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A WDCS Science report

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WDCS
Whale and Dolphin Conservation Society

WDCS is the global voice for the protection of whales, dolphins and their environment.

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ABSTRACT

This paper presents a synthesis of mainly published information relating to the cetaceans of the Indian Ocean Sanctuary (IOS). It highlights a number of new studies and other initiatives linked to the Sanctuary and reviews the current understanding of the biology of the Sanctuary's cetaceans.

Cetaceans in the IOS are exposed to a range of threats, including by-catch and the effects of climate change. Whilst no quantification can be made of these threats at this time, they may still be significant for the conservation of populations.

The role of the IOS in stimulating research to further establish the status of cetacean populations is acknowledged.

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INTRODUCTION

More than two decades have now passed since a proposal by the Republic of the Seychelles at the 1979 meeting of the International Whaling Commission was adopted, creating the Indian Ocean Sanctuary (IWC, 1980). This Sanctuary consists of those waters of the Northern Hemisphere from the coast of Africa to 100°E (including the Red and Arabian Seas and the Gulf of Oman) and those waters of the Southern Hemisphere between 20°E and 130°E from the equator to 55°S (*see* Fig. 1). The Sanctuary offers protection from commercial whaling to the great whales (IWC, 1980). In 1989, the Sanctuary was extended for another three years by the IWC (IWC, 1990) and, in 1992, for a further ten (IWC, 1993). At the 54th meeting of the IWC (2002), the Sanctuary was again reviewed and extended. This review is a revised and updated version of a paper that was submitted to the 2002 meeting of the Scientific Committee of IWC.

This paper presents a review of cetacean distribution and research within the Indian Ocean Sanctuary (IOS). We consider here the following areas: Southwestern Indian Ocean (South Africa; Mozambique; Comoros; Madagascar; Mauritius and La Réunion; Tanzania; Kenya; Seychelles; Somalia); Arabian and Red Seas (including the Gulf of Oman); Maldives; Northeastern Indian Ocean waters (Pakistan; India; Sri Lanka; Bangladesh; Burma; Thailand; Indonesia); Western Australian waters; Prince Edward and Amsterdam Islands; Sub-Antarctic waters (including the Prince Edward, Crozet and Kerguelen Islands) and the Central part of the Indian Ocean.

We hope that the arrangement of this review (*e.g.* the presentation of results for different areas) makes it easily comprehendible, although we also note that cetaceans also move between the areas defined. We consider here information relating to the following:

- The status of populations
- Present and potential threats to cetacean stocks and their habitats, including *inter alia* directed takes, by-catch, offshore mineral exploitation, shipping, whale-watching, climate change, and pollution and other forms of habitat degradation

The IOS encompasses a large area predominantly surrounded by developing countries. The existence of the IOS can be seen to have helped to generate research and conservation initiatives, although this is clearly limited by economic considerations in some parts of the sanctuary area. However, the continued existence of the IOS is expected to continue to help in the development of

- management strategies and plans for the conservation of cetacean stocks
- further research; and
- further regional-level initiatives, the need for which is highlighted in this review

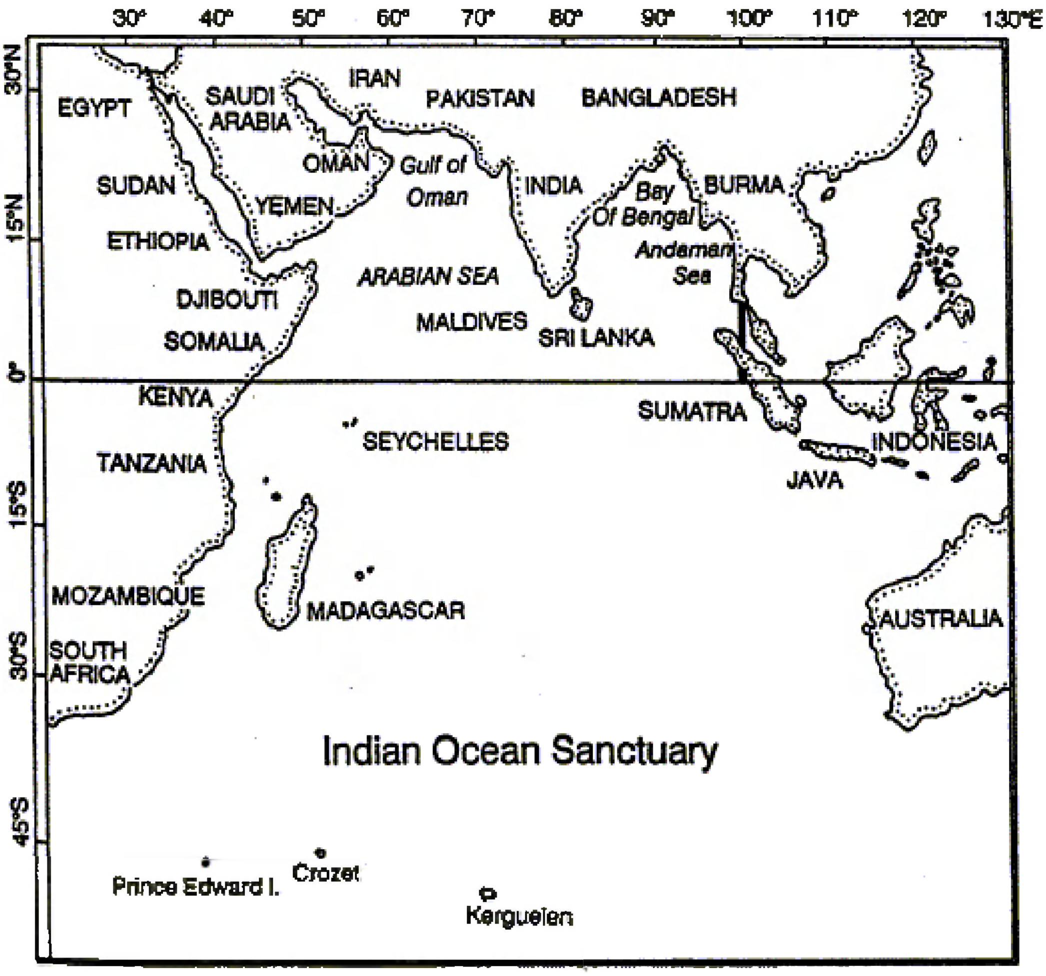

Figure 1. The Indian Ocean Sanctuary (*after* Leatherwood and Donovan, 1991).

1. Southwestern Indian Ocean (South Africa, Mozambique, Comoros, Madagascar, Mauritius, La Réunion, Tanzania, Kenya, Seychelles and Somalia).

In 1991 and 1992, the United Nations Environment Programme (UNEP), as Secretariat to the Global Plan of Action for Marine Mammals (MMAP), sponsored two training workshops on marine mammal biology and conservation in the Eastern and also Western and Central African regions (Borobia, 1997). As a follow-up to these workshops (and as a tool to gain knowledge about marine mammals in Africa, where recent research and few long-term studies had been conducted), UNEP then supported small-scale pilot survey projects between 1993 and 1996 in La Réunion, Ghana, Mauritius, Madagascar, Mozambique, Tanzania and Kenya (Borobia, 1997). The 'Indian Ocean Conservation Program' (IOCP) workshop took place in Kenya in 1995. This was a collaborative project with the mandate of integrating marine conservation activities around the Indian Ocean (Obura *et al*., 1996).

In the Eastern African and the Western Indian Ocean, the Western Indian Ocean Marine Science Association (WIOMSA) was established in 1991 to help facilitate the sound and effective development of marine science in its various forms. WIOMSA is a non-governmental and non-profit organisation dedicated to promoting the educational, scientific and technological development of all aspects of marine sciences throughout the western Indian Ocean region:

Comoro, Kenya, Madagascar, Mauritius, Mozambique, Reunion, Seychelles, Somalia, South Africa and Tanzania.

The recently formed Indo-South Atlantic Consortium on Humpback Whales (ISACH) established in 2001 consists of research groups from range states in the Northern and Southern Indian Oceans and the South Atlantic ocean, with the goal of facilitating collaborative research and conservation on this species (see below).

Since 1996, Howard Rosenbaum and colleagues from The Wildlife Conservation Society (WCS) and American Museum of Natural History (AMNH) have been conducting research on humpback whales and other marine mammals in the coastal waters of Madagascar (Rosenbaum *et al*. 1997). The goals of this research program include:

1) to produce a population assessment of humpback whales and other marine mammals in this area using a variety of techniques including genetics, photographic identification, and GIS analysis,
2) the application of these scientific findings to promote protection of humpback whales in Antongil Bay, a critical wintering habitat for this species,
3) to provide research and conservation training for Malagasy and African students and scientists,
4) to review and provide further instruction relating to the guidelines, training, and monitoring activities for responsible whale-watching, and
5) to develop a broader marine mammal conservation program for this region and elsewhere in Madagascar and Africa, where priorities for research and conservation have been identified (*see* Rosenbaum *et al*., 2001c and Avolio *et al*., 2002 for an in-depth overview of research and progress to date).

Building on the project in Madagascar, Rosenbaum and his colleagues have also established a research and conservation program for marine mammals in the waters of Mayotte, an island that is part of the Comoros Archipelago located in the Mozambique channel. Preliminary results of studies of species diversity and patterns of habitat are found Avolio *et al*. (2002).

A marine mammal project in Tanzania, coordinated by Per Berggren at Stockholm University, was launched in 1998 within the Sida/SAREC Regional Marine Science Program in East Africa. The objectives of this project are to investigate the status of marine mammals in Tanzania and train local scientists (Stensland *et al*., 1998).

Oceanography

Very strong upwelling systems occur particularly in the region of Somalia and Arabia and are associated with the SW Monsoon currents (Rao and Griffiths, 1998). The Somali Current (SC) is a strong western boundary current, which causes structural adjustments in the baroclinicity along the Somali coast and strong upwelling (*e.g*. Swallow and Bruce, 1966; Schott *et al*., 1990). As a result, the warm surface waters are entirely replaced by cold waters at less than 20°C (Swallow *et al*., 1983). Much of the water of the SC is re-circulated in an intense eddy, the centre of which is about 300km offshore and stretches in a north-south direction for about 1000km parallel to the coast (Rao and Griffiths, 1998). The northward flow of the SC is terminated by the warm outflow of surface waters from the Gulf of Aden, which thus brings about the separation of the Somali and Arabian upwelling systems (Rao and Griffiths, 1998).

The East Madagascar Current (EMC) is a narrow but well defined western boundary current between the surface and a depth of about 2000m (Schott *et al*., 1989). Below 3100m, there is a northward-flowing countercurrent (Rao and Griffiths, 1998). Some water from the EMC passes round the southern end of Madagascar and up the west coast till it meets the southward flowing Mozambique Current on the western side of the Mozambique Channel (Rao and Griffiths, 1998).

The Agulhass Current is a very narrow high-speed flow close to the Southeast coast of Africa, particularly between Dunbar and Port Elizabeth. This is one of the strongest currents in the world, showing little seasonal variation (Rao and Griffiths, 1998). The contribution of the Mozambique Current to the Agulhas Current is comparatively small, the East Madagascar Current being the more important source. The East Madagascar Current is the southern branch of the South Equatorial Current, which starts the eastern coast of Madagascar (Tomczak & Godfrey, 1994).

Species diversity

Fourteen species of delphinids have been reported from South Africa (IOS waters), although very little is known about most of the species distributed over the continental shelf (Peddemors, 1999). The fourteen species are made up of two forms of *Tursiops, Sousa chinensis, Delphinus delphis, Stenella attenuata, S. longirostris, Lagenodelphis hosei, Grampus griseus, Steno bredanensis, Globicephala melas, G. macrorhynchus, Peonocephala electra, Orcinus orca* and *Pseudorca crassidens.* At a recent conservation assessment and management plan (CAMP) workshop for South African mammals, forty-five cetaceans were assessed, including 1 Physeteridae, 2 Kogidae, 9 Ziphiidae, 20 Delphinidae, 1 Balaenidae, 1 Neobalaenidae, 8 Balaenopteridae (Peddemors, *et al*., 2002). Only one of the species assessed does not occur within the IOS, *Cephalorhynchus heavisidii*.

It is now recognised that there are probably two ecotypes of *Tursiops truncatus* within the southern African IOS region divided into 3 populations: two inshore (the smaller east coast form designated as *T.aduncus*) and one offshore (Ross, 1984; Ross and Cockcroft, 1990). The east coast form is found primarily within the 50-m isobath (Ross *et al*., 1987) from Mozambique to False Bay in the southwest. The offshore *Tursiops* is of the inshore west coast form and Findlay *et al*. (1992) suggests that there may be a contiguous population from east to west coasts.

At least 25 species of cetaceans are known to occur in the Eastern African Region, including six baleen whales, 10 toothed whales and nine dolphins (de Lestang, 1993; La Hausse de la Louviere, 1991).
The small cetaceans which are commonly found in coastal and inshore waters throughout the eastern region are *S. chinensis* and *Tursiops truncatus*, and spotted, striped and spinner dolphins (*Stenella sp*.) are also reported from throughout the region (Gambell *et al*., 1975; Small and Small, 1991). Spotted and spinner dolphins are found in both coastal and open oceanic waters, while the striped dolphin seems to be comparatively more pelagic in this eastern region (Borobia, 1997).

Sightings & strandings

<u>South Africa</u>
Land-based and aerial surveys and ship-based transects have been conducted during the last decade (*e.g.* Cockcroft, Ross and Peddemors, 1990, 1991; Cockcroft, Ross, Peddemors and Borchers, 1992; Peddemors, 1993; Findlay *et al*., 1994; Findlay and Best, 1996a & b: Best 1996, Ljungblad *et al*., 1997; Ersts and Rosenbaum, submitted) along with a series of studies on free-ranging delphinids throughout the region (*e.g.* Peddemors, 1995; Karczmarski, 1996; Karczmarski and Cockcroft, 1997, 1999; Keith *et al*., *in press*) and renewed investigations into feeding biology (*e.g.* Barros and Cockcroft, 1991; Cockcroft and Ross, 1990; Cockcroft, Haschik and Klages, 1993; Sekiguchi *et al*., 1992; Young and Cockcroft, 1994; Plön *et al*., 1997). Several investigations into the life history of South African cetaceans have also been completed using stranded and by-caught animals (*e.g.* Mendolia, 1990; Kroese, 1993; Plön *et al*., 1997, 1998).

<u>Mozambique</u>
Data on delphinid distribution and abundance are scant for Mozambique. However, in the waters of Mozambique and southern Madagascar, a minimum of 11 species have been reported by Peddemors *et al.* (1997b) including *Tursiops truncatus; Grampus griseus, Globicephala macrorhynchus, Stenella attanuata, S. longirostris, S. coeruleoalba, Peponocephala electra, Pseudorca crassidens, Sousa chinensis, Delphinus delphis* and *Steno bredanensis.*

Tursiops truncatus and *Sousa chinensis* are known to inhabit both Maputo (25°35'S-26°15'S and 32°35'E-33°00'E) and Bazaruto Bays (21°30'S-22°S, Cockcroft and Krohn, 1994).

Recent cetacean research efforts here have focussed on determining humpback whale (*Megaptera novaeangliae)* distribution and abundance in the south-west Indian Ocean (Best *et al.*, 1996a&b; Findlay *et al*., 1994).

<u>Madagascar</u>
Distribution and abundance studies of humpback whales in northeastern Madagascar (Rosenbaum *et al.* 1997; Ersts and Rosenbaum, submitted) and southern Madagascar have been conducted (Best *et al*., 1996; Rosenbaum, *in press*). Razafindrakoto *et al.* (2001) reported on humpback whale song from Antongil Bay. An overview of marine mammals of Madagascar is presented in Rosenbaum (*in press*) and cetacean surveys in Madagascar have also been reported by Cockcroft and Young (1998) and Peddemors *et al.* (1999).

A note on recent southern right whale (*Eubalaena australis*) sightings in Madagascar is provided by Rosenbaum *et al.* (2001a). An overview of what is known about *Sousa chinensis* species is provided in Baldwin *et al.* (2002).

Data collected between 1995 and 2001 confirmed that 4 large whale species occur in Madagascar's waters and 4 other species are suspected to occur there. Numerous species of small cetaceans including oceanic dolphins, several species of "blackfish" and pygmy sperm whales have also been documented (Rosenbaum, *in press*).

Mauritius
Corbett (1994) reported on the results of a year-long study in the Mascarenes, with an emphasis on the Island of Mauritius. Sperm whales and spinner dolphins were the most abundant species, but fin whales (*Balaenoptera physalus*), blue whales (*B. musculus*), humpback whales and several odontocetes species (spotted dolphins, Risso's dolphins, striped dolphins, bottlenose dolphins, short-finned pilot whales (*Globicephala macrorhynchus*), melon-headed (*Peponocephala electra*) or pygmy killer whales (*Feresa attenuata*) and two species of beaked whales were also recorded. Corbett (1994) also suggested that sperm whales use the area year-round. In addition, Blainville's beaked whales (*Mesoplodon densirostris*) have been found stranded on Mauritius (Michel and van Bree, 1976).

