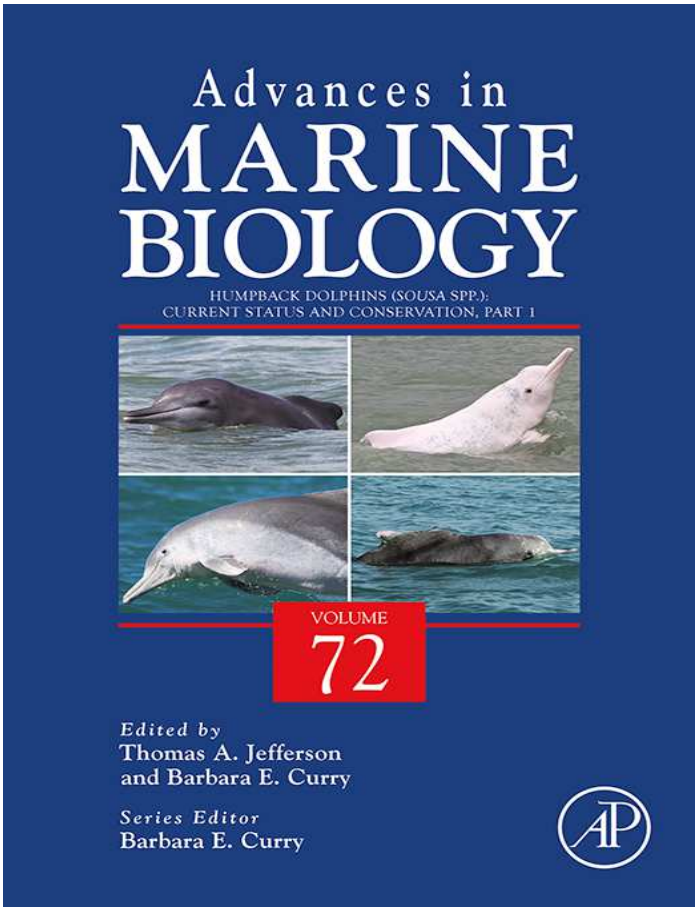

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CHAPTER FIVE

Assessment of the Conservation Status of the Indian Ocean Humpback Dolphin (*Sousa plumbea*) Using the IUCN Red List Criteria

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Abstract

Indian Ocean humpback dolphins (*Sousa plumbea*) are obligate shallow-water dolphins that occur exclusively in the near-shore waters of the Indian Ocean, from South Africa to the Bay of Bengal. They have a narrow habitat preference, restricted distribution and do not appear very abundant across any part of their range. There is no estimate of total species abundance; all populations that have been quantitatively evaluated have been small in size, usually fewer than 200 individuals. Fishing, dredging, land reclamation, construction blasting, port and harbour construction, pollution, boat traffic and other coastal development activities all occur, or are concentrated within, humpback dolphin habitat and threaten their survival. Although data are far from sufficient to make a rigorous quantitative assessment of population trends for this species, the scale of threats is large enough over a significant enough portion of the range to suspect or infer a decline of at least 50% over three generations, which qualifies it for listing on the IUCN Red List as Endangered. The issue primarily responsible is incidental mortality in fisheries, but the loss and degradation of habitat is likely a contributing factor. None of the threats have been adequately addressed in any part of the species' range, even though threat levels are increasing virtually everywhere.

1. INTRODUCTION

Indian Ocean humpback dolphins (*Sousa plumbea*) are obligate shallow-water dolphins that occur exclusively in the near-shore waters of the Indian Ocean from South Africa to the Bay of Bengal (Jefferson and Rosenbaum, 2014). In comparison with most other marine cetaceans, Indian Ocean humpback dolphins have a narrow habitat preference, restricted distribution and do not appear very abundant across any part of their range. Their coastal habitat is the most heavily impacted and exploited part of the ocean by humans, and thus the species is exposed to numerous anthropogenic activities, including fishing and habitat modification, raising serious concerns about their conservation status (IWC, 2002).

Sousa plumbea has only been recognised as a distinct species in its own right since 2014 (Jefferson and Rosenbaum, 2014). Information from many parts of its range is sparse. However, its elevation to a distinct species has increased concern over its status and will likely increase the level of research and conservation attention it receives in the future. In this chapter, we provide a concise review of what is currently known about the status and threats faced by the Indian Ocean humpback dolphin, based on existing published literature and unpublished reports. We then evaluate the conservation status of the species against the IUCN Red List criteria (IUCN, 2001) and make recommendations for its listing on the Red List.

2. TAXONOMY

2.1 Scientific and Common Names

Sousa plumbea (Cuvier, 1829) is commonly referred to as the Indian Ocean humpback dolphin throughout its range. The animal has many different names in the numerous local languages spoken around the Indian Ocean fringe where it occurs, including "kushuku" in some parts of Tanzania, and in Swahili in Tanzania and Kenya "Pomboo nundu" or "Pomboo mweupe". In South Africa, it is known as the "boggelrugdolfyn" in Afrikaans and does not appear to have any specific Zulu or Xhosa terms. In Madagascar, it is typically known by the French name "dauphin à bosse", but there are several names used by Malagasy fishers depending on region and dialect, including "fesodoby", "fesoke manjavany" and "fesobory". (Sutaria et al., 2015) listed the following colloquial names for humpback dolphins in India, depending upon province: "fukariyo", "gada/gad/gaadha reda", "kadal panni", "kadal ongi", "sori vedan", "paru vedan", "thella thoralu" or "goonu". Throughout Arabia, it is generally known as "dukhs". In Pakistan, humpback dolphins are called "malhar" in Sindh Province, and "Goco" or "Gocain" in Balochistan.

2.2 Taxonomic Notes

In 2014, a major taxonomic change in the genus *Sousa* resulted in formal recognition of the Indian Ocean humpback dolphin (*S. plumbea*) as a distinct species (Committee on Taxonomy, 2014; Jefferson and Rosenbaum, 2014). Prior to this change, humpback dolphins from South Africa to Australia were classified as the Indo-Pacific humpback dolphin (*Sousa chinensis*) (Jefferson and Karczmarski, 2001). A molecular genetic assessment using mitochondrial DNA (mtDNA) and nuclear DNA markers found Indian Ocean humpback dolphins to be significantly differentiated from the other *Sousa* species; they have no shared mtDNA control region haplotypes with the other species, and there are two diagnostic sites (Mendez et al., 2013). The skull of *S. plumbea* shows a greater length: breadth ratio (2.2–2.8) than that of *S. chinensis*, and the highest tooth counts (33–39 vs. as low as 27 for the other *Sousa* species) in the genus (Jefferson and Van Waerebeek, 2004). Skulls from South Africa clearly separated from all other *Sousa* spp. skulls in a discriminant function analysis (Mendez et al., 2013).

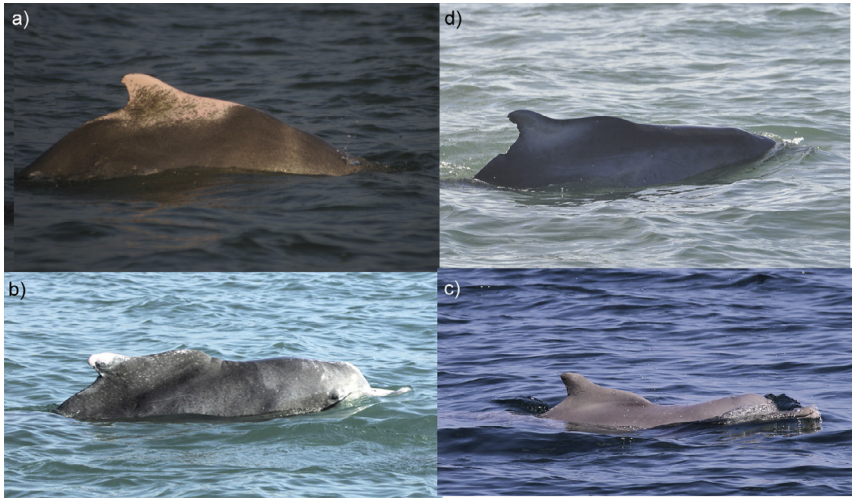

Figure 1 External morphology of adult Indian Ocean humpback dolphins (*Sousa plumbea*) from (A) Sri Lanka. Photograph: Anouk Ilangakoon. (B) Iran. Photograph: Hamed Moshiri/Plan 4 the Land. (C) Pemba Island, Tanzania. Photograph: Gill Braulik. (D) Mossel Bay, South Africa. Photograph: Renae Logston.

