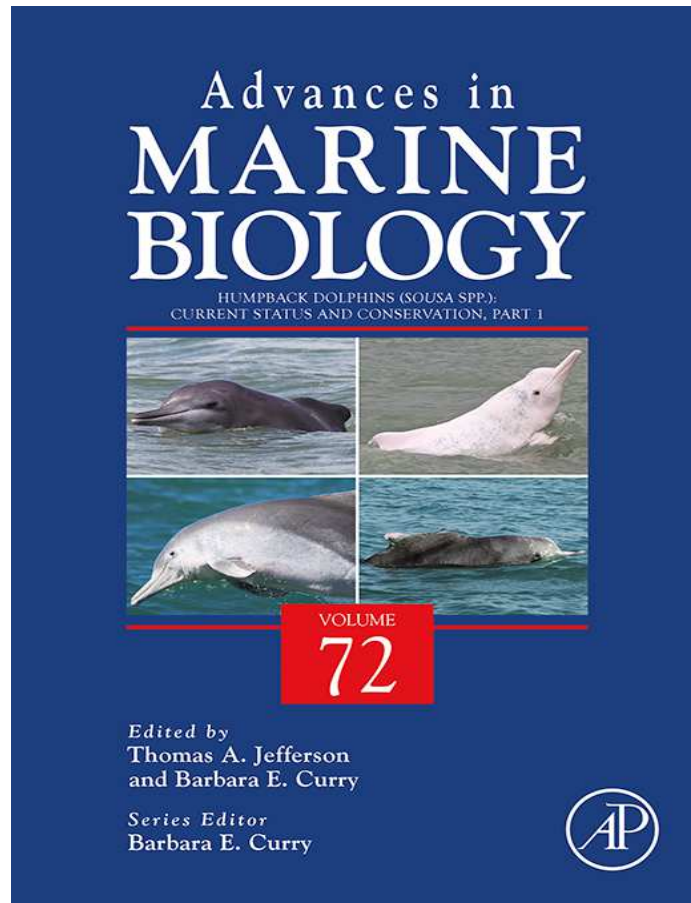


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Humpback Dolphins: A Brief Introduction to the Genus *Sousa*

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Abstract

The delphinid genus *Sousa* has recently undergone a major revision, and currently contains four species, the Atlantic humpback (*Sousa teuszii*), Indian Ocean humpback (*Sousa plumbea*), Indo-Pacific humpback (*Sousa chinensis*), and Australian humpback (*Sousa sahuensis*) dolphins. Recent molecular evidence suggests that humpback dolphins in the Bay of Bengal may comprise a fifth species. These moderate-sized dolphin species are found in shallow (<30 m), coastal waters of the eastern Atlantic, Indian, and western Pacific oceans. Abundance and trends have only been studied in a few areas, mostly in eastern Africa, China, and northern Australia. No global, empirically derived abundance estimates exist for any of the four species, but none appear to number more than about 20,000 individuals. Humpback dolphins feed mostly on small fishes, and sometimes shrimps; occur for the most part in small groups (mostly 12 or less); have limited near-shore movements; and in most parts of their range exhibit a fission/fusion type of social organization. Major threats that affect all the species are entanglement in fishing gear, and habitat degradation/destruction from various forms of coastal development. Impacts from vessel traffic (including behavioural disturbance and displacement, as well as mortality and morbidity from collisions with vessels) appear to be significant in most areas. Several other threats are apparently significant only in particular parts of the range of some species (e.g. high levels of organochlorine contaminants affecting Indo-Pacific humpback dolphins in Hong Kong). Direct hunting only occurs in limited areas and primarily on a small scale. Conservation actions so far have been limited, with most populations receiving little study and almost no management attention. Much more

work is needed on humpback dolphin population status, threats, and how the major threats can be reduced or eliminated. Extinction risks for the four species and some populations are preliminarily re-assessed using the IUCN Red List criteria in the current volume. The results suggest that all four species in the genus are threatened at some level (suggested Red List status ranges from Vulnerable for *S. chinensis* and *S. sahalensis* to Critically Endangered for *S. teuszii*).



