Estimation and Distribution of Indo – Pacific humpback dolphin population at Khanom Sea, Nakhon Si Thammarat

Suwat Jutapruet

A Thesis Submitted in Partial Fulfillment of the Requirements
for the Degree of Master of Science Program in Computational Science
Walailak University

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ชื่อวิทยานิพนธ์	การประมาณจำนวนประชากรและการกระจายตัวของโลมาหลังโหนกในทะเล ขนอม จังหวัดนครศรีธรรมราช
ผู้เขียน	สุวัฒน์ จุฑาพฤทธิ์
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ปีการศึกษา	2552

บทคัดย่อ

การศึกษานี้มุ่งศึกษาการประมาณจำนวนและการกระจายตัวของประชากรโลมาหลังโหนกบริเวณท่าเรือราชาเฟอร์รี่ อ.ดอนสัก จ.สุราษฎรานี จนถึง หาดคอเขา อ.ขนอม จ.นครศรีธรรมราช ครอบคลุมพื้นที่ประมาณ 73 ตารางกิโลเมตร บันทึกเส้นทางการสำรวจและตำแหน่งที่พบเห็นด้วยเครื่องบันทึกพิกัดสารสนเทศ โลมาหลังโหนกถูกพบได้ตลอดแนวเส้นทางสำรวจ และสามารถพบเห็นได้บ่อย 3 จุด คือ อ่าวนางกำ, อ่าวท้องโหนดและอ่าวท้องชิง เนื่องมาจากเป็นเขตทะเลเงียบสงบไม่เป็นแหล่งชุมชน ไม่มีการทำประมงชายฝั่งและไม่เป็นแหล่งท่องเที่ยวเชิงพาณิชย์มากนัก นอกจากนั้นข้อมูลจากเครื่องบันทึกพิกัดสารสนเทศ สามารถวิเคราะห์ช่วงเวลาที่พบเห็นได้บ่อยพบว่า เวลา 09.00-10.00 เป็นเวลาที่มีโอกาสพบโลมาได้บ่อยที่สุด โดยข้อมูลทางกายภาพที่ตรวจวัดเพื่อศึกษาความเชื่อมโยงของแหล่งที่อยู่อาศัยได้แก่ ระยะห่างจากชายฝั่ง, ความลึกและความขุ่นใสของน้ำทะเลพบว่าจะพบโลมาได้บ่อยที่ระยะห่างจากชายฝั่ง 21-1021 เมตร ที่ระดับความลึก 1.1-7.5 เมตรและความขุ่นใสที่ 67-275 เซนติเมตร ซึ่งในการเดินทางสำรวจแต่ละครั้งภาพถ่ายครีบหลังเพื่อระบุสัณฐานของโลมาหลังโหนกถูกบันทึกด้วยกล้องดิจิตอลความละเอียดสูง เพื่อใช้จำแนกโลมาแต่ละตัวจากลักษณะเส้นขอบของครีบหลัง, สี, ลวดลายและตำหนิหรือรอยแผลบนครีบ ด้วยลักษณะพิเศษของโลมาชนิดนี้สามารถบ่งชี้ถึงความแตกต่างของโลมาแต่ละตัวได้เป็นอย่างดี โดยจากการสำรวจข้อมูลจำนวนโลมาแบ่งเป็น 3 ช่วงอายุคือ เด็ก 8 ตัว, วัยรุ่น 8 ตัว และตัวเต็มวัย 33 ตัว รวม 49 ตัว เมื่อเทียบกับพื้นที่สำรวจแล้วจัดว่าทะเลในพื้นที่ขนอมมีความหนาแน่นของประชากรโลมาหลังโหนกสูง คือ 67 ตัว ต่อ

100 ตารางกิโลเมตร และจากการประมาณจำนวนประชากรด้วยวิธีทำเครื่องหมายและจับใหม่ของลินคอล์น-ปีเตอร์สัน, ชเนเบล, ซูมัคเกอร์-เอสเมเยอร์และโจลี-ซีเบอร์ โดยเปรียบเทียบภาพถ่ายครีบหลังโลมาแต่ละตัวแทนการติดเครื่องหมายบนตัวโลมา ด้วยวิธีการดังกล่าวสามารถประมาณจำนวนประชากรโลมาหลังโหนกในทะเลขนอมได้จำนวน 49-53 ตัว ข้อมูลดังกล่าวเป็นข้อมูลพื้นฐานที่สำคัญต่อการหาแนวทางในการอนุรักษ์โลมาหลังโหนกของทะเลขนอมต่อไปในอนาคต

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Abstract

This study estimated Indo-Pacific humpback dolphin population and its distribution along the Khanom coastline, Nakhon Si Thammarat. The study sites were from Racha Ferry transportation pier, Donsak District, Suratthanee to Koh Kao beach, Khanom District, Nakhon Si Thammarat covering the area of 73 km. The surveying route and dolphin encountered locations were recorded by GPS. Indo-Pacific humpback dolphins were most encountered at three locations: Nang Kham Bay, Thong Node Bay and Thong Ching Bay. These three locations had less human impacts due to no fisherman village, less fishery activities and not tourist attraction areas. Dolphins found most during 0900-1000 hr with feeding behaviour. Dolphin sighting locations were 21-1021 m off the shore at the depth of 1.1-7.5 m and water visibility of 67-275 cm. Indo-Pacific humpback dolphin dorsal fins were taken by digital camera from bi-monthly boat based survey from July 2008-June 2009. Individual dolphins were identified from dorsal fin pictures using edge of dorsal fin, dorsal colour, stripe, scar and mark on dorsal skin. From one year study, we found eight calves, eight juveniles and 33 adults with at total of 49 identified dolphins. Dolphin population density at Khanom coastline was 67 dolphins/ 100 km^2. The dolphin population size estimated from Peterson, Schnabel, Schmacher-Eschmeyer and Jolly-Seber methods was ranging from 49 to 53 dolphins. The results are important for the basic knowledge to conserve Indo – Pacific humpback dolphins at Khanom sea in the future.

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Suwat Jutapruet

Disclaimer

I certify that the material contained in this dissertation is my own work and does not contain significant portions of unreferenced or unacknowledged material. I also warrant that the above statement applied to the implementation of the project and all associated documentation.

In the case of electronically submitted work, I also consent to this work being stored electronically and copied for assessment purposes, including the graduate office use of plagiarism detection systems in order to check the integrity of assessed work.

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Suwat Jutapruet

Date..........................

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List of Symbols, Abbreviations and Technical Vocabulary

m = Metre

Kg = Kilogram

Cm = Centimetre

CI = Confidence Interval

N = North

E = East

Km^2 = Square Kilometre

Hr = Horse Power

Km/h = Kilometre per hour

mm = Millimetre

SD = Standard Deviation

GUI = Graphic User Interface

Introduction

Origins and Significances

Marine and Coastal Resource Research Centre, Central Gulf of Thailand has recorded the number of dead dolphins found at Nakhon Si Thammarat, Phatthalung and Songkla provinces from 2005-2009. They found that the death rate of four dolphin species showed an increasing trend in all three provinces from 2005-2009 (Figure 1a-c). It is very clear that Indo-Pacific humpback dolphins and Finless porpoises had the highest number of deaths in Nakhon Si Thammarat (Figure 1a). On the other hand, Irrawaddy dolphins had the highest number of deaths in Phatthalung and Songkla provinces. This difference could be due to the fact that Irrawaddy dolphins tend to inhabit in freshwater and brackish water whereas Indo-Pacific humpback dolphins tend to live in coastal and estuary areas. Phatthalung and Songkla provinces have very large freshwater and brackish area at Songkla lagoon.

Dead Indo-Pacific humpback dolphins and Finless porpoises were found mostly at Khanom area and at Songkla area. Most dead Irrawaddy dolphins were found in Songkla Lagoon. Bottlenose dolphins had the lowest number of deaths in these areas. This could be due to the fact that bottlenose dolphins are very acrobatic species, and can swim very fast. Therefore, this species tends not be caught by fish nets. Indo-Pacific Humpback dolphins and Irrawaddy dolphins are slow swimmers, tend to live in shallow coastal areas and feed on fish and small invertebrates from river, estuary, mangrove or coral reef areas. The major cause of dead dolphins was bycatch from fish nets, especially Irrawaddy dolphins (Figure 2a). When we compared between sexes, there was more dead female dolphins than male dolphins, especially in 2006 (Figure 2b).