Tanzania
The occurance and abundance of marine mammal species in Tanzanian waters is poorly known and no dedicated studies have been conducted to date (Stensland *et al*., 1998). Only a few publications exist reporting sightings, strandings and museum specimens (de Lestang, 1993).

However, several species of dolphins have been reported in the waters surrounding Zanzibar Island. In Menai Bay, Indo-Pacific humpback dolphins (*S. chinensis*) and bottlenose dolphins (*Tursiop sp*.) have been reported (*see* Stensland *et al*., 1998). In the north, bottlenose dolphins and spinner dolphins (*S. longirostris*) have been observed (Ortland, 1997).

Another dolphin species that has been reported is the rough-toothed dolphin (*Steno bredanensis*) (Chande *et al*., 1994, unpubl report to UNEP). Dolphins (without reference to species) have also been reported in the Rufiji Delta, Sadani, around Latham Island, Tanga (north Tanzania) and Mtwara (south Tanzania) (Lindén and Lundin, 1996).

Humpback whales (*Megaptera novaeangliae*) are known to migrate along the coast of Zanzibar Island (Ortland, 1997).

Kenya
Sightings of small groups of cetaceans and cetacean strandings are recorded for Kenya (KWS, 1996). The larger whale species known or believed to occur in Kenyan waters are *Physeter macrocephalus, Orcinus orca, Megaptera novaeangliae, Balaenoptera edeni, B. acutorostrata* and *Peponocephala electra*. Five species of dolphins were positively identified during an aerial survey in 1994, including *Tursiops sp., Delphinus sp., Sousa chinensis, Stenella longirostris, S. attenuata.* Additionally, *Lagenodelphis hosei, Grampus griseus* and *S. coeruleoalba* are also thought to occur in Kenyan waters (Wamukoya *et al*., 1996).

Somalia and Seychelles
Small and Small (1991) reported on cetacean observations from Somalia during boat based surveys conducted from September 1985 until March 1987. 14 different species were reported: Blue whale, Bryde's whale (*B. edeni*), sperm whale, melon-headed whale, false killer whale (*Pseudorca crassidens*), killer whale, short-finned pilot whale, Indo-Pacific humpback dolphin, common dolphin, *Tursiops sp.,* Risso's dolphin, spotted dolphin, spinner dolphin and striped dolphin.

Ballance and Pitman (1998) conducted a cetacean survey of the Western Tropical Indian Ocean (WTIO) and compared their findings with the cetacean communities of two other tropical ecosystems. They found that the WTIO was similar to the eastern tropical Pacific (ETP) and the Gulf of Mexico (GM) in several respects: Firstly, the same species were common and or rare, regardless of ocean. Second, these differences in abundance were due primarily to differences in encounter rate, and less to school size. Third, regardless of ocean, three species comprised the majority of the cetaceans encountered, *Stenella attenuata, S. longirostris,* and S. *coeruleoalba*. However, the ranking of abundance for these three species differed between oceans: *S. attenuata* appeared to be abundant in the ETP and GM but much less common in the WITO (Ballance and Pitman, 1998). Although habitat preferences for *S. attenuata* appeared to overlap considerably with those of *S. longirostris* in the ETP, there may actually be significant differences between these two species (Ballance and Pitman, 1998).

Distribution and migratory patterns

Using sightings of photo-identified individuals, Best *et al*. (1993) reported on long-range movements of South Atlantic right whales between Gough Island and South Africa, and between Argentina and Tristan da Cunha, southern Brazil, and South Georgia. The distribution and seasonality of humpback whales in the southwest Indian Ocean has been investigated by Best *et al.* (1996a&b) and three principal migratory routes were proposed by these authors: The first ("East African") meets the African coast at least as far west as Knysna (23°E). The number and timing of peak abundances at Durban, Cape Vidal and Linga Linga suggest that this migration continues as far as central Mozambique, where abundance peaks in the first half of August, and is slower and more protracted on the way south than on the way north.

The second route ("the Madagascar Ridge") meets the coast of Madagascar directly from the south. The seasonality of catches in modern whaling in southern Madagascar implies that this migration then proceeds north, and one nineteenth-century whaling ground was on the northeastern coast of Madagascar at 15°30'S. Subsequently, Rosenbaum *et al.* (1997) have identified a major wintering concentration of humpback whales in Antongil Bay in the northeastern part of Madagascar.

The third migratory route is the "Central Mozambique Channel", used by whales going to and from the coastal waters of the island of Mayotte (12°35' to 13°05' S; 44°55' to 45°20' E), the oldest landmass of the Comoros Archipelago, situated between the northwestern coast of Madagascar and Mozambique. Boat-based surveys of these waters surrounding Mayotte have been conducted in the austral winters of 1995-2002 in order to evaluate humpback whale and other marine mammal presence, distribution, and habitat significance (Rosenbaum *et al.* 2001b; Rosenbaum *et al.* in prep). Dugongs and more than ten different species of cetaceans have been observed.

A total of 102 individual humpback whales (*Megaptera novaeangliae*) have been identified from these waters (Rosenbaum *et al.* 2001b). Mother and calf pairs make up a large number of the total number of the groups observed, and have been seen in the region as late as November. Mother-calf pairs make extended stays in the region and have been re-sighted over a two-week period. Very little behaviour associated with mating activity (competitive groups and singing) has been observed in this area. Given the high percentage of mother/calf pairs and low frequency of mating activity, the waters of Mayotte may serve as a critical wintering habitat or resting point along the migration route for mothers and calves (Rosenbaum *et al.* 2001b). Some photographic matches have been made with other humpback whale wintering areas in Madagascar, providing some evidence of migratory links and the population structure of whales found around Mayotte. This will continue to be evaluated using photographic and genetic methods.

Relationships with other wintering grounds and migratory corridors are being evaluated using photographic and genetic methods (Rosenbaum *et al.* in prep). Further investigation of the role of Mayotte will help conservation in the region.

Findlay and Best (1997) reported characteristics of humpback whale migrations off Cape Vidal on the African East coast, noting significant differences between mean group size, distance offshore and speed of the migration between years.

Ersts and Rosenbaum (submitted) report on habitat use and social organization for humpback whales in Antongial Bay.

Migratory patterns and population structure of humpbacks and other large whales and an evaluation of relationships among Sousa chinensis populations in the Indian Ocean are in progress (Rosenbaum *et al.*a in prep; Rosenbaum *et al.*b, *in prep*).

By-catch and direct take

Cockcroft and Krohn (1994) commented that the majority of coastal states of the Indian Ocean are presently under-developed with poor infrastructure and limited harbour facilities. Consequently, there are few data on the extent and distribution of passive gear fisheries in this area. However, they indicated that Indo-Pacific humpback dolphins and bottlenose dolphins might be under heavy pressure from by-catch in some parts of the southwestern Indian Ocean, such as areas off South Africa and Mozambique.

<u>South Africa</u>
Increased fishing pressure in South African waters of the IOS will inevitably increase interactions between fisheries and the affected cetaceans. There is presently no known threat from high-seas fisheries. However, historically,

the shark nets fishery set off the coast of KwaZulu-Natal has created concerns for several small cetacean stocks (Cockcroft, 1990; Peddemors, Cockcroft and Best, 1997; Peddemors, 1999). Three delphinids were accorded Red List status (Peddemors *et al.*, 2002):

(1) the Indian humpback dolphin was classified as Vulnerable, due to the limited nearshore extent of both occurrence and occupancy;
(2) the resident stock of Indian Ocean bottlenose dolphin was considered to be Vulnerable due to its area of occupancy being less than 20,000 km^2, occurrence at less than 10 locations, continued decline in the area of occupancy due to nearshore habitat degradation, a continued decline in the number of mature individuals through bycatch in the KwaZulu-Natal shark nets and all mature individuals being within one sub-population;
(3) the migratory stock of Indian Ocean bottlenose dolphin was classified as Endangered due to the small number of mature individuals (<2500), continued decline in the number of mature individuals through bycatch in the shark nets off KwaZulu-Natal and >95% of mature individuals occurring in one sub-population.

Implementation of several by-catch mitigation measures, including deployment of active acoustic deterrents and sonar-reflecting air-filled ellipsoidal floats in the nets, plus a time-area closure for the fishery and investigation of alternative shark fishing devices such as drum-lines (baited hooks) appear to be reducing the bycatch of small cetaceans to within sustainable limits (Peddemors, 2001).

<u>*Mozambique*</u>

Mozambique is recognised as one of the poorest countries in the world. Like many other developing states, Mozambique has a high rate of population growth. Political and economic instability has recently promoted massive human demographic change and some 60% of Mozambique's population currently inhabit the coastal zone (Guissamulo and Cockcroft, 1997). Gill-net fisheries, both artisanal and commercial, have increased dramatically in the last decade. Where gill net use is extensive, there appears to have been a corresponding decline in coastal dolphin numbers (Cockcroft and Krohn, 1994). Guissamulo and Cockcroft (1997) reported on dolphin occurrence and distribution and fisheries interaction in Maputo and Bazaruto Bay, Mozambique, and that fisheries in Maputo Bay include artisanal drift and bottom set gill-net fisheries and semi-industrial shrimp trawling (Guissamulo and Cockcroft, 1997). Though no incidental catches were reported in Maputo Bay during the survey period, interviews with fishermen confirmed that dolphins, particularly humpback dolphins, are taken in the drift gill-net fishery. Interviews also confirmed that humpback dolphins are intentionally taken, and during the survey, five humpback dolphins were deliberately captured in the Saco da Inhaca, Maputo Bay (Guissamulo and Cockcroft, 1997). In Bazaruto Bay, there is a semi-artisanal gill-net fishery for sharks and turtles, which is known, both from reports from conservation officers and finds of skeletal remains in the vicinity of fishing villages, to take dolphins regularly (Guissamulo and Cockcroft, 1997).

<u>*Madagascar*</u>

Madagascar's coastal waters are inhabited or frequented by a rich diversity of cetaceans. There is, however, a lack of scientific information, particularly on direct exploitation and by-catch of marine mammals in these waters and for the entire southwestern Indian Ocean. Preliminary surveys indicate that many different species of cetaceans are intentionally or indirectly caught and then sold in some villages and cities, such as Mahajanga along the west coast of Madagascar (Cockcroft and Young 1998).

More recent systematic investigation undertaken in the southern region of Madagascar showed that hundreds of dolphins, primarily from three different species, were killed during the past five years in one village alone (Andrianavelo, 2001). Of particular concern is the status and exploitation of the Indo-Pacific humpbacked dolphin in this region (*see* Razafindrakoto *et al.*, 2002; Razafindrakoto *et al.* submitted).

While initial assessments have helped to identify some critical areas where concentrated hunting and high rates of by-catch occur, a more comprehensive assessment is needed with continued involvement and training for Malagasy scientists and local conservation managers. An expanded investigation of such activities is now planned to characterize cetacean diversity, distribution, and abundance along the western coast of Madagascar and provide detailed estimates on the extent and types of cetaceans directly targeted or taken incidentally and subsequently utilized (Andrianarivelo, 2001). Although further support is needed, the project will provide recommendations for cetacean conservation and management in Madagascar, as well as helping to develop systematic and regular monitoring programs for targeted and incidentally caught species in the identified critical areas (Andrianarivelo, 2001).

Mauritius

Mauritius is an important base for driftnetters and long-liners that have relocated there because of the increasingly rigid restrictions imposed by South Africa. It appears that the Mauritians have not historically exploited small cetaceans to the degree of other inhabitants of the Indian Ocean (Mitchell, 1975; Barnes, 1991; Manikfan, 1991) and this may explain why there is relatively little knowledge of and interest in cetaceans in Mauritius (Corbett, 1994).

Tanzania

In Tanzania, evidence of direct and incidental takes have been reported from Tanga, Bagamayo, Dar es Salaam and Mrwara, involving *Stenella sp*., *Steno bredanensis* and *Tursiops truncatus* (Chande *et al*., 1994). Dolphins were harpooned mainly for use as bait in a longline fishery targeting tiger sharks, *Galeocerdo cuvieri* (Borobia, 1997). Cetacean intestines and blubber are used to make a substance used in water proofing boats, locally known as "sifa" (Borobia, 1997). Entanglements have also been reported in coastal gillnets (Borobia, 1997).

Destructive fishing methods, such as dynamite fishing, may also be killing marine mammals in this region or may have a negative impact on them by destroying the habitat of their preferred food species (Stensland *et al*., 1998).

Seychelles

Although national legislation is now in place prohibiting the capture of cetaceans, which were formerly taken with harpoons (Keller *et al*., 1982; Leatherwood *et al*., 1984), it has been estimated that approximately 200-300 bottlenose dolphins are still taken annually by the Seychelles schooner fleet of some 20 vessels fishing at the edge of the Mahe Plateau and the outlining islands of the Seychelles group (de Lestang, 1993). As a result of the legal prohibition, the animals are reportedly butchered and salted out at sea (Borobia, 1989).

In the western Indian Ocean tuna purse-seine fishery, the association between *Stenella sp*. and yellowfin tuna appears to be rare (de Lestang, 1993), but the situation may not be the same for other areas within the region.

Environmental degradation

The development and over-exploitation of coastal regions has resulted in significant environmental degradation of marine habitats of cetaceans (Reeves and Leatherwood, 1994). In developing countries, the two key national priorities are economic development and the feeding of growing human populations. This is true for the western Indian Ocean states which are characterized by high population growth, little or limited industrial and infrastructural development and a tendency to subsistence economics (Cockcroft and Krohn, 1994 and Guissamulo and Cockcroft, 1997). Growing demands for fish, wood and building materials have resulted in depletion of these resources in many areas, especially near big cities (Linden, 1990; Coughanowr *et al*., 1995) and environmental considerations often have low priority (Stensland *et al*., 1998).

South Africa

Nearshore habitat degradation is particularly severe for species such as Indian humpback dolphins (*Sousa plumbea*), and Indian Ocean bottlenose dolphins (*Tursiops aduncus*), due to their reliance on a limited area of occupancy of the coastal zone (Peddemors *et al*., 2002). The siltation of estuaries, following farming malpractices, has led to reduced suitable nursery areas for prey fish species and siltation of the nearshore reefs, following summer rains, reduces suitable reef habitat available to prey fish, appearing to change the distribution of, particularly, *Tursiops* and *Sousa* (Peddemors and Cockcroft, 1997).

Persistent organochlorine residues have been reported in small cetaceans from the east coast of southern Africa (de Kock *et al.,* 1994) leading to the postulation that testosterone production is suppressed, causing changes in social and reproductive functioning, plus that the first-born calf of every female dies as a result of the ingestion of high levels of these pollutants (Cockcroft *et al*, 1989; 1990).

Tanzania

In Tanzania, marine pollution is primarily regarded as a localized problem and primarily comes from coastal cities, urban settlements and international shipping lanes (Lindén and Lundin, 1996).

Whale-watching

Whale or dolphin watching, if developed carefully, could bring much needed income to developing countries. In recent years, however, there have been instances of uncontrolled dolphin watching throughout this region, which could potentially threaten dolphin populations if allowed to continue (Stensland *et al*., 1998).

Interaction with whales and dolphins in South Africa is regulated under national legislation in the form of Regulation 58 of the Marine Living Resources Act (no 18 of 1998) which reads:

(1) No person shall, except on the authority of a permit-

1. engage in fishing, collecting, killing, attempting to kill, disturbing, harassing, keeping or controlling of, or be in possession of, any whale or any part or product thereof at any time;
2. use any fish processing establishment, fishing vessel or any other vessel for the freezing or processing of whales or participate in any manner in the operation of or activities on such an establishment, fishing vessel or vessel;
3. have on board any fishing vessel or vessel any gear, apparatus or appliance which can be used in any manner for the fishing, freezing or processing of whales;
4. supply any ships stores to any fishing vessel or vessel registered in a foreign state and used for the fishing, freezing or processing of whales or which has any connection with such fishing, freezing or processing;
5. operate any whale-watching business that causes a disturbance or harassment of any whale within the meaning of subregulation (2); or
6. offer his or her services for or make available his expertise in connection with any of the activities referred to in this subregulation.

(2) For the purposes of subregulation (1), "disturbing or harassing" shall also include-

1. the shooting at any whale;
2. approaching closer than 300 metres to any whale by means of a fishing vessel, vessel, aircraft, or other method; and
3. that in the event of a whale surfacing closer than 300 meters from a fishing vessel, vessel, aircraft, the person in charge of such fishing vessel, vessel, aircraft fails to proceed immediately to a distance of at least 300 metres from the whale:

Provided that paragraphs (b) and (c) shall not apply to bona fide efforts by any person rendering aid to a beached, entrapped or entangled whale.

(3) No person shall, except on the authority of a permit, engage in fishing, collecting, killing, attempting to kill, disturbing, harassing, keeping or controlling of, or be in possession of, any dolphin or porpoise or any part or product thereof at any time.

(4) For the purpose of subregulation (3), "disturb or harass" shall also include the deliberate driving a fishing vessel or vessel through a school of dolphins or porpoises.

(5) No person shall-

1. feed any wild dolphin or porpoise; or
2. advertise or engage in any fishing vessel or vessel trip, whether for gain or not, which is intended to provide for a swim-with-dolphins experience.