1. INTRODUCTION

Humpback dolphins (*Sousa* spp.) are not particularly well known to most people in western countries, though coastal residents in Africa and the Indo-Pacific region are likely more aware of them. In these areas, humpback dolphins are often the most conspicuous and most common species of coastal small cetacean. Despite this fact, and perhaps partly owing to the developing state of many nations in these areas, humpback dolphins are generally not well studied and there is far less known of their biology and natural history than there is, for instance, for the coastal bottlenose dolphins (*Tursiops* spp.).

Unfortunately, the nearshore habitat of humpback dolphins and their presence in some of the most intensively developed, and conversely, most impoverished (protein-poor) parts of the world, means that these animals face a diverse set of threats. Many populations appear to be in immediate danger of extirpation. At least three of the species (*S. teuszii*, *S. plumbea*, and the newly described *S. sahalensis*) have ranges that are restricted enough and have threats severe enough, that they may potentially be threatened with extinction within the next few decades.

This volume contains preliminary assessments of the International Union for the Conservation of Nature (IUCN) Red List conservation status of the four currently recognized species of humpback dolphins; current listings are summarized in Table 1. It is important to recognize that, at the date of publication of this volume (late 2015), these new assessments had not yet been formally accepted and published in the Red List, <http://www.iucnredlist.org>. Until they are, the official IUCN Red List status of humpback dolphins remains unchanged, i.e. Atlantic humpback dolphin (*S. teuszii*) as Vulnerable and Indo-Pacific humpback dolphin (*S. chinensis*) as Near Threatened. The Taiwan Strait 'subpopulation' of *S. chinensis* is the only unit below the species level that has been assessed and red-listed. This subpopulation was assessed in 2008 and listed as Critically Endangered (Reeves et al.,

Table 1 Summary of the Known Differences Among the Four Species of *Sousa*

| Characteristic | <i>S. teuszii</i> | <i>S. plumbea</i> | <i>S. chinensis</i> | <i>S. sahalensis</i> |
|-----------------------------|---|--|---|--|
| Range | Eastern Atlantic from W. Sahara to Angola | Western Indian Ocean from S. Africa to Myanmar | Eastern Indian Ocean and western Pacific from east India to China and SE Asia | Western Pacific from southern Australia to New Guinea |
| IUCN Red List status | | | | |
| Current | Vulnerable | Not listed | Near Threatened (includes all three Indo-Pacific species) | Not listed |
| External morphology | | | | |
| Dorsal hump | Prominent dorsal hump | Prominent dorsal hump | No dorsal hump | No dorsal hump |
| Sexual dimorphism | Sexually dimorphic | Sexually dimorphic | Little or no dimorphism | Slight dimorphism |
| Coloration | Uniform grey, with lighter belly | Uniform brownish grey with lighter belly | Mostly white as adults | Dark grey back and lighter belly, curved dorsal 'cape' |

2008a). More recently, these dolphins were described as a new subspecies, *S. c. taiwanensis* (Wang et al., 2016). The data currently available on humpback dolphins in other portions of their range, such as the Hong Kong/Pearl River Estuary are considered insufficient to determine whether they fit the Red List definition of subpopulation.

In this chapter, we provide a general introduction to dolphins of the genus *Sousa*. More detailed regional information about biology and conservation status for each of the species will be presented throughout this volume.



2. TAXONOMY

The taxonomy of the humpback dolphins has been in a state of disarray for several centuries, including much controversy about even such basic issues as how many species comprise the genus. The first species of humpback dolphins were described in the late 1700s and 1800s, in the genus *Delphinus*, which was used at the time as a repository for virtually any

new marine species of dolphin. However, it later became clear that these animals were distinctive enough to warrant their own genus, and first *Sotalia* (along with the South American dolphins that were thought to be closely related), and then later *Sousa*, were erected to separate these animals from other marine dolphin species (see review in [Jefferson and Rosenbaum, 2014](#)).

