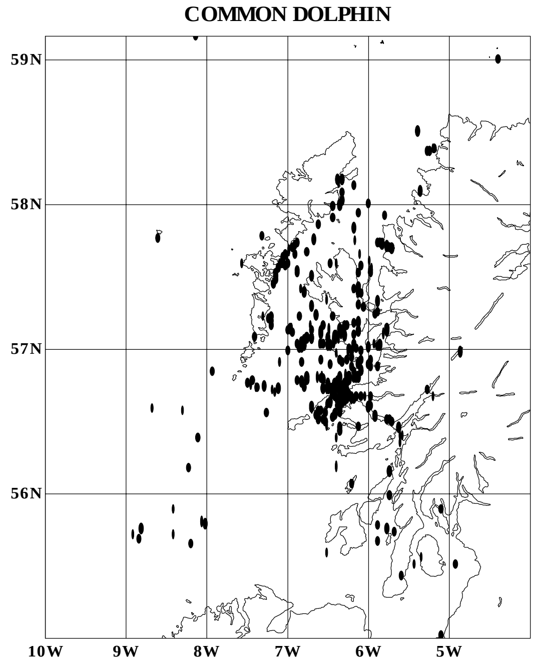


Fig. 6. Common dolphin sightings 1979-1999.

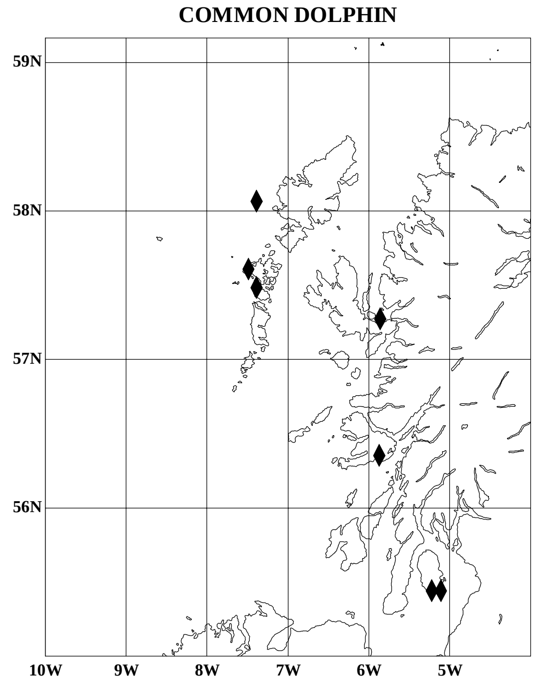


Fig. 7. Common dolphin strandings 1913-1992.

2.3.4. White-beaked dolphin (*Lagenorhynchus albirostris*)

White-beaked dolphins are predominantly distributed through the coastal waters of the Northern Minch and down the west of the Sea of Hebrides near Barra. They are also commonly observed in deeper offshore waters. (Fig. 8). They are found in association

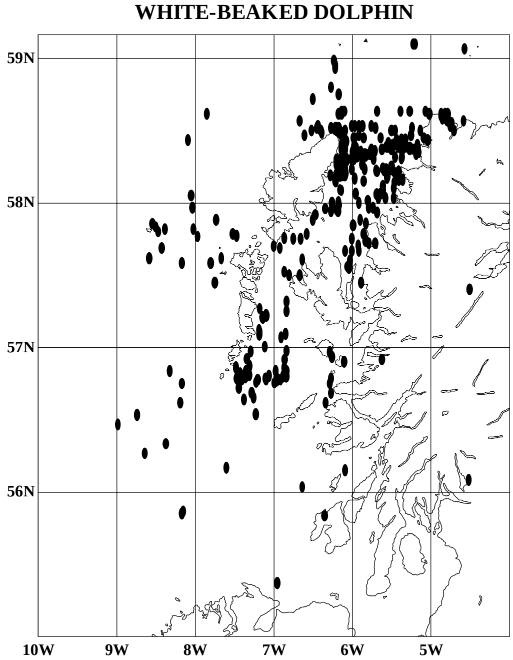


Fig. 8. White-beaked dolphin sightings 1979-1999.

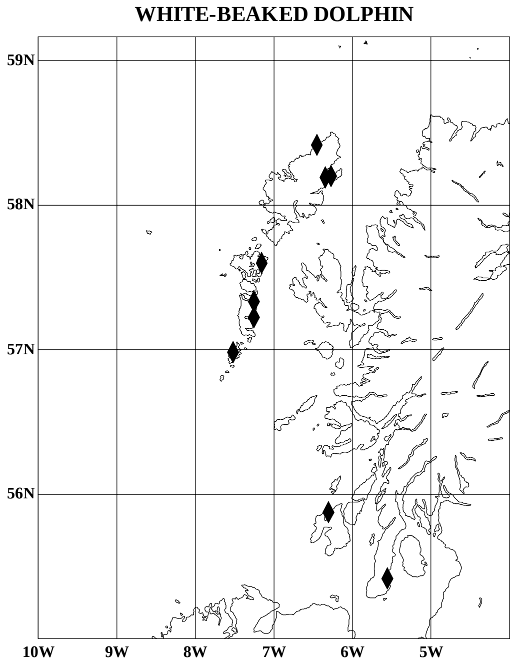


Fig. 9. White-beaked dolphin strandings 1913-1992.

with seasonal concentrations of mackerel (Evans, 1997b). The distribution of common dolphins and white beaked dolphins can be seen to be broadly allopatric (Boran *et al.*, 2000). Peak numbers appear in August to early September with group sizes ranging from 4-5, up to 50 (Boran *et al.*, 2000). Nine strandings have been recorded (Fig. 9), occurring mainly in the Outer Hebrides correlating with a predominantly northerly distribution.

2.3.5. Atlantic white-sided dolphin (*Lagenorhynchus acutus*)

Atlantic white-sided dolphins are uncommon with a sparse distribution. Being more pelagic species they are distributed mainly in deeper waters west of the Outer Hebrides, occurring sometimes in the Sea of Hebrides, particularly around Barra (Fig. 10). However, when sighted they appear in large aggregations of 100-1000, peak times are July and August (Evans, 1997b). Seven strandings have been recorded (Fig. 11).

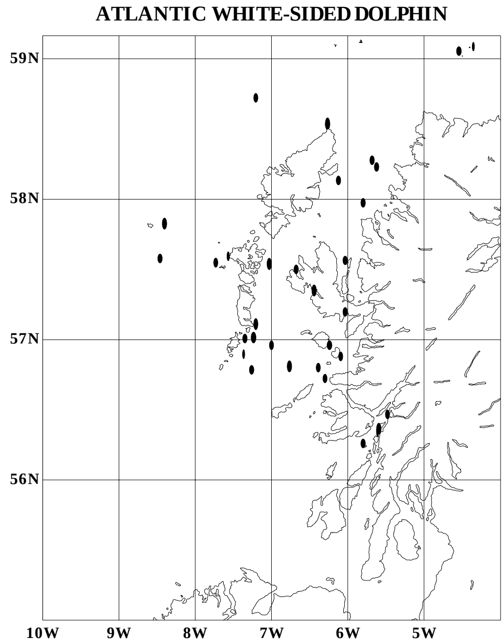


Fig. 10. Atlantic white-sided dolphin sighting 1979-1999.

2.3.6. Risso's dolphin (*Grampus griseus*)

Risso's dolphins are distributed predominantly along the east of the Outer Hebrides from the Butt of Lewis to Barra Head. Sightings also occur further east towards Canna, Coll and Tiree and offshore west of the Outer Hebrides (Fig. 12). They exhibit a strong fidelity to the Eye Peninsula and Tiumpan Head (Atkinson *et al.*, 1998) and research conducted by Atkinson *et al.* (1998) between 1992-1997 positively identified 142 individuals around the Eye peninsula. Risso's are regularly sighted around Southeast Harris and off Neist Point, Skye (Evans, 1997b). They occur in May to July following their main prey item, octopus (Atkinson *et al.*, 1998).

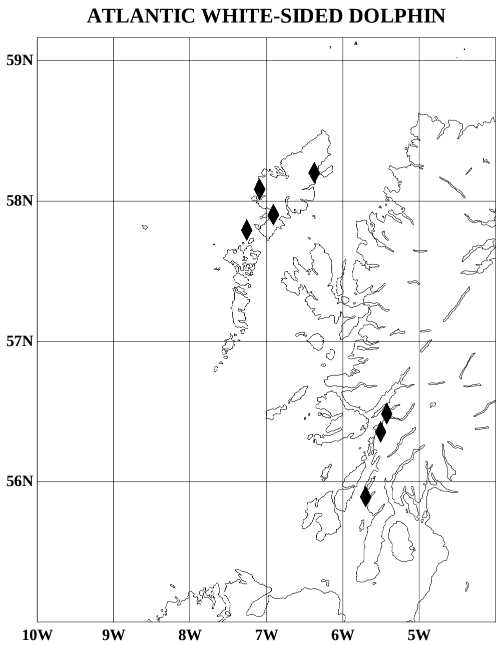


Fig. 11. Atlantic white-sided dolphin strandings 1913-1992.

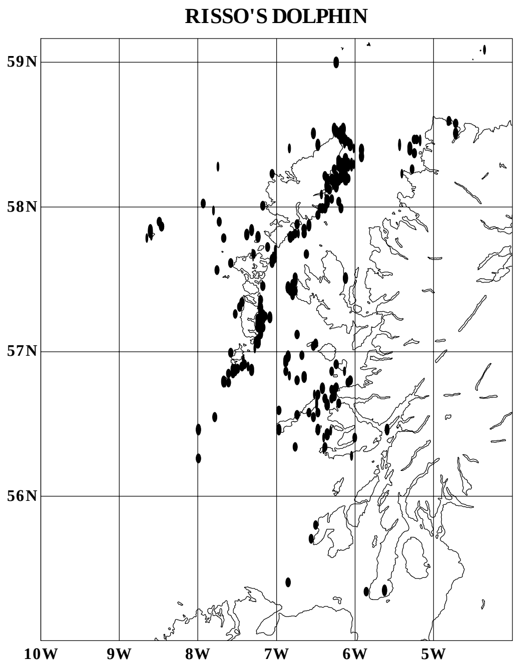


Fig. 12. Risso's dolphin sightings 1979-1999.

Ten strandings have been published (Fig. 13) largely in south Hebrides, in opposition with the main distribution patterns.

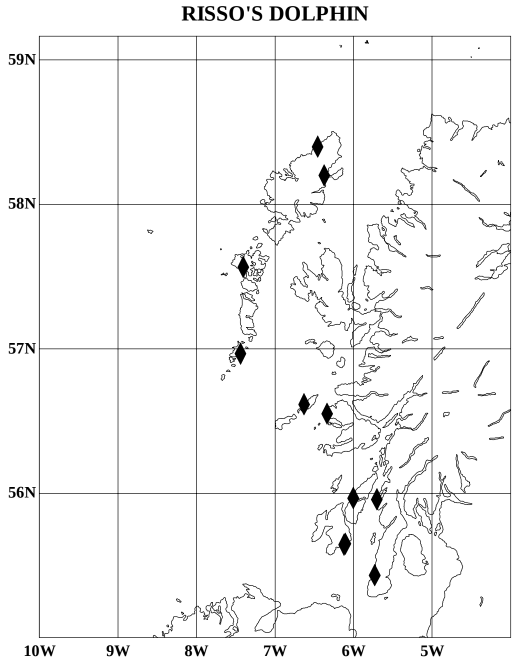


Fig. 13. Risso's dolphin strandings 1913-1992.

2.3.7. Striped dolphin (*Stenella coeruleoalba*)

Striped dolphins are uncommon in the Hebrides with only three positive sightings being made, all in inshore waters (Fig. 14).

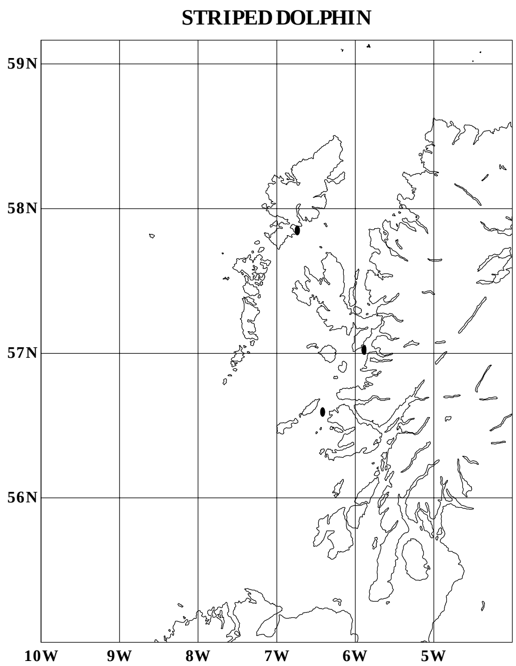


Fig. 14. Striped dolphin sightings 1979-1999.

Six strandings have been recorded distributed widely throughout the area (Fig. 15).

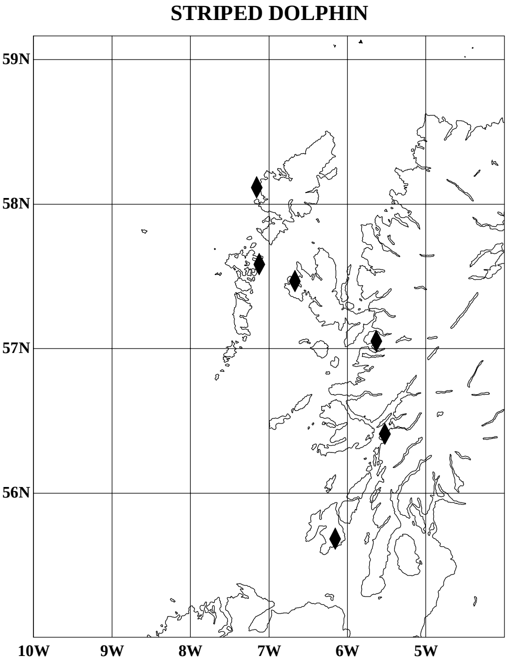


Fig. 15. Striped dolphin strandings 1913-1992.

2.3.8. Northern bottlenose whale (*Hyperoodon ampullatus*)

Northern bottlenose whales are uncommon in the Hebrides with the few sightings being confined mainly to inshore waters of central Hebrides, notably Skye (Fig. 16). Two whales were observed in Broadford Bay, Skye for three weeks in August 1998. Prior to this, individuals were sighted in Portree harbour, Skye in November 1994 (Evans, 1997b). Bottlenose whales could be more common in the Hebrides, however due to their mainly deep water nature and long dive duration many sightings of bottlenose whales could easily be missed or incorrectly identified. Historical evidence of northern bottlenose whales comes from commercial whaling records when 77 whales were caught between 1904-1928 and 1950-1951 (Thompson, 1928; Brown, 1976). Twelve strandings have been reported (Fig. 17).

2.3.9. Cuvier's beaked whale (*Ziphius cavirostris*)

Cuvier's beaked whales are rare in the Hebrides with only one positive sighting made near Skye (Fig. 18). However, Cuvier's beaked whales are very difficult to positively identify, therefore unless the observer has a high level of identification expertise, misidentification is likely. In comparison, an unusually high number of strandings have been recorded,

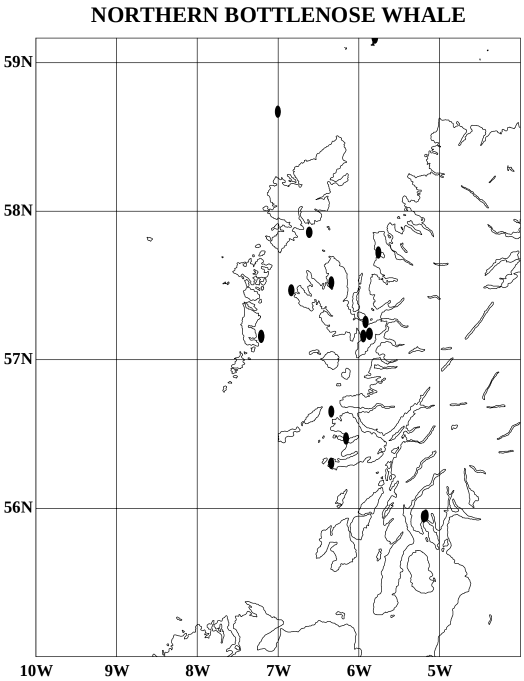


Fig. 16. Northern bottlenose whale sightings 1979-1999.

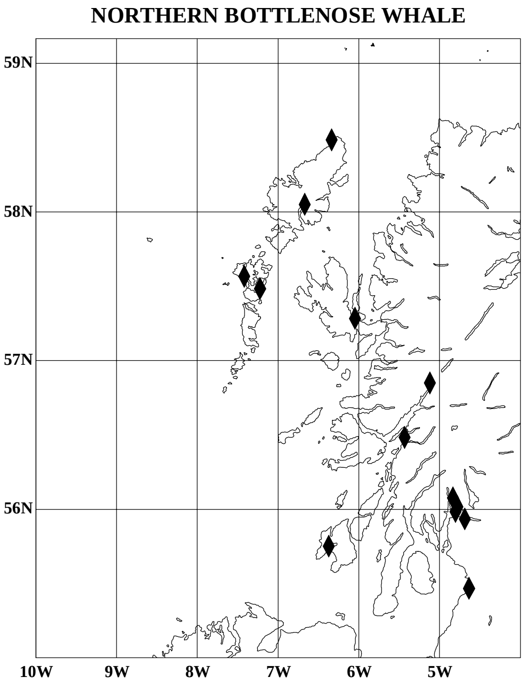


Fig. 17. Northern bottlenose whale strandings 1913-1992.

sixteen in total between 1920 and 1987, along the west coasts of islands (Fig. 19). This indicates that they may be more common than sightings data illustrates.

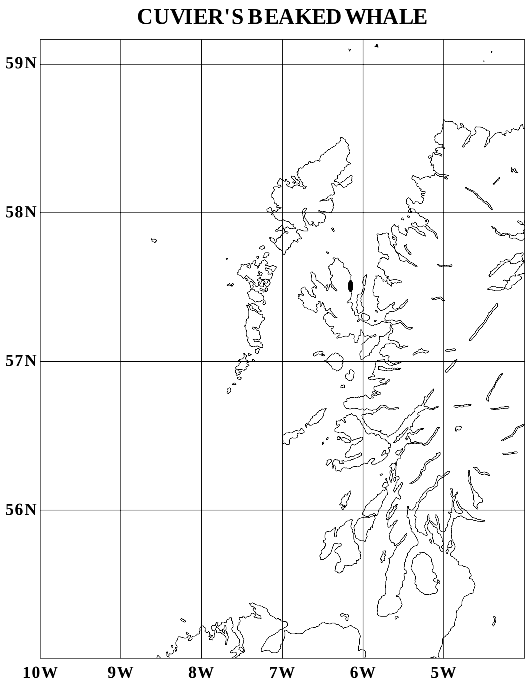


Fig. 18. Cuvier's beaked whale sightings 1979-1999.

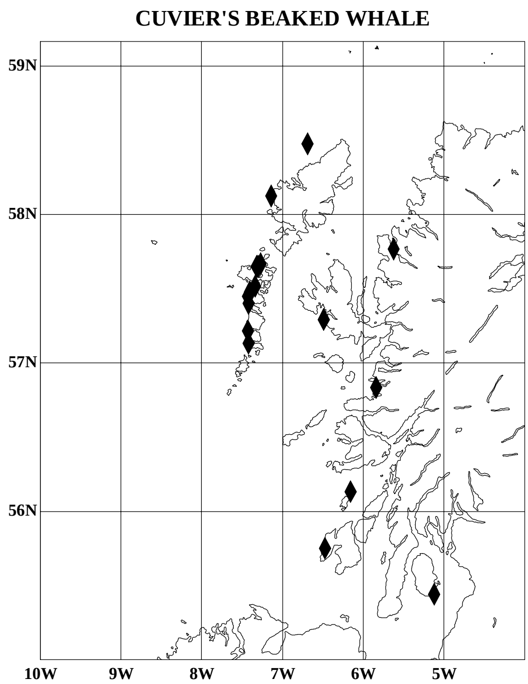


Fig. 19. Cuvier's beaked whale strandings 1913-1992.

2.3.10. Sperm whale (*Physeter macrocephalus*)

Sperm whales are predominantly offshore species, acoustic surveys indicate abundance was highest in waters >500m north west of

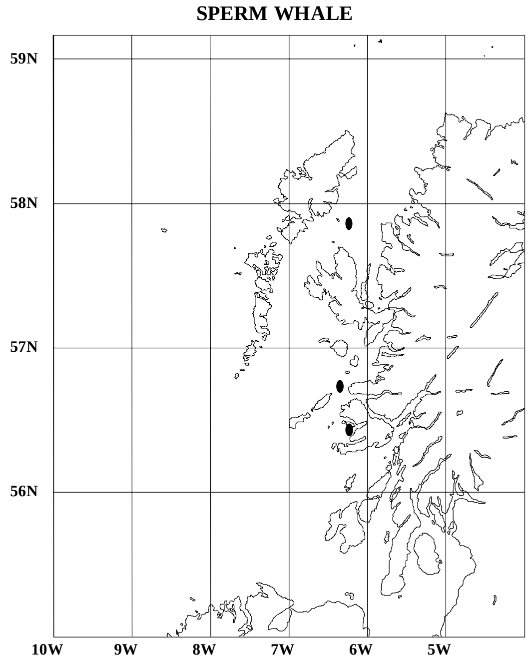


Fig. 20. Sperm whale sightings 1979-1999.

Lewis (Lewis *et al.*, 1998). Consequently sightings within the Hebrides are relatively rare, with only three positive sightings (Fig. 20). Thirteen strandings have been recorded mainly along the West coast of the Uists and Barra (Fig. 21). This is the expected pattern for an offshore species.

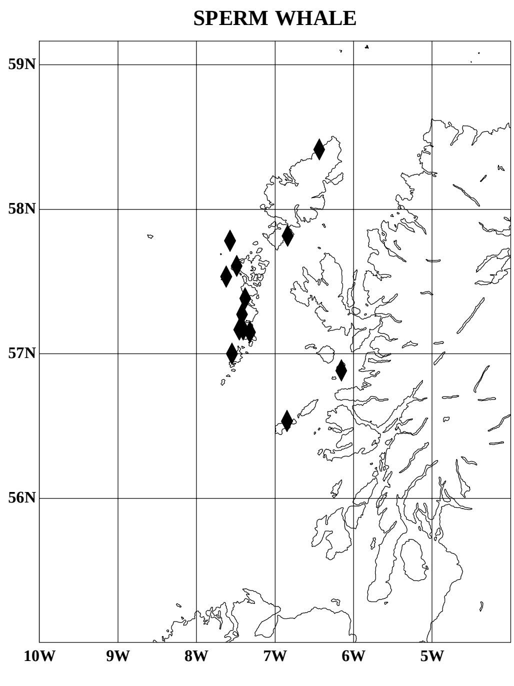


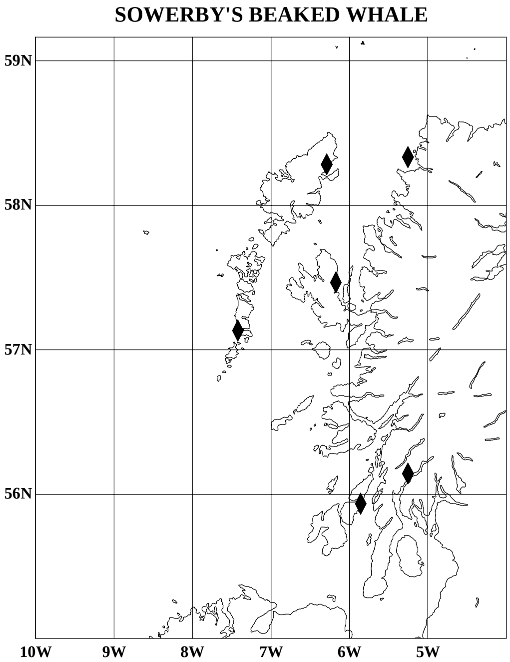
Fig. 21. Sperm whale strandings 1913-1992.

2.3.11. Pygmy sperm whale (*Kogia breviceps*)

Pygmy sperm whales are a deep water species occurring in tropical and warm temperate waters. To date, no sightings of live pygmy sperm whales have been made in the Hebrides. The first confirmed record of this species in West Scotland was on 18th October 1999, when an adult and calf were stranded north of Stranraer.

2.3.12. Sowerby's beaked whale (*Mesoplodon bidens*)

Sowerby's beaked whale has not been positively sighted in the Hebrides. Again, this is not surprising due to difficulty in identification. However they are present in Hebridean waters, indicated by six stranding



reports (Fig. 22).

Fig. 22. Sowerby's beaked whale strandings 1913-1992.

2.3.13. Fraser's dolphin (*Lagenodelphis hosei*)

A Fraser's dolphin, native to tropical/ subtropical waters of the Pacific, was stranded fresh on South Uist, September 1996. The fresh state of the animal indicated that it had been alive in Scottish waters (Bones *et al.*, 1998). Apart from this event no sightings or strandings have been recorded.

2.3.14. Long-finned pilot whale (*Globicephala melas*)

Long-finned pilot whale sightings are distributed sparsely throughout the Hebrides in nearshore waters, especially around the Small Isles and also in offshore waters (Fig. 23). They occur in groups of between 10-50 (Evans, 1997b). They are the most commonly stranded cetacean with 23 strandings recorded widely distributed throughout the Hebrides (Fig. 24). Eleven of these strandings occurred on Lewis in 1992.

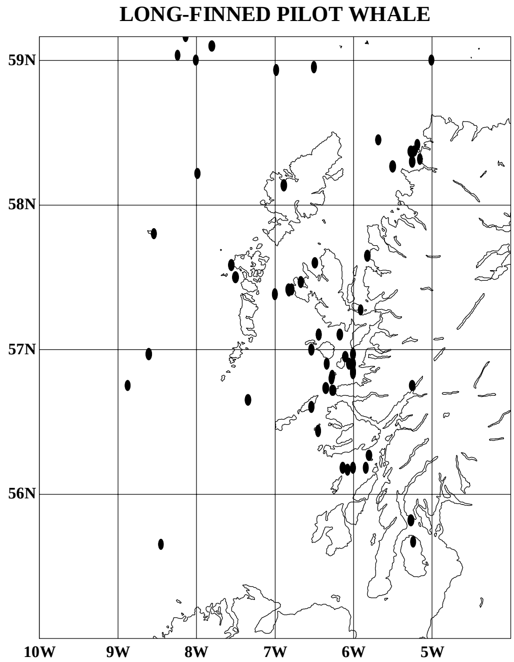


Fig. 23. Long-finned pilot whale sightings 1979-1999.

2.3.15. Narwhal (*Monodon monoceros*)

One sighting has been made of a narwhal in Hebridean waters, near Skye in 1976 (Fairweather, 1976). No strandings have been recorded and this species is considered transitory to the area.

2.3.16. Beluga whale (*Delphinapterus leucas*)

The beluga whale has only been sighted once in the Hebrides in April 1995 where it was observed for 3 days in Loch Duich and the coastal waters of East Raasay (Evans, 1997b). No strandings have been recorded and this species is thought to be transient to the Hebrides.

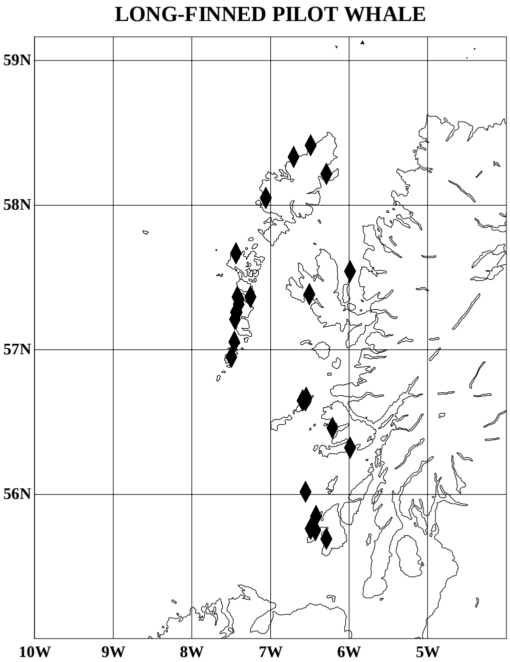


Fig. 24. Long-finned pilot whale strandings 1913-1992.

2.3.17. Killer whale (*Orcinus orca*)

Killer whales are regularly sighted throughout the Hebrides, predominantly in the Little Minch, West of Skye and in the Sea of Hebrides, around the Small Isles and down past Coll, Tiree, the Treshnish Isles, Staffa and Iona and as far south as the Mull of Kintyre (Fig. 25). Groups of 2-10 have been sighted throughout the Hebrides with several individuals being re-sighted year to year, indicating consistent use of area (Evans et al., 1993). One identifiable animal, '*John Coe*', has been sighted consistently since 1982 from Islay to Northern Skye. Eleven strandings have been recorded (Fig. 26).

2.3.18. False killer whale (*Pseudorca crassidens*)

The false killer whale has only been positively identified twice in the Hebrides, both times off of the Isle of Skye: once off of Neist Point (NW Skye) and once in Knock bay (SE Skye). No strandings have been recorded and it is considered a transitory species to the area.

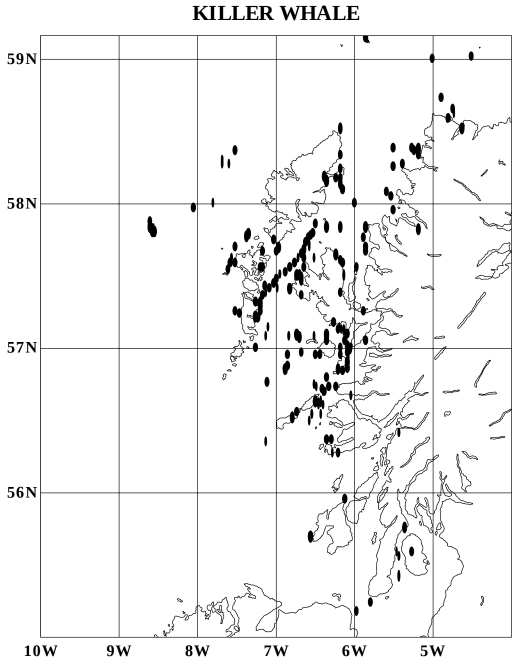


Fig. 25. Killer whale sightings 1979-1999.

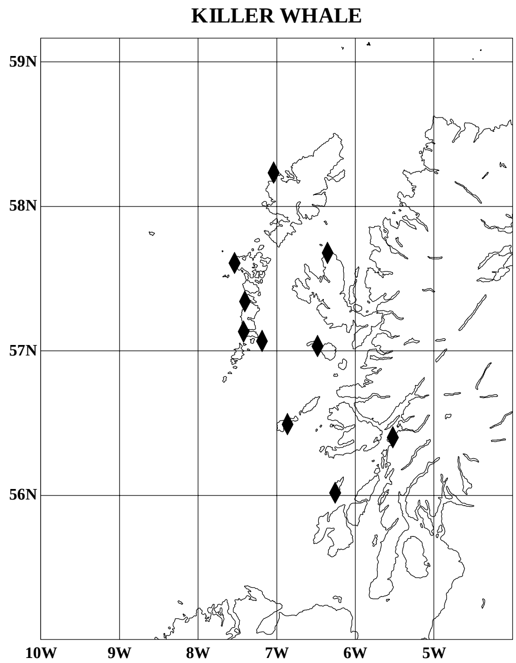


Fig. 26. Killer whale strandings 1913-1992.

