

## Population Size of Indo-Pacific Humpback Dolphins (*Sousa chinensis*) at Khanom, Thailand

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### Abstract

Indo-Pacific humpback dolphins (*Sousa chinensis*) were estimated with the Mark-Recapture Model from a boat-based photo-identification survey at Khanom, Nakhon Si Thammarat, Thailand from July 2008 - June 2009. Indo-Pacific humpback dolphins were encountered at a water depth of 1.1 - 7.5 m, a distance off shore of 21 - 1,021 m and water transparency of 67 - 256 cm. Groups and solitary Indo-Pacific humpback dolphins were sighted 39 times. They were extensively viewed in the coastal zone between Nang Kham bay to Thong Ching bay. There were 34 sightings of groups and five sightings of solitary individuals. A total of 49 individuals were identified and catalogued. There were 33 identified adults, eight juveniles and eight calves. The group size of humpback dolphins varied from 2 - 20 individuals. The group size of adults ranged between 2 - 12 dolphins. The juveniles group size ranged from 0 - 6 dolphins. There were no groups observed consisting solely of juveniles. Groups without juveniles were seen 8 times. The number of calves per group ranged between 0 - 4 individuals. The percentage and number of calves per group were significantly lower than the percentage and number of juveniles. The mean size of groups containing calves was larger than non-calf groups. The estimated abundance of this population from the Jolly-Seber method was 49 individuals.

**Keywords:** Photo-identification, *Sousa chinensis*, group, Khanom, Thailand

### Introduction

Human population in coastal developing countries has increased at an alarming rate resulting in overexploitation of marine resources [1,2]. Indo-Pacific humpback dolphins (*Sousa chinensis* (Osbeck, 1765)) inhabit the shallow coastal waters of the Indian Ocean and western Pacific [3-8]. Indo-Pacific humpback dolphins are subjected to anthropogenic threats including harmful fishing activities, intensive agriculture and aquaculture in the coastal areas causing pollution arising from coastal run-off and massive industrialisation [3,8-16]. These coastal problems are common in heavily populated Asian regions.

In Thailand, a major cause of Indo-Pacific humpback dolphin mortality is incidental

entanglement in gillnets. The rate of such mortality (5 out of 14 reported mortalities in 2006 - 2007) may exceed the potential replacement rate of the Indo-Pacific humpback dolphin population in Thailand, but this is unclear since few studies of dolphins have been done in Thailand [17-23]. A small number of Indo-Pacific humpback dolphins were reported along the Khanom coastline of Thailand with 11 and 16 reported carcasses in 2007 and 2008 respectively by the Department of Marine and Coastal Resource Research Area 3, Songkhla, Thailand. Serious conservation concerns about this population led to a survey to better understand the status of this population. Distribution and estimates of population size are

essential for improving our understanding of the species biology, assessing its conservation status and guiding conservation actions and decisions.

Most previous studies on dolphins in Thailand were based on stranded and by-caught specimens, available skeletons and interviews [23]. This study aims at examining the abundance of Indo-Pacific humpback dolphin population at the Khanom coastline in Thailand by using a mark-recapture analysis of photo-identification data.

## Materials and methods

### Study Area

The Khanom coastline is located at latitude 9° 19' N and longitude 99° 51' E in Nakhon Si Thammarat province, Thailand (**Figure 1**). Most of the Khanom coastline had a depth of less than 7.5 m. The mean spring and neap tidal ranges were 0.40 and 0.90 m respectively, with a mean sea level of 1.43 m. A main river discharge into the Khanom coastal area was the Bang Paeng River that flows from west to east. The Khanom coastal area is composed of various habitats: estuaries, mangrove habitats, sea grass beds and coral reefs.