Over the centuries, many different putative species of humpback dolphins were described and placed into the new genus. Nine nominal species were proposed through the end of the twentieth century ([Jefferson and Rosenbaum, 2014](#)). Reviews conducted in the 1900s generally concluded that most of these species were not valid, and eventually only two (*S. teuszii* and *S. chinensis*) or sometimes three (the previous two, plus *S. plumbea*) species were recognized. This state of affairs remained the *status quo* for many decades, in fact until 2013.

Earlier indications, from morphological and molecular studies, that *S. plumbea* might in fact be valid, and that a new species of humpback dolphin from Australian waters was justified, were finally documented with multiple lines of evidence and confirmed in late 2013 ([Mendez et al., 2013](#)). The following year, a comprehensive review of the taxonomy of the genus, including a detailed historical review of all the relevant nomenclature, was published ([Jefferson and Rosenbaum, 2014](#)). That review described or re-described four species in the genus: *S. teuszii* (the Atlantic humpback dolphin of West Africa), *S. plumbea* (the Indian Ocean humpback dolphin), *S. chinensis* (the Indo-Pacific humpback dolphin, from the Bay of Bengal and throughout Southeast Asia), and the new species, *S. sahalensis* (the Australian humpback dolphin, which is now also known to occur in at least southern New Guinea (see [Beasley et al., 2016](#))).

The four-species arrangement was quickly accepted and adopted by the Society for Marine Mammalogy's Ad Hoc Committee on Taxonomy (now considered by most to be the global authority on marine mammal taxonomy—Society for Marine Mammalogy ([SMM, 2014](#))). The four species are illustrated in [Figure 1](#) and the differences among them are summarized in [Table 1](#).

For centuries, one of the most perplexing issues in *Sousa* taxonomy has been the status of humpback dolphins in the Bay of Bengal (eastern India, Bangladesh, and Myanmar). This region contains dolphins that in some ways show characteristics associated with both *S. chinensis* and *S. plumbea* (e.g. some evidence of a dorsal hump, wide-based dorsal fins, extensive spotting on the body, and large unpigmented areas on the sides and back; [Muralidharan, 2013](#); [Smith et al., 2015](#); [Sutaria and Jefferson, 2004](#); and