2.3.19. Fin whale (*Balaenoptera physalus*)

Fin whales are predominantly offshore and are the most commonly acoustically detected cetaceans on the Atlantic Frontier (Clark & Chariff, 1998). They have been detected all year round with high levels from October to January (Clark & Chariff, 1998). Occasional sightings have been recorded in nearshore waters throughout the Hebrides from Harris to the Mull of Kintyre (Fig. 27). Historically, fin whales were the most commonly caught species in commercial whaling operations in 1904-1928 and 1950-51 when 1538 were caught (Thompson, 1928; Brown, 1976). Five strandings have been recorded along the west coast of Lewis, Harris and the Uists (Fig. 28), the expected pattern for an offshore species.

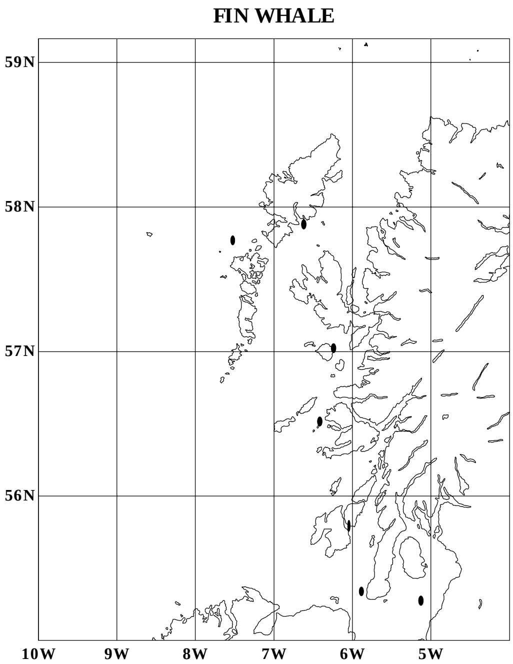


Fig. 27. Fin whale sightings 1979-1999.

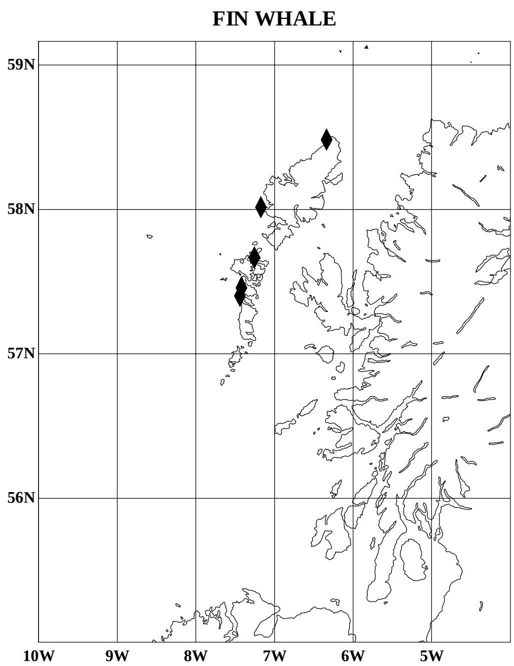


Fig. 28. Fin whale strandings 1913-1992.

2.3.20. Sei whale (*Balaenoptera borealis*)

Sei whales are predominantly offshore species. Occasional sightings have been recorded in nearshore waters of the eastern Hebrides (Fig. 29). Historical evidence of sei whales comes from commercial whaling records when 378 whales were caught between 1904-1928 and 1950-1951 (Thompson, 1928; Brown 1976). Two strandings have been recorded along the west coasts of Lewis and Harris (Fig. 30), the expected pattern for an offshore animal.

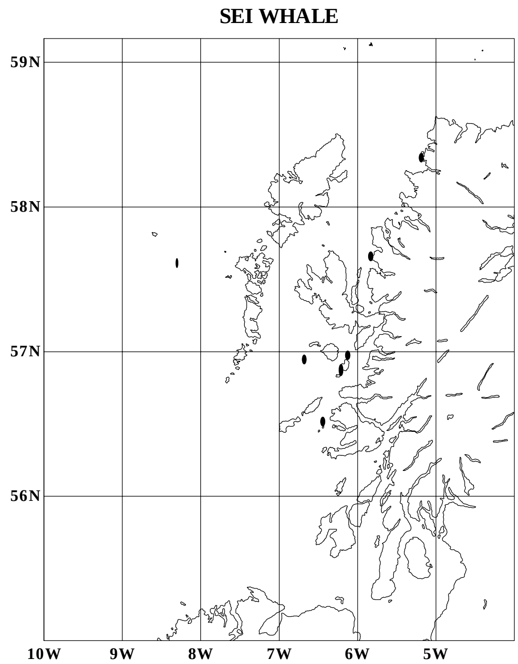


Fig. 29. Sei whale sightings 1979-1999.

2.3.21. Humpback whale (*Megaptera novaeangliae*)

Humpback whales are predominantly an offshore species with occasional sightings in nearshore waters of the Hebrides (Fig. 31). These include a humpback staying for one week in Loch Eynort, Skye in December 1994, and an immature animal in the Firth of Clyde from January to March 1994 (Gill, 1995; Evans, 1997a). Offshore surveys have detected humpbacks with a peak occurrence from January to March, suggesting the importance of the region as a migration route (Clark & Chariff, 1998). One stranding has been recorded, unusually far inshore, at the head of Loch Sunart.

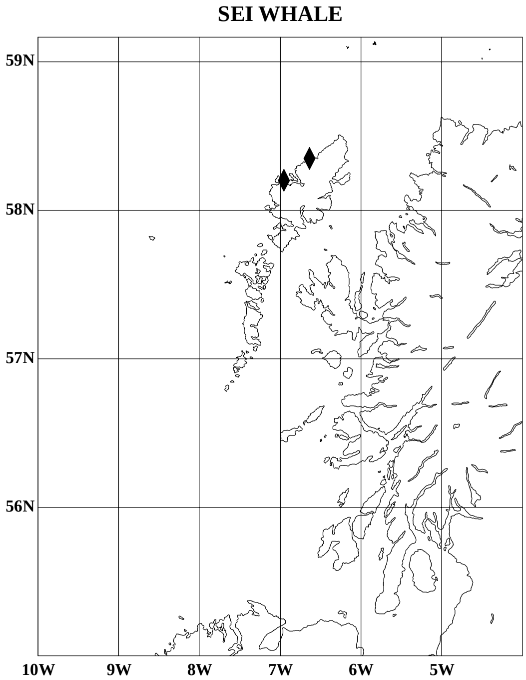


Fig. 30. Sei whale strandings 1913-1992.

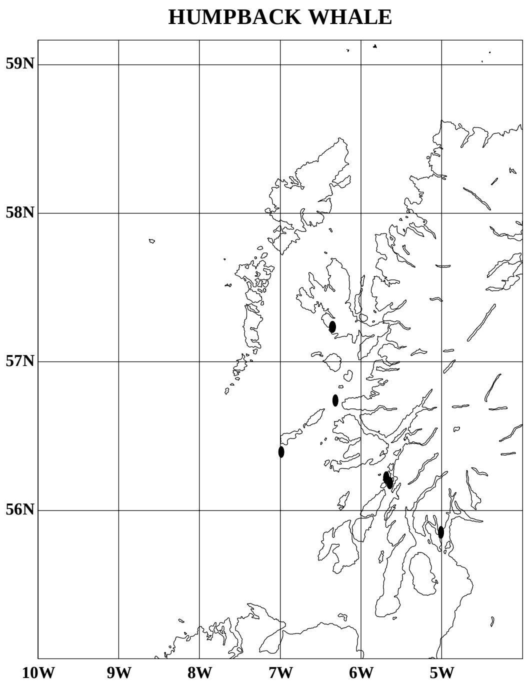


Fig. 31. Humpback whale sightings 1979-1999.

2.3.22. Minke whale (*Balaenoptera acutorostrata*)

The minke whale is the most commonly recorded baleen whale in the Hebrides. It is widely distributed throughout nearshore waters of the Hebrides. High sighting rates are observed in the coastal waters of North Coll, Ardnamurchan Point, the Small Isles, the east coasts of Outer Hebrides from Harris down to Barra and North Raasay, and offshore along the edge of banks in Minches, Sea of Hebrides and around St. Kilda. (Fig. 32). The minke whale is usually observed singly or in pairs (Gill & Fairbairns, 1995, 1996; Leaper *et al.*, 1997), but can occur in aggregations of up to 14 in areas of high prey abundance (Boran *et al.*, 2000). Peak numbers in August to September (Leaper *et al.*, 1997). Research conducted by HWDT (Gill 1994; Gill & Fairbairns, 1995, 1996) has, to date, identified 74 individuals in waters around the Small Isles (A. Gill, unpublished data). These whales are re-sighted year to year (Gill, 1994; Gill & Fairbairns, 1995, 1996) and may have specific territories (A. Gill, unpublished data). Thirteen strandings have been recorded (Fig. 33) and are widely distributed in line with sightings information.

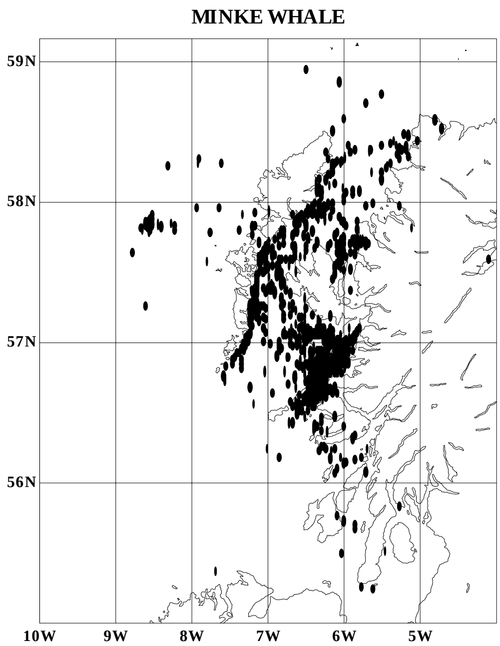


Fig. 32. Minke whale sightings 1979-1999.

2.3.23. Northern right whale (*Eubalaena glacialis*)

One sighting has been made of a northern right whale (Fig. 34), and this deep-water species is considered very rare in the region. No strandings have been reported. Historical evidence of northern right whales comes from commercial whaling records when 94 whales were caught between 1904-1928 and 1950-1951 (Thompson, 1928; Brown, 1976).

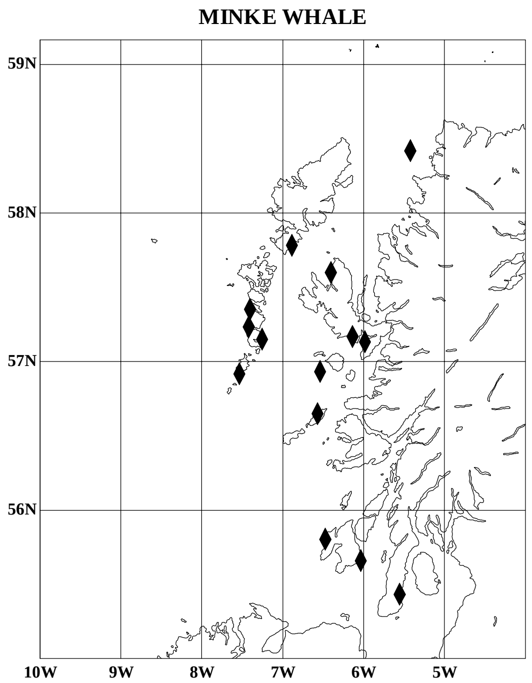


Fig. 33. Minke whale strandings 1913-1992.

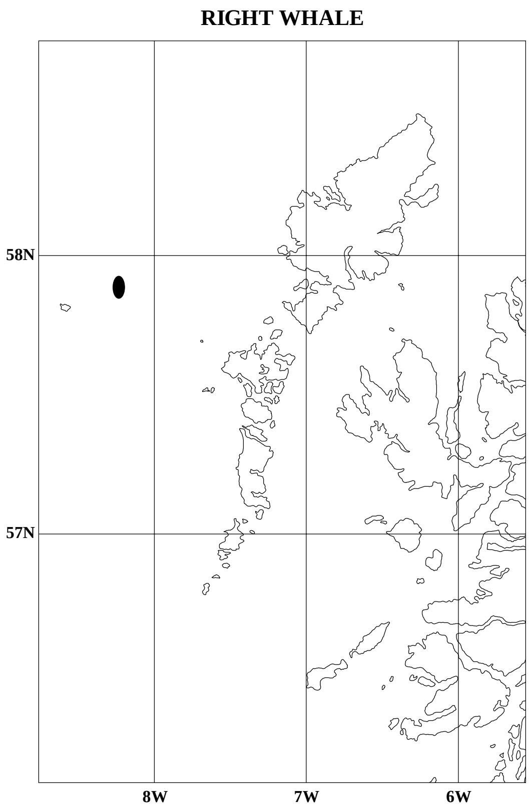


Fig. 34. Northern right whale sightings 1979-1999

2.3.24. Blue whale (*Balaenoptera musculus*)

Blue whales are acoustically detected all year round on the Atlantic Frontier (Clark & Chariff, 1998). Historical evidence of blue whales comes from commercial whaling records which record 316 whales being caught between 1904-1928 and 1950-1951 (Thompson, 1928; Brown, 1976). No sightings of live animals have been made in the Hebrides, although three strandings have been recorded (Fig. 35).

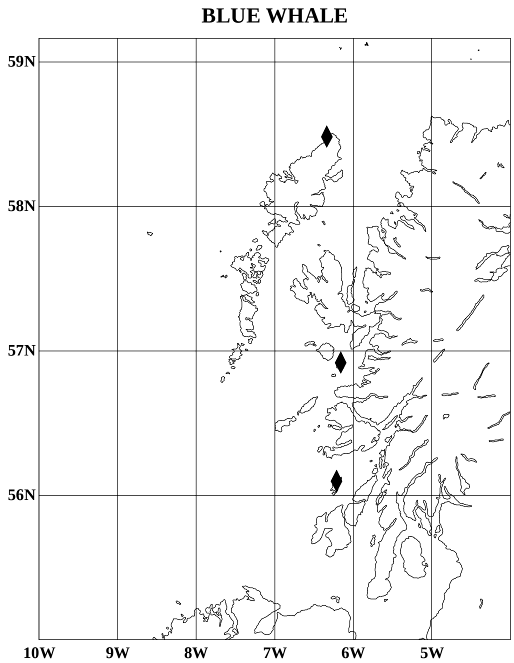


Fig. 35. Blue whale strandings 1913-1992.

2.4. SUMMARY

To date, 23 cetacean species have been reported from the Hebrides. Some of these, such as the beluga whale, narwhal, Fraser's dolphin and false killer whale are transient species, while the remaining species are thought to reside in Scottish waters for at least some part of the year. The most regularly sighted cetaceans in the Hebrides are the harbour porpoise, minke whale, bottlenose dolphin, common dolphin, Risso's dolphin, white-beaked dolphin and killer whale. It is clear that both the offshore and nearshore waters of the Hebrides are a very important location for many different species of cetacean.

Relative to other locations in the UK there is very little known about cetaceans in the Hebrides. Information is limited to broad patterns of distribution and favoured locations of species. Any information regarding absolute abundance, migration movements, habitat requirements and population trends is very sparse due to low levels of research. Some species have been the focus of directed research, and for these populations more detailed information exists. These being:

- minke whales around Mull, Coll and Muck;
- Risso's dolphins around Lewis;
- harbour porpoises in Gairloch; and
- killer whales.

From distribution data it is clear that there are many areas of the Hebrides where little distribution information is available but which, anecdotal and oceanographic evidence indicate, could be rich cetacean habitats. These are:

- south Argyll region, including waters around Colonsay, Islay, Arran and Firth of Lorn;
- coastal waters and offshore waters west of Outer Hebrides;
- offshore waters and fishing banks south of Tiree; and
- waters south and east of Barra.

3. Legal Protection for Hebridean Cetaceans

3.1. INTRODUCTION

To make recommendations for cetacean conservation the existing legislative framework requires reviewing to ascertain levels of legal protection currently afforded to Hebridean cetaceans. How these legislative instruments work and their weaknesses needs to be addressed to identify how they could be strengthened. In light of these issues, this chapter reviews the various agreements, conventions and legislative instruments relevant to cetacean species in the Hebrides. Frameworks that are currently not utilised are also explored. Levels of protection and the conservation status of each species is summarised below (Table 2) and discussed in the following sections.

Table 2. Legal protection and status afforded to Hebridean cetaceans.

Common name	HABITAT	BERN	BONN	CITES*	W&C Act	BIO-DIV	IUCN
ODONTOCETES							
Harbour porpoise	II IV	II	II	II*	V	P	VU
White-beaked dolphin	IV	III	II	II*	V	C	-
Risso's dolphin	IV	II	II	II*	V	C	DD
Common dolphin	IV	II	II	II*	V	C	-
Bottlenose dolphin	II IV	II	II	II*	V	C	DD
Killer whale	IV	II	II	II*	V	C	CD
Long-finned pilot whale	IV	II	II	II*	V	C	-
Atlantic white-sided dolphin	IV	II	II	II*	V	C	-
Striped dolphin	IV	II	II	II*	V	C	CD
Northern bottlenose whales	IV	II	II	I	V	P	CD
Cuvier’s beaked whale	IV	II	II	II*	V	C	DD
Sperm whale	IV	III	-	I	V	P	VU
Sowerby’s beaked whale	IV	II	II	II*	V	C	DD
Fraser’s dolphin	IV	III	-	II*	V	-	DD
False killer whale	IV	II	II	II*	V	C	-
Narwhal	IV	III	II	II*	V	C	DD
Beluga whale	IV	III	II	II*	V	C	VU
MYSTICETES							
Minke whale	IV	III		I	V	P	NT
Fin whale	IV	III		I	V	P	EN
Sei whale	IV	III		I	V	P	EN
Humpback whale	IV	II	I	I	V	P	VU
Northern right whale	IV	II	I	I	V	P	EN
Blue whale	IV	II	I	I	V	P	EN

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.

3.2. INTERNATIONAL CONVENTIONS

As migratory mammals, cetacean habitats range across international borders, with one individual often utilising habitats within several different countries. Many Hebridean species are thought to migrate seasonally in and out, or through, the area. Therefore, international agreement and legislation is essential to provide a co-operative framework for international conservation action for these species. Following are the current international agreements relevant to cetacean protection in the Hebrides.

3.2.1. United Nations Convention on the Law of the Sea (UNCLOS)

UNCLOS came into force on 16 November 1994, with the UK as a signatory. It defines marine zones and the legal controls applicable to each. This has implications for the nature and extent of marine conservation measures that can implemented. The maritime zones, as defined by Warren (1998) are listed below.

- **Internal waters** comprise any waters landward of the low water mark. Under UNCLOS the state has sovereignty over these waters and the resources found there.
- **Territorial sea** is comprised of the maritime waters up to 12nm from the low water mark [art.3]. Within this zone the state has sovereignty but must allow the innocent passage of foreign ships.
- **Exclusive Economic Zone** (EEZ), which encompasses waters within 200nm of the coast. Here the state has no sovereignty but has exclusive rights to exploit the resources that are found there. The UK has no EEZ but, it has claimed an Exclusive Fishing Zone (EFZ) which equates to nearly the same thing.
- Beyond the EFZ are the **High Seas** which are effectively *res nullis*, whereby no form of property rights are applied and are, therefore, open to exploitation by any state.

Under UNCLOS, whales are considered a "*marine living resource*" (Rose, 1996) and part of the economic resources of the sea and any harvesting must be carried out at a sustainable level. In all zones, except for the high seas, states have sovereign rights to exploit these. On the high seas, rights are shared equally between states (Rose, 1996). UNCLOS imposes obligations for the conservation of marine living resources. For migratory marine mammals, states are obliged to study, conserve and manage them within the EEZ and high seas and to *"co-operate with a view to the conservation of marine mammals and in the case of cetaceans shall in particular work through the appropriate international organisation for their conservation, management and study"* (Article 65 and 120, UNCLOS). The direct reference to cetaceans gives significant leverage for conservation measures to be implemented. However, although there is an obligation to conserve cetaceans, states may still commercially exploit them unless they have signed a voluntary agreement to the contrary.

3.2.2. Convention on Trade in Endangered Species of Wild Fauna and Flora (CITES).

CITES came into effect in 1975 with its objective being to prevent exploitative trade of vulnerable and threatened species and their products. Species listed in Appendix I are threatened with extinction and, therefore, commercial trade of these species is banned. Any non-commercial trade must be documented with both export and import permits (Wijnstekers, 1990). Appendix II species are classified as vulnerable, but a limited and controlled trade is allowed. All cetaceans are listed on either Appendix I or II (Table 2). CITES is implemented in the UK via the EC Regulation of Trade in Endangered Species (Council Regulation No. 3626/82). All cetaceans are listed on list C1 of this regulation, meaning that within the UK, no matter what appendix they are listed on, all cetaceans are treated as Appendix I species. Commercial trade is, therefore, prohibited for all cetaceans in the UK.

3.2.3. Berne Convention on the Conservation of Wildlife and Natural Habitats 1979.

The Berne Convention requires signatories to conserve listed flora and fauna and their natural habitats. Migratory species, which includes all small cetaceans, are listed in Appendix II and III (Table 2) and must be protected (Rose, 1996). The UK is a signatory to the Convention and responded to the Bern

Convention by developing and enacting the 1981 Wildlife and Countryside Act (WCA), and, more recently, the EC Habitats Directive 92/43/EEC.

3.2.4. International Union for the Conservation of Nature and Natural Resources (IUCN)

The IUCN is an international body consisting of sovereign states, government agencies and non-governmental organisations (NGOs). Whilst not providing legal protection, the IUCN drafts a *'red list'* which evaluates how threatened species are, and identifies those which are endangered or vulnerable. A full listing of the IUCN classifications for cetaceans recorded in West Scotland is presented in Table 2. Being classified as '*endangered'* means that the species faces a high risk of extinction in the wild, in the near future, (e.g. fin, blue, sei and right whales). A *'vulnerable'* species faces a high risk of extinction in the wild, in the medium term, (e.g. harbour porpoise and sperm whales). *'Conservation dependant'* means that a species is currently subject to a conservation programme, the cessation of which would cause the species to become vulnerable or endangered within five years, (e.g. Northern bottlenose and killer whales). *'Near threatened'* species are species which are not conservation dependent, but are close to qualifying for vulnerable status, (e.g. minke whales). *'Data deficient'* species are not otherwise categorised as there is inadequate information to make an assessment, however, further research may indicate that the species may qualify for one of the above categories.

Two IUCN action plans for the conservation of cetaceans have been published (Perrin, 1989; Reeves & Leatherwood, 1994), outlining projects that require urgent attention. Two of these projects are relevant to cetaceans in West Scotland. Project 44 in the 1988-1992 IUCN action plan (Perrin, 1989) outlines the need to investigate the effects of development on coastal cetaceans and is particularly relevant to coastal aquaculture development in Scotland. Project 26 in the 1994-1998 action plan (Reeves & Leatherwood, 1994) states the need for an assessment of the status of bottlenose dolphins and the identification of problem areas. The bottlenose dolphin has been high-lighted by the IUCN as populations maybe at risk by virtue of their proximity to human activities (Perrin, 1989; Reeves & Leatherwood, 1994). Little is known about the status or threats posed to bottlenose dolphin populations on the west coast of Scotland and this is, therefore, a priority area for research.

3.2.5. Convention on the Conservation of Migratory Species (The Bonn Convention)

The UK has been a signatory to the Bonn Convention since 1985. It requires states to enter into agreement to protect migratory species throughout their entire range and therefore providing a basis for international conservation measures to be implemented (Rose, 1996). Species covered by the Convention are listed in two Appendices noted in Table 2. Cetaceans have been pin-pointed by the Convention as a priority group. The Convention has facilitated regional conservation action agreements for cetacean species such as the Agreement on the Conservation of Small Cetaceans of the Baltic and North Seas (ASCOBANS). This agreement applies to all small cetaceans (all odontocetes except the sperm whale) in the North and Baltic seas and obliges parties to co-operate in order to achieve and maintain a favourable conservation status for small cetaceans. This is achieved via a management plan.

West Scotland is not covered by the ASCOBANS agreement, and although, the UK Government has agreed to apply *'the spirit'* of the Convention to all waters a more defined approach is required. This would have greater effect as the issues faced by cetaceans in the North and Baltic seas are very different to those faced in the Hebrides and East Atlantic region. It is hoped the Bonn Convention could facilitate similar agreements to ASCOBANS in the Northeast Atlantic, especially West/North Scotland and North/East Ireland. This would allow focused management plans to be drawn up which directly address the specific, and sometimes unique, issues faced by cetaceans in this region.

3.2.6. United Nations Convention on Biological Diversity.

This is a broad ranging international agreement that aims to protect bio-diversity. It was signed in 1992 by more than 150 states, who, as contracting parties, are required to:

- develop national strategies, plans or programmes for the conservation and sustainable use of biological diversity

(Article 6);

- identify and monitor important components of biological diversity, identify and monitor threats, and maintain a bio-diversity database (Article 7);
- establish a system of protected areas for conservation, and regulate and manage biological resources, develop guidelines for selection and management of protected areas; promote environmentally sound and sustainable development in areas adjacent to protected areas; develop and maintain legislation to protect threatened species and populations; regulate activities that threaten bio-diversity (Article 8); and
- integrate consideration of bio-diversity conservation and sustainable use into decision making (Article 10).

The Convention advocates the use of the *'precautionary principle'* for nature conservation, stating that a lack of full scientific knowledge should not be used as a reason to postpone action. The UK has stated that *"the precautionary principle will be applied over both the level of exploitation and methods used. Activities which could cause major damage to species, populations and ecosystems will be strictly controlled"* [para. 6.81] (HMSO, 1994a). In spite of this commitment the issue of precaution is one that the UK Government has not taken on board, especially in the case of the harbour porpoise, discussed. It is one that is particularly relevant for West Scotland, where the highest diversity of cetaceans in Europe exists, but for which few data are available.

Under the Convention all cetaceans are considered a '*Conservation Priority Species*', this is reflected in The UK National Bio-diversity Action Plans (BAP) that have been produced for baleen whales, toothed whales, dolphins and the harbour porpoise. These national targeted BAPs provide a basis for local BAPs to be formulated within which local conservation action can be focused. However, many of the key criteria highlighted for these species on a UK basis are not relevant to the Hebridean area as many of the threats posed in this area are regionally unique and not addressed by national BAPs. Local Authorities with the responsibility for drafting local BAPs in the Hebrides are Argyll and Bute, the Highlands and Western Isles councils. The Western Isles Council has not yet begun to formulate local BAPs and the Highlands Council is just initiating its local BAP programme. However, Argyll and Bute BAPs are currently in draft form with a BAP for all cetaceans and species-specific BAPs for the harbour porpoise, minke whale and bottlenose dolphin. Draft copies of these regional BAPs featured in Appendix A.

Local BAPs represent the last link between the objectives of the 1992 Rio Earth Summit and practical progress. To be effectively translated into action several issues need to be addressed. Co-ordination and full-time commitment is required. BAP Officers have been appointed for some areas in Scotland, including Argyll and Bute, but not yet for Western or Highlands regions. Strategic links that enable effective communication between all groups is required. This will allow BAPs to be implemented at the appropriate level and avoid duplication (Hiscock *et al.*, 1998). The wide-ranging nature of cetaceans suggests that a BAP for the entire Hebridean area would be more beneficial than three separate plans. Within this regional plan, more local initiatives can be set where resident or discrete populations occur. Also for many of the projects a significant amount of funding will be required. Currently, implementation is the responsibility of Local Authorities who, however, receive no additional funding for BAP implementation. Instead much time and resources are being put into locating funding bodies such as the Heritage Lottery Fund (Hiscock *et al.*, 1998) to finance substantial projects. To aid the process other bodies such as SNH and RSPB are redirecting funds and man-hours for local BAPs. Realising the aims of local BAPs is the responsibility of the UK Government and as such should be obliged to make funding available to take BAPs forward, which could be achieved through giving the UKBAP programme a statutory footing.

3.3. EU AND UK LAW

3.3.1. Wildlife and Countryside Act 1981 (WCA)

Part I [Sections 9-12] of the WCA deals with species protection. Under the WCA, all cetaceans are included in Schedule 5, meaning it is illegal to:

- intentionally kill, take or injure cetaceans;
- intentionally damage, destroy or obstruct an access to, any structure or place which cetaceans use for breeding or resting;

- intentionally disturb a cetacean whilst it is occupying such a structure or place;
- sell, possess, deal, transport and advertise for the purpose of sale any live, dead, part of or anything derived from a cetacean.

However, the WCA states that the above acts will not be illegal if *"the act was the incidental result of a lawful operation and could not reasonably be avoided"* [section 10, part 3(c)] (HMSO, 1981). Therefore, death by entanglement in nets or disturbance from seismic testing is not illegal unless the operation *"could be reasonably avoided"*. For charges to be brought the acts must be carried out intentionally which, legally, is very difficult to prove, especially in the case of disturbance where it is difficult to define specific areas used for breeding and resting. Even if an infringement could be substantiated the practical enforcement of the WCA at sea would prove difficult as only the police have the powers to enforce the act, and penalties incurred are small (Hughes, 1998).

Part II of the WCA is concerned with site protection, and provision was made, in Section 36, for the introduction of Statutory Marine Nature Reserves (SMNRs) into UK legislation (HMSO, 1981). SMNRs would be the marine equivalent of National Nature Reserves (NNRs), i.e. conservation areas for flora and fauna with a provision for study and research. However, the legal protection offered by SMNRs is much weaker that for NNRs. This is because conservancy agencies were not given the authority to introduce provisions or bylaws that may interfere with the functions of any authority or rights of an individual. This means, for example, that navigational rights of vessels, or fishery activity could not be restricted (Hughes, 1998). The designation process for SMNR's is arduous as it requires the conservancy agency to resolve ALL conflicts and objections before approval, and even then it can be rejected. After 18 years, only 3 SMNR's have been designated, none of which are in Scotland. It is unlikely the problems outlined above will be resolved considering that attention and resources are now focused upon the designation of Special Areas of Conservation (discussed later). The chief executive of Scottish Natural Heritage (the Scottish Government's statutory body with the responsibility for wildlife conservation) has stated that SMNR's are not feasible or practical for the protection of the marine environment and their designation will not be pursued (Gubbay, 1997).

3.3.2. Council Directive on the Conservation of Natural Habitats and Wild Fauna and Flora

The 'Habitats Directive' was adopted in May 1992. The main aim of the directive was to promote the maintenance of diversity through the protection of species and habitats. The Habitats Directive has been implemented into UK law via the Conservation of Natural Habitats Regulations 1994 (CNHRs). The directive gives provision for the protection of individual species of conservation concern and to protect their habitats.

3.3.2.1. The Habitats Directive and Species Protection

All cetacean species are listed under Annex IV of the Habitats Directive, meaning that they are protected from:

- all forms of deliberate capture or killing;
- deliberate disturbance of cetaceans, particularly during the period of breeding, rearing, hibernation and migration; and
- deterioration and destruction of breeding sites or nesting places [art.12, para.1] (HMSO,1992).

The use of the word *'deliberate'* is synonymous with *'intentional*' in the WCA and suffers the same limitations. Similarly, the focus upon breeding and nesting sites is problematic for wide ranging cetaceans. The Habitats Directive is therefore limited in the degree of protection afforded to Annex IV cetaceans.

