Aquatic Mammals 2014, *40*(4), 398-406, DOI 10.1578/AM.40.4.2014.398

Can the Indian Ocean Humpback Dolphin (*Sousa plumbea*) Survive in Sri Lanka? Occurrence of a Relict Population in Puttalam Lagoon

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Abstract

Until the last few years, the only records of Indian Ocean humpback dolphins (*Sousa plumbea*) in Sri Lanka were a small number of older stranding records and one unconfirmed sighting, but repeated verified sightings have been made since the early 2000s in the Puttalam Lagoon area of northwestern Sri Lanka. To determine dolphin status and distribution patterns, we conducted monthly surveys of the lagoon from July 2010 to June 2011 and sighted humpback dolphins in the lagoon in every month of the year. Repeated sightings of the same six individuals were made; and in March 2011, one of these humpback dolphins was killed by dynamite fishing. It appears that the population is very small, possibly now consisting only of these five individuals, and is resident in the lagoon. Although it is likely the species was more widespread and abundant in the past, it appears that Puttalam Lagoon may be the only location where this species persists in Sri Lanka at present. Additional research is needed to investigate possible mixing with populations in India, and urgent conservation measures are recommended to ensure the long-term survival of this enigmatic species in Sri Lanka.

Key Words: status, extirpation, management, protection, photo-identification, *lentiginosa*-type

Introduction

For most of the last several decades, only two species of humpback dolphins have been recognized: *Sousa teuszii* in the Atlantic Ocean and *S. chinensis* in the Indo-Pacific (see Ross et al., 1994; Jefferson & Van Waerebeek, 2004). However, recent research indicates that there are actually four species in this genus, with the Indo-Pacific humpback dolphin (*S. chinensis*) being restricted to the waters of Southeast Asia and the northern Bay of Bengal and the Indian Ocean humpback dolphin (*S. plumbea*) being the only species found in western and southern India, and Sri Lanka (see Mendez et al., 2013; Jefferson & Rosenbaum, 2014). The specimens from Sri Lanka appear to be of the *lentiginosa*-type (possibly a subspecies) as defined by Jefferson & Rosenbaum (2014).

Though *Sousa* has been known to science for over 250 y, there is a dearth of basic information on its status throughout much of its range, with a few exceptions in certain locations. In some areas where they have been studied, a marked decline in this genus's numbers has been observed or inferred (e.g., Taiwan – Wang et al., 2007; Hong Kong – Hung, 2014). Indian Ocean humpback dolphins have a wide distribution, occurring in coastal, inshore, and estuarine waters along the rim of the Indian Ocean from South Africa to the Bay of Bengal. They are found in waters generally less than 25 m deep, often near large river mouths (Ross et al., 1994). They have been reported from a variety of habitats from around the world, which include sandy shores, enclosed bays and coastal lagoons, mangrove areas, over seagrass meadows, and around rocky and coral reefs (see Jefferson & Karczmarski, 2001).

In areas where extensive studies have been conducted, humpback dolphins do not seem to make large-scale seasonal migrations, although seasonal shifts in abundance have been recorded in two areas in South Africa (Karczmarski, 1996; Karczmarski et al., 1999) and in Hong Kong (Jefferson, 2000), where they are restricted to the immediate vicinity of a large estuary, with most movements in the range of only a few tens of kilometers (Hung & Jefferson, 2004).

Puttalam Lagoon is the only place, to date, where recurring sightings of Indian Ocean humpback dolphins have been recorded in Sri Lanka (Ilangakoon, 2006; Broker & Ilangakoon, 2008).

This is the only species of cetacean in Sri Lanka that is known to prefer brackish lagoons with murky and turbid water (Ilangakoon, 2005). Anecdotal observations by local tour operators and fishermen also testify to the regular presence of Indian Ocean humpback dolphins in Puttalam Lagoon, with reports of at least one "resident pod." Yet, their habitat preferences and abundance in Sri Lankan waters have not been determined, and the existing abundance estimates are largely based on opportunistic sightings. Although a handful of references have been made to Indian Ocean humpback dolphins in Sri Lankan waters by several other authors at various times (see Sutaria & Jefferson, 2004), there have been no dedicated studies on their status, ecology, and biology, nor specific proposals developed for their conservation management in Sri Lanka. To fill these needs, the present study was carried out to identify the area of occupancy, abundance, current population status, and threats to Indian Ocean humpback dolphins found in the Puttalam Lagoon in Sri Lanka.