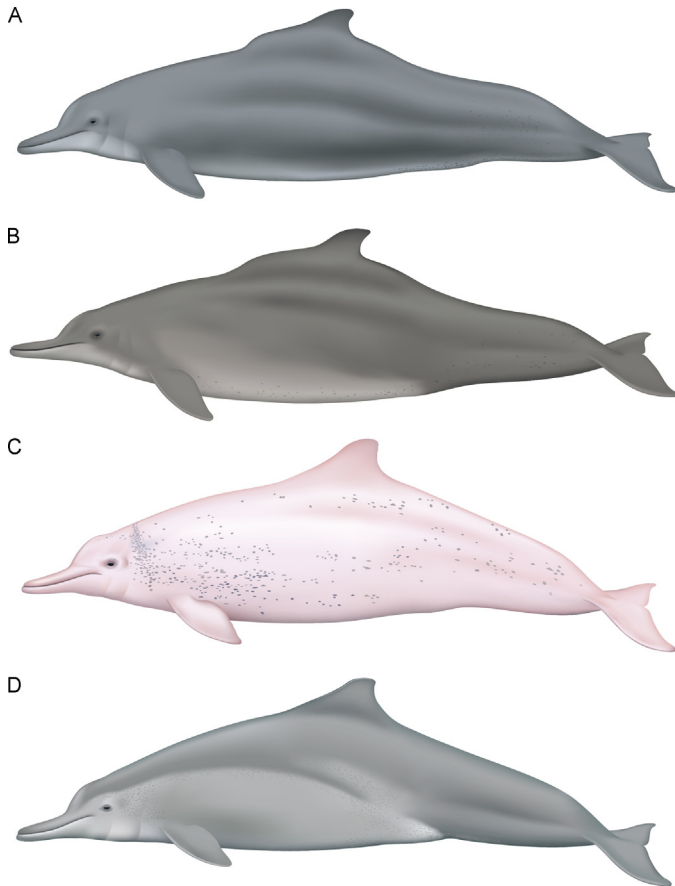


Figure 1 The four currently recognized species of humpback dolphins, genus *Sousa*: *S. teuszii* (A), *S. plumbea* (B), *S. chinensis* (C), and *S. sahalensis* (D). Illustration by U. Gorter.

see [Sutaria et al., 2015](#)). Similarly, due to seemingly intermediate characteristics, the affinity of the nominal species *S. lentiginosa* ([Owen, 1866](#)), from Vishakhapatnam in eastern India, has been difficult to ascertain (see [Jefferson and Rosenbaum, 2014](#)). Very few specimens of humpback dolphins from the Bay of Bengal have been available for taxonomic studies, and samples for molecular work have been almost non-existent. The information available at the time, led [Jefferson and Rosenbaum \(2014\)](#) to suggest that the Bay of Bengal may be an area of overlap in distribution of *S. chinensis* and *S. plumbea*, or that there may be some type of intermediate form there.

The recent collection and analysis of a reasonably large number ($n=15$) of genetic samples from humpback dolphins off Bangladesh has shed some

light on this issue (Amaral et al., 2015). Most of the samples were highly divergent from other humpback dolphins previously sampled, and did not appear to be closely associated with either *S. chinensis* or *S. plumbea* (Amaral et al., 2015). Although more work, including the use of additional genetic markers needs to be completed to confirm these preliminary results, the new information has led to suggestions that there may be a distinct species of humpback dolphin in the Bay of Bengal. Due to some similarities in morphology and coloration, it seems possible that this may correspond to *S. lentiginosa* (Owen, 1866), but comparisons of Owen's (1866) type specimen with the newly obtained genetic material remain necessary. There is even some preliminary evidence of a length difference between eastern Indian and western Indian/Sri Lankan humpback dolphins (the latter presumably corresponding to *S. plumbea*) (Jefferson, unpublished data). If indeed found to be a distinct species, and regardless of the eventual nomenclature (note that in addition to *S. lentiginosa*, the type of *S. plumbea* G. Cuvier, 1829, is also from the Bay of Bengal), this would add a fifth species to the genus *Sousa*, making it one of the most speciose of delphinid genera. In fact, if the paraphyletic genera *Lagenorhynchus* and *Stenella* are eventually split (see Perrin et al., 2013), then it would likely contain more species than any other in the family Delphinidae.



3. GEOGRAPHIC RANGE

Humpback dolphins are found in shallow (mostly <30 m), coastal waters of the Indo-Pacific region, and the eastern Atlantic (Parra and Ross, 2009; Ross et al., 1994; Figure 2). The Atlantic humpback dolphin occurs in the West African region from Morocco/Western Sahara south to Angola, apparently as several isolated populations or meta-populations (see Collins, 2015; Weir and Collins, 2015). The Indian Ocean humpback dolphin ranges from South Africa, around the rim of the Indian Ocean, north and east to at least the southern tip of India (and possibly to Myanmar), although the range limits in the eastern part of the distribution are not currently well known (see Braulik et al., 2015).