There is a requirement on member states to *"establish a system to monitor incidental capture and killing"* of cetaceans [art.12, para.4] (HMSO, 1992). However, this has not been translated into the CNHRs and so the UK is not currently legally bound to enact such a monitoring scheme (Hughes, 1998). This omission means the following clause to introduce *"further research or conservation measures as required to ensure that incidental capture and killing do not have a negative impact"* [art.12 para.4] (HMSO, 1992) is weakened. Article 15 prohibits the use of all indiscriminate means capable of causing local disturbance of, or serious disturbance to cetaceans. This would include activities such as seismic testing, testing of sonar, acoustic deterrents and non-selective fishing nets. However, Article 16 states that derogation's are permitted if:

- there is no satisfactory alternative;
- it is in the interests of public health or safety; or
- there are over-riding socio-economic matters.

This provision could be used to justify deleterious activities such as oil exploration, military and fish farm-related disturbances (summarised in *Section 4*).

3.3.2.2. Protected Areas and the Habitats Directive

Annex I and II of the Habitats Directive list the habitats and species for which Special Areas of Conservation (SAC) can be selected. The only cetacean species included in Annex II are the bottlenose dolphin and harbour porpoise. For aquatic species with wide ranges, SAC's will be proposed *'only where there is a clearly identifiable area representing the physical and biological factors essential to their life and reproduction'* [article 4; para1] (HMSO,1992). Clear identification of such areas has proved problematic, especially for the harbour porpoise.

Annex III [Stage 2, 2(d)] considers the number of Annex I and II species in a site as an important element of site assessment process. In the UK, this multi-purpose designation approach has been largely ignored (Hughes, 1998). In West Scotland there are 15 candidate (Fig. 36) and potential coastal or marine SACs that include, or could be extended to include, areas that are important for cetaceans. If a multi-purpose approach were to be adopted, provision could be made for cetacean conservation within the site management plan, accruing wider benefits than the current single species/habitat approach.

Table 3. The importance of candidate and potential SAC sites for cetaceans (SAC status data from Scottish Natural Heritage, June 1999).

LOCATION	STATUS[1]	SPECIES/HABITAT INTEREST	CETACEAN INTEREST[2]
Sound of Arisaig*	m/C	Sub-tidal sandbanks	**Bottlenose dolphin** ***Harbour porpoise*** *Minke whale*
Loch Sunart**	m/P	Old oak woodlands and Otter (*Lutra lutra*)	**Bottlenose dolphin** ***Harbour porpoise***
Firth of Lorn*	m/C (subject to consultation)	Reefs	**Bottlenose dolphin** ***Harbour porpoise*** *Minke whale*
St. Kilda*	m/C	Reefs	*Minke whale* Other mysticete cetaceans Atlantic white-sided dolphin White-beaked dolphin
Coll **	c/C	Machair, Slender naiad (*Najas flexilis*)	**Bottlenose dolphin** ***Harbour porpoise*** *Minke whale* Common dolphin
South Uist**	c/C	Machair Water lobelia (*Lobelia*), shoreweed (*Littorella*), quillwort (*Isoetes*).	**Bottlenose dolphin** ***Harbour porpoise*** Minke whale Other mysticete cetaceans Sperm whale Atlantic white-sided dolphin
North Uist**	c/C	Machair	**Bottlenose dolphin** ***Harbour porpoise*** *Minke whale* Other mysticete cetaceans Atlantic white-sided dolphin White-beaked dolphin
Tiree**	c/C	Machair	**Bottlenose dolphin** ***Harbour porpoise*** *Minke whale* Common dolphin
Monach Isles*	m/C	Machair, and Grey seal (*Hailchoerus grypus*)	**Bottlenose dolphin** ***Harbour porpoise*** *Minke whale* Sperm whale Long-finned pilot whale Risso's dolphin White-beaked dolphin
Loch Maddy*	m/C	Shallow inlet and bay Lagoon	***Harbour porpoise*** **Bottlenose dolphins**

			Risso's dolphin White-beaked dolphin
Loch Roag**	m/C	Lagoon	***Harbour porpoise*** Risso's dolphin White beaked dolphin
Loch Eport**	m/C	Lagoon	***Harbour porpoise***
South East Islay**	m/P	Common seal (*Phoca vitulina*)	*Minke whale* ***Harbour Porpoise*** Killer whale Common dolphin
Loch Alsh, Duich and Long*	m/C	Reefs	***Harbour porpoise***
North Rona*	m/C	Grey seal (*Hailchoerus grypus*)	*Minke whale* Other mysticete cetaceans Atlantic white-sided dolphin White-beaked dolphin Long-finned pilot whales

Notes: [1] - m/C - Candidate marine SAC; m/P - Potential marine SAC; c/C - Candidate coastal SAC.
[2] - Species in bold are **EU Habitats Directive appendix II species**, species in italics are *UKBAP conservation priority species.*
* Sites which encompass areas of importance for cetaceans.
** Sites which have borders which could be expanded to encompass areas of importance for cetaceans

In order to assess if favourable conservation status is being achieved a national programme of surveillance [art.11] (HMSO, 1992) is necessary. A valid assessment of the status of cetacean populations would require a long-term and costly monitoring programme. At present the Government will not fund the management or monitoring of sites, and external sources of funding will have to be found if cetacean populations are to be adequately monitored. Until 1999, SACs could only be designated up to 12nm from shore, and the government is currently under pressure to designate SACs further offshore, up to the 200nm limit of the UK's EFZ. This would fulfill obligations under the Bio-diversity Convention and UNCLOS, both of which the UK has acceded to. Such a revision to the CNHRs would substantially extend the potential boundaries for cetacean conservation in West Scotland. This would benefit many species inhabiting deeper waters, such as northern bottlenose whales and sperm whales.

Bottlenose dolphins

There is currently one proposed SAC for bottlenose dolphins in Scotland, the Moray Firth. West Scotland has several areas which could be potential candidates for SAC designation notably Barra, South Uist and the Isles of Mull, Coll and Tiree where bottlenose dolphins have been observed feeding and breeding. There have also been sightings of bottlenose dolphins from other areas (e.g. Islay and Loch Maddy), indicating that there may be other, as yet unrecognised populations in West Scotland. The Moray Firth's SAC designation benefits from the long history of research on the resident dolphin population. Potential sites in the Hebrides have been subject to little or no direct research and are, therefore, unable to fulfil the designation criteria of the Habitat Directive. The UK government should, therefore, make funding available for research upon these aforementioned bottlenose dolphin populations.

Harbour porpoises

Despite being a *'conservation priority species'* and considerable pressure from NGO's, no SACs for porpoises have been proposed, due *to "insufficient scientific evidence"* (Whitmee, pers. comm.), i.e. the precautionary approach has not been adopted. There are several areas where porpoises are abundant year round in the Hebrides. Most notable are the Sounds of

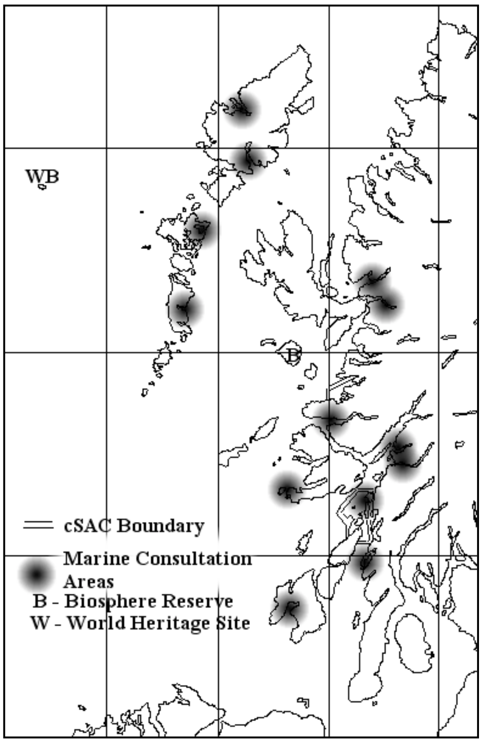


Fig. 36. Location of candidate SAC sites, World Heritage sites, Marine Consultation Areas and Biosphere Reserves in the Hebrides.

Mull, Monach and Harris; Lochs Tarbert, Maddy and Roag; Gairloch; the Treshnish Isles and the Small Isles -Canna, Rum, Eigg and Muck. In fact, the latter island is believed to derive its name from the large number of porpoises inhabiting its coastal waters (muc is a gaelic name for the harbour porpoise). Although they are abundant, porpoises have received little investigation in the Hebrides and there are no baseline data on population numbers. The first directed study on harbour porpoises and their habitat requirements in the Hebrides is currently being undertaken. Previous surveys undertaken, have been of a short duration, meaning that large variations in distribution and abundance are seen over the years. The data produced by these studies are not of a type that can be analysed to validly estimate population numbers, and so there is insufficient information to categorically judge the scale of the Hebridean porpoise populations on a national or regional scale.

3.3.3. National Scenic Areas (NSAs)

In 1980, the NSA designation was introduced under the Town and Country Planning Act 1972. The NSA designation is unique to Scotland and affords protection via the planning system to areas of land or water that are of "*outstanding scenic value and beauty in a national context*" (SNH, 1998). Although NSA objectives lay in land conservation several NSA sites include marine waters which have high cetacean sighting rates. These are illustrated in Figure 37 and include the Small Isles (Canna, Rum, Eigg and Muck), the west coast of Mull, Arisaig, North Uist and South Lewis. The NSA designation has previously lacked strength, in that the designation is not widely known or understood, and has limited influence outside of the planning system. SNH are currently in consultation with relevant bodies to revise the NSA designation. The main thrust will be to allow local authorities to develop individual management strategies for each NSA, in order to protect its scenic qualities. The strategy will define the scenic qualities and lay down provisions for its conservation. It could be possible to include marine mammals and other marine features, and make provision for their management, on the basis that they add to the scenic quality of an area.

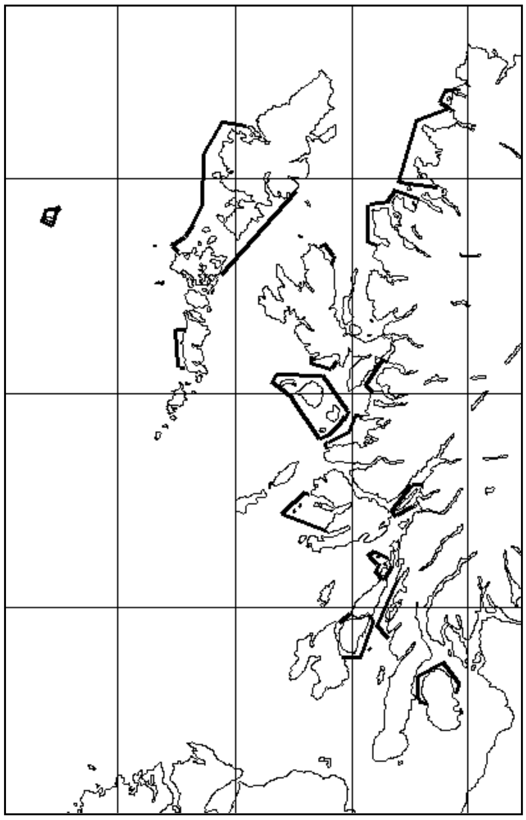


Fig. 37. The location of National Scenic Areas in the Hebrides.

3.4. NON-STATUTORY

DESIGNATIONS

3.4.1. Marine Consultation Areas (MCAs)

MCAs in the Hebrides are shown in Figure 36. These areas were introduced by the Nature Conservancy Council (NCC) in 1990 and comprise marine or coastal sites of high quality and particular sensitivity (Bryan, 1994). The MCA designation aimed to control the expanding fish farm industry by ensuring that the NCC, and now SNH, are involved in the consultation process for fish farm development in coastal waters (Hughes, 1998).

3.4.2. World Heritage Sites (WHSs)

This type of designation is assigned by the United Nations Educational, Scientific and Cultural Organisation (UNESCO) and was adopted in 1972, with the aim of protecting, monitoring and promoting the research of sites possessing outstanding elements of natural or cultural heritage (Bryan, 1994). The only WHS to be designated in the study area is St Kilda (see Fig. 36). Currently the IUCN wants to either expand St Kilda's designation or add it to the '*endangered*' WHS list (SCENES, 1999a). This is due to the threats posed by the expanding number of oil industry installations in the Atlantic Frontier (*Section 4*). A candidate list for UK WHS designations over the next 5-10 years has recently been submitted to UNESCO, none of the sites listed were marine sites (SCENES, 1999b).

3.4.3. Biosphere Reserves

Biosphere Reserves are designated by UNESCO under its "*Man and the Biosphere*" programme. The aim of Biosphere Reserves is to sustain natural and managed ecosystems through linking conservation with sustainable use and adopting a '*man in*' approach. There are two Biosphere Reserves in the Hebrides: the Isle of Rum and St. Kilda (Fig. 36). These Biosphere Reserves are primarily terrestrial, but they do have coastal elements which are important for cetaceans. In the UK, Biosphere Reserves have only been designated where there is prior security of tenure via the NNR system (Bryan, 1994), and are essentially paper designations with few practical benefits. But the '*man in*' approach runs parallel to the idea of building partnerships which are crucial for successful marine conservation (Hiscock *et al.*, 1998), and so the biosphere framework has great potential and is ideally suited to developing marine conservation (Kenchington & Agardy, 1990).

3.5. POTENTIAL MECHANISMS FOR MANAGEMENT

The previous sections have discussed those mechanisms that are already in place and part of the institutional framework. The following section shall address those mechanisms that are currently not in effect in Scotland, but have potential to strengthen protection of Hebridean cetaceans.

3.5.1. Marine National Parks

At present, Scotland has no national parks. However, this is changing as the Scottish policy on National Parks is being revised and consultations for the designation of two national parks are in process. Draft legislation was submitted in August 1999, with designation of Scotland's first National Park (Loch Lomond and the Trossachs) to be expected in April 2001. A key element of the National Park approach is to develop a system which can extend into Scotland's marine environment (SNH, 1999). Although at a preliminary stage, positive views have been expressed for Marine National Park designation. The National Trust for Scotland supports marine heritage protection in national parks and *"should be applied at an early stage to at least one area with substantial marine interests, such as the Small Isles, or Fair Isle"* (SCENES, 1999a). The present status of Rum as a NNR and a Biosphere Reserve, NSA and SPA make it a likely candidate for consideration. No marine parks have yet been formally considered, but, in addition to the Small Isles proposal, the Isle of Mull has been put forward as a possible terrestrial park (SNH, 1999). Both these sites would provide the first opportunity in the UK to integrate a marine and a terrestrial national park under one holistic management strategy. Both these areas are important cetacean habitats and it is hoped that provisions for cetacean conservation would be incorporated into Marine National Parks legislation.

3.5.2. Fisheries Legislation

The fishing industry poses several threats to cetaceans including incidental capture, prey depletion and habitat destruction which are discussed more fully in *Section 4*. Scottish fisheries, up to six miles from coast, are regulated through the Inshore Fisheries (Scotland) Act 1984 which, in turn, is managed by the Scottish Office Agriculture and Fisheries Department (SOAFD). It is being increasingly recognised that the fishing industry has a vital role to play in marine conservation and management, which has been indicated by fishery regulators being given powers to manage fisheries for environmental purposes. The Inshore Fisheries Act is currently under assessment. Central to the proposals is that future management policies should have the conservation of marine bio-diversity as a major objective and have a precautionary basis.

3.5.3. Cetacean Protection Act for Scotland (CPAS)

Unlike other countries, the UK does not protect cetaceans through direct legislation. The 1972 US Marine Mammal Protection Act (MMPA), the 1978 New Zealand MMPA and the 1980 Whale Protection Act of Australia are examples of where focused legislation has been successful in the protection and conservation of cetaceans. Under the New Zealand MMPA a much stricter definition of '*take*' is applied and means to '*kill, harm, injure, attract, poison, herd or harass*' (Donoghue, 1996), this covers a wide range of activities. Any unavoidable take during commercial operations requires a permit that imposes stringent measures for minimisation. The New Zealand MMPA also establishes a mandatory requirement for reporting fishery by-catches and for the designation of Marine Mammal Sanctuaries. This overseas experience and legislation could be used as blueprints for establishing a Cetacean Protection Act for Scotland.

3.6. SUMMARY

No established framework currently exists for cetacean conservation in the Hebrides, or in Scotland. The only legislative protection is via the WCA and Habitats Directive. However, these have a very general remit and their lack of focus means they are very difficult to apply specifically to cetaceans. Thus, although providing a basis for action, the difficulties in interpretation and enforcement of this legislation means they are rarely used, and if so, to little effect. With the exception of NSAs, there are no statutory marine protected areas for any marine environments in the Hebrides. This is set to change with the advent of SACs. However, none of the listed candidate or potential sites in West Scotland, although often including important cetacean habitats or populations, are designated on the basis of cetaceans. Nor are any provisions made for cetacean protection within the management plans of these SACs. Non-statutory MPAs offer little formal protection but do serve to earmark environmentally sensitive areas in the planning process.

Governmental marine conservation efforts in the Hebrides are fragmented, with little or no focus on cetaceans. This is a major stumbling block for the successful consultation, implementation and monitoring of marine and cetacean conservation strategies. This fact has been recognised by Government. *"Better legislation to provide workable and effective protection for important areas of nature conservation interest in the marine environment is needed as a matter of urgency"* (House of Lords European Communities Select Committee, 1999).

4. Threats to Hebridean Cetaceans

4.1. INTRODUCTION

There are five main threats to Hebridean cetaceans. These are directed takes, incidental take and injury, pollution, habitat degradation and fish farming. This section addresses the nature of these threats and, where possible, assesses their extent. Such an assessment involves considerable uncertainty for several reasons:

- lack of data regarding levels of pollutants/activities in the study area;
- incomplete knowledge of full impacts on cetaceans;
- little understanding of how multiple threats may interact;
- little information regarding habitat utilisation by Hebridean cetaceans; and
- cetacean mobility means it is very difficult to assess the exposure levels to threats.

One of the aforementioned threats, fish farming, is dealt with as a separate issue even though many of the impacts of fish farming are related to habitat degradation and pollution. This is because fish farming is ubiquitous throughout the Hebrides and is such a major cause of concern even though it is generally overlooked by conservationists elsewhere in the UK.

4.2. DIRECTED TAKES

Cetaceans are hunted both on a commercial and aboriginal/subsistence basis (Mulvaney, 1996; Stroud, 1996). Direct fisheries for cetaceans also exist for entertainment and display purposes and as a result of fishery conflicts (Mulvaney, 1996). Only commercial directed takes pose a potential threat to Scottish cetaceans.

Takes of cetaceans from Scottish-based commercial whaling ceased in 1951, when Norwegian-owned operations based in Loch Tarbet, Harris closed down. This operation ran from 1904-1928 and briefly re-opened between 1950-1951. The whaling station predominantly caught fin, sei and blue whales (1538, 378 and 316 animals, respectively) with some catches of northern right, sperm, northern bottlenose and humpback whales (94, 77, 1 and 19 whales, respectively) (Thompson, 1928; Brown, 1976). Under the WCA and the Habitats Directive, the direct taking of any cetaceans is prohibited in UK waters. Beyond this limit whaling is allowed, which is, at present, undertaken primarily by Norwegian boats who are operating in waters adjacent to Scotland. There is concern that these vessels may also enter Scottish waters during whaling operations (Parsons *et al*., 2000). The target species of commercial whaling is currently the North Atlantic minke whale. It is possible that Scottish minke whales could move from Scottish waters into current/future whaling grounds for part of the year. Currently there is no information regarding the migration patterns and routes of the minke whales that seasonally utilise Hebridean waters. Nor are Norwegian vessels required to keep catch records, therefore, the impact of whaling upon Scottish populations is unknown.

North Atlantic whaling activity is increasing. In 1993, when Norway recommenced whaling, 157 minke whales were taken, this rose to 580 in 1997, and there are plans to increase this catch still further to 2000 annually (Simmonds, 1997).

The fishing industry and cetaceans are often in competition for the same fish stocks and there is concern that cetaceans, in order to protect the viability of the fishing industry, maybe directly targeted if they are perceived to be interfering with fishery interests (Earle, 1996). There is no evidence of such competition or to suggest that deliberate cetacean culling is carried out in the Hebrides.

There is no threat to cetaceans from direct take for subsistence, entertainment or display purposes in the Hebrides as this practice is illegal in the UK.

4.3. INCIDENTAL TAKE AND INJURY

Incidental take and injury occurs from three main sources, fisheries, marine traffic and marine debris, and are discussed below.

4.3.1. Fisheries

The main cause of incidental take of cetaceans occurs as the result of cetacean by-catch in fisheries. The distribution and feeding habits of many cetaceans make them open to direct interaction with commercial fishing operations. Gill-net fishing operations, in particular, are a major cause for concern with respect to some cetacean populations. Tregenza *et al*. (1997) reported upon an unsustainable rate of harbour porpoise by-catch in the Celtic Sea. In 1986, the use of monofilament gillnets was banned in Scottish inshore fisheries. However, the Government considered that monofilament gillnets were no greater threat than multi-filament and multi-monofilament nets, which could be used legally, and the ban was repealed in 1996. After this repeal, there was considerable concern that the return of gill-nets may lead to high levels of harbour porpoise by-catch in the inshore waters of West Scotland.

Until recently there has been very little information regarding by-catch levels in the Hebrides. Ongoing research at the Sea Mammal Research Unit, St. Andrew's University, has recently posted observers on 3 gill-netters operating in the waters to the west of the Outer Hebrides. Preliminary results from these studies have demonstrated that by-catch of harbour porpoises does occur in this area (Northridge & Hammond, 1999). The highest rate of by-catch occurred in the dogfish fishery, which is the dominant target species for west coast gill-netters (Northridge & Hammond, 1999). The report also concluded that the gill-net fishery is a dynamic one and fishing effort varied widely from year to year. A survey conducted by the Hebridean Whale and Dolphin Trust reviewed fishery statistics and levels of by-catch in the inshore (within the 6 mile fishing limit) waters of the Hebrides (Gill, 1999). From 1997 SOAFD fisheries statistics 20 gill-netters operate from west coast ports, 14 are registered in Ayr, 3 in Stornoway, 2 in Ullapool and 1 in Campbeltown. However, vessels change their fishing methods from year to year. Of the 14 vessels registered in Ayr, 11 are owned by Spanish nationals, these *'flagships'* are foreign vessels registered to a UK port allowing them to fish UK waters. They rarely use Ayr as a homeport and consequently their movements, fishing effort and target species are unpredictable and it is not possible to assess levels of by catch for these vessels. The remaining gill-netters are generally locally owned and worked. From questionnaire responses, levels of porpoise by-catch seem to be low, but seal by-catch rates are high (Gill, 1999). Fishermen try and avoid known cetacean and seal habitats as cost and time incurred due to by-catch is high. The amount of gill-net fishing in this inshore region is very limited (Gill, 1999). The reason being that most fisheries have changed their onus to the exploitation of more profitable shellfish (Gill, 1999). The survey also identified local salmon netting as an area where gill-nets could also impact cetaceans. Gill-nets are sometimes set across the openings of river mouths to catch salmon and these nets could feasibly entangle coastal harbour porpoises and bottlenose dolphins. Other fishery interactions include kreeling and in 1987, a minke whale was found entangled in a kreel line west of Iona and, historically, a significant number of harbour porpoises and minke whales suffered entanglement in the Sound of Barra where kreel lines were set (D. Leaver, pers. comm.). Also several minke whales have been observed with rope marks on their rostra which were possibly caused by entanglement in kreel lines (A. Gill, pers. comm.).

4.3.2. Marine Traffic

Direct collisions with boat traffic, often travelling at speed, have the potential to cause death and injury. Boat collisions are a frequent cause of mortality for dolphins (Parsons & Jefferson, 2000) and whales (Kraus, 1990; Kenny, 1993) in areas of high shipping density.

To date, there have been no conclusive reports of cetaceans being killed or injured due to marine traffic. However, badly cut dorsal fins have been observed on a Risso's dolphin and a common dolphin that may be attributable to propeller damage. A code of conduct for boat users has been produced by the Hebridean Whale and Dolphin Trust and lists measures which aims to minimise disturbance and boat collisions (App. B). This code represents the first step to alleviating the threats of marine traffic.

4.3.3. Marine Debris

Due to the simplicity of this threat, it is often overlooked and concerns have been largely aesthetic. However, seaborne debris can have severe biological effects on cetaceans, causing death, injury and harm. The main threats, summarised by Laist (1987), are mechanical in nature when cetaceans become entangled, or ingest debris. Entanglement may result in individuals drowning, suffering wounds and subsequent infections, or altered behaviour that affects their survival. Ingestion may block digestive tracts or remain in the stomach, reducing the animal's feeding drive and causing internal damage. Ingested debris may also be a source for leached contaminants. The types of debris which pose most threat to cetaceans are discarded nets and net fragments, plastic strapping bands, bags, synthetic ropes, lines and small objects which fragment such as plastic cups (Laist, 1987).

As part of the 'Minch Project', a beach litter survey was undertaken in 23 locations around the Western Isles and Highlands and Islands. The Minch, in context of the rest of the UK, was found to exceed the national average for the amount of litter found, dispelling the conventional notion that West Scotland has some of the cleanest beaches (Tyler & McHattie, 1998). Most litter found was composed of plastics and polystyrene, which when analysed by type indicated that plastic rope/cord was by far the largest category with plastic pieces larger than 1cm being the next most common class of litter (Tyler & McHattie, 1998). Both these plastic types pose significant threat to cetaceans. It is thought that much of the rope/cord litter is derived from the fishing and or aquaculture sectors (Tyler & McHattie, 1998). In May 1999, a minke whale was observed with a piece of trawl net wrapped across the top of its head and blowhole (A. Gill, pers. comm.). This netting was probably a piece of discarded or "ghost" net.

This evidence suggests that marine debris and seaborne litter is cause for concern in the Hebrides, however, the level of mortality and the impact of this mortality upon specific populations is currently unknown.

4.4. POLLUTION

A number of pollutants are introduced to the marine environment via river run-off, land run-off, effluent discharges and atmospheric inputs. The impacts of these are becoming an increasing concern. *"Recent scientific research reveals that toxic pollution from industrial chemicals and pesticides poses grave risks to marine wildlife"* (WWF, 1995). Cetaceans, being the top predators in the food chain, are particularly vulnerable to pollution due to its often persistent and stable nature. Their mobility means that they are exposed to a wide range of pollutants that interact to increase toxicity. This section discusses the threats posed by organochlorine (OC), trace element, PAH, hydrocarbon, butylin and pathogen pollution.

4.4.1. Organochlorines

Organochlorines are synthetic molecules that are very stable and persistent in the environment. Due the connectivity of the marine environment OCs such as DDT and PCBs are now ubiquitous throughout the world's oceans and have the potential to impact not only coastal species but also offshore species. OCs have low solubility and high lipophlilicity and tend to accumulate in sediments and the marine biota. Cetaceans, not in contact with sediments, bio-accumulate OCs via the food chain, where the chemicals are retained in lipid rich substances, such as blubber. OC contamination has been well documented in many cetacean species (Aguilar, 1989; Borrell, 1993; Reijinders, 1996). Levels of contamination are dependent largely upon the diet, sex, age and behaviour of the cetacean species in question. For example, baleen whale tissues typically have lower contaminant concentrations than harbour porpoises as they feed at a lower trophic level (O'Shea & Brownell, 1994; McKenzie, 1999). Coastal species may accumulate higher levels due to closer proximity to discharge points. The long life span of cetaceans mean that they tend to accumulate pollutants over a long period resulting in an accumulation of high contamination levels with age (Wagemann & Muir, 1984). For females this trend is seen only until sexual maturity when levels plateau. The reason for this being that cetacean mammary milk is very lipid rich and accumulates OCs from the mothers blubber, these are then passed on to the next generation via lactation (Tanabe *et al.*, 1982). OCs at a chronic level have been found to have effects on the reproductive systems of mammals, causing a depression of reproductive ability (Fuller & Hobson, 1986). Research on common seals show that those feeding on PCB contaminated fish are less likely to produce pups than those fed on uncontaminated fish (Reijinders, 1986). It is thought that OCs can suppress the immune system and may have a role to play in high number of recent marine mammal mass mortalities (Harwood & Reijinders, 1988; Hall *et al*., 1992; Simmonds, 1992).

There are a variety of sources of OC pollution in the Hebrides. Chlordane, DDT and other OC pesticides have all been utilised by the agricultural and forestry industries in western Scotland. Four tonnes of lindane were used in Scotland in 1997 (SCENES, 1999b). Although these are now banned, any residues will ultimately find their way into the marine environment. There has been no scheme to recover old stocks, and there is a risk of release via the decay of storage vessels. PCBs are no longer manufactured but are still present in much electronic equipment, the damage or inadequate disposal of which may lead to contamination. This is a particular problem in West Scotland where remote populations traditionally use the sea as a dumping ground for many household items due to long distance between authority collection sites (Fulton, 1998). OCs accumulate in marine sediments. Therefore, there is a potential for the re-mobilisation of OCs into the water column from dredging and trawling activities. Cetaceans commonly feed on pelagic species, thus the main route for OC uptake of these prey species is from the water column. Information regarding levels of OC pollution in West Scotland comes from the analysis of dissolved OCs in the water column and of accumulated levels in the blubber of stranded animals. A recent study sampled OCs in Scottish waters (Balls & Campbell, 1999). This study noted that offshore sites had low concentrations of PCBs, with slightly elevated levels of OC pesticides. Higher levels of OCs were found in estuarine waters, especially in the Clyde which had the highest levels of γ-HCH for Scotland.

Contamination data from stranded animals are collected on an opportunistic basis and, due to the remoteness and difficulty of access to many stranding sites on the West Scottish coast, very few suitable tissue samples have been recovered for analysis. Published information on concentrations of OCs are summarised in Table 4. The highest reported concentrations of OCs for West Scotland were 54.6 ppm for DDT, 12.4 ppm for chlordanes and 33.1 ppm for PCBs (reported in two Atlantic white-sided dolphins; McKenzie *et al*., 1997).

Several OC levels summarised in Table 4 are of a magnitude equal to those which have been reported to cause reproductive and immune system (Lahvis *et al*., 1995) changes in species of small cetaceans. Levels of 50-200μg.g^{-1} were indicated to pose a serious risk to cetaceans (Wagemann & Muir, 1984), while research on Dall's porpoise concluded that lower levels of 10-20μg.g^{-1} were enough to cause reproductive suppression (Subramanian *et al*., 1987). Levels found in the Hebrides are lower than those found on the East coast of Scotland and are in the low to middle ranges relative to those observed world-wide (McKenzie, 1999). In general, the OC concentrations reported in West Scotland cetaceans are relatively low, although they may still be capable of causing some immune and reproductive system defects.

4.2.2. Trace elements

Trace elements are by-products of many industrial processes. They enter the marine environment through atmospheric and land based effluent sources. Once in the system, metals concentrate in protein rich tissues such as liver and muscle. High trace element burdens in cetaceans have been associated with a variety of responses. These include lesions and fatty degeneration in bottlenose dolphins (Rawson *et al*., 1993) and decreasing nutritional state (Siebert *et al*., 1995). Of particular concern is the build up of mercury, which marine mammals tend to accumulate in the liver to higher levels than other marine organisms (Law *et al*., 1991). Mercury can build up over time in cetaceans from the consumption of prey species, which are a major source of mercury, especially methylmercury (Siebert *et al*., 1999). This methylated form of mercury can pass across the placental barrier, causing high mercury burdens in young individuals (Andre *et al*., 1990).