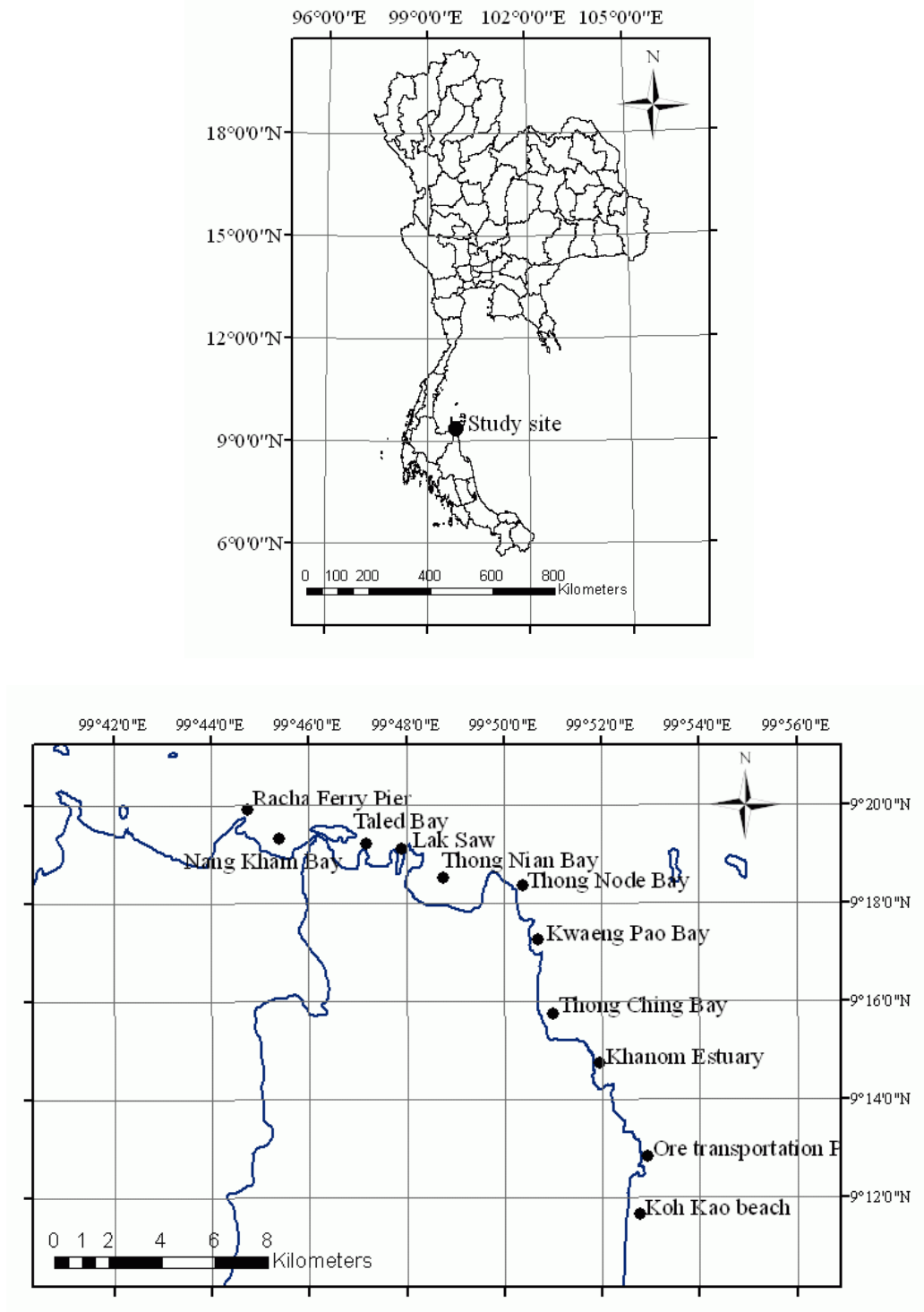
### Data Collection

Observations and photographs from boats are the most practical approach to study dolphins in most areas [24,25]. We conducted a boat-based survey over approximately 50 km of the Khanom coastline (**Figure 1**) throughout a one-year period from July 2008 - June 2009. When the weather/sea

conditions were suitable, we carried out boat-based surveys 2 times a month between 07.00 - 14.00 using an 8-m long-tailed boat (a common local vessel) powered by a 115 HP outboard engine travelling at an average speed of 15 km/h except in severe weather conditions. A minimum of two observers searched the waters. The track lines of the surveys were paralleled to the shoreline [8].