Methods

Study Area

Puttalam Lagoon is located in the northwestern province of Sri Lanka (7° 45' N, 79° 42' E), and the entire lagoon system is very shallow, with depths of no more than 1 to 2 m, except for the deep channels within the lagoon, where depths of 4 to 5 m have been documented (Figure 1; Pathirana et al., 2008). It is one of the largest lagoons in Sri Lanka, covering an area of 237 km^2, and the water is of normal oceanic salinity in the north, while high evaporation makes it generally hypersalinic in the south (Jayasuriya, 1991).

The average tidal period in Puttalam Lagoon is 12 h and 40 min, with a longer ebb period. The average tidal range is about 0.25 m at high tide with water flowing towards the lagoon with a mean velocity of 0.28 m/s (mean flood volume flux 2,000 m^3/s); at low tide, the lagoon water is drawn into the sea at an average speed of 0.23 m/s (mean volume flux of 1,800 m^3/s). Two perennial rivers empty into the lagoon, namely the Kala Oya and Mee Oya (Coast Conservation Department, 2003).

Present investigations indicate the lagoon water as having an average seawater salinity of 34 ppt in its northern part, while hyper-saline conditions exist in the southern part occasionally exceeding 55 ppt (Pathirana et al., 2008). This tendency may be due to a high rate of evaporation in the lagoon (Pathirana et al., 2008). The mean concentrations of nitrates and phosphates in Puttalam Lagoon were found to vary from 0.14 to 0.45 mg/1, respectively, indicating a prevalent non-polluted condition of the water. However, during periods of monsoonal precipitation, nutrient levels were found to increase in the lagoon and the estuaries of the Kala Oya and Mee Oya, exceeding the above values (Pathirana et al., 2008). Moreover, some other possible sources of pollution exist in the area. The Dutch Canal, a manmade water system directly connected with the lagoon, often brings considerable amounts of pollutants through effluents from adjoining shrimp farms (i.e., 0.50 mg/l sulphide, 0.12 mg/1 nitrates, and 0.45 mg/l ammonia). On the other hand, the two rivers flow into the lagoon, bringing in sediment from farther inland, causing significant impacts to the lagoon environment such as sedimentation. A number of small, low islets occurring within Dutch Bay and Puttalam Lagoon have already caused the alteration of the natural environment by sediment deposition coupled with sand transport by currents, tides, and winds (Ranasinghe, 2010).

Survey Methods

The study was carried out from July 2010 to July 2011. Puttalam Lagoon was surveyed during seven non-consecutive days of each month for a period of 12 mo. Each day, approximately 7 h was spent to survey the lagoon, about 4 h in the morning (0600-1000 h) and 3 h in the afternoon (1500-1800 h). The lagoon was surveyed using a 5.5-m fiberglass boat fitted with a 15-HP outboard motor, with two observers searching the water using binoculars (Bushnell Sport View 8 × 21, field 70°). The survey used line transect search methods, and the surveys were conducted approximately 50 m from shore (due to sand banks and islands less than 100 m from shore); however, the actual distance depended upon safe water depth since there are many sand bars in the lagoon. The two observers were placed at the port and starboard sides of the boat.