The Indo-Pacific humpback dolphin is found in waters of Southeast Asia, and is currently known from at least Myanmar (and possibly eastern India) eastward to the island of Borneo, and northward to central China (Jefferson and Smith, 2016). Finally, the newly described Australian humpback dolphin is found in the warmer waters of central and northern Australia, extending north to at the least the southern parts of the island

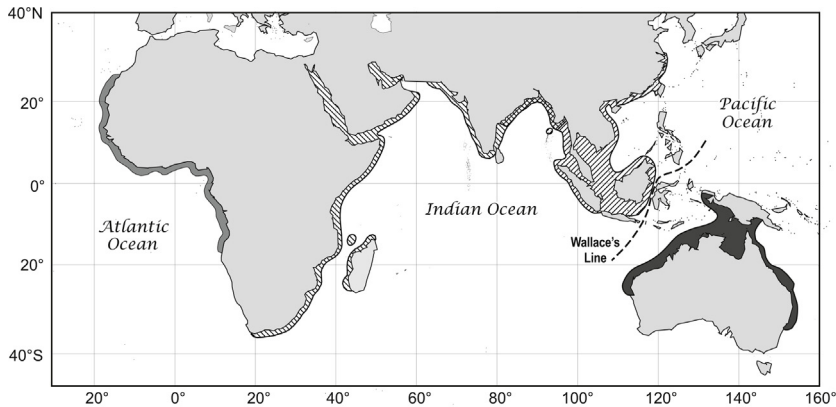


Figure 2 Approximate range of humpback dolphins, genus *Sousa*: *S. teuszii* (light grey shading), *S. plumbea* (135° hatching), *S. chinensis* (45° hatching), and *S. sahalensis* (dark grey shading). From [Jefferson and Rosenbaum \(2014\)](#). Note that some revisions to these ranges are proposed in chapters in this volume.

of New Guinea ([Beasley et al., 2016](#); [Parra and Cagnazzi, 2016](#)). Whether this latter species also occurs along the northern coasts of the island of New Guinea is currently unknown, but doubtful.



4. ABUNDANCE AND TRENDS

There are no empirically based global estimates of abundance for any of the four species of humpback dolphins. Moreover, many of the available estimates were made more than 10 years ago. Population size, or abundance, has only been numerically estimated via systematic studies for a few very specific areas of the genus' range. However, it is possible to estimate population sizes within very broad parameters for the four species by taking existing estimates and interpreting them in the context of each species' known range.

For the Atlantic humpback dolphin, there have been virtually no comprehensive population assessments, and all that is known of their population biology comes from rough 'approximations' or small-scale photo-identification catalogue sizes. Rough guesses of about 100 animals in the Saloum River delta, Senegal, of 'several hundred' in Guinea Bissau, and a group of about 10 photo-identified in Angolan waters are all that exist ([Van Waerebeek et al., 2004](#); [Weir, 2009](#)). Total population size is thought to be no more than about 3,000, and a population decline for the species is inferred ([Collins, 2015](#); [Reeves et al., 2012](#)).

The Indian Ocean humpback dolphin has been studied extensively only in southern/eastern Africa (i.e. South Africa, Mozambique, and Zanzibar), although there are other, more-recent, or cursory studies currently ongoing in Mayotte, Madagascar, the Persian Gulf area, Pakistan, and Sri Lanka. A few estimates of abundance are currently available (ca. 450 individuals in Algoa Bay, South Africa (Karczmarski et al., 1999); 207 in Richard's Bay, South Africa (Atkins and Atkins, 2002); 105 in Maputo Bay, Mozambique (Guissamulo and Cockcroft, 2004); ca. 60 in the Bazaruto Archipelago, Mozambique (Guissamulo and Cockcroft, 1997); and 62 in Zanzibar (Stensland et al., 2006)). Considering these in light of the species', overall range suggests that the total population is not likely to be much greater than 10,000 individuals, and a population decline can be inferred (Braulik et al., 2015; Reeves et al., 2008b).