(6) Subregulations (3), (4) and (5) shall not apply to bona fide efforts by any person rendering aid to a beached, entrapped or entangled dolphin or porpoise.

Boat-based whale watching is a permitted industry within South African waters.

Conclusion

There is a critical need to investigate the status of dolphin populations and threats to them in the countries bordering the southwestern Indian Ocean. More research emphasis should in future be placed on investigating by-catch and the possible overfishing of delphinid prey stocks.

Peddemors *et al.* (2002) highlighted the requirement for more data on abundance and distribution, particularly for offshore cetacean species, as these data are urgently needed to enable assessment of the status of many species following the IUCN Red listing criteria. They therefore recommended the initiation of regular ship-based offshore surveys within the region.

Within South Africa and Mozambique, there is limited evidence that the IOS has played a role in stimulating research on cetaceans to date and this is seen as reflecting the lack of importance that many developing nations surrounding the IOS place on cetaceans within their national waters (Peddemors pers. comm.). Most studies in the region have been initiated due to conservation and management requirements, following identification by international NGOs with local researchers of concerns for nearshore species.

Obtaining the necessary data to understand the ecology and behaviour of cetaceans inhabiting the southwestern Indian Ocean requires regional collaboration from scientists, managers, and organisations that are dedicated to the research and conservation of this species. In April 2001, Howard Rosenbaum (WCS), Ken Findlay (University of Cape Town), and Peter Ersts (AMNH) convened a highly successful regional planning workshop held in Cape Town, South Africa, that brought together 26 delegates from the Comoros, Gabon, Kenya, Madagascar, Mayotte, Mozambique, South Africa, Oman, and Tanzania. This workshop gave delegates the opportunity to discuss the current and proposed humpback whale research activities in their country, identified areas where future research and capacity building are needed, and began the process to develop a regional collaborative research program on humpback whales in the Indo-South Atlantic region. Additional activities such as a collaborative research and training cruise in the Indian Ocean and construction of a distributed database have been accomplished or are underway.

2. The Maldives

The islands of the Maldives are particularly rich in cetacean fauna, including geographically-isolated cetacean populations. Populations of the larger whales here are specifically of interest for the Indian Ocean Sanctuary, as they are potentially recovering from commercial exploitation and provide an opportunity to monitor such species.

There has been relatively little research on cetaceans in Maldivian waters. However, during the last decade, several papers have reported on strandings and sightings (Anderson, 1996; Anderson *et al*., 1999; Ballance *et al*., 2001).

Oceanography

The Maldives lies at the heart of the Indian Ocean Sanctuary and consists of an isolated archipelago of approximately 1200 islands in a series of atolls, located between 7°N and 1°S. Equatorial up-welling does not occur in the Indian Ocean as it does in the Pacific and Atlantic. Instead, it is believed that semi annual zonal mass redistribution in the Indian Ocean is caused almost entirely by the near-equatorial currents (the monsoonal surface currents, the inter-monsoon jets and the undercurrent; Wyrtki, 1973). During the northeast monsoon (December to March-April), winds and currents are generally from the northeast or east. During the southwest monsoon (May-June to October), winds and currents are from the southwest and west. April-May and November are intermonsoon periods with variable winds and changing currents.

Species diversity

The Maldivian cetacean community is diverse; a total of 19 different species have been recorded here, including 2 rare species of beaked whale (Anderson *et al*., 1999; Balance *et al*., 2001). Species include: blue whale, Bryde's whale, spinner dolphin, rough-toothed dolphin (*Steno bredanensis*), Fraser's dolphin, spotted dolphin, striped dolphin, Risso's dolphin, bottlenose dolphin, Cuvier's beaked whale *(Ziphius cavirostris*), Blainville's beaked whale, ginkgo-toothed beaked whale (*M. ginkgodens*), melon-headed whale, killer whale, pygmy killer whale, false killer whale, short-finned pilot whale, sperm whale and dwarf sperm whale.

Records of strandings

Anderson *et al*. (1999) reviewed published records of 26 cetacean strandings and an additional further 56 records. The sperm whale was the most frequently reported species, accounting for about half of all strandings.

The distribution of cetacean strandings in the Maldives is affected by the seasonal monsoons (Anderson, 1990; Anderson *et al*., 1999). Floating cetacean carcasses will tend to drift with the prevailing current. For this reason, they are found most commonly off the west coast, during the southwest monsoon season, and off the east coast, during the northeast monsoon season (Anderson *et al*., 1999).

Records of sightings

Ballance *et al*. (2001) report the results of a survey conducted off the northeastern portion of the atoll chain during April 1998, primarily to obtain biopsy samples of blue whales as part of a worldwide assessment of stocks of this endangered species. They recorded 267 sightings of 16 species, including 2 rorquals, sperm whales, dwarf sperm whales, 2 ziphiids and 10 tropical dolphins. Significant results included that:

i. Cetaceans were abundant and species diversity was high and included most pelagic cetaceans routinely recorded in tropical waters ;
ii. Blue whales were rare (only 4 sightings were made and 3 biopsy samples were collected);
iii. A large concentration of Bryde's whales (28 sightings) was apparently feeding in near-shore waters;
iv. A first record in the Maldives was made for Cuvier's beaked whale and Blainville's beaked whale; and
v. Spotted dolphins were rare and almost always associated with yellowfin tuna (*Thunnus albacares*), spinner dolphin, or sea birds, as has been reported in the eastern pacific and western Indian Ocean.

A report is currently in preparation summarizing cetacean sightings made around the Maldives during the last twelve years (R.C. Anderson, *in prep*)

Distribution and migratory patterns

Blue whales (*Balaenoptera musculus* perhaps of the subspecies *brevicauda* or *indica*) were reported to strand on Maldivian and other south Asian coasts most frequently during January to April (Anderson *et al*., 1999). Those authors suggested that blue whales migrate from the central Indian Ocean to the western Arabian Sea to feed on upwelling-associated plankton during July and October.

Pollution

No information exists to date about chemical pollution in cetaceans around the Maldives. Ballance *et al.* (2001) reported collecting 38 biopsy samples from 11 species, including blue whales, Bryde's whales, spotted dolphins, pygmy killer whales, rough-toothed dolphins, Fraser's dolphins, spinner dolphins, bottlenose dolphins, short-finned pilot whales, striped dolphins and false killer whales. However, these samples await analysis.

By-catch and direct take

A traditional fishery for tiger sharks (which died out in the early 1960s) used harpoon-caught dolphins as bait (Anderson and Ahmed, 1993). There is no evidence that large whales were ever hunted in the Maldives as suggested by Phillips (in Hill, 1958) (Anderson *et al*., 1999).

At present, cetaceans are not hunted in the Maldives, nor is there any local cetacean by-catch reported (Anderson *et al*., 1999). The capture of all cetaceans is specifically banned under Maldivian law (Fisheries Law, no.5/87, *iulaan* no. FA-A1/29/93/14/15 May 1993), as is the export of cetacean products (under the Import/Export Law, no. 31/79) (Anderson *et al*., 1999). The main fishing methods now used in the Maldives (pole and line for tuna; handline for reef fish and tuna; longline for shark and tuna) do not catch cetaceans (Anderson *et al*, 1999). Pelagic gillnets and purse seines are also prohibited (Law no. 5/87) in order to protect the livelihoods of traditional pole and line tuna fishermen (Anderson *et al*., 1999). A single pygmy killer whale was taken accidentally during experimental drift net fishing trials in 1988. Drift nets proved to be less efficient than traditional pole and line for catching tunas, and so they were not introduced commercially (Anderson, 1990; Anderson and Waheed, 1990). Although there is no local fishery that takes cetaceans, there is evidence that some cetaceans are killed by the fishing activities of other countries who drift into Maldivian waters (Anderson *et al*., 1999).

Biodegradation, climate change

No information relating to cetaceans is available.

Conclusion

The Maldives are a potentially important area for long-term monitoring and conservation of cetaceans, because:

i. They support high cetacean abundance and diversity;
ii. They may be an important area for populations of baleen whales currently recovering from exploitation (Ballance *et al.,* 2001); and
iii. There is evidence that the Maldives region may at times provide an important habitat for rare blue whales (Ballance and Pitman, 1998; Ballance *et al.,* 2001).

3. Amsterdam and Saint-Paul Islands <u>(37°50'S, 77°31'E and 38°43'S, 77°35'E)</u>

Dusky dolphins (*Lagenorhynchus obscurus*) have been recorded from the Amsterdam and Saint-Paul Islands (Van Waerebeek *et al.*, 1995) as have killer, fin, Southern right, humpback and sperm whales (Roux, 1986). Other (smaller) species, likely to be associated with oceanic islands, are to be expected.

Migration

Killer whales were reported by Roux (1986) to be regular visitors but they are less frequent than around the sub-Antarctic islands of the Indian Ocean. A clear seasonal cycle of occurrence was found: rare in July and August, and common in February and March i.e. 3 to 5 months later than their peak in abundance around sub-Antarctic Islands.

Whaling

The Crozets, Kerguelen, Amsterdam and Saint-Paul Islands used to be called the Right Whaling Grounds.
Right whales were abundant at sea and among these islands in season, and blue whales were seen here in February (Wray and Martin, 1983). By the 1870s, right whales were scarce, though it was unclear whether they had been over-exploited or had been 'driven from the ground' (Wray and Martin, 1983).

A possible Connection between the right whales seen in Madagascar with these found in Crozet is suggested by Rosenbaum *et al.* (2001b), although the Crozet animals could also represent long-range migrants from South Atlantic populations.

4. Arabian and Red Seas, Gulf of Oman and Persian Gulf

Oceanography

The influence of the monsoons on the Indian Ocean is seen in the annual reversal of the surface circulation and in the hydrographic conditions of the surface waters to 10-20°S. The most striking effect of the monsoon winds is the reversal of the Somali Current. This reversal is unique among the western boundary currents and has been a subject of great scientific interest (e.g. Swallow *et al.*, 1991; Subrahmanyam *et al.*, 1996).

Due to up-welling of cool subsurface water in the Arabian Sea, there is an annual-mean heat flux into the northern ocean. This is associated with abrupt cooling (*i.e.* decrease in surface temperature). This cooling occurs during the Southwest monsoon in boreal summer, at a time which, in other parts of the Northern Hemisphere, would coincide with warming (Mc Creary *et al.*, 1993). Associated with the up-welling is a significant input of nutrients to surface waters, leading to extremely high levels of primary productivity.

The Arabian (Persian) Gulf is connected to the Gulf of Oman by the Strait of Hormuz. Most of the water flowing into the Gulf enters on the north side of the Strait. Circulation is poor, with a turnover time of about 3-5 years for water entering the Gulf (Robineau, 1998). The Average depth is only 35m. The high salinity, high turbidity and pronounced seasonal flux in water temperature make the Gulf a 'naturally stressful environment' for cetaceans and other fauna (Robineau, 1998).

Species diversity

The waters off the Arabian Peninsula are host to a number of cetacean species (*see* table 1). They are recorded mainly from stranding data, limited surveys and sightings. Offshore data are sparse whereas the situation in some coastal areas (*e.g.* Oman, Saudi Arabia, UAE) is better documented (*e.g.* Baldwin *et al.*, 1999; SC/54/SM6; SC/54/O4; SC54/H3). For other countries (*e.g.* Iran, *see* also table 2&3, and Yemen) virtually nothing is known. The most commonly encountered species are small odontocetes. Baleen whales and larger odontocetes are less commonly recorded.

Sightings & Strandings

A summary of the collated records to date is presented in Table 1. *Tursiops* species are difficult to distinguish in the field; therefore most records group them together. Similarly, some authors do not distinguish between the different 'forms' of *Sousa* sp. and the different 'forms' of *Delphinus* sp.

Morphotypes, virtually unique to the region, have been described for the humpback dolphin, common dolphin and spinner dolphin (Ross *et al.,* 1994; van Bree, 1971; van Bree and

Gallagher, 1978; van Waerebeek *et al.*, 1999). To date, their taxonomic status has not been clarified.

The finless porpoise and humpback dolphin in the Arabian (Persian) Gulf and possibly the spinner dolphin off Oman are regarded as discrete populations (Baldwin and Minton, 2000; Gallagher, 1991a; Papastravrou and Salm, 1991; van Waerebeek *et al.*, 1999).

Research on the genetic status of humpback whales and humpback dolphins is also on-going (*see* Collins *et al.*, 2002 and Razafindrakoto *et al.*, 2002).

Arabian Sea and Gulf of Oman

Baldwin *et al.* (1998) submitted a review about the small cetaceans of the Arabian Peninsula to the 1998 IWC Scientific Committee and reported the occurrence of 16 small cetaceans (*Kogia sima, Ziphius cavirostris, Peponocephala electra, Steno bredanensis, Pseudorca crassidens, Orcinus orca, Grampus griseus, Sousa chinensis, Delphinus sp., Tursiops sp. (2 forms), Stenella coeruleoalba, S. attenuata and S. longirostris)*.

The most frequently encountered species in Omani coastal waters are *Delphinus sp., Tursiops sp., S. chinensis* and *S. longirostris* (Baldwin *et al.*, 1998). The pygmy killer whale (*Feresa attenuata)* has now been positively identified for Omani waters (Baldwin *et al.*, unpublished data), and there are unconfirmed reports of *Globicephala sp*. The latter has been reported elsewhere in the western tropical Indian Ocean, including off Somalia (Small and Small, 1991) and Socotra Island (Balance and Pitman, 1998). The complete lack of *Neophocaena* in Omani waters and to the west is of considerable interest. It appears that the Arabian Gulf and Iranian coastal waters constitute the westernmost limits for this species (IWC, 1999), although there are recent reports of it from the coastal waters of Pakistan.

The available data on small cetaceans in the Arabian region were reviewed by Leatherwood (1986) and de Silva (1987). Many data on small cetaceans were noted as coming from incidental observations recorded during more general surveys of marine and coastal habitats, particularly along the coast of Oman (Papastravrou and Salm, 1991; Salm *et al.*, 1993). Elsewhere in the Arabian region, recent surveys have been conducted in both the Gulf of Oman and the Arabian Sea, spanning offshore waters of UAE, Oman and Yemen (Minton *et al.*, 2002; Baldwin, 1995b; Balance and Pitman, 1998). Surveys are ongoing in Omani waters. A number of other investigators report sightings of small cetaceans in the region (Ross, 1981; Weitkovitz, 1992; Eyre, 1995) and in the Red Sea (Smeenk *et al.*,1996; Eyre, 1994).

Balance & Pitman (1998) surveyed the southern Arabian Sea, Somali coast and coast of Oman. They reported 20 out of 25 of the species listed in Table 1. Pilleri & Gihr (1972 & 1974) and Parsons (1998) reported on cetaceans in coastal regions of the northern Arabian Sea, including in particular, *Sousa* cf. *S. plumbea* in the Indus Delta and off the coast of Goa. Various collections of skeletal remains exist, particularly for the coast of Oman. These have been described and categorized by a number of investigators (Chantrapornsyl *et al.*, 1991;Gallagher, 1991a; Leatherwood *et al.*, 1991; Robineau and Rose, 1984; Papastravrou and Salm, 1991; van Bree, 1971; van Bree and Gallagher, 1978; van Waerebeek *et al.*, 1999). Collections are held at different museums, including the British Museum of Natural History, Oman Natural History Museum, Sultan Qaboos University and Zoological Museum Amsterdam among others (Baldwin *et al.*, 2002).

Records of baleen whales in the Arabian Sea and Gulf of Oman include humpback, Bryde's, blue, fin and minke whales (Collins *et al.*, 2002; Minton *et al.*, 2002; Baldwin *et al.* unpublished data).

The Arabian Gulf

Robineau (1998) submitted a review on cetaceans of the Arabo-Persian Gulf to the IWC Scientific Committee and reported 13 species of cetaceans. Of these, three species are commonly seen: *Delphinus cf. tropicalis, Sousa chinensis* and *Tursiops cf. aduncus. Neophocaeana phocaenoides*, *Pseudorca crassidens* and *Baleanoptera edeni* were also reported but appeared to be relatively rare. Other species recorded (*Globicephala sp., Grampus griseus, Stenella attenuata, S. longirostris, B. musculus, B. physalus* and *Megaptera novaengliae)* are also known from a very small number of strandings and/or sightings and could be occasional visitors. Baldwin (IWC, 1998) questioned the records for *Globicephala sp* and *Grampus griseus* and could not trace them to a confirmed source.

In the Persian Gulf, Henningsen & Constantine (1992) surveyed near and offshore areas in the western and northern Gulf, noting four species, predominantly *Sousa* and *Tursiops* but also *Delphinus* and N*eophocaena*.

Baldwin (1995a&b) and Preen *et al.* (2000) conducted studies along the coast the United Arab Emirates, where small cetaceans were reported to be most common, and large baleen whales (particularly *B. edeni*) were rarely recorded. Preen (pers. comm.) reports a significant decline in small cetacean populations in the eastern Arabian Gulf between the years 1987 and 2000 based on the results of aerial surveys.