Published information on trace metal concentrations in cetaceans from West

Table 4. Concentrations of organochlorine pollutants in the blubber tissue of cetaceans from West Scotland (concentrations are expressed as parts per million, wet weight).

Area	Species	n	ΣPCB	Dieldrin	HCB	Σchlordane	ΣDDT

Ayr	*Phocoena phocoena*[1]	1	10.0	2.21	-	2.01	7.34
Oban	*Lagenorhynchus acutus*[2]	1	33.1	4.74	0.76	12.4	45.7
Islay	*Stenella coeruleoalba*[1]	2	5.63-7.25	0.51-0.84	0.22-0.26	1.62-2.21	5.46-6.98
Coll	*Grampus griseus*[1]	1	9.54	0.69	0.07	1.09	7.51
Mull	*Physeter macrocephalus*[3]	1	0.71	-	-	-	-
Skye	*Physeter macrocephalus*[1]	2	2.62-2.90	0.13-0.15	0.17-0.18	0.42-0.52	3.61-4.32
	Stenella coeruleoalba[1]	1	6.37	1.48	0.19	4.49	10.2
	Mesoplodon bidens[1]	1	3.12	0.02	0.09	0.12	1.89
N.Uist	*Lagenorhynchus acutus*[2]	1	30.2	4.60	1.10	11.9	54.6
	Lagenorhynchus acutus[1]	1	3.57	0.95	0.66	2.09	7.20
Lewis	*Phocoena phocoena*[1]	1	4.08	0.23	0.23	0.23	1.96
	Globicephala melaena[1]	4	6.16-10.3	0.37-1.15	0.16-0.26	1.71-4.51	7.83-14.1
	Grampus griseus[1]	1	4.32	0.55	0.08	0.83	1.85
	Mesoplodon bidens[1]	3	3.10-3.33	0.07-0.09	0.07-0.11	0.27-0.54	2.00-2.82

Note: [1] McKenzie, 1999.
[2] McKenzie *et al*., 1997.
[3] Wells & Echarri, 1992.

Scotland is summarised in Table 5.

Wagemann and Muir (1984) suggest that levels of 100-400μg.g^{-1} wet weight of mercury in liver may present a threat to marine mammals. However, more chronic effects may occur with concentrations as low as 61μg.g.$^{-1}$ (Rawson *et al*., 1993). Levels in Scottish cetaceans are generally below this threshold, although individual pilot whales do have concentrations that exceed this level.

Zinc is an essential trace element and levels are normally kept under homeostatic control (Law *et al*., 1991). Therefore, as would be expected, concentrations of zinc were comparable to concentrations observed in other cetacean species. Concentrations of tin and lead are relatively low in the cetaceans that have been examined so far. However, concentrations of mercury and cadmium were elevated, particularly in long-finned pilot whales and striped dolphins. These trace elements were present in concentrations of up to 71 and 99 μg.g^{-1}, respectively. Both pilot whales and striped dolphins forage upon cephalopods. The fact that these two species have accumulated elevated levels of cadmium and mercury suggests elevated concentrations in their prey species. Kruuk *et al*. (1997) have reported upon elevated concentrations of mercury in otters from western Scotland which suggests that other aquatic species occupying the same coastal and sealoch habitats, such as harbour porpoises and bottlenose dolphins, may also be exposed to relatively higher mercury levels. However, data upon these two species are currently limited to the levels reported upon by Law *et al.* (1991) for a neonate porpoise from Islay. This animal possessed relatively low levels of trace elements, which is unsurprising as most toxic trace elements accumulate with age.

Table 5. Concentrations of trace element pollutants in the tissues of cetaceans from West Scotland (concentrations are expressed as parts per million, wet weight).

Area	Species	n	Tissue	Cd	Hg	Pb	Sn	Zn

Islay	*Phocoena phocoena*[1]	1	Liver	<0.07	0.7	<0.07	-	49
	Stenella coeruleoalba[2]	2	Liver	5.5-10.3	16.7-20	b.d.	0.13-0.28	46-87
Skye	*Stenella coeruleoalba*[2]	1	Liver	5.5	15.9	b.d.	0.13	30.5
Ben-Becula	*Stenella coeruleoalba*[2]	2	Liver	4.5-8.0	2.09-4.89	b.d.-0.12	0.15-0.17	44-83
			Kidney	33.2-33	0.88-3.38	b.d.-0.03	0.07-0.10	33-36
N.Uist	*Lagenorhynchus acutus*[2]	1	Liver	0.3	0.89	b.d.	0.09	70
			Kidney	0.26	0.33	b.d.	0.06	23
Lewis	*Globicephala melaena*[2]	4	Liver	2.1-37.2	1.99-71	b.d.-0.28	0.07-0.20	13.8-53
			Kidney	47-99	1.58-7.26	b.d.-0.21	0.05-0.13	22-40
	Grampus griseus[2]	1	Liver	8.70	1.47	0.10	0.10	27
			Kidney	3.34	7.97	0.41	0.16	27
	Mesoplodon bidens[2]	3	Liver	0.40-6.7	0.97-1.05	b.d.	0.14-0.86	28-35

Notes: b.d.: below detection limits. [1] Law *et al*., 1991. [2] McKenzie, 1999.

Adults would be expected to possess a higher contaminant burden. Therefore, it is suggested that trace element concentrations should be investigated in coastal bottlenose dolphins and harbour porpoises from the Hebrides. Results from stranded cetaceans in West Scotland indicate that concentrations of trace elements are well within the ranges observed for marine mammals world-wide (McKenzie, 1999).

4.4.3. Hydrocarbons

There are thousands of hydrocarbons that vary widely in their toxicity to marine mammals from inert long chain alkanes such as paraffin to Polycylic Aromatic Hydrocarbons (PAHs) which can be highly toxic or carcinogenic. These contaminants enter the marine environment from both natural and anthropogenic sources. The main sources include natural seeps, transportation, offshore oil and gas production, incomplete burning of fossil fuels and industrial and domestic wastes. The breakdown of hydrocarbon pollution in the marine environment is largely dependent upon environmental factors such as turbulence, sunlight and temperature. Potential impacts are determined by this and the hydrocarbon's composition.

Oil can affect cetaceans in several ways (Geraci, 1990; Gubbay & Earll, 1999).

- *Inhalation* - Lighter fractions of oil, being more reactive and therefore more toxic, will evaporate quickly from a slick. On surfacing, cetaceans breathe from a narrow band of air just above the water surface, the zone of evaporation. Therefore, quantities of oil inhaled by cetaceans may be more of a problem in the first few hours after a spill when volatile hydrocarbons evaporate. Inhalation of vapours can result in lethargy, intoxication and irritation of the respiratory membrane (Geraci, 1990).
- *Ingestion* - Hydrocarbons may be directly ingested when feeding and are toxic to many mammals (Gubbay & Earll, 1999). Cetaceans may ingest oil from the water column and contaminated food but are thought to effectively metabolise hydrocarbons. This is indicated by a lack of adverse effects after experimental feeding of oil to a bottlenose dolphin and the subsequent presence of the enzyme Cytochrome P-450, which indicates the metabolisation of oil (Geraci, 1990). Also, most prey species are able to release hydrocarbons from their tissues and so bioaccumulation up the food chain is rare.
- *Physical contact* - Exposure varies between species and those that have a restricted range such a bottlenose dolphin and harbour porpoise, may be prolonged (Gubbay & Earll, 1999). Also those that feed at surface will be likely to come into contact with oil. However, there seems to be little in the way of impacts that can be attributed to physical contact with oil. There have been reports of dolphins swimming through oil with no effect,

although slight behavioural changes have been observed, including spending less time at the surface, and faster and more infrequent blowing (Geraci, 1990), thus indicating that cetaceans may be able to detect oil but do not necessarily avoid it. The cetacean epidermis is an effective barrier to hydrocarbon compounds, even prolonged immersion does not result in any irritation. Even when the epidermis is cut, oil seems to have little impact on the healing process (Geraci, 1990). The baleen of whales may also get fouled by oil, but studies show that 95% of oil is cleaned in 24hrs with no impairment of function (Geraci, 1990). However, there is very little information regarding the toxic and long-term effects of oil spills or more chronic oil pollution upon cetaceans.

The main sources of hydrocarbon pollution into the Hebrides are natural inputs, marine traffic, land-based discharges and offshore oil exploitation, which are discussed below.

Natural Inputs

Hydrocarbons enter the marine system naturally in the form of marine seeps and sediment erosion. It is not possible to quantify the amount of hydrocarbons entering Hebridean waters via this route.

Marine Traffic

The Hebrides is classified under UNCLOS as territorial waters, meaning that foreign vessels have the right of innocent passage. As a result there is a considerable amount of potentially polluting commercial shipping that utilises the Hebrides. Although no area is under license for the exploration or exploitation of oil or gas, the close proximity of oil fields means that much of the shipping traffic is oil related (App. C). Hebridean waters form a natural route for oil tankers en route from Norway and Sweden to Milford Haven and the Celtic Seas. The risk of pollution, either deliberate (as the result of sluicing out the tanks of oil tankers after offloading) or unintentional (accidental discharges, collision and oil spills) is high in these areas of intense use. Risks are elevated by narrow navigable north and south bound shipping channels, which are only 0.75 and 1.3 miles wide respectively (Fig. 38).

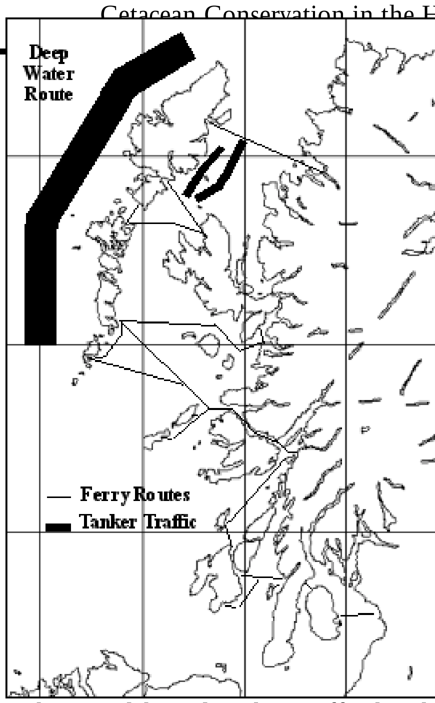


Fig. 38. Map showing the main vessel movements in the Hebrides.

The environmental sensitivity of the area and the risks posed by oil tanker traffic has been recognised, and in 1987 a Deep Water Route (DWR) was established (HMSO, 1994a). The DWR runs west of the Outer Hebrides (Fig. 38) and is the only one in the UK to be established for environmental reasons. Only laden tankers of 10,000 tonnes and above are obliged to used the DWR, smaller tankers and those that are unladen are not required to do so. In 1993, a voluntary code of conduct was implemented, stating that no tankers (laden or unladen) of 10,000 tonnes and above were to pass through the Minches unless under *'stress of weather'* or *'force majeure'* (HMSO, 1994a). However, in reality, the majority of tankers still use the Hebrides as a regular route. Only 1/5th of tankers use the DWR in preference to the Hebridean route (Habberley, 1989). This is thought to be due to the financial and operational disadvantages that the DWR presents. This pattern has continued to recent years (Bryan, 1994; A. Gill pers. comm.). For those tankers using the DWR, there is no navigation guidance for the route at the north end. As a result tankers tend to take the shortest route which means passing very close to Barra Head and the Butt of Lewis. The Donaldson report recommended the Minch be designated a Marine Environmental High Risk Area (MEHRA), effectively withdrawing the right of innocent passage, but, to date, no action has been taken (SCENES, 1998a).

Smaller discharges may occur from public and recreational traffic, for example, the ferries that connect many of the Hebridean Islands. Risk of discharges are likely to be higher in and around ports and along main ferry routes. The main ports and routes used are indicated on Figure 38. Inshore traffic levels were monitored during 1997/8 in the Applecross area, and typical levels are summarised in Appendix C. Discharges from these sources, although small, are likely to be lighter fuel oils rather than crude oils. Fuel oils are less stable, more reactive and, therefore, more toxic. They tend to evaporate more readily and so may pose a threat via inhalation. Discharges are likely to occur over a broader area but will be primarily coastal which will have greater implications for harbour porpoises and bottlenose dolphins.

The number of oil spill related incidents in the Hebrides are summarised in Appendix C, and can be seen to be generally small in quantity. To date no major oil incident as occurred. However in 1998 the 'Westminister' carrying 80,000 tonnes of crude oil lost power off the west coast of South Uist. Fortunately the tanker regained power and averted a potentially serious incident (Fulton, 1999). The number of oil spill incidents has increased since 1982 (App. C), whether this is due to increased amounts of marine traffic in the area or a more rigorous reporting scheme is not clear. The number of spills requiring clean up action is low (App. C) compared to other coastal regions, this is analogous with the area having less traffic. However, it cannot be discounted that the remoteness of the area may not warrant such rigorous clean up actions than busier more populated regions would demand.

Oil Exploration

Although oil pollution is generally thought of in terms of crude oil, there are other forms of pollutants connected with oil exploration, e.g. drilling lubricants and production water that can contain toxic additives. The expansion of the oil industry into the Atlantic Frontier will introduce a significant source of hydrocarbon pollution to West Scotland. The risks of accidental discharges are greater in this area than the North Sea due to deeper water and severe weather conditions. For example, there are two oil developments in the Atlantic Frontier, which caused three serious incidents within their first year of operation (SCENES, 1999c). There are also several oil-related facilities that have potential to pollute, one example is the oil yard at Kishorn, Wester Ross, used for oil industry servicing and potential rig decommissioning.

Land-based Discharges

Hydrocarbons will also be discharged via domestic and trade outfalls within the area. It is not possible to quantify the volume of hydrocarbon compounds entering the study area from this route.

PAHs

As the most toxic group of hydrocarbons it is important to consider the extent of threat from PAHs, which are derived from the sources described above. A study by Law *et al.* (1997) detected PAHs in coastal and estuarine waters in England and Wales. However, no similar data is available for levels of PAHs in the Hebrides. Data regarding PAH levels in cetaceans in West Scotland are extremely scarce and are limited to a single neonate harbour porpoise stranded on Islay. No other stranded cetaceans have been analysed for the presence of PAHs. The porpoise had detectable levels of PAHs despite being a neonate (Ekofisk equivalents: 1.0ppm; Chrysene equivalents: 0.23 ppm, wet weight; Law & Whinnett, 1992), and it would be expected that adults from the region would accumulate greater concentrations. Considering the potential for PAH contamination in West Scotland, the levels of this contaminant in cetacean tissues warrants further research.

4.4.4. Butylins

The nature and extent of threat posed by butylins is dealt with in *Section 4.6.3.*

4.4.5. Radionuclides

Radionuclides occur naturally in the marine environment, but a number of artificial radionuclides have been introduced from the atmospheric fallout of nuclear weapons, accidental release from nuclear installations and discharges from nuclear plants. Once in the marine environment, depending on their chemical nature, radionuclides either remain dissolved in seawater or bind to sediments. Radionuclides in sediments can be remobilised by trawling and dredging back into the water column. Radionuclides have been detected in a number of cetacean species around the world (Samuels *et al*., 1970; Calmet *et al*., 1992; Berrow *et al*., 1998). This research has established that cetaceans can concentrate radionuclides. However, studies upon the effects of radionuclide contamination have been largely restricted to man and little research has been undertaken on cetaceans. The impacts of radionuclides upon cetaceans are, therefore, highly uncertain but cetaceans are thought to be extremely vulnerable to radioactive contamination (Johnston *et al*., 1996).

It is not possible to quantify the levels of radionuclides entering the system via natural, fallout or accidental sources. The commonest radionuclide found in Hebridean waters is radiocaesium (Fulton, 1998), the most significant source being the Sellafield nuclear fuel reprocessing plant. Since 1952, Sellafield has been discharging radioactive waste (Leonard *et al*., 1997) into the Irish Sea, which is immediately adjacent to the Hebrides (Craig, 1959). In 1994, the Enhanced Actinide Removal Plant (EARP) at Sellafield went into operation. This was initially designed to reduce alpha and beta radioactivity in effluents and, as a result, radioactive discharges have decreased. However, the EARP is now treating concentrated effluents previously stored on site and this has significantly increased the levels of Technetium-99 (^{99}Tc) released to the marine environment (Leonard *et al*., 1997). Prior to the EARP, ^{99}Tc concentrations in Hebridean waters ranged from 0.2 - 2.3 mBq1^{-1}, however, post EARP levels were measured at 0.1 - 15.4 mBq1^{-1}, decreasing with distance from site (Leonard *et al*., 1997). ^{99}Tc remains in the water column, therefore increasing its potential to be taken up by prey species of cetaceans. Levels of the radionuclides in cetacean prey species have not been investigated in the area and so no assessment of this threat can be made. However, considering the uncertainty of effects, the persistent nature of radionuclides and the predicted levels of discharge (30 billion litres over the next ten years; Greenpeace, 1998), more research is warranted.

4.4.6. Pathogens

There is concern that bacteria in wastewater discharged to the marine environment may pose a threat to cetacean populations. Pathogens present in human sewage include *Salmonella* sp., *Escherichia coli*, *Streptococcus* sp., the fungi *Candida,* and viral infections including enteroviruses, hepatitis, influenza and herpes. These bacterial populations are only removed from wastewaters through tertiary ozone and ultraviolet treatments. Many of these pathogens have been isolated in marine mammals (Parsons, 1997) and cetaceans may, therefore, be vulnerable to infection. However, no causal link has yet been established between sewage pollution and its effects on cetaceans (Parsons, 1997). Pathogens may enter the cetacean system via several routes: lesions and lacerations, gastrointestinal tract from the ingestion of prey items, and through mucous membranes and the respiratory tract (Parsons, 1997). Pathogens in the Moray Firth may be a factor leading to the high incidence rate of skin disease found in resident bottlenose dolphins (Thompson & Hammond, 1992). Pathogens are opportunistic and may affect animals that are already stressed or compromised due to pollution and disturbance, reducing resistance to disease. The link between sewage and disease is little understood but could present serious health problems.

Pathogen sources in the Hebrides include industrial, domestic and fish farm effluents. It is difficult to determine the extent of threat from pathogens in the Hebrides, as although pathogens can cause disease, the extent to which cetaceans are exposed is difficult to determine. *E. coli* remains viable for a few hours to 1 day, *Streptococcus* spp. can stay viable for several weeks, and enteroviruses may persist for months (HMSO, 1990). Exposure levels to viable pathogens is not possible to assess due to lack of data on cetacean habitat use. Most sewage effluents are discharged into coastal waters, therefore, posing greatest risk to harbour porpoise, bottlenose dolphin and coastal Risso's dolphin populations. Discharges are controlled and monitored by the SEPA under the EU Urban Waste Water Directive (91/27/EEC) implemented by the Urban Waste Water Treatment Regulations (Scotland). Regions relevant to the Hebrides are the Western Isles, the Highlands and Argyll and Bute. With the exception of Oban, which has primary screening, all sewage waste is discharged directly into the sea untreated. Most towns and villages, due to their remote location have little or no public sewer system and sewage is discharged via septic tanks or private outfalls. Therefore, most sewage pollution is localised. Increased seasonal populations in the summer mean increased discharges which coincides with times of high cetacean abundance. Improvements to the existing infrastructure are planned through the EU Urban Waste Water Directive. However, this does not extend to tertiary treatments.

Industries producing woollen materials, leather goods, whisky and fish products all produce discharges which are, on the whole untreated and could have toxicological impacts upon local communities of cetaceans. The greatest source of untreated sewage pollution in the coastal waters of Scotland is the aquaculture industry discussed in *Section 4.6*.

4.5. HABITAT DEGRADATION

As well as threats posed by pollutants, cetaceans are under increasing pressure from the degradation of the marine environment via man's activities. Causes of habitat degradation include prey depletion, ozone depletion and acoustic disturbance.

4.5.1. Prey Depletion

Depletion of prey species may have dramatic effects on cetacean populations, causing cetaceans to move to other prey rich areas, or turn to alternative prey species (Curran *et al*., 1996). Most cetaceans are flexible feeders and, due to their mobility and blubber reserves, may be able to respond to short-term prey fluctuations (Thompson, 1992). If shifts in prey species are long-term, changes in growth rates, reproductive rates and survival may occur. These may be exacerbated as contaminants contained in the blubber layer are mobilised (Curran *et al*., 1996). There are several explanations for a reduction in prey species including, natural fluctuations, climate change, ozone depletion, pollution and fisheries. Climate change trends alter oceanic circulation and, therefore, the distribution of marine species which in turn affects cetacean distribution (Perry, 1999). Global phenomena such as ozone depletion may play a role in prey reduction (discussed in *Section 4.5.2.*). Pollutants such as those discussed in *Section 4.4.* can be deleterious to many marine organisms, therefore, depleting prey. Fisheries activities such as dredging and trawling disturb the benthic environment which supports demersal fish production. Trawling effort and, therefore, benthic damage increases as fish densities decline and so an escalating problem is created. In particular, scallop dredging depletes cetacean prey resources through such thorough destruction of the seabed that it may be several years before there is any recovery. Depletion of food resources also occurs as a result of over-fishing.

Climate Change

This is a global issue and it is not possible to assess how large scale temperature and oceanic changes may be affecting prey distribution in the Hebrides.

Fisheries

The Hebrides holds important fishing grounds and many of the commercially important fish species caught in the region are also important prey species for cetaceans. In 1997, there were 1265 boats registered, for the west coast of Scotland, in the ports of Kinlochbervie, Lochinver, Mallaig, Ullapool, Stornoway, Oban, Campletown and Ayr and also operating out of Tarbert, Port Ellen, Luing, Tobermory, Gairloch, Castlebay, Berneray, Kyle and Uig (Gill, 1999). However, a large proportion of fishermen operating in this area are not from West Scotland, but rather other regions (e.g. East Coast Scotland and Spain) landing their catches outside of the Hebrides. The traditional pelagic fishery for species such as herring and mackerel has declined in the Hebrides (Brady, 1991). Due to overseas competition, it is no longer commercially viable for small-scale, local operators in the Hebrides to exploit these stocks and so these operators have shifted fishing effort toward demersal and shellfish species. Trawl fisheries make up 17% of the west coast fishing fleet in the Hebrides (Gill, 1999). External trawlers also frequent coastal waters and have no knowledge of previous fishing effort of the trawl sites. Therefore, the seabed is not left to recover before being trawled again. Coastal waters could be managed by local fishing organisations to allow seabed recovery before re-trawling. Therefore, fishery yields would be maximised and the habitat and prey species of cetaceans protected. Although mechanical scallop dredges make up only 5% of west coast fishing fleet they are highly destructive to the benthos, much more so than trawl fisheries.

There is currently a fisheries quota system in operation in Scotland, with takes being calculated to alleviate the problem of over-fishing. However, the quotas are based upon the amount of fish landed at recognised ports. The quotas do not take into account fish which are discarded at sea, a common practice for undersized fish and non-target species. This discard may account for a biomass as much as a third of the total reported catch (Hughes, 1998). In addition, the illegal landing of fish is a serious problem and is common practice in many areas. It has been estimated that 40-60% of landed fish are done so illegally and are, therefore, not officially entered into catch statistics (Hughes, 1998). Due to a combination of these two factors, fisheries quotas are being greatly exceeded and, therefore, stocks of fish, and thus cetacean prey species, are being diminished.

4.5.2. Ozone Depletion

The depletion of the ozone layer and associated increase in ultra-violet (UV) radiation may pose threats to cetaceans. These potential impacts include deleterious effects on vision, immune response, reproductive success, and disease occurrence on increased exposure to UV radiation (Tynan & DeMaster, 1998). Indirect effects of ozone depletion include prey depletion (Perry, 1999). Increased UV may cause death, decreased reproductive capacity, reduced survival and impaired larval development in many zooplankton and fish species (Hader *et al*., 1995). Of particular concern are those species which spawn in shallow areas and are therefore exposed to higher UV levels such as herring and cod which also constitute an important part of many cetacean diets.

Ozone levels over the Northern Hemisphere have been reported to be depleted by 40% when compared to 1979-1992 levels (NASA, 1997; WMO, 1997). The extent that this may directly impact cetaceans or their food sources has not been determined, but could be considerable. If increased UV is having an impact on cetaceans due to reduced ozone coverage, one would expect decreasing fish stocks and cetacean species to display an increasing amount of dermal lesions. It is possible that dermal lesions reported from bottlenose dolphins in the Moray Firth and similarly the Hebrides are not the result of pollution but of increased UV exposure.

4.5.3. Acoustic Disturbance

Sound is efficiently propagated underwater and is central to cetacean survival: they use sound to navigate, locate prey and maintain social contact. Because of their acoustic dependence cetaceans are particularly vulnerable to any noise which may disrupt their biological functioning. Increasing levels of underwater noise from man's activities such as shipping, coastal development and offshore exploration have a potential to cause disturbance to cetaceans. A cetacean will respond to a certain sound frequency if it can detect it, and it is generally accepted that cetaceans are sensitive to frequencies in their own vocalisation range (Gordon & Moscrop, 1996). Therefore, different species are vulnerable to different sorts of noise pollution. The sound frequencies of mysticetes and odontocetes are reviewed below, with data specific to Hebridean species tabulated in Appendix D.

Mysticetes

Baleen whales produce intense, low frequency, sounds which are well designed for long transmission (Payne & Webb, 1971) and maintaining long distance communication. Some species produce more complex and individual signature whistles which are associated with social situations (Moscrop & Simmonds, 1994). The dominant frequencies for baleen whales are 12Hz - 3kHz, however there is much interspecies variation as seen in Appendix D. There is no direct measure of hearing in baleen and it assumed their auditory sensitivity coincides with their vocalisation range.

Odontocetes

Toothed cetaceans use a wide range of sophisticated sounds including whistles, high frequency echolocation clicks and grunts, and other pulsed calls (Perry, 1998). The range of frequencies utilised by odontocetes is highly variable and is summarised in Appendix D. Their auditory sensitivities are greatest between 10 and 150 kHz (Evans & Nice, 1996) with relatively poor hearing at low frequencies (Nachtigall *et al*., 1996).

Acoustic disturbance can threaten cetaceans in three main ways (Simmonds & Dolman, 1999). Full literature reviews of different cetacean reaction to noise can be found in Gilders (1988), Moscrop and Simmonds (1994) and Perry (1998).

- *Physical* - High energy intense sound, such as explosions, produce shock waves which can cause direct tissue damage and permanent damage to auditory organs. A shift in hearing thresholds can also occur, whereby faint sounds are less easily detected.
- *Behavioural* - An increase of ambient background noise can produce long and short-term behavioural changes. Elevated background noise can mask biological acoustic cues that are used for hunting or breeding and decrease the range within which cetaceans can communicate. This may cause cetaceans to modify their acoustic signals or in the case of oceanic species may cause communication difficulties. Short-term behavioural changes such as increased blow rates, longer dive times, shorter surface intervals and evasive movements have been observed in some cetaceans when exposed to acoustic disturbance. Where disturbance is long-term, displacement of cetaceans to another area is observed.

- *Stress* - The stress induced by chronic acoustic disturbance may affect the health of the animal and result in increased vulnerability to threats from pollution and disease.

In the Hebrides, there are a number of potential sources of acoustic pollution that may pose a threat to cetaceans. Due to the seabed conditions of the area, comprising hard rock and steep coastlines, amplification of these sounds may occur and exacerbate the problem.

Marine traffic

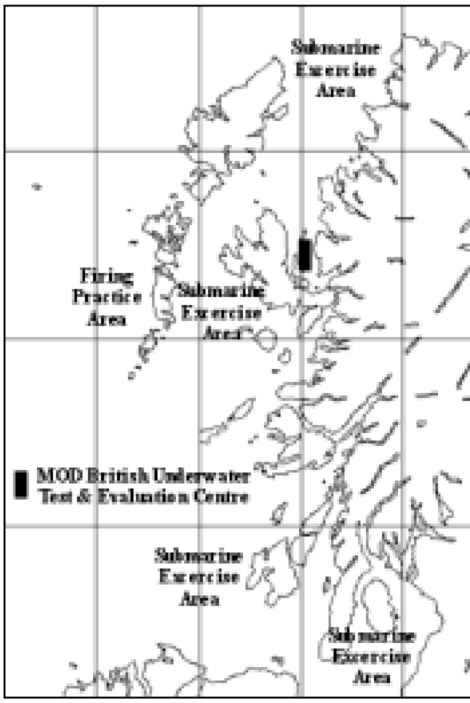
Noise from ships dominates marine waters and emanates from the ships propellers, machinery, the hulls passage through the water (Gordon & Moscrop, 1996), and the increasing use of sonar (Perry, 1998). Most shipping has a low frequency range of 0.02 -0.9 kHz (Evans & Nice, 1996) which coincides with the frequencies used by baleen whales (Moscrop, 1993). Any propeller damage may cause some cavitation which will generate a higher frequency range sound therefore disturbing smaller cetaceans. The expanding marine tourism industry has lead to increased levels of marine recreational traffic in coastal areas. There is the potential for recreational traffic to disturb cetaceans (Donoghue, 1996). Leisure craft generate sound in the 1 - 50 kHz range (Evans, 1990) which has the potential to threaten toothed whales. Evans *et al.* (1992) studied the effects of pleasure craft on bottlenose dolphins and reported that the cetaceans exhibited negative responses to boat traffic, including changes in dive times and the avoidance of an approaching vessel at a distance of 150 - 300m. Quieter, faster boats caused more disturbance than slower larger boats, as noise emitted by high speed boat rises above ambient levels only a short time before closest contact, thereby provoking a 'startle' reaction.

The whale-watching industry, which has increased dramatically in recent years (Hoyt, 1995) can also have a disruptive effect on cetaceans (Gordon *et al.*, 1992; Heimlich-Boran *et al.*, 1994; Janik & Thompson, 1996). Operators frequent areas which are known cetacean grounds, thereby increasing exposure of cetaceans to disturbance.

Areas of high shipping activities are summarised in *Section 4.4.3*, and numbers of ships passing through the area are tabulated in Appendix C. With the development of the Atlantic continental shelf and potential superquarry development in inshore areas, it is likely that the amount of shipping through the area will rise, with increasing levels of disturbance to cetaceans. Marine tourism is now becoming increasingly important to the Hebridean economy, directly contributing £9 million/year and supporting approximately 400 jobs (SCENES, 1998b). A recent survey estimated that marine wildlife tourism brought in an extra £9.3million to the economy of the Island of Mull, when direct and indirect (accommodation, food and souvenir purchase etc.) visitor spends were calculated (Warburton, 1999). There are currently more than 30 marine wildlife tour operators, with the greatest density of operators occurring in the Argyll and Islands region (AMTD, 1997). To date, no causal relationship has been established between whale-watching boats in Scotland and changes in cetacean population and behaviour (Masters *et al*., 1998). As the profitability of whale watching is realised, it will undoubtedly attract more investment and industry expansion. The early adoption of precautionary action and guidelines will minimise disturbance. The code of conduct produced by Hebridean Whale and Dolphin Trust raises awareness to this problem and is currently being distributed (App. B). In 1998, the Scottish Marine Wildlife Tour Operators Association produced the '*Minch Code*' to promote environmentally sustainable marine wildlife tourism.

Oil exploration

Seismic testing for oil and gas uses both high and low testing arrays, which produce intense



noise at frequent intervals. Depending on the test used, frequencies from 0.005 to 200 kHz are occupied at levels of 225 - 270 dB (see Appendix D) and can be detected up to 100km from source (Richardson *et al.,* 1991). Seismic testing is known to cause disturbance to cetaceans (e.g. Evans & Nice, 1996; Gordon & Moscrop, 1996; Swift, 1997). Drilling of oil and gas is also a significant noise source, producing low frequency sounds (App. D).

