

A review of cetacean research and conservation in Sri Lanka

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ABSTRACT

Sri Lanka is a developing island nation in the northern Indian Ocean. Travellers and historians have documented whales in the waters around the island as far back as the 14th century but the first scientific records of live cetaceans from vessel-based research observations were documented only in the early 1980s. Sri Lanka's waters have high cetacean species richness with 27 species recorded to date and year-round abundance. Small cetaceans are however increasingly threatened due to the developing fisheries industry, with bycatch being a major cause for concern. Other identified threats include increasing shipping traffic and unregulated marine tourism. Cetaceans are protected by national legislation but implementation of the relevant laws and conservation measures is hampered by resource constraints. The prevailing gaps in knowledge are also due to a lack of resources to carry out dedicated long-term research on cetaceans in a developing country with more immediate human development priorities. Therefore strengthened law enforcement and finding adequate resources for sustained systematic research that can inform management decisions are priorities in Sri Lanka.

KEYWORDS: CONSERVATION; INDIAN OCEAN; INCIDENTAL CATCHES; SPERM WHALE; BLUE WHALE; BLAINVILLE'S BEAKED WHALE; INDO-PACIFIC HUMPHACK DOLPHIN; SPINNER DOLPHIN; COMMON BOTTLENOSE DOLPHIN; RISSO'S DOLPHIN; PAN-TROPICAL SPOTTED DOLPHIN; FRASER'S DOLPHIN; ROUGH-TOOTHED DOLPHIN; SHORT-FINNED PILOT WHALE; FALSE KILLER WHALE; PYGMY KILLER WHALE; KILLER WHALE; MELON-HEADED WHALE; COMMON DOLPHIN; CUVIER'S BEAKED WHALE; BLAINVILLE'S BEAKED WHALE; GINKGO-TOOTHED BEAKED WHALE; LONGMAN'S BEAKED WHALE; SOUTHERN BOTTLENOSE WHALE; PYGMY SPERM WHALE; DWARF SPERM WHALE; FIN WHALE; COMMON MINKE WHALE; HUMPHACK WHALE; BRYDE'S WHALE

INTRODUCTION

Sri Lanka (5°–9°N, 79°–81°E) is a developing island nation in the northern Indian Ocean (Fig. 1) with a long tradition of fisheries around her shores. Travellers and historians have referred to whales around Sri Lanka (previously referred to as Serendib, Taprobane or Ceylon) as far back as the 14th century (Tennant, 1859). Records of stranded whales and museum specimens were first reported from the 1850s (Blyth, 1859; Deraniyagala, 1945; 1960; Fernando, 1912; Kelaart, 1852) and interactions between cetaceans and fisheries from the 1880s (Lantz and Gunasekera, 1955; Nevill, 1887). Scientific records of live cetaceans were not documented until as recently as the early 1980s and present knowledge remains limited due to a lack of dedicated research.

After the International Whaling Commission (IWC) established the Indian Ocean Sanctuary in 1979, cetaceans and cetacean research in Sri Lanka became an area of focus both nationally and internationally (Ilangakoon, 2002; Leatherwood and Reeves, 1989). Further impetus was added with the convening of the first Symposium on Indian Ocean Marine Mammals, held in Colombo in 1983. In the early 1980s, the World Wildlife Fund sponsored 'Tulip Expedition' studied sperm whales (*Physeter macrocephalus*) in the waters around Sri Lanka and brought the occurrence of large numbers of sperm whales and blue whales (*Balaenoptera musculus*) close to land in northeastern waters to the attention of cetacean researchers around the world (Alling *et al.*, 1991; Whitehead, 1989; Whitehead *et al.*, 1983). Consequently, the first national marine mammal research programme in Sri Lanka was initiated by the National Aquatic Resources Research and Development Agency (NARA) in 1984. The initial focus of that programme was on large whales, but early efforts indicated that Sri Lanka was a 'hotspot' in terms of diversity and abundance of cetaceans in general. Soon the

scope of the programme expanded to include small cetaceans, as the threat posed by incidental bycatch in fishing gear was recognised early in the project. With this awareness, a further multi-pronged national research programme was initiated in 1985 with funding from the United Nations Environment Programme (UNEP). These national efforts continued for the next decade and since the mid-1990s individual researchers and international Non-Governmental Organisation (NGO) funded projects have continued sporadic research in Sri Lankan waters. Much of what is known about cetaceans around Sri Lanka today is a result of these varied projects and research efforts (Ilangakoon, 1989; 1997; 2002; 2006c; 2009; Ilangakoon *et al.*, 2000a; Ilangakoon and Perera, 2009; Ilangakoon *et al.*, 2000b; Leatherwood and Reeves, 1989; Ocean Alliance, 2003).

This paper summarises the current state of knowledge on cetaceans in Sri Lankan waters, focuses attention on current and potential threats, and highlights future research and conservation priorities.

RESULTS AND DISCUSSION

Three decades of research, even though sporadic and discontinuous, has resulted in the collection of some valuable information on cetaceans around Sri Lanka. It has also resulted in a small but growing national consciousness about an important aspect of marine biodiversity that was largely unknown before. The present state of knowledge can be examined in relation to what is known about cetaceans in these waters, the threats they face, legal aspects, conservation, research, information gaps and future priorities.

Species diversity and relative abundance

The waters off Sri Lanka are inhabited by a rich diversity of cetaceans, with apparent year-round abundance (Ilangakoon,

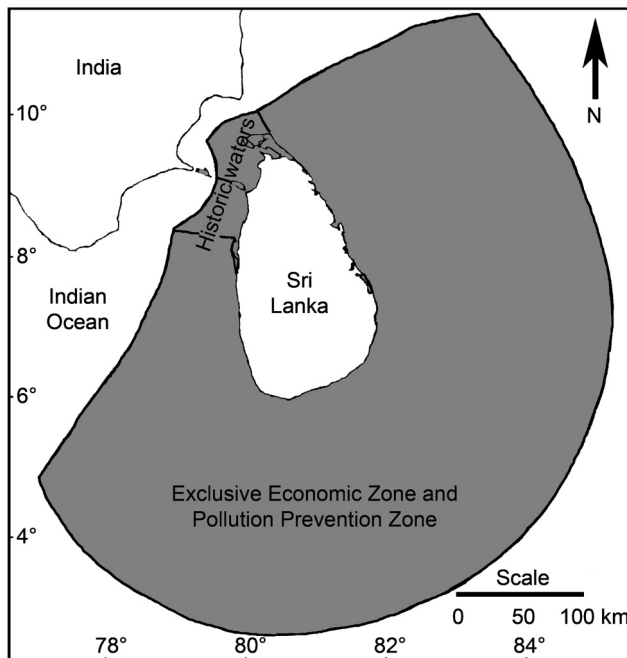


Fig. 1. Location map of Sri Lanka and surrounding waters.