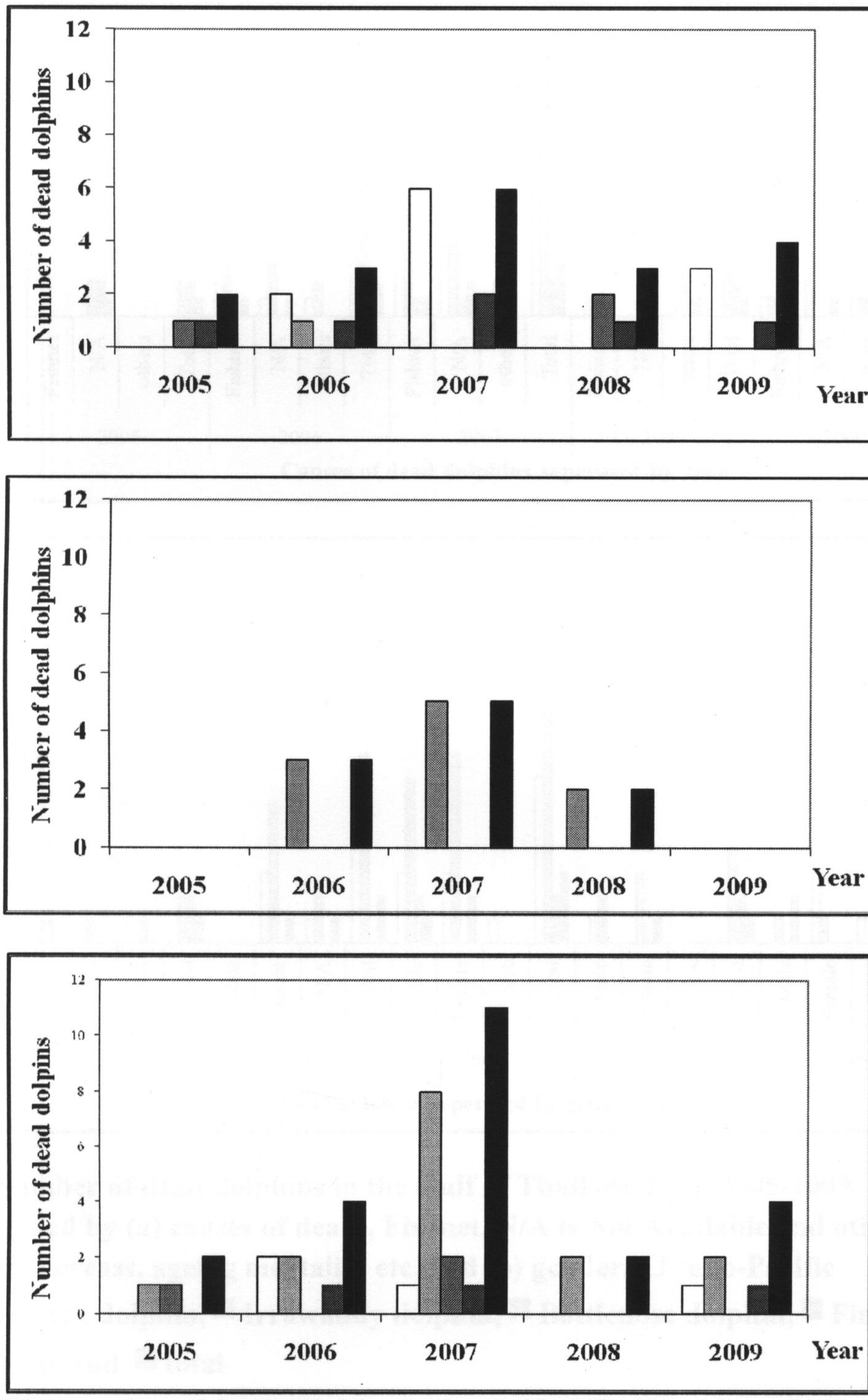


Figure 1. The number of dead dolphins in the Gulf of Thailand from 2005-2009 (a) Nakhon Si Thammarat, (b) Phatthalung, and (c) Songkla, □ Indo-Pacific humpback dolphin, ▒ Irrawaddy dolphin, ■ Bottlenose dolphin, ■ Finless porpoise and ■ Total.

(a)
(b)

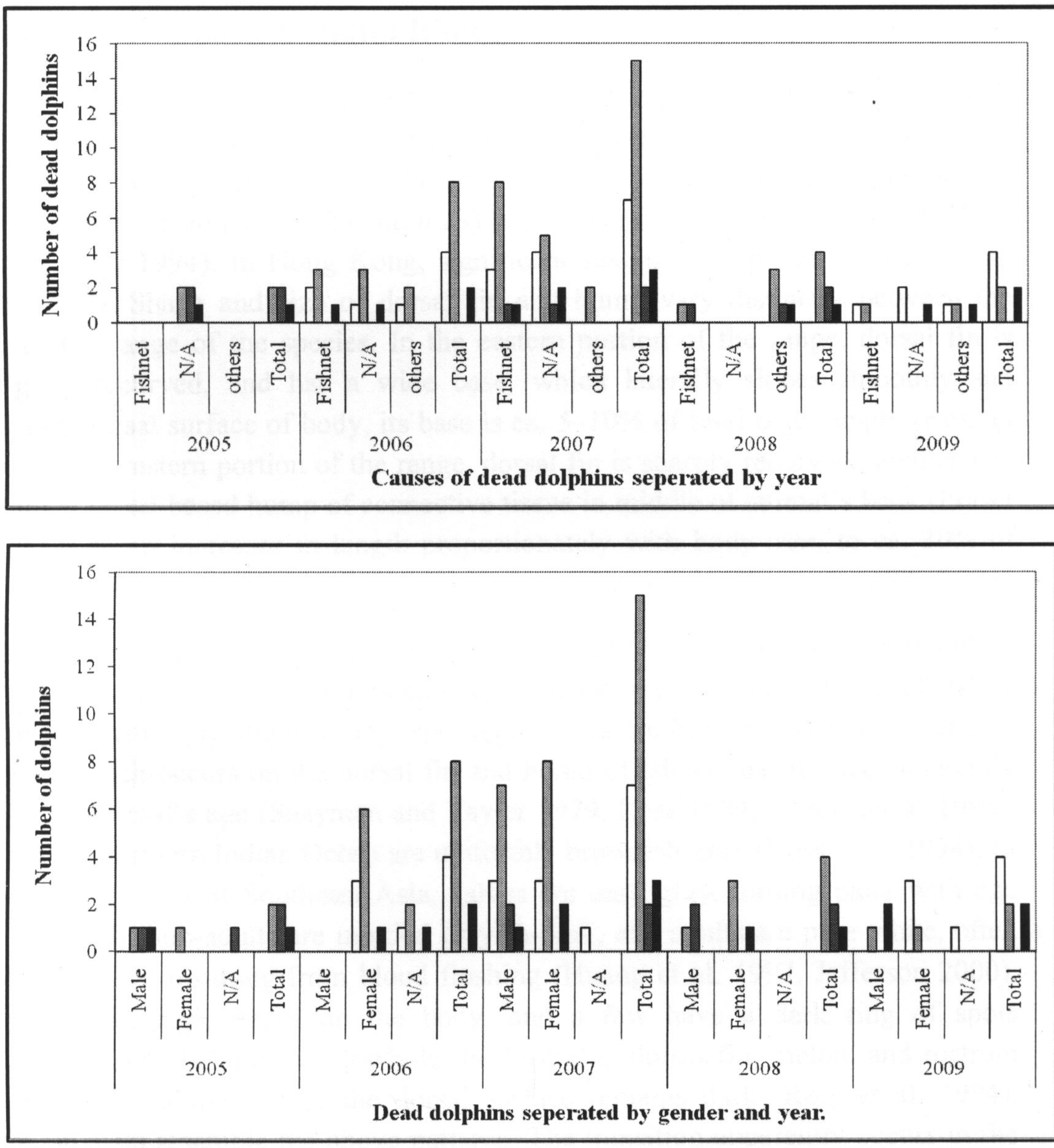


Figure 2. The number of dead dolphins in the Gulf of Thailand from 2005-2009 separated by (a) causes of death, Fishnet, N/A is Not Available and others are no carcass, ageing mortality etc. and (b) gender, □ Indo-Pacific humpback dolphin, ▒ Irrawaddy dolphin, ▓ Bottlenose dolphin, ■ Finless porpoise and ■ total

