

## Sightings, Catches, and Other Records of Indo-Pacific Humpback Dolphins in the Coastal Waters of Madagascar

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### Abstract

Little is known about the Indo-Pacific humpback dolphins that inhabit the coastal waters of Madagascar. We examine what is currently known about humpback dolphins around Madagascar from a variety of sources, ranging from interviews to surveys, to provide some initial information on distribution and threats. Interviews and boat-based surveys were conducted in 1997, 1998, and 1999 to evaluate the presence and status of *Sousa chinensis* along the western coast of Madagascar. From these surveys and through other sources of information, it appears that humpback dolphins may largely be restricted to the west coast. Approximately 65 humpback dolphins were observed in five groups (mean group size of 13) off Anakao, a village south of Toliara, during boat-based surveys conducted in 1999. Direct takes and incidental mortality in shark nets are the two known threats to cetaceans in the waters of western Madagascar. Indo-Pacific humpback dolphins were among the dolphin species intentionally targeted for their meat in southwestern Madagascar. From interview surveys, 22 humpback dolphins had been recorded as directly hunted and an additional 30 animals as "stranded" in Anakao between 1985 and 1999. Additional research and conservation measures are needed to better monitor the population of Indo-Pacific humpback dolphins in Madagascar's coastal waters.

**Key Words:** Indo-Pacific humpback dolphin, *Sousa chinensis*, relative abundance, distribution, fishing, direct-takes, incidental mortality, conservation

### Introduction

Indo-Pacific humpback dolphins (*Sousa chinensis*<sup>1</sup>) are distributed in coastal environments through large stretches of the Indian and western Pacific Oceans. This species has a restricted inshore distribution and is known to prefer shallow waters < 20 m deep (Jefferson, 2000; Karczmarski et al., 2000; Ross et al., 1994). Indo-Pacific humpback dolphins are frequently associated with mangrove-based coastal lagoons, river deltas, and estuaries (Durham, 1994; Parsons, 1998a; Ross et al., 1994). Recent studies have been conducted on residency patterns, and limited movements of individual humpback dolphins have been found (Baldwin et al., 2004; Guissamulo, 2000; Hung, 2000; Jefferson, 2000; Jefferson & Karczmarski, 2001; Karczmarski et al., 2000; Parsons, 1998b). Indo-Pacific humpback dolphins have varying population size estimates throughout their range (Jefferson & Karczmarski, 2001). One of the most intensely studied populations is the population that exists in Hong Kong and the Pearl River Estuary (People's Republic of China), which numbers at least 1,400 individuals (Hung & Jefferson, 2004; Jefferson, 2000). The inshore distribution of this species renders them particularly susceptible to the effects of human activities in the coastal zone (Cockcroft & Khron, 1994; Klinowska, 1991; Reeves & Leatherwood, 1994).

While recent studies are beginning to reveal detailed information concerning distribution

<sup>1</sup> Revision of taxonomy and systematics within the genus *Sousa* is in progress (Jefferson & Van Waerebeek, 2004; Rosenbaum et al., in prep.). For the purpose of the present paper, we equate Indo-Pacific humpback dolphins from Madagascar as *Sousa chinensis*. Earlier references to the presumably same species from Madagascar may use *Sousa plumbea*.