1997; 2002; 2006a; 2006c; Ilangakoon *et al.*, 2000b; Leatherwood and Reeves, 1989). Based on current taxonomy 27 species of cetaceans under the two sub-orders Mysticeti and Odontoceti and placed within the six families of *Balaenopteridae*, *Physeteridae*, *Kogiidae*, *Ziphiidae*, *Delphinidae* and *Phocoenidae* have been recorded from the

waters around the island (Table 1). This species list is based on specimens obtained from strandings on the coastline (Deraniyagala, 1945; Deraniyagala, 1948; Deraniyagala, 1960; 1965; Ilangakoon, 2002; 2006c; Leatherwood and Reeves, 1989; Pearson, 1931), specimens from the fisheries bycatch and direct take (Dayaratne and Joseph, 1993; Ilangakoon, 1989; 1997; 2002; Ilangakoon *et al.*, 2000a; Ilangakoon *et al.*, 2000b; Leatherwood, 1990; Leatherwood and Reeves, 1989; Prematunga *et al.*, 1985) and sightings from offshore surveys (Afsal *et al.*, 2008; Alling, 1986; Alling *et al.*, 1991; Ballance and Pitman, 1998; Ilangakoon, 2002; 2005; 2006a; 2009; Ilangakoon *et al.*, 2000a; Leatherwood *et al.*, 1984; Leatherwood and Reeves, 1989; Ocean Alliance, 2003). It is likely that this species list is still incomplete, as dedicated research has been limited and new species continue to be added. One such example is the addition of Blainville's beaked whale (*Mesoplodon densirostris*) in 2002, based on a specimen identified in fisheries bycatch (Ilangakoon, 2002; 2003).

The continental shelf around Sri Lanka, except in the north and northwest, is relatively narrow, with deep waters being found quite close to the shore around most of the island's coastline (Wijeyananda, 1997). Cetaceans are distributed all around the island. Although no specific abundance estimates have yet been made for any species, bycatch studies (Dayaratne and Joseph, 1993; Ilangakoon, 1989; 1997; Ilangakoon *et al.*, 2000b; Leatherwood and Reeves, 1989) and limited vessel surveys (Afsal *et al.*, 2008; Bröker and Ilangakoon, 2008; Ilangakoon, 2002; 2005; 2006a; 2006c; 2009; Ilangakoon and Perera, 2009) demonstrate that the

Table 1
Cetacean species recorded in Sri Lankan waters.

Species	Based on			Key references
	Si	St	Ca	
Blue whale (<i>Balaenoptera musculus</i>)	X	X	–	Deraniyagala (1948); Leatherwood and Reeves (1989); Ilangakoon (2002)
Fin whale* (<i>Balaenoptera physalus</i>)	–	?	X	Deraniyagala (1965); Leatherwood and Reeves (1989)
Bryde's whale* (<i>Balaenoptera brydei/edeni</i>)	X	X	–	Leatherwood and Reeves (1989); Ilangakoon (2002); Herath (2007)
Minke whale (<i>Balaenoptera acutorostrata</i>)	X	X	–	Deraniyagala (1963); Leatherwood and Reeves (1989); Ilangakoon (2002)
Humpback whale (<i>Megaptera novaeangliae</i>)	X	X	–	Deraniyagala (1965); Leatherwood and Reeves (1989); Ilangakoon (2002)
Sperm whale (<i>Physeter macrocephalus</i>)	X	X	X	Deraniyagala (1965); Leatherwood and Reeves (1989); Ilangakoon (2002)
Pygmy sperm whale (<i>Kogia breviceps</i>)	–	X	X	Pearson (1931); Leatherwood and Reeves (1989); Ilangakoon (2002)
Dwarf sperm whale (<i>Kogia sima</i>)	X	X	X	Leatherwood and Reeves (1989); Ilangakoon (2002; 2006b)
Spinner dolphin (<i>Stenella longirostris</i>)	X	X	X	Phillips (1935); Leatherwood and Reeves (1989); Ilangakoon (2002)
Pantropical spotted dolphin (<i>Stenella attenuata</i>)	X	–	X	Alling (1986); Leatherwood and Reeves (1989); Ilangakoon (2002)
Striped dolphin (<i>Stenella coeruleoalba</i>)	X	–	X	Alling (1986); Leatherwood and Reeves (1989); Ilangakoon (2002)
Common bottlenose dolphin (<i>Tursiops truncatus</i>)	X	X	X	Phillips (1935); Leatherwood and Reeves (1989); Ilangakoon (2002)
Indo-Pacific hump-backed dolphin (<i>Sousa chinensis</i>)	X	X	X	Deraniyagala (1945); Ilangakoon (2005; 2006b)
Rough-toothed dolphin (<i>Steno bredanensis</i>)	X	–	X	Leatherwood and Reeves (1989); Ilangakoon (2002)
Common dolphin* (<i>Delphinus capensis</i>)	–	–	X	Alling (1986); Leatherwood and Reeves (1989); Ilangakoon (2002)
Fraser's dolphin (<i>Lagenodelphis hosei</i>)	X	–	X	Leatherwood and Reeves (1989); Ilangakoon (2002)
Risso's dolphin (<i>Grampus griseus</i>)	X	–	X	Alling (1986); Leatherwood and Reeves (1989); Ilangakoon (2002)
Short-finned pilot whale (<i>Globicephala macrorhynchus</i>)	X	X	X	Alling (1986); Leatherwood and Reeves (1989); Ilangakoon (2002)
Melon-headed whale (<i>Peponocephala electra</i>)	X	–	X	Leatherwood and Reeves (1989); Ilangakoon (2002; 2005; 2006b)
Pygmy killer whale (<i>Feresa attenuata</i>)	X	–	X	Leatherwood and Reeves (1989); Ilangakoon (2002; 2009)
False killer whale (<i>Pseudorca crassidens</i>)	X	X	X	Pearson (1931); Leatherwood and Reeves (1989); Ilangakoon (2002; 2009)
Killer whale (<i>Orcinus orca</i>)	X	–	X	Ilangakoon <i>et al.</i> (1992); Leatherwood and Reeves (1989); Ilangakoon <i>et al.</i> (2010)
Cuvier's beaked whale (<i>Ziphius cavirostris</i>)	X	X	X	Deraniyagala (1965); Alling (1986)
Ginkgo-toothed beaked whale (<i>Mesoplodon ginkgodens</i>)	–	X	–	Deraniyagala (1965); Moore and Gilmore (1965)
Blainville's beaked whale (<i>Mesoplodon densirostris</i>)	–	X	X	Ilangakoon (2003; 2006a)
Longman's beaked whale (<i>Indopacetus pacificus</i>)	X	X	X	Pitman <i>et al.</i> (1999); Anderson <i>et al.</i> (2006); Afsal <i>et al.</i> (2009)
Finless porpoise* (<i>Neophocaena phocaenoides</i>)	?	–	X	Phillips (1935); Leatherwood and Reeves (1989)