<u>The Red Sea</u>

At least 8 species of small cetaceans are known to inhabit the Red Sea (IWC, 1998), of which the humpback dolphin, the bottlenose dolphin (*aduncus* form and an undescribed larger form in the Gulf of Suez) (Beaden, 1991) and the pantropical spotted dolphin are the most common. Spinner dolphins, rough-toothed dolphins, Risso's dolphins, killer whales and false killer whales are also present. Smeenk *et al.* (1996) reported on sightings of *Delphinus* cf. *Tropicalis* in the Red Sea. However, our knowledge of cetaceans in the Red Sea remains poor.

Distribution and migratory patterns

The humpback whale is thought to be resident in the region (Reeves *et al.*, 1991; Mikhalev, 1997). Whitehead (1985) had earlier recorded humpback whale songs in January, during the boreal winter, and more recent surveys have also recorded humpbacks during this period (Minton *et al.*, 2002). Papastavrou and van Waerebeek (1996) suggested that due to the predictable presence of food that results from strong upwellings in the coastal areas of the Sultanate of Oman, some humpback whales may be resident year-round in the northern Indian Ocean. Brydes whales are known to be resident in the region (Baldwin, 1995).

Minton *et al.* (2002) reported ongoing studies on distribution and relative abundance of Humpback whales off the coast of Oman and some preliminary evidence for relationships between whales from Oman and humpback whales recorded elsewhere is provided by Rosenbaum *et al.* (2002)

Sperm whales are probably year-round residents in the region (Baldwin 1995; Gallagher, 1991b) and are apparently relatively abundant (Ballance *et al.*, 1995).

By-catch

In the Arabian Gulf, extensive shrimp trawling, trapping, gill netting and beach seining occurs (Siddeek *et al.*, 1999). Similar practices also occur off the coasts of Oman and Yemen. Total fishing effort in the Arabian Gulf, especially along the Iranian coast, is thought to have been increasing recently. A decline in pelagic fish stocks, chiefly the kingfish (*Scomberomorus commerson*), is forcing a trend towards demersal fishing practices (Siddeek *et al.*, 1999). Gill and seine netting are a particular threat to cetaceans (Baldwin, 1995; Baldwin *et al*, 1999). Bycatch data are limited, but mortality resulting from bycatch is thought to be relatively high (Kruse *et al.*,1991; Baldwin *et al.*, 1999; Collins *et al.*, 2002).

Body scars, suggestive of contact with fishing gear, are evident on *Tursiops* sp. seen in coastal areas in the Gulf of Bahrain (Keith, pers. obs.). Stranded specimens of several species and live net-caught humpback whales provide further evidence of entanglement, particularly along the Arabian Sea coast of Oman (Gallagher, 1991a; Baldwin *et al.*, 2002) and in a litter survey conducted in the Arabian Gulf, discarded fishing floats and nettings represented 16.9% of the total items examined (Khordagui and Abu-Hilal, 1994).

Some authors have also reported the existence of marine mammal fisheries off Oman (Gallagher, 1991a; Papastravrou and Salm, 1991).

There is no published information for fisheries by-catch in Iran, although the country possesses a sizeable drift-net fishery and, therefore, significant by-catch mortalities would be expected (Perrin *et al.* 1994).

Pollution

The well-being of cetaceans was investigated following the 1992 Arabian Gulf War (Henningsen and Constantine, 1992; Robineau and Fiquet, 1992; 1994; 1996; Baldwin, 1996a,b). In the Arabian Gulf, industrial and shipping activities combined with low flushing rates imply high levels of pollutants (Sheppard, 1993). Oil pollution and its effects have been very well documented there, especially after the Gulf War (Al-Madfa *et al.*, 1999). However, very few studies focus on the impact of oil on marine mammals and the impact of the Gulf War oil spill was never evaluated fully (Henningsen and Constantine, 1992; Robineau and Fiquet, 1994).

Data are sparse on persistent pollutants. DDT residues have been found in fish species in the Arabian Sea (Hamilton, 1989) and Persian Gulf (Ali *et al*., 1998), as have other organochlorine pesticide residues (Douabul *et al*., 1987) and heavy metals (Al-Yousuf *et al.* 2000). These fish include the prey species of cetaceans. However, no toxicological data exist for cetacean specimens in the region.

Mass mortalities have been reported for some species and in particular *Sousa* and *Tursiops* sp. (Baldwin and Minton, 2000; Gallagher, 1991a; Leatherwood *et al*., 1991; Robineau and Fiquet, 1994; Papastravrou and Salm, 1991; Collins *et al*., 2002). Oil is a suggested as a possible cause of these deaths as are toxins from red tide events (OWDRG, 2002; Baldwin and Minton, 2000; Gallagher, 1991a) and the possibility of poisoning by wastes cannot be ruled out.

Habitat degradation

Increasing development of the coastal zone (as well as some offshore areas, e.g. for hydrocarbon exploration and production) throughout the region has led to significant habitat destruction and is continuing. Shallow coastal areas, including rich mangrove habitats are important for demersal species such as *Sousa* sp. and *Neophocaena phocaenoides*. Another consequence of rapid development is increased man-made litter in more developed areas (Khordagui and Abu-Hilal, 1994).

Countries of the region are developing and yet have significant economic resources and wealth. Development is therefore rapid. In general, research on cetaceans has been conducted during the rapid development period (since the 1970s). There are therefore few baseline data on which to assess change and development continues to progress at a rate that exceeds current capacities for research into its effects on cetaceans.

Disturbance

Development in the region also threatens cetaceans and their habitat. Of particular concern is the possibility of disturbance due to offshore hydrocarbon exploration, including seismic surveying (Baldwin *et al*., 1998). The busy shipping lanes and heavy boat traffic as well as military exercises also threaten to disturb cetaceans in the region (OWDRG, 2001).

Conclusions

Despite the general lack of research in some parts of the Arabian region, significant data are now available for countries such as Oman, Saudi Arabia and UAE due to research in the past decade which has revealed a high diversity of cetaceans. In all of these countries, as well as in Kuwait, research is on going at some level. The existence of the Indian Ocean Sanctuary is noted by Baldwin and Salm (1994) was an important element in the history of cetacean research in the Sultanate of Oman, the country in which the vast majority of research in the Arabian region has been conducted.

As in many other parts of the Indian Ocean Sanctuary, in spite of serious potential pollution problems, incidental takes may now be the most serious threats for cetaceans of this region, although there is also particular concern about oil and other pollution.

5. Northeast Indian Ocean Sanctuary (Pakistan; India; Sri Lanka; Bangladesh; Burma; Thailand; Indonesia).

The marine mammals of Southeast Asia were considered during a special meeting in Kyoto in 1993 where the small cetaceans subcommittee of the Scientific Committee of the International Whaling Commission focused on the status and exploitation of small cetaceans in Southeast Asia (IWC, 1994). Furthermore, in 1995, a conference on the Biology and Conservation of Small Cetaceans and Dugongs of SE Asia was held by the Silliman University Marine Laboratory, Philippines, in collaboration with UNEP (East Asian Seas Action Plan and Global Plan of Action for Marine Mammals; Perrin *et al*., 1996a). The Second International Conference on the Marine Mammals of Southeast Asia was held in Dumaguete, Philippines (22-26 July 2002). This conference was sponsored by the Convention on Migratory Species of Wild Animals (CMS), focusing on the pressing issue of the assessment and management of bycatch in fisheries. The conference was hosted in collaboration with the Southwest Fisheries Science Center of the U.S. National Oceanic and Atmospheric Administration (NOAA; conference website: http://swfsc.nmfs.noaa.gov/SEAMAMII). This conference, although predominantly concerning waters outside the sanctuary, is of importance to the Indian Ocean Sanctuary because it will help to co-ordinate research in adjacent sea areas.

The information on cetaceans in Thai waters has increased substantially since 1991, when intensive international co-operation began under the precursor to SCIGTAS (Small cetaceans of the Gulf of Thailand and the Andaman Sea) (Perrin *et al.,* 1996a), a collaborative effort of the Danish and Thai governments.

Oceanography

The Indian subcontinent divides the north Indian Ocean into two basins, the Arabian Sea and the Bay of Bengal. The general eastward flow in the north Indian Ocean during summer is called the Southwest Monsoon Current (SMC). The SMC appears as an extension of the Somali Current system in the western Arabian Sea. It flows southeast in the eastern Arabian Sea and then flows eastward, south of India (Hastenrath and Greischar, 1991). East of Sri Lanka, a part of the SMC flows into the Bay of Bengal (Vinayachandran *et al*., 1999).

The SMC is important because of its role in the interbasin exchange of water between the Arabian Sea and the Bay of Bengal. These two basins located along the same latitude are influenced by monsoons (Vinayachandran and Shetye, 1991) and show large differences in their salinity because of the excess evaporation over the Arabian Sea, in contrast to the large freshwater input into the Bay of Bengal. It is not understood yet how the two basins exchange fresh water and heat. Currents along the west and east coasts of India (Shetye *et al*., 1991; Shetye *et al*., 1996) suggest a possible link between these two basins via the coastal circulation around India and Sri Lanka.

Circulation in the Bay of Bengal is characterised by anti-cyclonic flow during most months and strong cyclonic flow during November. During the Southwest monsoon season, currents in the entire bay are weak. Complete reversal of the East Indian Current into the East Indian Winter Jet is not achieved until late October. The East Indian Winter Jet is a powerful western boundary current that feeds water into the Arabian Sea (Tomczack and Godfrey, 1994). In the Andaman Sea, east of the Bay of Bengal, the oceanic flow changes direction twice during the year (Potemra *et al*., 1991).

The Indonesian Throughflow is a system of surface currents flowing from the Pacific to the Indian Ocean through Indonesian seas. It is the only current between ocean basins at low latitudes and consequently, plays an important role in the transport of heat in the climate system. This flow of water is governed by a strong pressure gradient from the Pacific to the Indian Ocean. The annual and semiannual variations in transport are dynamically related to the monsoon winds. This is because winds are blowing westward during the southwest monsoon in the tropical Indian Ocean and cause a lowering of sea level on its eastern side (and an increase on the western side). During the northeast monsoon, winds reverse in the tropical Indian Ocean, leading to an increase of sea level on its eastern side, thus minimizing the transport. The western Pacific shows annual variations but the sea level difference between the two basins is governed chiefly by the sea level in the eastern Indian Ocean. The Throughflow increases surface temperatures in the eastern Indian Ocean and reduces temperatures in the equatorial Pacific, and shifts the warm pool and centres of deep convection in the atmosphere to the west

(Schneider, 1998; Schneider and Barnett, 1997). The significant interannual variations of the throughflow probably contribute to the aperiodicity of El Nino /Southern Oscillation (ENSO) events (Tomascik *et al.* 1997).

Indonesian waters are very productive. The seasonal development of the Asian monsoons and the Southeast Trades cause upwellings off the southwest coast of Sumatra, the south coast of Java, the Banda Sea, the Arafura Sea, the south coast of Bali and the islands of Nusa Tenggara (Tomascik *et al.* 1997).

Species diversity

A summary of the collated records of cetaceans in the North-eastern Indian Ocean Sanctuary is presented in Table 2.

Four species (or currently recognised subspecies) are endemic to the North-eastern Indian Ocean, especially to the shelf waters of Southeast Asia, although their taxonomic position is still insufficiently known (Rice, 1998; Rudolph and Smeenk, 2002).

- The Pacific humpback-dolphin (*Sousa chinenesis*) is distributed along the coastal waters of Southeast Asia and northern Australia.
- A dwarf form of the spinner dolphin (*Stenella longirostris roseiventris*) is described by Perrin *et al.* (1999) and has been found in the inner waters of Southeast Asia (Gulf of Thailand, Borneo, Moluccan Sea and northern Australia).
- The Irrawaddy dolphin (*Orcaella brevirostris*) has distinct riverine, estuarine and coastal populations and is discontinuously distributed in shallow coastal waters of the Bay of Bengal, Strait of Malacca, the Indo-Malayan Archipelago, Gulf of Thailand and northern Australia.
- A distinct small form of the Bryde's whale (*Balaenoptera edeni*), the Sittang whale or pygmy Bryde's whale, has been identified in the eastern Indian Ocean and tropical West Pacific; in Southeast Asia it has been found from Burma (Myanmar) to Western Australia, the southern Philippines, the South China Sea and the Solomon Islands, and apparently is restricted to coastal and shelf waters. The southernmost record is of an animal entrapped in the Manning River on the east coast of Australia, at about 32° S (Priddel. and Wheeler, 1998). Molecular evidence from allozyme and mtDNA analyses, as well as osteological comparisons, indicate that the small form does not belong genetically with the larger Bryde's whales and almost certainly constitutes a separate species, to which the name *B. edeni* would apply, judging by the holotype, which is from the mouth of the Sittang River, Burma (Wada and Numachi, 1991; Perrin *et al.* 1996 b; Dizon *et al.* 1998; Rice, 1998; Rudolph and Smeenk, 2002).

Records of strandings & sightings

See table 2

By-catch and direct take

<u>Pakistan</u>
The situation in Pakistan is probably similar to that in India. Fisheries operating from the Karachi region probably account for large takes of shallow water coastal species such as Indo-Pacific hump-backed dolphins and finless porpoises, whereas more oceanic species may be taken in fisheries operating along the Baluchistan coast (Niazi, 1990).

<u>India</u>
The sub-continent of India boasts over 2.5 million fishermen and an estimated 1,216,000 passive gill nets (Lal Mohan 1994). An estimated 1000-1500 cetaceans are taken annually, 90% of which are killed along the southwest coast (Lal Mohan 1994). Most of these animals are spinner or common dolphins, although coastal fisheries in India also exert a toll on Indo-Pacific hump-backed dolphin populations (Lal Mohan 1994). Lal Mohan (1998) studied dolphin mortalities along the Calicut coast and reviewed the mortality of dolphins in the northeastern Indian Ocean, covering India, Bangladesh, Myanmar, Sri Lanka and Maldives, and providing valuable data on the various aspects of the mortality of marine mammals occurring along the Indian coast. Continued monitoring of the entanglement of dolphins along the Indian coast is very important as the expanding coastal gillnet fishery has great impact on some coastal dolphins such as *S. chinensis*. Dhandapani and Alfred (1998) suggested that India, as a strongly conservation-orientated country, should establish *in situ* conservation programmes for species dwelling along the coastal zone. They also noted that all species of cetaceans are now listed in Schedule-I of the Indian Wildlife Protection Act of 1972. Jayaprakash *et al.* (1995) presented details on by-caught dolphins landed at Fisheries Harbor, Cochin and noted that the magnitude of such mortality along the Indian Coast is as alarming as in the Eastern Pacific.

Sri Lanka

There are an estimated 350,000 gill-nets in use around the coasts of Sri Lanka (Perrin *et al*., 1994). Leatherwood (1994) estimated that in the period 1984 to 1986, between 8,042 and 11,821 by-catch mortalities occurred in Sri Lanka. As the human population has increased and the economy has faltered, a greater reliance upon fisheries has evolved, resulting in an increased number of by-catches and direct takes. Llangakoon (1997) reported on species composition, seasonal variation, sex ratio and body length of small cetaceans caught off the west, south-west and south coast of Sri Lanka. *Stenella longirostris* appeared to be the most abundantly caught species at all sites. The post-monsoonal period from the end of August to November appeared to be the season when peak catches were recorded at all sites. It was further reported that a sizeable proportion of the small cetacean catch was caught by harpoon and that the practise itself seems to be spreading to new areas (Llangakoon, 1997).

Thailand

In comparison to other Asian countries, there is relatively good information on the status of cetaceans in Thailand. By-catches occur in purse-seine nets and gill-nets, although some trawler by-catches have been reported (Chantrapornsyl & Andersen 1995; Perrin *et al*., 1995, 1996a). Gill-nets in this region are typically 100-200 meters long and are set within 2km of the coast, although larger gill-nets (>1km) are utilised and result in cetacean mortalities (Perrin *et al*., 1995, 1996a). Catches of spinner, Irrawaddy and Indo-Pacific humpbacked dolphins have been recorded (Sundara, 1994).

Indonesia

Although Indonesia was used as a hunting ground for sperm whales during the nineteenth century by British and American whalers, in only two Indonesian communities (Lamalera village on Lembata Island and Lamakera on Solor Island) are residents known to still hunt regularly (Beale, 1839; Townsend, 1935; Barnes, 1991). Barnes (1991, 1996a) reported that residents of Lewotobi, Flores, also hunt cetaceans, but there is no information about their fishery. The whalers of Lamalera specialise in catching manta rays and sperm whales, which they hunt in open rowing/sailing boats called "*peledangs*". Records of the annual catch at Lamalera are haphazard and intermittent. Barnes (1996a) published the annual catch of sperm whales (and large rays) for the period 1959-1995 and reported an average annual catch of 21 sperm whales in Lamalera. The number of sperm whales caught fluctuated greatly over this period with a peak of 56 whales caught in 1969 and a low of 2 whales in 1983. Between 1988 and 1994, the average annual capture rose to 9 (Rudolph *et al*., 1997). During the 1995 season, Lamalera hunters took 38 sperm whales, which is the highest record of sperm whales taken at Lamalera in the last 25 years (Barnes, 1996a).