Although no seismic surveys are carried out in internal waters of the Hebrides, there is increasing activity off the west coast of the Outer Hebrides, which has potential to impact offshore species. The area in which seismic surveys are being conducted is known to be inhabited by several species of cetacean, in particular beaked, bottlenose, sperm, fin, sei and pilot whales and Atlantic white-sided dolphins (Northridge *et al*., 1995; Lewis *et al*., 1998; Hughes *et al*., 1998). In a recent study, Swift (1997) monitored the acoustic behaviour of cetaceans before, during and after seismic surveys and noted significant behavioural changes. Due to these behavioural abnormalities, and as the Habitats Directive is now deemed to extend to the deep waters of the Atlantic Frontier (the main oil exploration area) seismic surveys are thus contravening the Habitats Directive by disturbing Annex IV listed species in their habitats.

The UK Government has recently issued the oil industry with a code of practice to attempt to mitigate the impacts of seismic surveys upon cetaceans. This code of practice should help prevent the lethal and sub-lethal effects of seismic testing, but the issue of habitat degradation and disturbance of cetaceans within breeding and resting grounds as the result of oil exploration still remains.

Military activity

There is a high level of marine based military activity in the Hebrides which could pose an acoustic threat. Vonk and Martin (1989), Simmonds and Lopez-Jurado (1991), and Frantzis and Cebrian (1999) have suggested that military activities, notably the testing of sonar, may have caused a mass stranding of Cuvier's beaked whales in the Canary Islands and the Ionian Sea. Sperm whales and long-finned pilot whales have also demonstrated changes in vocal behaviour in response to the use of military sonar (Watkins *et al*., 1985; Rendell & Gordon, 1999).

Fig. 39. Military Areas in the Hebrides.

Areas in the Hebrides which are designated as military areas are shown in Figure 39. Activities undertaken in Hebridean waters include torpedo testing, firing ranges, extensive sonar use and submarine exercises all of which have the potential to disturb a variety of cetacean species. The Ministry of Defence (MOD) British Underwater Test and Evaluation Centre is situated near the Kyles of Lochalsh. The adjacent area is used as a torpedo testing range. Some 130 squares miles of the Sound of Raasay are considered to be a danger area to shipping because of the use of explosives in this region. This area is also an important habitat for cetaceans, notably the northern bottlenose whale and harbour porpoise. Therefore, the use of torpedoes in the area may not only disturb cetaceans but could also be physically damaging. A missile firing range is situated on the island of South Uist, which fires ordinance westwards out to sea, where a large number of cetacean strandings are reported, suggesting a diverse cetacean population in the waters adjacent to the missile range (Sheldrick, 1989; Bones & Maclennan, 1994a,b). In particular, there have been a large number of sperm whale strandings in this area (Evans, 1997c). As yet, there has been no analysis of the pattern of strandings on South Uist in relation to military activity, but this is an area that merits research. Live-firing exercises also occur, but are restricted to the southern approaches to the Firth of Clyde and Cape Wrath.

Since 1946, NATO has conducted tri-annual Joint Maritime Courses (JMC) throughout the Hebrides. These training exercises are carried out in coastal waters and in deeper waters to the North and West of Scotland. Concern has been voiced from wildlife tour operators that this exercise coincides with a period of abnormally low local cetacean abundance (B. Fairbairns; I. Birks; D. Leaver, pers. comm.). No research has been undertaken to evaluate this and, due to the extent of activities in the Hebrides, is a priority. The amount of military activity in the area is considerable (App. E), and so the potential for lethal and sub-lethal impacts upon cetacean populations in this region is high. Due to the classified status of much military activity and equipment used (especially sonar), it is impossible to determine impacts on cetaceans without input from the Ministry of Defence. In 1998 and 1999, discussions took place between the MOD, SNH and HWDT to address these issues. A code of conduct for military vessels was produced (App. E) and a more open forum for discussion created. However, as of yet, very little progress has been made to address the real issues of concern.

The US Navy has recently lost a legal battle to the US Natural Resources Defence Council which has forced the navy to abandon underwater test explosions by proving a link between underwater noise and whale disturbance and trauma (Winkler, 1999). Such a case provides grounds for similar action against the Royal Navy, under both the WCA and the EU Habitats Directive. However, research is required to more precisely assess the effects of noise on cetaceans in the area.

Superquarries

The expanding aggregate extraction industry could also cause acoustic disturbance to cetaceans. Scotland is a rich source of aggregate for which there is a high demand. This could be potentially supplied by the development of coastal superquarries. Threats are posed from increased shipping traffic, as discussed above, and also quarry blasting. Quarry blasting may have a direct impact (Schliemann *et al*., 1995) or indirectly through impacting fish populations, effectively degrading areas as feeding grounds (Evans & Heimlich-Boran, 1994).

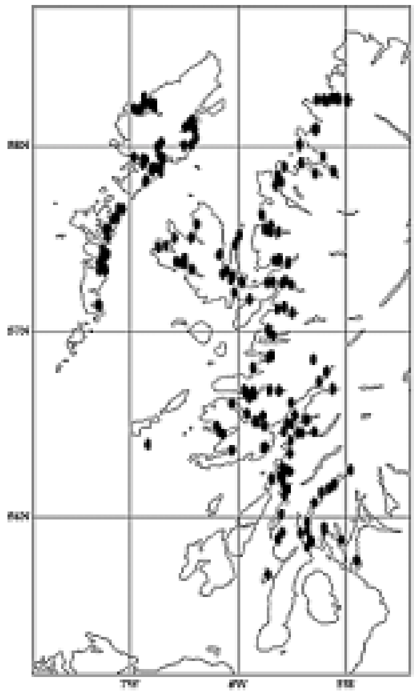
There is currently one coastal superquarry already in operation at Glensanda. The products of this quarry are shipped through the Sound of Mull, which is a habitat for harbour porpoises. A Scottish Office report identified 5 other locations for a potential superquarry, 4 of these were in the Hebrides being South Harris, Loch Ewe, Loch Linnhe and Kentallen (McKirdy, 1992). In an assessment of the South Harris superquarry it was determined that if ship movements increased by more than one vessel per day, cetaceans would be deterred from the area. The effect of blasting at the quarry was not clear, as direct measurement of underwater noise levels would be required (Evans & Heimlich-Boran, 1994). The development of any of these sites would cause additional acoustic pollution and do in theory represent a significant threat, however, the impacts of each quarry would need to determined on an individual basis.

Dredging

Dredging activities (including scallop suction dredging and aggregate dredging) produce significant and continuous noise at a frequency of 250 Hz, with source levels between 150 - 162 dB (App. D). This noise, which can carry for dozens of miles, could have an impact upon cetaceans.

A review of 1997 fisheries statistics by Gill (1999) revealed that there were 64 scallop dredges in operation on the west coast, which represents representing 5% of the regional fishing fleet. It is not possible to identify areas of high scallop dredging effort and so it is not possible to assess what the impacts would be to individual cetaceans populations.

Dredging for aggregate in the Hebrides is



limited although there is potential for the industry to expand. For example, prospecting licences have been issued for maerl beds off of Barra and South Uist, areas which are inhabited by cetaceans. Also, chromite and olivine reserves 3km south east of Rum have been subject to reconnaissance surveys (McKirdy, 1994). The amount of noise produced by such dredging activities would be substantial and would be expected to have an impact on cetaceans.

4.6. FISH FARMING

Marine cage fish farming is common throughout West Scotland and almost all sealochs and sheltered bays now contain a fish farm. The number and distribution of fish farms in West Scotland can be seen in Figure 40. Salmon production has been steadily increasing. Overall, Scotland has seen an increase in production from 64,066 tonnes in 1994 to 83,121 tonnes in 1996 (SOAFD, 1999). This was predicted to rise again to 132,000 tonnes by the year 2000 (Ross, 1997). This rapid growth has occurred with little guidance or developmental control from Government. As a result, the intensity of production processes have been left unchecked, producing a variety of impacts on the marine environment. Fish farms use a wide range of chemical substances, including antibiotics, parasite controllers and butyltins, which have potential to pollute the surrounding marine environment. In addition, they input large quantities of organic and nutrient wastes. They also employ the use of acoustic deterrents that further degrade the habitat via acoustic disturbance. This section shall review these, and the potential threats posed to cetaceans.

4.6.1. Antibiotics

Due to high stocking densities in fish farms, antibiotics are routinely used to keep disease spread under control. There four are classes of antibiotics that are used on fish farms,

Fig. 40. Location of licensed fish farm sites in the Hebrides.

oxytetracycline, oxoclinic acid, potentiated sulphonamides and amoxycillin (Ross, 1997).

These antibiotics are usually incorporated into feed and ingested by the fish. However, there is concern that the antibiotics can pass through the cages in their active form, either as faeces or uneaten food and may affect non-target species.

Between 74-100% of wild fish caught near fish farms were found to have antibiotics in their flesh (Morton, 1995). Oxytetracycline and oxoclinic acid are persistent in the environment and are still found in sediment up to 7 months after application (Ross, 1997).

The administration of antibiotics prolongs infection viability and exposes wild organisms to unnaturally high levels of pathogens through increasing bacterial resistance which facilitates the spread of more virulent strains of disease (Morton, 1995). The impacts

Table 6. Antibiotics (in kg) used by salmon farms in the SEPA West region.

Antibiotic	1991	1992	1993	1994	1995	1996
Oxytetracylcine	705	1561	1170	561	772	144
Oxoclinic acid	273	503	674	109	468	89
Pot. Sulphonamides	1401	1315	1094	1209	751	223
Amoxycillin	602	993	842	747	854	1116
Total	2981	4372	3780	2626	2845	1572

Source: SEPA in Ross (1997)

and spread of antibiotic resistant disease to cetaceans has not been fully investigated, but in 1997 a dead female orca, previously seen feeding on escaped salmon, was found to contain levels of resistant bacteria at levels dangerous to human health (Morton, 1998). Whether bacteria were responsible, or contributory to the mortality, was not investigated.

There is very little data regarding the extent of antibiotic use in the Hebrides and nothing is available concerning levels of disease resistant bacteria in cetaceans or any other wild organisms. The use of antibiotics is regulated by veterinary prescription under the Medicines Act 1968, however no discharge limits are set and no central records of use levels are kept (Ross, 1997). SEPA West is the only region in Scotland to have maintained a comprehensive database, which is summarised in Table 6.

With the current state of knowledge, it is very difficult to assess levels of antibiotics entering the Hebridean system. It can be seen from Table 6 that the total amount of antibiotics being used is decreasing, which may reflect an increasing resistance to these antibiotics and/or an increase in the use of vaccines used at the smolting stage. However, significant amounts are still entering the marine system, the impacts of which on cetaceans, non-target prey species and the wider marine environment are not fully understood. A more regulated and precautionary approach should be adopted.

4.6.2. Sea Lice Control

Farmed fish are commonly treated with organophosphates to combat fish lice, the main treatments being;

- dichlorvos which is highly toxic, with harmful effects from acute exposure and cumulative toxicity from repeated low dose exposure (Health and Safety Executive cited in Ross, 1989). As an acetylcholinesterase inhibitor dichlorvos can have impacts on the human nervous system with many concerns for fish farm operatives (Ross, 1997).
- Ivermectin has been found to be lethally toxic to a range of estuarine and marine invertebrates, with sub-lethal effects on behaviour occurring at levels 1000 times lower than the LC_{50} level (the concentration of a substance which results in a 50% mortality rate) (Grant & Briggs, 1998a). Only 30% administered appeared in salmon flesh, the rest (70%) entered the marine environment (Hoy *et al*., 1990). Levels in the vicinity of fish farms may be in excess of those necessary to cause ecological effects (Grant & Briggs, 1998b).
- Azamethiphos is ten times more toxic to sealice than dichorlvos. Cholinesterase inhibition from azamethiphos has been observed in other mammals including humans and may have similar effects on cetaceans. (Ross, 1998a).
- Cypermethrin is a synthetic pyrethroid that is known to be a hormone (or endocrine) disrupter. Adverse effects are seen on the reproductive and immune system and can occur at much lower levels than standard toxicity testing (Ross, 1997). There is concern over the long term effects of exposure on cetaceans, especially on individuals or populations which may already be compromised (Ross, 1998b).

To date, there has been no study on the levels of organophosphates in cetaceans in the Hebrides, neither has their impact upon cetaceans been studied. However, they are all known to be toxic at low levels to other marine organisms. There is significant uncertainty about their fate, impacts of chronic toxicity, cumulative effects of repeated exposure, individual sensitivities and potential synergistic effects of these chemicals once in the marine environment. Therefore, not only is more research required, but also precaution on the part of consenting bodies. Prolonged use will increase resistance of sea lice meaning that chemicals will be used more frequently or at higher concentrations. Until 1993, dichlorvos was the only sea lice treatment on the market and was widely used despite it being a *'red list'* substance. Use has declined with the advent of other treatments being licensed and pressure under the 1987 North Sea Conference to reduce inputs to 50% by 1995. Ivermectin, illegal since 1991, was granted a consent for discharge by SEPA in 1996, and is thought to have been used illegally prior to this (Grant & Briggs, 1998b). Azamethiphos was authorised for use in 1996.

4.6.3. Antifoulants

Butlyins (BTs) are toxic compounds that have been highlighted as being of risk to marine biota (Fent, 1996). BTs were primarily used as anti-fouling treatments on fish farm cages, ship hulls and marine structures. BTs are extremely toxic and can cause growth retardation and imposex in marine organisms in concentrations as low as 10-20 $ng.L^{-1}$ (Lawler & Aldrich 1987; Gibbs & Bryan, 1986), and to disrupt the immune system of mammals (Seinen & Willems 1976; Vos *et al*., 1984). There is concern about the possible toxicological implications for BT pollution on cetacean populations (Iwata *et al*., 1994, 1995). BTs have been identified in at least 14 species of cetaceans from North Pacific and Asian waters, with elevated levels being seen in coastal species, indicating that, in Scotland, species such as harbour porpoise and bottlenose dolphin would be more at risk from BT contamination (Tanabe *et al*., 1998). BTs are thought to have played a role in mass mortality events of bottlenose dolphins in Florida through suppression of the immune system (Jones, 1997).

Davies *et al.* (1987) reported elevated BT levels in Loch Laxford, an area used by harbour porpoises. The highest values were observed adjacent to fish farms. In 1986, the use of Tributylin (TBT) on boats less than 25m was banned in Scotland and in 1987 use was prohibited on fish farm cages. However, Ambrose (1994) noted that around 69% of ships are still being painted with TBT. It is likely that, with the increasing cage sizes used on fish farms which hamper physical drying, the pressure to use antifoulants such as TBT is high. Areas around fish farms and harbours would therefore be expected to have elevated concentrations of BTs. Bailey (1991) recorded an increase in imposex in dog whelks (*Nucella lapillus*) near harbours, marinas and fish farms in West Scotland, which was correlated to BT concentrations. It would be expected that coastal species frequenting sealochs, such as bottlenose dolphins and harbour porpoises, would, therefore, be exposed to elevated levels of BT contamination. There have been no studies of BT contamination in cetaceans in West Scotland. Although several seals have been discovered coated with TBT paint from fish farm cages in recent years (M. Stroud, pers. comm.). The possible impacts of BTs upon the health of coastal cetaceans is an area that requires urgent attention.

4.6.4. Organic and Nutrient Inputs

Salmon farms contribute large quantities of organic waste to the marine environment. This faecal matter is entirely untreated and gathers in high concentrations under fish farm cages, which together with unconsumed fish food, forms a mat of decaying organic matter. As fish farms are typically situated in sealochs and sheltered areas, these enclosed water systems result in the accumulation of the organic detritus, giving rise to anoxic conditions and reduced water quality. The presence of untreated faecal matter will introduce high levels of pathogens to the water column, the impacts of which were discussed previously in *Section 4.4.6*. Given the opportunistic nature of pathogens, such large untreated volumes of sewage entering the marine system poses a significant threat. The choice of husbandry techniques used, including larger cages and automated feeding systems, increase the volume of organic waste input. The trend to larger cages and farms, and higher stocking densities means that more waste is produced. In addition, the increasing prevalence of automated feeders results in less efficient food conversion rates (Ross, 1997) and, therefore, more uneaten food entering marine system.

Salmon farms generate substantial quantities of dissolved wastes, in the form of nitrogenous and phosphate wastes, which have potential to impact the quality of surrounding waters (Ross, 1997). Elevated nutrient levels can lead to increased levels of primary productivity, and subsequently eutrophication and, potentially, toxic algal blooms. Usually, the proportions of nitrogen and phosphorous released in fish farm effluents are comparable to those that occur naturally and do not pose a great threat (Gowen & Ezzi, 1992). However, the nutrient balance of the water column can be upset by the reduction of grazing zooplankton populations. Organophosphates are known to be toxic to zooplankton (Ross, 1997), therefore increasing the likelihood of unchecked primary production and algal blooming. Red tides in Canada have been attributed to salmon farming (Morton, 1995) and there is evidence to suggest that toxic dinoflagellate blooms are linked to marine mammal mortalities including monk seals (Hernandez *et al*., 1998) and humpback whales (Geraci *et al*., 1989).

By SEPA's own admission it is *"difficult to estimate the quantities of contaminated solid wastes produced on Scottish farms"* (Taylor *et al*., 1998). Figures published for 1996 estimate that for the 80,000 tonnes of farmed salmon produced, there are 35,000 tonnes of faecal waste, i.e. 0.44 tonnes of waste per tonne of produced salmon (Taylor *et al*., 1998). Using SEPA data for 1999, 114,638 tonnes of salmon would have been produced, meaning that 50,440 tonnes of faecal waste would have been discharged into the marine environment. Discussions with fish farm site managers revealed that manual feeding was more efficient and the preferred option but, management preference for automated systems meant these are often used.

Of total excretory waste in fish farms, 3.2% is voided as soluble wastes (Willoughby, 1972 cited in Gowen *et al*., 1988). Therefore, according to calculations above, 1,614 tonnes of soluble wastes will be input into West Scottish waters. Elevated nutrient levels have been found in many Scottish sealochs that have fish farms (Gowen & Ezzi, 1992: Gillibrand *et al*., 1996). There has been concern that the rise of the dinoflagellate toxin causing Paralytic Shellfish Poisoning (PSP), Diarrhetic Shellfish Poisoning (DSP) and Amnesic Shellfish Poisoning (ASP) in Scottish coastal waters may be attributable to nutrient inputs from fish farms. A monitoring scheme conducted throughout England, Wales and Scotland for algal toxins concluded that toxic dinoflagellates *Akxandrium* spp. responsible for PSP, *Dinophysis* spp. and *Prorocentrum lima* producers of DSP and *Pseudonitzchia* spp. associated with ASP were detected in Scottish waters and shellfish flesh. (Howard *et al*., 1998). Before 1997 ASP toxins were not tested for in the EU, as they were not considered an issue (A. Berry, pers. comm.). Incidents of algal toxic blooming which have resulted in closure of shellfish fisheries are tabulated below. Many of the areas noted are utilised by cetaceans and these animals would be exposed to levels of toxins higher than permitted for human consumption. For most of the summer of 1999, the entire Hebrides was closed to scallop dredging and diving due to the widespread prevalence of ASP.

During the ASP outbreak in Skye, in 1998, whales entered Broadford Bay and were observed for several weeks circling and were, apparently, unable to leave. Anecdotal evidence suggests that their disorientation may be due to presence of algal toxins. There has been no work to date establishing a link between algal toxins and cetacean ill health and mortality in West Scotland. However, the high density of fish farms, risk of eutrophication of waters and the rising incidence of dinoflagellate toxins in west Scottish waters suggests that this is an issue which may pose a significant threat to cetaceans and warrants immediate research.

Table 7. Algal toxin events in the Hebrides 1994-1998 (sites in *italics* indicate areas that are important for cetaceans).

Year	PSP[1]	DSP[2]	ASP[3]
1994[a]	West coast widely affected down to *Ardnamurchan point*. Detected for first time at sites in *Lewis* and *S. Uist.*	Widespread detection, especially in *Lochs Laxford, Inchard* and Greshornish and Skye where levels exceeded 116μg/100g for 4 weeks.	--
1995[a]	Widespread toxicity, exceeding permitted levels in some areas.	Prolonged toxicity found in *Loch Scridain, Mull.*	--
1996[a]	Widespread detection especially in North and central west areas. Worst affected were Lochs *Laxford, Broom, Hourn* and Greshornish.	Short lived events on north-west coast at Kyle of Tongue and Loch Inver.	--
1997[a]	Toxins of up 366μg/100g found in Skye.	Widespread toxicity throughout notably in Lochs *Inchard, Roag,* Seaforth (293μg/100g), *Hourn,* Snizort and Creran. Also, the west coast from Loch Ainort to Loch Cean Traigh was affected for six weeks.	Toxins detected in *Loch Broom Loch Scridain* and *Loch Hourn*.
1998[b]	Levels above threshold levels at *Loch Torridon* and Greshornish for two weeks, and also in Ardtoe. *Loch Scridain* levels were above threshold levels for 5 weeks.	DSP toxins were detected at *Loch Torridon*, Greshornish, and Eishort. Ardtoe also tested positive for toxins.	ASP levels were exceeded in Loch Eishort.

Notes: [a] Heath, 1998, 1999; [b] Howard *et al*., 1998;
[1] Permitted levels = 80μg/100g; [2] Permitted levels = 0μg/100g; [3] Permitted levels = 20μg/100g

4.6.5. Acoustic deterrents

The fish farm industry suffers to a large extent from predation by seals. In response to this, *'seal scarers'* have been developed to deter seals from fish farming areas. The devices are designed to frighten and induce pain to seals in order to permanently displace them from fish farming areas and have become known as Acoustic Harassment Devices (AHDs). There is growing concern over the effect of AHDs on non-target species such as cetaceans. The hearing of many odontocetes species is believed to be more sensitive than pinnipeds (Richardson *et al*., 1995). The level of noise pollution associated with AHDs may negatively impact cetaceans especially coastal species of harbour porpoise and bottlenose dolphin which utilise coastal areas where fish farms are located (Johnston & Woodley, 1998). It is suggested that harbour porpoises are excluded within 400m of an AHD, and abundance is significantly reduced within 3.5 km of the device (Olesiuk *et al*., 1996). A study of AHD's in Canada observed a decline in a range of cetacean species, including killer whales, minke whales and harbour porpoise using areas where AHD's are deployed (Morton, undated).

There are 211 (SEPA, pers. comm) fish farm licenses in the Hebrides and an unknown number of these farms utilise AHDs. Evidence from local fish farm managers suggests that AHDs are used routinely even if the area does not have seal predation problems or if AHDs are ineffective. The reason for this unwarranted use is for insurance purposes, so that fish farms are seen to be taking action to protect stocks in the event of predation occurring. If this is the prevailing view, it is feasible that many of the West Scotland fish farms will use AHDs. Extrapolating from data presented by Olesiuk (1996), that AHDs would exclude cetaceans from an area of 50,2654 m^2 around each fish farm and would have acoustic impacts over an area of 38.4 km^2 around each site, if all the fish farms in West Scotland used AHDs the area affected by AHDs would total 8,102 km^2. This would represent a major loss of cetacean habitat.

Fish farming is an expanding industry with new sites regularly being proposed. Increased production is increasing the pressure for new sites. Moreover, the pressure for new sites is also rising due to the Infectious Salmon Anaemia (ISA) outbreaks common in West Scotland over the past year. European law states that after eradication of ISA, sites must remain fallow for at least six months and due to the large numbers of sites affected by ISA, salmon farming companies cannot place incoming smolts into these fallow areas and are, therefore, having to look for alternative sites previously free of fish farms (Rea, 1999).

Moreover, aquaculture developments are not limited to salmon farming: the potential for halibut and cod farming are also being investigated. If this trend is to continue, the range of environmental impacts that fish farming entails needs to be thoroughly understood. The impacts of fish farming upon coastal and sealoch-dwelling cetaceans such as harbour porpoises and bottlenose dolphins has, as yet, been unstudied. An investigation of these possible impacts should be considered a research priority.

4.7. SUMMARY

Cetaceans are vulnerable to a wide range of threats throughout the Hebrides. These range from global issues such as ozone depletion to very localised problems associated with litter, seal scarers and marine traffic. Information regarding specific threats in the Hebrides is limited due to the lack of research that has been undertaken in the region.

In addition, many of the threats have the potential to act synergistically, and much more research is required in order to assess the impacts of these combined threats. However, it is clear that many threats do have the potential to have significant impacts on cetacean populations.

On assessment of the threats, the following have been identified as '*priority issues*' which require immediate research and/or action:

- the direct take of Northeast Atlantic minke which are likely to frequent Scottish waters;
- incidental take and injury from marine debris, the Hebrides being above national average for marine litter;
- pathogen pollution due to lack of sewage treatment in region, and vast quantities of untreated sewage that enter the marine system via fish-farming;
- depletion of prey and habitat destruction due to over-fishing, illegal catches and high by-catch rates;
- intense and widespread fish-farming activity which inputs significant quantities of chemicals into the marine environment. These inputs are largely unregulated and are, to date, unstudied with regard to cetaceans;
- the use of acoustic deterrents on fish-farms, excluding large tracts of coastal waters for cetaceans; and
- the scale and intensity of military activities in the area which, as of yet are unstudied but have been observed to have marked impact on cetacean sighting rates.

5. Conclusions and Recommendations

5.1. INTRODUCTION

It is clear that the Hebrides contains a wide diversity of cetacean species, many of which utilise areas that bring them into direct conflict with a range of human activities. Having assessed the present state of knowledge regarding cetacean populations, the protection currently afforded and the threats posed, concluding recommendations can be put forward to promote their conservation. The problems facing cetaceans are diverse, and include tangible threats posed by pollutants and fisheries by-catch, but also institutional and perceptual issues that affect how cetaceans are being conserved. Therefore, to resolve the issues facing cetacean conservation in the Hebrides, a broad management strategy is required. As a result, the recommendations made have a wide scope, including:

- The establishment of an effective *Management Framework;*
- The establishment of *Marine Protected Areas;*
- *Threat Minimisation;*
- A programme of *Prioritised Research;*
- *Communication* and *Education* initiatives.

5.2. MANAGEMENT FRAMEWORK

As identified previously, the Hebrides has no management framework within which to co-ordinate cetacean conservation strategies, or that has cetacean conservation as its prime objective. Therefore, before any progress can be made, a framework is required. This management framework must incorporate certain elements in order to be effective, these being:

- To hold cetacean conservation as its primary objective;
- To hold the precautionary principle at its core, to allow positive action to be taken in the face of scientific uncertainty, not only benefiting cetaceans but the wider marine environment;
- To allow an integrative approach, allowing diverse threats that are synergistic in nature, to be managed in a holistic rather than sectorial manner;
- To allow flexibility, such as establishing a system of feedback control whereby measures can be evaluated, refined and improved as new information comes to light;
- An ability to function at different institutional levels including international, national, regional and local arenas; and
- The accommodation of existing initiatives beneficial to cetacean conservation in order to maximise work currently in progress.

One theoretical suggestion is the provision of a Cetacean Protection Act for Scotland (CPAS) in conjunction with the established UKBAP structure, which together would fulfil the objectives outlined above. A CPAS would provide a framework with cetacean conservation as its primary objective combined with the strength of Government commitment and directed funding to push action forward. Provisions should be made to:

- Introduce specific legislation to directly address issues of particular concern to cetaceans, effectively replacing the less focused Wildlife and Countryside Act and Habitats Directive. The legislation should widen definition of *'take'* as in the New Zealand and US Marine Mammal Protection Acts.
- Designate Marine Protected Areas for cetaceans where appropriate; or make provision for cetacean conservation in existing designations (e.g. marine Special Areas of Conservation, National Scenic Areas or Marine National Parks).
- Prioritise research and secure funding for future work.
- Interact at international level to secure conservation agreement for migratory species and control of dispersed threats, thereby facilitating and securing a regional agreement in the Northeast Atlantic under the Bonn Convention, i.e., an agreement equivalent to ASCOBANS for the Northeast Atlantic.
- Interact with government departments to ensure cetacean consideration in issues

that are co-ordinated nationally such as military activities, oil exploration and fisheries.

- Ensure cetacean conservation is considered in the planning process, which is particularly important in the Hebrides, where most developments entail a marine element.
- Initiate monitoring programmes for implemented activities to allow evaluation and revision.
- Collate copies of relevant reports, papers, theses, catalogues and recordings (audio and video). Such a central library facility would aid research, management decisions and facilitate the flow of information between local and international fora.

The implementation of a top-down, centrally driven, legislative instrument may be problematic to enforce and not easily accepted in the sparsely populated areas of the Hebrides. Implementation needs to be focused at the local level through community discussion and consultation. This approach would facilitate long-term agreements and, therefore, increase the potential for conservation success. This need for local consultation has already been addressed through the local Bio-diversity Action Plan structure (LBAP), which has built up a network of strategic links that could be utilised to carry forward CPAS objectives. Action could be focused through the establishment of regional Cetacean Management Groups (CMG) under the LBAP system. Regional management would address the differing needs and levels of information of cetaceans throughout Scotland which national management would miss. A regional cetacean BAP would have the flexibility to prioritise issues from region to region in an integrated and co-ordinated manner, overseen by the CMG. Local input to regional BAPs/CMGs would be through the local BAP structure that would have the power to address locally important issues. In this way, proposals for designated areas, research and education initiatives would come from a local forum, creating an community-led approach to marine management, more suited to the Hebrides. The Minch project exemplifies how localised action has been utilised successfully. By using the BAP structure to pinpoint local needs and issues, resources can be effectively directed where most required.

This proposed management structure allows the needs of cetacean conservation to be addressed and funded at the appropriate level within the legislative strength of a national framework. Figure 41 illustrates how the different elements of the management model would interact.

This model could be applied across Scotland. In the context of the Hebrides, work as already begun with the draft Argyll and Bute local BAPs for cetaceans and species specific plans for the minke whale, harbour porpoise and bottlenose dolphin (App. A). Given the mobile nature of cetaceans and the range of threats posed management would be more effective on a regional basis rather than within arbitrary administrative boundaries currently imposed. In conjunction with Western Isles and The Highlands councils, the Argyll and Bute BAP could be used as a basis to formulate a regional BAP overseen by the Hebridean CMG. Within this regional plan more localised initiatives for specific research, action and education programmes can be identified by local BAP groups through local consultation. For example, proposals put forward by the Western Isles would vary from those proposed by Argyll and Bute. They would be focussed on species common in the northern Hebrides and on Atlantic shelf, such as Risso's and white-beaked dolphins, and with more emphasis on the threats posed by oil development and superquarries.

To carry out such work significant funding will be required. This funding could be an integral part of the proposed the CPAS. However, by giving the UKBAP programme a statutory basis, funding could also allocated to cetacean-related projects.

5.3. MARINE PROTECTED AREAS

Overseas experience, and the European Natura 2000 network has shown that MPAs do have the potential to be used for cetacean conservation. Areas most suited to spatial management include those with resident (annual or seasonal) populations that are relatively discrete. Potential vehicles for establishing a cetacean protected area in the Hebrides are MNPs, SACs and NSAs, the implementation and management of which could be facilitated via the proposed Cetacean Protection Act for Scotland. Recommendations for developing MPAs in the Hebrides are listed below.