Notes: Si = sightings; St = strandings; and Ca = catch.

Species in relation to which there are uncertainties, revisions and clarifications in the main text are marked with an * in this table.

spinner dolphin (*Stenella longirostris*) is by far the most common species around the island. This species appears to be evenly distributed throughout both coastal and offshore waters. Other commonly encountered species of small cetaceans include the common bottlenose dolphin (*Tursiops truncatus*) and Risso's dolphin (*Grampus griseus*) (Alling, 1986; Ilangakoon, 1989; 1997; 2006a; 2006c; Ilangakoon and Perera, 2009; Ilangakoon *et al.*, 2000b; Kruse *et al.*, 1991).

A small population of Indo-Pacific humpback dolphins (*Sousa chinensis*) was identified in nearshore waters centered on the Puttalam lagoon in the northwest of Sri Lanka as recently as 2004 (Bröker and Ilangakoon, 2008; Ilangakoon, 2005; 2006a; 2006c). Although a museum specimen of a skull of this species from Mannar further to the north (Blanford, 1891) and a probable sighting in Dutch Bay during an aerial survey in the early 1980s (Leatherwood *et al.*, 1984) existed, it remained unconfirmed until regular sightings were made during cetacean surveys in 2004/05. Other small delphinids recorded as sightings (Alling, 1986; Ilangakoon, 2002; Leatherwood and Reeves, 1989; Ocean Alliance, 2003) and/or bycatch (Dayaratne and Joseph, 1993; Ilangakoon, 1989; 1997; 2002; Ilangakoon *et al.*, 2000b; Leatherwood and Reeves, 1989; Prematunga *et al.*, 1985) from around Sri Lanka include pan-tropical spotted dolphin (*S. attenuata*), striped dolphin (*S. coeruleoalba*), rough-toothed dolphin (*Steno bredanensis*), Fraser's dolphin (*Lagenodelphis hosei*) and common dolphin (*Delphinus capensis*). The original records of bycaught specimens of common dolphin were thought to be *D. delphis* are listed as such in the literature, based on knowledge available at the time (Dayaratne and Joseph, 1993; Ilangakoon, 1997; 2002; Leatherwood and Reeves, 1989). However, following the review of Jefferson and Van Waerebeek, (2002) it is more likely that these are *D. capensis tropicalis*.

Five species commonly referred to as 'Blackfish' have been recorded in Sri Lanka's waters, but none appears to be common. Short-finned pilot whale (*Globicephala macrorhynchus*), false killer whale (*Pseudorca crassidens*), pygmy killer whale (*Feresa attenuata*), melon-headed whale (*Peponocephala electra*) and killer whale (*Orcinus orca*) have been recorded as bycatch around the island (Ilangakoon, 1997; 2002; Ilangakoon *et al.*, 2000b; Ilangakoon *et al.*, 1992; Leatherwood *et al.*, 1991; Leatherwood and Reeves, 1989). Most sightings of these species around Sri Lanka have been in continental shelf waters that are not very deep (Bröker and Ilangakoon, 2008; Ilangakoon, 2002; 2005; 2006a; 2009; Ilangakoon *et al.*, 2010) though these are all species that are thought to be usually more common in pelagic waters.

Four species of Ziphiid have been recorded in strandings and bycatch (Dayaratne and Joseph, 1993; Deraniyagala, 1965; Ilangakoon, 2002; 2003; Leatherwood and Reeves, 1989) but sightings (Alling, 1986) are rare. The four species recorded are Cuvier's beaked whale (*Ziphius cavirostris*), Blainville's beaked whale (*M. densirostris*), ginkgo-toothed beaked whale (*M. ginkgodens*) and Longman's beaked whale (*Indopacetus pacificus*). Specimens of the latter species had earlier been referred to as southern bottlenose whales (*Hyperoodon planifrons*) (Alling, 1986; Dayaratne and Joseph, 1993; Ilangakoon, 2002). However, following the studies of Pitman *et al.* (1999) and Dalebout *et al.* (2003),

Anderson *et al.* (2006) referred the Sri Lankan specimens to Longman's beaked whale. Subsequently there has been a confirmed sighting of this species reported from southeast of Sri Lanka by Afsal *et al.* (2009).

Both the pygmy sperm whale (*Kogia breviceps*) and dwarf sperm whale (*K. sima*) have been recorded in low numbers (Bröker and Ilangakoon, 2008; Chantrapornsyl *et al.*, 1991; Deraniyagala, 1960; Ilangakoon, 1989; 1997; 2002; 2005; 2006a; 2006c; Ilangakoon *et al.*, 2000b; Leatherwood and Reeves, 1989; Pearson, 1931) around Sri Lanka.

Among the larger cetaceans, the sperm whale is one of the most commonly encountered and widely distributed in Sri Lankan waters. In the 1980s sperm whales were recorded as being abundant in the waters off the northeast coast, especially in association with the Trincomalee canyon, where very deep water occurs close to the coast (Gordon, 1991; Leatherwood *et al.*, 1984; Whitehead *et al.*, 1983). Subsequent surveys off the south, southeast, west and northwest of Sri Lanka have also regularly sighted this species (Ilangakoon, 2002; 2006a; 2009; Ilangakoon *et al.*, 2000b; Leatherwood and Reeves, 1989; Ocean Alliance, 2003). Sperm whale strandings are also documented from all coastal areas (Deraniyagala, 1948; 1960; Ilangakoon, 2002; 2006b).