There is considerable variation and population structure within the Indian Ocean humpback dolphin species and it is possible that additional work will reveal several subspecies (Figure 1; Jefferson and Rosenbaum, 2014). There is uncertainty about the taxonomic affinities of the humpback dolphins in eastern India, Sri Lanka, Bangladesh and Myanmar, but there are few samples available from this area to provide clarity (Jefferson and Rosenbaum, 2014). Preliminary genetic analysis indicates that humpback dolphins in Bangladesh are genetically distinct from all other members of the genus (Amaral et al., 2015). Future studies will confirm whether *S. plumbea* actually occurs east of the southern tip of India and will clarify the relationships and taxonomic affinities of humpback dolphins in the Bay of Bengal. However, as the taxonomy is currently not clearly resolved, we tentatively include *Sousa* that occur in the western Bay of Bengal within this *S. plumbea* review.

3. GEOGRAPHIC RANGE

3.1 Range Description

Indian Ocean humpback dolphins occur exclusively in the developing world around approximately 27,000 km of the coastal fringe of the Indian

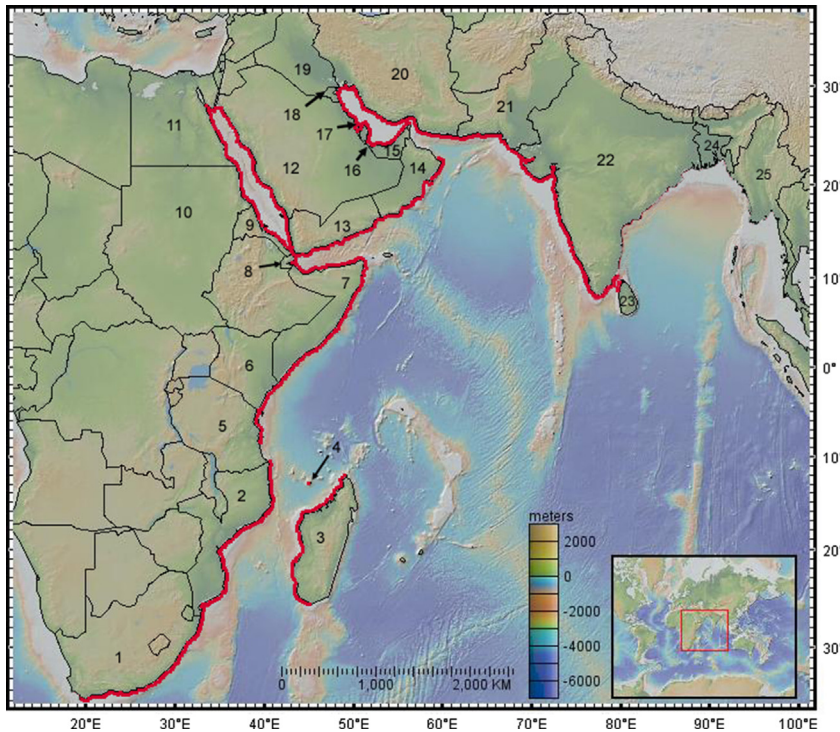

Figure 2 The assumed distribution of the Indian Ocean humpback dolphin (*Sousa plumbea*). Numbers refer to countries specified in Section 3.2.

Ocean (Figure 2). This species is found in a narrow strip of shallow, coastal waters from False Bay, South Africa, in the west, through the coastal waters of southern and eastern Africa, the Middle East and South Asia to at least the tip of India and possibly through the Bay of Bengal. Distribution includes the Red Sea, the Arabian/Persian Gulf, Gulf of Aden, western Madagascar and several offshore islands including the Andamans, Mayotte and Zanzibar. Their distribution covers approximately 65° of latitude (30°N to 35°S) and 60° of longitude (19–80°E). Large portions of the species' range have not been surveyed, and particularly in many parts of north Africa and the Middle East (including Somalia, Yemen, Djibouti, Eritrea, Sudan, Saudi Arabia, Egypt etc.), these animals are known to be present only from a handful of sighting or stranding records (Baldwin et al., 2004). Level of knowledge is greatest in South Africa, the Southwest Indian Ocean and Oman. The species typically occurs less than 3 km from shore and/or in water less than 25 m deep, and populations are usually found in locations with extensive shallows, such as protected bays and estuaries. Their distribution likely

reflects the existence of pockets of suitable habitat and possibly local extirpations and range reductions (IWC, 2002). Known areas of *S. plumbea* concentration include Algoa, Richard's and Mossel Bays in South Africa (James et al., 2015; Karczmarski, 2000; Keith et al., 2013); Maputo Bay (Guissamulo and Cockroft, 2004), the Bazaruto Archipelago (Guissamulo and Cockcroft, 1997) and Beira in Mozambique; Nosy Be and the Nosy Iranja/Ampasindava Peninsula in Madagascar (Cerchio et al., 2015); the west coast of Unguja (Stensland et al., 2006) and Pemba Islands (Braulik, unpublished data) in Tanzania; Shimoni in Southern Kenya (Samuel V. Meyler et al., 2011); much of the Arabian Sea coast of Oman; and Goa and Cochin in India (Afsal et al., 2008; Parsons, 1998). They are one of the most common cetaceans in the Arabian/Persian Gulf (Baldwin et al., 2004; Braulik et al., 2010). In India, they are distributed almost continuously along most of the coast and they also occur in northwestern Sri Lanka (Nanayakkara et al., 2014; Sutaria and Jefferson, 2004). There are several sighting records for the northeast Andaman Islands, but none from oceanic archipelagos, such as the Lakshadweep and Maldive Islands (Sutaria and Jefferson, 2004), nor from eastern Madagascar (Cerchio et al., 2015). Humpback dolphins have not been recorded in the Union of Comoros (Kiszka et al., 2010a), however they do exist in very small numbers in the neighboring island of Mayotte (Kiszka et al., 2010b).

Interestingly, the western limit of the species' distribution in South Africa appears to have undergone a recent extension (Findlay et al., 1992). The photographed record of a humpback dolphin from Langebaan Lagoon in 2004/2005 is presumed a vagrant *S. plumbea*, rather than a vagrant *S. teuszii* (Best, 2007). Similarly, the record of a single humpback dolphin on the Mediterranean coast of Israel is a vagrant (Kerem et al., 2001) and these extra-limital records are not depicted on Figure 2.

There is a hiatus in distribution of several hundred kilometres along the Sea of Oman coast of Oman (Baldwin et al., 2004). It is unclear if this results from the influence of recent human population expansion and associated development or has an ecological basis (Baldwin et al., 2004). Recent information indicates that, contrary to earlier assumptions, humpback dolphins do occur along the coasts of eastern Iran and western Pakistan (Kiani and Van Waerebeek, 2015). Survey effort in early 2015 revealed a possible distribution hiatus along several hundred kilometres of the southern Tanzania coast, where the continental shelf is very narrow, and shallow habitat almost non-existent (Braulik, unpublished data). Genetic data suggest that within the western Indian Ocean, there is significant genetic population

structure, correlated with large-scale oceanographic regimes distinguishing humpback dolphin populations from Oman, Zanzibar and South Africa/Mozambique (Mendez et al., 2011). More detailed sampling and analysis will likely reveal additional population structure at finer scales. While additional survey effort in unknown parts of this species' range will likely reveal more areas of concentration, it will probably also reveal areas of absence along exposed and deep coastlines, or areas of high human impact, and more discontinuities in distribution than are currently known.