Other cetacean species reported taken in Lamalera were: killer whale (*Orcinus orca)*[1]; short-finned pilot whale (*Globicephala macrorhynchus*)[2], Cuvier's beaked whale (*Ziphius cavirostris*)[3] and small cetaceans[4] like, *Grampus griseus*, *Tursiops sp*., *Stenella attenuata*, *S. longirostris*, *Lagenodelphis hosei*, *Peponocephala electra*, and *Kogia sima.*

The fishery at Lamakera, Solor Island, is similar in many respects to that of Lamalera, although, they primarily hunt for baleen whales[5] (Barnes, 1996b).

Pirate whaling may also be ongoing in the remote eastern parts of Indonesia. Salm *et al*. (1982) reported an incident of fin whale poaching in the straits between Halmahera and northern Sulawesi.

Live capture operations have removed a number of dolphins, for permanent export (e.g. in China

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[1] 24 killer whales were recorded killed between 1960 and 1995 (Rudolph *et al*. 1997)

[2] 48 short-finned pilot whales were recorded killed between 1959-1994 (Rudolph *et al*. 1997). An additional three whales were taken between January and June 1996 (P. Rudolph, unpublished data), and two between May and August 1999 (Alvard and Nolin, *in press*);

[3] Barnes (1991) stated that the Cuvier's beaked whale is occasionally hunted by villagers of Lamalera.

[4] The catching of 186 smaller cetaceans has been recorded between 1959 and 1999 (Hembree, 1980; Barnes, 1991; Rudolph *et al*., 1997; Alvard and Nolin, *in press*).

[5] Sei whales (*Balaenoptera borealis*), Bryde's whales (*B.* cf *edeni*) and minke whales (*B. acutorostratus*) (Barnes, 1991). The take of the following species is also confirmed by Rudolph *et al*., 1997: *Grampus griseus*, *Tursiops sp*., *Stenella attenuata*, *Peponocephala electra*, *Globicephala macrorhynchus*, and *Balaenoptera cf. edeni*. Hembree (1980) documented a minke whale from Lamakera, by baleen plates, although this material does not seem to have been preserved, so the identification cannot be confirmed.

and Thailand), for use within Indonesia and also for use in a travelling dolphin show that performs internationally. Reeves *et al*. (1994) reported that nine bottlenose dolphins, presumably taken from the Java Sea, were imported by Ocean Park, Hong Kong from Indonesia in December 1987. Bottlenose dolphins (*Tursiops sp*.), Irrawaddy dolphins (*Orcaella brevirostris*) and spinner dolphins (*S. longirostris*) have all been taken in live-capture operations[6] for Gelanggang Samudera Jaya Ancol (Jaya Ancol Oceanarium). The impact of these live-capture operations are not known. However, recent surveys for the Irrawaddy dolphin in the Mahakam river indicated, that not more than 50 dolphins are found in the entire dolphin distribution area (Kreb, 1999 ; Rudolph and Smeenk, 2002) and any additional takes from this area might have a serious impact on the population.

By-catches of cetaceans in local fisheries in Indonesia have been reported and appear to be a major problem throughout Indonesia, but there is no quantitative information available on the species involved or the level of take. Tas'an and Leatherwood (1983), reported the entanglement of two finless porpoises (*Neophocaena phocaenoides*) in gill-nets between Batang and Pekalongan, northern Java, in mid-November 1975 and entanglements of bottlenose dolphins have been reported from northern Sulawesi and from Ambon Island, Moluccas (Tas'an and Leatherwood, 1983; Strack, 1993). An important Taiwanese driftnet fishery was operating in the Arafura Sea, north Australia between 1974 and 1986. Species involved in by-catches of this fishery included bottlenose dolphins (60 % of by-caught cetaceans), spinner dolphins (35 %) and spotted dolphins (4 %). Total catches over a four and half year period were estimated at 14,000 cetaceans (3,100 per year), and these catches were an important factor in the closure of this fishery (Northridge, 1991).

After prohibition from fishing in Australian waters, the fleet moved to Indonesian waters. In 1987, a total of 14,427 fishing days were reportedly fished by Taiwanese driftnet vessels fishing in and around the Arafura and Banda Sea (Northridge, 1991). The numbers of vessels involved was not stated, but must have exceeded 48. No information on by-catch was recorded but oceanographic conditions are similar to those in northern Australian waters, so similar cetacean catch rates might be expected.

Indonesian driftnet fisheries are not well documented, but driftnets are widely used in all parts of Indonesia. The Southeast Asian Fisheries Development Center (SEAFDEC) indicates that over 148 000 vessels use gill nets in Indonesia (Northridge, 1991). Other destructive fishing methods, e.g. blast fishing, cyanide fishing, trap fishing and inshore trawling are a perennial problem throughout Indonesian waters (Pet-Soede and Erdman, 1998). However, the impact and effect on cetaceans are not known.

It is suggested, that the direct exploitation of small cetaceans in Indonesia is low. Their meat and fat are not popular among Indonesians, with the exception of some fishermen in East Nusa Tenggara (e.g. Lamalera and Lamakera) (Priyono, 1995). However, cetacean meat might be used in some local communities, where cetaceans are incidentally taken in fishing operation. Strack (1993) reported that he bought a head of a bottlenose dolphin at the market of Ambon City, Ambon Island, Moluccas in November 1990. He was told that dolphins are occasionally caught by fishermen for consumption by the Chinese. According to Perrin *et al*. (1996a) most local fishermen generally believe that the presence of dolphins signals the presence of harvestable quantities of fish, thus, regarding dolphins as their friends. Priyono (1995) stated that the Irrawaddy dolphin in the Mahakam region is not deliberately disturbed and its activities mesh peacefully with those of the local human population. However, Tas'an *et al*. (1980) reported that Irrawaddy dolphins are recognized as competitors for food and chased away from nets by fishermen.

Pollution (see table3 & 4)

Asia's rapid economic, industrial and population growth has occurred without an accompanying growth in environmental research. With a few exceptions, there has been relatively little research into the effects of pollution on coastal marine life. Species such as the Irrawaddy dolphin, Indo-Pacific hump-backed dolphin and finless porpoise are particularly susceptible to pollutants as they live in discrete populations often at the mouths of river deltas. Many of

[6] 28 bottlenose dolphins were taken between 1975-1982 from the Java sea (Tas'an and Leatherwood, 1983); 16 Irrawaddy dolphins were removed from Semajang Lake (Kalimantan), 6 in 1974 and 10 in 1978 (Tas'an and Leatherwood, 1983). A further 6 were taken from the Mahakam river system in 1984; 9 Spinner dolphins were caught in the Java sea in 1976 (Tas'an and Leatherwood, 1983).

these same rivers are also situated next to large, industrial cities where industrial and other wastes are discharged, often untreated, into the watercourse.

Aerial contamination of the Indo-Pacific by organochlorines continues, caused by the volatilization of historical organochlorine residues and recent applications of pesticides (Philips & Tanabe 1989). Water bodies in the tropics then act as a sink for these air-borne pollutants, which ultimately contaminate the marine biota (Tanabe *et al.* 1993). It is expected that there will be a significant increase in organochlorine contamination of cetaceans in the Indo-Pacific during the next decade, as a result of their accumulation of both historical and recent organochlorine discharges, including DDT.

DDT and some other pesticides are still widely used in India (Shailaja & Singbal 1994) and considerable quantities of DDT, aldrin and HCHs have been recorded from coastal sediments in the Bay of Bengal (Sakar & Sen Gupta 1988). These contaminated sediments are known to be ingested by coastal fish, which then also become contaminated, (Shailaja & Singbal 1994). From an analysis of these contaminated fish, it was discovered that primary DDT was a major component of the total DDT concentration (Shailaja & Singbal 1994), suggesting a recent input of the toxin into the biota. Fish from the mid-western coast of India did not reveal any primary DDT in their tissues when analysed (Shailaja & Sen Gupta 1989), suggesting that the western coast may be less contaminated in comparison with the east. However, more pollution-oriented studies are required around the coasts of the sub-continent to help to understand further the threat that organochlorine compounds poses to coastal cetaceans.

Boat traffic *(see table 3)*

There are few published data on cetacean mortality as the result of boat traffic in the Indian Ocean Sanctuary area. Animals living near coastal tourist resorts could also be particularly threatened by boat traffic. Water-sports are becoming increasingly popular, putting coastal cetaceans at risk of being hit by ineptly or recklessly piloted jet-skis, powerboats and similar vessels. In 1995, a finless porpoise was killed in a collision with a jet-ski in Thailand (Chandrapornsyl & Andersen 1995) just outside the IOS area. As economic growth continues in Asia, the volume of boat traffic will increase and lead to a greater likelihood of casualties, including in the IOS.

Habitat loss (see table 3)

Within the Indo-Pacific, human populations are increasing, economies are growing and industrialisation is escalating. With these trends comes an increasing pressure on cetacean habitats. Rivers are either being diverted for irrigation projects or dammed to provide hydroelectric power or both. River mouths become choked with sediments as deforestation upstream leads to the loss of topsoil into the rivers. Dredging removes once fertile seabeds and coastal areas are filled in as a result of reclamation projects.

Most coastal cities in Malaysia and Indonesia are either conducting or planning large scale projects. In Goa, western India, a vast reclamation project is being planned in order to build a container port at Vasco de Gama, a project which could substantially reduce the habitat of Indo-Pacific hump-backed dolphins which live in the region ear-marked for development (Parsons 1998). Further up the western coast of India, plans have also been put forward for another coastal port in Maharashtra.

Indonesia is a developing country, with a high population growth and rapid industrialisation. High pollution levels and habitat loss are known to have occurred near major population centres in Indonesia, such as Jakarta (Rice, 1991). Habitat degradation of riverine habitats has resulted from water pollution, watershed degradation, human activities along the river (particular intensive transportation), and unselective fishing methods. There is special concern that continued extensive development in the Mahakam and other river systems will significally reduce the chances of survival for the Irrawaddy dolphin and other riverine vertebrates (Perrin *et al.*, 1996a).

Another problem is the conservation of the Irrawaddy dolphin in the rivers of Kalimantan. Extensive logging in the watersheds had resulted in downstream siltation and destruction of river beds, and the dolphins are reported to be decreasing in abundance (see Perrin *et al.*, 1995). The extensive forest fires in Sumatra and Kalimantan in the last few years, caused by legal and illegal fire-clearing from several sources (national and international timber-companies, local settlers etc.) may have threatened local populations of the Irrawaddy dolphin. In the Mahakam river, in 1984-1985, dolphins were found with skin disease and Wirawan (1989) suggested that the outbreak may have been triggered by water chemistry changes in the lower Mahakam, following an extensive forest fire there in 1983. The potential for oil pollution, due to exploration in Kalimantan, is also cited as possible threat to the Irrawaddy dolphin (Stacey and Leatherwood, 1998).

Conclusions

The increase in human population in the coastal developing countries in this region has resulted in the overexploitation of marine resources. Therefore the need to focus more effort on surveying and assessing marine mammal population is significant. The authors of this current study agree with Aragoness *et al*. (1997) that survey techniques such as interview surveys and shore-based sightings may be particularly appropriate where funding is limited and infrastructure poorly developed.

6. Australia

The Australian government regards the Australian EEZ waters as a Sanctuary. It has financially supported long-term research on humpback and right whales, and recently on blue whales, off Western Australia, showing a commitment to contributing results to the IWC assessment of whale stocks. Australia has also identified the value of sanctuaries in providing a range of additional management strategies for the conservation of cetacean stocks (IWC, 1993).

Oceanography

The dynamics of the eastern boundary current along the Western Australian coast, known as the Leeuwin Current, are very unusual. In the Pacific and Atlantic Oceans, equatorial winds along the eastern boundary produce coastal upwelling, an equator-ward surface flow and a pole -ward undercurrent. In the Indian Ocean, annual mean winds along western Australia blow toward the equator, but at the surface, a vigorous pole-ward flow runs against the wind, and the undercurrent moves towards the equator. The reason is that eastern boundary currents are driven by the combined effects of alongshore winds and alongshore pressure gradients in the upper ocean. It has been suggested that this anomalous behaviour off West Australia is due to the volume transport from the Pacific to the Indian Ocean (Tomczak and Godfrey, 1994).

Satellite-derived sea surface temperatures show the Leeuwin Current as a strong meandering current moving southward from Exmouth (North West Cape) along the continental shelf to Cape Leeuwin, then eastwards into the Great Australian Bight (Pearce and Pattiaratchi, 1997). Studies using satellite data and drifting buoys have shown that the Leeuwin Current is a complex of mesoscale eddies and meanders interposed with along-shore current jets.

Near-shore oceanography has defined a system of seasonally varying counter currents, that are generally wind-driven during the summer months, moving cooler water northward close to the coast (Pearce and Pattiaratchi, 1997, 1998). This is specifically evident off the southwest of the State with the Capes Current flowing from Cape Leeuwin and Cape Naturaliste to north of Rottnest Island. This cool current is narrow and shallow, persisting from about October to March when wind stress is strongly northward, and may also involve localised upwelling (Gersbach *et al*., 1999).

Strandings & Sightings

Southwestern Australia

Boat-based cetacean research has been conducted in coastal areas of western and southwestern waters of Australia and further offshore (the latter often during voyages between Australia and Antarctic waters) (*e.g*. Gill, 1997; Tynan, 1996; de Boer *et al*., 1999; de Boer, 2000; Kato *et al*., 1996; Burton *et al*., 2001). A diversity of marine cetaceans has been recorded in the general southwestern area of the state, both historically and more recently (Table 5). This table represents a preliminary list of cetaceans for the waters of south-western Australia using known sightings and available references (Bannister *et al*., 1996; Gill and Burke, 1999).

The North West Shelf

Survey work has been conducted in coastal waters between Darwin and north of Shark Bay, primarily in the region of the NW Shelf, and in oceanic waters between the NW Shelf and Cocos Island. Cetaceans sighted, or likely to be seen in this area, are listed in Table 6.

The tropical dolphin species in the 'likely to be present' list (*see* Table 6) may be found in pelagic waters and around continental shelves and seamount/reef/island habitats. Most of the Balaenopterids on the same list might travel through the area, except Bryde's whale, and even perhaps some others, which might concentrate in as yet unknown areas of the coast. Beaked whales may be found in similar environments to the tropical dolphins, as well as in or near trenches in the deep ocean. Nearshore species such as humpback dolphins and Irrawaddy dolphins occur close to the coast. The smaller whales and larger dolphins may be found in pelagic waters, near shore and around seamounts/reefs/islands.

Small cetaceans

Indian Ocean bottlenose dolphins (*Tursiops truncatus*) in Shark Bay are relatively well studied (*e.g.* Connor *et al.*, 1992a&b, Connor and Smolker, 1995 and Connor *et al.*, 2000; Mann and Smuts, 1999). They form classic fission-fusion societies in which individuals associate in subgroups that often change in size and composition over time (Connor *et al.*, 2000).

Little is known about other inshore dolphin species, such as the Irrawaddy dolphin (*Orcaella brevirostris*). Van Parijs *et al.* (2000) recently reported sounds produced by these dolphins in coastal waters off northern Australia, revealing a varied repertoire, consisting of broadband clicks, pulsed sounds and whistles. The sounds produced did not resemble those of their nearest taxonomic relative, the killer whale.

Preliminary studies on Irrawaddy dolphin skull morphology appear to support the hypothesis of geographical variation between Australia/New Guinea and southeast Asia populations (Beasly *et al.*, 2000).

The distribution and status of humpback dolphins (*Sousa chinensis*) was discussed by Corkeron *et al.* (1997). These authors indicated that humpback dolphins occurred at a density of approximately 0.1 dolphin/km^2 off southeast Queensland but they suggested that these animals might be declining in Australian waters.

The southern right whale (Eubalaena australis)

The southern right whale is presently considered as 'Endangered' under the Australian EPBC Act (Appendix 2), 'Vulnerable' under the Action Plan for Australian Cetaceans ("population very severely reduced; probably increasing but not yet secure") (Bannister *et al.*, 1996) and 'Vulnerable' by the World Conservation Union (IUCN). The population using the southern Australian coast during the winter and spring months is thought to number about 1000 individuals (Burnell and McCulloch, 2001).

Southern right whales in the areas C Leeuwin - Twilight Cove (WA), since 1983, and C Leeuwin, WA-Ceduna, SA (where the majority of the Australian population occurs), since 1993, have shown encouraging increases, of around ca 7-10% (Bannister, 2001, 2002). Sightings have been made as far north as Shark Bay and Exmouth Gulf (Bannister 2001).

Cows accompanied by calves of the year occur on the coast mainly between July and October, in shallow inshore areas, where they may reside for up to three months and move along the beaches just outside the surf zone (Burnell and Bryden, 1997; Burnell, 1999). Other animals also occur there, more frequently but irregularly, often in sub-adult or adult interactive groups and demonstrating courting and mating behaviour (Bannister, 2001).

Blue whales (Balaenoptera musculus)

Two subspecies of blue whale are recognised in the Indian Ocean – the 'true' blue whale (*Balaenoptera musculus intermedia*) and the pygmy blue whale (*Balaenoptera musculus brevicauda*). The true blue is presently considered as 'Endangered' under both the EPBC Act and the Action Plan for Australian Cetaceans (Bannister *et al.*, 1996), and also as 'Endangered' by the World Conservation Union (IUCN). The pygmy blue whale is listed under the EPBC Act and has no category assigned under the Australian Action Plan, as there is insufficient information.