Five species of large *Balaenopterid* whales have been recorded around Sri Lanka with blue whales and Bryde's whales being the most common and widely distributed. Blue whales were first sighted in abundance in the northeastern waters near Trincomalee canyon (Alling *et al.*, 1982; Leatherwood *et al.*, 1984; Whitehead *et al.*, 1983) during the 'Tulip Expedition' in the early 1980s. These early records were followed by sightings off the south, southeast, west and northwest (Ilangakoon, 2002; 2006a; 2009; Ilangakoon *et al.*, 2000b; Leatherwood and Reeves, 1989; Ocean Alliance, 2003) indicating widespread occurrence around the island. Blue whale strandings are also documented from all coastal areas other than the northern coastline (Deraniyagala, 1948; Deraniyagala, 1960; Ilangakoon, 2002; 2006b).

Bryde's whales have been frequently sighted all around the island by most surveys undertaken thus far (Ilangakoon, 2002; 2009; Ilangakoon and Perera, 2009; Leatherwood *et al.*, 1984; Leatherwood and Reeves, 1989; Ocean Alliance, 2003) though strandings of this species are rare (Ilangakoon, 2006b). The taxonomic status of this species in Sri Lankan waters is uncertain. Mitochondrial DNA analysis of tissue samples from a Bryde's whale killed off the west coast by a ship strike in 2003 (Herath, 2007) suggested that it was a specimen of *B. brydei*. It is possible that *B. edeni* also occurs but this remains undetermined at present.

The other baleen whales recorded are fin whale (*B. physalus*), minke whale (*B. acutorostrata*) and humpback whale (*Megaptera novaeangliae*). There is considerable uncertainty regarding the occurrence of the fin whale in the tropical northern Indian Ocean, with no recent sightings or strandings. Since occurrence in Sri Lanka is based mainly on old and poorly documented stranding records (Deraniyagala, 1948) and just one more recent net entanglement (Leatherwood and Reeves, 1989) there is a possibility that these may have been misidentifications. Minke whales appear to occur mainly in the shallower northwestern waters of the Gulf of Mannar, based on recorded strandings (Deraniyagala, 1963) and sightings

(Bröker and Ilangakoon, 2008; Ilangakoon, 2006a). Humpback whales, while not common in Sri Lankan waters, have stranded sporadically on the west coast (Deraniyagala, 1948; Ilangakoon, 2002; Leatherwood and Reeves, 1989; Reeves *et al.*, 1991) and their songs have been recorded in northwestern waters (Leatherwood and Reeves, 1989; Whitehead, 1985). These animals are probably part of the Arabian Sea population but their stock affinities are as yet undetermined.

The only species of porpoise recorded from Sri Lanka is the finless porpoise (*Neophocaena phocaenoides*). Phillips (1935) reported sightings of this species off the east coast but no details were given and there have been no reported sightings since then. One specimen in the Harvard Museum of Comparative Zoology was reported in earlier literature (Ilangakoon, 2002; Leatherwood and Reeves, 1989) as having been caught by a Smithsonian Carangid Survey team on the Wadge Bank (Indian waters), but it is catalogued in the Museum collection as coming from Kuru Nagar, Jaffna in northern Sri Lanka (Charles Anderson, pers. comm.). The collector of the specimen has confirmed (Tyson Roberts, pers. comm.) to Charles Anderson that the fresh dead specimen was purchased by him at a fish landing site in Jaffna and handed over to the Museum of Comparative Zoology.

Threats

Cetaceans throughout the world's oceans face a multitude of threats due to increasing human activities, and those around Sri Lanka are no exception. The primary threat to small cetaceans around Sri Lanka is the fishing industry. Interactions between cetaceans and fisheries were first mentioned in the literature in 1887 (Nevill, 1887) but were documented in more detail in the 1950s (Lantz and Gunasekera, 1955). Although the island has a long history of artisanal fishing, traditional nets were made of natural fibers and posed little threat to cetaceans, which could usually break through unharmed if accidentally entangled. Development of modern fisheries began in the late 1940s and with this came the adoption of synthetic fibre gillnets. These gillnets are now widely used, and accidental bycatch has become a major problem, causing the mortality of thousands of small cetaceans each year (Dayaratne and Joseph, 1993; Ilangakoon, 2002; Leatherwood and Reeves, 1989).

Although direct hunting is not as widespread as bycatch in Sri Lanka, the use of a hand-held harpoon to kill small cetaceans has been documented off the south coast (Ilangakoon, 1989; 1997; 2002; Ilangakoon *et al.*, 2000b; Leatherwood and Reeves, 1989). Within the past two decades this practice has spread to other areas on the west and southwest coast and the numbers of small cetaceans being killed annually in this manner continue to increase (Ilangakoon, 2002; 2007; Ilangakoon *et al.*, 2000b).

At present, fisheries cause both targeted and accidental mortality of cetaceans, and both forms of take are indiscriminate in relation to species, sex and size, with rare species, pregnant and lactating females and young animals being taken among others (Ilangakoon, 1989; 2007; Ilangakoon *et al.*, 2000a; Kruse *et al.*, 1991). The availability of dolphin flesh originally derived from accidental bycatch, has led to a newly acquired taste for this non-traditional

source of protein, for some parts of the human population (Breiwick and Tsunoda, 1987; Ilangakoon, 1989; 2002; 2007; Ilangakoon *et al.*, 2000a). This demand-driven market for dolphin flesh is now fed by a growing direct take (Ilangakoon, 2006c; 2007).

Some cetacean catch studies indicate that spinner dolphins comprise more than 50% of the total recorded catch in Sri Lanka (Dayaratne and Joseph, 1993; Ilangakoon, 1989; 1997; 2007; Ilangakoon *et al.*, 2000b). This high rate of bycatch is possibly a result of the association of this species with the tuna that are targeted by fishermen (Ilangakoon, 2006a). The spinner dolphin's natural behaviour of frequently bow-riding with boats also makes it an easy target for direct take using hand-harpoons (Ilangakoon, 1989; 2002; Ilangakoon *et al.*, 2000b). Spinner dolphins could therefore be at particular risk in Sri Lanka's waters, but as no population estimates are available it is difficult to assess the impact.