Survey information was recorded each time the boat changed course. When humpback dolphins were sighted, the species, date, time, GPS position (using a handheld Garmin Colorado 300 GPS), group size, and behavior were recorded, as much as possible, prior to going off-effort and departing from the trackline to photograph the humpback dolphins. Photographs were taken for photo-identification, which relies on the use of high-resolution images to identify individuals using naturally occurring pigmentation patterns, scarring, and morphological differences (see Würsig & Jefferson, 1990). Photographs of every individual observed were taken (the dorsal flank/fin) using a Nikon D5000 camera with a 300-mm Nikon lens. Humpback dolphins were catalogued based on each individual's unique markings (e.g., dorsal hump and fin shape, scarring, and color

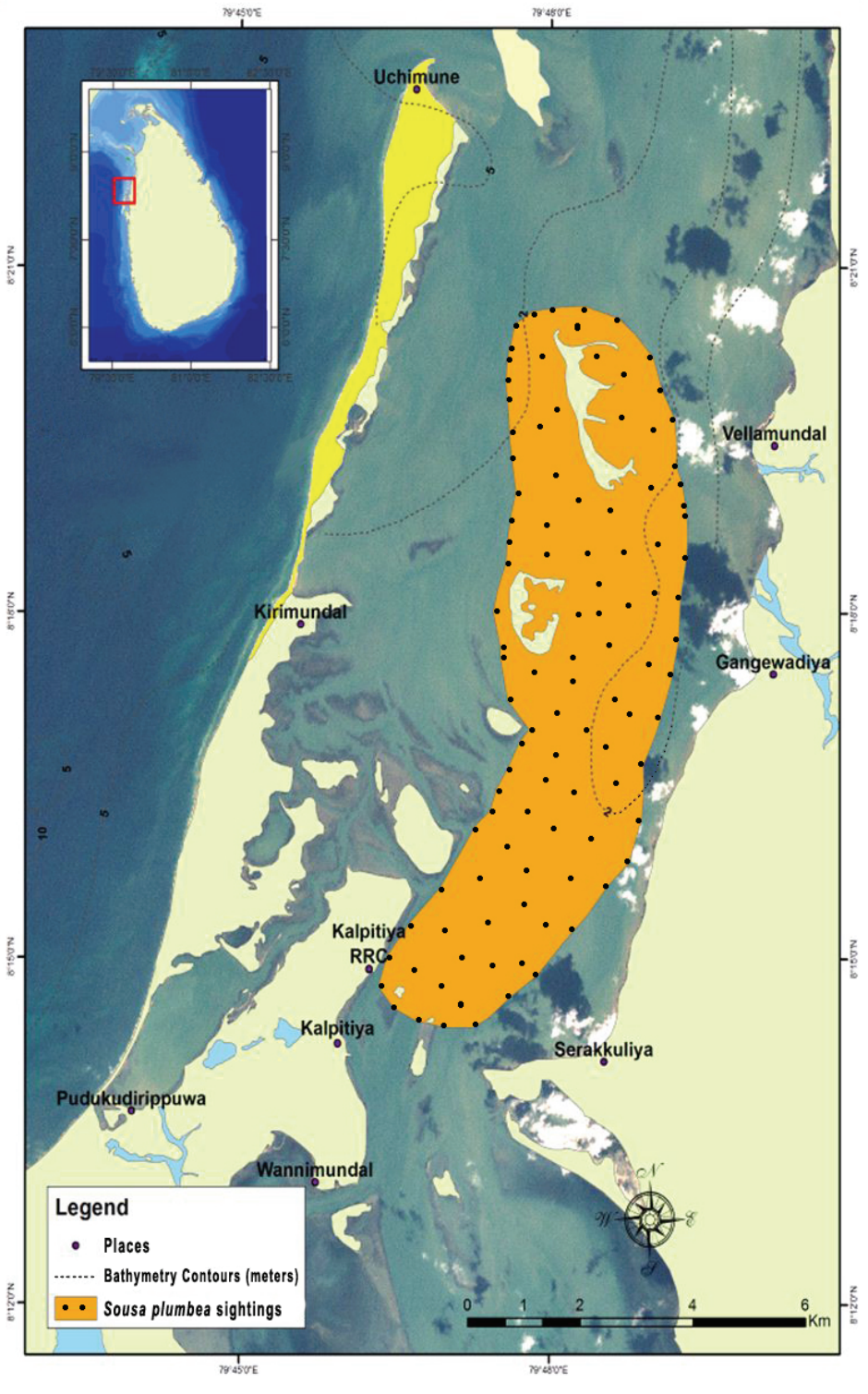

Figure 1. Study area in Puttalam Lagoon showing distribution of Indian Ocean humpback dolphins (*Sousa plumbea*) in the lagoon

patterns). Time spent photographing the animals was not included as on-effort search.