3.2 Countries

Indian Ocean humpback dolphins are believed to occur from the coastal waters of 23 different countries or territories: South Africa (1), Mozambique (2), Madagascar (3), Mayotte (4), Tanzania (5), Kenya (6), Somalia (7), Djibouti (8), Eritrea (9), Sudan (10), Egypt (11), Saudi Arabia (12), Yemen (13), Oman (14), United Arab Emirates (15), Qatar (16), Bahrain (17), Kuwait (18), Iraq (19), Iran (20), Pakistan (21), India (22), and Sri Lanka (23). Humpback dolphins from Bangladesh (24) and Myanmar (25) are of unknown taxonomic status and are included in the *S. chinensis* chapter (Jefferson and Smith, 2016). (Numbers refer to locations in Figure 2)

4. POPULATION

4.1 Abundance

Indian Ocean humpback dolphin abundance has been estimated, using mark-recapture of photo-identified individuals, from several discrete locations in South Africa and the Southwest Indian Ocean (Table 1). There are no absolute abundance estimates from anywhere north or east of Kenya in the species range (Baldwin et al., 2004; Braulik et al., 2010; Gore et al., 2012; Kiani and Van Waerebeek, 2015; Sutaria et al., 2015). All populations that have been quantitatively evaluated have been small in size, always less than 500 individuals and usually fewer than 200 (see Table 1). Richard's Bay in KwaZulu-Natal has received much research focus because it reports the highest incidental catches of humpback dolphins in shark nets in the region (Keith et al., 2002). The population in Richard's Bay was considered to be open, with some residents and other individuals that range along the coast, and over approximately a 15-year period was estimated at between 74 (60–88) (Keith et al., 2002) and 160 (134–229) (Durham, 1994) individuals. No marked animals from Richard's Bay were recorded off Algoa Bay,

Table 1 Indian Ocean Humpback Dolphin (*Sousa plumbea*) Published Abundance Estimates and Confidence Intervals (CI)

Country	Location	Time Period	Estimate (95% CI)	Author
South Africa	KwaZulu-Natal coast (including Richard's Bay)	March 1991 to August 1992	160 (134–229)	Durham (1994)
South Africa	Richard's Bay	1998	74 (60–88)	Keith et al. (2002)
South Africa	Algoa Bay	1991–1994	466 (447–485)	Karczmarski et al. (1999)
South Africa	Mossel Bay	2011–2013	125 (61–260)	James et al. (2015)
South Africa	Plettenberg Bay		112 (75–133)	Jobson (2006)
Mozambique	Maputo Bay	1995–1997	105 (30–151)	Guissamulo and Cockroft (2004)
Mozambique	Bazaruto Archipelago	1992	ca. 60	Guissamulo and Cockcroft (1997)
Tanzania	Zanzibar, Kisimkazi	1999 2001 2002	58 (56–79) 65 (62–102) 63 (57–95)	Stensland et al. (2006)
Kenya	Shimoni archipelago	2006	104 (67–160)	Meyler et al. (2011)

where Karczmarski et al. (1999) estimated the total abundance at 466 individuals. Populations in Plettenberg Bay and Mossel Bay were estimated at about 112 (Jobson, 2006) and 125 individuals (95% CI 61, 260) (James et al., 2015), respectively.

Generally, the sites in the northwest of Madagascar appear to have larger populations of *S. plumbea* than the southwest region (Cerchio et al., 2015). All populations evaluated in Mozambique, Tanzania and Kenya are estimated at approximately 100 individuals or less (see Table 1).

In Oman and much of the Arabian Gulf, this species is among the most commonly recorded coastal cetaceans, and group size can be large, frequently more than 40 individuals, sometimes up to a hundred or more (Baldwin et al., 2004). Pilleri and Pilleri (1979) conducted limited surveys in the Indus Delta of Pakistan and based on these made an "educated guess" that there were approximately 500 individuals in the entire delta, which, if accurate, would make it one of the larger populations of this species. Standardised surveys for *S. plumbea* was recorded in the Gulf of Kachchh

and the Goa coast of India, and the *S. plumbea* density was over six times higher in Goa (Sutaria and Jefferson, 2004).

The limited data presented above suggest that *S. plumbea* is not abundant anywhere in its range. There is no estimate of total species abundance, but Jefferson and Rosenbaum (2014) stated that the available estimates for specific populations suggest that the range-wide abundance is probably no higher than the low tens of thousands, which we agree is reasonable.

4.2 Population Trend

Most Indian Ocean humpback dolphin populations are small, comprising no more than a few hundred individuals (Guissamulo and Cockroft, 2004; Meyler et al., 2011; Stensland et al., 2006). Like all cetaceans, they have a low reproductive rate and therefore cannot sustain even a moderate level of anthropogenic mortality (Reilly and Barlow, 1986). Removal of only two or three animals per year is likely to be sufficient to cause a decline in such small populations, and it is clear that mortality rates from fisheries bycatch alone exceed this by several orders of magnitude in most places that *S. plumbea* occurs (see Section 7). In Algoa Bay, there were modelled population growth rates of −3% to +2% per year for that population (Karczmarski, 2000), but there are no quantitative estimates of population dynamics for any of the other small populations recorded across the range. Consequently, trends must be inferred by evaluating the magnitude of mortalities or declines in relative sighting rates. Along the KwaZulu-Natal coast, incidental capture of humpback dolphins in shark nets has been very high; 203 animals were caught between 1980 and 2009 (an average of 6.8 animals per year), of which 61% originated from Richards Bay (Atkins et al., 2013). Between 1984 and 1992, there was a decrease of 50% in incidental sightings of this species by the KwaZulu-Natal Sharks Board, indicating a possible population decrease in this region (Durham, 1994), despite a lack of decline in the bycatch rate suggesting the persistence of the population. Significantly, Atkins et al. (2013) noted that the majority of shark net mortalities were of males.

In the Arabian Gulf, aerial surveys recorded Indian Ocean humpback dolphins as the second most commonly sighted cetacean after the Indo-Pacific bottlenose dolphin *Tursiops aduncus* (Preen, 2004). Between 1986 and 1999, the data indicate a statistically significant decline in abundance of 70% for all cetaceans combined, which included the Indian Ocean humpback dolphin, bottlenose dolphin and Indo-Pacific finless porpoise, *neophocaena phcaenoides* (Preen, 2004).

In Madagascar, there was an observed decline in sighting rates Indian Ocean humpback dolphins in the southwest region (off Anakao), along with a decrease in mean group size between 2004 and 2013, potentially due to hunting, bycatch and habitat degradation (Cerchio et al., 2015). In addition to declining abundance, high levels of anthropogenic mortality in this species are likely to create distribution gaps in areas of high threat.

Although little quantitative data on population trends exist, because of the restricted distribution and small population sizes of this species, in many cases only 4–8 deaths per year is sufficient to cause a 50% decline over three generations necessary to qualify for listing as Endangered. The overwhelming level of threat due to intensive use by humans of their exclusively nearshore habitat and consistently high reported mortality rates throughout the parts of their range where monitoring has occurred, means that the global *S. plumbea* population size is almost certainly decreasing (Friedmann and Daly, 2004; Reeves et al., 2008).