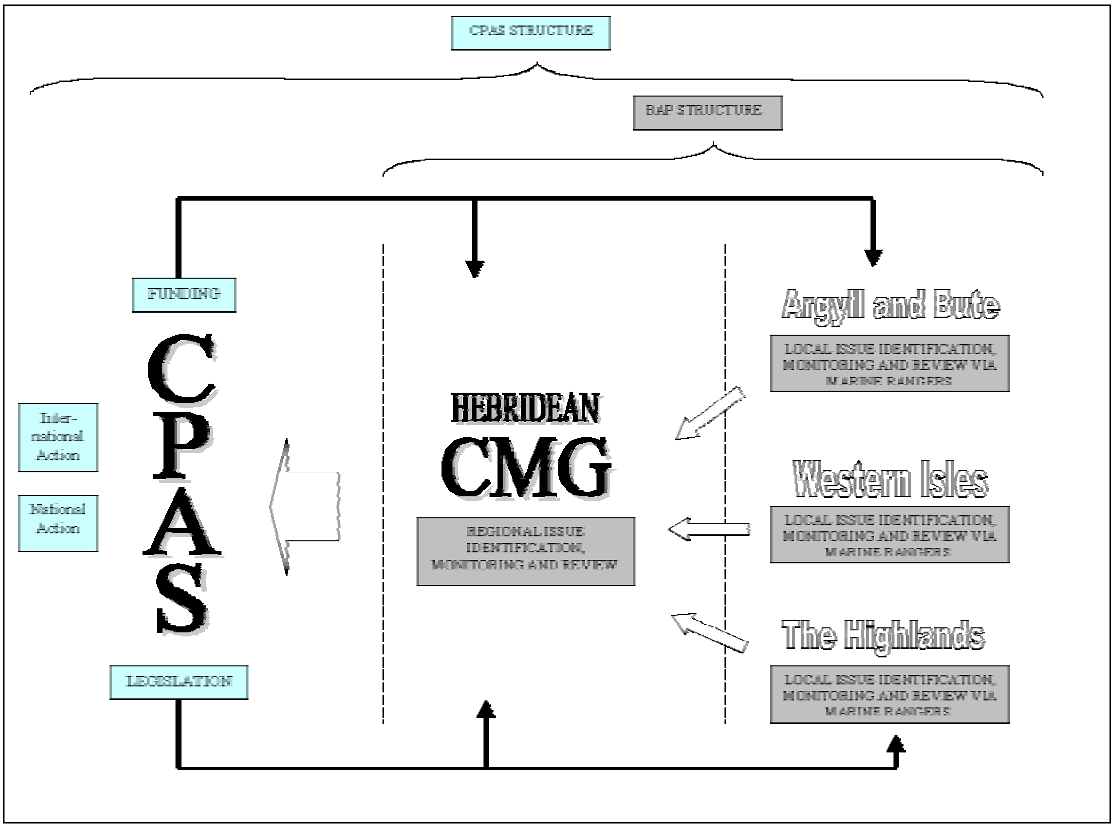


Fig. 41. Management framework for cetacean conservation in the Hebrides.

5.3.1. National Action

- The adoption of a multi-disciplinary approach to SAC designation, which would be able to include cetacean management measures and deliver wider benefits to marine environment;
- The establishment of a CPAS with provisions for MPA designation; and
- The development of biosphere reserve planning.

5.3.2. Regional/Local Action

- The identification of potential cetacean MPAs.

Areas which could be potential MPAs, identified as a result of this study, are Gairloch (harbour porpoises), Rum, Muck and Mull (minke whales, harbour porpoises, bottlenose dolphins and common dolphins), and the Eye of Lewis (Risso's dolphins) as information on cetacean habitat usage and abundance already exists for these locations. Further local community liaison would expand potential options.

- Assess the feasibility of implementing MPAs in these areas. Options for MPAs include:
    - ◊ A Marine National Park, with a provision for cetacean protection, around the Small Isles.
    - ◊ A SAC for harbour porpoises in Gairloch, an area where practical fieldwork has been undertaken and so provides a basis for management strategies.
    - ◊ The NSA framework, to incorporate provisions for cetaceans conservation, using one of the NSAs identified previously as a pilot study (e.g. the Small Isles, North Uist and Harris)
    - ◊ A new Protected Area for Cetaceans, providing sanctuary-like status. The coastal waters of the Isle of Lewis could be a potential option due to resident

Risso's dolphins throughout the area.

- Take the proposed MPAs forward.

This would be through local discussion and consultation to achieve voluntary agreement with the objectives of a cetacean MPA. This would require a dedicated long-term strategy incorporating further research with local community participation to arrive at a plan suited to the individual requirements of the area. Issue identification and consultations could be initiated via locally appointed '*marine rangers*' with a wide remit including marine education and marine ecotourism development, who could then provide input to local BAP groups and CMGs.

The benefits of local action is illustrated by the Assynt Field Club and Highland Ranger Service collaboration which, in 1998, initiated local cetacean sightings scheme. Response was greatest where the ranger service had local contact. A proposal has been put forward for a marine ranger in Northern Argyll through the NADAIR project (a coalition of environmental heritage NGOs and local statutory bodies).

It can be seen that much progress has already been made in establishing local links, through which, given the importance of the area for cetaceans, the objectives of a CPAS could be taken on board.

5.4. THREAT MINIMISATION

The threats posed to cetaceans are very diverse and need to be managed in an integrated manner. This could be done either through a CPAS, or the proposed CMG, which could be used as a central forum for regulating and controlling bodies. Many threats are little understood, although their potential to have an impact is recognised to be significant. Therefore, a precautionary approach must be adopted in threat management, an obligation instilled by a CPAS. As well as interactive and precautionary management, specific actions can be identified which will minimise the range of threats to cetaceans and improve the quality of the marine environment as a whole. To facilitate this, it is necessary to identify at what level actions would be most effectively implemented, being either international, national, regional or local. Recommendations for threat minimisation and the appropriate implementation level are summarised in Table 8.

5.5. PRIORITISED RESEARCH

It is clear that little research has been conducted regarding the ecology of cetaceans or the threats facing them in the Hebrides. To improve our knowledge base and, therefore, increase our power to make effective conservation decisions, the following areas of research, in addition to current actions, are recommended.

5.5.1. Expand areas of research in order to more precisely assess the distribution and abundance of cetaceans in areas where little information exists.

- Conduct annual dedicated line transect surveys to provide baseline data on cetacean distribution, effort-related abundance and population trends over time; and
- Collect data on environmental variables to correlate distribution with habitat types.

Surveys should be focused initially where information is scant, these being South of Mull around Colonsay, Jura, Islay, Arran and Kintyre, South and East of Barra and West of the Outer Hebrides.

5.5.2. Where important cetacean habitats exist or are identified by above surveys or local BAP input, undertake further intensive research including:

- Year-long studies to assess seasonal movements, behaviour, ecology and biology of population using land-based and sea-based observations, and photo ID and acoustic survey techniques; and
- An assessment of localised threats to populations.

Ideally, such actions could be undertaken through marine rangers and co-ordinated by the proposed Hebridean CMG.

5.5.3. Species-specific research including:

- Monitoring the seasonal movements of minke whales to establish their vulnerability to whaling; and
- Photo-ID study on bottlenose dolphins around Mull and Islay to establish population estimates of the size of these populations.

5.5.4. Carry out MPA feasibility studies for local cetacean SACs, NSAs, MNPs and the potential of a Cetacean Protected Area.

5.5.5. Assess acoustic impacts on cetaceans by:

- Exploring any correlations between cetacean distribution and behaviour in relation to military exercises over last ten years;
- In co-operation with the MOD, carry out intensive surveys prior, during and after military exercises to ascertain changes in distribution, abundance, extent and type of disturbance observed;
- Investigate for evidence of auditory damage in stranded cetaceans;
- Evaluate the extent of AHD use in the Hebrides;
- Investigate the reactions of coastal species to AHDs;
- Promote the development of less disturbing predator control devices; and
- Promote the development of '*quiet*' technology for vessels, especially dredges.

5.5.6. Assess pollution impacts on cetaceans by:

- Testing for the presence of algal toxins, fish farm chemicals (e.g. organophosphates and butylins), PAHs and radionuclides in stranded cetaceans, in addition to continued research on organochlorine and trace element contamination;
- Investigate the accumulation and impacts of radionuclides on Hebridean cetaceans;
- Establish the degree to which Hebridean cetaceans are exposed to sewage-related pathogens and produce an evaluation of the health impacts of sewage pollution; and
- Investigate extent of TBT use on fish farm cages and vessels.

5.6. COMMUNICATION AND EDUCATION

In addition to the education initiatives recommended in Table 8, it is important to raise awareness throughout the Hebrides about:

- Which cetaceans are present in the Hebrides;
- The importance of reporting cetacean strandings and sightings;
- The range of threats that are faced by cetaceans;
- What local action can be taken to actively help, i.e. beach cleans and community involvement; and
- The benefits of developing marine tourism in the Hebrides, with an emphasis on cetacean-watching and, thereby, developing an economic incentive for cetacean conservation.

Table 8. Recommendations to minimise specific threats.

THREAT	RECOMMENDED ACTION	ACTION LEVEL
Directed take	♦ Increase international pressure for whaling nations to submit geographical position, photographs and genetic samples of whales taken.	International.
	♦ Increase international pressure for a reduction of the Norwegian directed take of minke whales in the Northeast Atlantic.	International.
Incidental take/injury		
• Fisheries	♦ Assess levels of salmon netting and non-target species by-catch in this fishery.	Regional/Local.
	♦ Reduce use of harmful fishing gear in sensitive areas.	Regional.
	♦ Research and develop use of 'pinger' devices on harmful gear (used successfully in other areas).	National.
	♦ Reduce ghost net /rope discard by the fishing industry.	Regional/Local.
• Boat collisions	♦ Continued education through HWDT's code of conduct for boat users.	Regional.
	♦ Limitation on boat speeds in key cetacean habitats.	Local.
	♦ Collaboration with the Scottish Marine Wildlife Operations Association to produce guidelines for entire Hebrides for whale and marine wildlife-watching operations.	Regional.
• Marine debris	♦ Provide accessible reception facilities for waste, particularly in harbours/docks and encourage their use via education of boat users, fisherman and fish farmers.	Local.
	♦ Promote reuse, recycling and waste minimisation.	Regional/Local.
	♦ Island collection schemes to reduce marine dumping of domestic waste.	Regional.
	♦ Beach cleans.	Local.

Pollution		
• Oil/PAHs	♦ Identification of sensitive areas and the formulation of oil spill contingency plans.	Regional.
	♦ Promote good practice of commercial and recreational boat operators for fuel handling at sea.	National.
	♦ Reduce risks of oil spills by implementing recommendations made in 1994 Donaldson Report, including compulsory use of Deep Water Route for tankers over 10,000 tonnes and pilotage through the narrow Little Minch.	National/Regional.
	♦ Regular inspections of tankers.	National.
• Pathogens	♦ Continued improvements to sewage treatment facilities under EU Wastewater Directive throughout the Hebrides.	National/Regional/Local.
	♦ Establish monitoring system to ensure waters meet water quality standards.	National/Regional/Local.
• Organochlorines/ Trace elements	♦ Continue national and international initiatives to ban use and reduce discharges of organochlorines and trace elements.	International.
	♦ Mandatory central collection and disposal of stocks of banned chemicals.	National/Regional.
• Radionuclides	♦ Reduce radionuclides emissions to the marine environment.	National.
Habitat Degradation	♦ Assessment and sustainable management of West Scotland fisheries stocks.	National/Regional.
• Prey depletion	♦ Cease 'flag ships' operating in Scottish waters.	National.
	♦ Cease illegal landings of catch.	National.
	♦ Reduce amount of non-target discard, through gear design and multi-species fisheries.	National.
	♦ Protection of coastal stocks via local fishery management groups.	Local.
	♦ Promote sustainable fishing methods.	National/Regional/Local.
	♦ Investigate stock enhancement e.g. via artificial reefs.	Regional/Local.
	♦ Continued international action to reduce global warming.	International.
• Ozone Depletion	♦ Continue international action to reduce emissions of ozone depleting substances.	International.
• Acoustic Disturbance	♦ Acoustic impacts on cetaceans must be assessed through an EIA for any development.	Local.

	♦ Restrictions on disturbing activities in areas important to cetaceans.	
	♦ Continue open liaison with MOD re: military activities in area with view to reducing levels of military activity in important cetaceans habitats.	Local. National.
	♦ Mandatory use of bubble curtains to reduce the acoustic impacts of submarine developments with high noise outputs, when these projects occur in cetacean habitats.	National.
	♦ Promotion of scallop-diving operations rather than suction dredging for scallops.	
	♦ Inspection and repair of damaged propellers.	Regional/Local.
	♦ Informing boat users and tour operators about ways to reduce the impacts of boat traffic on cetaceans.	National.
	♦ Give the current Government guidelines on seismic testing a statutory status.	Regional/Local.
		National.
Fish Farming	♦ Shift to organic fish-farming with reduced stocking densities, thereby reducing need to use high levels of chemical additions.	National.
	♦ Maximise use of non-chemical sea lice treatments, such as placing golden wrasse in fish cages.	National.
	♦ Statutory monitoring of releases of fish farm chemicals into the environment, in order to assess input levels.	National/Regional.
	♦ Discourage the use of automated feeding systems in order to reduce feed waste.	National.
	♦ Install waste collection systems under fish farms.	National.
	♦ Minimise AHD use by assessing the *real* need for AHDs at each site.	Local.
	♦ Research the impacts of AHDs on cetaceans.	National/Local.
	♦ Do not locate fish farms in areas with a high risk of seal predation.	Regional/ Local.
	♦ Flexible insurance assessment against seal predation, depending on the level of risk, therefore discouraging the blanket use of AHDs.	National.
	♦ Initiate open discussion fora with fish farming companies to address some of these issues.	Regional/Local.

References

AMTD (A & M Training and Development). (1997). *Review of Wildlife Tourism in Scotland.* Report to the Scottish Tourism and Environment Taskforce, Inverness.

Aguilar, A. (1989). Organochlorine pollutants and cetaceans: a perspective. *European Research on Cetaceans,* **3,** 10-11.

Ambrose, P. 1994. Anti-fouling news. *Marine Pollution Bulletin*, **28**, 134.

Andre, J.M., Ribeyre, F. & Boudou, A. (1990). Mercury contamination levels and distribution in tissues and organs of delphinids (*Stenella attentata*) from the eastern tropical Pacific, in relation to biological and ecological factors. *Marine Environmental Research*, **30**, 14-20.

Atkinson, T., Gill, A. & Evans, P.G.H. (1998). A photo identification study of Risso's dolphins in the Outer Hebrides, Northwest Scotland. *European Research on Cetaceans,* **12**, 102.

Bailey, S.K. 1991. *Tributilyn (TBT) contamination in Scottish waters*. PhD Thesis, Napier Polytechnic, Edinburgh, UK.

Baxter, J.M. & Munford, J.G. (1992). Towards a marine nature conservation strategy. *Proceedings of the Royal Society of Edinburgh*, **100B**, 185-194.

Balls, P.W. & Campbell, D.C. (1999). Organochlorines in sea water and suspended particulates from Scottish Coastal Sites. *Marine Pollution Bulletin*, **38**, 142-145.

Berrow, S.D., Long, S.C., McGarry, A.T., Pollard, D., Rogan, E. & Lockyer, C. (1998). Radionuclides (^{137}Cs and ^{40}K) in Harbour Porpoises *Phocoena phocoena* from British and Irish coastal waters. *Marine Pollution Bulletin*, **36**, 569-576.

Bones, M. & Maclennan, D. (1994a). Cetacean strandings in the Western Isles in 1992. *Hebridean Naturalist*, **12**, 47-50.

Bones, M. & Maclennan, D. (1994b). Cetacean strandings in the Western Isles in 1993. *Hebridean Naturalist*, **12**, 51-54.

Bones, M., Neil, B. & Reid, B. (1998). Fraser's dolphin (*Lagenorhynchus hosei*) stranded in South Uist: first record in U.K. waters. *Journal of Zoology (London)*, **246**, 460-461.

Boran, J.R., Evans, P.G.H. & Rosen, M.J. (2000). Cetaceans of the Hebrides: seven years of surveys. *European Research on Cetaceans,* **13**, 169-174.

Borrell, A. (1993). PCB and DDT's in Blubber of Cetaceans from the Northeastern North Atlantic. *Marine Pollution Bulletin*, **26**, 146-151.

Brady, P. (1991). Fisheries of Scotland. *Yearbook of the Scottish Fishing Industry*. Fleetwood, Commercial Fishing Enterprises.

Brown, S.G. (1976). Modern whaling in Britain and the north-east Atlantic. *Mammal Review*, **6**, 25-36.

Bryan, A. (1994). *The Minch Review*. Report to The Western Isles Council and Scottish Natural Heritage.

Calmet, D., Woodhead, D. & Andre, J.M. (1992). 210Pb, ^{137}Cs and ^{10}K in three species of porpoises caught in the eastern Tropical Pacific Ocean. *Journal of Environmental Radioactivity*, **15**, 153-169.

Clark, C.W. & Charif, R.A. (1998). *Acoustic monitoring of large whales to the West of Britain and Ireland using bottom-mounted hydrophone arrays, October 1996 – September 1997. JNCC Report No. 281*. Joint Nature Conservation Committee, Peterborough, UK.

Craig, R.E. (1959). *Hydrography of Scottish Coastal Waters. Marine Research Series No. 2*. HMSO, London.

Curran, S., Wilson, B. & Thompson, P.M. (1996). *Recommendations for the sustainable management of the bottlenose dolphin population in the Moray Firth. Scottish Natural Heritage Review. No 56*. Scottish Natural Heritage, Battleby, UK.

Davis, I.M., Bailey, S.K. & Moore, D.C., (1987). Tributylin in Scottish sealochs, as indicated by degree of imposex in the dogwhelk *Nucella lapillus* (L.). *Marine Pollution Bulletin*, **18**, 400-404.

Donoghue, M. (1996). The New Zealand Experience - one country's response to cetacean conservation. In: *The Conservation of Whales and Dolphins. Science and Practice* (Ed. by M.P. Simmonds & J.D. Hutchinson), pp. 423-445. Wiley and Sons, Chichester, UK.

Earle, M. (1996). Ecological Interactions between cetaceans and fisheries. In: *The Conservation of Whales and Dolphins. Science and Practice* (Ed. by M.P. Simmonds & J.D. Hutchinson), pp. 167-204. Wiley and Sons, Chichester, UK.

Evans, P.G.H. (1997a). Whales, dolphins and porpoises. In: *Coasts and Seas of the United Kingdom. Region 14 South-west Scotland: Ballantrae to Mull.* (Ed. by J.H. Barnes, C.F. Robson, S.S. Kaznwska, J.P. Doody, N.C. Davidson & A.L. Buck), pp. 140-143. Joint Nature Conservation Committee, Peterborough, UK.

Evans, P.G.H. (1997b). Whales, dolphins and porpoises. In: *Coasts and Seas of the United Kingdom. Region 15 & 16 North-west Scotland: The Western Isles and West Scotland.* (Ed. by J.H. Barnes, C.F. Robson, S.S. Kaznwska, J.P. Doody, N.C. Davidson and A.L. Buck), pp. 162-166. Joint Nature Conservation Committee, Peterborough.

Evans, P.G.H. (1997c). Ecology of sperm whales (*Physeter macrocephalus*) in the eastern North Atlantic, with special reference to sightings and strandings records from the British Isles. *Biologie*, **67**, 37-46.

Evans, P.G.H & Heimlich-Boran, J.R. (1994). *Cetaceans in the Hebrides: possible impact of proposed South Harris super quarry*. Seawatch Foundation, Oxford, UK.

Evans, P.G.H. & Nice, H. (1996). *Review of the effects of underwater sound generated by seismic surveys in cetaceans.* Seawatch Foundation, Oxford, UK.

Evans, P.G.H., Canwell, P.J. & Lewis, E. (1992). An experimental study of the effects of pleasure craft noise upon bottlenose dolphins in Cardigan Bay, West Wales. *European Research on Cetaceans*, **6**, 43-46.

Evans, P.G.H., Swann, C., Lewis, E., Parsons, E., Heimlich-Boran, S. & Heimlich-Boran, J. (1993). Survey of cetaceans in the Minches and Sea of Hebrides, Northwest Scotland. *European Research on Cetaceans,* **7***,* 111-116.

Fairweather, B. (1976). *Highland Wildlife.* The Glencoe and North Lorn Folk Museum, Fort William.

Fent, K. (1996). Ecotoxicology of organotin compounds. *Critical Reviews of Toxicology*, **26**, 1-117.

Frantzis, A. & Cebrian, D. (1999). A rare mass stranding of Cuvier's beaked whales: cause and implications for the species biology. *European Research on Cetaceans*, **12**, 332-335.

Fraser, F.C. (1934). *Report on Cetacea stranded on the British coasts from 1927 - 1932.* British Museum (Natural History), London, UK.

Fraser, F.C. (1946). *Report on Cetacea stranded on the British coasts from 1933 - 1937.* British Museum (Natural History), London, UK.

Fraser, F.C. (1953). *Report on Cetacea stranded on the British coasts from 1938 - 1947.* British Museum (Natural History), London, UK.

Fraser, F.C. (1974). *Report on Cetacea stranded on the British coasts from 1948 - 1966*. British Museum (Natural History), London, UK.

Fuller, G.B. & Hobson, W.C. (1986). In: *Effects of PCB's and the Environment, Vol. 3* (Ed. by J.S. Waid), pp 101-125. CRC Press, Boca Raton, Florida, USA.

Fulton, G. (1999). *Pollution threats to the Minch Area.* Report to the Minch Project, Highlands and Islands Partnership Programme.

Geraci, J,R. (1990). Physiologic and toxic effects on cetaceans: In: *Sea mammals and oil. Confronting the risks* (Ed. by J.R. Geraci & D.J. St. Aubin). Academic Press, San Diego, USA.

Geraci, J.R., Anderson, D.M., Timperi, R.J., St. Aubin, D.J., Early, G.A., Prescott, J.H. & Mayo, C. (1989). Humpback whales *(Megaptera novaeangliae)* fatally poisoned by dinoflagellate toxin. *Canadian Journal of Fisheries and Aquatic Sciences*, **46**, 1895-1898.

Gibbs, P.E. & Bryan, G.W. (1986). Reproductive failure in population of dog-whelk *Nucella lapillus* caused by imposex induced by tributilyn from anti-fouling paints. *Jounal of the Marine Biological Association of the United Kingdom*, **66**, 767-777.

Gilders, M. (1988). *The influence of anthropogenic acoustic disturbance on cetaceans.* MSc Thesis. Oxford University, UK.

Gill, A. (1994). *The photo-identification of the minke whale* (Balaenoptera acutorostrata) *off the Isle of Mull, Scotland*. MSc Thesis. Aberdeen University, UK.

Gill, A. (1995). *Analysis of data collected from observations of a humpback whale (*Megaptera novaeangliae*) in the Clyde Estuary, Glasgow.* Report to the Whale and Dolphin Conservation Society.

Gill, A. (1999*). Study to investigate the extent and nature of the fixed-net fishery in Hebridean waters and possible conflicts with harbour porpoise* (Phocoena phocoena) *populations.* Hebridean Whale and Dolphin Trust, Tobermory, Mull, UK.

Gill, A. & Fairbairns, R. (1995). Photo-Identification of the minke whale *Balaenoptera acutorostrata* off the Isle of Mull, Scotland. In: *Whales, Seals, Fish and Man* (Ed. by A.S. Blix, L.Walloe & O. Ulltand), pp. 129-132. Elsevier Science, Netherlands.

Gill, A. & Fairbairns, R. (1996). Photo-Identification of the minke whale *Balaenoptera acutorostrata* off the Isle of Mull, Scotland, UK. *European Research on Cetaceans*, **9**, 129-131.

Gillibrand, P.A., Turrel, W.R., Moore, D.C., & Adams, R.D. (1996). Bottom water stagnation and oxygen depletion in a Scottish Sea Loch. *Estuarine and Coastal Shelf Science*, **43**, 217-235.

Gordon, J. & Moscrop, A. (1996). Underwater noise pollution and its significance for whales and dolphins. In: *The Conservation of Whales and Dolphins. Science and Practice* (Ed. by M.P Simmonds & J.D. Hutchinson), pp 281-31. Wiley and Sons, Chichester, UK.

Gordon, J., Leaper, R., Hartley, G.F. & Chappel. (1992). *Effects of whale-watching vessels on the surface and underwater acoustic behaviour of Sperm Whales off Kaikoura, New Zealand. Science & Research Series 52*. New Zealand Department of Conservation, Wellington, NZ.

Gowen, R.J. & Ezzi, I.A. (1992). *Assessment and prediction of the potential for hypernutrifucation and eutrophication associated with cage culture of salmonids in Scottish Coastal waters.* Dunstaffnage Marine Laboratory, Oban, UK.

Gowen, R.J., Brown, J.R., Bradbury, N.B. & McLusky, D.S. (1988). *Investigations into benthic enrichment, hypernutrification and eutrophication associated with mariculture in Scottish coastal waters. (1984-1988).* Report to the Highlands and Islands Development Board, Crown Estate Commissioners, Nature Conservancy Council, Countryside Commission for Scotland and Salmon Growers Association.

Grant, A. & Briggs, A.D. (1998). Toxicity of Ivermectin to estuarine and marine invertebrates. *Marine Pollution Bulletin*, **36**, 540-541.

Grant, A. & Briggs, A.D. (1998). Uses of Ivermectin in marine fish farms: some concerns. *Marine Pollution Bulletin*, **36**, 566-568.

Grellier, K., Arnold, H., Thompson, P., Wilson, B. & Curran, S. (1995). *Management recommendations for the Cardigan Bay bottlenose dolphin population. Contract Science Report 134.* Report the to Countryside Council for Wales.

Greenpeace (1998). Press release. Internet site, http://www.greenpeace.org.

Gubbay, S. & Earll, R. (1999). *Review of literature on the effects of oil spills on cetaceans*. Report to Talisman Energy and Scottish Natural Heritage.

Gubbay, S. (1997). *The Marine Environment. Scottish Environment Audits No.1*. Scottish Wildlife and Countryside Link, Perth, UK.

Habberley, J.S. (1989). *Review of tanker traffic in the deep water route west of the Hebrides and through the Minches. Final Report*. Warsah, Southhampton, Institute of Higher Education.

Hader, D.P., Worrest, R.C., Kumar, H.D. & Smith, R.C. (1995). Effects of increased solar ultraviolet radiation on aquatic ecosystems. *Ambio*, **24**, 174-180.

Hall, A.J., Law, R.J., Wells, D.E., Harwood, J., Ross, H.M., Kennedy, S., Allchin, C.R., Campel, C.A. & Pomeroy, P.P. (1992). Orgaoncholrine levels in common seals (*Phoca vitulina*) which were victims and survivors of the 1988 Phocine Distemper Epizootic. *Science of the Total Environment*, **115**, 145-162.

Harmer, S.F. (1914). *Report on Cetacea stranded on the British coasts during 1913.* British Museum (Natural History), London, UK.

Harmer, S.F. (1915). *Report on Cetacea stranded on the British coasts during 1914.* British Museum (Natural History), London, UK.

Harmer, S.F. (1916). *Report on Cetacea stranded on the British coasts during 1915*. British Museum (Natural History), London, UK.

Harmer, S.F. (1917). *Report on Cetacea stranded on the British coasts during 1916.* British Museum (Natural History), London, UK.

Harmer, S.F. (1918). *Report on Cetacea stranded on the British coasts during 1917.* British Museum (Natural History), London, UK.

Harmer, S.F. (1919). *Report on Cetacea stranded on the British coasts during 1918.* British Museum (Natural History), London, UK.

Harmer, S.F. (1921). *Report on Cetacea stranded on the British coasts during 1919 and 1920.* British Museum (Natural History), London, UK.

Harmer, S.F. (1923). *Report on Cetacea stranded on the British coasts during 1921 and 1922.* British Museum (Natural History), London, UK.

Harmer, S.F. (1925). *Report on Cetacea stranded on the British coasts during 1923 and 1924.* British Museum (Natural History), London, UK.

Harmer, S.F. (1927). *Report on Cetacea stranded on the British coasts during 1925 and 1926.* British Museum (Natural History), London, UK.

Harwood, J. & Reijinders, P.J.H. (1988). Seals, sense and sensibility. *New Scientist*, **15th October 1988**, 28-29.

Heath, S. (Ed.). (1998). *Reports and Accounts 1997 - 1998.* Fisheries Research Services, Aberdeen, UK.

Heath, S. (Ed.). (1999). *Environmental Monitoring of the seas around Scotland 1994-1997.* Fisheries Research Services, Aberdeen, UK.

Heimlich-Boran, J.R., Heimlich-Boran, S.L., Montero, R. & Martin, V. (1994). An Overview of whale-watching in the Canary Islands. *European Cetacean Society Newsletter*, **21.**

Hernandez, M., Robinson, I., Aguilar, A., Gonzalez, L.M., Lopez-Jurado, L.F., Reyero, M.I., Cacho, E., Franco, J., Lopez-Rodas, V. & Costas, E. (1998). Did algal toxins cause monk seal mortality. *Nature*, **393**, 28-29.

Hiscock, K., Gilliand, P., Pritchard, R. & White, R. (1998). Bio-diversity Action Plans in the coastal environment. *Marine Environmental Management Review of 1997 and Future Trends*, **5** (14), 101-107.

HMSO (Her Majesty's Stationary Office). (1981). *Wildlife and Countryside Act 1981*. Her Majesty's Stationary Office, London, UK

HMSO (Her Majesty's Stationary Office). (1990). *Fourth report. Pollution of beaches, Vol.1.* House of Commons Environment Committee, London.

HMSO (Her Majesty's Stationary Office). (1992). *Council Directive 2/43/EEC on the Conservation of natural habitats and of wild fauna and flora. Official Journal of the European Communities, No. 206/7.* Her Majesty's Stationary Office, London, UK

HMSO (Her Majesty's Stationary Office). (1994a). *Safer Ships, Cleaner Seas*. Report of Lord Donaldson's Inquiry into the Prevention of Pollution from Merchant Shipping. Her Majesty's Stationary Office, London, UK

HMSO (Her Majesty's Stationary Office). (1994b). *The UK Action Plan*. Her Majesty's Stationary Office, London, UK

House of Lords European Communities Select Committee (1999). *Biodiversity in the European Union: Interim Report United Kingdom Measures, Eighteenth Report.* Her Majesty's Stationary Office, London, UK

Howard, F.G., Kelly, M., Basford, D. & Hess, P. (1998). *The marine Biotox monitoring and surveillance programme in Scotland - 1998. Report for the period 1st April - 31 October 1998*. Aberdeen Marine Laboratory, Aberdeen, UK.

Hoy, T., Horsberg, T.E. & Nafstad, I. (1990). The disposition of ivermectin in Atlantic salmon (*Salmo salar.). Pharmacology and Toxicology*, **67**, 307-312.

Hoyt, E. (1995). *The worldwide value and extent of whale watching, 1995*. Whale and Dolphin Conservation Society, Bath, UK.

Hughes, K. (1998). *The status of the harbour porpoise (*Phocoena phocoena*) in UK waters.* MSc Thesis, University of Greenwich, London, UK.

Hughes, K., Arnold, H., De Boer, M., Irish, R., Mackins, C., Murray, E., Norris, K., Pert, J., Simmonds, M. & Stanley, M. (1998). Results from Greenpeace/WDCS cetacean survey of the Atlantic Frontier; July-August 1998. In*: The Atlantic frontier, Britain's Last Wilderness* (Ed. by E. Murray & M. Simmonds), pp 18-36. Whale and Dolphin Conservation Society & Greenpeace, London, UK.