and relative abundance of large cetaceans in Madagascar's coastal waters (Best et al., 1996; Rosenbaum et al., 1997; Rosenbaum, 2003), only limited information is available on population characteristics and threats facing small cetaceans in this area. In particular, very little information for Indo-Pacific humpback dolphins exists for the coastal waters of Madagascar. Specifically, no accurate information has been available regarding the population size, the extent of their distribution, habitat use, and the extent of their exploitation. Robineau & Rose (1984) reported on the incidental capture of a humpback dolphin along the western coast of Madagascar at Nosy Be (northwestern Madagascar) in 1960. Based on the analysis of photographs presented to them, they identified the animal as *Sousa plumbea* and suggest that this represented the first documentation of this species off Madagascar. Beyond this report, additional information concerning humpback dolphins off Madagascar has been non-existent or largely anecdotal. No information exists as to where concentrations of humpback dolphins exist in Madagascar's waters. This paper summarizes records resulting from several different surveys along the west coast of Madagascar. These surveys include marine and coastal inventories along the west coast of Madagascar in 1997, two expeditions to investigate dolphin hunting and by-catch in Mahajanga's coastal waters in 1997 and 1998, and an inventory of cetaceans and investigation into dolphin hunting and by-catch in Anakao and Toliara in 1999. The compilation of this information represents what is currently known concerning population characteristics, distribution, and the extent of direct and indirect takes of humpback dolphins for some of the first dedicated surveys along the west coast of Madagascar.

### Materials and Methods

Four expeditions were carried out during the period of 1997-1999 in different locations along the western coast of Madagascar. These sites range along a large stretch of the west coast of Madagascar, between Toliara (23°23'S, 43°43'E) and Nosy Mitsio (12°54'S, 48°30'E). Cockroft & Young (1998) carried out expeditions between Toliara and Nosy Mitsio during the period of April to May 1997. These were largely rapid marine/coastal inventories for a broad range of taxa, including, but not specific to humpback dolphins. Twenty-four survey "stations" were completed during these expeditions.

To evaluate the extent of dolphin hunting along the west coast of Madagascar, a preliminary survey was carried out in three fishing camps situated north of Mahajanga on the coast

(Razafindrakoto & Rosenbaum, 1997). We carried out a follow-up survey in two other fishing camps in November 1998 between the latitudes 15°30'S and 15°42'S. The most recent and in-depth study was conducted in Anakao, a village situated south of Toliara (23°38'S, 43°36'E) between 2 October and 19 December 1999 (Andrianarivelo, 2001). This study focused mainly on assessments into the extent of dolphin hunting and incidental catch in the area; it should be noted that boat-based surveys were designed to obtain information on cetacean diversity and relative abundance in the region. The study period coincided with the period for hunting cetaceans, August through December, that was initially identified during the course of our preliminary investigations in Anakao.

Interviews were conducted at these sites to collect information on cetacean species, their distribution in these west coast areas, and the extent of their exploitation and incidental catch. The survey interviews were done informally, so that the interviewees could share their experiences and knowledge on the subject (Razafindrakoto, 1998; Razafindrakoto & Rosenbaum, 1997). The interviews also were designed to address very specific questions with systematic questionnaires to more accurately document the extent of hunting humpback dolphins and other cetaceans in Anakao (Andrianarivelo, 2001). Local fishermen (including women), members of a diving club, and hotel owners were interviewed regarding information on cetacean-hunting techniques; local and commercial use of the marine resources; and the amount of directed take, stranding, and by-catch. The boat pilot, who is a native of Anakao, accompanied the team members during each interview session. His presence was very important in order to inspire confidence in the interviewees and for confirmation of the veracity of the responses from the fishermen. Illustrated posters, photographs, and Carwardine's (1995) field guide were used for matching the identification of the species caught in the area.

Surveys were conducted between October and December 1999 (weather permitting) in southwestern Madagascar from a 6-m fiberglass boat powered with one 40-hp engine. A team consisting of three to four members, including the two boat operators, carried out the observations during the dedicated surveys. A series of randomly generated transects were predetermined each day to evaluate the relative abundance and distribution of Indo-Pacific humpback dolphins or other dolphin species in the survey area (Andrianarivelo, 2001). Surveys were conducted using a closing mode methodology (Barlow, 1997) in which the vessel would leave a previously determined transect to close on the group of humpback dolphins or other

cetaceans sighted. A Garmin 12XL GPS was used for both navigation to, and along, transects and for the collection of positional data. Positional data and descriptive attributes (e.g., time, group size, species type) were recorded for all cetacean encounters. Minimum, maximum, and best size estimates for each group sighting were made when more precise numbers of individuals within a group could not be determined, especially for larger groups. When possible, photographs were collected for individual identification, using Nikon 35-mm cameras with 200-300 mm lenses, and color slide film (ISO 100).