Indo-Pacific Humpback Dolphin Biology

Indo-Pacific humpback dolphins are medium-sized dolphins, up to 2.8 m in length (Ross et al. 1994). Maximum weight is 250–280 kg (Ross et al. 1994, Jefferson 2000). In southern African waters, Indo-Pacific humpback dolphins are sexually dimorphic in length, with males (mean length 226 cm, *n* 29) larger than females (mean length 216 cm, *n* 10—Ross et al. 1994). In Hong Kong, significant sexual dimorphism is not evident (Jefferson 2000). Shape and size of dorsal fin and hump vary distinctly between the extremes of the range of the species. In the eastern portion of the range, dorsal fin is short, slightly recurved, and has a wide base, which laterally slopes smoothly and gradually into dorsal surface of body, its base is ca. 5–10% of total body length (Ross et al. 1994). In the western portion of the range, dorsal fin is sharply recurved, smaller yet, and sits atop a broad-based hump of connective tissue in middle of animal's back (Fraser 1966). Dorsal hump increases in length proportionately with body size, to ca. 30% of body length (Ross et al. 1994).

Colour varies greatly throughout the range, and developmental variation is extensive. Adults are dark gray on dorsum and sides, shading gradually into an off-white ventral surface, with only slight, if any, spotting. Calves are lighter in colour. A distinct pinkish-white patch occurs on the dorsal fin and hump of adults, and its size apparently increases with animal's age (Saayman and Tayler 1979, Ross 1984, Karczmarski 1996). Dolphins in the northern Indian Ocean are uniformly brownish-gray (Ross et al. 1994). In China, and some areas of Southeast Asia, calves are dark gray, turning paler with age (Ross et al. 1994). Sub-adults are mottled grayish-pink, and adults are pure white, often with a pinkish tinge resulting from blood flushing (Huang et al. 1997, Jefferson 2000). Some adults have dark flecks on the body, and a few have a dark ring of spots surrounding the neck behind the blowhole. In Australia, dorsal fin, melon, and rostrum whiten with age, but the rest of the dorsal surface remains dark (Ross et al. 1994). Elsewhere, animals resemble the above patterns. The transition apparently occurs in the eastern Indian Ocean, between India and Thailand.

Distribution

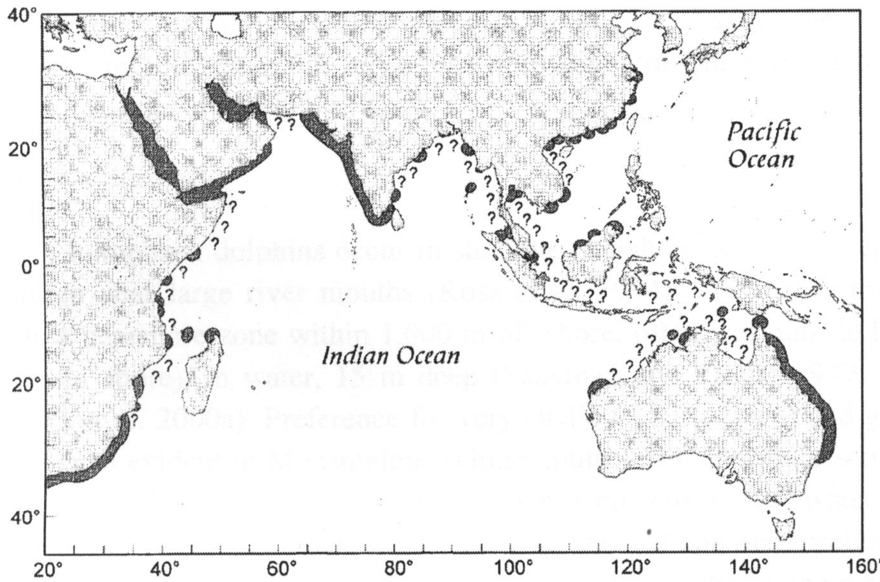


Figure 3. Distribution of Indo-Pacific humpback dolphin (*Sousa chinensis*) (Ross et al. 1994)

Ontogeny and Reproduction

Some calves may be born throughout the year, but spring or summer calving peaks are the norm in populations from southern Africa (Saayman and Tayler 1979, Cockcroft 1989, Karczmarski 1996, 1999), southern China (Wang 1965, 1995, Jefferson 2000), and probably India (Lal Mohan 1982). A 3-year calving interval has been suggested for animals from South Africa (Cockcroft 1989, Karczmarski 1996, 1999).

Gestation lasts ca. 10–12 months (Wang 1965, 1995, Cockcroft 1989). A single calf is born. Length at birth may be ca. 100 cm (Wang 1965, 1995, Ross 1984, Cockcroft 1989, Jefferson 2000). Fetal growth is ca. 8.8 cm per month (Jefferson 2000). Lal Mohan (1982) described a 47-cm fetus from Indian waters, with no bristles on its beak. Although age at weaning is not known with any certainty, in South African waters lactation may last 2 years (Cockcroft, 1989) and female–calf associations remain consistent and strong for at least 3–4 years (Karczmarski 1999).

Age at sexual maturity for South African animals is ca. 10 years for females and ca. 12–13 years for males (Cockcroft 1989). Although Wang (1965, 1995) suggested that in Chinese specimens, adult females reach sexual maturity at 200–250 cm and adult males at 190–240 cm, recent evidence suggests that sexual maturity does not occur until lengths of ca. 235 cm and ages of 9–10 years in females (Jefferson 2000). About 60% of adult females (*n* 10) from Xiamen, southern China, were pregnant (Wang and Sun 1982). Postnatal growth in southern China appears to be rapid in the first 2 years, then levels off (Jefferson 2000). Asymptotic length in specimens from southern China is reached at ca. 243 cm and 16 years (Jefferson 2000).

Ecology

Indo-Pacific humpback dolphins occur in shallow, nearshore waters, generally, 20 m deep, most often near large river mouths (Ross et al. 1994). In South Africa, they inhabit the shallow nearshore zone within 1,000 m off shore, often just outside breaking waves (500 m from shore), in water, 15 m deep (Saayman and Tayler 1979, Durham 1994, Karczmarski et al. 2000a). Preference for very shallow (10 m deep) and generally nearshore areas is also evident in Mozambique (Guissamulo 1993, 2000). In some areas, these dolphins range much further offshore (up to 55 km from shore) if the water remains shallow (Corkeron et al. 1997, Jefferson 2000). They display no apparent preference for clear or turbid waters (Karczmarski et al. 2000a). Water depth is probably the main factor limiting their offshore distribution, and the 25-m isobath has been suggested to represent the critical depth in the South African region (Karczmarski et al. 2000a). These dolphins have been reported to occur in a variety of coastal habitats including sandy beaches, enclosed bays and coastal lagoons, mangrove areas (particularly mangrove channels), over sea grass meadows, around rocky and coral reefs, and in turbid estuarine waters (Pilleri and Pilleri 1979, Saayman and Tayler 1979, Corkeron 1990, Beadon 1991, Guissamulo 1993, 2000, Durham 1994, Karczmarski 1996, 2000, Porter 1998, Jefferson 2000, Karczmarski et al. 2000a). Although the choice of key habitats varies between different geographical regions, the choice of habitat is well defined and persistent at each location.