Sri Lanka is located on a major international shipping route across the Indian Ocean. Increased shipping traffic is a threat that affects all marine mammals, but appears to be more of a direct threat to large whales in the waters around the island. Recent stranding records show evidence of several large whales being killed by ship strikes (Herath, 2007; Ilangakoon, 2006b; 2006c), with some dead animals being pushed along by container vessels into Colombo harbour. Increased shipping traffic also increases the risk of marine pollution, both acoustic and chemical, that can be harmful to cetaceans (Norris, 1994; Sousa-Lima and Clark, 2008; Wise *et al.*, 2009).

Habitat degradation due to destructive fishing practices and pollution of coastal waters from land-based and marine-based sources also poses a threat to cetaceans in Sri Lanka. This may be particularly severe for those species that are restricted to coastal waters. Based on current knowledge, the range of the Indo-Pacific humpback dolphin in Sri Lanka is restricted to a small, nearshore area, off the northwest of the island, including the Puttalam lagoon, which is extensively used for human activities (Bröker and Ilangakoon, 2008; Ilangakoon, 2006a; 2007). This area is also currently earmarked for tourism development. Disturbance and pollution could become a threat to the long-term viability of this population. Anthropogenic impacts on other coastal species have not yet been studied, documented or assessed.

A recent and growing activity around Sri Lanka is marine tourism, notably whale and dolphin watching off the southern coast (Ilangakoon, 2009; Ilangakoon and Perera, 2009). This may become a threat to cetaceans if unregulated. Although cetaceans are legally protected in Sri Lanka, there are no specific regulations in place to control or monitor whalewatching. With only a few seasons of such activities having taken place from 2007 onwards, problems in the form of harassment of large whales have already been documented (Ilangakoon and Perera, 2009). Even if regulations were framed to control such activities under the existing law, enforcement would be difficult due to constraints faced by the authorities. These constraints include the lack of trained personnel and basic equipment, such as boats for monitoring activities at sea. Elsewhere in the world, where whale and dolphin watching is a well-developed part of the tourism industry, adverse impacts have become evident, especially

on species and populations of small cetaceans inhabiting coastal waters (Constantine *et al.*, 2004; Lusseau, 2003) and some large whales (Au and Green, 2001; Gordon *et al.*, 1992; McCauley and Cato, 2001). Such impacts have taken place even where strict regulations are in place (Garrod and Fennell, 2004) and this is now a cause for concern in Sri Lanka.

Legal status and conservation

All cetaceans are protected under national legislation in Sri Lanka. They are afforded blanket protection as a group, under the Fauna and Flora Protection Ordinance, as amended in 1993. Cetaceans are also protected under the Fisheries Act of 1996. While this legislation is in theory adequate to provide protection for all species of whales and dolphins, implementation and enforcement of these laws are negligible at present. As a result, small cetaceans continue to be landed as bycatch and direct take, while the flesh from these animals is openly sold for human consumption, in violation of existing laws (Ilangakoon, 2002; 2006c). Under both sets of legislation it is not only a punishable offence to kill or harm cetaceans, but it is also an offence to sell or have possession of any part of such an animal. Being protected under two sets of legislation also causes some confusion and loopholes in enforcement, because the penalties differ under each legislative instrument (Ilangakoon, 2006c).

Sri Lanka has an extensive network of terrestrial protected areas, but Marine Protected Areas (MPAs) have not been given priority in the protected area system of the country (Ilangakoon, 2006c). Presently there are only six MPAs around the island, four of which were created with the priority aim of protecting coral reefs, while the other two were designated for fisheries management (Perera and De Vos, 2007). Cetacean occurrence and distribution has only been assessed in one of these MPAs, and that too, long after its boundaries were demarcated (Bröker and Ilangakoon, 2008; Ilangakoon, 2006a; 2007). No protected area has yet been created for the express purpose of protecting cetaceans, or important cetacean habitat. Some cetacean species, such as the Indo-Pacific humpback dolphin that is dependent on shallow nearshore waters, could benefit from well-managed protected areas declared specifically for their protection. However, even in the existing Marine Protected Areas (MPAs), enforcement and management are almost non-existent, for reasons including lack of resources and trained personnel (Ilangakoon, 2006c).

Research gaps and constraints

There has been little dedicated, long-term research on cetaceans in Sri Lanka. During the past three decades, several short-term research projects and studies have been conducted when external funds were available and data have also been collected using platforms of opportunity when possible. Therefore, research on cetaceans has been sporadic and discontinuous making results obtained from these surveys difficult to compare. Such data are not conducive to deciphering cetacean life histories, long-term population trends or impacts of human activities. Land-based studies, such as those on fisheries bycatch and direct take, have been more extensive and thorough than boat-based surveys on live animals. This is mainly due to a lack of resources for at-sea

research surveys, which are expensive and often unaffordable for small developing countries like Sri Lanka with more immediate human development priorities. The work already undertaken has helped develop baseline data including a national species list, while temporal and spatial distribution patterns of some of the more common species are only now being unravelled through on-going work. Little however is known about the distribution of other species, migration patterns, population trends or species/populations at particular risk. Even the ecological needs of many of the coastal small cetaceans are currently not clearly understood in Sri Lanka, making it difficult to assess the impacts of human development activities.

Likewise, no molecular biological studies to determine stock affinities or population structures have ever been carried out, with species identifications having been primarily based on morphological characteristics. These research gaps have also resulted in taxonomic uncertainties, especially in relation to some of the large baleen whales. For example, although Bryde's type whales are common around Sri Lanka, the recent splitting of the species (Wada *et al.*, 2003) has created uncertainty as to which species occur(s) around the island. Likewise, there is uncertainty about the movements and population affinities of blue whales. While feeding aggregations of this species including mother-calf pairs have been recorded off the north-east (Alling *et al.*, 1991) and south (Ilangakoon, 2009) coasts, at least some animals are present in Sri Lankan waters throughout the year, raising the possibility of a resident population (Ilangakoon, 2002; 2006c; Leatherwood and Reeves, 1989).

In terms of spatial coverage, Sri Lanka's northern waters have been totally neglected in relation to cetacean research, due to the civil unrest and terrorism which prevailed in the area for the past 25 years. The uncertain security situation made the area inaccessible to researchers. While almost nothing is known about cetacean occurrence and distribution in these northern waters, the cessation of hostilities in 2009 presents opportunities for future research activities.

