

Sousa plumbea – Indian Ocean Humpback Dolphin



Brett Atkins

Regional Red List status (2016)	Endangered A4cd+B1ab(iii,v)*
National Red List status (2004)	Vulnerable B1ab(ii,iii)
Reasons for change	Genuine change
Global Red List status (2008)	Endangered A3cd+4cd
TOPS listing (NEMBA) (2007)	None
CITES listing (1979)	Appendix I
CMS listing	Appendix II
Endemic	No

*Watch-list Data

As studies examining the morphological and genetic variability of Humpback Dolphins have accumulated, our view of *Sousa* as one of the most highly-variable and locally-adapted genera of small cetaceans has begun to emerge (Mendez et al. 2011).

Taxonomy

Sousa plumbea (Cuvier 1829)

ANIMALIA - CHORDATA - MAMMALIA -
CETARTIODACTYLA - DELPHINIDAE - *Sousa* - *plumbea*

Common names: Indian Ocean Humpback Dolphin,
Indian Ocean Humpbacked Dolphin (English),
Boggelrugdolfyn (Afrikaans)

Taxonomic status: Species

Taxonomic notes: The taxonomy of the genus *Sousa* has been controversial. The 2004 South African assessment was conducted on *S. plumbea* in anticipation of the splitting of the genus (Friedmann & Daly 2004). A recent comprehensive study using genetic and morphological data collected from throughout the known *Sousa* range yielded convincing evidence of divergence (Mendez et al. 2013), and the genus has subsequently been split into four species: *S. teuszii* in the Atlantic off West Africa, *S.*

plumbea in the central and western Indian Ocean, *S. chinensis* in the eastern Indian and western Pacific oceans, and *S. sahalensis* over the Sahul Shelf extending between Australia and the island of New Guinea (Jefferson & Rosenbaum 2014).

Assessment Rationale

The Indian Ocean Humpback Dolphin (from here on, Humpback Dolphin) ranges along the southern and eastern South African coast, from False Bay to Kosi Bay, in shallow waters typically less than 25 m in depth. Correspondingly, the majority of the population occurs within 500 m to 2 km of the coastline. The length of the coastline from False Bay to Kosi Bay is 2,661 km (including estuaries), which yields an extent of occurrence (EOO) between approximately 1,331 to 5,322 km². Using 1.5 km as a proxy for water depth yields 3,992 km². In reality as the suitable habitat is likely to vary between 500 m and 2 km from shore along the length of the country's coastline and many areas are unsuitable, it is highly probable that the overall EOO is < 5,000 km². The restriction of Humpback Dolphins to a narrow coastal belt of shallow water makes them susceptible to human activities occurring in both the terrestrial and the marine environments. Ongoing coastal development (construed as proportional to general urban expansion) of 5.6–8.6% between 2000 and 2013 in Western Cape, Eastern Cape, and KwaZulu-Natal, and increasing boat traffic, especially in estuaries and around harbours, continues to negatively impact foraging and nursery areas. Simultaneously, there is ongoing loss of individuals from bycatch in shark-nets (on average 6.3±3.5 mortalities / year from 1980–2014, half of which are probably adolescents). Subpopulation estimates are generally small, ranging from 41 (Plettenberg Bay; estimated in 2013) to 466 (Algoa Bay area; estimated in 1994) individuals, with correspondingly fewer mature individuals. Habitats appear to be discontinuous along the coast, possibly resulting in a number of subpopulations, which are likely fragmented, but supporting evidence is lacking. Some initial molecular analyses indicated a degree of population structure, and females appear to show strong philopatry, thus dispersal between subpopulations north and south of Durban may be rare.

Small subpopulation size, low reproductive rate and restricted habitat makes this species sensitive to mortalities resulting from shark-nets and other anthropogenic disturbances. Mortality of only 4 individuals / year from a subpopulation of 100, or 7 from a subpopulation of 200, would result in a 50% decline over three generations (75 years). A subpopulation of 100 individuals with a recruitment rate of 5% and a mortality rate of 7 individuals / year would go locally extinct in 50 years (two generations). Empirical evidence suggest that mortality rates from shark-nets alone are consistently at or above this level (average of 7 mortalities per annum from 1980–2009). A decline in bycatch rate in KwaZulu-Natal from 1980–2014 ($R^2 = 0.12$, $df = 32$, $p = 0.046$), may signal a declining population or be the result of more

Recommended citation: Plön S, Atkins S, Conry D, Pistorius P, Cockcroft V, Child MF. 2016. A conservation assessment of *Sousa plumbea*. In Child MF, Roxburgh L, Do Linh San E, Raimondo D, Davies-Mostert HT, editors. The Red List of Mammals of South Africa, Swaziland and Lesotho. South African National Biodiversity Institute and Endangered Wildlife Trust, South Africa.