Abundance has been estimated in only a few selected areas. The KwaZulu-Natal population off South Africa was ca. 160–165 individuals (*95% CI* 134–229), based on mark–recapture analysis of photo-identification data (Durham 1994). The same approach produced an estimate of 466 dolphins (*95% CI* 447–485) in the Algoa Bay region, Eastern Cape, South Africa (Karczmarski et al. 1999a). However, only a small part of this population is present in Algoa Bay at any given time, with the majority of the population members ranging over a considerable length of the Eastern Cape coastal zone (Karczmarski 1999, Karczmarski et al. 1999a, b). The relative density for the Eastern Cape region was estimated to be 0.42 dolphins/km^2 (Karczmarski 1996, Karczmarski and Cockcroft 1997). In Hong Kong waters, line transect ship surveys have been used to estimate seasonal abundances ranging from ca. 88 (spring) to 145 (summer) individuals in the highest-density area, north of Lantau Island (*CV* = 15–18%— Jefferson and Leatherwood 1997, Jefferson 2000). For the same general area, mark–recapture analysis of photo-identification data estimated 100–128 animals (*95% CI* = 82–118 and 94–184, respectively—Porter 1998). The total population size in Hong Kong and the adjacent Pearl River Estuary was estimated to consist of 1,028 animals (*CV* = 15– 86%—Jefferson 2000). Mark–recapture estimates of abundance for Moreton Bay, Australia, ranged from 119 to 163 dolphins (*95% CI* 81–166 and 108–251, respectively—Corkeron et al. 1997).

Behaviour

The diel pattern of occurrence of Indo-Pacific humpback dolphins varies between different locations. In Algoa Bay, South Africa, dolphins can be seen mostly in the morning and, to a lesser extent, in the evening (Karczmarski et al. 2000). Their activities follow a well-defined daylight pattern that varies little between seasons (Karczmarski and Cockcroft 1999, Karczmarski et al. 2000). In Maputo Bay, Mozambique, they are seen in the afternoon more often than in the morning (Guissamulo 2000).

Indo-Pacific humpback dolphins are either solitary or live in relatively small groups. Groups in most areas are, 25 animals, but groups of, 10 are most common. Little seasonal variation in group size occurs in Hong Kong waters, but geographic areas differ (Parsons 1998, Jefferson 2000). Largest groups are usually composed of all age classes, with adults representing between one half and two thirds of the group (Saayman and Tayler 1979, Durham 1994, Karczmarski 1999, Guissamulo 2000, Jefferson 2000). Activity and behaviour determine group spatial geometry, but not size (Karczmarski and Cockcroft 1999a).

Significance of Research

Human population in coastal developing countries has increased at an alarming rate resulting in overexploitation of marine resources. Indo-Pacific humpback dolphins (*Sousa chinensis* (Osbeck, 1765)) inhabit shallow coastal waters of the Indian Ocean, western Pacific and South Africa (Ross et al. 1994, Karczmarski 1999, Karczmarski et al. 2000, Jeffferson and Karczmarski 2001, Hung and Jefferson 2004, Wang et al. 2007). This makes them susceptible to the effects of human activities in the coastal zone and general degradation of inshore habitats (Klinowska 1991, Reeves and Leatherwood 1994, Cockcroft and Krohn 1994, Karczmarski et al. 2000). These include harmful fishing activities, intensive agriculture and aquaculture in the coastal areas causing pollution arising from coastal run-off, and massive industrialisation (Klinowska 1991, Cockcroft and Krohn 1994, Lal Mohan 1994, Reeves and Leatherwood 1994, Ross et al. 1994, Hale

1997, Wang et al. 2007). These coastal problems are common in heavily populated Asian regions.

Indo-Pacific humpback dolphins are threatened throughout its range by incidental catches, primarily in gillnets, and in several areas by habitat degradation and capture for captive display (e.g. Crockcroft and Krohn 1994, Reeves and Leatherwood 1994, Karczmarski 2000). In Thailand, a major cause of Indo-Pacific humpback dolphin mortality is from incidental entanglement of gill nets. This mortality rate may surpass the possible replacement rate of Indo-Pacific humpback dolphin population in Thailand. Few studies of dolphins have been done in Thailand (Pilleri and Gihr 1974, Perrin et al. 1989, Andersen and Kinze 1995, Chantrapornsyl et al. 1996, 1999, Mahakumlayanakul 1996, Adulyanukosol 1999). A small population of Indo-Pacific humpback dolphins was reported in Khanom coastline, Thailand with 2, 6 and 3 reported carcasses in 2006, 2007 and 2009 by the Department of Marine and Coastal Resource Research Area 3, Songkla, Thailand. Serious conservation concerns about this population led to a survey to better understanding the status of this population. Distribution and abundance information is essential for improving our understanding of the dolphin biology and assessing its conservation status, guiding conservation actions and decisions.

Photo-identification has been used in field studies of cetaceans and proven to be a useful tool in population estimations (Hammond et al. 1990, Aragones et al. 1997, Karczmarski and Cockcroft 1998, Karczmarski et al. 1999a). The shape of the trailing edge of the dorsal fin in most dolphins is the most diagnostic feature (Würsig and Jefferson 1990, Karczmarski and Cockcroft 1998). The notch pattern of dorsal fin tends to vary between individual dolphins due to incidental events. Defran et al. (1990) developed the technique for analysing and cataloging dorsal fin photographs for bottlenose dolphins and used by many researchers since (Karczmarski and Cockcroft 1998). Most studies on dolphins in Thailand were obtained from stranded and by-catch specimens, available skeletons and interviews (Adulyanukosol 1999). This study is the first to examine an abundance and density of Indo-Pacific humpback dolphin population at Khanom coastline, Thailand using mark-recapture analysis of photo-identification data.

Methodology

Study Area

Khanom coastline is located at latitude 9° 19'N and longitude 99°51'E in Nakhon Si Thammarat province, Thailand covering 222 km^2 (Figure 4). Most of Khanom coastline has a depth less than 7.5 m. The mean spring and neap tidal ranges are 0.40, and 0.90 m, with the mean sea level of 1.43 m (Hydrographic chart no. 1210, 2002, The Gulf of Thailand). A main river, Bang Paeng River, discharges into the Khanom coastal area flows from west to east. Daily tide changes are semi-diurnal, and the mean tidal range was 1.56 m.

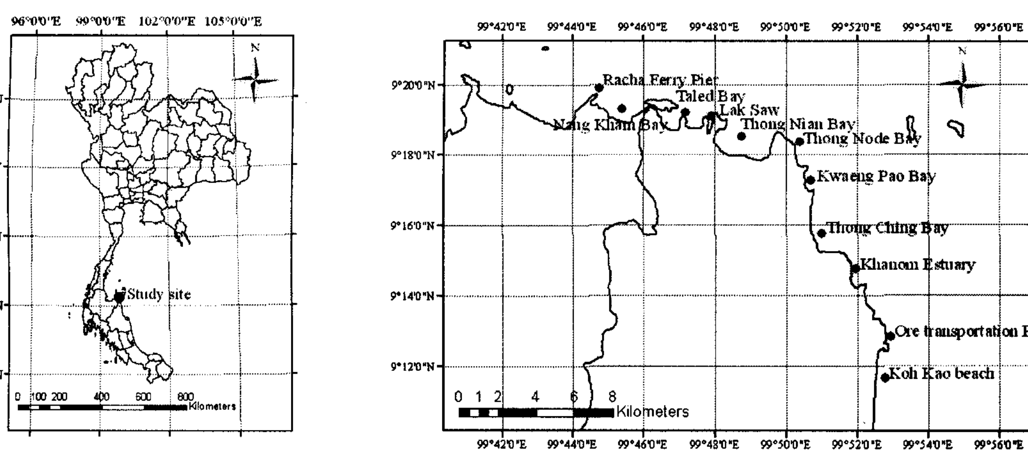


Figure 4. Khanom coastline, Nakhon Si Thammarat, Thailand.