When dolphins were sighted, we collected the date, time, geographic location, species, number of individuals of the 3 size classes and number of mother-calf pairs. Dolphins were photographed using a 12.1 megapixel digital camera equipped with 18 - 135 mm and 70 - 300 mm lenses. The camera was angled as close to perpendicular to the dolphin body axis and dorsal fins as possible.

We classified Indo-Pacific humpback dolphins based on Karczmarski [4] into 3 age classes i.e. calf, juvenile and adult. Calves were defined as animals accompanied by a mother two-thirds or less the length of an adult. Juveniles were defined as animals approximately 2 m long, less robust than adults but swimming independently. Adults were defined as animals approximately 2.5 m long, robust and with a well pronounced dorsal hump. Based on previous studies [4,5], we defined a group as any aggregation of more than one dolphin in all age classes within visual range of the survey team. If the group contained calves, we defined it as a nursery group [4].



**Figure 1** Khanom coastline, Nakhon Si Thammarat, Thailand.

### Data Analysis

We estimated the humpback dolphin population, the probability of survival and the dilution rate from a mark-recapture analysis using the Jolly-Seber open population model [26,27]. The probability of survival was calculated as the ratio of the number of marked animals at the start of sample  $t + 1$  to the number of marked animals at the end of the sample. The dilution rate was calculated as an estimate of the number of animals added to the population through birth and immigration. It is the ratio of the actual population size at  $t + 1$  to the expected population size at  $t + 1$  if no additions through birth and immigration had occurred. We compared between (1) the percentage and number of calves per group and the percentage and number of juveniles and (2) the mean size of the groups containing calves and non-calf groups using Mann-Whitney U-tests. All tests were two tailed.