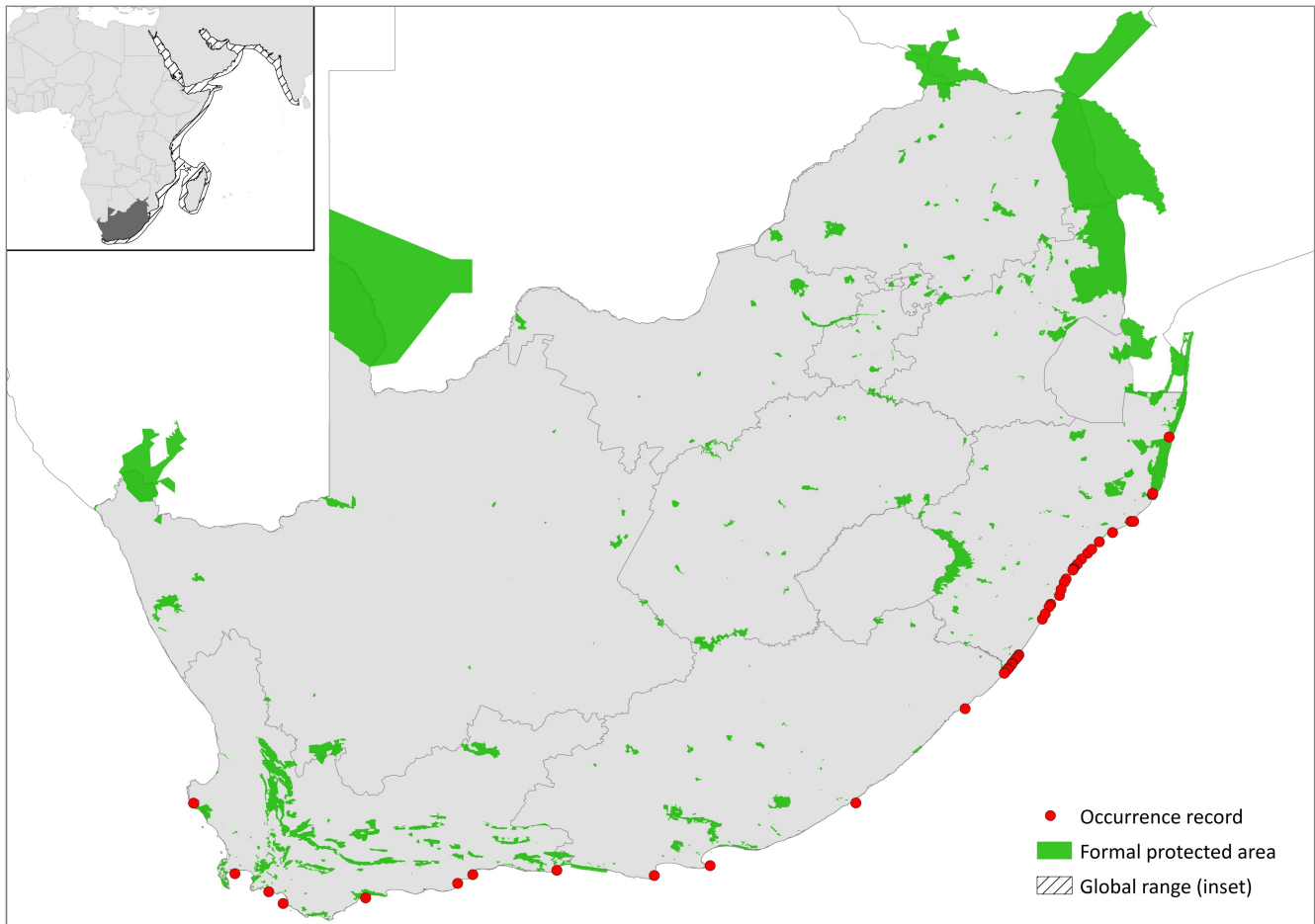


Figure 1. Distribution records for Indian Ocean Humpback Dolphin (*Sousa plumbea*) within the assessment region

Table 1. Countries of occurrence within southern Africa

Country	Presence	Origin
Mozambique	Extant	Native
Namibia	Absent	-
South Africa	Extant	Native

effective mitigation measures. Corroborating the decline hypothesis, there is an estimated subpopulation reduction, using mark-recapture analyses, from Plettenberg Bay from 93 (95% CI 72–114) to 41 (95% CI 28–54) individuals between 2002 and 2013, which indicates a > 50% decline over ten years.

We thus list Humpback Dolphins as Endangered B1ab (iii,v), based on an estimated EOO of < 5,000 km², a continuing decline in habitat quality (and likely area of occupancy) in patchy key resource areas correlating with general urban expansion, the likely isolation of subpopulations, and continuing adult mortality from anthropogenic disturbances (especially shark-nets). It also qualifies for Endangered A4cd based on an inferred and suspected population reduction of over 50% from 1960 to 2035 due to deteriorating habitat quality and bycatch from shark-nets, which have thus far not been mitigated by any successful conservation intervention and will thus continue into the future. As such, this is a genuine uplisting since the previous national assessment. A national coordinated monitoring programme is recommend to detect future changes in population size, and this species should be reassessed as more data on subpopulations become available. Reducing

anthropogenic disturbance and development around inshore reefs is the key intervention needed for this species.

Regional population effects: As the global population is suspected to be similarly declining, and information on calf mortality and population estimates from Maputo Bay is supporting this (Guissamulo & Cockcroft 2004), immigration from waters north of South Africa are likely to become increasingly rare and thus no rescue effects are predicted.

Distribution

In South Africa, Humpback Dolphins occur along the eastern and southern coasts from Kosi Bay to False Bay in a narrow band of shallow, nearshore water (Best 2007; Elwen et al. 2011) (Figure 1). Regionally, they also occur along the coast of Mozambique (Table 1). They are usually observed in waters less than 25 m in depth (Durham 1994; Atkins et al. 2004; Keith et al. 2013; James 2014; B. Melly unpubl. data), in protected bays and/or near estuaries. They are rarely encountered more than a couple of kilometres from shore, with this distance being dictated by water depth. In the Richard’s Bay study area (that extended 5 km from the shore), 97% of encounters were within 2 km of the shore (Atkins et al. 2004). In Plettenberg Bay, all encounters were within 1 km of the shore (Saayman & Taylor 1979), and in Algoa Bay the majority of sightings were within 500 m of the shore (Koper et al. 2015; B. Melly unpubl. data), and over 80% of sightings were within 400 m of the shore (Karczmarski et al. 2000).

Known high-density areas in South Africa are Algoa Bay, Richard's Bay and Mossel Bay. However, research to determine the relative density of Humpback Dolphin distribution over large areas along the South African coastline has not been conducted. In the KwaZulu-Natal Province, the subpopulation is concentrated predominantly north of the Thukela Mouth, where the very narrow "Natal inshore" ecozone (Driver et al. 2012) extends further offshore than usual. A 450 km stretch of coastline was sampled in the 1990s and a high-density area was identified between Thukela Mouth and St Lucia (Durham 1994), with lower densities south of the Thukela Mouth on the KwaZulu-Natal/ Eastern Cape border and at the one sampling site to the north of St Lucia (Sodwana Bay). The spatial pattern of bycatch in the KwaZulu-Natal Province shark-nets is similar: high at Richards Bay, the only shark-net installation north of the Thukela Mouth; and low south of the Thukela Mouth (Atkins et al. 2013). Within the high-density area, they appear to be associated with rivers (Durham 1994). In KwaZulu-Natal Province, most (61%) identified individuals were sighted more than once in three years. Of the re-sighted individuals, most (59%) were in the vicinity of their first sighting, but the remainder were observed at two or three other areas at distances ranging from 17 to 120 km away (Durham 1994).

South of the KwaZulu-Natal Province, they have been observed in isolated pockets and it is unclear whether areas between study sites lack Humpback Dolphins or simply lack research effort. There are only few reports of Humpback Dolphins from the Eastern Cape Province, but, with the exception of Algoa Bay, this province is not well researched and has relatively few urban centres. Humpback Dolphins in Algoa Bay are believed to form part of a larger subpopulation, but its extent is unknown. However, it does not extend to KwaZulu-Natal, 1,000 km away (Karczmarski et al. 1999). Strandings of the species in Eastern Cape waters were recorded in the 1970s and 1980s, but are absent since the 1990s (S. Plön unpubl. data). Possible population declines and/or scavenging of carcasses by sharks may explain this pattern.