Research in the past three decades resulted in several publications specifically on cetaceans in Sri Lanka (Ilangakoon, 2002; Leatherwood and Reeves, 1989) and a number of scientific papers, reports and articles. These however, have not been adequate to raise awareness among management authorities, law enforcement personnel, tourism authorities or the general public within the country. There is still a large gap in awareness about cetaceans in the waters around the island, their ecological needs and conservation status, due to a dearth of information and non-scientific literature on the subject.

CONCLUSION AND RECOMMENDATIONS

There is a diversity of cetacean species, inhabiting both coastal and offshore waters around Sri Lanka. This understanding is however based on limited research. There is a need to expand the research base, and to cover more areas, including the north and offshore waters. Likewise, it is desirable that long-term and consistent research activities are initiated in order to assess population trends, ecological needs and the conservation status of cetacean populations in these waters. While it is important to carry out research on all aspects of cetaceans in Sri Lanka's waters, priority needs

to be given to management and conservation-oriented research. Information that is crucial for management purposes includes population trends and immediate and growing threats. More detailed, long-term studies on species and behavioural aspects should be undertaken, along with continuous monitoring of all cetacean related human activities, as and when resources become available.

Sri Lanka has good potential for the development of non-consumptive activities like commercial whale and dolphin watching. At present cetaceans remain a potentially important but underutilised resource that could, through careful management, become economically beneficial to the country. Such activities can benefit underprivileged coastal communities that presently view small cetaceans only as a source of food or supplementary income. Benefits of activities like whale and dolphin watching would be an incentive for these local communities to realise the value of live animals in their waters, as opposed to the exploitation that takes place at present. In developing these activities, baseline data and continuous monitoring are important for long-term sustainability.

It is also important to raise awareness regarding cetaceans and cetacean conservation within the country. Data from scientific studies should therefore be used to create awareness among management authorities as well as the general public. It is only through this kind of heightened awareness and understanding at a local level, especially among coastal communities, that long-term conservation and rational management goals can be achieved.

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REFERENCES

- Afsal, V.V., Manojkumar, P.P., Yousuf, K.S.S.M., Anoop, B. and Vivekanandan, E. 2009. The first sighting of Longman's beaked whale, *Indopacetus pacificus*, in the southern Bay of Bengal. *Mar. Bio. Rec.* 2(33): doi: 10.1017/s1755267209990510.
- Afsal, V.V., Yousuf, K.S.S.M., Anoop, B., Annop, A.K., Kannan, P., Rajagopalan, M. and Vivekanandan, E. 2008. A note on cetacean distribution in the Indian EEZ and contiguous seas during 2003–07. *J. Cetacean Res. Manage.* 10(3): 209–16.
- Alling, A. 1986. Records of odontocetes in the northern Indian Ocean (1981–1982) and off the coast of Sri Lanka (1982–1984). *J. Bombay Nat. Hist. Soc.* 83(2): 376–94.
- Alling, A., Gordon, J., Rotton, N. and Whitehead, H. 1982. WWF-Netherlands Indian Ocean sperm whale study 1981–1982 interim report. Paper SC/34/Sp9 presented to the IWC Scientific Committee, March 1982 (unpublished). 46pp. [Available from the Office of this Journal].
- Alling, A.K., Dorsey, E.M. and Gordon, J.C.D. 1991. Blue whales *Balaenoptera musculus* off the northeast coast of Sri Lanka: Distribution, feeding and individual identification. pp.247–58. In: Leatherwood, S. and Donovan, G.P. (eds). *Cetaceans and Cetacean Research in the Indian Ocean Sanctuary*. United Nations Environment Programme Marine Mammal Technical Report No. 3, Nairobi, Kenya. 287pp.
- Anderson, R.C., Clark, R., Madsen, P.T., Johnson, C., Kiszka, J. and Breyse, O. 2006. Observations of Longman's beaked whale (*Indopacetus pacificus*) in the western Indian Ocean. *Aquat. Mamm.* 32: 223–31.
- Au, W.W.L. and Green, M. 2001. Acoustic interaction of humpback whales and whalewatching boats. *Mar. Environ. Res.* 49: 469–81.
- Ballance, L.T. and Pitman, R.L. 1998. Cetaceans of the western Tropical Indian Ocean: distribution, relative abundance, and comparisons with cetacean communities of two other tropical ecosystems. *Mar. Mammal Sci.* 14(3): 429–59.