### Results

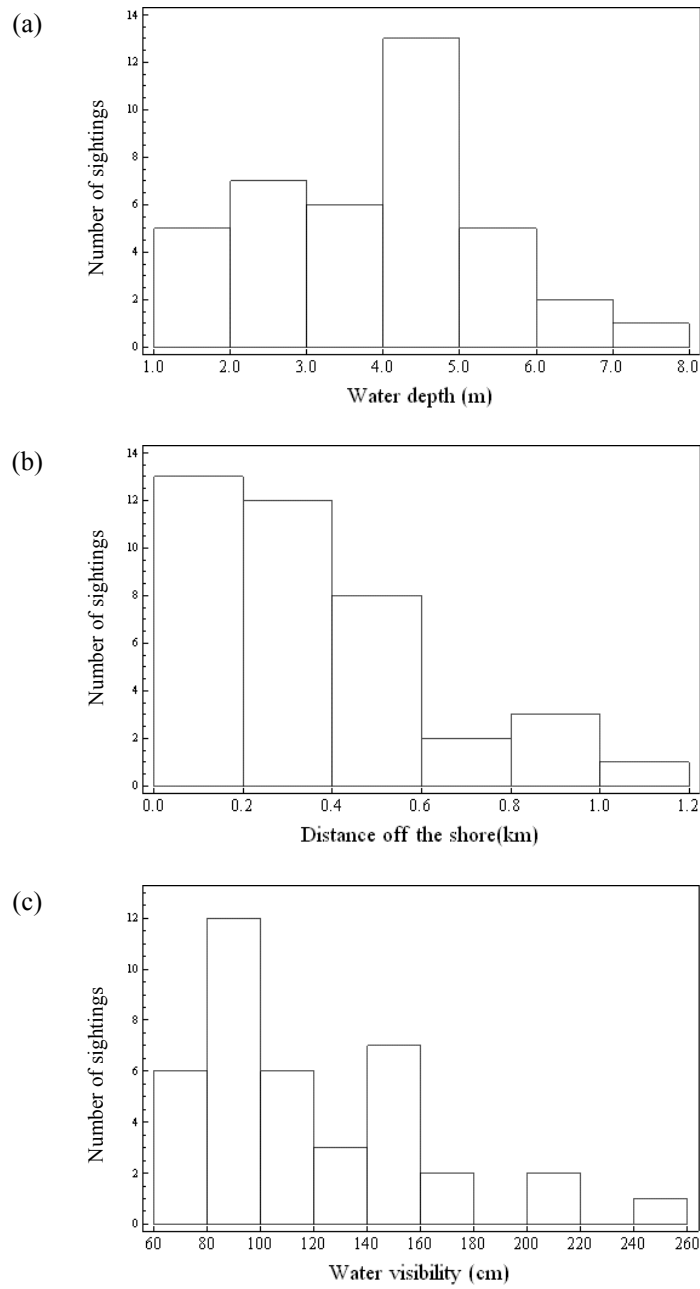
#### Habitat Characteristic

Indo-Pacific Humpback dolphins were encountered at a water depth of 1.1 - 7.5 m and at a

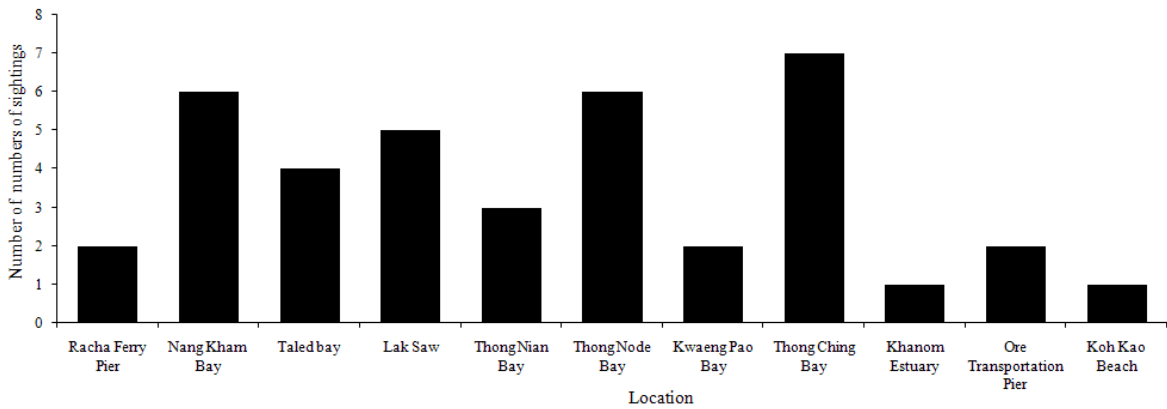
distance off shore of 21 - 1,021 m and water visibility of 67 - 256 cm (**Figures 2a-c**).