In the Western Cape Province, surveys in the 150 km between Tsitsikamma and Goukamma suggest higher densities around Buffalo Bay, Goukamma Nature Reserve, Robberg seal colony and Keurboomstrand. Within this area, Humpback Dolphins identified in Plettenberg Bay were also sighted at Buffalo Bay, about 40 km away (Jobson 2006), and individuals identified off Goukamma Nature Reserve, Buffalo Bay and Knysna were later resighted about 90 km away at the Bloukrans River estuary in the Tsitsikamma Marine Protected Area (D. Conry, unpubl. data). Humpback Dolphins are sighted regularly at Mossel Bay: of the dolphins seen in Mossel Bay, 13% were also identified in Plettenberg Bay (140 km away), but none were re-sighted in East London (600 km away), De Hoop (150 km away) nor Gansbaai (300 km away) (though sample sizes at the latter three locations were small) (James 2014). Permitted boat-based whale watching operators have reported Humpback Dolphin sightings at Plettenberg Bay, Knysna, Hawston, Gansbaai, and seasonally in False Bay (M. Meyer unpubl. data). Although there was uncertainty about the western limit of the species' range historically (Findlay et al. 1992), it is hypothesised that there has been a westward extension along the coast into False Bay. Vagrant animals have been reported on the west coast: two individuals were photographed in Saldanha Bay over a period of a few months in 2012 (S. Kirkman pers. comm. 2015) (Figure 1).

The length of the coastline from False Bay to Kosi Bay is 2,661 km (including estuaries and excluding the vagrant sightings at Saldanha Bay), which yields an extent of occurrence ranging from 1,331 to 5,322 km², using 500 m to 2 km distance to shore as a proxy for water depth. Using 1.5 km distance yields 3,992 km². The area of occupancy (AOO) within this wide range is suspected to be considerably curtailed as only certain areas along the coast are suitable or contain key resource areas, such as estuaries and nearshore reefs, while open or sandy coastlines may represent transit zones between subpopulations (Karczmarski 2000). The AOO can be estimated as the amount of inshore rocky habitat within the EOO (using data from Driver et al. 2012), which yields 1,068 km². However, further surveys are required to more accurately determine occupancy within its range.

Population

As detailed molecular studies on population structure of Humpback Dolphins in South African waters are missing to date, and few examinations into movement patterns have been carried out, the term 'subpopulation' is used here in the context of pockets/ areas where these animals occur.

All subpopulations that have been surveyed have been small in size, always fewer than 500 individuals, and usually fewer than 200. Within the assessment region, no formal abundance estimate exists at a national level, but estimates have been calculated at a few localities. All available local estimates are in the tens to low hundreds. At Richards Bay, a hotspot for Humpback Dolphins in KwaZulu-Natal Province, estimates vary between 74 (95% CIs = 60–88) (Keith et al. 2002) and 170–244 animals (Atkins & Atkins 2002). In the Eastern Cape Province, 466 (95% CIs = 447–485) dolphins were estimated for the Algoa Bay area in the early 1990s (Karczmarski et al. 1999). In the Western Cape Province, the population estimate for Plettenberg Bay was 112 (95% CIs = 75–133) (Jobson 2006) and for Mossel Bay, 116 (95% CIs = 54–247) (James 2014). A provincial estimate of 166 (95% CIs = 143–229) existed for KwaZulu-Natal in the early 1990s (Durham 1994).

Quantitative trend data is only available for the Plettenberg Bay area, where the population declined from about 93 (95% CI 72–114) to 41 (95% CI 28–54) individuals between 2002 and 2013 (Greenwood 2013). Similar declines could be occurring range-wide as group size is estimated to be decreasing in other areas. For example, in Algoa Bay, group size has halved from the early 1990s to 2010 (Koper et al. 2015), which could mean a population decline, emigration of animals from the study area, or a change in social structure related to reduced prey availability. Thus, two independent datasets suggest a population decline in two different localities over the past ten to twenty years. Similarly, we suspect a continuing decline based on the mean annual mortality rate in the KwaZulu-Natal shark-nets of seven Humpback Dolphins (Cockcroft 1990; Atkins et al. 2013), which may be close to or exceed the recruitment rate of 5%. A minimum of 203 Humpback Dolphins were captured in shark-nets in the thirty years between 1980 and 2009, which corresponds to 6.8 animals / year corresponding to 5–10% of the population per annum. Although bycatch in shark-nets appears to be declining (37 mortalities from 2005–2014; mean = 3.7 animals / annum, KZN Sharks Board & S. Atkins unpubl. data), it is presently unclear if this is due to administration

of the nets or if it is reflective of a declining population. Genetic evidence suggests philopatry of females and limited male movement north and south of Durban, which means that local extirpation due to shark-nets is a possibility (Smith-Goodwin 1997).

A large-scale genetic study of Humpback Dolphins in the Western Indian Ocean showed a likelihood of a common South African and Mozambican stock/ population (Mendez et al. 2013). Strong population structure indicates that migration events are either very infrequent or may no longer occur with subpopulations north of Mozambique (Mendez et al. 2013). Within South Africa, one genetic study has been conducted in KwaZulu-Natal Province, with the inclusion of one sample each from the Eastern Cape and Western Cape (Smith-Goodwin 1997). Results from an mtDNA analysis suggested three units: 1) Richards Bay, 2) Zinkwazi to Durban, and 3) south of Durban, including the Eastern Cape and Western Cape samples. However, microsatellite DNA suggested no structure between these units. The difference between the two sets of results could be an mtDNA sampling error because only a single haploid locus was investigated or could indicate strict female philopatry with wider ranging patterns for males. Dispersal is estimated to be infrequent south of Durban (though sample size was small) and the recommendation was that Humpback Dolphins north of Durban be managed separately from Humpback Dolphins elsewhere along the coast.

Current population trend: Uncertain, but possibly declining in some areas.

Continuing decline in mature individuals: Yes. Ongoing mortalities from shark-nets.

Number of mature individuals in population: Unknown

Number of mature individuals in largest subpopulation: Unknown

Number of subpopulations: Unknown, but possibly three: Richards Bay, Algoa Bay and Plettenberg Bay.

Severely fragmented: Yes. Dispersal between subpopulations is suspected to be limited, especially for females. Key resource areas are patchily distributed across the coast.

Habitats and Ecology

Humpback Dolphins have a clear preference for shallow rocky reefs (Karczmarski 2000), usually less than 25 m in depth, and perhaps less than 20 m in depth (Ross 1984). Thus it is likely that the 25 m isobath represents the critical depth. There are usually 6 to 7 individuals per group (Skinner & Chimimba 2005), but solitary individuals are most frequent; group size ranges from two to 25 individuals (Best 2007). Humpback Dolphins appear to be opportunistic feeders, consuming a wide variety of nearshore, estuarine, and reef fishes, many of which are soniferous, suggesting passive acoustic detection of prey in turbid waters (Barros & Cockcroft 1999). Isotope analysis indicates that the species occupies a narrow niche along the coast (Browning et al. 2014). Stomach content analysis of 22 individuals incidentally caught in shark-nets between 2004–2009 indicated that squid (*Loligo* spp., 37.5%) made up the largest percentage in weight of the total prey species consumed, followed by Ribbon Fish (*Trichiurus lepturus*, 15.8%), Bearded Croaker (*Johnius amblycephalus*, 7.2%), Glassnosed Anchovy (*Thryssa vitirostris*, 7.1%), and Olive Grunter (*Pomadasy*



olivaceum, 5.1%); 27.3% were made up of 53 other prey species (Plön et al. 2011). At Richards Bay, KwaZulu-Natal Province, the core feeding area of Humpback Dolphins is centred at the harbour entrance (Keith et al. 2013), which is bisected by a shipping lane used by all commercial and recreational vessels. The use by Humpback Dolphins of this habitat elevates the exposure of the animals to a variety of threats (for example, chemical pollution through land-based runoff, noise pollution, boat disturbance and food-web changes due to xenobiotic contamination and climate change).