Photographs of humpback dolphins were added to the database and compared with the existing photographs to verify whether an individual had already been identified and assigned a number. When a new individual was identified, the animal was given a unique number and entered into the database (e.g., PLHD-###, with PLHD denoting Puttalam Lagoon Humpback Dolphin). This technique also allowed us to gather a variety of natural history information for examining such aspects as home range, movement patterns, reproduction, and association patterns. Possible threats were identified through visual observation, and informal discussions were made from time to time with fishing communities, villagers, and law enforcement personnel.

Results

The present study comprised a total of 84 field surveys covering nearly 588 h survey time in the 736.4 km^2 study area of the lagoon and adjacent waters (Table 1). We recorded Indian Ocean humpback dolphin sightings between Kalpitiya and Uchchimuni areas (Figure 2), especially where the two perennial rivers empty into the lagoon (Figure 1).

Surveys within Puttalam Lagoon were conducted on 68 d and consisted of 373.05 h of survey time. Humpback dolphins were seen on every survey for a total of 106 sightings (Table 1). On many days, surveys and sightings were made in both morning (n = 56) and afternoon (n = 50) surveys. Photo-identification confirmed that all the sighting records were restricted to six individuals, and only these six were encountered during the entire study (Figure 3). Among the six, two were found with prominent markings, enabling us to distinguish them quite easily by eye from the rest of the group. During the study on 13 February 2011, one individual (PLHB-006) was found dead due to anthropogenic causes (it was apparently a victim of dynamite fishing). Most sightings (91%) were of the entire group (which consisted of either five or six individuals), but in 9% of the sightings, only part of the group was observed, most commonly three individuals. This indicates that there was some splitting of the group, though this was rare.

Humpback dolphins were often sighted near the river mouth areas during October, November, and December; these months coincide with the northeast monsoon season. However, during the months of July and August, the height of the dry season, humpback dolphins were less frequently encountered.

Behavioral Observations

During the course of field observations, the feeding behaviour of *S. plumbea* was observed. This was surmised to be feeding behavior due to the humpback dolphins' surface times being very short and their increased pace; this also was supported by the observation that some species of fish were recorded leaping out of the water as the humpback dolphins approached them. Most of the time, the humpback dolphins were observed herding fish towards the edges of the lagoon, and they continued feeding along the edge. Out of the species of possible prey fish, two species were identified to genus level: *Hilsa* sp. and *Liza* sp. Upon diving, the humpback dolphins sometimes lifted their flukes above the water surface.

Strandings and Mortality

Stranding and live records of Indian Ocean humpback dolphins were recorded from the northwestern, western, southwestern, and southern

Table 1. Surveys conducted and Indian Ocean humpback dolphin (*Sousa plumbea*) sightings in Puttalam Lagoon

	Morning surveys		Afternoon surveys	
Month	Hours	Sightings	Hours	Sightings
July 2010	4	1	6	2
Aug. 2010	4	1	0	0
Sept. 2010	19.5	5	18	6
Oct. 2010	28.25	7	15	5
Nov. 2010	20	5	15	5
Dec. 2010	28	7	9	3
Jan. 2011	12	3	18	6
Feb. 2011	28	7	21	7
March 2011	20	5	9	3
April 2011	20	5	9	3
May 2011	16	4	20.3	7
June 2011	24	6	9	3
Totals	223.75	56	149.3	50