#### Site Fidelity

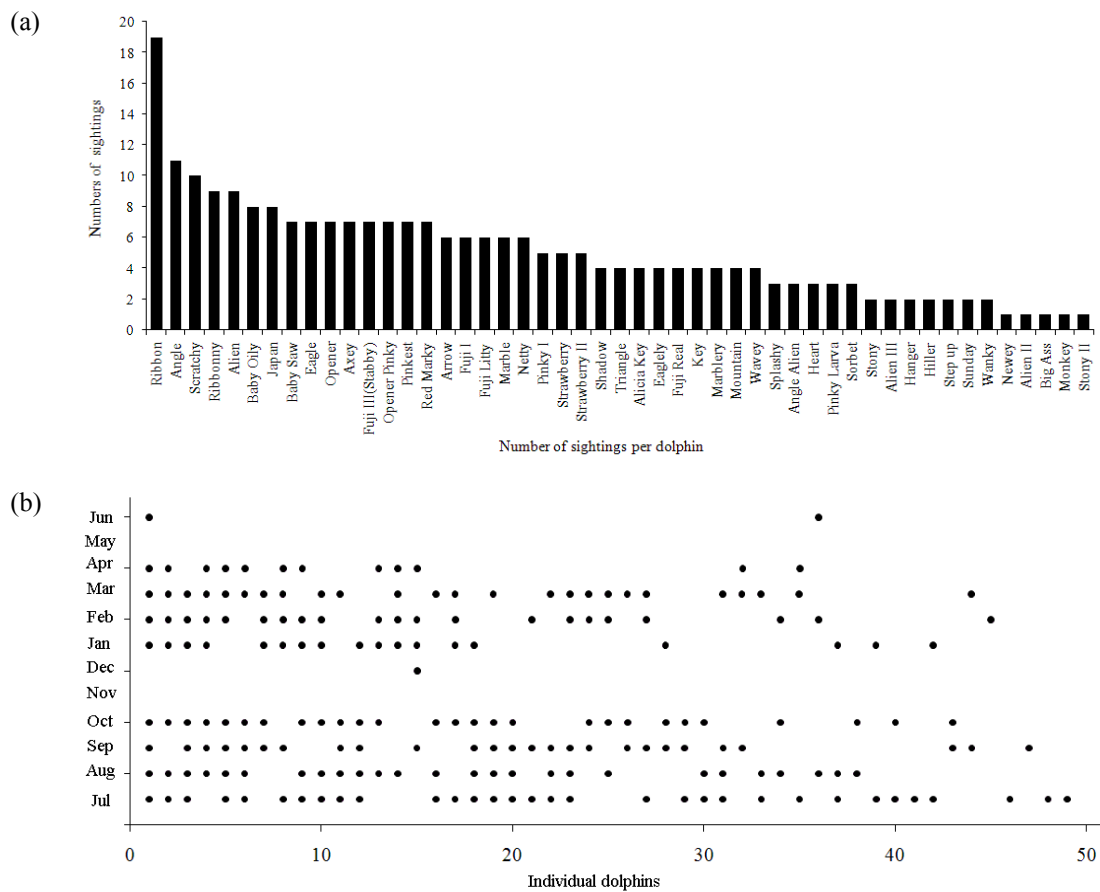
Groups and solitary Indo-Pacific humpback dolphins were sighted 39 times and observed for over 130 h. The majority of sightings (seven) were at Thong Ching Bay (**Figure 3**). Dolphins were not evenly distributed over the Khanom coastline. They were found extensively in the coastal zone between Nang Kham bay to Thong Ching bay (**Figure 3**). There were 34 sightings of groups and 5 sightings of solitary individuals (**Figure 4a**). Over 5,000 photographs were collected during 22 boat surveys. A total of 49 individuals were identified and catalogued. The majority of these dolphins were adults ( $n = 33$ ). There were 8 calves and 8 juveniles. About 10 % of the identified and catalogued humpback dolphins were seen only once (**Figure 4a**). Resightings of individuals ranged between 1 - 19 (**Figure 4a**). The most frequently seen dolphin was recorded in 10 of the 12 months surveyed (**Figure 4b**).



**Figure 2** Habitat characteristics where Indo-Pacific humpback dolphins were found. (a) water depth (m), (b) distance off shore (km) and (c) water visibility (cm).



**Figure 3** Number of sightings of Indo-Pacific humpback dolphins encountered during the boat survey of the Khanom coastline, Thailand.



**Figure 4** Number of identified Indo-Pacific humpback dolphins. (a) number of sightings per identified dolphins and (b) months that found each identified dolphin.