Data Collection

Observations and photographs from boats are the most practical approach to study dolphins in most areas. We conducted a boat-based survey over approximately 50 km of Khanom coastline (Figure 4) throughout a one year period from July 2008-June 2009 twice a month. When the weather/sea conditions were suitable, we carried out the boat-based surveys bimonthly from 0700-1400 hr using a 8-m long-tailed boat (a unique local vessel) by a 115 HP outboard engine travelling at an averaged target 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 parallel to the shoreline (Wong et al. 2007).

When dolphins were sighted, we collected date, time, geographic positions using Garmin GPS MAP 76CSx, species observed, the number of individuals, and the number of mother-calf pairs. Dolphins were photographed using the Nikon D80 DSLR digital camera with lens 18 – 135 mm, and 70 – 300 mm. The camera was angled perpendicular to dolphin body axis and dorsal fins as much as possible. Individual dorsal fins were subsequently identified using the Digital Analysis Recognised of Whale Images and Network (DARWIN) software. The mean number of photographs taken for each identifiable dolphin per survey was 50 photographs per dolphin. Even thought, we have been collected the physical data: water visibility with Sechi – Disc, water depth with the depth sounder, and distance off the shore by measuring distance between encountered position that perpendicular with shoreline on the Google Earth.

We classified humpback dolphins based on Karczmarski (1999) into three age classes: calf, juvenile and adult. Calves were defined as animals two-thirds or less the length of an adult accompanying with the mother. Juveniles were defined as animals approximately 2 m long, less robust than adults and swim independently. Adults were defined as animals approximately 2.5 m long, robust and had well pronounced dorsal hump. We defined a group based on previous studies (Karczmarski 1999, Karczmarski and Cockcroft 1999) 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 as a nursery group (Karczmarski 1999).

DARWIN System

The manual photo-identification process can be extremely time consuming and visually stressful particularly with large collections of dorsal fin images. Methods for the computer assisted identification of individual marine mammals have been proposed for a bottlenose dolphin (Defran et al. 1999, Kreho et al. 1999, Araabi 2000). Identifying dolphins by comparing dorsal fins are similar to whale identification based upon fluke characteristics. While pigmentation and injury patterns such as rake marks may be used as secondary identifiers, it is the overall shape and the specific details of damage found along the fin profile that have become the primary identifiers used within the cetacean research community to identify individual dolphins. Characterising the outline of a dorsal fin has some unique challenges. Dolphin dorsal fin outlines have no easily determined beginning and ending points. The user must decide where the dorsal fin and the dolphin's back meet. Often the dorsal fin is partially obscured by other dolphins or water. This uncertainty leads to significant variation in the portion of the fin outline that is used to determine matches and complicates scaling and alignment.

The Digital Analysis and Recognition of Whale Images on a Network (DARWIN) system is a straightforward application of image processing, computer vision, and content-based image retrieval techniques. The novelty of the DARWIN system is in its use of well known techniques to provide an almost completely automatic process, from image load to display of a rank ordered list of possible dolphin identities, while providing numerous user check points and correction tools, allowing the user to enhance or override the system's automatic processes. This produces significant time savings, and still leaves the human user in the position of final decision maker.

As cetacean – whales, dolphins, porpoises – can be uniquely identified by the features of their dorsal fins. The DARWIN system has been used with bottlenose dolphins and whales. Researchers construct a catalog of known individuals and classify fins based on the location of primary identifying damage features. The subsequent comparison of unknown fins to this catalog is time consuming and tedious. With the pervasive use of digital cameras in such research, the quantity of photographic data is increasing and the backlog of individual identification delays meaningful data analysis. Thus, automated fin comparison can potentially improve productivity. Automated methods to compare dorsal fin photographs exist and significantly reduce the number of photographs which must be examined manually to correctly identify an individual. However, these methods often require more work on the end user's part than simply looking through a catalog of photos. Tracing a fin outline accounts for a large portion of the time required for data input. Not only is the process time consuming, but also the nature of the task causes visual fatigue. In fact, some institutions still prefer the classic catalog approach to automated methods. Many institutions employ a digital catalog, but do not employ an automated recognition package. In order to make these packages more usable and increase the end user experience, a process to automatically extract a fin outline from a photograph is desirable (Hale 2006).

Individual dorsal fins were subsequently identified using the DARWIN system (Hale 2006). The DARWIN system was downloaded from URL http://darwin.eckerd.edu/. The average number of photographs taken for each identifiable dolphin per survey was 50 photographs per dolphin. We cropped dorsal fins from photographs to reduce the photograph size and made it possible to input the photographs in the DARWIN database (Figure 5). Dorsal fin photographs were imported into the DARWIN system and adjusted for brightness and contrast. By doing this, it helped to automatically trace the dorsal fin outline. However, for poor quality photographs, the DARWIN system was not able to perform automatic trace for the dorsal fin outline, therefore, manual tracing was required.

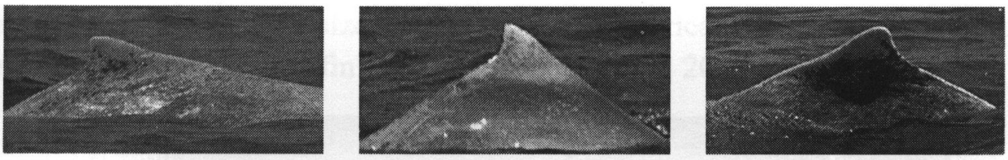


Figure 5. Indo-Pacific humpback dorsal fins.

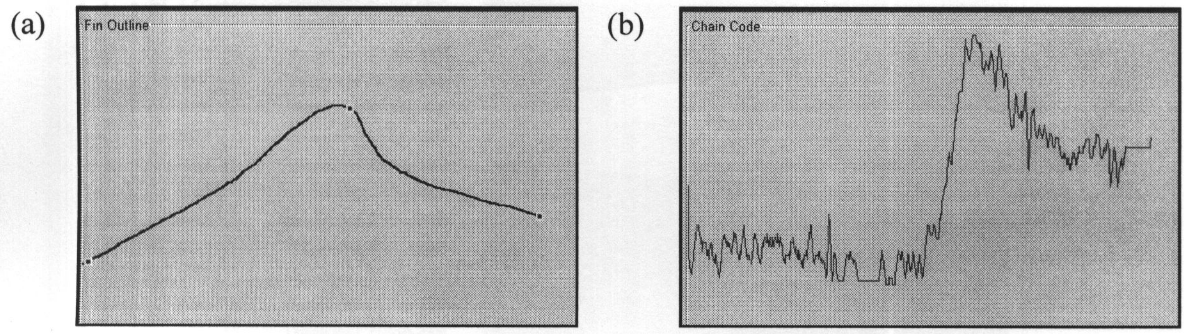


Figure 6. DARWIN system on dorsal fin photograph matching. (a) Humpback dolphin dorsal fin outline with feature points and (b) chain code of outline.

Feature point identification

The DARWIN system used unsupervised threshold selection, morphological processing and active contours to generate fin outlines as described in Kreho et al. (1999). The DARWIN system represented each fin with an outline contour (a sequence of evenly spaced points closely approximating its two-dimensional placement and shape), a chain code (a one dimensional representation of the orientation of successive outline edge segments), and a set of salient features (BEGIN, TIP, NOTCH and END). These feature points were used to establish alignment of two fin outlines during matching. The BEGIN and END points were user identified. The TIP and largest NOTCH along the fin's trailing edge were identified by an unsupervised process using a quadratic spline wavelet decomposition (Mallat et al. 1992) of the chain code, but their positions might be adjusted manually (Stewman et al. 2008).

The DARWIN system was used to match dorsal fin photographs from their dorsal fin outline (Figure 6a). Chain code was created containing active contours and feature point location (Figure 6b). The DARWIN system was used to map unknown outlines to the reference outlines, and had configurable constants that were set values based on an assumption of approximate overall fin size (Figure 7). The actual values of these constants and the standard fin size were determined empirically in order to obtain the best results in all processing of the fin outlines (Stewman et al. 2006).