An Environment Australia funded project initiated in 1999 has provided data from aerial and boat surveys and acoustic monitoring on the distribution of blue whales, thought to be *Balaenoptera musculus brevicauda,* in deep water (the Perth Canyon area) off Rottnest Island (32 S 115 E), near Perth Western Australia (Bannister and Burton, 2000; McCauley *et al.*, 2001, Jenner *et al.*, *in prep*). These surveys are concentrated in a relatively small area west of the Island and have defined a seasonal distribution from December to April, with some animals showing feeding behaviour.

Due to the vagaries of weather, availability of aircraft and of observers only one blue whale was seen on the surveys (conducted under the field leadership of C. Burton) between February 1999 and January 2000. However, in February 2000, two flights recorded a total of 15 Blue whales. In addition to the flights, 30 days of boat-based operations were undertaken (by the Centre for Whale Research, C and M-N Jenner) in the same area (January-March 2001), and 75 Blue whale sightings were recorded, including 5 calves (although some are likely to have been duplicate sightings). The largest daily count from the boat was 12, including one calf. A smaller number of sightings were recorded in 2001-2002. The boat-based operations designed to provide identification photographs of individuals, and skin samples for genetic studies, continued in December 2001 and were completed in April 2002. As with the aerial surveys, only small numbers of animals were recorded.

Until May 2002 the project was carried out in conjunction with a comprehensive programme of aerial survey and boat work (including photo-identification, biopsy sampling and satellite telemetry, begun in December 2001). The aerial survey covered a wide area of the west coast between C. Naturaliste in the south and Lancelin in the north. The program is the responsibility of a group of agencies, comprising Curtin University, the Centre for Whale Research and the Western Australian Museum, under contract to the Australian Navy. Parallel acoustic studies have been conducted in the area (by R McCauley, Centre for Marine Science and Technology, Curtin University, WA), mainly using automatic "loggers" that record underwater sounds over a period of time, but also from hydrophones deployed opportunistically during the boat-based operations. Even in the absence of sightings, many records of sounds probably attributable to blue whales were obtained during February-April 2000. Boat-based opportunistic sound recording continued during 2001, with 76 records obtained from early January to mid-March.

The results so far suggest that the occurrence of blue whales in the Perth Canyon area is most probably linked to the presence of their food, itself dependent on oceanographic conditions, which in that area can be very variable. At the time of year of the major occurrence so far of blue whales (mid-late summer) most if not all the sightings are likely to have been pygmy blue whales.

Moderate numbers of blue whales (also thought to be pygmy blue whales) have been observed regularly in Geographe Bay on the southwest coast of WA since 1994, during whale-watching and research cruises (Burton, unpubl.). The whales are observed very close to shore (within 1km), usually moving west from south of Busselton, past Dunsborough to Cape Naturaliste. They often occur in water less than 20m deep. Females with calves have also been observed. As yet their distribution in the wider part of Geographe Bay remains unknown, but there is a possibility of them being present during summer and autumn.

There are stranding records of pygmy blues in Princess Royal Harbour, Albany in 1973 and 1974, off Garden Island and, more recently, at Hamelin Bay in 2002. Five presumed pygmy blue whales were observed in Princess Royal Harbour (Albany) during May 2001 and one was sighted in Flinders Bay in June 2001. Further work is required to provide a clearer picture of the abundance and distribution of blue whales off western Australia.

Distribution and migratory patterns

<u>Humpback whales</u>

Through compilation of historical whaling data (Chittleborough, 1953, 1959a and 1959b; Dawbin, 1964 and 1966), aerial surveys (Bannister, 1991a, 1991b and 1994; Jenner and Jenner, 1993; Coastwatch data 1994-1996; Centre for Whale Research (CWR) data; 1991-1993; McCauley *et al.*, 1998), shipboard surveys (Burton, 1991; Dawbin and Gill, 1991; CWR data 1990-1998) and photographic catalogues (CWR data 1990-1998), a general framework for the overall peaks of migration has been estimated for the temporal and spatial movements of Group IV humpback whales[7] along the western Australian coast (Jenner *et al., 2001).*

The migration paths of humpback whales along the western Australian coast lie within the continental shelf boundary or 200m bathometry (Jenner *et al., 2001)*. Major resting areas along the migratory path have been identified at

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[7] The humpback whale stock that winters off Western Australia and summers in the Antarctic generally to the south west of the State

Exmouth Gulf (southern migration only) (Jenner *et al., 2001)* and at Shark Bay (Burton, 2001; Jenner *et al., 2001)*. The northern endpoint of migration and resting areas for reproductively active whales in the population appears to be Camden Sound in the Kimberley (Jenner *et al.*, 2001). A 6,750 square km^2 area of the Kimberley region, inclusive of Camden Sound, has also been identified as a major calving ground .The northern and southern migratory paths have been shown to be divergent at the Perth Basin, Dampier Archipelago and Kimberley regions. In all cases, the northern migratory route is further offshore (Jenner *et al., 2001)*.

A series of aerial surveys were conducted near Shark Bay during the winter of 1999 for the purpose of providing an estimate of the population of the Group IV humpback stock that annually migrates along the western Australian coastline (Bannister and Hedley, 2001). The estimate for the population lies between 8,000 and 13,000 animals, but is heavily dependent on the 'deep diving time' of migrating whales used in the model.

Shark Bay was important for the capture of humpback whales over the period 1949-63. Aerial surveys within Shark Bay in 1999 have indicated that this recovering population of humpback whales is using the area in increasing numbers (Burton, 2001). Their spatial distribution within this large embayment may be influenced by the unique oceanographic conditions there.

During their northward migration, humpback whales are frequently observed on the WA south coast from east of Albany to Augusta but rarely in Geographe Bay on the south west coast. Increasing numbers of humpbacks have been observed in Flinders Bay, near Cape Leeuwin, from late May to August. During the southern migration the opposite is true; they are observed in large numbers in Geographe Bay from September to December, but not regularly observed on the south coast.

Aerial surveys in Geographe Bay in 1992 found that numbers of humpback whales were higher during the southern migration in September and October than during the northern migration of June and July (Jenner *et al.*, 2001). It is postulated that either there are annual differences in timing of the northern migration (the whales may leave Antarctic waters later and be missed by the aerial surveys) or that there is a displacement of whales offshore in the vicinity of Geographe Bay (Jenner *et al.,* 2001).

Research on the southern migration of humpback whales in coastal waters off Perth (32° S 115° 30' E) during 1989, demonstrated that the residence times of some individuals may be up to a week, but more often 1-3 days (Burton, 1991). The highest sighting rates were recorded during September and October with cow-calf pairs increasing during November. Ongoing work within this area has monitored sightings and undertaken photo-identification of humpbacks since 1990.

Southern right whale
Photographic identification 'matches' made between 2 of 15 right whales identified in southern ocean waters south of Australia in summer 1995 and animals previously recorded from coastal Australian winter breeding grounds, provided the first direct evidence of a link between onshore and offshore distributions in that area (Bannister *et al.*, 1997). The data support the understanding that their preferred feeding grounds lie north of the Antarctic convergence, as amphipod crustacean samples were collected from faecal samples there (Kato *et al.*, 1996; Bannister *et al.*, 1997). However, recent information suggests that southern right whales also frequent colder waters south of Australia and feed on krill. Observations of right whales feeding have been made there (Tormosov *et al.*, 1998) and one animal photographed south of 60°S in February 1996 has been identified off the southern WA coast a number of times since 1978 (Bannister *et al.*, 1999).

The duration and timing of coastal residence of individually identified southern right whales at a principal aggregation area (Head of the Bight, SA) on the southern Australian coast demonstrates a marked difference between females with calves and unaccompanied whales (Burnell and Bryden, 1997). A general circular, anti-clockwise migration movement has been hypothesised based on the movement of individually identified whales between areas in South and Western Australia (Burnell, 1999, Burnell and McCulloch, 2001).

Blue whale
Limited information is available on the migratory patterns and movements of both true blues and pygmy blues. Both, but particularly true blues, undertake extensive migrations between warm water breeding areas in low

latitudes and cold water feeding areas in high latitudes (Bannister *et al.*, 1996). Pygmy blue whales seem rarely to travel further south than 55°S.

Whaling

A small number of pygmy blues were taken off the Western Australian coast during humpback whaling in the period 1954-1963; a USSR factory ship, hunting whales along the Western Australian coast in the period March - May 1965, took a total of 269 blue whales (Bannister and Burton, 2000).

Environmental degradation and by-catch issues

Nearly all small cetaceans are classified as 'insufficiently known' under Australian, regional and international conservation status listings. Due to the high mobility and wide ranging habits of many small cetaceans many of those species found in the Indian Ocean area may be subjected to a number of anthropogenic threats.

An important Taiwanese driftnet fishery was operating in the Arafura Sea, north Australia between 1974 and 1986. Species involved in by-catches of this fishery included bottlenose dolphins (60 % of by-caught cetaceans), spinner dolphins (35 %) and spotted dolphins (4 %). Total catches over a four and half year period were estimated at 14,000 cetaceans (3,100 per year), and these catches were an important factor in the closure of the fishery (Northridge, 1991).

Dolphins inhabiting inshore regions around Australia are the Irrawaddy dolphin (*Orcaella brevirostris*), the Indo-Pacific humpbacked dolphin (*Sousa chinensis*), and an inshore form of the bottlenose dolphin (*Tursiops aduncus*). Their habitats include estuaries and near-shore coastal areas, which are utilised for resource extraction and recreation and have been degraded in many areas as a result of urban, industrial and agricultural development. Conservation problems include incidental capture in nets, loss of prey from over-fishing and destruction of fish habitat, vessel disturbance, possibly pollution and maybe direct killing (Hale, 1997). Long-term conservation will require a mixture of regulation, education and community involvement. A focus solely on regulation through enforcement is likely to be of little benefit. Research into female survivorship and calving will assist efforts to assess population viability (Hale, 1997).

A review of heavy metal and organochlorine levels in marine mammals in Australia has been provided by Kemper *et al.* (1994).

Whale watching

Whale watching has become an important tourist industry in Western Australia with a number of locations offering access, mainly to migrating humpback whales. A number of operators provide regular trips from September to December, with a high sighting rate of humpback whales in waters between the Perth metropolitan coastline and Rottnest Island, 12 nm offshore. Some locations on the south coast provide regular viewing of southern rights whales. One location in the southwest has more recently been able to offer blue whale sightings (the animals concerned are thought to be pygmy blue whales, *Balaenoptera musculus brevicauda*). Other vessels operate from locations as far north as Broome in the Kimberley region.

Two operators working from Perth and one from both Augusta and Dunsborough in the southwest have provided excellent platforms of opportunity to collect systematic data on sightings, photo-id and behavioural observations over a long period of time.

Conclusions

In 2002, a research vessel 'The Odyssey' conducted cetacean research within the Sanctuary, including biopsy sampling, which is thought likely to be facilitated by the presence of undisturbed whales[8] (www.oceanalliance.org and www.pbs.org/odyssey).

Obtaining more information on
- cetacean distribution,
- habitat requirements and
- movements in Australian waters and ecosystems has been highlighted in national, regional and international forums as critical

[8] De la Mare (1991) emphasized the potential importance of sanctuaries in providing an opportunity to study ecosystems under conditions in which some components are unexploited. He further argued that sanctuaries have a role to play in refining the predictions of the range in which the yields from exploited whale stocks might lie, particularly by permitting monitoring of the recovery of previously depleted stocks.

to the process of determining the nature and extent of the conservation issues facing these species and developing strategic long term management and planning for effective conservation outcomes (Reeves and Leatherwood 1994, UNEP reports 1991and 1996, Burns 1994).

A main objective of future cetacean research is to utilise appropriate 'platform of opportunity' vessels to conduct standardised sighting studies to contribute towards understanding of the distribution of cetacean species in this region. Collection of environmental variable data is of great importance to cetacean research if we are to understand the underlying processes which affect cetacean distribution and movements, and thus leave a legacy of simultaneously collected data for future ecological modelling and analysis.

7. Sub-Antarctic waters of the Southern Indian Ocean Sanctuary

Most information on cetaceans in the Southern Indian Ocean has been reported from sub-Antarctic islands and from research vessels underway to Antarctica (e.g. Kasuya and Wada, 1991; Parker, 1978; Tynan, 1997; Thiele *et al.*, 2000; Borsa, 1997; de Boer *et al.*, 1999; de Boer, 2000; Leatherwood *et al.*, 1982).

Oceanography

The circulation of the Southern Ocean is dominated by the largest current in the world, the eastward-flowing Antarctic Circumpolar Current (ACC), which is driven by the powerful westerly winds at latitudes of 45°-55°S. The AAC is dominated by circumpolar deep water, a warm, saline water mass which originates at lower latitudes and shoals southward beneath northward flowing Antarctica surface water and Antarctic intermediate water (Tynan, 1997).

The Antarctic Convergence marks the northern extent of the northward surface flow of Antarctic surface water. High concentrations of iron at the Polar front contribute to the formation of spring phytoplankton blooms whose biomass is orders-of-magnitude greater than that of adjacent AAC waters (de Baar *et al.*, 1995).

The Antarctic Divergence (AD) is the oceanographic regime near the Antarctic continent where the wind reverses direction from the eastward westerlies (which drive the AAC) to the westward East Drift. Where the southern AAC occurs near the AD, there is the potential for Ekman upwelling to bring older water, low in oxygen and high in nutrients, closer to the surface. In addition, the AD is composed of a 'street' of eddies within which circumpolar deep water upwells to shallower layers (Wakatsuchi and Ohshima, 1994).

The deep circulation of the southern Indian Ocean is obstructed by the north-south alignment of the Kerguelen Plateau. Deep water flows eastward around the northern edge of the Plateau, entering the Australian-Antarctic Basin through the Kerguelen-Amsterdam Passage. Where the ACC meets the Kerguelen Plateau, the majority of the current flows around the northern edge of the Plateau and the path of the southern ACC Front is forced South of the Plateau (Orsi *et al.*, 1995). Tynan (1997) suggested that the southeastern edge of the Kerguelen Plateau is a predictable productive foraging location for cetaceans and their prey.

Species diversity

The Sub-Antarctic waters of the Indian Ocean are rich in cetaceans. Apart from migratory species (such as Southern Hemisphere baleen and sperm whales), wide-ranging odontocetes (for example, killer, false killer and long-finned pilot whales), some beaked whales [9], and also cold-water species (such as Hourglass, Commerson's, Dusky, Southern right whale dolphins and spectacled porpoises) have been recorded there (for literature sources *see* 'records of sightings').

Records of strandings

Strandings have been reported from Kerguelen Islands (See Robineau, 1989), including of *M. layardii*. A skull of a young Dusky dolphin was reported in 1953 by Paulian (1953) collected from the Golfe du Morbihan (*see* Robineau, 1989), and several sightings have been reported between Kerguelen and Crozet Islands (Robineau, 1989).

Records of sightings

Sightings of cetaceans within Sub-Antarctic waters have mainly been made by research or whaling vessels underway to Antarctica or from

[9] *i.e.* Cuvier's, Blainville's, strap-toothed, southern bottlenose, Tasman (Shepherd's), Arnoux's and Gray's beaked whales (Jefferson *et al.*, 1994; Kasamatsu *et al.*, 1990).

sub-Antarctic Islands (e.g. Kasuya and Wada, 1991; Parker,1978; Tynan, 1997; Thiele *et al*., 2000; Borsa, 1997; de Boer, 2000[10]; de Boer *et al*., 1999; Leatherwood *et al*, 1982).

<u>*Sub-Antarctic Indian Ocean (general)*</u>
Southern Hemisphere baleen whales - blue, fin, minke (dwarf and/or Antartic minke *B. bonaerensis*), sei, and humpback whales) migrate south during the spring/early austral summer to Antarctic feeding grounds via sub-Antarctic waters, and back again during late/summer autumn. Southern right whales migrate to and from southern feeding grounds close to the Antarctic Convergence, and at times into the Antarctic.

Pygmy right whales occur between the Antarctic Convergence (~60°S) and about 30°S, in both coastal and oceanic waters (Jefferson *et al.,* 1994; Kemper *et al* 1997; Kemper and Leppard 1999) A sighting of a large school of pygmy right whales (~80) was made just south of the sub-tropical convergence in the Southeast Indian Ocean (Matsuoka *et al*., 1996).

Killer whales are relatively common on both sides of the Antarctic Convergence (Kasuya and Wada, 1991).

False killer whales are generally tropical to warm water cetaceans that have a worldwide distribution. However, Bellison (1966) listed false killer whales in Antarctic waters but, given current knowledge about this species, it appears unlikely that they occur at such high latitudes (Leatherwood *et al*., 1991) and we therefore consider false killer whales as rare/vagrant species in sub-Antarctic waters.

Long-finned pilot whales have been recorded in sub-Antarctic waters and in higher latitudes (*e.g*. de Boer *et al*., 1999; Borsa, 1997; Kasamatsu *et al*., 1990).