Iwata, H., Tanabe. S., Miyazaki, N. & Tatsukawa, R. (1994). Detection of butylin compound residues in the blubber of marine mammals. *Marine Pollution Bulletin*, **28**, 607-612.

Iwata, H., Tanabe, S., Mizuno, T. & Tatsukawa, R. (1995). High accumulation of toxic butylins in marine mammals from Japanese coastal waters. *Environmental Science Technol*ogy, **29**, 2959-2962.

Janik, V.M. & Thompson, P.M. (1996). Changes in surfacing patterns of bottlenose dolphins in response to boat traffic. *Marine Mammal Science*, **12**, 597-602.

Johnston, D.W. & Woodley, T.H. (1998). A survey of acoustic harassment devices (AHD) use in the Bay of Fundy, NB, Canada. *Aquatic Mammals*, **24**, 51-61.

Johnston, P.A., Stringer, R.L. & Santillo, D. (1996). Cetaceans and environmental pollution: the global concerns. In: *The Conservation of Whales and Dolphins. Science and Practice* (Ed.

by M.P. Simmonds & J.D. Hutchinson), pp. 219-262. Wiley and Sons, Chichester, UK.

Jones, P. (1997). TBT implicated in Mass Dolphin Deaths. *Marine Pollution Bulletin*, **34**, 146.

Jones, P. (1998). *UK Marine Conservation Policy*. Unpublished paper. Jackson Environment Institute.

Kraus, S. D. (1990). Rates and potential causes of mortality in North Atlantic right whale (*Eubalaena glacialis*). *Marine Mammal Science*, **6**, 278-291.

Kenchington, R.A. (1990). *Managing Marine Environments.* Taylor and Francis, New York, USA.

Kenchington, R.A. & Agardy, M.T. (1990). Achieving marine conservation through Biosphere planning and management. *Environmental Conservation*, **17**, 39-44.

Kenney, R. D. (1993). Right whale mortality-a correction and an update. *Marine Mammal Science*, **9**, 445-446.

Kruuk, H., Conroy, J.W.H. & Webb, A. (1997). Concentrations of mercury in otters *(Lutra lutra*) in Scotland in relation to rainfall. *Environmental Pollution*, **96**, 13-18.

Lahvis, G.P., Wells, R.S., Kuehi, D.W., Stewart, J.L., Rhinehart, H.L. & Via, C.S. (1995). Decreased lympocyte responses in free-ranging bottlenose dolphins (*Tursiops truncatus*) are associated with increased concentrations of PCBs and DDT in peripheral blood. *Environmental Health Perspective*, **103**, 67-72.

Laist, D.W. (1987). Overview of the biological effects of lost and discarded plastic debris in the marine environment. *Marine Pollution Bulletin*, **18**, 319-326.

Law, R.J. & Whinnet, J.A. (1992). Polycylic aromatic hydrocarbons in muscle tissue of harbour porpoises *(Phocoena phocoena)* from UK waters. *Marine Pollution Bulletin*, **24**, 550-553.

Law, R.J., Fileman, C.F., Hopkins, A.D., Baker, J.R., Harwood, J., Jackson, D.B., Kennedy, S., Martin, A.R. & Morris, R.J. (1991). Concentrations of trace metals in the livers of marine mammals (seal, porpoises and dolphins) from waters around the British Isles. *Marine Pollution Bulletin*, **22**, 183-191.

Law, R.J., Dawes, V.J., Woodhead, R.J. & Matthiessen, P. (1997). Polycylic Aromatic Hydrocarbons (PAH) in seawater around England and Wales. *Marine Pollution Bulletin*, **34**, 306-321.

Lawler, I.F & Aldrich, J.C. (1987). The sublethal effects of bis(tributilyn)oxide on *Crassostrea gigas* spat. *Marine Pollution Bulletin*, **18**, 274-278.

Leaper, R., Fairbairns, R., Gordon, J., Hiby, A., Lovell, P. & Papastavrou, V. (1997). Analysis of data collected from a whalewatching operation to assess relative abundance and distribution of the Minke whale (*Balaenoptera acutorostrata*) around the Isle of Mull, Scotland. *Reports of the International Whaling Commission*, **47**, 505-511.

Leonard, K.S., McCubbin, D., Brown, J., Bonfield, R. & Brooks T. (1997). Distribution of Technetium-99 in UK coastal waters. *Marine Pollution Bulletin*, **34**, 628-636.

Lewis, T.P., Swift, R., Gozalbes, P., Butler, J. & Gordon, J. (1998). *Report on the Passive acoustic monitoring of cetacean distribution north-west of the Hebrides 1997-1998*. Hebridean Whale and Dolphin Trust, Tobermory, Mull, UK.

Mayer, S. & Simmonds, M.P. (1996). Science and precaution in cetacean conservation. In: *The Conservation of Whales and Dolphins. Science and Practice* (Ed. by M.P. Simmonds & J.D. Hutchinson), pp. 391-406. Wiley and Sons, Chichester, UK.

Masters, D., Nautilus Consultants & Carter, J. (1998). *Marine wildlife tourism: developing a quality approach in the Highlands and Islands.* Report to the Tourism and Environment Initiative and Scottish Natural Heritage.

McIntyre, A.D. (1992). Introduction: a perspective on marine conservation. *Proceedings of the Royal Society of Edinburgh*, **100B**, 1-2.

McKenzie, C. (1999). *Concentrations and Patterns of Environmental Contaminants in marine mammals and their diets.* PhD Thesis. Robert Garden University, Aberdeen, UK.

McKenzie, C., Rogan, E., Reid, R.J. & Wells, D.E. (1997). Concentrations and patterns of organic contaminants in Atlantic white-sided dolphins (*Lagenorhynchus acutus*) from Irish and Scottish coastal waters. *Environmental Pollution*, **98**, 15-27.

McKirdy, A. (1994). Development of our physical resources - sustainability in practice, In: *The Islands of Scotland. A Living Marine Heritage*. (Ed. by J.M Baxter & M.B. Usher), pp. 239-254. Her Majesty's Stationary Office, London, UK.

Morton, A. (1995). *Salmon Farming's Hidden Harm.* Paper presented at the Aquaculture briefing, Smithsonian Institiute, Washington, DC, June 1995.

Morton, A. (1998). *Fish farms devastate the environment*. *Victoria Times Colonist*, **21st November**.

Morton, A. (undated). *Impact of salmon aquaculture acoustic Harrasment devices on cetaceans in the Broughton Archipelago*. Raincoast Research, Simoom Sound, British Columbia, Canda.

Moscrop, A. (1993). *An assessment of threats to marine cetaceans resulting from the degradation of their habitats*. MSc. Thesis. University of Greenwich, London.

Moscrop, A. & Simmonds, M.P. (1994). *The threats posed by noise pollution and other disturbances to health and integrity of cetacean populations around the UK.* Whale and Dolphin Conservation Society, Bath, UK.

Mulvaney, K. (1996). Directed kills of small cetaceans worldwide. In: *The Conservation of Whales and Dolphins. Science and Practice* (Ed. by M.P. Simmonds & J.D. Hutchinson), pp. 89-108. Wiley and Sons, Chichester, UK.

Nachtigall, P.E., Au, W.W.L. & Pawloski, J. (1996). Low frequency hearing in three species of odontocetes. *Journal of the Acoustical Society of America,* **100**, 26-11.

NASA (National Aeronautical and Space Administration). 1997. Earth probe TOMS animation of Northern Hemisphere. Internet site, http://jwocky.gsfc.nasa.gov.

Northridge, S. & Hammond, P.S. (1999). Estimation of porpoise mortality in UK gill and tangle-net fisheries in the North Sea and West of Scotland. *Paper presented to the Scientific Committee at the 51st Meeting of the International Whaling Commission, 1999*. SC/51/SM42.

Northridge, S.P., Tasker, M.L., Webb, A. & Williams, J.M. (1995). Distribution and relative abundance of harbour porpoises (*Phocoena phocoena L.*) white-beaked dolphins (*Lagenorhynchus albirostris Gray*.), and minke whales (*Balaenoptera acutorostrata*) around the British Isles. *ICES Journal of Marine Science*, **52**, 55-66.

Olesiuk, P.F., Nichol, L.M., Sowden, P.J. and Ford, J.K.B. (1996). *Effects of sounds generated by an acoustic deterrent device on the abundance and distribution of harbour porpoise* (Phocoena phocoena) *in Retreat Passage, British Columbia.* Department of Fisheries and Oceans, Pacific Biological Station. Nanimo, BC., Canada.

O'Shea, T.J. & Brownell, R.L. (1994). Organochlorine and metal contaminants in baleen whales: a review and evaluation of conservation implications. *Science of the Total Environment*, **154**, 179-200.

Parsons, E.C.M. (1997). *Sewage pollution in Hong Kong: implications for the health and conservation of local cetaceans.* Friends of the Earth, Hong Kong.

Parsons, E.C.M. & Jefferson, T.A. (2000). Post-mortem investigations on stranded dolphins and porpoises from Hong Kong waters. *Journal of Wildlife Diseases*, **36**, 342-356.

Parsons, E.C.M., Shrimpton, J. & Evans, P.G.H. (2000). Cetacean conservation in Northwest Scotland: perceived threats to cetaceans. *European Research on Cetaceans*, **13**, 128-133.

Payne, R. & Webb, D. (1971). Orientation by means of long range acoustic signaling in baleen whales. *Annals of the New York Academy of Sciences*, **188**, 110-141.

Perrin, W.F. (1989). *Dolphins, Porpoises and Whales. An Action Plan for the Conservation of Biological Diversity: 1988-1992*. The International Union for Conservation of Nature and Natural Resources, Gland, Switzerland.

Perry, C. (1998). A review of the impact of anthropogenic noise on cetaceans. *Paper presented to the Scientific Committee at the 50th Meeting of the International Whaling Commission, 1998*. SC/50/E9.

Perry, C. (1999). A Brief Overview of Global Environmental Change and its potential Impact on Cetaceans. *Paper presented to the Scientific Committee at the 51st Meeting of the International Whaling Commission, 1999*. SC/51/E3.

Rawson, A.J., Patton, G.W., Hofmann, S., Pietra, G.G. & Johns, L. (1993). Liver abnormalities associated with chronic mercury accumulation in stranded Atlantic bottlenose dolphins. *Ecotoxicology and Environmental Safety*, **25**, 41-47.

Rea, J. (1999). *Marine Fish Farms Temporary Site Application. 19th March 1999*. Report to Crown Estate Office, Edinburgh.

Reeves, R.R. & Leatherwood, S. (1994). *Dolphins, Porpoises and Whales. An 1992-1998 Action Plan for the Conservation of Cetaceans*. The International Union for Conservation of Nature and Natural Resources, Gland, Switzerland.

Reijinders, P.J.H. (1986). Reproductive failure in common seals feeding on fish from polluted coastal waters. *Nature*, **324**, 456-457.

Reijinders, P.J.H. (1996). Organohalogen and heavy metal contamination in cetaceans: observed effects, potential impacts and future prospects. In: *The Conservation of Whales and Dolphins Science and Practice*. (Ed. by M.P. Simmonds & J.D Hutchinson), pp. 205-218. John Wiley and Sons, Chichester, UK.

Rendell, L.E. & Gordon, J.C.D. (1999). Vocal responses of long-finned pilot whales (Globicephala melas) to military sonar in the Ligurian Sea. *Marine Mammal Science*, **15**, 198-204.

Richardson, W.J., Greene, C.R., Mame, C.I. & Thomson, D.H. (1995). *Marine Mammals and Noise*. Academic Press Inc, San Diego, USA.

Rose, G. (1996). International law and the status of cetaceans. In: *The Conservation of Whales and Dolphins Science and Practice*. (Ed. by M.P. Simmonds & J.D Hutchinson), pp. 23-53. John Wiley and Sons, Chichester, UK.

Ross, A. (1989). Nuvan use in salmon farming. The antithesis of the precautionary principle. *Marine Pollution Bulletin*, **20**, 372-374.

Ross, A. (1997). *Leaping in the dark. A review of the environmental impacts of marine salmon farming in Scotland and proposals for change*. Scottish Wildlife and Countryside Link, Perth, UK.

Ross, A. (1998a). Application for consent to discharge sea lice treatment residues. Letter dated 7th May, 1998 to Scottish Environment Protection Agency. Ref. T/B06/036/98(00).

Ross, A. (1998b). Request to the Secretary of State to call-in the application for discharge consent for Excis at Avoch Bay. Letter dated 3rd July, 1998 to Scottish Office Agriculture, Environment and Fisheries Department. Ref. T/B06/036/98(00).

Samuels, E.R., Cawthron, M., Lauer, B.H. & Baker, B.E. (1970). Strontium-90 and caesium-137 in tissues of fin whales (*Balaenoptera physalus*) and harp seals (*Pagophilius groenlandicus*). *Canadian Journal of Zoology*, **48**, 267-269.

Schliemann, T., Amundin, M. & Miller L.A. (1995). Prevention of stress in captive Atlantic bottlenose dolphins (*Tursiops trucatus*) in connection with excavation by blasting. In: *Sensory Systems of Aquatic Animals* (Ed. by R.A Kastelein, J.A. Thomas & R.E Nacthtigall) De Spil Publishers, Woerden.

SCENES. (1998a). *Scottish Environmental News in February 1998*. Issue 122, March 1998.

SCENES. (1998b). *Scottish Environmental News in August 1998*. Issue 128, September 1998.

SCENES. (1998c). *Scottish Environmental News in March 1998*. Issue 123, April 1998.

SCENES. (1999a). *Scottish Environmental News in December 1998*. Issue 132, January 1999.

SCENES. (1999b). *Scottish Environmental News in April 1999*. Issue 136, May 1999.

SCENES. (1999c). *Scottish Environmental News in January 1999*. Issue 133, February 1999.

SNH (Scottish Natural Heritage). (1998). *National Scenic Areas. A consultation paper*. Scottish National Heritage, Perth, UK.

SNH (Scottish Natural Heritage). (1999). *National Parks for Scotland. Scottish Natural Heritage's advice to Government*. Scottish Natural Heritage, Perth, UK.

Seinen, W. & Willems, M.L. (1976). Toxicity of organotin compounds. I. Atrophy of thymus and thymus-dependant lympoid tissue in rats fed di-*n*-octytin dichloride. *Toxicology and Applied Pharmacology*, **35**, 63-75.

Sheldrick, M.C. (1989). Stranded whale records for the entire British coastline, 1967 - 1986. *Investigations on Cetacea*, **22**, 298-329.

Sheldrick, M.C., Chimonides, P.J., Muir, A.I., George, J.D, Reid, R.J., Kuiken, T., Iskjaer-Ackley, C. & Kitchener, A. (1994). Stranded cetacean records for England, Scotland and Wales, 1987-1992. *Investigations on Cetacea*, **25**, 259-283.

Siebert, V., Joiris, C., Holsbeck, L., Weiss, R., Lick, R, Benke, H. & Frese, K. (1995). Mercury analysis and necropsy findings in small cetaceans in German waters of the North and Baltic Sea. *European Research on Cetaceans*, **9**, 277-279.

Siebert, U., Joiris, C., Holsbeek, L., Benkes, H., Failing, K., Frese, K. & Petzinger, E. (1999). Potential relation between mercury concentrations and necropsy findings in cetaceans from German waters of the North and Baltic Seas. *Marine Pollution Bulletin*, 38, 285-295.

Simmonds, M.P. (1992). Cetacean mass mortalities and their potential relationships with pollution. In: *Proceedings of the Symposium 'Whales- Biology- Threats- Conservation', Brussels 1991* (Ed. by J.J. Symoens), pp. 217-245. Royal Academy of Overseas Science, Brussels, Belgium.

Simmonds, M.P. (1997). The status of cetaceans in the North East Atlantic and their ongoing threat to their survival. *Marine Environmental Management Review of 1996 and Future Trends,* **4** (16), 103-106.

Simmonds, M. & Lopez-Jurado, L.F. (1991). Whales and the military. *Nature*, **337**, 448.

Simmonds, M.P. & Dolman, S. (1998). A note on the vulnerability of cetaceans to acoustic disturbance *Paper presented to the Scientific Committee at the 51st Meeting of the International Whaling Commission, 1999*. SC/51/E15.

Stroud, C. (1996). The ethics and politics of whaling. In: *The Conservation of Whales and Dolphins. Science and Practice* (Ed. by M.P. Simmonds & J.D. Hutchinson), pp. 55-88. Wiley and Sons, Chichester, UK.

Subramanian, M.M., Tanabe, S., Tatsukawa, R., Saito, S. & Miyazaki, N. (1987). Reduction in the testosterone levels by PCB's and DDE in Dall's propose of northwestern North Pacific. *Marine Pollution Bulletin*, **37**, 304-305.

Swift, R. (1997). *The effects of array noise on cetacean distribution and behaviour*, MSc. Thesis, University of Southampton, UK.

Taylor, G., Telfer, T., Beveridge, M. & Muir, J. (1998). *Collection and treatment of waste chemotherapeutants and the use of enclosed-cage systems in salmon aquaculture*. Scottish Environmental Protection Agency, Stirling, UK.

Tanabe, S., Tatsukawa, R., Maruyama, K. & Miyazaki, N. (1982). Transplacental transfer of PCBs and chlorinated hydrocarbon pesticides from a pregnant striped dolphin, *Stenella coeruleoalba*, to her fetus. *Agricultural and Biological Chemistry*, **46**, 1249-1254.

Tanabe, S. (1998). PCB problems in the future: Foresight from current knowledge. *Environmental Pollution*, **50**, 5-28.

Tanabe, S., Prudente, M., Mizuno, T., Hasegawa, J., Iwate, H. & Miyazaki, N. (1998). Butylin contamination in marine mammals from North Pacific and Asian coastal waters. *Environmental Science and Technology*, **32**, 193-198.

Thompson, D.A. (1928). On whales landed at the Scottish whaling stations during the years 1908-1914 and 1920-1927. *Scientific Investigations on Fisheries in Scotland*, **3**, 1-40.

Thompson, P.M. (1992). The conservation of marine mammals in Scottish waters. *Proceedings of the Royal Society of Edinburgh*, **100B**, 123-140.

Thompson, P.M. (1994). Marine Mammals in Scottish Waters: research requirements for their effective conservation and management. In: *The Islands of Scotland. A Living Marine Heritage*. (Ed. by J.M Baxter & M.B. Usher), pp. 179-196. Her Majesty's Stationary Office, London, UK.

Thompson, P.M. & Hammond, P.S. (1992). The use of photography to monitor dermal disease in wild bottlenose dolphins (*Tursiops truncatus*). *Ambio*, **21**, 135-137.

Thompson, T.J., Winn, H.E. & Perkins, P.J. (1979). Mysticete sounds. In: *Behaviour of Marine Animals Vol. 3. Cetaceans* (Ed. by H.E Winn & B.L. Olla). Plenum Press, New York, USA.

Tregenza, N.J.C., Berrow, S.D., Hammond, P.S & Leaper, R. (1997). Harbour porpoise (*Phocoena phocoena L.*) by-catch in set gill nets in the Celtic Sea. *ICES Journal of Marine Science*, **54**, 896-904.

Tyler, P. & McHattie, A. (1998). *Minch Project 1998. Beach Litter Survey*. West Highland Free Press, Inverness, UK.

Tynan, C.T. & DeMaster, D.P. (1998). Ozone depletion in the Arctic. *Paper presented to the Scientific Committee at the 50th Meeting of the International Whaling Commission, 1990*. SC/50/E4.

Vonk, R. & Martin, V. (1989). Goosebeaked whales *Ziphus cavirostris* mass strandings in the Canary Isles. *European Research on Cetaceans*, **3**, 73-77.

Vos, J.G., De Klerc, A., Krajnc, E.I., Kruizinga, W., Van Ommen, B. & Rozing, J. (1984). Toxicity of bis(tri-n-butilyn)oxide in the rat II. Suppression of thymus-dependant immune response and of parameters of non specific resistance after short term exposure. *Toxicology and Applied Pharmacology*, **75**, 387-408.

Wagemann, R. & Muir, P.C.G. (1984). Concentrations of heavy metals and organochlorines in marine mammals of northern waters: overview and evaluation. *Canadian Technical Report on Aquatic Sciences*, **1276**, 1-97.

Warburton, C. (1999). *Marine wildlife tourism and whale-watching on the Island of Mull, West Scotland*. MSc Thesis, University of Kent, UK.

Watkins, W.A., Moore, K.E. and Tyack, P. (1985). Sperm whales acoustic behaviour in the Southeast Caribbean. *Cetology*, **49**, 1-15.

Wells, D.E. & Echarri, I. (1992). Determination of individual chlororbiphenyls (CBs), including non-ortho, and mono-ortho chloro substituted CBs in marine mammals from Scottish waters. *International Journal of Environmental Analytical Chemistry*, **47**, 75-97.

Warren, L.M. (1998). Legal Boundaries and the scope for effective marine nature conservation in offshore areas. *Marine Environmental Management Review of 1997 and Future Trends*, **5** (11), 85-90.

Wijnstekers, W. (1990). *The evolution of CITES*. Secretariat of the Convention on International Trade of Endangered Species of Wild Fauna and Flora, Lausanne, Switzerland.

Wilson, B., Hammond, P. & Thompson, P. (1999). Estimating size and assessing status of a coastal bottlenose dolphin population. *Ecological Applications*, **9**, 288-300.

Winkler, T. (1999). *Dolphins 'put at risk' by navy exercises*. *The Scotsman*, **5th July 1999**.

WMO (World Meteorological Organisation). 1997. Spring ozone deficiency over the Northern Polar region. Internet site, http://www.wmo.ch/web/arep/nho3.htm.

WWF (Worldwide Fund for Nature). (1995). *Whales and pollution. IWC 1995 Special Marine Update*. World Wide Fund for Nature, London, UK.

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Appendices

APPENDIX A. ARGYLL & BUTE BIO-DIVERSITY ACTION PLAN

1. MINKE WHALE (*BALAENOPTERA ACUTOROSTRATA*)

1.1. CURRENT STATUS

1.1.1. Status in UK waters

The minke whale is Britain's most common baleen whale species and is particularly abundant on the west coast of Scotland. This species is most commonly sighted in inshore waters in the summer and is believed to migrate out of the area during the winter to unknown breeding grounds. Within Europe, the minke whale is limited to the waters of the Northeast Atlantic and North Sea. Estimates on the size of these two minke whale stocks are currently under dispute.

1.1.2. Status in Argyll waters

The minke whale is common in northern Argyll waters, particularly to the north of the Isle of Coll. Reports of frequent sightings have also been made for the waters south of Iona. Minke whales are present in north Argyll waters from April-November. From April-July they are more common off the north of Coll and during August-November this distribution shifts slightly north to the Small Isles, both areas being important feeding grounds for this species in Argyll waters. The Hebridean Whale and Dolphin Trust has, to date, identified 74 individual whales in northern Argyll waters and these whales are known to return to the same area year after year. The predominance of certain individuals suggests that minke whales may have specific territories which they return to annually.

There is scant information on the distribution or abundance of minke whales in the waters south of Mull although sightings have been reported around Islay, Colonsay and Kintyre. There are suggestions (as yet unconfirmed) that a proportion of the minke whale population may be present in some areas of Argyll for most of the year.

There is no information for the Argyll region to ascertain whether the minke whale is in decline. The Argyll region is believed to encompass a large proportion of the UK population of minke whales.

1.1.3. Legal status

Bio-Diversity Action Plan: Middle list

Habitats Directive: Annex IV

IUCN Status: Near Threatened

Bern Convention: Annex III

Bonn Convention: Appendix II

CITES: Appendix I

Wildlife & Countryside Act: Schedule V

Species Ranking Values for Argyll Minke Whales

Criterion	Value	Description
Priority List	2	Middle List
Local Decline	1	Possible decline
Local Rarity	0	Common
Local Threat	1	Indirect threat
Geographic Range	3	10-20% of UK population?
Argyll range	2	Widespread
Distinctiveness	2	Flagship
TOTAL	**11**	

1.2. CURRENT FACTORS CAUSING LOSS OR DECLINE IN ARGYLL WATERS

Factors affecting this species are not clear but may include:

1.2.1. Incidental capture and drowning in fishing gear (creel lines).

1.2.2. Environmental contaminants (e.g. sewage, oil, fish farm-related pollutants, litter and marine debris, persistent organic pollutants, anthropogenic noise).

1.2.3. Military activities (e.g. naval sonar use).

1.2.4. Commercial whaling (Norway currently hunts the minke whale in the North Atlantic and captured animals may include individuals which inhabit Argyll waters for part of the year).

1.3. CURRENT ACTION IN ARGYLL

1.3.1. Collection and collation of sightings of minke whales in Argyll waters (Hebridean Whale and Dolphin Trust/ Seawatch Foundation).

1.3.2. The collation of a catalogue of individual minke whales inhabiting north Argyll waters. This catalogue is currently being used to estimate a minimum population size for this area and patterns of individual habitat use (Hebridean Whale and Dolphin Trust).

1.3.3. A study into seasonal changes in minke whale feeding behaviour in North

Argyll waters (Hebridean Whale and Dolphin Trust).

1.3.4. A code of conduct for whale and dolphin watching for members of the public and wildlife tour operators to minimise disturbance to cetaceans (Hebridean Whale and Dolphin Trust).

1.3.5. An educational programme to increase public awareness and knowledge of minke whales and other cetaceans in Argyll waters (Hebridean Whale and Dolphin Trust/ Scottish Natural Heritage).

1.3.6. Post-mortem and tissue studies of stranded cetaceans to establish cause of death (Scottish Agricultural College).

1.4. PROPOSED ACTION WITH LEAD AGENCIES

1.4.1. Policy and legislation

1.4.1.1. Ensure that no whaling is conducted in Scottish waters or in waters adjacent to Scotland. There have been suggestions that Norwegian whaling vessels enter Scottish waters to hunt minke whales but as there are no records for where the Norwegians capture their animals this cannot be verified. The UK Government should insist at meetings of the International Whaling Commission that information on Norwegian minke whale capture positions, photographs and genetic samples of the captured animals should be submitted to ascertain whether whales which may inhabit Scottish waters or belong to Scottish sub-populations are being captured (Scottish Natural Heritage/Scottish Office).

1.4.1.2. Seek to improve and control water quality by reducing discharges of substances which are toxic, persistent and liable to bio-accumulate. To investigate the scale and variety of agricultural and aquaculture-related pollutants entering local coastal waters (Scottish Environmental Protection Agency).

1.4.2. Site Safeguard and Management

1.4.2.1. Identify further important minke whale breeding and feeding sites. Anthropogenic activities which may impact these areas and ways to protect these areas from disturbance should then be investigated (Scottish Natural Heritage/Hebridean Whale and Dolphin Trust).

1.4.2.2. Investigate the possibility of local community-led voluntary marine reserves to protect minke whale populations (Scottish Natural Heritage/Hebridean Whale and Dolphin Trust).

1.4.3. Species Management and Protection

Collect information on the genetic profile of Scottish minke whales (genetic fingerprinting) to investigate their population dynamics and to used to determine if minke whale meat being sold in Norway and the Orient comes from Scottish minke whales (and would therefore be illegal) (Hebridean Whale and Dolphin Trust/Scottish Agricultural College/Scottish Natural Heritage).

1.4.4. Advisory

Provide advice, as appropriate, to international fora involved with the conservation and management of North Atlantic minke whales (e.g. IWC, CITES, ICES). (Scottish Office/Scottish Natural Heritage/Hebridean Whale and Dolphin Trust).

1.4.5. Future Research and Monitoring

1.4.5.1. Conduct surveys to document minke whale distribution in the Argyll and Islands region. These surveys should:

- follow a system of pre-determined transect lines using established methodologies in order to estimate the number of minke whales inhabiting the Argyll region;
- be conducted annually to determine definitively whether Argyll minke whale populations are declining, stable or increasing;
- gather environmental data (depth, water temperature, abundance of fish, chlorophyll levels, tidal state etc.) in conjunction with distribution data to determine how distribution correlates with habitat type.

(Hebridean Whale and Dolphin Trust/Scottish Natural Heritage).

1.4.4.2. Conduct long-term research into the biology, behaviour and ecology of minke whales in the Argyll region (Hebridean Whale and Dolphin Trust/Scottish Natural Heritage).

1.4.4.3. Instigate a benign satellite tagging programme to gather information on minke whale migration patterns and seasonal changes in habitat use (Hebridean Whale and Dolphin Trust/Scottish Natural Heritage).

1.4.4.4. Conduct research into the possible impacts of agricultural, shipping and aquaculture-related pollutants upon Argyll minke whale habitats and populations (Scottish Agricultural College/Hebridean Whale and Dolphin Trust/Scottish Natural Heritage).

1.4.4.4. Conduct research into the possible impacts of military activities upon minke whale habitats and populations.

1.4.5. Communications and Publicity

1.4.5.1. Continue to publicise the existence of minke whales in the Argyll region, threats that they might face and their distribution. This awareness programme should also publicise the need to report minke whale sightings and strandings (Hebridean Whale and Dolphin Trust/Scottish Natural Heritage).

1.4.5.2. Encourage responsible whale-watching as a means of providing sources of income to coastal Argyll communities and increase awareness of the economic benefits that conserving minke whales may bring to the Argyll region (Hebridean Whale and Dolphin Trust/Scottish Natural Heritage).

2. HARBOUR PORPOISE (*PHOCOENA PHOCOENA*)

2.1. CURRENT STATUS

2.1.1. Status in UK waters

There is some evidence of harbour porpoise decline in UK waters as the result of pollution, incidental capture and drowning in fishing gear and habitat loss or degradation. Levels of fishing by-catch in the Celtic Sea exert a mortality rate of an estimated 6%. According to the IWC subcommittee this level of by-catch is unsustainable. The harbour porpoise is believed to have been extirpated in the English Channel.

2.1.2. Status in Argyll waters

The harbour porpoise is common in northern Argyll waters, and several groups inhabit the coastal waters of north and western Mull and Coll. There is scant information on the distribution or abundance of harbour porpoises in southern Mull waters, Tiree coastal waters or the Firth of Lorn. There is no information on their distribution south of Mull although they are believed to be present. There is no information for the Argyll region to ascertain whether the harbour porpoise is in decline, although this species is believed to be in general decline throughout UK waters.

2.1.3. Legal status

Bio-Diversity Action Plan: Short list

Habitats Directive: Annex II* IV

IUCN Status: Vulnerable

Bern Convention: Annex II

Bonn Convention: Appendix II

Wildlife & Countryside Act: Schedule V

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

*** A species whose conservation requires the designation of Special Areas of Conservation (SACs).**

Species Ranking Values for Argyll Harbour Porpoises

Criterion	Value	Description
Priority List	2	Short List
Local Decline	1	Possible decline
Local Rarity	0	Common
Local Threat	1	Indirect threat
Geographic Range	0	
Argyll range	2	Widespread
Distinctiveness	2	Flagship
TOTAL	**8**	

2.2. CURRENT FACTORS CAUSING LOSS OR DECLINE IN ARGYLL WATERS

The current factors affecting this species are not clear but may include:

2.2.1. Incidental capture and drowning in fishing gear.

2.2.2. Environmental contaminants (e.g. sewage, oil, fish farm-related pollutants, litter and marine debris, persistent organic pollutants).

2.2.3. Military activities (e.g. naval sonar use).

2.2.4. Acoustic disturbance (e.g. seal scrammers).

2.3. CURRENT ACTION IN ARGYLL

2.3.1. Fishermen interviews to discover the distribution of fishing effort and gear use in Argyll waters and to determine if there may be conflicts between high usage fishing grounds and porpoise distribution (Hebridean Whale and Dolphin Trust).