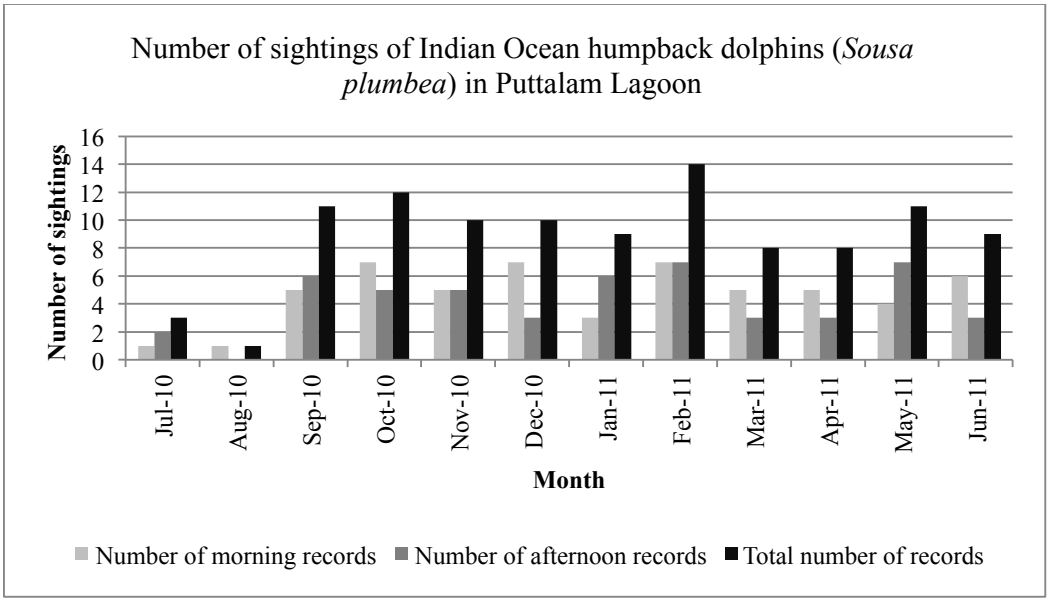

Figure 2. Monthly sighting records of Indian Ocean humpback dolphins in Puttalam Lagoon

Table 2. Records of Indian Ocean humpback dolphins in Sri Lanka

Year	Area	Record type	Notes	Reference(s)
pre-1889	Mannar (Aripo)	Stranding (skull)	Species ID uncertain	Flower, 1883; Blanford, 1888
3 April 1934	Egoda-Uyana	Bycatch	270 cm TL	Deraniyagala, 1945
4 March 1983	Puttalam Lagoon	Possible sighting	Species ID uncertain	Leatherwood et al., 1984
2004-2005	Bar Reef/ Puttalam Lagoon	Sightings	*n* = 10 sightings	Ilangakoon, 2006; Broker & Ilangakoon, 2008
2010-2011	Puttalam Lagoon	Sightings	*n* = 106 (all months)	This paper
1 July 2010	Beruwala	Stranding	255 cm TL	This paper
19 Sept. 2010	Colombo Harbor	Stranding	COD: Vessel collision	This paper
25 Dec. 2010	Kalpitaya	Stranding	COD: Fishing interaction	This paper
13 Feb. 2011	Kalpitaya	Stranding (PLHB-006)	COD: Dynamite fishing	This paper
11 May 2011	Adam's Bridge	Sightings	*n* = 2 sightings	This paper
3 April 2011	Kandakuliya	Stranding	262 cm TL	This paper

beaches of Sri Lanka (Table 2). During the present study, five dead specimens and two live strandings were recorded. With these new records, the total number of recorded localities in Sri Lanka of the Indian Ocean humpback dolphin was increased to 12 (Figure 4). Stranded, dead humpback dolphins were recorded from Beruwala, Colombo Harbor, Kalpitiya, and Kandakuliya (Figure 4). The humpback dolphin found dead in Colombo Harbor was a victim of a collision with a motor vessel as was evident by the extensive propeller cuts on its body (Figure 4). One animal from Kalpitiya was apparently a victim of dynamite fishing as indicated by necropsy findings of severe internal hemorrhaging particularly on the right side, and internal bleeding in the nasal cavity, head, and eye region (Figure 4). The other specimen was found entangled in a fishing net. These animals may have drifted, either incapacitated or as carcasses, for some distance before making landfall, meaning that such evidence may not reflect the actual distribution of the species. Still, two live records were made from Kirinda and Adam's Bridge during the study period.