5. HABITAT AND ECOLOGY

5.1 Habitat

Throughout their range, Indian Ocean humpback dolphins occur around a variety of coastal habitats including mangroves, rocky reefs, coastal lagoons and shallow, protected bays. The over-riding habitat preference appears to be for water less than 25 m in depth. In Richards Bay, South Africa, all encounters with humpback dolphins were in water shallower than 20 m. Dolphins used the area within 2 km from shore extensively and were rarely seen beyond 3 km from shore (Atkins et al., 2004). In Algoa Bay, over 80% of sightings were within 400 m of the shore and there was a consistent preference for feeding over shallow rocky reefs throughout the year, despite considerable changes in dolphin abundance (Karczmarski et al., 2000). In Zanzibar, distribution of humpback dolphin groups was restricted to a median distance of 830 m (min–max: 200–1550 m) from the shore and a median water depth of 11 m (min–max: 2–26 m) (Stensland et al., 2006). In Nosy Be, Madagascar, the mean depth of sightings was 8.2 m with 95% of sightings in water less than 20 m deep (Cerchio et al., 2015). In Goa and the Gulf of Kutchchh, India, most groups were sighted in water less than 10 m in depth (Sutaria and Jefferson, 2004), and similarly in Chennai, dolphins occurred in water from between 10 and 25 m deep (Muralidharan, 2013). In Oman and the Arabian Gulf, humpback dolphins generally occur in water depths of less than 20 m. In some areas, they occur

along rocky shores with a narrow continental shelf, but in such cases, they occur very close (a few hundred metres at most) from the coast. Humpback dolphins also occur in channels within the mangroves of the massive Indus (Kiani and Van Waerebeek, 2015; Pilleri and Gihr, 1972) and Ganges–Brahmaputra deltas (Smith et al., 2006).

5.2 Food and Feeding

Humpback dolphins feed on a variety of fishes, cephalopods and crustaceans found in coastal areas. In the Eastern Cape of South Africa, common inshore and brackish water fish and an octopus were found in the stomachs of *S. plumbea* (Barros and Cockroft, 1991). In Natal, South Africa, prey items were all fish, 61% were littoral or estuarine species and 25% were demersal species primarily associated with reefs (Ross et al., 1994). Stomach samples collected from eight dead individuals in southern Oman showed a high incidence of cephalopods and crustaceans in the diet (Baldwin et al., 2004). The species generally feeds in shallow near-shore areas, including around reefs and rocky coasts as well as over soft sediments, and in estuaries and mangroves (Baldwin et al., 2004; Kiani and Van Waerebeek, 2015; Ross, 1984; Saayman and Tayler, 1979; Stensland et al., 2006). In Richard's Bay, South Africa, inshore areas were important for feeding, and feeding behaviour decreased with distance offshore and animals moved further offshore to rest (Atkins et al., 2004).

Sousa plumbea have been observed in the Arabian Gulf and the Bazaruto Archipelago in Mozambique, herding fishes onto exposed sand banks and deliberately beaching to seize their prey (Baldwin, 1995; Peddemors and Thompson, 1994).

5.3 Reproduction

There is very little information on the life history of this species, with the vast majority of existing information originating only from South Africa. There is an austral spring or summer calving peak in South Africa, with 70% of births occurring between October and May (Cockcroft, 1989; Karczmarski, 1996; Karczmarski et al., 1999). Mating behaviour was observed in Pakistan only in January and February (Kiani and Van Waerebeek, 2015) and in Maputo, Mozambique, births occurred throughout the year (Guissamulo and Cockroft, 2004). Gestation is believed to last about 10–12 months and length at birth was estimated to be approximately 100 cm (Cockcroft, 1989). In South African waters lactation may

last for more than 2 years (Cockcroft, 1989), mother–calf associations remain strong for at least 3–4 years (Karczmarski et al., 1999) and a 3-year calving interval was suggested (Cockcroft, 1989; Karczmarski, 1996; Karczmarski et al., 1999). Age at sexual maturity for South African animals is about 10 years for females and 12–13 years for males (Cockcroft, 1989; Plön et al., 2015).

Sousa plumbea appear to be sexually dimorphic in South Africa, with adult females on average approximately 30 cm shorter than males. Adult males reach around 270 cm, and females 240 cm and the maximum weight recorded was around 260 kg. This species is believed to reach the age of at least 40 years (Cockcroft, 1989). Lengths of 88 specimens from the Arabian Gulf ranged from 93 to 269 cm (Ross et al., 1994). Although it is possible that animals may be larger in the northern Indian Ocean than in South Africa, several records of animals over 3 m in length have been discounted (Jefferson and Rosenbaum, 2014; Jefferson and Van Waerebeek, 2004). Maximum reliable total length for *S. plumbea* is considered to be 279 cm (Jefferson and Rosenbaum, 2014). Generation length of *S. chinensis* and *S. plumbea* combined was modelled to be approximately 25 years (Moore, in press).

5.4 Migration and Movements

The majority of *S. plumbea* populations appear to be composed of long-term resident individuals that show limited movements and a varying proportion of transient animals that range along the shore for tens or hundreds of kilometres (Guissamulo and Cockroft, 2004; Karczmarski et al., 1999; Keith et al., 2002; Parsons, 1998). Humpback dolphins off the southeast tip of Zanzibar showed a very high degree of residency, with 94% of identified individuals re-sighted 2 years later (Stensland et al., 2006). However, Zanzibar is an island surrounded by deep water and dispersal opportunities for this population are therefore fewer than along the coast of mainland Africa. In contrast, the largest known *S. plumbea* population in the Algoa Bay region of South Africa is composed primarily of animals that move along the coast (Karczmarski et al., 1999). Nine photo-identified individuals were recorded to move 140 km between Plettenberg Bay and Mossel Bay in South Africa (James et al., 2015). One dolphin was recorded in Durban in June 1998, and within 8 days had moved around 150 km to Richard's Bay (Keith et al., 2002). Similarly, an animal photo-identified in Kisite in southern Kenya was recently re-sighted in Watamu around 150 km to the north (Kenya Marine Mammal Network, 2012).

The along-shore movement among "populations" in South Africa suggested by photo-identification studies is supported by genetic studies that showed no population structure between sampling sites in South Africa and Mozambique (Mendez et al., 2011). The strong maternal genetic differentiation displayed between humpback dolphins from South Africa/Mozambique, Zanzibar and Oman suggests limited recent gene flow, however some degree of historic migration between these distant areas (Mendez et al., 2011). This suggests that at least along the east coast of the African continent longer movements of humpback dolphins are very rare.

In Algoa Bay, there were two seasonal peaks in abundance, one in summer and one in late winter, possibly due to changes in prey distribution (Karczmarski et al., 1999). In Maputo Bay, Mozambique, there was also an influx of individuals into the study area in summer (Guissamulo and Cockroft, 2004). There is still a great deal to be clarified about the residency, movements and seasonal changes in distribution of this species.

6. USE AND TRADE

Throughout the majority of their range, except perhaps South Africa, accidentally captured humpback dolphins are generally used. Animals are reported to be eaten (termed "marine bushmeat") in numerous countries including Madagascar (Razafindrakoto et al., 2004), Mozambique (Guissamulo, 2008), Tanzania (Amir et al., 2002) and India (Kumarran, 2012). Humpback dolphin meat is sometimes used as bait for sharks (Amir et al., 2002), or for crabs or other fish (Kiani and Van Waerebeek, 2015), and the oil is used as wood preservative for boats (Berggren and Coles, 2009), for cooking, or as medicine (Gore et al., 2012). A dolphin drive hunt in the southwest of Madagascar operates exclusively to capture dolphins for human consumption (Cerchio et al., 2015).

Although they are often utilised, reports of actual sale of animals at market are less common. Humpback dolphins were reported for sale at three different locations on the west coast of India (Goa, Malpe in Karnataka and Trivandrum in Kerala) (Kumarran, 2012; Mohan, 1994), and in Madagascar animals were for sale in the local village (Cerchio et al., 2015). Mohan (1994) reported that one *S. plumbea* was kept in a polythene-lined pool in Calicut for public display.