Kasamatsu *et al*. (1990) reported that hourglass dolphins inhabit the Southern Ocean mainly between 43°S -67°S, with most sightings between 54°S-62°S, near the Antarctic Convergence.

Southern right whale dolphins are found in cool temperate to sub-Antarctic waters. The southern limit appears to be bounded by the Antarctic Convergence (Jefferson *et al.,* 1994).

The spectacled porpoise can be found around offshore islands in the Southern Indian Ocean (Kerguelen and Heard Island). Although only few sightings have been made at sea, it is suggested that this porpoise may be circumpolar in the sub-Antarctic (Jefferson *et al.,* 1994; Goodall and Schiavini, 1995).

Dusky dolphins have only been recorded as possible sightings at sea on several occasions in the sub-Antarctic waters of the Southern Indian Ocean (Jefferson *et al.,* 1994; Brownell and Cipriano, 1999).

Commerson's dolphins appear to prefer relatively shallow coastal waters of Kerguelen Islands within the Sub-Antarctic waters of the Southern Indian Ocean (Jefferson *et al.,* 1994).

Southern bottlenose whales have a generally circumpolar distribution in the Southern Hemisphere south of 29°S (Jefferson *et al*., 1994).

<u>*Kerguelen Islands (48°30'-50°S; 68°30'-70°45'E)*</u>
Four mysticetes (minke, sei, Southern right and humpback whales*)* and seven odonotocetes (long-finned pilot, strap-toothed, killer and sperm whale, hourglass and Commerson's dolphins, and spectacled porpoises) have so far been reported from the waters and shores of Kerguelen Islands (Borsa, 1997; Robineau, 1989).

Large baleen whales (most likely to be fin whales) were sighted in March, 2000 (*see* Table 7), together with possible humpback whales and sperm whales. Other surveys confirmed the sightings originally reported by Robineau (1989) and Borsa (1997), including minke whales, strap-toothed whales, Commerson's dolphins, spectacled porpoises and hourglass dolphins (*see* table 7). Spectacled porpoises have only been reported from a few sightings near Kerguelen or within the Golfe du Morbihan (an enclosed, sheltered and shallow water bay of Kerguelen's Grande Terre) (Frost and Best, 1976).

One spectacled porpoise was sighted during low tide within the Golfe du Morbihan in December 1999 (*see* de Boer, 2000). The porpoise was observed for a period of 10 minutes milling in patches of exposed sea weed. An inflatable was launched and seemed to attract the animal's attention. The striking black back and white

[10] These surveys were conducted as a consequence of the recognition of the importance of the Indian and Southern Ocean Sanctuary areas (J. Frizell, Pers. comm)

underside were clearly observed. Commerson's dolphins were seen the previous and next day and the coloration of this species noted as significantly different (*i.e.* a white back) when compared to the spectacled porpoise sighted here. Furthermore, the dorsal fin was low and triangular, the animal appeared to be rather small with a completely black back and was surfacing in a typical porpoise swimming style (i.e. slow, forward-rolling motion).

Offshore waters of the Kerguelen shelf/Kerguelen-Amsterdam Passage/Southeast Indian Ridge
Possible spectacled porpoises, sperm, fin and minke whales (*see* Table 7) and Commerson's dolphins (Robineau, 1989) were sighted in the offshore waters of the Kerguelen shelf. Southern right, Blainville's beaked whales, killer, beaked, minke and fin whales, as well as hourglass dolphins were sighted in the Kerguelen-Amsterdam Passage (*see* Table 7). Long-finned pilot, minke, sei, sperm, fin, Southern right, beaked and humpback whales were sighted along the Southeast Indian Ridge (*see* Table 7).

Southwest Indian Ridge/Prince Edward/Crozet
Sperm whales were recorded in the Prince Edward Fracture Zone and a minke whale in the Southwest Indian Ridge (*see* Table 7). Southern bottlenose whales were sighted in the Conrad Rise (51-52°S, 46-48°E; *see* Table 7). Dusky dolphins have been recorded from Prince Edward Island (Van Waerebeek *et al.*, 1995) and from several sightings between Kerguelen and Crozet Islands (Robineau, 1989).

Guinet *et al.* (2000) reported a co-ordinated attack on a minke whale and prey sharing by killer whales at Crozet Archipelago. The same killer whales have been observed attacking other large cetaceans (Guinet, 1991; 1992) and are known to use the "stranding hunting" techniques (Guinet and Bouvier, 1995).

Distribution and migratory patterns

Southern Indian Ocean (general)
The distributions of blue, minke, fin, sei, humpback and southern right whales, as well as sperm, killer, pilot whales, ziphiids and hourglass, dusky, southern right whale dolphins (and other small cetaceans) are shown in Kasamatsu *et al.* (1990).

The southern right whale southernmost limit shifts seasonally from 40-45°S in November to 55-60°S in February and March (Kasuya and Wada, 1991). The density near the southern limits increases in January, but densities are always highest between 40-45°S from November to February and overlap with the sei whale distribution. Kasuya and Wada (1991) suggested that the majority of right whales remain in lower latitudes during the austral summer. Movement from the Antarctic, south of 60°S to the Australian coast has been confirmed (Bannister *et al.* 1999)

Kemper *et al.* (1997) suggested that pygmy right whales inhabit coastal waters for at least part of their annual cycle. Ross *et al* (1975) suggested a seasonal migration of pygmy right whales into South African waters in December during a period of high biomass of zooplankton occurring near the Cape Peninsula because of upwelling in the region. Matsuoka *et al.* (1996) reported a large school of pygmy right whales in an area where large patches of the species *Calanus tonsus* have been described, suggesting that whales were perhaps resting or waiting for a vertical ascent of the prey species. It was also suggested that this accumulation of animals indicated a late spring migration to higher latitudes (Matsuoka *et al.*, 1996).

Kerguelen Islands
The occurrence of minke whales in Kerguelen waters is restricted to November and March-April (Borsa, 1997). Borsa (1997) suggested that the Kerguelen region lies on the minke whales' route of migration from its breeding areas in the tropical Indian Ocean to its feeding areas in Antarctica waters and *vice versa*. De Boer *et al.* (1999) and de Boer (2000), however, reported minke whales in the Golfe du Morbihan (an enclosed, sheltered and shallow water bay of Kerguelen's Grande Terre) during December and February, which may well indicate that some minke whales at least remain in Kerguelen waters during the austral summer.

Borsa (1997) and de Buffrénil *et al.* (1989) reported peaks of density for Commerson's dolphins in the Golfe du Morbihan (in October and in November) and their absence in the winter. Borsa (1997) speculated that the winter (June-August) inshore sea-surface temperatures lie below the preferences of the Kerguelen Commerson's dolphin population, which then migrates to the warmer (~4°C) offshore waters of the Kerguelen shelf, where pods of ~10 individuals have been sighted in the winter (Robineau, 1989). Collet and Robineau (1988) presented evidence of both calving and mating of Commerson's dolphins during December and January. Borsa (1997) further mentioned the possibility that killer whales occur year-round in the inshore waters of Kerguelen.

Pollution

A literature search has revealed no published information.

By-catch and direct take

Right whales were once abundant at the Crozets and Kerguelen during the whaling season, and blue whales were similarly previously seen there in February (Wray and Martin, 1983). By the 1870s, right whales were scarce there, as elsewhere in the Southern Ocean by that time (IWC 2001). In 1909, nearly all whales that were caught from the station Port-Jeanne-d'Arc (in de Golfe du Morbihan) were humpback whales (Tonessen and Johnsen, 1982).

Cockcroft and Krohn (1994) reported on passive gear fisheries of the southwest Indian and southeastern Atlantic Oceans and assessed their possible impact on cetaceans. They reported evidence of substantial use of drift or gillnets in some areas, which may result in the depletion of local stocks of coastal cetaceans. The only known fisheries within Kerguelen's EEZ are commercial bottom and mid-water trawling operations by French and Russian vessels. No cetacean bycatch has been reported for either these or other fisheries in the area (Cockcroft and Krohn, 1994).

Climate change

Historically, much of the whaling in the Antarctic occurred in the vicinity of the ice edge where the whales congregated to feed on krill (Murphy and King, 1997). An analysis of catch data by de la Mare (1997) notes that there was a large and rapid decrease in Antarctic summertime sea-ice extent between the 1950s and 1970s. This abrupt change poses a challenge to model simulations of recent climate change, and could imply changes in Antarctic deep-water formation and in biological productivity (de la Mare, 1997).
Krill (*Euphausia superba*) provide a direct link between primary producers and higher trophic levels in the Antarctic marine food web (*e.g.* Brierley *et al.*, 2002; Reid and Croxall, 2001; Quitin and Ross, 1991; Nicol, 1995; Marchant and Murphy, 1994) and its decline may impact populations that migrate into the IOS.

Other

Hodges and Woehler (1993) reported on associations between seabirds and cetaceans in the Australian sector of the Southern Indian Ocean from data collected by ANARE and re-supply vessels. Most species of seabirds commonly observed in the Australian sector have been recorded in association with cetaceans, but further research examining associative and non-associative behaviour, feeding and non-feeding associations, diets of associating taxa and prey abundance is required in order to determine which seabird species associate more frequently with cetaceans and what benefits are derived from the association.

Future work/conclusions

Sub-Antarctic Islands form suitable 'platforms' for research and we would like to suggest here that more cetacean research could be carried out from such Islands, particularly with respect to seasonal occurrence of cetaceans and the extent and impact of environmental changes. We also highlight the need for further observational cetacean research at sea, where research vessels focussed on other investigations may offer suitable platforms of opportunity (de Boer, 2001).

8. Central Indian Ocean

Oceanography

The ocean floor is dominated by the Central Indian Ridge and subdivided by the Southeast Indian Ocean Ridge, Southwest Indian Ocean Ridge, and Ninety-East Ridge (Rao and Griffiths, 1998). The Ninety-East Ridge divides the deeper areas into several basins, particularly at the depth of the 4,000m isobath and affects the deepwater movement in the Indian Ocean (Rao and Griffiths, 1998). There is great variability of depth from less than 1,000 to over 5,000m. The surface water is characterised by the reversal of currents north and south of the Equator and the seasonal monsoon periods (*e.g.* Rao and Griffiths, 1998).

Species Diversity

Species that inhabit temperate and tropical pelagic conditions have also been recorded for the central Indian Ocean. Kato *et al* (1995) reports on the distribution of blue whale sub-species within the Sanctuary. Those found in mid-latitudes are believed to be pygmy blue whales (*Balaenoptera musculus brevicauda*).

Kasuya and Wada (1991) suggest different stocks of Bryde's whale in the Sanctuary, but this needs further investigation.

Spinner dolphins and sperm whales appear to be major components of the cetacean fauna in the central Indian Ocean (Eyre, 1997), however more systematic surveys need to be conducted to establish an accurate picture of the distribution and relative abundance of cetaceans in this area.

Pygmy right whales have been recorded from the western and eastern sectors of the Sanctuary (Matsuoka, *et al*., 1996; Ross *et al*, 1975) and may occur in the central portion.

Sightings

Stenella sp., *Delphinus* sp., *Physeter macrocephalus, Orcinus orca, Globicephala* sp., *Pseudorca crassidens, Feresa attenuata, Peponocephala electra, Grampus griseus, Steno bredanensis*, *Tursiops* sp., *Ziphius cavirostris* and other ziphiids, *Balaenoptera musculus* and *B. edeni* have been encountered in the deep waters of the central Indian Ocean (Leatherwood, 1980; Leatherwood *et al*, 1991; Kasuya and Wada, 1991; Eyre, 1995, 1997, 2000; de Boer, 2001).

Both species of pilot whale have been recorded from this part of the Sanctuary. Short-finned pilot whales (*Globicephala macrorhynchus*) have been positively identified from the northern portion of the central Indian Ocean (Bernard and Reilly, 1999).

Distribution and Migratory Patterns

Eyre (1995, 1997, 2000) and de Boer (2001) report species encountered on transit across the Sanctuary during April, May and June. The low encounter rate may reflect the actual abundance and temporal distribution of species in an area of relatively low productivity.

Migration patterns are largely unknown. Anderson *et a.l* (1999), Leatherwood (1980), Kato *et a.l* (1995), Kasuya and Wada (1991) and Robineau (1991) report seasonal occurrences of Balaenopterids in the Indian Ocean.

Kasuya and Wada (1991) conclude sperm and killer whales inhabit similar geographic areas of the Sanctuary, including the central sector. Townsend's (1935) charts show catch locations and seasonality for sperm whales.

No data exist for abundance estimates or temporal movements of small cetaceans in the central Indian Ocean.

By-catch and Direct Take

Pelagic purse-seining and long-line operations have been observed mid-ocean (Eyre, 1995, 2000), and some interaction with cetaceans has been noted (Robineau, 1991; Sabadach and Hallier, 1993; Evans, 1994; Leatherwood *et al*., 1991).

No information exists for direct take of cetaceans in this area. However, it is possible that animals are killed for long-line bait.

Environmental Degradation

Shipping lanes in the northern central Indian Ocean may constitute hazards in the form of ship collisions, acoustic disturbance and chemical spills.

There is no information to date on chemical pollution and its effects on cetaceans in the central Indian Ocean.

Grace (1994, 1995, 1997a, 1997b and 2000) has investigated man-made debris in the central Indian Ocean. Elsewhere, delphinids and other cetacea have been reported to ingest foreign items (Kruse, *et al*., 1999).

Conclusion

The cetacean fauna of the central Indian Ocean has not been systemically or extensively studied, although a series of surveys (Eyre, 1995, 1997, 2000; de Boer *et al*., 1999; de Boer, 2000 and 2001; Grace, 1994, 1995, 1997b and 2000; see also Table 7) have been conducted as a consequence of the recognition of the importance of the Indian Ocean Sanctuary areas (J. Frizell, Pers. comm).

As many merchant vessels cross the Sanctuary, they could be investigated as possible platforms of opportunity for sightings. Whilst the migratory termini of two balaenopterids (humpbacks, right whales) in the Sanctuary are well known, those for other baleen whales and their specific migration routes are not. The use of acoustics to monitor for species should be further investigated.

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Table 1: Records of cetaceans in the Arabian region

Odontocetes	**Persian Gulf**	**Gulf of Oman**	**Arabian Sea**	**Gulf of Aden**	**Red Sea**	***Inshore/ Offshore***
Neophocaena phocaenoides, finless porpoise *	✓					In
Tursiops truncatus, Bottlenose dolphin *	✓✓	✓✓	✓✓	✓✓	✓	In & Off
Tursiops aduncus, Bottlenose dolphin *	✓✓	✓✓	✓✓	✓✓	✓	In & Off
Delphinus delphis, Common dolphin *	✓✓	✓✓	✓✓	✓✓		In & Off
Delphinus cf. *D. tropicalis* (Van Bree, 1971), Tropical dolphin *	✓	✓✓	✓✓	✓✓	✓	In & Off
Stenella longirostris, Spinner dolphin *	✓	✓✓	✓✓	✓✓	✓	In & Off
Stenella attenuata, Spotted dolphin	✓	✓	✓✓	✓✓	✓	In & Off
Stenella coeruleoalba, Striped dolphin		✓	✓✓	✓✓		Off
Grampus griseus, Risso's dolphin *	(✓)	✓✓	✓✓	✓	✓	Off
Sousa chinensis Indo-Pacific humpback dolphin*	✓		✓✓	✓✓	✓	In
Sousa cf. *S. plumbea* (G. Cuvier, 1829), Humpback dolphin Indian form *	✓✓	✓✓	✓✓	✓✓	✓	In
Steno bredanensis, Rough-toothed dolphin		✓	✓		✓	In & Off
Pseudorca crassidens, False killer whale *	✓	✓✓	✓✓	✓	✓	In & Off
Feresa attenuata, Pygmy killer whale		✓	✓			Off
Orcinus orca, Killer whale	✓	✓	✓	✓	✓	Off
Globicephala macrorhynchus, Pilot whale		(✓)	(✓)	(✓)		Off
Peponocephala electra, Melon-headed whale			✓	✓		Off
Kogia simus, Dwarf sperm whale		✓	✓	✓		In & Off
Physeter macrocephalus, Sperm whale *		✓	✓✓	✓		Off
Ziphius cavirostris, Cuvier's beaked whale		✓	✓			Off
Mysticetes						
Megaptera novaeangliae, Humpback whale *	✓	✓	✓✓		(✓)	In & Off
Balaenoptera edeni, Bryde's whale *	✓	✓✓	✓	✓		In & Off
Balaenoptera acutorostrata, Minke whale		✓	✓			Off
Balaenoptera musculus, Blue whale	(✓)	✓	✓	✓		In & Off
Balaenoptera physalus, Fin whale	✓		✓			Off
Balaenoptera borealis, Sei whale	(✓)	(✓)	(✓)			Off

Footnotes: Recorded: ✓, More Frequently Recorded ✓✓, Unconfirmed: ( ), Known breeding resident: *.
Note: The boundary between the Gulf of Oman and Arabian Sea is taken to be Ra's al Hadd, Oman (22°32'N, 59°47'S).