**Group Size**

Solitary individuals were observed throughout the year. They constituted 10 % (n = 5) of all sightings. Groups of humpback dolphins varied in size from 2 to 20 dolphins with an overall mean  $\pm$  SD of  $5.93 \pm 5.38$  dolphins. The number of adults per group ranged between 2 and 12 dolphins with the mean  $\pm$  SD of  $3.02 \pm 3.39$  dolphins. The number of juveniles per group ranged from 0 and 6 dolphins with a mean  $\pm$  SD of  $1.61 \pm 1.70$  dolphins. There was no group consisting solely of juveniles. Groups without juveniles were seen 8 times. The number of calves per group ranged between 0 to 4 dolphins with the mean  $\pm$  SD of  $0.93 \pm 1.28$  dolphins. The percentage and number of calves per group were significantly lower than the percentage and number of juveniles (Mann-Whitney U-test: Percentage of calves per group:  $U = 639.50$ ,  $n = 88$ ,  $p < 0.05$ ; number of calves per group:  $U = 714.00$ ,  $n = 88$ ,  $p < 0.05$ ). The mean size of groups containing calves (7.45 dolphins, n

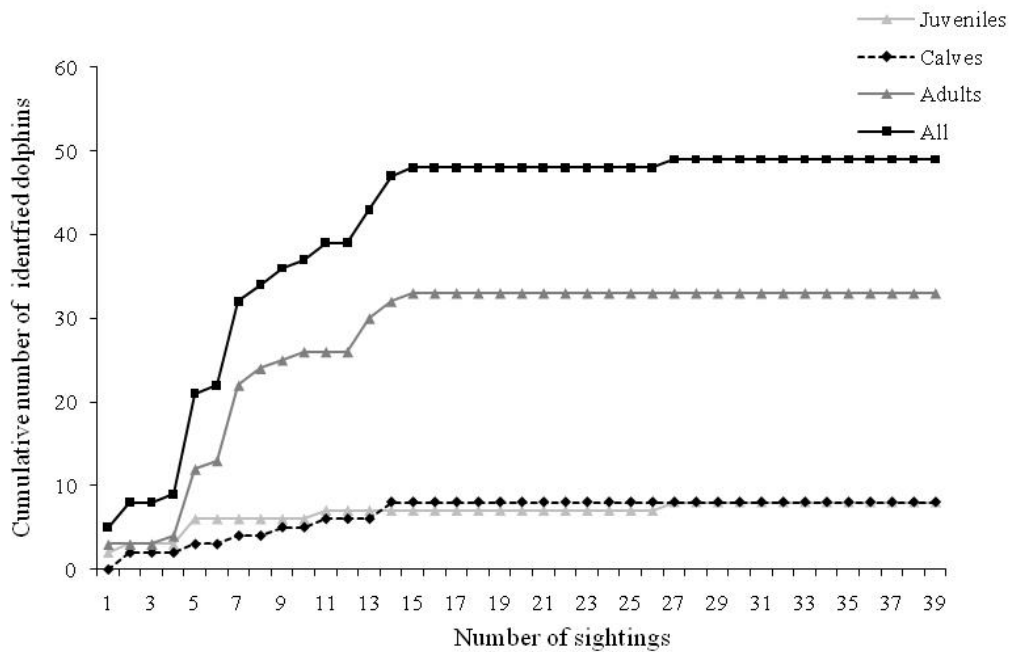
= 31) were larger than non-calf groups (1.08 dolphins, n = 13) (Mann-Whitney U-test:  $U = 19.500$ ,  $n = 44$ ,  $p < 0.05$ ).