### Results

Two sightings of Indo-Pacific humpback dolphins were recorded during the surveys done along the west coast of Madagascar by Cockcroft & Young (1998). Table 1 summarizes the results of three separate surveys along the west coast of Madagascar. The data were incomplete or insufficient to calculate the relative abundance of the population between Toliara and Nosy Mitsio.

Between October and December 1999, a total of 98.41 h of boat surveys were conducted over 18 separate days covering a total of 982.50 km in Anakao. Five groups of Indo-Pacific humpback dolphins were observed, consisting of

approximately 65 individuals. A simple calculation of the encounter rate was 0.66 individuals/hour or 0.066 dolphins/km in the waters surrounding Anakao (Andrianarivelo, 2001). Most dolphin encounters occurred in October and November, although surveys only spanned the period between October and December. A single group of five animals was observed in December, however, despite an increase in the number of surveys during this month. Of the estimated 65 individuals observed, suitable photographs for individual identification were obtained from ten animals. There were no resights of the identified individuals.

In Anakao, the group size ranged from 5 to 25, with a mean group size of 13 (SD=7.61). Individual humpback dolphins were seen in mixed-species groups, accompanying bottlenose dolphins (*Tursiops* spp.) or both bottlenose dolphins and spinner dolphins (*Stenella longirostris*) during the surveys in this southern region around Anakao (Table 1). In all surveys, Indo-Pacific humpback dolphins were evasive and disappeared quickly when approached (Andrianarivelo, 2001).

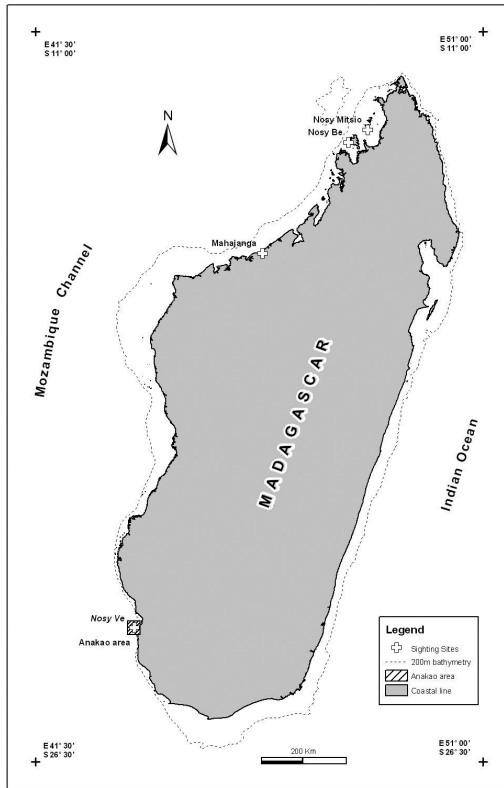
From all sources of information, including previous reports and surveys presented here, a preliminary assessment of the location of sightings for Indo-Pacific humpback dolphins throughout Madagascar's coastal waters is shown in Figure 1.

**Table 1.** Summary of the humpback dolphin records and sightings along the west coast of Madagascar; <sup>1</sup>Cockcroft & Young (1998), <sup>2</sup>Razafindrakoto & Rosenbaum (1997), <sup>3</sup>Andrianarivelo (2001), <sup>4</sup>Robineau & Rose (1984)