Population biology of the Indo-Pacific humpback dolphin has been studied extensively in Chinese waters, starting about 20 years ago (e.g. Chen et al., 2008, 2010; Jefferson, 2007; Wang et al., 2012), but there are only a few studies that provide abundance estimates for areas outside of China/Taiwan (one in Borneo (Minton et al., 2016) and two in Thailand (Jaroensutasinee et al., 2010; Jutapruet et al., 2015)). The available abundance/population estimates add up to about 5500 animals (Jefferson and Smith, 2016), and taking account of the unstudied portions of the species' range, it appears that the total species population is unlikely to number much greater than 16,000 individuals. Where studied, most populations are confirmed or suspected to be declining, and thus a declining population should be inferred for *S. chinensis* as a whole (Jefferson and Smith, 2016).

The newly described Australian humpback dolphin has not been well studied, but in the past decade or so there has been work on its population biology in Queensland (abundance estimates of 44 in Cleveland Bay (Parra et al., 2006) and 141 in Moreton Bay (Corkeron et al., 1997)), and more recently in Western Australia (see Parra and Cagnazzi, 2016). Although these represent only a very small portion of the species' overall range, it appears unlikely that the species would number over 10,000 individuals, and it is probably much smaller. A population decline can reasonably be inferred, although this is uncertain (Parra and Cagnazzi, 2016).



5. HABITAT AND ECOLOGY

The habitat of each of the four species is very similar. They all occur in tropical to warm temperate regions, and show a strong preference for

shallow (<20–30 m deep) nearshore waters. Although most of the four species also seem to prefer brackish waters associated with estuarine systems, in some areas they have been found to occur in mangrove areas, around rocky and coral reefs, over sandy bottoms, and along rocky shorelines. They do not inhabit deep, oceanic areas, and their movements appear to be limited by water depth (ca. 40 m appears to be the limit) more than distance from shore (e.g. Hanf et al., 2016; Weir and Collins, 2015).

Group size and structure for humpback dolphins is similar among the four species. All occur mostly in small groups, from pairs to groups of up to about a dozen. Larger aggregations do develop on occasion. In Bangladesh, some groups may number as many as 205 individuals (Jefferson and Smith, 2016), and in Hong Kong and adjacent waters, when dolphins aggregate behind active trawlers to feed on prey stirred up by the nets, they may gather into groups as large as 44 individuals (Hung, 2008). Group structure has not been studied in most areas, but where it has, most humpback dolphin populations appear to have a fission/fusion type social structure, with only short-term associations beyond the mother/calf bond (see Jefferson and Karczmarski, 2001). However, in a few areas (e.g. Mozambique and off the west coast of Taiwan), these dolphins exhibit more stability in group structure (Guissamulo and Cockcroft, 2004; Wang et al., 2016).

There have only been a few long-term, detailed studies of the behaviour of humpback dolphins (e.g. South Africa (Karczmarski, 1999; Karczmarski and Cockcroft, 1999; Karczmarski et al., 1999, 2000), Hong Kong (Hung, 2014; Würsig et al., 2016)), and much of what is known about their behavioural ecology comes from relatively superficial, often-opportunistic observations. Certain general rules seem to hold throughout the range of the genus, however. Humpback dolphins rarely ride the bow or stern waves of vessels, and exhibit moderate levels of aerial activity (see Jefferson and Karczmarski, 2001). Breaching, acrobatic leaps, spyhopping, and other active surface behaviours are not uncommon, and are seen especially frequently during the times of year when reproductive activity is at its peak. Responses to human activities (in particular to boats) are variable, with populations in most areas having been described as shy and difficult to approach, but in other areas (e.g. Hong Kong), dolphins may have become accustomed to human activities and may tolerate human presence with relatively little sign of obvious disturbance (see Jefferson and Karczmarski, 2001; Piwetz et al., 2015; Würsig et al., 2016).