Non-consumptive uses of humpback dolphins include dolphin watching tourism; however, because of their low abundance and shy behaviour, they

are often not the primary target of the activity. Humpback dolphins can be viewed in Kisimkazi, Zanzibar, where the primary target species is Indo-Pacific bottlenose dolphins (Berggren et al., 2007). They are also targeted in Nosy Be Madagascar, and near Salalah, on the Arabian Sea coast of Oman and around the Musandam Peninsula in the Straits of Hormuz, Oman.

7. THREATS

7.1 Major Threats

The preference of Indian Ocean humpback dolphins for shallow waters places them in some of the world's most intensively utilised, fished, shipped, modified and polluted waters. The primary threat to the Indian Ocean humpback dolphin species throughout most, or all, of its range is incidental mortality in fisheries, including in shark control nets in South Africa. There appear to be very few, and possibly no, areas that may be a refuge from this pervasive threat.

With the exception of the KwaZulu-Natal Shark Control Programme, there have been no on-board observer studies from which bycatch estimates could be generated. Although it is impossible to evaluate the magnitude in most areas, incidental fishing mortality is clearly pervasive and certainly unsustainable. In many countries around the Indian Ocean, fisheries are primarily artisanal, boats or canoes are small and frequently oar or sail powered, and therefore fishing concentrates precisely within the preferred near-shore habitat of humpback dolphins. For example, in Pemba in Tanzania approximately 90% of humpback dolphins sighted during recent surveys occurred less than 1 km from shore, and 95% of recorded fishing vessels occurred in precisely the same habitat. Of 27 photo-identified humpback dolphins in the same area, 41% had clear injuries from previous entanglements in fishing nets (Braulik, unpublished data). This clearly demonstrates the degree to which most humpback dolphins have to negotiate and frequently interact with fishing gear and there is every reason to believe that this example from Pemba is the norm throughout the species' range.

Significant incidental mortality of humpback dolphins in coastal gillnets is reported from most countries within their range (IWC, 2002). The best-studied bycatch is in Richard's Bay in South Africa, where a total of 203 humpback dolphins were captured in shark nets in the 30 years between 1980 and 2009 (6.8/year corresponding to 5–10% of the population per annum, which is highly unsustainable (Atkins et al., 2013; Durham, 1994; Keith et al., 2002). In Mozambique, intense coastal fishing effort

was considered to be the main threat to this species, and shark fishery gillnets and trawl nets have incidentally killed dolphins throughout the country (Guissamulo, 2008). Incidental catch of humpback dolphins has been documented in gillnets off the south coast of Zanzibar in Tanzania (Amir et al., 2002). There are currently no estimates of the magnitude of the bycatch, but given that even two humpback dolphins taken per year would exceed 2% of the population, it is very likely that bycatch represents a threat to the dolphins in the area (Stensland et al., 2006). In Oman, high incidences of beachcast *S. plumbea* are presumed to result from interactions with fisheries (Collins et al., 2002). The reported mortality rate due to fisheries interactions (both bycatch and directed take) in the southwest region of Madagascar was noted to be almost certainly unsustainable (Cerchio et al., 2015). Although it is impossible to evaluate the magnitude in most areas, in the areas that it has been evaluated incidental fishing mortality of this species appears to be high, unsustainable and resulting in rapid local population declines. There is every reason to believe that interactions with fisheries are equal or possibly even greater elsewhere in the species' range.

There are very few areas within the known range of Indian Ocean humpback dolphins where anthropogenic alteration to habitat has not occurred. Destruction of inshore habitats is likely to be one of the greatest threats for humpback dolphins, particularly in the southern African region and in the Arabian Gulf as well as in many other increasingly developed urban coastal areas (Baldwin et al., 2004; Karczmarski, 2000). Dredging, land reclamation, construction blasting, port and harbour construction, pollution, boat traffic, oil and gas exploration (including seismic surveying) and other coastal development activities all occur, or are concentrated within, humpback dolphin habitat and threaten their survival (IWC, 2002). It was also noted by the IWC (2002) that the continued presence of humpback dolphins in highly degraded habitats does not rule out adverse effects of habitat degradation. This is a pervasive threat that is increasing throughout the species' range and there is no reason to expect this trend to change in the foreseeable future.

In comparison to other marine mammals with wider and more oceanic distributional ranges, the exposure of *S. plumbea* to environmental contaminants is likely to be very high (Jefferson and Karczmarski, 2001). Many of the large urban centres and ports around the Indian Ocean, including Mumbai, Karachi, Dubai, Aden, Mombasa, Dar es Salaam, Maputo and Durban, release a toxic cocktail of agricultural runoff and untreated human and industrial waste into coastal waters, which are inhabited by humpback

dolphins. Humpback dolphins in Natal in South Africa had the highest levels of organochlorines in the blubber of any marine mammal in the country. Elsewhere the effects of such pollution on local dolphins have yet to be studied, but may be severe (Gore et al., 2012). For example, in Pakistan very high levels of chemical pollution in creeks of the Indus delta are toxic enough to cause fish kills and are likely to have adverse effects on cetaceans (Kiani and Van Waerebeek, 2015). In Gadani, Pakistan, up to 100 ships per year are scrapped and dismantled, leading to the release of large amounts of heavy metals, asbestos, dioxins and other persistent organic pollutants in coastal waters. These problems are widespread and increasing in many countries; their impact on coastal dolphins has not been evaluated, but pollution is likely contributing to local declines in range and abundance and may have caused extirpations adjacent to major industrial centres.

7.2 Minor or Local Threats

Other threats that appear somewhat less serious (possibly because of lack of information) or only affect a certain portion of the species range include direct killing, boat traffic/harassment and oil spills and exploration (IWC, 2002).

There is little evidence of intense hunting of humpback dolphins except for in Madagascar (IWC, 2002). In the southwest of the country, dolphins were historically taken with harpoons, but are now targeted with gillnets or in drive hunts. Andrianarivelo (2001) estimated a minimum of 61 mortalities of *S. plumbea* between 1985 and 1999 in Anakao related to the directed takes including drive hunts. The hunting tradition is restricted to a single ethnic group and specific villages, but is widespread along a large section of the country and is apparently spreading (Cerchio et al., 2015). Given the relatively small population sizes reported throughout the SWIO region, the reported mortality rate due to hunting is likely unsustainable and contributing to population decline in at least the southwest of Madagascar (Cerchio et al., 2015).

Dolphin hunting used to occur in Menai Bay in Zanzibar; the last hunt occurred in 1996, taking 23 individuals, assumed to be *S. plumbea* and *T. aduncus*. This would represent an annual mortality close to 12% for a combined population estimate of 199 animals for the two dolphin species in the area. This was certainly unsustainable, resulting in a negative impact on the status of the dolphins off the south coast of Zanzibar (Stensland et al., 2006).

Humpback dolphins reportedly were hunted in former years in the Arabian Gulf, and there was some evidence that there was continued hunting of dolphins in Oman from small, motorised boats using harpoons (Baldwin et al., 2004). In Maputo Bay, Mozambique, dolphins were also reported to be hunted for meat in intertidal shallow areas and estuaries (Guissamulo, 2008).

Blast fishing using dynamite or other explosives is an intense threat to humpback dolphins in the few countries in which it occurs frequently: Tanzania (Cagua et al., 2014) and Sri Lanka (Cornelis et al., 2008; Nanayakkara et al., 2014). This illegal activity is concentrated in near-shore areas that are also specifically humpback dolphin habitat.