Figure 3. Six different individuals of Indian Ocean humpback dolphins identified using the photo-identification technique in Puttalam Lagoon

Discussion

The present study clearly indicates that Indian Ocean humpback dolphins in Sri Lanka are largely restricted to coastal waters of the northwestern region of the island. Apart from a few sporadic stranding records and live records from the western and southwestern parts of the country, essentially all recent records have been from Puttalam Lagoon and the adjacent coastal waters. Previous workers (Ilangakoon, 2005, 2006; Broker & Ilangakoon, 2008) mentioned encountering Indian Ocean humpback dolphins in the Puttalam Lagoon and Bar Reef area. These were the first confirmed live sighting records of Indian Ocean humpback dolphins from the island. There are large groups of Indian Ocean humpback dolphins in Palk Bay, and these animals are regularly seen along Talaimannar, adjacent to Adam's Bridge. These pods have been observed forming associations with bottlenose dolphins (*Tursiops* sp.) and are regularly seen swimming to and from Indian waters by us. There are some other anecdotal reports of Indian Ocean humpback dolphins from the southeast of the island; however, those reports do not have sufficient supporting evidence in the form of photographs to confirm the identifications. From the available evidence, it is probable that the only existing resident population

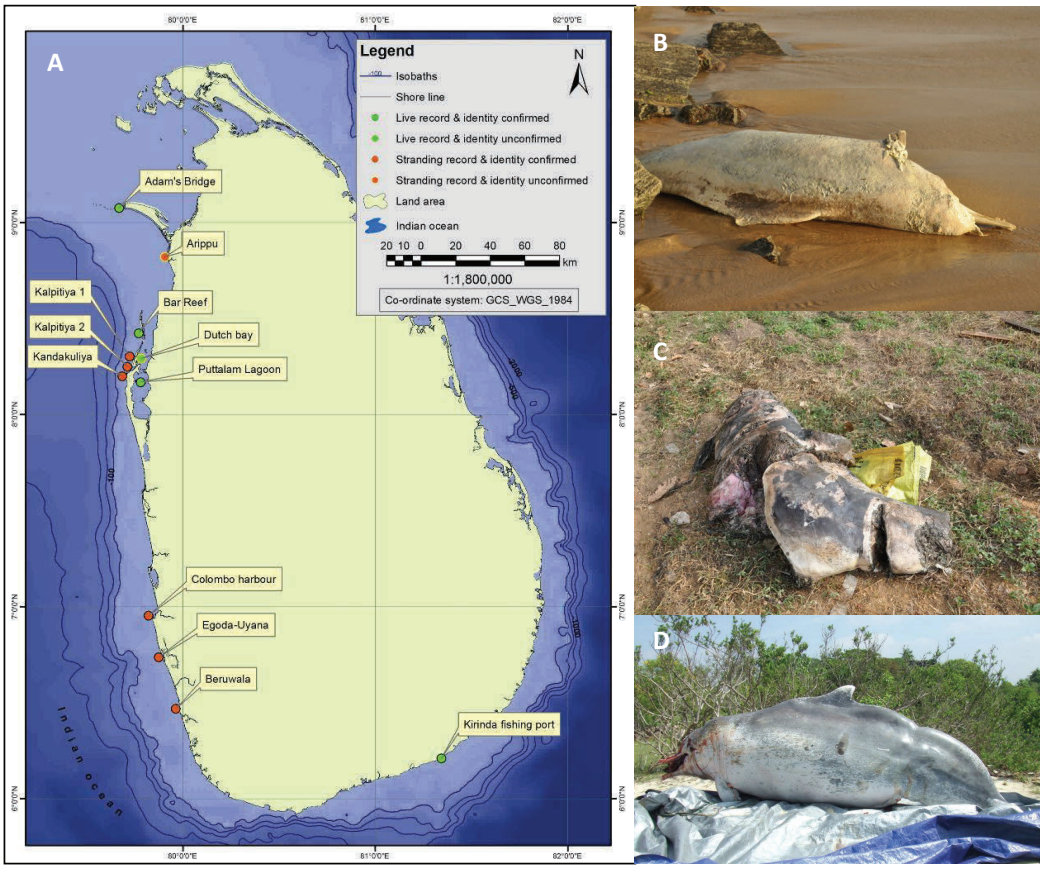

Figure 4. (A) Current and historical records of Indian Ocean humpback dolphins in Sri Lanka; (B) dead specimen from Beruwala; (C) dead specimen from Colombo Harbor; and (D) dead specimen from Kalpitiya due to dynamite fishing.

of Indian Ocean humpback dolphins in Sri Lanka is found in the Puttalam Lagoon.