Ecosystem and cultural services: Coastal dolphins, as long-lived, long-term residents along the coast, can serve as important sentinels of the health of coastal marine ecosystems (Wells et al. 2004). As top-level predators on a variety of fish, they concentrate contaminants through bioaccumulation and integrate broadly across the ecosystem in terms of exposure to environmental impacts. As a marine apex predator in the coastal zone the Humpback Dolphin is a good indicator of marine ecosystem health (Lane et al. 2014); in fact decline or disappearance from certain areas over the past few decades has been speculated to be linked to a decline in prey abundance (Koper et al. 2015).

Use and Trade

There is no trade in the species within South Africa. An annual permit is issued to the KwaZulu-Natal Sharks Board to be in possession of dead dolphins accidentally captured during the shark control programme, but the dolphins, or parts thereof, may not be sold. 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.

Threats

The restriction of this species to a narrow coastal belt of water, due to its preference for shallow water, makes it highly susceptible to a number of anthropogenic threats (Reeves & Leatherwood 1994; Plön et al. 2015), particularly as it is subject to threats from human activities in both the terrestrial (pesticide use, agricultural run-off etc.) and the marine (noise pollution, coastal development, boating and fishing) environments (D. Gui et al. unpubl. data). The coastal zone has the greatest number of overlapping threats, especially near population centres (Crain et al. 2009). Ranking the threats is difficult and we lack an understanding of the cumulative effects of the multiple threats but their small subpopulation size, low reproductive rate and restricted habitat means they are vulnerable to disturbance (Plön et al. 2015). Dredging, land reclamation, port and harbour construction, pollution,

Table 2. Use and trade summary for the Indian Ocean Humpback Dolphin (*Sousa plumbea*)

Category	Applicable?	Rationale	Proportion of total harvest	Trend
Subsistence use	No	-	-	-
Commercial use	Yes	Ecotourism	No harvest	Stable
Harvest from wild population	No	-	-	-
Harvest from ranched population	No	-	-	-
Harvest from captive population	No	-	-	-

boat traffic, oil and gas exploration (including seismic surveying), and other anthropogenic activities all occur, or are concentrated within, Humpback Dolphin habitat and threaten the species' survival in ways that are challenging to quantify. We suspect that the cumulative impacts effectively reduce the quality of the habitat and thus area of occupancy for this species. Further, Humpback Dolphins exhibit a number of life history parameters that result in a low population growth potential, making it difficult for populations to recover from anthropogenic impacts (Jefferson & Karczmarski 2001; Jefferson et al. 2012; Plön et al. 2015).

The following have been identified as being the main threats to the species currently:

Shark-nets: Shark-nets are gillnets that are set close to shore at about 40 beaches along the coast of the KwaZulu-Natal Province, with the aim of reducing shark-bather

interaction (Dudley 1997). Humpback Dolphins are incidentally caught in these nets, which pose the greatest direct threat (Cockcroft 1990; Atkins et al. 2013). The bycatch occurs mainly at Richards Bay, fluctuates annually, and lacks seasonality; it is male-biased and consists mostly of adolescent animals (Atkins et al. 2013).

Coastal development: Coastal development is the greatest pressure on coastal biodiversity in South Africa (Driver et al. 2012) and may represent a major underlying threat to Humpback Dolphins. Developments in estuaries (especially those used for harbours and marinas) impact Humpback Dolphins directly and, because they use these areas for foraging, indirectly through effects on their estuarine-dependent prey (Barros & Cockcroft 1999; Jefferson et al. 2009; Plön et al. 2011). The alteration or loss of habitat, such as rocky shores, possibly a critical habitat for Humpback Dolphins, could reduce the foraging area available to these animals as well as possibly

Table 3. Threats to the Indian Ocean Humpback Dolphin (*Sousa plumbea*) ranked in order of severity with corresponding evidence (based on IUCN threat categories, with regional context)

Rank	Threat description	Evidence in the scientific literature	Data quality	Scale of study	Current trend
1	5.4.3 Fishing & Harvesting Aquatic Resources: accidental bycatch in shark-nets.	Cockcroft 1990 Atkins et al. 2013	Empirical Empirical	Regional Regional	A minimum of 203 individuals was caught between 1980 and 2009.
2	1.2 Commercial & Industrial Areas: expanding coastal development reduces habitat quality.	James 2015	Empirical	Local	Higher sighting rate occurred before desalination and in control areas without reverse osmosis plants.
3	5.4.4 Fishing & Harvesting Aquatic Resources: overfishing may reduce prey base and thus depress population.	Koper et al. 2015 Plön et al. 2015	Indirect	Regional	-
4	9 Pollution: uptake of organochlorides impedes reproductive capability.	Cockcroft 1999 D. Gui et al. submitted	Empirical	National	Humpback Dolphins show the highest levels of organochlorines of any marine mammal in South Africa.
5	4.3 Shipping Lanes: increased boat traffic reduces habitat area and quality, especially around ports and harbours.	Karczmarski et al. 1997, 1998 Koper et al. 2015	Indirect Indirect	Local Local	Humpback Dolphins were observed to alter their behaviour or actively avoid vessels.
6	9.6.3 Noise Pollution: sustained, low-intensity sonic pollution from shipping and industrial processes are suspected to depress the population.	Koper and Plön 2012 Plön et al. 2015	Indirect Indirect	Regional Regional	-
7	7.2 Dam & Water Management/Use: reduction of fresh water flow into estuaries is suspected to reduce habitat quality.	-	Anecdotal	-	-
8	11.1 Habitat Shifting & Alteration: climate change may exacerbate existing threats, especially as the species is on the edge of its global range.	-	Anecdotal	-	-



reducing the nursery areas of important Humpback Dolphin prey species. Recent evidence from the Western Cape Province showed that discharge from four desalination plants between Mossel Bay and Plettenberg Bay significantly decreased Humpback Dolphin sighting rate and habitat use (James 2014).

Overfishing: Fishing is a key driver of change in South Africa's marine and coastal ecosystems (Driver et al. 2012) and a declining prey base is perceived to be a major threat to Humpback Dolphins (Plön et al. 2015). A decline in reef fish is suspected by fisheries biologists, and many estuarine-dependent marine species remain over-exploited, which will cause indirect decreases in Humpback Dolphin populations. Overfishing of Humpback Dolphin prey is possibly an important threat in Algoa Bay (Koper et al. 2015).