Humpback dolphins seem to be highly susceptible to disturbance caused by inshore boat traffic in Algoa Bay (Karczmarski et al., 1997) and areas most heavily used by inshore traffic were reported to be seldom visited by humpback dolphins (Karczmarski, 1996). Humpback dolphins do not ride the bow waves of boats and generally actively avoid moving vessels. In Puttalam Lagoon in Sri Lanka, the small area of shallow habitat in which *S. plumbea* is observed is used extensively by high-powered fishing and navy vessels, which present a threat to this small population (Cornelis et al., 2008; Nanayakkara et al., 2014). Increases in the number of small personal water craft, such as jet-skis, to many coastal areas as tourism expands is another potential disturbance within Indian Ocean humpback dolphin habitat and there is also a risk of collisions.

8. CONSERVATION ACTIONS

For many countries and regions throughout their range, Indian Ocean humpback dolphins are extremely poorly known, and although many threats exist, there have been few conservation actions. One exception is KwaZulu-Natal in South Africa, where since 1999 attempts have been made to reduce the large and unsustainable accidental capture of dolphins in shark nets by using acoustic deterrents (pingers) or by making the nets more conspicuous acoustically (e.g. air-filled floats, clangers, etc.) (Cliff and Dudley, 2011), but these have so far been unsuccessful (Atkins et al., 2013). Increasing the mesh size of nets was effective, but compromised the nets ability to repel sharks. Some high catch shark nets were replaced with baited drumlins, which do not catch dolphins (Atkins et al., 2013). Acoustic pingers were also trialled on gillnets in Tanzania.

Dolphins used to be hunted in Menai Bay in the south of Unguja Island, Tanzania; however since 1997, the hunt has been replaced

by swim-with-the-dolphin tourism (Berggren et al., 2007). Similarly in Madagascar in the southwest region, there has been a focus on community engagement to mitigate marine mammal hunting and bycatch through the establishment of community-based ecotourism, local protection and enforcement, and social outreach campaigns, which have met with some success (Cerchio et al., 2009, 2014).

9. IUCN RED LIST JUSTIFICATION

In the places where studies have occurred Indian Ocean humpback dolphin populations are small, always less than 500 and often less than 100 individuals in discrete, semi-isolated areas. They have one of the most specific habitat preferences and restricted distributions of any marine megafauna species, and these are both aspects that are proven to reduce the resilience of species to environmental change and anthropogenic threats, thereby increasing their extinction risk (Davidson et al., 2011; Purvis et al., 2000). Indian Ocean humpback dolphins are concentrated in coastal waters less than 2 km from shore and often only a few hundred metres from land. This places them in direct conflict with artisanal fisheries that occur intensively throughout their range and focus in exactly the same near-shore habitat. High and clearly unsustainable mortality rates are reported from several areas and heavy mortality can be inferred from the high degree of scarring (41% of individuals) in Pemba, Tanzania. Although information on population size, threats and mortality is only available from some portions of the species' range, there is every reason to suspect and infer that these will be similar or possibly worse elsewhere.

Mortality of only 4 individuals per year from a population of 100, or 7 from a population of 200 would result in the 50% population decline necessary to qualify this species for Endangered. The available evidence from South Africa and indications from elsewhere in the range suggest that mortality rates are consistently at or above this level. The species' restricted habitat and small populations overlap in both space and time with several ubiquitous and pervasive threats that are increasing in severity, leaving no refuge for this species from anthropogenic mortality. The threats are large enough over a significant enough portion of the range that evidence leads us to suspect and infer a decline of at least 50% over three generations (about 75 years) spanning both the past and the future. The factor primarily responsible for the decline is incidental mortality in coastal artisanal fisheries, which were introduced to the region in the 1960s (Tarbit, 1984), but the loss and

degradation of habitat in numerous coastal areas is a contributing and increasing factor. None of the threats have been adequately addressed in any part of the species' range, even though threat levels are increasing virtually everywhere. All evidence suggests that threats and declines will continue and may increase in the future.

The Indian Ocean humpback dolphin therefore qualifies for Endangered under IUCN criteria A4cd, an inferred and suspected population reduction of greater than or equal to 50% over three *S. plumbea* generations (75 years), from approximately 1960 in the past to 2035 in the future, considering that the causes of the suspected/inferred decline in population size—bycatch and decline in habitat quality—have not ceased and are not well understood. This is based on (c) a decline in quality of habitat, and (d) actual or potential levels of exploitation, in this case fisheries bycatch and hunting. As there have been virtually no conservation actions to address these threats, all evidence suggests that they will continue and may escalate in the future, and we strongly suspect that high mortality and continued population declines of this species will occur in the coming years, therefore satisfying criteria A3cd.

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REFERENCES

Afsal, V.V., Yousuf, K.M.M., Anoop, B., Anoop, A.K., Kannan, P., Rajagopalan, M., Vivekanandan, E., 2008. A note on cetacean distribution in the Indian EEZ and contiguous seas during 2003–07. J. Cetac. Res. Manag. 10, 209–215.

Amaral, A.R., Smith, B.D., Mansur, R., Brownell, R.L., Rosenbaum, H.C., 2015. Genetic identity of Indo-Pacific humpback dolphins (*Sousa* spp.) in the northern Bay of Bengal, Bangladesh. Document SC/66a/SM/24 Submitted to the International Whaling Commission Scientific Committee.

Amir, O.A., Berggren, P., Jiddawi, N.S., 2002. The incidental catch of dolphins in gillnet fisheries in Zanzibar, Tanzania. Western Indian Ocean J. Mar. Sci. 1, 155–162.

Andrianarivelo, N., 2001. Essai d'évaluation de l'importance de la pêche aux dauphins dans la région d'Anakao (sud-ouest de Madagascar). Unpublished DEA thesis, Institut Halieutique et des Sciences Marines, Université de Toliara, Madagascar.

Atkins, S., Pillay, N., Peddemors, V.M., 2004. Spatial distribution of Indo-Pacific humpback dolphins (*Sousa chinensis*) at Richard's Bay, South Africa: environmental influences and behavioural patterns. Aquat. Mamm. 30, 84–93.

Atkins, S., Cliff, G., Pillay, N., 2013. Humpback dolphin bycatch in the shark nets in KwaZulu-Natal, South Africa. Biol. Conserv. 159, 442–449.

Baldwin, R.M., 1995. Whales and Dolphins of the United Arab Emirates. Emirates Printing Press, Dubai, UAE.