As is typical for the genus, the population in the Puttalam Lagoon seems to be very small in size, and they inhabit core areas of shallow habitats that are influenced by the freshwater inputs from two rivers (Kala Oya and Mee Oya). During this study, Indian Ocean humpback dolphins were less commonly encountered inside Puttalam Lagoon during the dry months of the year (i.e., from July to August). They were seen in the Dutch Bay and Bar Reef areas in these months (Figure 4). This might be due to elevated levels of fishing pressure at the stipulated period as rough weather encountered in the seas caused fishermen to concentrate their efforts in the more protected lagoon areas during July and August. From October to December, humpback dolphins were often sighted in the river mouth areas, probably attracted by nutrient discharge caused by the monsoonal rains, which may increase feeding opportunities.

The threats identified to the continued existence of the Indian Ocean humpback dolphins in Sri Lankan waters are illegal fishing practices such as dynamite fishing, direct hunting for human consumption and shark bait, vessel collisions, environmental pollution, habitat degradation from coastal development, and uncontrolled ecotourism-based dolphin-watching, as well as excessive fishing activities that disturb travel corridors and cause entanglements (e.g., gillnetting and trawling). It is certain that the ecological integrity in Puttalam Lagoon area will play a vital role for the existence of the humpback dolphin population. This species displays a strong preference for shallow waters (see Ross et al., 1994; Jefferson & Karczmarski, 2001). Based on these observations, the prevailing shallow condition in the lagoon may be inferred as one of the reasons for their presence.

The area of historic occurrence of the Indian Ocean humpback dolphin will remain difficult to establish, with the 30-y-long terrorist war that

prevailed in the northern and eastern parts of the country drastically restricting research activities in these areas. Additionally, the inshore distribution of the humpback dolphin population exposes it to high levels of anthropogenic threats. Considering the present degraded state of the estuarine waters around Puttalam Lagoon, it is very reasonable to assume that the population's distribution, abundance, and density were much greater prior to the heavy and rapid modification of the coastline for human activities. Humpback dolphins are known to be highly susceptible to such human impacts, and such small, confined populations may experience a high likelihood of extirpation.

There is an urgent need for measures to conserve and manage Puttalam Lagoon and to ensure the *in situ* conservation of the remaining Indian Ocean humpback dolphin population in Sri Lanka. In addition, the lagoon is frequented by the dugong (*Dugong dugon*), which is also a threatened species. Though humpback dolphins are protected under the Fauna and Flora Protection Revised Act 22 of 2009 and Fisheries and Aquatic Resources Act No. 2 of 1996, there has been virtually no progress in mitigating any of the existing threats to these animals. A conservation management plan should adopt the precautionary principle, and priorities for ensuring the long-term conservation of the species in Puttalam Lagoon should include reduction of all direct threats through stricter regulations and enforcement of them in a comprehensive manner, implementation of education programs in fishing villages, and prevention of inshore habitat degradation in the key areas inhabited by *Sousa plumbea*. Progress must be made in these areas very quickly or Sri Lanka may lose its only population of this enigmatic and engaging species of marine mammal.

Acknowledgments

The authors would like to thank the staff of the National Museum of Sri Lanka, the National Aquatic Resource Research and Development Agency, and the Department of Wildlife Conservation for providing the necessary literature pertaining to the research, and thanks also to the field assistants, the boatmen, and the villagers in the areas where the research was conducted. We wish to acknowledge to B. A. Y. B. Jayawardana for preparing maps, and R. R. Reeves, D. Sutaria, and K. Dudzinski for reviews of earlier drafts of the manuscript.

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