Pollution: The use of the nearshore coastal zone by Humpback Dolphins, particularly their association with rivers and estuaries, as well as their high trophic level of feeding puts them at risk of pollution impacts (Cockcroft 1999; Reijnders et al. 2009). Beyond waste water discharge, pollution was not addressed in the technical report of the marine and coastal component of the National Biodiversity Assessment (Driver et al. 2012). However, persistent organic and inorganic pollutants are a major problem for coastal ecosystems around the world (Crain et al. 2009). Humpback Dolphins off the KwaZulu-Natal coast are persistently recorded with the highest levels of organochlorines and PCBs, DDT and Dieldrin of any marine mammal off South Africa (Cockcroft 1999; D. Gui et al. unpubl. data). The sources of these are believed to be agricultural and industrial pollutants and these toxins can cause reproductive abnormalities (Duinker et al. 1979) and can impair testosterone production (Subramanian et al. 1987), which can reduce the reproductive capacity of a population and prevent its recovery (Martineau et al. 1987). However, current effects on the South African population are unknown even though persistent organic pollutants have been accumulating (D. Gui et al. unpubl. data).

Vessel traffic: Boat traffic has also been identified as a major cause of disturbance to Humpback Dolphins (Karczmarski et al. 1997, 1998; Koper et al. 2015). Ship traffic around South Africa is considerable, with a particularly high concentration of oil tankers and cargo ships, and the resulting threats (oil spills, introduction of alien species, dumping of waste material, ship strikes and noise) may thus impact Humpback Dolphins directly and indirectly (Driver et al. 2012; Koper et al. 2015). In Algoa Bay, Humpback Dolphins were observed to alter their

behaviour or actively avoid vessels (Karczmarski et al. 1997, 1998). Humpback Dolphins were also observed to avoid areas that were important for foraging and feeding as boat traffic increased (Karczmarski 1996). The threat is mostly localised at harbours and ports, though all vessel launch sites in Humpback Dolphin areas have the potential to include vessel impacts and disturbance. Behavioural changes due to vessel disturbance have been documented and Humpback Dolphins appear to be sensitive to both motorised and non-motorised vessels (Koper et al. 2015).

Noise pollution: Loud noises (for example, from construction and geoprospecting) can have negative physical and physiological effects on animals, but less obvious and even more pervasive are the lower intensity, longer duration noises (for example, shipping noise) that can also induce physiological and behavioural stress and mask important acoustic cues in the environment (Koper & Plön 2012; Plön et al. 2015). The latter may be particularly important for Humpback Dolphins as many of their prey are soniferous and thus high ambient noise levels may well impact on their ability to hear and thus catch prey (Barros & Cockcroft 1999). In China and Australia, boat traffic has been shown to disturb Humpback Dolphin behaviour, mask their vocalisations and hinder communication (Van Parijs & Corkeron 2001a, 2001b; Ng & Leung 2003). More data on this threat are required.

Reduced freshwater flow: The reduction of freshwater flow (by damming upriver) compromises important processes in estuaries and the nearshore environment, including nursery functions, environmental cues, productivity and food web processes (Driver et al. 2012). This is of particular concern in the Humpback Dolphin high-density areas, particularly in estuaries in the KwaZulu-Natal Province.

Climate change: Coastal species are particularly vulnerable to climate change (Driver et al. 2012). The South African Humpback Dolphin population is at the edge of the species' distribution range, heightening concerns about climate change impacts, and further exacerbating the synergistic effects of other threats, such as a decline in prey base or altered freshwater flows. Alternatively, climate change could allow for a range extension of the Humpback Dolphin.

Current habitat trend: Nearly a fifth of South Africa's coast has some form of development within 100 m of the shoreline (Driver et al. 2012). This is set to continue as urban expansion has increased by 6.4% on average for the Western Cape, Eastern Cape and KwaZulu-Natal between 2000 and 2013 (GeoTerraImage 2015).

Conservation

Nationally, the species is protected under the Marine Living Resources Act. More than 20% of South Africa's coastline is protected (though < 10% is "no-take") (Driver et al. 2012). However, most of the Marine Protected Areas (MPAs) in KwaZulu-Natal are in low-density areas for Humpback Dolphins. Marine Protected Areas that coincide with the extent of occurrence of Humpback Dolphins include: De Hoop MPA, Stilbaai MPA, Goukamma MPA, Robberg MPA, Tsitsikamma MPA, Sardinia Bay MPA, the proposed Greater Addo Elephant MPA, Amathole MPA, Dwesa-Cwebe MPA, Hluleka MPA, Pondoland MPA, Trafalgar MPA, Aliwal Shoal MPA, Isimangaliso Wetland Park.

Table 4. Conservation interventions for the Indian Ocean Humpback Dolphin (*Sousa plumbea*) ranked in order of effectiveness with corresponding evidence (based on IUCN action categories, with regional context)

Rank	Intervention description	Evidence in the scientific literature	Data quality	Scale of evidence	Demonstrated impact	Current conservation projects
1	<i>1.1 Site/Area Protection</i> : establish MPAs (with seaward boundary at least 25 m) in high-density areas with strict controls on human disturbance.	-	Anecdotal	Local	-	Two projects currently assessing the value of MPAs/protected areas (Goukamma MPA, Robberg MPA, Tsitsikamma MPA) to Humpback Dolphins (CDS/NMMU)
2	<i>1.1 Site/Area Protection</i> : delineate effective conservation and management units in South African waters based on population genetic data and revised population abundance estimates.	-	-	Local	-	-
3	<i>1.1 Site/Area Protection</i> : determine high use areas/critical habitat for the species throughout its range in South African waters and implement protection from anthropogenic impacts (coastal development, fishing, boating and tourism etc.).	-	-	Local	-	-
4	<i>1.2 Resource & Habitat Protection</i> : establish multiple-use buffer zones around MPAs.	-	Anecdotal	-	-	-
5	<i>5.2 Policies & Regulations</i> : conservationists should work with municipalities and provincial governments to prevent industrial and agricultural pollution, as well as urban development, on rivers upstream of estuaries forming MPAs and buffer zones.	-	Anecdotal	-	-	-
6	<i>2.1 Site/Area Management</i> : replace shark-nets with baited hooks (drumlines).	Cliff & Dudley 2011	Empirical	Regional	Decrease in catch rate.	-
7	<i>2.1 Site/Area Management</i> : trial the reduction of vessel speed to reduce noise pollution and ship strikes.	-	Anecdotal	-	-	-
8	<i>2.1 Site/Area Management</i> : interventions to make shark-nets more conspicuous or installing acoustic warning devices (for example, pingers).	Peddemors et al. 1990; Peddemors & Cockcroft 1994	Empirical	Regional	Unsuccessful. Bycatch continued.	-

Few interventions have been tested to generate evidence for their effectiveness. Exceptions include bycatch mitigation devices and methods, and noise-dampening strategies, although even these studies have been qualitative rather than quantitative and some remain unpublished:

Shark-net mitigation: A number of efforts have been undertaken to understand the cause of dolphin capture in the shark-nets and various strategies have been tested to mitigate the unintentional catch in the shark-nets. Devices have been added to the nets to make the nets more conspicuous acoustically, (for example, with air-filled floats and clangers) or to deter the dolphins with sounds (for example, pingers), but have not been proven successful (Peddemors et al. 1990; Cliff & Dudley 2011). Modifying the fishing gear by increasing the mesh size was more successful, but was not a viable option in terms of effective bather protection (Cliff & Dudley 2011). At Richards Bay, which has the highest catch of Humpback

Dolphins in KwaZulu-Natal Province, certain nets catch more dolphins than others (KZN Sharks Board and S. Atkins unpubl. data). In 2005, half of one of these nets was replaced with three baited hooks (drumlines), which do not catch cetaceans (Dudley et al. 1998; Cliff & Dudley 2011). Since then the catch in this net has been reduced significantly (from 1.55 ± 0.35 to 0.50 ± 0.25 animals; two-sample $t = 2.25$, $p = 0.036$) and in the whole shark-net installation (from 4.82 ± 0.71 to 2.9 ± 0.69 dolphins; $t = 1.66$, $p = 0.112$), although the latter was non-significant (KZNSB & S. Atkins unpubl. data). To completely mitigate the impact of these nets on Humpback Dolphins (and other large marine animals), a non-lethal method of bather protection should be sought. In the interim, the permanent removal of some of the nets, and further replacement of nets with baited hooks, especially high-catch nets, is likely to be more effective than making the nets more conspicuous. It should be noted that, for Humpback Dolphins, mitigation at Richards Bay could reduce this threat significantly.

Noise pollution mitigation: To mitigate some of the impacts of noise, particularly underwater construction noise associated with coastal development, various techniques have been trialled, such as bubble curtains and ramping up of noise (Jefferson et al. 2009). However, the effectiveness of these methods remains a topic of debate as more data emerge. In general, current mitigation measures include temporal and geographic restrictions of construction to avoid peak migration and activity times as well as impact on important habitats (Koper & Plön 2012). Additional mitigation involves sound containment of construction noise, improved-engineering strategies as well as operational mitigation e.g. warning sounds and ramping up of noise (Koper & Plön 2012). At present, national legislation on this topic appears to be missing.

Shipping noise is another topic of concern as vessel noise increases with vessel speed (Spence et al. 2007), and thus it may be worth investigating the effects of vessel speed on noise levels and Humpback Dolphins and, if deemed important, speed regulations may be an option in sensitive areas where vessel traffic overlaps with Humpback Dolphin high-density areas. This could have a knock-on effect and lower the chance of boat strikes (Laist et al. 2014).

Recommended interventions: Humpback Dolphins should be considered a flagship species of the Indian Ocean coastline and incorporated into the general conservation of coastal ecosystems. Multiple-use management areas, extending over hundreds of kilometres, should be established with controlled ecotourism and fishing zones buffering strict reserves in high-density areas (Karczmarski 2000). For example, MPAs should be established specifically for this species in the Algoa and Richards Bay areas, with the seaward boundary of such reserves extending at least along the 25 m isobaths (Cockcroft 1997). Such MPAs and buffer zones should be connected to ecosystem processes upstream of estuaries (Álvarez-Romero et al. 2011), where strict zoning policies should limit industrial and agricultural pollution and urban development. At some sites where MPAs are not feasible (for example, Richards Bay), alternative interventions are required (for example, speed limits for vessels).

Recommendations for managers and practitioners:

- A national coordinated monitoring programme is needed to allow detection of future changes in population numbers.
- A mitigation strategy should be developed to reduce Humpback Dolphin bycatch in the KwaZulu-Natal shark-nets; it should be focused at Richards Bay and must be implemented year-round. Similarly, interventions are required at Richards Bay where the core feeding area is bisected by a shipping lane; for example, vessel speed reduction should be investigated and regulated.
- Strategies to reduce noise impacts (for example, during construction and geoprospecting) should be used and new ones designed.
- Restrictions in recreational boat use close to estuaries that are important habitat for Humpback Dolphins need consideration, possibly in the form of zonation.
- Population Viability Analyses should be considered

at areas where high densities of Humpback Dolphins and threats co-occur, such as Richards Bay and Algoa Bay, as well as where a subpopulation decline has been detected, such as in Plettenberg Bay.

Research priorities: At present, research is patchy and disjointed and local research groups should be unified under a systematic, national research agenda. A high priority is a region-wide investigation of population dynamics designed to allow the monitoring of trends accurately. Clarification is required on the levels of the various threats and their impacts on Humpback Dolphins, such that threats can be assessed and their cumulative impacts understood. A coherent body of evidence for the effectiveness of the interventions mentioned above needs to be generated, and of innovative, new interventions. Studies on the population status and habitat use of Humpback Dolphins in the southern Cape (Goukamma to Tsitsikamma) are currently being conducted by Nelson Mandela Metropolitan University, the Department of Environmental Affairs, and the Centre for Dolphin Studies. This project commenced in 2014, extending on previous research restricted to the Plettenberg Bay area. Monthly surveys of the entire coastal section is performed with the aim of estimating population numbers, identifying important habitat and assessing the value of the current MPA network within the area in terms of fulfilling a conservation role.

Surveys for a revised population size estimate, habitat use, and social structure are under way in Algoa Bay. Studies on the movement of animals are being carried out for KZN and EC waters. Both projects are conducted by NMMU (PI: Stephanie Plön).

Other key research questions include:

- An estimate of national population size and trend is required with information on relative spatial density.
- Revised population abundance estimates are required for the historically largest populations (Algoa Bay and Richards Bay). Monitoring of these populations is needed.
- Identification and delineation of population genetic structure is needed in order to design effective management and conservation units in South African waters.
- Investigations on the effects of noise, particularly regarding predator-prey interactions. Areas of overlap of known Humpback Dolphin habitats and high levels of vessel traffic (ships, boats and others), such as Algoa Bay and Richards Bay, are priority areas.
- Previous research on pollutants should be advanced, with particular focus on persistent organic and inorganic pollutants and mitigation strategies should be developed.
- Research into the cumulative impact of multiple simultaneous stressors should be conducted.

Encouraged citizen actions:

- This is an easily recognisable species and thus sightings on virtual museum platforms (for example, iSpot and MammalMAP) will greatly enhance knowledge of its distribution. A [smart app](#) for identifying and logging cetacean sightings off the Wildcoast has been developed by NMMU and Eastern Cape Parks and Tourism Agency (ECPTA):

- Use information dispensed by the South African Sustainable Seafood Initiative (SASSI) to make good choices when buying fish in shops and restaurants.
- Buy fresh produce that has been grown in pesticide-free environments.
- Save electricity and fuel to mitigate CO₂ emissions and hence rate of climate change.
- Buy local products that have not been shipped.
- Reduce boat speed in bays and harbours.
- When participating in whale/dolphin watching tours, ensure regulations are followed.
- Don't approach or chase dolphins in boats or skis.
- Good habits for marine resource users should be encouraged: no littering or discarding of fishing gear.