Baldwin, R.M., Collins, M., Van Waerebeek, K., Minton, G., 2004. The Indo-Pacific humpback dolphin of the Arabian region: a status review. Aquat. Mamm. 30, 111–124.
Barros, N.B., Cockroft, V., 1991. Prey of humpback dolphins (*Sousa plumbea*) stranded in eastern Cape Province, South Africa. Aquat. Mamm. 17, 134–136.
Berggren, P., Coles, P., 2009. Whales and Dolphins—A Field Guide to Marine Mammals of East Africa. WIOMSA/East Publishing, Tanzania.
Berggren, P., Amir, O.A., Guissamulo, A., Jiddawi, N.S., Ngazy, Z., Stensland, E., Sarnblad, A., Cockroft, V.G., 2007. Sustainable dolphin tourism in East Africa: MASMA Technical Report. WIOMSA Book Series No. 7, ix+72 pp.
Best, P.B., 2007. Whales and Dolphins of the Southern African Subregion. Cambridge University Press, Cape Town.
Braulik, G.T., Ranjbar, S., Owfi, F., Aminrad, T., Dakhteh, S.M.H., Kamrani, E., Mohsenizadeh, F., 2010. Marine mammal records from Iran. J. Cetac. Res. Manag. 11, 49–63.
Cagua, F., Bassett, C., Kayanda, R., Rubens, J., Machano, H., 2014. Acoustic Monitoring of Blast Fishing. WWF, Dar es Salaam, Tanzania.
Cerchio, S., Andrianarivelo, N., Razafindrakoto, Y., Mendez, M., Rosenbaum, H., 2009. Coastal dolphins hunting in the southwest of Madagascar: status of populations, human impacts and conservation actions. In: Paper SC/61/SM15 presented to the International Whaling Commission Scientific Committee.
Cerchio, S., Andrianarivelo, N., Andrianantenaina, B., Cordi, V., 2014. Ecology, status, fisheries interactions and conservation of coastal Indian Ocean humpback dolphins and Indo-Pacific bottlenose dolphins on the west coast of Madagascar. In: Paper SC/65B/SM21 presented to the International Whaling Commission Scientific Committee.
Cerchio, S., Andrianarivelo, N., Andrianantenaina, B., 2015. Ecology and conservation status of Indian Ocean humpback dolphins (*Sousa plumbea*) in Madagascar. Adv. Mar. Biol., 72, 163–199.
Cliff, G., Dudley, S.F.J., 2011. Reducing the environmental impact of shark-control programs: a case study from KwaZulu-Natal, South Africa. Mar. Freshw. Res. 62, 700–709.
Cockcroft, V.G., 1989. Biology of Indopacific humpback dolphins (*Sousa plumbea*) off Natal, South Africa. In: Paper presented at the Eight Biennial Conference on the Biology of Marine Mammals, Pacific Grove, CA (unpublished). Available at http://www.marinemammalscience.org.
Collins, T., Minton, G., Baldwin, R., Van Waerebeek, K., Hywel Davies, A., Cockroft, V., 2002. A preliminary assessment of the frequency, distribution and causes of mortality of beach cast cetaceans in the Sultanate of Oman, January 1999 to February 2002. In: Paper SC/54/O4 presented to the IWC Scientific Committee, May 2002 (unpublished). 13 pp (available from the Office of this Journal).
Committee on Taxonomy, 2014. List of marine mammal species and subspecies. Society for Marine Mammalogy, www.marinemammalscience.org, consulted on 4th February 2014.
Cornelis, K., Broker, A., Ilangakoon, A., 2008. Occurrence and conservation needs of cetaceans in and around the Bar Reef Marine Sanctuary, Sri Lanka. Oryx 42, 286–291.
Cuvier, G., 1829. Le regne animal distribute d'apres son organisation, pour servir de base a l'histoire naturelle des animaux et d'introduction a l'anatomie comparee. Chez Deterville, Libraire, Paris, France.
Davidson, A.D., Boyer, A.G., Kim, H., Pompa-Mansilla, S., Hamilton, M.J., Costa, D.P., Ceballos, G., Brown, J.H., 2011. Drivers and hotspots of extinction risk in marine mammals. Proc. Natl. Acad. Sci. U.S.A. 109 (9), 3395–3400. www.pnas.org/cgi/doi/10.1073/pnas.1121469109.
Durham, B., 1994. The Distribution and Abundance of the Humpback Dolphin (*Sousa chinensis*) on the Natal Coast, South Africa. University of Natal, Durban, South Africa.

Findlay, K.P., Best, P.B., Ross, G.J.B., Cockcroft, V.G., 1992. The distribution of small odontocete cetaceans off the coasts of South Africa and Namibia. S. Afr. J. Mar. Sci. 12, 237–270.

Friedmann, Y., Daly, B., 2004. Red Data Book of the Mammals of South Africa: A Conservation Assessment. CBSG southern Africa. Conservation Breeding Specialist Group (SSC/IUCN) Endangered Wildlife Trust, Johannesburg, South Africa.

Gore, M.A., Kiani, M.S., Ahmad, E., Hussain, B., Ormond, R.F., Siddiqui, J., Waqas, U., Culloch, R., 2012. Occurrence of whales and dolphins in Pakistan with reference to fishers' knowledge and impacts. J. Cetac. Res. Manag. 12, 235–247.

Guissamulo, A., 2008. Ecological Studies of Bottlenose and Humpback Dolphins in Maputo Bay, Southern Mozambique. Department of Zoology and Entomology. University of Kwazulu-Natal, Durban, South Africa.

Guissamulo, A., Cockcroft, V.G., 1997. Dolphin and dugong occurrence and distribution and fisheries interactions in Maputo and Bazaruto Bays, Mozambique: International Whaling Commission Scientific Committee Report SC/49/SM24. Available at http://iwc.int/sc-documents. 12.

Guissamulo, A., Cockroft, V.G., 2004. Ecology and population estimates of Indo-Pacific humpback dolphins (*Sousa chinensis*) in Maputo Bay, Mozambique. Aquat. Mamm. 30, 94–102.

IUCN, 2001. IUCN Red List Categories and Criteria: Version 3.1. IUCN Species Survival Commission, IUCN, Gland, Switzerland and Cambridge, UK.

IWC, 2002. Annex K. Report of the standings sub-committee on small cetaceans. J. Cetac. Res. Manag. 4 (Suppl.), 325–338.

James, B.S., Bester, M.N., Penry, G.S., Gennari, E., Elwen, S.H., 2015. Abundance and degree of residency of humpback dolphins (*Sousa plumbea*) in Mossel Bay, South Africa. Afr. J. Mar. Sci., in press.

Jefferson, T.A., Karczmarski, L., 2001. Sousa chinensis. Mamm. Species 665, 1–9.

Jefferson, T.A., Rosenbaum, H.C., 2014. Taxonomic revision of the humpback dolphins (Sousa spp.), and description of a new species from Australia. Mar. Mamm. Sci. 30, 1494–1541.

Jefferson, T.A., Smith, B.D., 2016. Re-assessment of the conservation status of the Indo-Pacific humpback dolphin (*Sousa chinensis*) using the IUCN Red List Criteria. Adv. Mar. Biol. 73, (in press).

Jefferson, T., Van Waerebeek, K., 2004. Geographic variation in skull morphology of humpback dolphins (*Sousa* spp.). Aquat. Mamm. 30, 3–17.

Jobson, A.J., 2006. Insights into population size, group dynamics and site fidelity of humpback dolphins (*Sousa chinensis*) in Plettenberg Bay, South Africa. MSc. Thesis, Nelson Mandela Metropolitan University, Port Elizabeth.

Karczmarski, L., 1996. Ecological Studies of Humpback Dolphins *Sousa chinensis* in the Algoa Bay Region, Eastern Cape, South Africa. Ph.D. dissertation, University of Port Elizabeth, Port Elizabeth, South Africa, p. 202.

Karczmarski, L., 2000. Conservation and management of humpback dolphins: the South African perspective. Oryx 34, 207–216.

Karczmarski, L., Thornton, M., Cockroft, V.G., 1997. Description of selected behaviours of humpback dolphins *Sousa chinensis*. Aquat. Mamm. 23, 127–133.

Karczmarski, L., Winter, P.E.D., Cockroft, V.G., McLachlan, A., 1999. Population analyses of Indo-Pacific humpback dolphins *Sousa chinensis* in Algoa Bay, Eastern Cape, South Africa. Mar. Mamm. Sci. 15, 1115–1123.

Karczmarski, L., Cockroft, V., McLachlan, A., 2000. Habitat use and preferences of Indo-Pacific humpback dolphins *Sousa chinensis* in Algoa Bay, South Africa. Mar. Mamm. Sci. 16, 65–79.

Keith, M., Peddemors, V.M., Bester, M.N., Ferguson, J.W.H., 2002. Population characteristics of Indo-Pacific humpback dolphins at Richards Bay, South Africa: implications for incidental capture in shark nets. S. Afr. J. Wildl. Res. 32, 153–162.

Keith, M., Atkins, S., Johnson, A., Karczmarski, L., 2013. Area utilization patterns of humpback dolphins (*Sousa plumbea*) in Richards Bay, KwaZulu-Natal, South Africa. J. Ethol. 31, 261–274.

Kenya Marine Mammal Network, 2012. Newsletter of the Kenya Marine Mammal Network. Issue 1, May 2012.

Kerem, D., Goffman, O., Spanier, E., 2001. Sighting of a single humpback dolphin (*Sousa* sp.) along the Mediterranean coast of Israel. Mar. Mamm. Sci. 17, 170–171.