2.3.2. Studies into the habitat requirements of harbour porpoises in north Argyll waters, examining distribution data collected by whale-watching vessels (Hebridean Whale and Dolphin Trust).

2.3.3. Study into the feasibility of designating SACs for harbour porpoises in Argyll waters (Hebridean Whale and Dolphin Trust).

2.3.4. Collection and collation of sightings of harbour porpoises in Argyll waters (Hebridean Whale and Dolphin Trust/ Seawatch Foundation).

2.3.5. A code of conduct for whale and dolphin watching for members of the public and wildlife tour operators to minimise disturbance to cetaceans (Hebridean Whale and Dolphin Trust).

2.3.6. An educational programme to increase public awareness and knowledge of harbour porpoises and other cetaceans in Argyll waters (Hebridean Whale and Dolphin Trust/ Scottish Natural Heritage).

2.3.7. Post-mortem and tissue studies of stranded cetaceans to establish cause of death (Scottish Agricultural College).

2.4. PROPOSED ACTION WITH LEAD AGENCIES

2.4.1. Policy and Legislation

Seek to improve and control water quality by reducing discharges of substances which are toxic, persistent and liable to bio-accumulate. To investigate the scale and variety of agricultural and aquaculture-related pollutants entering local coastal waters (Scottish Environmental Protection Agency).

2.4.2. Site Safeguard and Management

2.4.2.1. Propose possible SACs for the protection of harbour porpoises (Scottish Natural Heritage/Hebridean Whale and Dolphin Trust).

2.4.2.2. Investigate the possibility of local community-led voluntary marine reserves to protect harbour porpoise populations (Scottish Natural Heritage/Hebridean Whale and Dolphin Trust).

2.4.3. Species Management and Protection

Work with local fishermen with the aim of reducing and avoiding by-catches in passive and active gear and to dispose of discarded gear safely.

2.4.4. Future Research and Monitoring

2.4.4.1. Conduct surveys to document harbour porpoise distribution in the Argyll and Islands region. These surveys should:

- follow a system of pre-determined transect lines using established methodologies in order to estimate the number of porpoises inhabiting the Argyll region;
- incorporate both visual and acoustic detection survey techniques to increase the accuracy of the surveys;
- be conducted annually to determine definitively whether Argyll harbour porpoise populations are declining, stable or increasing;

- gather environmental data (depth, water temperature, abundance of fish, chlorophyll levels, tidal state etc.) in conjunction with distribution data to determine how distribution correlates with habitat type.

(Hebridean Whale and Dolphin Trust/Scottish Natural Heritage).

2.4.4.2. Conduct long-term research into the biology, behaviour and ecology of harbour porpoises in the Argyll region (Hebridean Whale and Dolphin Trust/Scottish Natural Heritage).

2.4.4.3. Expand current research into harbour porpoise by-catch in other areas of the UK, to include the Argyll area. If by-catch is considered to be a problem, seek to reduce the by-catch of harbour porpoises in fishing gear by promoting research into fishing gear modifications and the feasibility of placing acoustic deterrents upon net lines (JNCC/Scottish Natural Heritage/Hebridean Whale and Dolphin Trust).

2.4.4.4. Conduct research into the possible impacts of agricultural, shipping and aquaculture-related pollutants upon Argyll harbour porpoise habitats and populations (Scottish Agricultural College/Hebridean Whale and Dolphin Trust/Scottish Natural Heritage).

2.4.4.5. Conduct research into the possible impacts of military activities upon harbour porpoise habitats and populations (Hebridean Whale and Dolphin Trust/Scottish Natural Heritage).

2.4.5. Communications and Publicity

2.4.5.1. Subject to the results of research into whether by-catch is a threat to harbour porpoises in the Argyll area, consider the need to encourage fishermen to report sightings and by-catches through an awareness programme (Hebridean Whale and Dolphin Trust/Scottish Natural Heritage).

2.4.5.2. Continue to publicise the existence of harbour porpoises in the Argyll region, threats that they might face and their distribution. This awareness programme should also publicise the need to report porpoise sightings and strandings (Hebridean Whale and Dolphin Trust/Scottish Natural Heritage).

3. BOTTLENOSE DOLPHIN (*TURSIOPS TRUNCATUS*)

3.1. CURRENT STATUS

3.1.1. Status in UK waters

At a length of 3-3.8m, bottlenose dolphins occurring in British waters are larger than conspecifics occurring in other regions of the world. The species occurs in discrete coastal populations in several areas of the British Isles including the Cardigan Bay (Wales), Cornwall, Dorset (England) and the Moray Firth, Barra and Northern Argyll (Scotland). These Scottish populations express the northern limits of this species' distribution. In addition to the aforementioned Scottish locales, sightings of bottlenose dolphins have also been made in other parts of western Scotland, such as Loch Maddy (North Uist) and Northern Skye and these sightings could be indicative of other populations.

Several studies (Cornwall, Dorset, Cardigan Bay and the Moray Firth) have been initiated to produce photo-identification catalogues to assess the population size of bottlenose dolphins, their habitat use, their ecology and to monitor the status of the population. The most established of these projects is in the Moray Firth and data collected to date suggests that the population (of approximately 130 animals) is in decline.

3.1.2. Status in Argyll waters

The bottlenose dolphin is the second most commonly sighted small cetacean in Argyll. Sightings have been reported from the coastal waters of Coll, Tiree and Mull as well as in the Firth of Lorn. Sightings have also been made in neighbouring Lochaber (for example in Loch Sunart and off Ardnamurchan Point). These animals have been sighted year round and preliminary photo-identification studies have shown that some identifiable individuals have been sighted in the area over a period of several years.

Sightings of bottlenose dolphins have also been made off the Mull of Kintrye, which could suggest a second Argyll population.

There is no information for the Argyll region to ascertain whether bottlenose dolphins are in decline.

3.1.3. Legal status

Bio-Diversity Action Plan: Long list

Habitats Directive: Annex II & IV

IUCN Status: Data deficient

Bern Convention: Annex II

Bonn Convention: Appendix II

Wildlife & Countryside Act: Schedule V

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

Species Ranking Values for Argyll Bottlenose Dolphins

Criterion	Value	Description
Priority List	1	Long List
Local Decline	1	Possible decline
Local Rarity	0	Common
Local Threat	1	Indirect threat
Geographic Range	2	Isolated
Argyll range	2	Widespread
Distinctiveness	2	Flagship
TOTAL	**9**	

3.2. CURRENT FACTORS CAUSING LOSS OR DECLINE IN ARGYLL WATERS

Factors affecting this species are not clear but may include:

3.2.1. Incidental capture and drowning in fishing gear.

3.2.2. Environmental contaminants (e.g. sewage, oil, fish farm-related pollutants, marine debris, persistent organic pollutants).

3.2.3. Military activities (e.g. naval sonar use).

3.2.4. Acoustic disturbance (e.g. seal scrammers).

3.3. CURRENT ACTION IN ARGYLL

3.3.1. Collection and collation of sightings of bottlenose dolphins in Argyll waters (Hebridean Whale and Dolphin Trust/ Seawatch Foundation).

3.3.2. Collection of photographs/video taken by members of the general public to be used as the basis for a preliminary photo-identification catalogue (Hebridean Whale and Dolphin Trust).

3.3.3. A code of conduct for whale and dolphin watching for members of the public and wildlife tour operators to minimise disturbance to cetaceans (Hebridean Whale and Dolphin Trust).

3.3.4. An educational programme to increase public awareness and knowledge of bottlenose dolphins and other cetaceans in Argyll waters (Hebridean Whale and Dolphin Trust/ Scottish Natural Heritage).

3.3.5. Post-mortem and tissue studies of stranded cetaceans to establish cause of death (Scottish Agricultural College).

3.4. PROPOSED ACTION WITH LEAD AGENCIES

3.4.1. Policy and legislation

Seek to improve and control water quality by reducing discharges of substances which are toxic, persistent and liable to bio-accumulate. To investigate the scale and variety of agricultural and aquaculture-related pollutants entering local coastal waters (Scottish Environmental Protection Agency).

3.4.2. Site Safeguard and Management

3.4.2.1. Identify further important bottlenose dolphin breeding and feeding sites. Anthropogenic activities which may impact these areas and ways to protect these areas from disturbance should then be investigated (Scottish Natural Heritage/Hebridean Whale and Dolphin Trust).

3.4.2.2. Investigate the feasibility and/or action plan for establishing an SAC (or other form of conservation area) for bottlenose dolphins in Argyll (Scottish Natural Heritage/Hebridean Whale and Dolphin Trust).

3.4.3. Future Research and Monitoring

3.4.3.1. Initiate a dedicated photo-identification study to photograph individual bottlenose dolphins occurring in the coastal waters of Argyll and use this identification catalogue to:

i) assess the size of the population.

ii) determine whether the population is increasing in size or is in decline.

iii) monitor the habitat usage and movement patterns by individual animals.

iv) gather environmental data (depth, water temperature, abundance of fish, chlorophyll levels, tidal state etc.) in conjunction with positional data to determine how the distribution of bottlenose dolphins correlates with habitat type.

(Hebridean Whale and Dolphin Trust/Scottish Natural Heritage).

3.4.3.2. Investigate the genetic profile of Argyll bottlenose dolphins and compare with populations in the Moray Firth, Cardigan Bay and other parts of the Hebrides (Barra) to determine the degree to which the population is isolated from other bottlenose dolphin groups (and thus help to assess the population's viability and vulnerability to anthropogenic impacts) (Scottish

Agricultural College/Hebridean Whale and Dolphin Trust/Scottish Natural Heritage).

3.4.3.3. Conduct research into the possible impacts of agricultural, shipping and aquaculture-related pollutants upon Argyll bottlenose dolphin habitats and populations (Scottish Agricultural College/Hebridean Whale and Dolphin Trust/Scottish Natural Heritage).

3.4.3.4. Conduct research into the possible impacts of military and fish farm-related activities upon bottlenose dolphin habitats and populations.

3.4.5. Communications and Publicity

3.4.5.1. Continue to publicise the existence of bottlenose dolphins in the Argyll region, threats that they might face and their distribution. This awareness programme should also publicise the need to report dolphin sightings and strandings (Hebridean Whale and Dolphin Trust/Scottish Natural Heritage).

3.4.5.2. Encourage responsible dolphin-watching as a means of providing sources of income to coastal Argyll communities and increase awareness of the economic benefits that conserving bottlenose dolphins may bring to the Argyll region (Hebridean Whale and Dolphin Trust/Scottish Natural Heritage).

4. CETACEANS (all species)

4.1. CURRENT STATUS

4.1.1. Status in UK waters

Twenty-six species of cetacean have been recorded in UK waters. Several of these species are transient animals, such as beluga whales, false killer whales and narwhals. The majority of the species do, however, reside in British waters for at least part of the year.

Commercial whaling was last carried out in British waters in 1951, from a whaling station based in the Outer Hebrides. Whaling from this station and similar operations nearly brought about the extirpation of several species of large whales in British waters, e.g. the humpback, fin, Northern right and blue whale. British populations of most of these species have still to recover from this whaling activity.

The west coast of Scotland is arguably the most important habitat for cetaceans in the UK and one of the most important habitats for cetaceans in Europe. A wide range of oceanic features (shallow coastal waters and sea lochs and deep oceanic trenches) have resulted in the largest diversity of cetaceans in the UK:

twenty-four of the twenty-five recorded species have been documented to occur in West Scottish waters.

Despite the importance of this region for cetaceans, there is currently no information on the absolute abundance of cetaceans in this region, information on mortality rates from anthropogenic activities nor data on population trends.

4.1.2. Status in Argyll waters

To date, 19 cetacean species have been recorded from Argyll and Bio-diversity Action Plans have been drafted for the three most commonly occurring species: the harbour porpoise, bottlenose dolphin and minke whale.

At present distribution data on cetaceans in the Argyll and Bute region is largely limited to northern Argyll. However, due to various oceanographic features present in the southern Argyll region and Bute, substantial populations of cetaceans would be expected in several areas, for example the waters to the west of Corrywreckan, the coastal waters of Colonsay and Islay and the deep water areas around the Isle of Arran.

4.1.3. Legal status see Table 1.

4.2. CURRENT FACTORS CAUSING LOSS OR DECLINE IN ARGYLL WATERS

Factors affecting this species are not clear but may include:

4.2.1. Incidental capture and drowning in fishing gear (creel lines).

4.2.2. Environmental contaminants (e.g. sewage, oil, fish farm-related pollutants, litter and marine debris, persistent organic pollutants, anthropogenic noise).

4.2.3. Military activities (e.g. naval sonar use).

4.2.4. Acoustic disturbance (e.g. seal scrammers).

4.3. CURRENT ACTION IN ARGYLL

4.3.1. Collection and collation of sightings of cetaceans in Argyll waters (Hebridean Whale and Dolphin Trust/ Seawatch Foundation).

4.3.2. A code of conduct for whale and dolphin watching for members of the public and wildlife tour operators to minimise disturbance to cetaceans (Hebridean Whale and Dolphin Trust).

4.3.3. An educational programme to increase public awareness and knowledge of cetaceans in Argyll waters

(Hebridean Whale and Dolphin Trust/ Scottish Natural Heritage).

4.3.4. Post-mortem and tissue studies of stranded cetaceans to establish cause of death (Scottish Agricultural College).

Table 1. Cetacean species occurring in the Argyll region and their legal status

Common name	Scientific name	Gaelic name	HABITAT	BERN	BONN	CITES *	W&C Act	IUCN	BIO-DIV
ODONTOCETES									
Atlantic white-sided dolphin	*Lagenorhynchus acutus*	Deilf-chliathaich-ghil	IV	II	II	II*	V	-	L
Beluga whale	*Delphinapterus leucas*	-	IV	III	II	II*	V	VU	L
Bottlenose dolphin	*Tursiops truncatus*	Muc-bhiorach	II IV	II	II	II*	V	DD	L
Common dolphin	*Delphinus delphis*	Deilf	IV	II	II	II*	V	-	L
Cuvier's beaked whale	*Ziphius cavirostris*	-	IV	II		II*	V	DD	L
Harbour porpoise	*Phocoena phocoena*	Peileag	II IV	II	II	II*	V	VU	S
Killer whale	*Orcinus orca*	Mada-chuain	IV	II	II	II*	V	CD	L
Long-finned pilot whale	*Globicephala melaena*	Muc-mhara-chinn-mhoir	IV	II	II	II*	V	-	L
Northern bottlenose whale	*Hyperoodon ampullatus*	-	IV	III	II	I	V	CD	M
White-beaked dolphin	*Lagenorhynchus albirostris*	Deilf-gheal-ghobach	IV	III	II	II*	V	-	L
Risso's dolphin	*Grampus griseus*	Deilf-Risso	IV	II	II	II*	V	DD	L
Sowerby's beaked whale	*Mesoplodon bidens*	-	IV	II		II*	V	DD	L
Sperm whale	*Physeter macrocephalus*	Muc-mhara-sputach	IV	III		I	V	VU	M
Striped dolphin	*Stenella coeruleoalba*	-	IV	II		II*	V	CD	L
MYSTICETES									
Blue whale	*Balaenoptera musculus*		IV	II	I	I	V	EN	M
Fin whale	*Balaenoptera physalus*	Muc-an-sgadain	IV	III		I	V	EN	M
Sei whale	*Balaenoptera borealis*	Muc-mhara-sei	IV	III		I	V	EN	M
Humpback whale	*Megaptera novaeangliae*	Muc-mhara-crotach	IV	II	I	I	V	VU	M
Minke whale	*Balaenoptera acutorostrata*	Muc-mhara-mionc	IV	III		I	V	NT	M

HABITAT: Directive on Conservation of Natural Habitat and Wild Fauna and Flora ; **BERNE**: Convention on the Conservation of European Wildlife and Natural Habitats II =strictly protected endangered and vulnerable animals; III =protected animals.; **BONN**: Convention on Conservation of Migratory Species of Wild Animals ; **CITES**: Convention on the International Trade in Endangered Species; **W&C Act**:Wildlife and Countryside Act 1981; **IUCN**:EN=endangered; VU= vulnerable; CD=conservation dependent; NT= near threatened; DD= data deficient; LC=least concern; **Bio-Div**: UK Bio-Diversity Action Plan Conservation Status : UK Biodiversity Action Plan: S= short list; M= middle list; L= Long list C= species of conservation concern ;

* 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

Table 2. Species Ranking values for Argyll Cetaceans (all species).

Common name	Scientific name	Priority List	Local Decline	Local Rarity	Local Threat	Geographic Range	Argyll Range	Distinctiveness	**TOTAL**
ODONTOCETES									
Atlantic white-sided dolphin	*Lagenorhynchus acutus*	1	1	1	1	0	1	2	**7**
Beluga whale	*Delphinapterus leucas*	1	1	3	1	1	?	2	**9**
Bottlenose dolphin	*Tursiops truncatus*	1	1	0	1	2	2	2	**9**
Common dolphin	*Delphinus delphis*	1	1	0	1	0	2	2	**7**
Cuvier’s beaked whale	*Ziphius cavirostris*	1	1	2	1	?	?	2	**7**
Harbour porpoise	*Phocoena phocoena*	2	1	0	1	0	2	2	**8**
Killer whale	*Orcinus orca*	1	1	1	1	2	2	2	**10**
Long-finned pilot whale	*Globicephala melaena*	1	1	1	1	0	?	2	**6**
Northern bottlenose whale	*Hyperoodon ampullatus*	2	1	2	1	?	?	2	**8**
White-beaked dolphin	*Lagenorhynchus albirostris*	1	1	1	1	0	2	2	**8**
Risso's dolphin	*Grampus griseus*	1	1	1	1	0	2	2	**8**
Sowerby’s beaked whale	*Mesoplodon bidens*	1	1	3	1	?	?	2	**8**
Sperm whale	*Physeter macrocephalus*	2	1	2	1	?	?	2	**8**
Striped dolphin	*Stenella coeruleoalba*	1	1	1	1	0	2	2	**8**
MYSTICETES									
Blue whale	*Balaenoptera musculus*	2	1	3	1	1	1	2	**11**
Fin whale	*Balaenoptera physalus*	2	1	3	1	1	1	2	**11**
Sei whale	*Balaenoptera borealis*	2	1	3	1	1	1	2	**11**
Humpback whale	*Megaptera novaeangliae*	2	1	3	1	1	1	2	**11**
Minke whale	*Balaenoptera acutorostrata*	2	1	0	1	2	3	2	**11**

4.4. PROPOSED ACTION WITH LEAD AGENCIES

4.4.1. Policy and legislation

Seek to improve and control water quality by reducing discharges of substances which are toxic, persistent and liable to bio-accumulate. To investigate the scale and variety of agricultural and aquaculture-related pollutants entering local coastal waters (Scottish Environmental Protection Agency).

4.4.2. Site Safeguard and Management

4.4.2.1. Identify further important cetacean habitats in the Argyll region. Anthropogenic activities which may impact these areas and ways to protect these areas from disturbance should then be investigated (Scottish Natural Heritage/Hebridean Whale and Dolphin Trust).

4.4.2.2. Investigate ways in which existing legislation can be used to maximise protection of cetaceans in Argyll and Bute, e.g. within the management plans of candidate Special Areas of Conservation, National Scenic Areas and Marine Consultation Areas and under the Wildlife and Countryside Act/EU Habitats Directive (Scottish

Natural Heritage/ Hebridean Whale and Dolphin Trust)

4.4.3. Species Management and Protection

Work with local fishermen with the aim of reducing and avoiding by-catches in passive and active gear and to dispose of discarded gear safely.

4.4.4. Advisory

Provide advice, as appropriate, to international fora involved with the conservation and management of cetaceans (e.g. ASCOBANS, IWC, CITES, ICES). (Scottish Office/Scottish Natural Heritage/Hebridean Whale and Dolphin Trust).

4.4.5. Future Research and Monitoring

4.4.5.1. Conduct surveys to gather baseline information on the abundance and distribution of cetaceans in the Argyll region. These surveys should:

- follow a system of pre-determined transect lines using established methodologies in order to estimate the number of cetaceans of all species inhabiting the Argyll region;
- be conducted annually to determine definitively whether Argyll cetacean populations are declining, stable or increasing;
- gather environmental data (depth, water temperature, abundance of fish, chlorophyll levels, tidal state etc.) in conjunction with distribution data to determine how distribution correlates with habitat type.

(Hebridean Whale and Dolphin Trust/Scottish Natural Heritage).

4.4.5.2. If the above surveys identify areas which are important cetacean habitats, conduct further, year-round, intensive surveys into:

a) the biology, behaviour and ecology of cetaceans occurring in these key habitats;

b) anthropogenic threats to the integrity of these habitats;

c) possible locally-based management schemes to protect the aforementioned key habitats.

4.4.5.3. Conduct research into the possible impacts of agricultural, shipping and aquaculture-related pollutants upon Argyll cetacean habitats and populations (Scottish Agricultural College/Hebridean Whale and Dolphin Trust/Scottish Natural Heritage).

4.4.5.4. Conduct research into the possible impacts of military activities upon cetacean habitats and populations.

4.4.6. Communications and Publicity

4.4.6.1. Continue to publicise the existence of cetaceans in the Argyll region, threats that they might face and their distribution. This awareness programme should also publicise the need to report cetacean sightings and strandings (Hebridean Whale and Dolphin Trust/Scottish Natural Heritage).

4.4.6.2. Encourage responsible whale and dolphin-watching as a means of providing sources of income to coastal Argyll communities and increase awareness of the economic benefits that conserving cetaceans may bring to the Argyll region (Hebridean Whale and Dolphin Trust/Scottish Natural Heritage).

APPENDIX B. WHALE-WATCHING CODE OF CONDUCT

- Always BE AWARE that whales and dolphins may be in the area.
- If you see whales or dolphins nearby SLOW DOWN (to no wake speed), keep a STEADY SPEED and AVOID RAPID CHANGES in direction or speed.
- Always take EXTREME CARE when whales and dolphins are nearby.
- If possible, avoid coming closer than 100m and never approach the animals HEAD ON.
- Avoid groups containing CALVES - they are easily frightened and could suffer.
- If stopping to watch a whale or dolphin - put the gears into NEUTRAL or SWITCH OFF the engines if stopping for longer.
- Never CHASE, CIRCLE or OVERTAKE whales or dolphins - Let the whales and dolphins come to you.....IF THEY WANT TO!
- Avoid having more than ONE VESSEL within 300m of any group of whales or dolphins.
- Never let your vessel get into the MIDDLE OF A GROUP of animals - you could split the group up and young animals may lose their mothers.
- If the whales and dolphins show any sign of becoming ALARMED move away - slapping their tails or hitting their heads on the surface of the water may be signs of distress.
- HARASSING and deliberately disturbing a whale or dolphin is a CRIMINAL OFFENCE!
- It's not advisable to swim with or touch whales or dolphins - they're wild animals and CAN BE DANGEROUS. Treat them with respect.
- Never attempt to FEED whales or dolphins.
- Dispose of fuel, food and litter appropriately when back on shore - some types of rubbish can kill, poison or injure whales and dolphins - DON'T POLLUTE OUR SEAS!

Seeing whales and dolphins in the wild is a great privilege - enjoy it!

APPENDIX C. OIL SPILLS

Table C1. Tanker traffic in the Minch, 1993 - 1998.

CARGO	NO. OF VESSELS	% OF TOTAL	% > 10,000 TONNES
Drilling oil	7	1.1	14
Brent crude	5	0.8	100
Crude oil	68	10.5	94
Jet oil	3	0.5	0
Heavy fuel oil	11	1.7	9.1
Fuel oil	36	5.6	30.5
Lube. oil	5	0.8	0
Oil products	19	2.9	5.9
Motor spirit/Petroleum	76	11.8	14
Benzene	27	4.2	37
Kerosene	37	5.7	0
Methanol	12	1.8	0
Gas oil	76	11.8	13.2
Propane	91	14.1	4.4
Butane	42	6.5	0
Avgas	3	0.5	0
Chemicals	17	2.6	0
Caustic soda	37	5.7	13.5
Acid	3	0.5	0
Phosphoric acid	4	0.6	0
Sulphuric acid	74	11.4	1.3
Ammonium nitrate	6	0.9	0
Toulene	3	0.5	37
Calcium Chloride	7	1.1	14.3
Fertiliser	54	8.4	1.8
Laden tankers < 10,000 GRT	**545**	**84.2**	--
Laden tankers > 10,000 GRT	**89**	**13.8**	--
Laden tankers > 100,000 GRT	**14**	**2.2**	--
Unknown GRT	**21**	**3.2**	--

Source: The Highland Council, in Fulton, 1999

Table C2. Traffic types and numbers recorded near Applecross from 1/1/97 - 14/6/98

VESSEL TYPE	NUMBER	% OF TOTAL
Coaster	840	66.1
Fish farm vessel	167	13.1
Tug	67	5.3
Fishing vessel	43	3.4
RMAS vessel	35	2.7
Cruise liner	28	2.2
HMS vessel	25	1.9
Fishery patrol vessel	21	1.6
Lifeboat	8	0.6
Fishery research	7	0.5
Northern lights vessel	7	0.4
Passenger ferry	5	0.4
Cable layer	5	0.2
Tanker	3	0.2
Barge	3	0.08
Oil rig support vessel	1	0.08
Customs vessel	1	0.08
Bulk Carrier	1	0.08
Diving tender	1	0.08
Gas tanker	1	0.08
Survey vessel	1	0.08
Total	1270	--

Source: Range Monitoring Watch, in Fulton, 1998

Table C3. Summary Oil spill data for West Scotland Region.

Year	Number of Incidents	Number of Spills over 100 gallons	Number of spills requiring clean up
1982	22	6	3
1983	18	3	3
1984	16	3	4
1985	11	3	1
1986	13	1	5
1987	18	6	1
1988	19	2	4
1989	15	6	7
1990	30	7	11
1991	25	6	7
1992	32	3	2
1993	33	3	10
1994	45	7	8
1995	42	10	14
1996	47	11	8

Source : Advisory Committee on Protection of the Sea, Surveys of Oil Pollution Around the Coasts of the UK 1982-1996.

APPENDIX D. ACOUSTIC FREQUENCIES

Table D1. Acoustic frequencies utilised by cetaceans occurring in the Hebrides**.**

SPECIES	SOUND TYPE	FREQUENCY RANGE (kHz)	DOMINANT FREQUENCIES (kHz)	SOURCE LEVEL (dB re 1 uPa/1 a)
ODONTOCETES				
Harbour porpoise	Pulses	41.0	--	149-188
	Clicks	<100-160	125-140	
White-beaked dolphin	Squeals	--	8.0-12.0	--
Risso's dolphin	Whistles	--	3.5-4.5	--
	Rasp/pulse burst	0.1- 8.0+	2.0-5.0	--
Common dolphin	Barks	--	<0.5-3.0	
	Whistles	4.0 -16.0	--	
	Chirps	--	8.0-14.0	
	Clicks	10.0-110	26, 90, 110	
Bottlenose dolphin	Barks	0.20-16.0	--	--
	Whistles	0.80-24.0	3.5-14.5	125-173
	Clicks	0.10-300	15.0-130	max. 227
Killer whale	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
Long-finned pilot whale	Whistles	0.50-8.0	1.6-6.7	--
	Clicks	0.10-18.0	--	180
Atlantic white-sided dolphin	Whistles	--	6.0-15.0	--
Northern bottlenose whale	Whistles	3.0-16.0	--	--
	Clicks	0.5-26.0+	--	--
Sperm whale	Clicks	0.10-30.0	2.4, 10-16	160-180
Narwhal	Pulsed tone	0.5-5.0	--	--
	Whistle	0.3-18.0	0.3-10.0	
Beluga whale	Whistle	0.26-20.0	2.0-5.9	
	Pulse	0.4-12.0	1.0-8.0	
	Echolocation	40.0-120	variable	160-180
MYSTICETES				
Minke whale	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	less than 12	151
	Thump trains	0.19-2.0	0.1-0.2	--
Fin whale	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	--	--
Sei whale	Pulses	2.5-3.5	3	--
Northern right whale	Tonal moans	0.03-1.25	0.16-0.50	--
	Pulses	0.03-2.20	0.05-0.50	172-187
Blue whale	Moans	0.012-0.39	0.16-0.25	188
	Clicks	6-8, 21-31	6-8, 25	130, 159
Humpback whale	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

Source: Evans and Nice 1996: Perry 1998

Table D2. Sound Sources from Maritime Activities.

ACTIVITY	FREQUENCY RANGE (KHZ)	AV. SOURCE LEVEL (dB re 1 uPa/1 a)
Seismic surveys		
i) High Resolution		
pingers, side-scanner	10-200	<230
ii) Low resolution		
Airguns	0.008-0.5	230-250
Sleeve exploder	0.005-0.5	225-270
Vibroseis	0.02-0.07	260
Oil exploration		
Jack-up	0.005-1.2	85-127
Drilling production	0.25	163
Gravel dredging	--	130
Suction dredging	0.38	160
Vessels		
650cc jet ski	0.8-50.0	75-125
6hp outboard inflatable	0.8-20.0	105-130
90hp outboard speedboat	0.8-20.0	110-130
240hp inboard fishing boat	0.1-20.0	110-135
Large merchant vessel	0.05-0.9	160-190
Supertanker	0.02-0.1	187-232
Military vessel	--	190-203
Aquaculture		
Acoustic Deterrent	Broad band 25.0 pulse	194
Sonar		
Low frequency Active Sonar (LFAS) used by NATO.	broadband	230
High frequency sonar		
	0.25-3.0	
	100-200	
Explosions (0.5kg) for military training, tests and seismic surveys	0.45-7.07	267

Source: Evans and Nice 1996: Perry 1998

APPENDIX E. MILITARY ACTIVITIES

Table E1. Naval Activity in the Hebrides during 1998 (NB. Figures are in ship days and high figures reflect multiple vessel exercises)

LOCATION	SUBMARINE ACTIVITY	SURFACE ACTIVITY
Rona North	52 days	45 days
Rona South	52 days	209 days
Rona West	59 days	2 hours
Raasay	58 days	543 days
Tiumpan	46 days	6 hrs
Stoer	38 days	6 hrs
Shiant	48 days	41 days
Ewe	40 days	34 days
Portree	--	195 days
Trodday	55days	1 day 1 hour
Lochmaddy	59 days	2 hours
Dunvegan	76 days	1 day 1 hour
Ushenish	60 days	1 day
Neist	63 days	8 days
Canna	33 days	--
Bracadale	33 days	--
Rhum	9 hours	--
Sleat	--	219 days
Barra	56 days	--
Hawes	44 days	3 hours 29 minutes
Tiree	47 days	3 days
Ford	75 days	5 days
Boyle	72 days	4 days
Place	77 days	6 days
Staffa	34 days	3 days
Eigg	9 hours	2 hours 30 mins
Colonsay	33 days	2 days
Mull	22 days	156 days
Sound of Jura	6 days	17 days
Linnhe	--	30 days
Blackstone	51 days	16 days
Mackenzie	36 days	3 days
Orsay	80 days	9 days
Islay	57 days	9 days
Otter	81 days	26 days
Gigha	30 days	35 days
Earadale	24 days	20 days
Kintyre	70 days	12 days

Source: C. Wheatley, MOD Conservation Officer pers. comm.

Table E2. MOD guidelines for minimising cetacean disturbance

(Source: Appendix 14 to Annex A to Operations Plan 73701, Exercise Northern Light 99, Dated 15 June 99)

The sea areas off the North West of Scotland, the Minches and Sea of Hebrides are known cetacean breeding grounds, the principal mating season for these marine mammals falls within the period July-September. 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.
e. Be aware of, and attempt to minimise, possible sources of noise disturbance.