References

Álvarez-Romero JG, Pressey RL, Ban NC, Vance-Borland K, Willer

Data Sources and Quality

Table 5. Information and interpretation qualifiers for the Indian Ocean Humpback Dolphin (*Sousa plumbea*) assessment

Data sources	Field study (literature, unpublished), indirect information (literature, expert knowledge)
Data quality (max)	Estimated
Data quality (min)	Suspected
Uncertainty resolution	Maximum / minimum values
Risk tolerance	Precautionary

C, Klein CJ, Gaines SD. 2011. Integrated land-sea conservation planning: the missing links. *Annual Review of Ecology, Evolution, and Systematics* **42**:381–409.

Atkins S, Atkins BL. 2002. Abundance and site fidelity of Indo-Pacific humpback dolphins (*Sousa chinensis*) at Richards Bay. Scientific Committee report SC/54/SM25, 54th annual meeting of the International Whaling Commission. International Whaling Commission, Shimonoseki, Japan.

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

Atkins S, Pillay N, Peddemors VM. 2004. Spatial distribution of Indo-Pacific humpback dolphins (*Sousa chinensis*) at Richards Bay, South Africa: Environmental influences and behavioural patterns. *Aquatic Mammals* **30**:84–93.

Barros NB, Cockcroft VG. 1999. Prey resource partitioning between Indo-Pacific hump-backed (*Sousa chinensis*) and bottlenose dolphins (*Tursiops truncatus*) off South Africa—competitive exclusion or mutual tolerance? Page 13. Abstracts of the 12th Biennial Conference on the Biology of Marine Mammals. Maui, Hawaii, USA.

Best PB. 2007. *Whales and Dolphins of the Southern African Subregion*. Cambridge University Press, Cape Town, South Africa.

Browning NE, Cockcroft VG, Worthy GA. 2014. Resource partitioning among South African delphinids. *Journal of Experimental Marine Biology and Ecology* **457**:15–21.

Cliff G, Dudley SFJ. 2011. Reducing the environmental impact of shark-control programs: a case study from KwaZulu-Natal, South Africa. *Marine and Freshwater Research* **62**:700–709.

Cockcroft VG. 1990. Dolphin catches in the Natal shark nets, 1980 to 1988. *South African Journal of Wildlife Research* **20**:44–51.

Cockcroft VG. 1997. Conservation biology of humpback dolphins in South and Eastern Africa. Pages 1–5. Proceedings of a Colloquium for the Development of a Management Strategy for Chinese White Dolphins. Agriculture and Fisheries Department, The Government of the Hong Kong Special Administrative Region, Hong Kong.

Cockcroft VG. 1999. Organochlorine levels in cetaceans from South Africa: a review. *Journal of Cetacean Research and Management*:169–176.

Crain CM, Halpern BS, Beck MW, Kappel CV. 2009. Understanding and managing human threats to the coastal marine environment. *Annals of the New York Academy of Sciences* **1162**:39–62.

Driver A, Sink KJ, Nel JN, Holness S, Van Niekerk L, Daniels F, Jonas Z, Majiedt PA, Harris L, Maze K. 2012. National Biodiversity Assessment 2011: An assessment of South Africa's biodiversity and ecosystems. Synthesis Report. South African National Biodiversity Institute and Department of Environmental Affairs, Pretoria, South Africa.

Dudley SFJ. 1997. A comparison of the shark control programs of New South Wales and Queensland (Australia) and KwaZulu-Natal (South Africa). *Ocean & Coastal Management* **34**:1–27.

Dudley SFJ, Haestier RC, Cox KR, Murray M. 1998. Shark control: experimental fishing with baited drumlines. *Marine and freshwater research* **49**:653–661.

Duinker JC, Hillebrand MTJ, Nolting RF. 1979. Organochlorines and metals in harbour seals (Dutch Wadden Sea). *Marine Pollution Bulletin* **10**:360–364.

Durham B. 1994. The distribution and abundance of the humpback dolphin (*Sousa chinensis*) along the Natal coast, South Africa. M.Sc. Thesis. University of KwaZulu-Natal, Durban, South Africa.

Elwen SH, Findlay KP, Kiszka J, Weir CR. 2011. Cetacean research in the southern African subregion: a review of previous studies and current knowledge. *African Journal of Marine Science* **33**:469–493.

Findlay KP, Best PB, Ross GJB, Cockcroft VG. 1992. The distribution of small odontocete cetaceans off the coasts of South Africa and Namibia. *South African Journal of Marine Science* **12**:237–270.

Friedmann Y, Daly B, editors. 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, South Africa.

GeoTerralimage. 2015. Quantifying settlement and built-up land use change in South Africa.

Greenwood G. 2013. Population changes and spatial distribution of Indo-Pacific humpback dolphins (*Sousa chinensis*) within the Plettenberg Bay area. B.Sc (Hons) Thesis. Department of Zoology, Nelson Mandela Metropolitan University, Port Elizabeth, South Africa.

Guissamulo A, Cockcroft VG. 2004. Ecology and population estimates of Indo-Pacific humpback dolphins (*Sousa chinensis*) in Maputo Bay, Mozambique. *Aquatic Mammals* **30**:94–102.

James BS. 2014. Natural and human impacts on habitat use of coastal delphinids in the Mossel Bay area, Western Cape, South Africa. M.Sc. Thesis. University of Pretoria, Pretoria, South Africa.

Jefferson TA, Hung SK, Robertson KM, Archer FI. 2012. Life history of the Indo-Pacific humpback dolphin in the Pearl River Estuary, southern China. *Marine Mammal Science* **28**:84–104.

Jefferson TA, Hung SK, Würsig B. 2009. Protecting small cetaceans from coastal development: Impact assessment and mitigation experience in Hong Kong. *Marine Policy* **33**:305–311.