Kiani, M.S., Van Waerebeek, K., 2015. A review of the status of the Indian Ocean humpback dolphin *Sousa plumbea* in Pakistan. Adv. Mar. Biol. 72, 201–227.

Kiszka, J., Vely, M., Breysse, O., 2010a. Preliminary account of cetacean diversity and humpback whale (*Megaptera novaeangliae*) group characteristics around the Union of the Comoros (Mozambique Channel). Mammalia 74, 51–56.

Kiszka, J., Ersts, P., Ridoux, V., 2010b. Structure of a toothed cetacean community around a tropical island (Mayotte). Afr. J. Mar. Sci. 32, 543–551.

Kumarran, R.P., 2012. Cetaceans and cetacean research in India. J. Cetac. Res. Manag. 12, 159–172.

Mendez, M., Subramanian, A., Collins, T., Minton, G., Baldwin, R., Berggren, P., Särnblad, A., Amir, O.A., Peddemors, V.M., Karczmarski, L., Guissamulo, A., Rosenbaum, H.C., 2011. Molecular ecology meets remote sensing: environmental drivers to population structure of humpback dolphins in the Western Indian Ocean. Heredity, 107, 349–361.

Mendez, M., Jefferson, T.A., Kolokotronis, S.-O., Krützen, M., Parra, G.J., Collins, T., Minton, G., Baldwin, R., Berggren, P., Särnblad, A., Amir, O.A., Peddemors, V.M., Karczmarski, L., Guissamulo, A., Smith, B., Sutaria, D., Amato, G., Rosenbaum, H.C., 2013. Integrating multiple lines of evidence to better understand the evolutionary divergence of humpback dolphins along their entire distribution range: a new dolphin species in Australian waters? Mol. Ecol. 22, 5936–5948.

Meyler, S.V., Felix, H., Crouthers, R., 2011. Abundance and distribution of Indo-Pacific humpback dolphins (*Sousa Chinensis*) in the Shimoni Archipelago, Kenya. Western Indian Ocean J. Mar. Sci. 10 (2), 201–209.

Mohan, L.R.S., 1994. Review of Gillnet Fisheries and Cetacean Bycatches in the Northeastern Indian Ocean. In: Perrin, W.F., Donovan, G.P., Barlow, J. (Eds.), Gillnets and Cetaceans. Report of the International Whaling Commission, Cambridge, UK, pp. 329–346.

Moore, J.E., in press. Intrinsic growth (rmax) and generation time (T) estimates for the cetacean genera Sousa, Orcaella, and Neophocaena, in support of IUCN Red List assessments. NOAA Tech. Memo. NMFS-SWFSC.

Muralidharan, R., 2013. Sightings and behavioral observations of Indo-Pacific humpback dolphins *Sousa chinensis* (Osbeck, 1765) along Chennai Coast, Bay of Bengal. J. Threat. Taxa 5, 5002–5006.

Nanayakkara, R.P., Kusuminda, T., Jefferson, T.A., 2014. Can the Indian Ocean humpback dolphin (*Sousa plumbea*) survive in Sri Lanka? Occurrence of a relict population in Puttalam Lagoon. Aquat. Mamm. 40, 398–406.

Parsons, C.M., 1998. Observations of Indo-Pacific Humpbacked dolphins, *Sousa chinensis*, from Goa, Western India. Mar. Mamm. Sci. 14, 166–170.

Peddemors, V.M., Thompson, G., 1994. Beaching behaviour during shallow water feeding by humpback dolphins *Sousa plumbea*. Aquat. Mamm. 20, 65–67.

Pilleri, G., Gihr, M., 1972. Contribution to the knowledge of the cetaceans of Pakistan with particular reference to the Genera *Neomeris*, *Sousa*, *Delphinus* and *Tursiops* and description of a new Chinese porpoise (*Neomeris asiaorientalis*). Invest. Cetac. 4, 107–162.

Pilleri, G., Pilleri, O., 1979. Observations on the dolphins in the Indus delta (*Sousa plumbea* and *Neophocaena phocaenoides*) in winter 1978–1979. Invest. Cetac. 10, 129–135.

Plön, S., Cockcroft, V.G., Froneman, W.P., 2015. The natural history and conservation of Indian Ocean humpback dolphins (*Sousa plumbea*) in South African waters. Adv. Mar. Biol. 72, 143–162.

Preen, A., 2004. Distribution, abundance and conservation status of dugongs and dolphins in the southern and western Arabian Gulf. Biol. Conserv. 118, 205–218.

Purvis, A., Gittleman, J.L., Cowlishaw, G., Mace, G.M., 2000. Predicting extinction risk in declining species. Proc. R. Soc. Lond. 267, 1947–1952.

Razafindrakoto, Y., Andrianarivelo, N., Rosenbaum, H.C., 2004. Sightings, catches, and other records of Indo-Pacific Humpback dolphins in the coastal waters of Madagascar. Aquat. Mamm. 30, 103–110.

Reeves, R.R., Dalebout, M.L., Jefferson, T.A., Karczmarski, L., Laidre, K., O'Corry-Crowe, G., Rojas-Bracho, L., Secchi, E.R., Slooten, E., Smith, B.D., Wang, J.Y., Zhou, K., 2008. Sousa chinensis. IUCN 2013. IUCN Red List of Threatened Species. Version 2013.2. Downloaded on 04 February 2014, www.iucnredlist.org.

Reilly, S.B., Barlow, J., 1986. Rates of increase in dolphin population size. Fish. Bull. 84, 527–533.

Ross, G.B.G., 1984. The smaller cetaceans of the south east coast of Southern Africa. Ann. Cape. Prov. Mus. 15, 173–410.

Ross, G.J.B., Heinsohn, G.E., Cockcroft, V.G., 1994. Humpback dolphins *Sousa chinensis* (Osbeck, 1765), *Sousa plumbea* (G. Cuvier, 1829) and *Sousa teuszii* (Kükenthal, 1892). In: Ridgway, S.H., Harrison, R. (Eds.), Handbook of Marine Mammals. In: The First Book of Dolphins, vol. 5. Academic Press, New York, pp. 23–42.

Saayman, G.S., Tayler, C.K., 1979. The Socioecology of Humpback dolphins (*Sousa* sp.). In: Winn, H.E., Olla, B.L. (Eds.), Behavior of Marine Animals. Current Perspectives in Research. In: Cetaceans, vol. 3. Plenum Press, New York, London, pp. 165–225.

Smith, B.D., Braulik, G., Strindberg, S., Ahmed, B., Mansur, R., 2006. Abundance of Irrawaddy dolphins (*Orcaella brevirostris*) and Ganges River dolphin (*Platanista gangetica gangetica*) estimated using concurrent counts made by independent teams in waterways of the Sundarbans mangrove forest in Bangladesh. Mar. Mamm. Sci. 22, 527–547.

Stensland, E., Carlen, I., Sarnblad, A., Bignert, A., Berggren, P., 2006. Population size, distribution, and behavior of Indo-Pacific Bottlenose (*Tursiops aduncus*) and humpback (*Sousa chinensis*) dolphins off the South Coast of Zanzibar. Mar. Mamm. Sci. 22, 667–682.

Sutaria, D., Jefferson, T.A., 2004. Records of Indo-Pacific humpback dolphins (*Sousa chinensis*, Osbeck, 1765) along the coasts of India and Sri Lanka: an overview. Aquat. Mamm. 30, 125–136.

Sutaria, D., Panicker, D., Jog, K., Sule, M., Muralidharan, R., Bopardikar, I., 2015. Humpback dolphins (Genus *Sousa*) in India: an overview of status and conservation issues. Adv. Mar. Biol. 72, 229–256.

Tarbit, J., 1984. Inshore Fisheries of the Tanzanian Coast. Overseas Development Administration, London.