Localities	Date	Sources	Estimated # of individuals	Group composition	Habitat
<sup>1</sup> Mahajanga	1997	Boat survey	2	Humpback dolphins	Harbor
<sup>1</sup> Nosy Mitsio	1997	Boat survey	2	Humpback dolphins	Fringing reefs
<sup>2</sup> Antsanitia (Mahajanga)	1997	Interview, sample/by-catch#	1	?	?
<sup>3</sup> Anakao (Toliara)	5 Oct. 1999	Boat survey	25/95*	Humpback, bottlenose ( <i>Tursiops</i> spp.), spinner dolphins	Fringing reefs
<sup>3</sup> Anakao (Toliara)	15 Oct. 1999	Boat survey	15/90*	Humpback, bottlenose ( <i>Tursiops</i> spp.), spinner dolphins	Fringing reefs
<sup>3</sup> Anakao (Toliara)	4 Nov. 1999	Boat survey	11/31*	Humpback, bottlenose ( <i>Tursiops</i> spp.), spinner dolphins	Fringing reefs
<sup>3</sup> Anakao (Toliara)	7 Nov. 1999	Boat survey	9/44*	Humpback, bottlenose dolphins ( <i>Tursiops</i> spp.),	Fringing reefs
<sup>3</sup> Anakao (Toliara)	6 Dec. 1999	Boat survey	5/23*	Humpback, bottlenose dolphins ( <i>Tursiops</i> spp.),	Fringing reefs
<sup>4</sup> Nosy Be	14 Oct. 1960	Entanglement/by-catch	1	Humpback dolphin	?

\* Represents the estimated total number of dolphins of the mixed species group

# Species identification as humpback dolphin independently confirmed with genetic analysis (Rosenbaum et al. [in prep.] )



**Figure 1.** Locality of sightings of Indo-Pacific humpback dolphin recorded in the study sites along the western coast of Madagascar during surveys conducted between 1997 and 1999. Crosses represent sightings or record sites from Table 1. The striped area represents the location of the 1999 surveys in the Anakao region.

The species might have a broad distribution range along Madagascar's west coast. No confirmed sightings of humpback dolphins have been made along Madagascar's east coast despite considerable survey effort for humpback whales and other cetacean species. These areas along the east coast include one area of northeastern Madagascar where surveys have been conducted over the last nine years and in two other areas of the east coast with suitable habitat for humpback dolphins (Sainte Marie and Fort-Dauphin) that are frequented by whale-watching vessels (Rosenbaum, 2003; M. Vely, pers. comm.). In Anakao, humpback dolphins were frequently observed along fragmented or patchy reefs in the proximity of Nosy Ve island, located approximately 8 km west of Anakao; however, Indo-Pacific humpback dolphins were also observed in the vicinity of islands

(Nosy Be and Nosy Mitsio), at exposed reefs, and near a harbor (Mahajanga) during the 1997 surveys along the west coast. The depth of these sightings ranged from 10 m to 20 m (Cockcroft & Young, 1998).

#### *Direct Takes, Incidental Catch, and Strandings*

Indo-Pacific humpback dolphins were among the cetacean species targeted for direct takes along the west coast. The overall rate of what are also considered incidental mortalities or strandings of dolphin species appears to be high due to the use of shark nets, but no exact estimates on the extent to which this occurs are available. It is well known that shark fishing constitutes a valuable source of revenue in different coastal regions of Madagascar.

Accurate, comprehensive, or precise estimates of individual humpback dolphins killed along the entire west coast of Madagascar waters are not yet available. As part of this research, the hunting and by-catch rates were estimated for the period of 1985 to 1999 in Anakao. Our interviews revealed that 22 humpback dolphins were caught intentionally and an additional 30 "stranding" events were reported during this 15-year period. It was not clear whether these stranding events were natural or the result of human influence. Interestingly, no individuals were reported as by-catch in the Anakao area, despite the known widespread use of shark nets in the Anakao region. Three individual humpback dolphins were caught in nets near Mahajanga region in 1997, however. Several tissue samples obtained from skeletons of net-caught or stranded animals were confirmed as Indo-Pacific humpback dolphins using molecular methods (Rosenbaum et al., in prep.).