**Abundance**

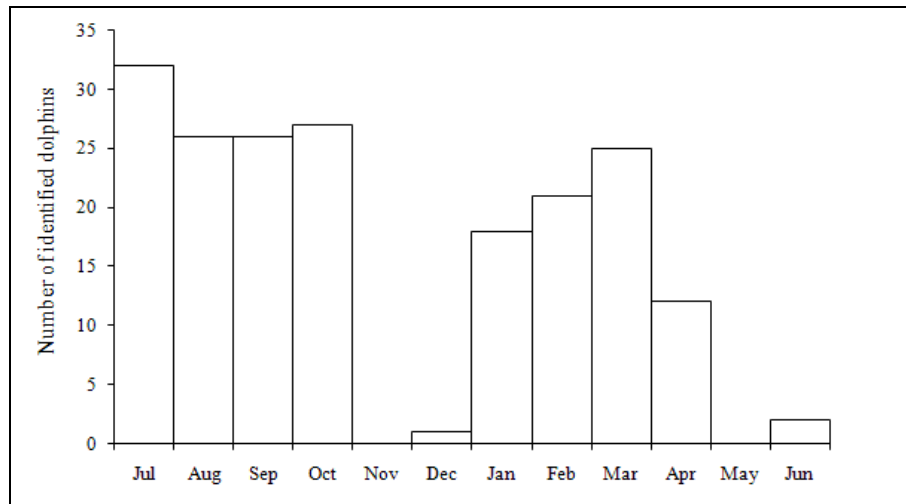
Humpback dolphins were sighted during 20 out of 22 boat surveys. The cumulative number of identified animals increased and reached a plateau (Figure 5). The population estimated from the Jolly-Seber method was 49 individuals. The probability of survival was 0.94 and the dilution rate was 1.01.

**Daily and Seasonal Variations in Khanom Dolphin Distribution**

Indo-Pacific humpback dolphins were observed on the Khanom coastline throughout the observation time and the year. The number of sightings varied monthly but the majority were observed during August 2008 (Figure 6).



**Figure 5** Cumulative number of identified Indo-Pacific humpback dolphins and number of sightings. ■ = all individuals, ▲ = adults, ▲ = juveniles, ◆ = calves.



**Figure 6** Seasonal variations of Indo-Pacific humpback dolphins at the Khanom coastline from July 2008 - June 2009.

### Discussion

Our results support the previous findings that Indo-Pacific humpback dolphins tend to be distributed in highly restricted inshore areas [3,7,8,28-29]. The population inhabits shallow waters, mostly < 7.5 m deep, approximately 0.37 km of the shore along the Khanom coastline from Nang Kham bay to Thong Ching bay. Humpback dolphins at Algoa bay were observed within 150 - 400 m of the shore. Only two groups from three years observation ventured 1.0 - 1.5 km offshore and moved back inshore after a short period [5,28]. The Eastern Taiwan Strait dolphin population was observed within 2 km from shore [8]. The distribution of the Khanom population seems to resemble that of the Taiwanese and South African populations, where there are small river estuaries entering shallow coastal waters along a linear coastline [5,8,30]. On the other hand, some dolphin populations prefer large river estuaries such as in Pearl River Estuary, People's Republic of China and Cleveland Bay, Australia [7,16,31].

The Khanom population seems to show some seasonal variability in occurrence and distribution. There were no dolphin sightings in November because weather conditions were not suitable to conduct boat-based surveys due to heavy rain in the monsoon season. Karczmarski *et al* [28] showed that the humpback dolphin group size varied seasonally and increased in summer and

again in late winter. They suggested that the seasonal variability of dolphin group size could be due to water temperature fluctuation and seasonal changes in food abundance [7,16,31].

The percentage of solitary humpback dolphins in the Khanom population was slightly less than at Algoa bay (15.4 %) and the KwaZulu-Natal coast (20 %), South Africa [28,34]. This could be due to two possible reasons. First, the Khanom area is very small and second the population is comparatively low. However, the range group size was similar to other populations in South Africa: Algoa population with a mean group size of seven animals [28,35], Natal coast population [34] and Cape Coast population [30] with a mean group size of seven animals.