Life history and reproductive parameters have only been studied in detail for two regions: for Indian Ocean humpback dolphins in South African

waters (Cockcroft, 1989; Nolte, 2013; Plön et al., 2015), and for Indo-Pacific humpback dolphins in the Pearl River Estuary of China (Jefferson et al., 2012). Because most life history parameters for these two populations at different ends of the genus's range were found to be similar, there is most likely similarity throughout the entire range, although this is not confirmed. Humpback dolphins appear to live to be in their 40s, and become sexually mature at about 9–13 years of age (a few years earlier for females than males) (however, see Plön et al., 2015, for a discussion of a potential different interpretation of South African life history parameters). Gestation is about 10–11 months, and a single calf is born, and then nursed for 2–5 years. Calving likely occurs year-round in most parts of the range, but where studied, there appears to be a peak in calving in spring/summer months (see Jefferson et al., 2012; Plön et al., 2015).

Feeding habits of humpback dolphins are known mostly from stomach contents studies on just a few populations, but the general rule appears to be that humpback dolphins are opportunistic feeders, taking a wide variety of prey. They seem to prefer small schooling and benthic/demersal fishes, although shrimps are sometimes taken in some areas. Squids and other cephalopods do not seem to be a major part of their diet anywhere (Jefferson and Karczmarski, 2001).

The natural predators of humpback dolphins throughout their range are likely to be killer whales (*Orcinus orca*) and large sharks, although killer whales tend to be rare in the very nearshore shallow waters of the tropics/subtropics that humpback dolphins primarily inhabit. Shark bites are commonly seen on Indian Ocean humpback dolphins in South African waters (Cockcroft et al., 1989), but are very rare on Indo-Pacific humpback dolphins in waters of the Pearl River Estuary or elsewhere in China (see Jefferson et al., 2006). Diseases and associated pathology have not been well studied in humpback dolphins, and as these dolphins are rarely held captive, little is known, other than the documentation of a few diseases, and that these animals are hosts to a number of parasites (both internal and external) (Jefferson and Karczmarski, 2001; also see Plön et al., 2015).



6. THREATS

The coastal habitats of humpback dolphins, especially in developing nations, involve a large number of potential threats (see Piwetz et al., 2015). Two threats that appear to be major factors for virtually all humpback dolphin populations, whether they occur in highly developed or in

less-impacted areas, are entanglement in fishing gear and impacts of vessel traffic (the latter encompasses both behavioural disturbance from vessel movements and noise, and the more serious issue of mortality and morbidity from collisions with vessels—see [Karczmarski et al. \(2016\)](#)). A third threat that appears to affect most, if not all, populations of humpback dolphins is habitat degradation/destruction from coastal development and other anthropogenic activities (e.g. [Karczmarski et al., 2016](#); [Sutaria et al., 2015](#)).

Serious threats that may only be a major factor for some populations of the genus are the deleterious effects of environmental contaminants (especially organochlorines; e.g. Hong Kong ([Jefferson et al., 2006](#); and see [Karczmarski et al., 2016](#))), and prey depletion from overfishing (e.g. [Wang et al., 2016](#)). Direct hunting is only known to occur in a few places in the range of the genus, but where it does, the catches always appear to be unregulated, and thus this threat has the potential to be a major one for the affected populations (e.g. West Africa (see [Collins, 2015](#)); Pakistan (see [Kiani and Van Waerebeek, 2015](#)); Madagascar (see [Cerchio et al., 2015](#))). A few other threats are sometimes mentioned, but at present, are probably not major factors for most populations of humpback dolphins. These include habitat alteration from climate change, and harassment from dolphin-watching operations.



7. CONSERVATION ACTIONS AND STATUS

Although dolphins in many human societies are thought of as ‘charismatic megafauna’ and therefore enjoy popular status among the general public, the unfortunate reality is that, even with laws protecting them in place, most humpback dolphin populations appear to be negatively affected by many human activities. Where legislation exists, often laws are not enforced, and in many cases there is simply inadequate information on the biology of these animals to conserve and manage them effectively, whatever the attitudes of the government officials or local citizens may be (e.g. [Karczmarski et al., 2016](#)). The proposed new IUCN Red List assessments are presented in [Table 2](#).