Based on information gained from interviews, it was found that dolphin meat is sold or consumed locally. When the number of dolphins caught is low (1-2), the meat is shared among family members or sold in the local villages. Trade in dolphin meat occurs when harvests are good: dolphin meat is dried and sold in larger urban centers. The price of the meat varies regionally. For example, 1 kg of dolphin meat was 0.66 USD compared to 0.38 USD for fish in Anakao; in Mahajanga, price for dolphin meat was 0.15 USD (fresh) and 0.30 USD (dried) (prices are from 1997). It was not exactly determined why the dried meat was more expensive in the Mahajanga market, but this may have been due to travel/shipping costs from fishing villages to urban centers.

## Discussion

This paper provides the first overview on the status, sightings, distribution, and exploitation of Indo-Pacific humpback dolphins in Madagascar's waters, principally along the west coast; however, considerable uncertainty remains about other areas where Indo-Pacific humpback dolphins may reside within the coastal waters of Madagascar. Our planned and future efforts will expand upon research and conservation initiatives to better understand the conservation status of this species in Madagascar. The low frequency of sightings compared to bottlenose and spinner dolphins off Anakao and the level of exploitation are of high concern for this species locally. Survey effort needs to be increased throughout the year to further evaluate the status of humpback dolphin populations in this region.

The previous records revealed that humpback dolphins might tend to inhabit and might even be largely restricted to the western coastal waters of Madagascar. Our data support these hypotheses, but are still insufficient to provide a definitive conclusion on the overall distribution of the species in Madagascar's waters; however, these preliminary sightings do contribute additional evidence to previous observations on the habitat use of this species, which appears to be restricted to shallow nearshore waters (Corkeron, 1990; Durham, 1994; Jefferson & Karczmarski, 2001; Karczmarski et al., 2000). The difference in depth gradients related to distance from the coast is very different between the east and the west coasts of Madagascar, and this might explain the apparent absence of the species along the east coast. Humpback dolphins have been reported to inhabit a variety of coastal habitat types (Jefferson & Karczmarski, 2001). The species appears to be dependent on a restricted type of habitat and might be limited by the abundance of prey (Karczmarski et al., 2000). In the region of Anakao, depths are fairly uniform and are less than 10 m between the island of Nosy Ve and mainland Madagascar. To the west of Nosy Ve, depths are uniform (20-30 m) for approximately four km, where the reef occurs. Just beyond this area, water depths become greater than 600 m fairly rapidly (< 1 km). All of the mixed-species associations with Indo-Pacific humpback dolphins occur in this region to the west of Nosy Ve around or just outside the fringing reef, where typical deep-water/offshore species, such as spinner dolphins, may come in contact with Indo-Pacific humpback dolphins. Similar situations are observed with mixed species groups of dolphin species in the waters of Mayotte, where a barrier reef forms a

shallow, protected lagoon with a dramatic drop-off and deep water less than 1 km outside of the reef (Rosenbaum et al., in prep.).

The sightings around Anakao showed a higher group size compared to other sites in South Africa, one of the populations of closest proximity to Madagascar. Group sizes were seldom larger than 13 animals in South Africa (Karczmarski et al., 1999; Saayman & Tayler, 1979). Other group sizes from the Indo-Pacific ranged between 2.6-2.8 individuals for Goa, western India, Australia, and Hong Kong (Corkeron, 1990; Jefferson, 2000; Parsons, 1997, 1998a, 1998b). While the sample size is small, humpback dolphin groups from Anakao were more similar in group size to groups encountered off Mozambique, where a mean group size of 14.9 was reported (SD=7.32) (Guissamulo, 2000). Data from the Arabian region showed that humpback dolphins do form large groups, like other delphinids, consisting of 30, 50, and even around 100 individuals (Baldwin et al., 2004). In Madagascar, group sizes were estimated visually and not by determination of precise numbers of identified individuals. It should be noted that there could be considerable variance associated with these estimations; however, it is clear that group size was considerably larger than the mean of two to three individuals estimated from other regions (Corkeron, 1990; Jefferson, 2000; Parsons, 1998a, 1998b).