Our results support previous findings [28,30] that nursery groups were larger than non-calf groups. This may be due to two principal reasons. First, Indo-Pacific humpback dolphins form allomaternal care for offspring [4,30]. Karczmarski *et al* [28] reported that humpback dolphins from the Algoa Bay formed temporary alliances of nursing females for calf-care. Second, larger group size would provide better protection and a better learning environment for calves [36].

Capture-recapture analysis of photographically-identified individuals is a common approach to estimate dolphin abundance. Our results support previous beliefs that the



Khanom dolphin population is very small. Our study might estimate population imprecisely due to the limited number of sightings (i.e. 39 sightings). Buckland *et al* [37] recommended that 60 sightings should be used to obtain a relatively precise population estimation. However, the shape of the cumulative number of individual dolphins through time showed an initial rapid increase in the number of newly identified dolphins and then reached a plateau. This would indicate that the Khanom population might be a closed population and strong site fidelity with little or no immigration from other populations nearby.

Humpback dolphins show varying degrees of site fidelity [6]. In South Africa, Algoa, KwaZulu-Natal and Eastern Cape coast populations displayed a low level of site fidelity [4,34]. In Mozambique (Maputo Bay population), Hong Kong (Pearl River Estuary population) and Australia, humpback dolphins display a high degree of site fidelity and occur in discrete and geographically localised populations [7,16,38-39]. There are several factors that affect site fidelity such as spatial and temporal variability in the quality of the site, as well as breeding and foraging success [40-42]. The Khanom area is an estuarine system receiving freshwater input from rivers and surrounded by coral reef from small islands nearby and mangrove-based coastal lagoons where fish are abundant. Although the diet of Indo-Pacific humpback dolphins is poorly documented, they seem to feed predominantly on estuarine, reef fish and cephalopods [43]. Indo-Pacific humpback dolphins may return to this area regularly due to the higher chances of finding prey and potential mates.

With no previous estimates of abundance, it is impossible to assess if the Khanom population has been stable, increasing or decreasing. It is instructive to compare abundance of the Khanom population to those of other known populations in Asia [8,31]. There were 80, 99 and 1,500 individual dolphins at Jiulong River Estuary (JRE), Eastern Taiwan Strait (ETS), and Pearl River Estuary (PRE), respectively [8,31]. The PRE population densities varied from 60 - 280 individuals per 100 km<sup>2</sup> in high density areas, 15 - 50 in medium density areas and < 10 in low density area [8]. The Khanom population density of 49 individuals per 73 km<sup>2</sup> is at the lower end of the PRE high density areas (i.e. 67 individuals per 100 km<sup>2</sup>). This suggests that the density along the

Khanom coastline is high but clustered around a small area.

Small populations are more likely to become extinct than large populations due to lower genetic variability and environmental stochasticity [44]. Studies on bottlenose dolphin and Hector's dolphin indicate that populations of less than a hundred animals face very high extinction probabilities [45,46]. Our low estimates (i.e. less than a hundred animals) raise concerns about the long-term survival of Indo-Pacific humpback dolphins in this local region and emphasises the need to increase research and conservation efforts in Thailand in order for conservation to be successful.

Our results clearly demonstrate that the Khanom population is highly vulnerable to threats from rapid coastal degradation due to human activities. Due to the low reproductive rate of Indo-Pacific humpback dolphins, long generation times and high parental investment, Indo-Pacific humpback dolphins are particularly vulnerable to even small declines in adult survivorship. These life history traits, combined with anthropogenic impacts affecting coastal environments in Thailand probably explain their diminished population size and limited areas of occurrence. Although little quantitative data are available for assessing threats, accidental killing in gillnets and stake traps is believed to be the greatest source of human-caused mortality of Indo-Pacific humpback dolphins in Thailand, even though it is assumed that intentional killing of dolphins has not occurred in Thailand for over 50 years [23]. Without effective and precautionary conservation efforts for the Khanom population of Indo-Pacific humpback dolphins, their existence in Thai coastal waters is minimal.

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