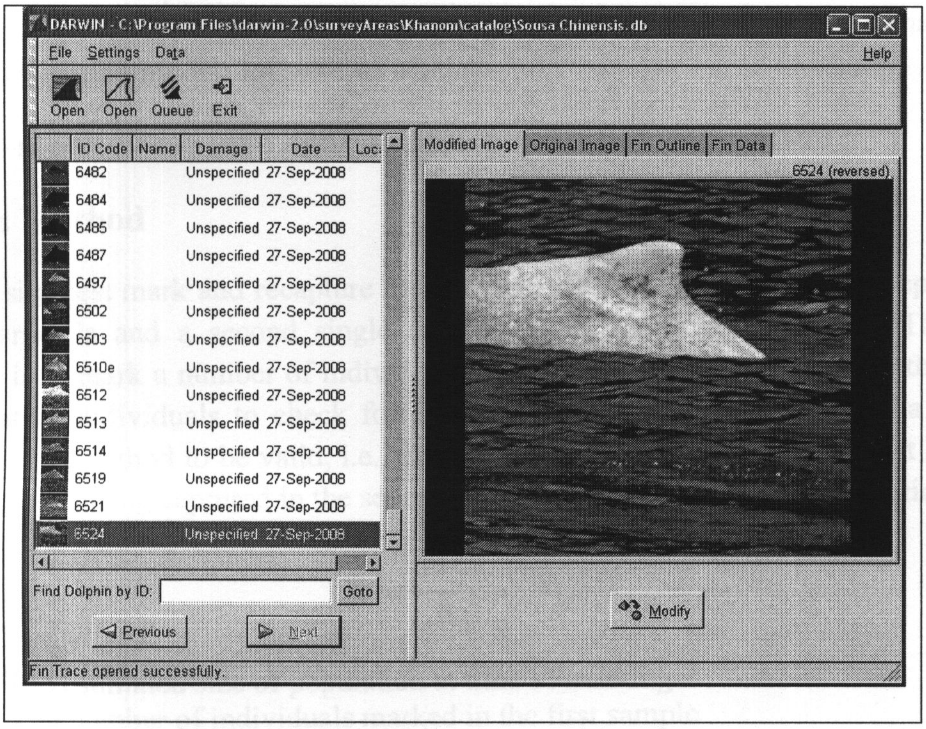


Figure 7. DARWIN software: GUI.

Data Analysis

Encountered dolphins were scored as 0 (absent) and 1 (present). We tested three close population models: (1) Peterson, (2) Schumacher-Eschmeyer, (3) Schanabel and one open population model: Jolly-Seber Model.

Capture-mark-recapture analyses for population estimation

Peterson Method

The simplest mark and recapture method because it is based on a single episode of marking animals and a second single episode of recapturing individuals. The basic procedure is to mark a number of individuals over a short time period, release them, and then recapture individuals to check for marks. The second sample must be a random sample for this method to be valid, i.e., marked and unmarked individuals must have the same chance of being captured in the second sample. So, manipulating the equation is

$$\mathbf{N} = \frac{\mathbf{MC}}{\mathbf{R}} \tag{1}$$

N = The estimated size of population at time of marking
M = The number of individuals marked in the first sample
C = Total number of individuals captured in the second sample
R = The number of individuals in second sample that are marked

This equation (1) is intuitively clear but it is a biased estimator of population size, tending to overestimate the actual population. Unbiased equation is

$$\mathbf{N} = \frac{\mathbf{(M+1)(C+1)}}{\mathbf{(R+1)}} - \mathbf{1} \tag{2}$$

$$\text{Variance of } \mathbf{N} = \frac{\mathbf{(M+1)^2(C+1)(C-R)}}{\mathbf{(R+1)^2(R+2)}} = \frac{\mathbf{N^2(C-R)}}{\mathbf{(C+1)(R+2)}} \tag{3}$$

$$\text{Standard error} = \sqrt{\textbf{Variance of N}}\text{r} \tag{4}$$

$$95\% \text{ confidence limits of N} = \text{N} \pm (\text{Standard error}) \tag{5}$$

Schnabel Method

Schnabel (1938) extended the Petersen method to a series of samples in which there is a 2, 3, 4, …, nth sample. Individuals caught at each sample were first examined for marks, and then released. Only a single type of mark is used, because we need to distinguish only marked and unmarked animals. If different marks or tags were used for different samples, then the capture – recapture history of any animal caught during the experiment is known, N_t is estimated by the ratio of the number of marked animals release into the population to the estimated proportion of marks in the population. In fact, the Schnabel estimate of N_t is simply a weighted average of individual Peterson estimates namely

$$\mathbf{N_t} = \frac{\sum_{t=1}^{n} \mathbf{C_t M_t}}{\sum_{t=1}^{n} \mathbf{R_t}} \tag{6}$$

$$\text{Variance of samples} = \mathbf{s^2} = \frac{\sum_{t=1}^{n}\left(\frac{R_t^2}{C_t}\right) - \left[\frac{\left(\sum_{t=1}^{n} R_t M_t\right)^2}{\sum_{t=1}^{n} R_t M_d^2}\right]}{\mathbf{m-1}} \tag{7}$$

m = number of days (or sightings) in which dolphins were actually caught.

$$\text{Variance of } \mathbf{N} = \mathbf{N^2}\left[\frac{N_s^2}{\sum_{t=1}^{n} R_t M_t}\right] \tag{8}$$

$$\text{Standard error} = \sqrt{\textbf{Variance of N}} \tag{9}$$

$$95\% \text{ confidence limits of N} = \text{N} \pm (\text{Standard error}) \tag{10}$$

Schumacher-Eschmeyer Method

The Schumacher-Eschmeyer method uses the same data and assumptions as the Schnabel method. The differences from Schnabel method, in that it estimates the N_t as the reciprocal of the slope of the line describing the relationship between the R_t/C_t (the dependent variable) and M_t (the independent variable) that also passes through the origin. Thus, an estimate of $1/N_t$ can be obtained from the estimate of the slope of regression of R_t/C_t on M_t. The CI of N_t.

Jolly-Seber Method

We estimated humpback dolphin population size, the probability of survival and the dilution rate from mark-recapture analysis using the Jolly-Seber open population model. The probability of survival was calculated as the ratio of number of marked animals at the start of sample *t+1* to the number of marked animals at the end of 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 had occurred.

The Jolly-Seber method estimates initial population size, N_0, from multiple mark-recapture samplings on an open population. The proportion of marks in a recapture sample is an estimate of the proportion of marks in the population. However, because there are multiple marking and recapturing samples and we allow for an open population, the way we account for the animals is more complicated.

m_t = number of marked animals caught in sample t
u_t = number unmarked animals caught in sample t
n_t = number of animals caught in sample t, $m_t + u_t$
s_t = number of animals released after sample t
m_{rt} = number of marked animals caught in sample t, last caught in sample r
R_t = number of the s_t individuals released at sample t and caught again in a later sample
Z_t = number of individuals marked before sample t, not caught in sample t, but caught in some sample after t.

The calculations that will lead to an estimate of N_t, the number of animals just before time t, for each time period (except the first and last) and several other parameters. First we need to compute the proportion of animals marked as,

$$\hat{\alpha}_t = \frac{m_t + 1}{n_t + 1} \tag{11}$$

Estimation of N_t, we need to divide the number of marks by alpha (eqn 11). However, the number of marked animals in the population, M_t, must be estimated in this method. Seber (1982) showed that M_t can be estimated by,

$$\hat{M}_t = \frac{(s_t + 1)Z_t}{R_t + 1} + m_t \tag{12}$$

Then,

$$\hat{N}_t = \frac{\hat{M}_t}{\hat{\alpha}_t} \tag{13}$$

In addition to estimating population size just before time *t*, estimates of the probability of survival and dilution rate for each time t can also be made. The probability of survival is the ratio of number of marked animals at the start of sample *t+1* to the number of marked animals at the end of sample *t*. In equations, this is

$$\hat{\Phi}_t = \frac{\hat{M}_{t+1}}{\hat{M}_t + (s_t + m_t)} \tag{14}$$

It should be noted that this survival rate includes all losses to the marked population (i.e. including emigration). The dilution rate is 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 had occurred. In equations, this is

$$\hat{\lambda}_t = \frac{\hat{N}_{t+1}}{\hat{\Phi}_t[\hat{N}_t - (n_t - s_t)]} \tag{15}$$

It should be noted that population size, dilution rate cannot be obtained for the first sample. None of the estimates can be made for the last sample. The probability of survival cannot be made for the second to last sample. Thus, if you are going to use the Jolly-Seber method, you must begin one time period before and continue to two time periods after the time interval of interest.