- Jefferson TA, Karczmarski L. 2001. *Sousa chinensis*. Mammalian Species:1–9.
- Jefferson TA, Rosenbaum HC. 2014. Taxonomic revision of the humpback dolphins (*Sousa* spp.), and description of a new species from Australia. *Marine Mammal Science* **30**:1494–1541.
- Jobson AJ. 2006. Insights into population size, group dynamics and site fidelity of Humpback Dolphins (*Sousa chinensis*) in Plettenberg Bay, South Africa. M.Sc. Thesis. Nelson Mandela Metropolitan University, Port Elizabeth, South Africa.
- Karczmarski L. 1996. Ecological studies of humpback dolphins *Sousa chinensis* in the Algoa Bay region, Eastern Cape, South Africa. Ph.D. Thesis. Department of Zoology, University of Port Elizabeth, Port Elizabeth, South Africa.
- Karczmarski L. 2000. Conservation and management of humpback dolphins: the South African perspective. *Oryx* **34**:207–216.
- Karczmarski L, Cockcroft VG, McLachlan A. 2000. Habitat use and preferences of Indo-Pacific humpback dolphins *Sousa chinensis* in Algoa Bay, South Africa. *Marine Mammal Science* **16**:65–79.
- Karczmarski L, Cockcroft VG, McLachlan A, Winter PED. 1998. Recommendations for the conservation and management of humpback dolphins *Sousa chinensis* in the Algoa Bay region, South Africa. *Koedoe* **41**:121–129.
- Karczmarski L, Thornton M, Cockcroft V. 1997. Description of selected behaviours of humpback dolphins, *Sousa chinensis*. *Aquatic Mammals* **23**:127–134.
- Karczmarski L, Winter PE, Cockcroft VG, McLachlan A. 1999. Population analyses of Indo-Pacific humpback dolphins *Sousa chinensis* in Algoa Bay, Eastern Cape, South Africa. *Marine Mammal Science* **15**:1115–1123.
- Keith M, Atkins S, Johnson AE, Karczmarski L. 2013. Area utilization patterns of humpback dolphins (*Sousa plumbea*) in Richards Bay, KwaZulu-Natal, South Africa. *Journal of Ethology* **31**:261–274.
- Keith M, Peddemors VM, Bester MN, Ferguson JWH. 2002. Population characteristics of Indo-Pacific humpback dolphins at Richards Bay, South Africa: implications for incidental capture in shark nets. *South African Journal of Wildlife Research* **32**:153–162.
- Koper RP, Karczmarski L, Preez D, Plön S. 2015. Sixteen years later: Occurrence, group size, and habitat use of humpback dolphins (*Sousa plumbea*) in Algoa Bay, South Africa. *Marine Mammal Science* **32**:490–507.
- Koper RP, Plön S. 2012. The potential impacts of anthropogenic noise on marine animals and recommendations for research in South Africa. EWT Research & Technical Paper No. 1. Endangered Wildlife Trust, South Africa.
- Laist DW, Knowlton AR, Pendleton D. 2014. Effectiveness of mandatory vessel speed limits for protecting North Atlantic right whales. *Endangered Species Research* **23**:133–147.
- Lane EP, De Wet M, Thompson P, Siebert U, Wohlsein P, Plön S. 2014. A systematic health assessment of Indian ocean bottlenose (*Tursiops aduncus*) and indo-pacific humpback (*Sousa plumbea*) dolphins incidentally caught in shark nets off the KwaZulu-Natal Coast, South Africa. *PLoS one* **9**:e107038.
- Martineau D, Béland P, Desjardins C, Lagacé A. 1987. Levels of organochlorine chemicals in tissues of beluga whales (*Delphinapterus leucas*) from the St. Lawrence Estuary, Québec, Canada. *Archives of Environmental Contamination and Toxicology* **16**:137–147.
- Mendez M et al. 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 et al. 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? *Molecular ecology* **22**:5936–5948.
- Ng SL, Leung S. 2003. Behavioral response of Indo-Pacific humpback dolphin (*Sousa chinensis*) to vessel traffic. *Marine Environmental Research* **56**:555–567.
- Peddemors VM, Cockcroft VG, Wilson R. 1990. Incidental dolphin mortality in the Natal shark nets: a preliminary report on prevention measures. Pages 129–137. *Cetaceans and cetacean research in the Indian Ocean Sanctuary*. United Nations Environment Programme, Marine Mammal Technical Number 3, Nairobi, Kenya.
- Plön S, Cockcroft VG, Froneman WP. 2015. The Natural History and Conservation of Indian Ocean Humpback Dolphins (*Sousa plumbea*) in South African Waters. *Advances in Marine Biology* **72**:143–162.
- Plön S, Venter K, Weltz K, Smale M, Froneman WF. 2011. Long-term trends in the diet and body condition of Indo-Pacific humpback dolphins (*Sousa chinensis*) in the coastal waters of South Africa. 19th Biennial Conference of the Society for Marine Mammalogy. Tampa, Florida, USA.
- Reeves RR, Leatherwood S. 1994. Dolphins, porpoises and whales: 1994-1998 action plan for the conservation of Cetaceans. IUCN/SSC Cetacean Specialist Group, Gland, Switzerland.
- Reijnders PJH, Aguilar A, Borrell A. 2009. Pollution and marine mammals. Pages 890–898 in Perrin WF, Würsig B, Thewissen JGM, editors. *Encyclopedia of Marine Mammals*. Second edition. Academic Press, San Diego, California, USA.
- Ross GJ. 1984. Smaller cetaceans of the south east coast of southern Africa. *Annals of the Cape Province Museum of Natural History* **15**:173–410.
- Saayman G, Taylor C. 1979. The socio-ecology of humpback dolphins (*Sousa* sp.). Pages 165–226 in Win H, Olla B, editors. *Behavior of Marine Animals*. Vol 3. Plenum, New York, USA.
- Skinner JD, Chimimba CT. 2005. *The Mammals of the Southern African Subregion*. Cambridge University Press, Cambridge, England.
- Smith-Goodwin JA. 1997. A molecular genetic assessment of the population structure and variation in two inshore dolphin genera on the east coast of South Africa. Rhodes University, Grahamstown.
- Spence J, Fischer R, Bahtiaran M, Boroditsky L, Jones N, Dempsey R. 2007. Review of existing and future potential treatments for reducing underwater sound from oil and gas industry activities. Page 185. Report prepared for the Joint Industry Programme on E&P Sound and Marine Life by the Noise Control Engineering, Inc. Report number: NCE.
- Subramanian AN, Tanabe S, Tatsukawa R, Saito S, Miyazaki N. 1987. Reduction in the testosterone levels by PCBs and DDE in Dall's porpoises of northwestern North Pacific. *Marine Pollution Bulletin* **18**:643–646.
- Van Parijs SM, Corkeron PJ. 2001a. Vocalizations and behaviour of Pacific humpback dolphins *Sousa chinensis*. *Ethology* **107**:701–716.
- Van Parijs SM, Corkeron PJ. 2001b. Boat traffic affects the acoustic behaviour of Pacific humpback dolphins, *Sousa chinensis*. *Journal of the Marine Biological Association of the UK* **81**:533–538.
- Wells RS, Rhinehart HL, Hansen LJ, Sweeney JC, Townsend FI, Stone R, Casper DR, Scott MD, Hohn AA, Rowles TK. 2004. Bottlenose dolphins as marine ecosystem sentinels: developing a health monitoring system. *EcoHealth* **1**:246–254.

Assessors and Reviewers

**Stephanie Plön¹, Shanan Atkins², Danielle Conry¹,
Pierre Pistorius¹, Victor Cockcroft¹, Matthew Child³**

¹ Nelson Mandela Metropolitan University, ²Private, ³Endangered
Wildlife Trust

Contributors

**Gill Braulik¹, Ken Findlay², Simon Elwen², Mike Meyer³,
Herman Oosthuizen³**

¹Wildlife Conservation Society, ²University of Pretoria, ³Department
of Environmental Affairs

Details of the methods used to make this assessment can
be found in *Mammal Red List 2016: Introduction and
Methodology*.