In poor, developing countries with inadequate legislation (e.g. Madagascar—see [Cerchio et al., 2015](#)), and in relatively wealthy, developed countries that may have laws in place for wildlife protection (e.g. Hong Kong—[Jefferson et al., 2009](#); [Karczmarski et al., 2016](#)), humpback dolphins are facing serious threats, and populations are apparently declining. An

Table 2 Summary of the New IUCN Red List Status Assessments Proposed for the Four Species of *Sousa*

| Species | Proposed Status | Criteria | Reference |
|--|-----------------------|----------|--|
| Atlantic humpback dolphin <i>S. teuszii</i> | Critically Endangered | A3cd | Collins (2015) |
| Indian Ocean humpback dolphin <i>S. plumbea</i> | Endangered | A4cd | Braulik et al. (2015) |
| Indo-Pacific humpback dolphin <i>S. chinensis</i> | Vulnerable | A4cd | Jefferson and Smith (2016) |
| Australian humpback dolphin <i>S. sahulensis</i> | Vulnerable | C2a(i) | Parra and Cagnazzi (2016) |

These are not yet official.

example of the former situation is found throughout West Africa, where Atlantic humpback dolphins are poorly studied, and where there has been almost no attempt at management of stocks or populations. There, these dolphins are sometimes killed directly by humans as a food source (see [Collins, 2015](#)). Populations in West Africa are also impacted by pollution, shipping, oil and gas operations, fishing activities, and coastal development, all in the absence of effective environmental impact assessment ([Collins, 2015](#); [Weir et al., 2011](#)). Examples of the serious threats facing humpback dolphins that are found in the territories of relatively wealthy nations, are evident along Chinese coastlines (e.g. Hong Kong, Guangdong Province, Xiamen, and Taiwan), where Indo-Pacific humpback dolphins apparently occur as a collection of distinct populations (though, as previously mentioned, some of these may have formerly shared connections, and may now be separated only as a result of human impacts), some very small (<100 individuals) and some quite large (>2000 animals)).

In China and Taiwan, well-developed environmental impact assessment legislation exists, wildlife protective laws are in place, marine parks and reserves have been established (often with the express goal of protecting dolphin habitat), dolphin populations are relatively well studied (with basic information on population size, and sometimes even trends, available in most areas), and there is a segment of society that is willing to advocate for the welfare of these animals. Despite all of this, humpback dolphins

are declining in Xiamen, Taiwan, and in Hong Kong and the Pearl River Estuary region (Jefferson and Smith, 2016; Karczmarski et al., 2016). The federal and provincial governments have failed to provide adequate protection for the animals to avoid population declines. In Hong Kong, dolphin numbers have been declining for over a decade (although the overall abundance, of humpback dolphins occurring throughout the Pearl River Estuary, remains large, and is probably still viable; see Jefferson and Smith, 2016), and in Taiwan, dolphin numbers continue to dwindle (currently less than 75 dolphins; Wang et al., 2016).

Because so little is known about humpback populations in some areas (e.g. see Collins, 2015 for West Africa; Cerchio et al., 2015 for Madagascar; and Minton et al., 2016 for Borneo) and research work has been scant, some populations of humpback dolphins may have already been extirpated, without us even being aware of it. Only by thoroughly evaluating and recognizing the conservation status of the various species, subspecies, and populations of humpback dolphins will we have any chance of preserving the biological diversity that remains today. There is an urgent need to take stock of what we know about these dolphins, acknowledge what still remains to be learned, and identify the most important risk factors affecting them. Beyond this, we also need to assess how these threats impact the various taxa, and aggressively pursue solutions to eliminate, or at least reduce, these threats to sustainable levels. The approaches used will need to be tailored to each area and taxon to be effective. It is our hope that the chapters that follow in this volume represent significant steps towards achieving this important goal.

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