The individuals dolphin was encountered was represent by 0 (absent) and 1 (present), then data that include 0, 1 value was computed from above equation and put it in Table 1.

Table 1. m_t, s_t, n_t, R_t, Z_t, α , ϕ, λ from Jolly-Seber Model

Time of capture(t)	m_t	s_t	n_t	R_t	Z_t	α	M_t	N_t	ϕ	λ
1	0	5	5	10	N/A	0.17	N/A	N/A	N/A	N/A
2	8	11	11	6	0.00	0.75	8.00	10.67	0.80	1.03
3	8	8	8	10	1.00	1.00	8.82	8.82	1.08	1.10
4	9	10	10	21	1.00	0.91	9.50	10.45	2.27	1.55
5	21	33	33	23	2.00	0.65	23.83	36.83	0.61	1.02
6	22	23	23	30	0.00	0.96	22.00	22.96	1.58	1.31
7	32	42	42	38	4.00	0.77	36.41	47.44	0.76	1.03
8	34	36	36	33	1.00	0.95	35.09	37.09	1.10	1.05
9	36	38	38	41	5.00	0.95	40.64	42.84	0.89	1.02
10	37	38	38	35	1.00	0.97	38.08	39.09	1.09	1.05
11	39	41	41	46	4.00	0.95	42.57	44.70	0.91	1.00
12	39	39	39	45	2.00	1.00	40.74	40.74	1.17	1.09
13	43	47	47	51	5.00	0.92	47.62	51.94	0.99	1.08
14	47	51	51	47	4.00	0.92	51.33	55.61	0.97	1.02
15	48	49	49	50	6.00	0.98	53.88	54.98	1.11	1.00
16	48	48	48	57	15.00	1.00	60.67	60.67	0.79	1.00
17	48	48	48	35	0.00	1.00	48.00	48.00	1.04	1.00
18	48	48	48	50	2.00	1.00	49.92	49.92	0.00	N/A
19	48	48	48	47	1.00	1.00	49.02	49.02	0.00	N/A
20	48	48	48	47	0.00	1.00	48.00	48.00	0.00	N/A
21	48	48	48	48	0.00	1.00	48.00	48.00	0.00	N/A
22	48	48	48	48	0.00	1.00	48.00	48.00	0.00	N/A
23	48	48	48	48	0.00	1.00	48.00	48.00	0.00	N/A
24	48	48	48	48	0.00	1.00	48.00	48.00	0.00	N/A
25	48	48	48	52	4.00	1.00	51.70	51.70	0.00	N/A
26	48	48	48	45	0.00	1.00	48.00	48.00	0.00	N/A
27	49	50	50	50	1.00	0.98	50.00	51.00	0.00	N/A
28	49	49	49	48	0.00	1.00	49.00	49.00	0.00	N/A
29	49	49	49	50	1.00	1.00	49.98	49.98	0.00	N/A
30	49	49	49	52	4.00	1.00	52.77	52.77	0.00	N/A
31	49	49	49	49	4.00	1.00	53.00	53.00	0.00	N/A
32	49	49	49	45	0.00	1.00	49.00	49.00	0.00	N/A
33	49	49	49	49	0.00	1.00	49.00	49.00	0.00	N/A
34	49	49	49	50	0.00	1.00	49.00	49.00	0.00	N/A
35	49	49	49	48	0.00	1.00	49.00	49.00	0.00	N/A
36	49	49	49	49	0.00	1.00	49.00	49.00	0.00	N/A
37	49	49	49	49	0.00	1.00	49.00	49.00	0.00	N/A
38	49	49	49	49	0.00	1.00	49.00	49.00	0.00	N/A

Results

Habitat characteristic

Indo-Pacific Humpback dolphins were encountered at the water depth of 1.1-7.5 m, the distance off shore of 21-1021 m and water visibility of 67-256 cm (Figure 8a-c).

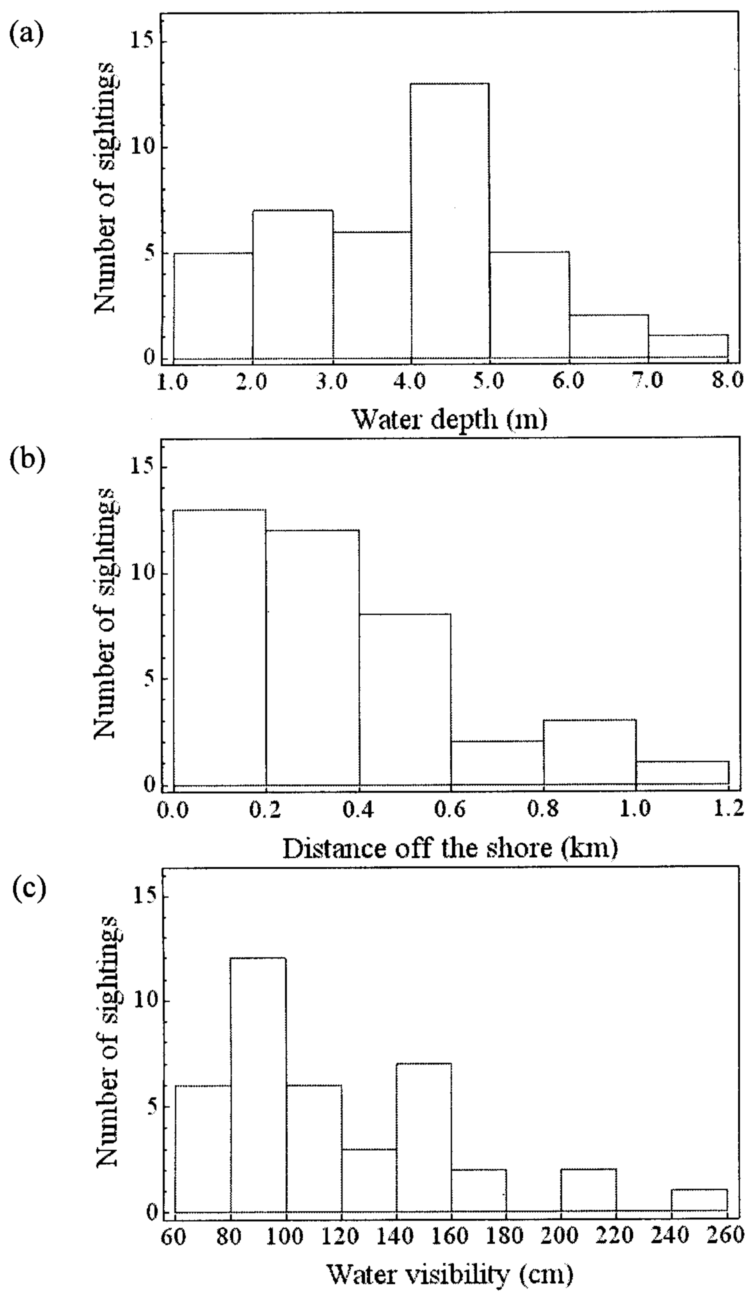


Figure 8. Habitat characteristics where dolphins were found. (a) water depth (m), (b) distance off shore (m) and (c) water visibility (cm).

Site fidelity

Groups and solitary Indo-Pacific humpback dolphins were seen. Thirty nine sightings were observed over 130 hr. The majority of times (seven sightings) were at Thong Ching Bay (Figure 9a, b). Dolphins were not evenly distributed over Khanom coastline. They were extensively used stretch of coastal zone between Nang Kham Bay to Thong Ching Bay (Figure 9a, b). Over 5000 photographs were collected during 22 boat surveys. There were 34 sightings of groups and five sightings of solitary individuals (Figure 10a). A total of 49 individuals were identified and catalogued. The majority of these dolphins were adults (n = 33). There were eight calves and eight juveniles. About ten percent of the identified and catalogued humpback dolphins were seen only once (Figure 10a). Re-sightings of individuals ranged between one and 19 (Figure 10a). The most frequently seen dolphin was recorded in 10 of the 12 months surveyed (Figure 10b).