Sources: Balance & Pitman (1998), Baldwin (1995), Baldwin & Minton (2000), Baldwin *et al*. (1999) Baldwin *et al*. unpublished data, Chantrapornsyl *et al*. (1991), Gallagher (1991a & b), Henningsen & Constantine (1992), Kruse *et al*. (1991), Leatherwood *et al.* (1991), Mikhalev (1997), Reeves *et al.* (1991), Robineau & Rose (1984), Robineau & Fiquet (1994), Papastavrou & Salm (1991), Parsons (1998), Pilleri & Gihr (1972 & 1974), Preen *et al.* (2000), Small & Small (1991), IWC (1998), Smeenk *et al*. (1996), Eyre (1994) and van Waerebeek *et al.* (1999).

Table 2. The occurrence of cetacean species in North-eastern Indian Ocean waters and Iran.

Species	Iran	Pakistan	India	Sri Lanka	Bangladesh	Myanmar (Burma)	Thailand	Indonesia
Eubalaena australis			+					
Megaptera navaeangliae		●	●	●				
Balaenoptera acutorostrata				●				
Balaenoptera edeni		●	●	●			●	●
Balaenoptera borealis			●					●
Balaenoptera physalus		●	●	●				●
Balaenoptera musculus		●	●	●	+			●
Physeter macrocephalus			●	●			●	●
Kogia breviceps			●	●		○		
Kogia sima	○	●	●	●		○	●	●
Ziphius cavirostris[4]		●		●				●
Hyperoodon sp.				●				●
Mesoplodon ginkodens				●		○	●	
Steno bredanensis			●	●		○	●	●
Sousa chinensis	○	●	●	●	○	○	●	●
Tursiops spp. [1]	○	●	●	●	○	○	●	●
Stenella attenuata	○	○	●	●	○	○	●	●
Stenella longirostris	○		●	●	○	○	●	●
Stenella coeruleoalba[3]				●		○	●	○
Delphinus spp. [2]		●	●	●	○	○	●	●
Lagenodelphis hosei			●			○		●
Grampus griseus	○	○	●	●	○	○		●
Peponocephala electra	○	●	●	●		○	●	●
Feresa attenuata			○	●		○		●
Pseudorca crassidens	●	●	●	●	○	○	●	●
Orcinus orca	○	●	●	●	○	○	●	●
Globicephala macrorhynchus	●	○	●	●	○	○	●	●
Orcaella brevirostris			●		○	○	●	●
Neophocaena phocaenoides	○	●	●		●	○	●	●

○: occurrence of species not confirmed but suspected to occur; ●: species known to occur;+: species reported before 1950;[1] *Tursiops aduncus* typically occurs in many coastal waters of Asia and may be sympatric with the larger, more robust species *Tursiops truncatus* in several locales, although the latter may inhabit more oceanic waters;[2] *Delphinus delphis*; *Delphinus capensis* and *Delphinus* c.f. *tropicalis*. The latter two forms are predominant south and west of China; [3] *S. coeruleoalba* was recorded in Northern Sulawesi (Indonesia), however, outside the Indian Ocean Sanctuary (Benoldi and Peccioni, 1999); [4] Pilleri and Gihr (1972) reported on a vertebra in Pakistan, that they identified as *Ziphius cavirostris*.

Sources of data: Leatherwood 1986; Chantrapornsyl *et al.* 1991; Leatherwood *et al.* 1991; Elkin 1992; Chantrapornsyl & Andersen 1995; Kim & Huh 1995; Perrin *et al*. 1996a; Parsons & Wang 1998, Andersen & Kinze 1999; Bonhote, 1903;Leatherwood and Reeves (1989); De Silva (1987); Alling (1987); Pitman *et al*. (1999); Dhanapani and Afred (1998); Pilleri 1973; Pilleri and Gihr 1974; Forman, 1993; Chantrapornsyl *et al*. (1996); Perrin *et al*., 1989; Tas'an & Leatherwood (1983); Rudolph *et al*. (1997); Kahn (1999);Kahn (2000); Hembree (1980);Eyre (1995); Leatherwood *et al*. (1984); Alverson (1981); De Boer (2001);Hoffman (1998); Kartasantana & Suwelo (1994); Mörzer Bruyns (1966); Kreb (1999); Priyono (1995); Leatherwood *et al*. (1991); Dammerman (1926); Barnes (1991); Pitman *et al*. (1999); Oshumi (1980); Benoldi and Peccioni (1999); Pilleri and Gihr (1972); Roberts, 1997

Table 3. A country by country summary of factors which could threaten or impact to coastal small cetaceans. Open circles refer to possible impacts, whereas filled circles indicate definite impacts to cetacean species within that particular country (Parsons, 1999).

Country	Direct takes	By-catch	Habitat loss			Pollution	Boat Traffic
			Deforestation	Reclamation	Capture Fisheries		
Iran		●				●	○
Pakistan		●	○			○	
India		●	○	○	○	●	●
Sri Lanka	○	●	○			○	
Bangladesh		●	○			○	
Myanmar (Burma)		●	○			○	
Thailand		●	●		●	○	●
Indonesia	●	●	●		●	●	○

Table 4. Table showing levels of toxic pollutant contamination in small cetaceans from India. Concentrations are listed as μg.g^{1} wet weight. Concentrations of metals and butyltins ΣBT) are from liver tissue and organochlorine concentrations are from blubber.

		Trace Metals				Organochlorines		
	Species	Cd	Hg	Pb	ΣBT	ΣPCB	ΣDDT	Reference
India	*S. longirostris*	-	-	-	-	0.24-0.95	4.5-35	Tanabe *et al.* 1993
	T. truncatus	-	-	-	-	0.37-0.67	2.1-14	
	S. chinensis	-	-	-	-	0.92-1.8	11-14	

Table 5. Cetaceans recorded in the waters off the southwest coast of Western Australia (Preliminary list using available records and references). (p = presumed; s=sighting record only)

Species	*Conservation Status*		*South west waters occurrence*	
	Australian Action Plan[1]	*EPBC Act*[2]	*Records Exist*	*May Occur*
Toothed Whales				
Common Dolphin – *Delphinus delphis*	*NCA(b)*	*Not Listed*	√	
Bottlenose Dolphin – *Tursiops truncatus*	*NCA(a)*	*Not Listed*	√	
Striped Dolphin – *Stenella coeruleoalba*	*NCA(a)*	*Not Listed*	√	
Dusky dolphin – *Lagenorhynchus obscurus*	*NCA(a)*			√
Risso's Dolphin – *Grampus griseus*	*NCA(a)*	*Not Listed*	√	
Southern Right Whale Dolphin – *Lissodelphis peronii*	*NCA(a)*	*Not Listed*	√s	
Pan-tropical spotted dolphin – *Stenella attenuata*	*NCA(b)*	*Not Listed*	√	
Long-finned Pilot Whale – *Globicephala melas*	*NCA(b)*	*Not Listed*	√	
Short finned pilot whale – *Globicephala macrorhynchus*	*NCA (b)*		√	
Killer Whale – *Orcinus orca*	*NCA(c)*	*Not Listed*	√	
False Killer Whale – *Pseudorca crassidens*	*NCA(b)*	*Not Listed*	√	
Spinner dolphin – *Stenella longirostris*	*NCA(a)*	*Not Listed*	√	
Sperm Whale – *Physeter macrocephalus*	*Insufficiently Known*	*Not Listed*	√	
Pygmy sperm whale – *Kogia breviceps*	*NCA(a)*		√	
Dwarf sperm whale – *Kogia simus*	*NCA(a)*		√	
Southern Bottlenose Whale – *Hyperoodon planifrons*	*NCA(b)*	*Not Listed*	√p	
Shepherd's beaked whale – *Tasmacetus shepherdi*	*NCA(a)*		√	
Arnoux's beaked whale – *Berardius arnouxii*	*NCA(b)*		√	
Hector's Beaked Whale – *Mesoplodon hectori*	*NCA(a)*	*Not Listed*	√	
Andrew's Beaked Whale – *Mesoplodon bowdoini*	*NCA(a)*	*Not Listed*	√	
Gray's Beaked Whale – *Mesoplodon grayii*	*NCA(b)*	*Not Listed*	√	
Strap-toothed Beaked Whale – *Mesoplodon layardii*	*NCA(b)*	*Not Listed*	√	
True's beaked whake – *Mesoplodon mirus*	*NCA(a)*		√	
Melon-headed whale – *Peponocephala electra*	*NCA(a)*	*Not Listed*		√
Cuviers Beaked Whale – *Ziphius cavirostris*	*NCA(b)*	*Not Listed*	√	

Baleen Whales				
Blue Whale – *Balaenoptera musculus intermedia*	***Endangered***	***Endangered*** *(TS); MS*	√	
Pygmy Blue Whale – *Balaenoptera musculus brevicauda*	*NCA(a)*	*Not Listed*	√	
Southern Right Whale – *Eubalaena australis*	***Vulnerable***	***Endangered*** *(TS); MS*	√	
Pygmy Right Whale - *Caperea marginata*	*NCA(b)*	*Not Listed*	√	
Humpback Whale – *Megaptera novaeangliae*	***Vulnerable***	***Vulnerable*** *(TS); MS*	√	
Sei Whale – *Balaenoptera borealis*	***Vulnerable***	***Vulnerable*** *(TS)*		√
Fin Whale – *Balaenoptera physalus*	***Vulnerable***	***Vulnerable*** *(TS)*	√	
Bryde's Whale – *Balaenoptera edeni*	*NCA(a)*	*Not Listed*		√
Minke Whale – *Balaenoptera acutorostrata bonaerensis*	*Secure*	*Not Listed*	√	

1 Bannister *et al.*, 1996 **2** TS: List of Threatened Species; MS: List of Migratory Species

NCA(a) No category assigned, because of insufficient information; **NCA(b)** No category assigned, but possibly secure; **NCA(c)** No category assigned, but probably secure

Table 6. Species recorded during surveys and those likely to be present in the tropical Indian Ocean pelagic, shelf and near-shore waters.

Genus/species		**Other species likely to be present**[11]	
Scientific name	Common name	*Scientific name*	Common name
Balaenoptera musculus.	blue whale	*Balaenoptera physalus*	fin whale
Balaenoptera edeni	Bryde's whale	*Balaenoptera borealis*	sei whale
Balaenoptera acustorostrata	minke whale	*Balaenoptera acutorostrata bonaerensis*	minke whale (ordinary)
Megaptera novaeangliae	humpback whale	*Balaenoptera acutorostrata*	dwarf minke whale
Physeter macrocephalus	sperm whale	*Kogia simus*	dwarf sperm whale
Mesoplodon densirostris	Blainville's beaked whale	*Kogia breviceps*	pygmy sperm whale
Hyperoodon planifrons	Southern bottlenose whale	*Hyperoodon sp.*	tropical bottlenose whale
Orcinus orca	killer whale	*Ziphius cavirostris*	Cuvier's beaked whale
Globicephala sp.	pilot whale	*Globicephala macrorhynchus*	short finned pilot whale
Pseudorca crassidens	false killer whale	*Feresa attenuata*	pygmy killer whale
Peponocephala electra	melon headed whale	*Tursiops aduncus*	bottlenose dolphin
Sousa chinensis	Indo-Pacific humpbacked dolphin		
Steno bredanensis	rough toothed dolphin		
Grampus griseus	Risso's dolphin		
Tursiops sp.	bottlenose dolphins		
Stenella longirostris	long snouted dolphin		
Stenella attenuata	spotted dolphin		
Delphinus sp.	common dolphins		
Stenella coeruleoalba	striped dolphin		
Lagenodelphis hosei	Fraser's dolphin		

[11] Source: Bannister *et al.*, 1996; Burns, 1994; Indonesia Pilot, 1999; Pitman *et al.,* 1999; Reeves and Leatherwood, 1994; UNEP, 1996; UNEP, 1991; Wilson *et al.*, 1987; D. Thiele (pers. commn).

Table 7. Information on cetacean sightings within sub-Antarctic waters of the Indian Ocean Sanctuary made by Greenpeace[12]

Voyage	Species	Number	°S	°E	Area
Cape Town (SA) to Fremantle (AU), December 1999.	Unidentified whale	1	44°05'	31°39'	Southwest Indian Ridge
	Unidentified dolphin	1	44°08'	31°44'	Prince Edward Fracture Zone
	Unidentified dolphin	4	44°17'	32°02'	Prince Edward Fracture Zone
	Sperm whale	1	44°49'	33°03'	Prince Edward Fracture Zone
	Sperm whale	1	44°53'	33°11'	Prince Edward Fracture Zone
	Unidentified dolphin	5	47°07'	37°26'	Prince Edward Fracture Zone
	Minke whale	3	50°35'	45°03'	Southwest Indian Ridge
	Southern bottlenose whale	1	51°08'	46°22'	Conrad Rise
	Southern bottlenose whale	2	52°13'	48°53'	Conrad Rise
	Minke/bottlenose whale?	1	51°14'	68°31'	Offshore waters of the Kerguelen shelf
	Hourglass dolphin	7	49°31'	70°25'	Kerguelen
	Unidentified whale	1	48°39'	74°22'	Offshore waters of the Kerguelen shelf
	Fin whale	3	48°30'	74°54'	Offshore waters of the Kerguelen shelf
	Minke whale	1	48°30'	74°55'	Offshore waters of the Kerguelen shelf
	Unidentified whale	1	48°19'	75°23'	Offshore waters of the Kerguelen shelf
	Fin whale	3	47°53'	76°33'	Kerguelen-Amsterdam Passage
	Hourglass dolphin	5	47°53'	76°33'	Kerguelen-Amsterdam Passage
	Unidentified whale	1	46°29'	80°20'	Kerguelen-Amsterdam Passage
	Blainville's beaked	5	46°18'	80°55'	Kerguelen-Amsterdam Passage
	Cuvier's beaked whale	2	46°15'	81°08'	Kerguelen-Amsterdam Passage
	Killer whale	1	46°09'	81°31'	Kerguelen-Amsterdam Passage
	Beaked whale	1	45°01'	84°28'	Kerguelen-Amsterdam Passage
	Pilot whale	16	43°29'	88°13'	Southeast Indian Ridge
	Minke whale	1	42°58'	89°20'	Southeast Indian Ridge
	Beaked whale	2	41°38'	92°51'	Southeast Indian Ridge
	Humpback whale	1	40°34'	95°17'	Southeast Indian Ridge
	Humpback whale	1	40°34'	95°17'	Southeast Indian Ridge
Fremantle (AU) to Port Louis (Mauritius), March 2000.	Sei whale (probable)	1	41°48'	95°58'	Southeast Indian Ridge
	Sperm whale (possible)	1	48°10'	72°03'	Kerguelen-Amsterdam Passage
	Sperm whale	1	48°44'	71°35'	Offshore waters of the Kerguelen shelf
	Humpback whale (poss.)	2	48°48'	70°12'	Kerguelen
	Fin whale (possible)	2	48°48'	70°24'	Kerguelen
	Fin whale (possible)	4	48°49'	70°20'	Kerguelen
	Fin whale (possible)	4	48°49'	70°10'	Kerguelen
	Fin whale (possible)	4	48°50'	70°11'	Kerguelen
	Sperm whale	1	48°38'	71°23'	Offshore waters of the Kerguelen shelf
	Unidentified whale	4	46°28'	66°42'	Offshore waters of the Kerguelen shelf
Hobart (AU) – Port Louis (Mauritius), February-March 1999 (de Boer *et al.* 1999)	Strap-toothed whale	1	49°27'	70°13'	Kerguelen
	Minke whale	1	49°27'	70°13'	Kerguelen
	Minke whale	1	49°26'	70°12'	Kerguelen
	Commerson's dolphin	3	49°25'	70°10'	Kerguelen
	Unidentified whale	1	49°02'	71°02'	Kerguelen
	Spectacled porpoise?	4	48°28'	71°34'	Offshore waters of the Kerguelen shelf
	Unidentified whale	2	48°56'	76°19'	Offshore waters of the Kerguelen shelf
	Right whale	1	51°24'	79°14'	Kerguelen-Amsterdam Passage
	Fin whale	1	51°36'	79°25'	Kerguelen-Amsterdam Passage
Hobart (AU) to Fremantle (AU), November 1999-February 2000 (de Boer, 2000)	Dolphin sp.	1	51°06'	68°37'	Kerguelen
	Minke whale	1	49°28'	70°14'	Kerguelen
	Commerson's	1	49°21'	70°11'	Kerguelen
	Porpoise	1	49°21'	70°12'	Kerguelen
	Commerson's	3	49°27'	70°13'	Kerguelen
	Commerson's	2	49°28'	70°13'	Kerguelen
	Commerson's	2	49°30'	70°19'	Kerguelen
	Minke	1	51°44'	70°25'	Offshore waters of the Kerguelen shelf
	Right whale	2	46°17'	108°09'	Southeast Indian Ridge
	Fin whale	1	44°57'	109°04'	Southeast Indian Ridge
	Sperm whale	1	44°48'	109°08'	Southeast Indian Ridge
	Unidentified whale	1	42°18'	110°30'	Southeast Indian Ridge
	Unidentified whale	1	41°36'	110°53'	Southeast Indian Ridge

[12] Sources: De Boer *et al.*, 1999; De Boer, 2000; J. Frizell and R. Witte.

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