- Blanford, W.T. 1891. *The Fauna of British India, including Ceylon and Burma*. Taylor and Francis, London. 617pp.
- Blyth, E. 1859. On the great porpoise of the Indian Ocean, with notices of other cetals, and of the Syrenia or marine pachyderms. *J. Asiatic Soc. Bengal* 28: 481–98.
- Breiwick, J.M. and Tsunoda, L. 1987. Comments submitted by J.M. Breiwick and L. Tsunoda (USA) on the research plan for the feasibility study on 'The program for research on the Southern Hemisphere minke whale and for preliminary research on the marine ecosystem in the Antarctic' by the Government of Japan. Paper SC/D87/26 presented to the IWC Scientific Committee Special Meeting to Consider the Japanese Research Permit (Feasibility Study), Cambridge, December 1987 (unpublished). [Paper available from the Office of this Journal].
- Bröker, K.C.A. and Ilangakoon, A. 2008. Occurrence and conservation needs of cetaceans in and around the Bar Reef Marine Sanctuary, Sri Lanka. *Oryx* 42: 286–91.
- Chantrapornsil, S., Kinze, C.C., Leatherwood, S. and Prematunga, W.P. 1991. Notes on the genus *Kogia* in the northern Indian Ocean. pp.79–88. In: Leatherwood, S. and Donovan, G.P. (eds). *Cetaceans and cetacean research in the Indian Ocean Sanctuary*. United Nations Environment Programme Marine Mammal Technical Report No. 3, Nairobi, Kenya. 287pp.
- Constantine, R., Brunton, D.H. and Dennis, T. 2004. Dolphin-watching tour boats change bottlenose dolphin (*Tursiops truncatus*) behaviour. *Biol. Conserv.* 117: 299–307.
- Dalebout, M.L., Ross, G.J.B., Baker, C.S., Anderson, R.C., Best, P.B., Cockroft, V.G., Hinsz, H.L., Peddemors, V. and Pitman, R.L. 2003. Appearance, distribution and genetic distinctiveness of Longman's beaked whale, *Indopacetus pacificus*. *Mar. Mammal Sci.* 19(3): 421–61.
- Dayaratne, P. and Joseph, L. 1993. A study of dolphin catches in Sri Lanka. *Bay of Bengal Programme, Madras BOBP/REP/56*: 47pp.
- Deraniyagala, P.E.P. 1945. Some Odontoceti from Ceylon. *Spolia Zeylan.* 24(2): 113–20.
- Deraniyagala, P.E.P. 1948. Some mystacetid whales from Ceylon. *Spolia Zeylan.* 25: 61–63.
- Deraniyagala, P.E.P. 1960. Some southern temperate zone snakes, birds and whales that enter the Ceylon area. *Spolia Zeylan.* 29(1): 79–85.
- Deraniyagala, P.E.P. 1963. Mass mortality of the new subspecies of little piked whale *Balaenoptera acutorostrata thalimaha* and a new beaked whale *Mesoplodon hotaula* from Ceylon. *Spolia Zeylan.* 30: 80–84.
- Deraniyagala, P.E.P. 1965. A sanctuary for turtles, the dugong, whales and dolphins in the Indian and Southern Oceans. *Loris* 10(4): 246–50.
- Fernando, H.F. 1912. Whales washed ashore on the coast of Ceylon from 1889 to 1910. *Spolia Zeylan.* 8(29): 52–54.
- Garrod, B. and Fennell, D.A. 2004. An analysis of whalewatching codes of conduct. *Annals of Tourism Research* 31(2): 334–52.
- Gordon, J., Leaper, R., Hartley, F.G. and Chappell, O. 1992. *Effects of Whale-Watching Vessels on the Surface and Underwater Acoustic Behaviour of Sperm Whales off Kaikoura, New Zealand*. Department of Conservation, Wellington. 63pp.
- Gordon, J.C.D. 1991. The World Wildlife Fund's Indian Ocean sperm whale project: an example of cetacean research within the Indian Ocean Sanctuary. pp.219–39. In: Leatherwood, S. and Donovan, G.P. (eds). *Cetaceans and cetacean research in the Indian Ocean Sanctuary*. United Nations Environment Programme Marine Mammal Technical Report No. 3, Nairobi, Kenya. 287pp.
- Herath, D. 2007. Identification of a stranded whale by mitochondrial DNA analysis – www.DNA analysis program in action. *Asian Fisheries Science* 20: 319–24.
- Ilangakoon, A. 1989. A socio-economic study of cetacean harvesting in Sri Lanka. pp.54–67. In: Leatherwood, S. and Reeves, R.R. (eds). *Marine Mammal Research and Conservation in Sri Lanka 1985–1986*. Marine Mammal Technical Report No. 1., United Nations Environment Programme (UNEP), Oceans and Coastal Areas Activity Centre, Nairobi. 138pp.
- Ilangakoon, A. 1997. Species composition seasonal variation, sex ratio and body length of small cetaceans caught off west, south-west and south coast of Sri Lanka. *J. Bombay Nat. Hist. Soc.* 94: 298–306.
- Ilangakoon, A. 2002. *Whales and Dolphins of Sri Lanka*. WHT Publications, Sri Lanka. 99pp.
- Ilangakoon, A. 2003. Blaineilles's beaked whale (*Mesoplodon densirostris*): a new species identified and added to the list of cetaceans in Sri Lanka's waters. *Loris* 23(2): 6–8.
- Ilangakoon, A. 2005. Research and conservation of marine mammals in relation to the Bar Reef Marine Sanctuary North-Western Sri Lanka. Project completion report, Coastal Resources Management Project of the Coast Conservation Department, Ministry of Fisheries and Ocean Resources Sri Lanka and Asian Development Bank. 37pp. (Unpublished report). [Available from the Coast Conservation Department, Sri Lanka or the author].