In contrasting dolphin behavior in the northern and southern regions of the west coast, individuals in the southern region around Anakao were evasive and avoided boats, while dolphins were reported to be generally highly active and more approachable to areas further north (Cockcroft & Young, 1998). This behavior might reflect the difference of the disturbance level in the two areas. Avoidance is among the behavioral responses of most cetacean species to human activities (Au & Perryman, 1982; Nowacek et al., 2001; Patenaude et al., 2002). The high incidence of dolphin hunting may trigger this behavioral response given that tourism activities are comparable in the two areas. Bottlenose dolphins, which were the most targeted species after spinner dolphins, also displayed this evasive behavior in Anakao (Andrianarivelo, 2001; Rosenbaum et al., in prep.).

Coastal exploitation of marine resources appears to be extremely high along the western coast of Madagascar. This situation has been leading local communities to directly target marine mammals for consumption. The exploitation rate of cetacean species seems to differ regionally along the western coast, depending upon different local tribes or provinces. Recent research efforts have been dedicated toward understanding the

extent of pressure from hunting on cetacean species, particularly on humpback dolphins. Hunting of cetaceans is generally considered taboo on the western side of Madagascar (Razafindrakoto & Rosenbaum, 1997), but our surveys showed hunting and/or netting small cetaceans appeared to have been a common activity in the southwestern region of Madagascar. Since gill netting was introduced in 1985, however, fishermen have been using nets instead of harpoons to catch dolphins in Anakao. The harvesting or hunting season for cetaceans typically lasts for five months between August to December (which is one reason why surveys in 1999 were concentrated within this time period); generally, it is associated with the high production of bonefish (*Albula vulpes*) in Anakao. Fishing activity is very high, as is the direct take of dolphins during this period (Andrianarivelo, 2001; Rosenbaum et al., in prep.).

Fishermen have intentionally hunted any cetacean species encountered in the waters. Even though some errors in reporting or identification are likely to occur, the level of direct takes for two other dolphin species (bottlenose and spinner dolphins) are several orders of magnitude higher than takes of humpback dolphins over the same period in Anakao. Nonetheless, without more precise estimates of population size and trends in abundance, the number of humpback dolphins killed in Anakao during the 15-year period between 1985 and 1999 should be considered as a critical situation. Following the worldwide review on the status of humpback dolphins by the Small Cetacean Subcommittee of the International Whaling Commission in 2002, the Anakao region of Madagascar may be the only place that has been identified where direct takes for humpback dolphins occur. The amount of direct takes for this species might reflect a small population size, the lower occurrence for the population in this area due to avoidance behavior associated with hunting, or difficulty in capturing these dolphins compared to other species encountered. Several records of stranded or by-caught cetaceans were recorded prior to 1985, but none were humpback dolphins. In the absence of more precise data on the current population(s), it is difficult to determine the consequence of the overall rate of directed takes; however, given that the levels of documented exploitation are high, dolphin meat was readily available, and the trend worldwide is typically for under-reporting of direct and indirect takes, the current level of direct takes raises great concerns about its impact on dolphin populations in this region. Despite being forbidden by local laws in southern Madagascar, the amount of hunting is unregulated. The directed takes from Anakao reported here represent the catch

from only one of many fishing villages. Even if reporting or assessment of humpback dolphins killed from Anakao is considered accurate, there are no estimates from other surrounding villages in the region that may be targeting the same population. In the Mahajanga region, dolphin meat is transported to the city markets from surrounding villages. To minimize and reduce these impacts to local populations of humpback dolphins, additional conservation measures with local stakeholders and environmental education within the local community are needed. Given the initial survey effort and indications of a small population of humpback dolphins off Anakao, the continued direct catch and by-catch of humpback dolphins potentially threatens the only known population or concentration in this region. An accurate estimate of population size and more precise estimates of removals from the population are urgently needed to ascertain how the level of directed catches impact viability of this population. Additional research, a monitoring program, and the likely reduction of the directed takes and by-catch are essential for the conservation of Indo-Pacific humpback dolphins in the coastal waters of western Madagascar.

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