- Ilangakoon, A. 2006a. Cetacean occurrence and distribution around the Bar Reef Marine Sanctuary, northwest Sri Lanka. *J. Nat. Sci. Found. Sri Lanka* 34(3): 149–54.
- Ilangakoon, A. 2006b. Preliminary analysis of large whale strandings in Sri Lanka 1889–2004. *Pak. J. Oceanog.* 2: 61–68.
- Ilangakoon, A. 2006c. Taxonomy and current status of marine mammals in Sri Lanka. pp.302–08. In: Bambaradeniya, C.N.B. (eds). *The Fauna in Sri Lanka: Status of Taxonomy, Research and Conservation*. IUCN, Sri Lanka Country Office, Colombo. 308pp.
- Ilangakoon, A. 2007. A developing country perspective of cetacean bycatch monitoring and mitigation. pp.80–83. In: Kizka, J. and Muier, C. (eds). *Incidental Catch of Non-Targeted Marine Species in the Western Indian Ocean: problems and Mitigation Measures*. Workshop proceedings, 13–15 November 2006, Mayotte. 111pp.
- Ilangakoon, A. 2009. Cetacean survey off Sri Lanka to assess the potential for conservation through cetacean based tourism – Project Completion Report. Report to the Whale and Dolphin Conservation Society, UK (unpublished). 25pp. [Available from the author].
- Ilangakoon, A., Jayewardene, R. and Perera, L.D. 2010. First confirmed sighting of the killer whale (*Orcinus orca*) in Sri Lanka's waters. *Mar. Bio. Rec.* 3(14): doi: 10.1017/S17552672100000047.
- Ilangakoon, A., Miththapala, S. and Ratnasooriya, W.D. 2000a. Sex ratio and size range of small cetaceans in the fisheries catch on the west coast of Sri Lanka. *Vidyodaya J. Sci.* 9: 25–35.
- Ilangakoon, A. and Perera, L.D. 2009. Cetacean and sea bird survey off south-west Sri Lanka – project completion report. Report to the Ocean Park Conservation Foundation (unpublished). 37pp. [Available from the authors].
- Ilangakoon, A., Ratnasooriya, W.D. and Miththapala, S. 2000b. Species diversity, seasonal variation and capture method of small cetaceans on the west coast of Sri Lanka. *Vidyodaya J. Sci.* 9: 37–52.
- Ilangakoon, A., Subasinghe, H.A.K. and Mahendra, W.P. 1992. On rare cetacean species off Sri Lanka including the killer whale *Orcinus orca* (Linn.) (*Delphinidae: Cetacea*). *J. Bombay Nat. Hist. Soc.* 89(3): 363–65.
- Jefferson, T.A. and Van Waerebeek, K. 2002. The taxonomic status of the nominal dolphin species *Delphinus tropicalis* van Bree, 1971. *Mar. Mammal Sci.* 18(4): 787–818.
- Kelaart, E.F. 1852. *Prodromus Fauna Zeylanica: being contributions to the zoology of Ceylon*, Colombo. 197pp.
- Kruse, S.L., Leatherwood, S., Prematunga, W.P., Mendes, C. and Gamage, A. 1991. Records of Risso's dolphins, *Grampus griseus* in the Indian Ocean, 1891–1986. pp.67–77. In: Leatherwood, S. and Donovan, G.P. (eds). *Cetaceans and cetacean research in the Indian Ocean Sanctuary*. United Nations Environment Programme Marine Mammal Technical Report No. 3, Nairobi, Kenya. 287pp.
- Lantz, A.W. and Gunasekera, C. 1955. Commercial utilisation of dolphins (porpoise) in Ceylon. *Bull. Fish. Res. Stn., Ceylon* 3: 1–14.
- Leatherwood, S. 1990. Deaths of whales, dolphins, and porpoises in gillnets. *Species* 15: 24–26.
- Leatherwood, S., McDonald, D., Prematunga, W.P., Girton, P., Ilangakoon, A. and McBrearty, D. 1991. Records of the 'Blackfish' (killer, false killer, pilot, pygmy killer and melon-headed whales) in the Indian Ocean, 1772–1986. pp.33–65. In: Leatherwood, S. and Donovan, G.P. (eds). *Cetaceans and cetacean research in the Indian Ocean Sanctuary*. United Nations Environment Programme Marine Mammal Technical Report, Nairobi, Kenya. 287pp.
- Leatherwood, S., Peters, C.B., Santerre, R., Santerre, M. and Clarke, J.T. 1984. Observations of cetaceans in the northern Indian Ocean Sanctuary, November 1980–May 1983. *Rep. int. Whal. Commn* 34: 509–20.
- Leatherwood, S. and Reeves, R.R. 1989. Marine mammal research and conservation in Sri Lanka 1985–1986. *UNEP Mar. Mamm. Tech. Rep.* 1: [vi], 1–138.
- Lusseau, D. 2003. Effects of tour boats on the behaviour of bottlenose dolphins: using Markov chains to model anthropogenic impacts. *Conserv. Biol.* 17(6): 1785–93.
- McCauley, R.D. and Cato, D.H. 2001. The underwater noise of vessels in the Hervey Bay (Queensland) whale watch fleet and its impact on humpback whales. *J. Acoust. Soc. Am.* 109: 2455.
- Moore, J.C. and Gilmore, R.M. 1965. A beaked whale new to the western hemisphere. *Nature* 205: 1239–40.
- Nevill, H. 1887. Aeolian's account of the dolphins of Toprobane. *Taprobanian* 2(1): 1. Trubner and Co., London.
- Norris, T.F. 1994. Effects of boat noise on the acoustic behaviour of humpback whales. *J. Acoust. Soc. Am.* 43: 383–84.
- Ocean Alliance. 2003. Voyage of the Odyssey, Sri Lanka. Regional report, 29 March to 17 June 2003. 11pp. Unpublished report by Ocean Alliance, Lincoln, MA. [Available from www.oceanalliance.org].
- Pearson, J. 1931. A note on false killer whale, *Pseudorca crassidens*, (Owen). *Spolia Zeylan.* 16(2): 199–203.
- Perera, N. and De Vos, A. 2007. Marine Protected Areas in Sri Lanka: a review. *Env. Manage.* 40: 727–38.
- Phillips, W.W.A. 1935. *Manual of the Mammals of Ceylon*. Ceylon Museum, Colombo. 389pp.
- Pitman, R.L., Palacios, D.M., Brennan, P.L.R., Brennan, B.J., Balcomb Iii, K.C. and Miyashita, T. 1999. Sightings and possible identity of a bottlenose whale in the tropical Indo-Pacific: *Indopacetus pacificus*? *Mar. Mammal Sci.* 15(2): 531–49.
- Prematunga, W.P., Alling, A. and Leatherwood, S. 1985. Species composition of small cetacean bycatches in gillnets off Trincomalee, Sri Lanka, January 1984 through April 1985. Paper SC/37/SM9 presented to the IWC Scientific Committee, June 1985 (unpublished). 9pp. [Paper available from the Office of this Journal].
- Reeves, R.R., Leatherwood, S. and Papastavrou, V. 1991. Possible stock affinities of humpback whales in the northern Indian Ocean. pp.259–69. In: Leatherwood, S. and Donovan, G.P. (eds). *Cetaceans and cetacean research in the Indian Ocean Sanctuary*. United Nations Environment Programme, Nairobi, Kenya. 287pp.
- Sousa-Lima, R.S. and Clark, C.W. 2008. Modelling the effect of boat traffic on the fluctuation of humpback whales singing out in the Abrolhos National Marine Park, Brazil. *Can. Acous.* 36(1): 174–81.
- Tennant, J.E. 1859. *Ceylon: an account of the island, physical, historical and topographical with notices of the natural history, antiquities and productions. Volume I*. Longman, Green. Longman and Roberts, London. 619pp.
- Wada, S., Oishi, M. and Yamada, T.K. 2003. A newly discovered species of living baleen whale. *Nature* 426: 278–81.
- Whitehead, H. 1985. Humpback whale songs from the North Indian Ocean. *Invest. Cetacea* 17: 157–62.
- Whitehead, H. 1989. *Voyage to the Whales*. Robert Hale, London. xi+195pp.
- Whitehead, H., Gilligan, P., Smyth, C., Weilgart, L. and Converse, C. 1983. WWF/IUCN Indian Ocean Whale Project. Interim Report, Oct–Dec. 1983. (Unpublished.) 34pp. [Available from the author].
- Wijeyananda, N.P. 1997. Maritime zones. pp.5–7. In: Somasekaram, T., Perea, M., de Silva, M.B.G. and Godellawatta, H. (eds). *Arjuna's Atlas of Sri Lanka*. Arjuna Consulting Company Limited, Colombo. 220pp.
- Wise, J.P., Payne, R., Wise, S.S., Lacerte, C., Wise, J., Gianios, C., Thompson, W.D., Perkins, C., Zheng, T., Zhu, C., Benedict, L. and Kerr, I. 2009. A global assessment of chromium pollution using sperm whales (*Physeter macrocephalus*) as an indicator species. *Chemosphere* 75(11): 1461–67.

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