(a)

(b)

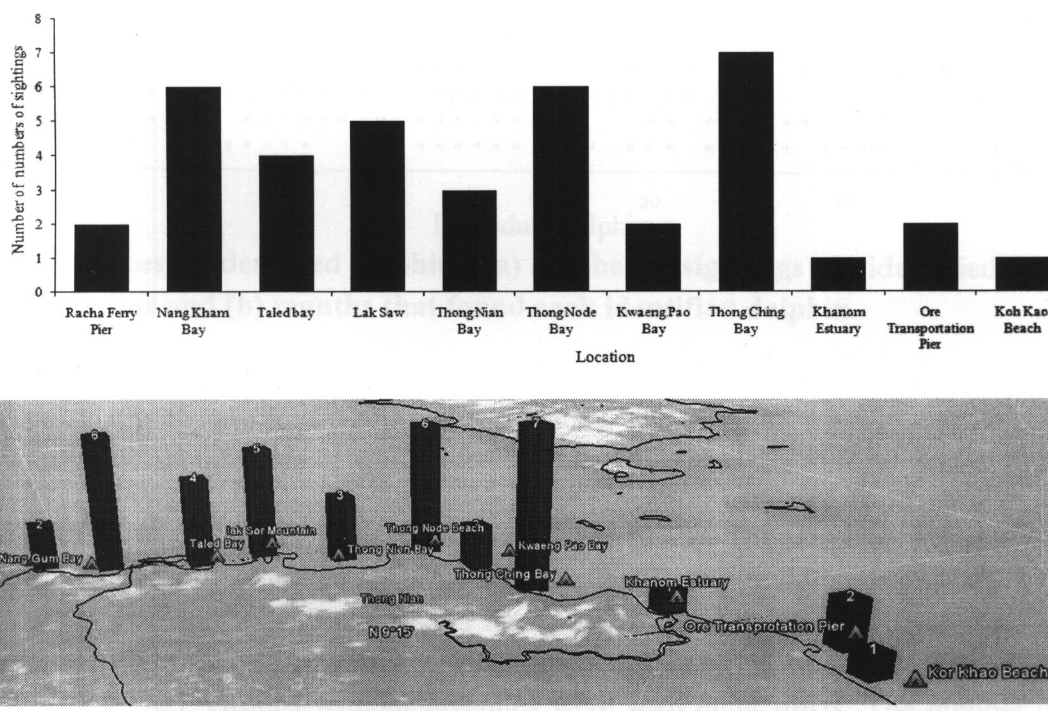


Figure 9. (a) Number of sightings of humpback dolphins encountered during boat survey in Khanom coastline and (b) Number of sightings of dolphins overlaid on Google Earth.

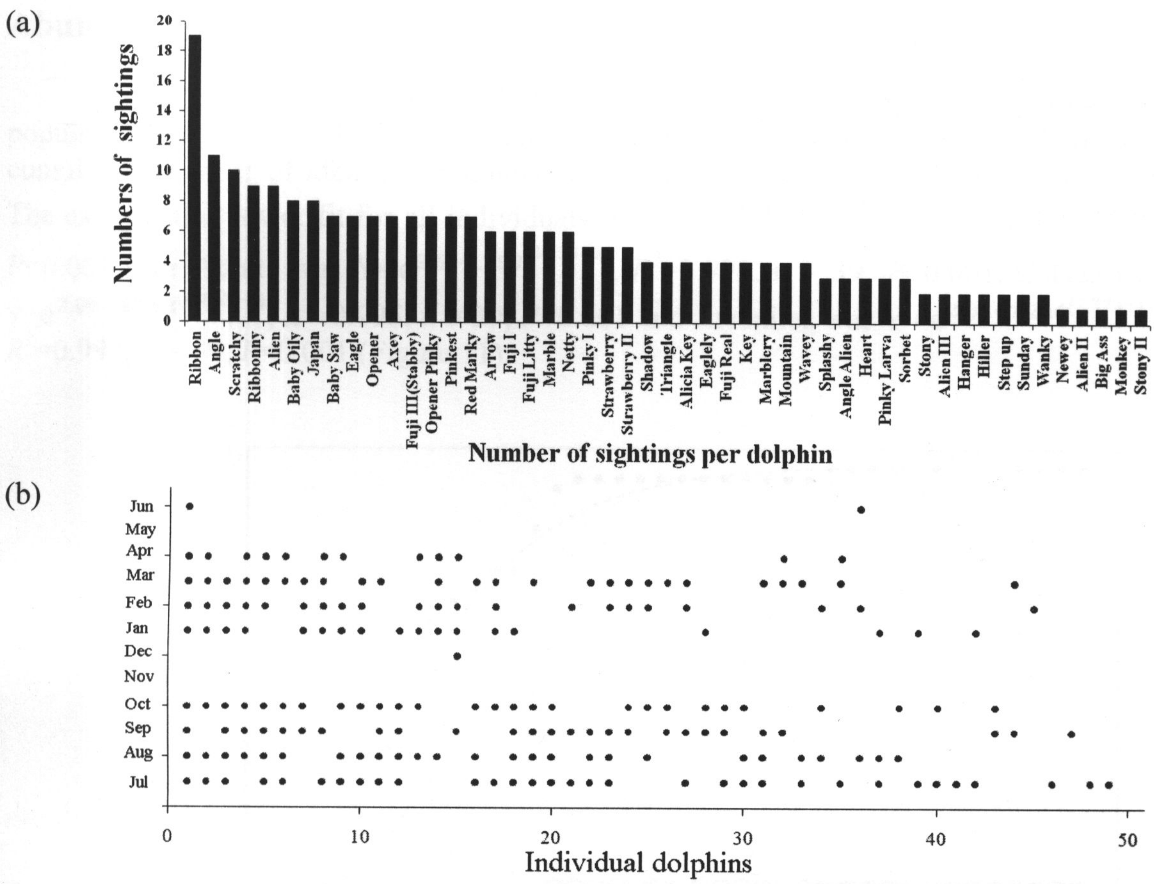


Figure 10. Number of identified dolphins. (a) number of sightings per identified dolphins and (b) months that found each identified dolphin.

Group size

Solitary individuals were observed throughout the year. They constituted ten % (n = 5) of the sightings. Groups of humpback dolphins varied in size from two to 20 dolphins with an overall mean of 5.93 dolphins (SD = 5.38). The number of adults per group ranged between two and 12 dolphins with the mean of 3.02 dolphins (SD = 3.39). The number of juveniles per group ranged from zero and six dolphins with a mean of 1.61 dolphins (SD = 1.70). There was no sightings of a group that was consisting solely of juveniles observed. Groups without juveniles were seen eight times. The number of calves per group ranged between zero and four dolphins with the mean of 0.93 dolphins (SD = 1.28). The percentage and number of calves per group were significantly lower than the percentage and number of juveniles (Mann-Whitney U-test: Percentage: U = 639.50, n = 88, P<0.05, number: 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 20 out of 22 times from boat surveys. The population range was 73 km^2. No sightings were made more than 2 km from shore. The cumulative number of identified animals increased and reached the plateau (Figure 11). The exponential power fit for all individuals was $Y=e^{3.9-1.253^{(4.943-x)}}$, R^2=0.998, n = 39, P<0.001 , for Adults was $Y= e^{3.5-1.259^{(5.635-x)}}$, R^2=0.995, n = 39, P<0.001, Calves was $Y=e^{2.08-1.193^{(4.803-x)}}$, R^2=0.995, n = 39, P<0.001 and Juveniles was $Y= e^{2.08-1.226^{(2.373-x)}}$, R^2=0.993, n = 39, P<0.001 (Figure 11).

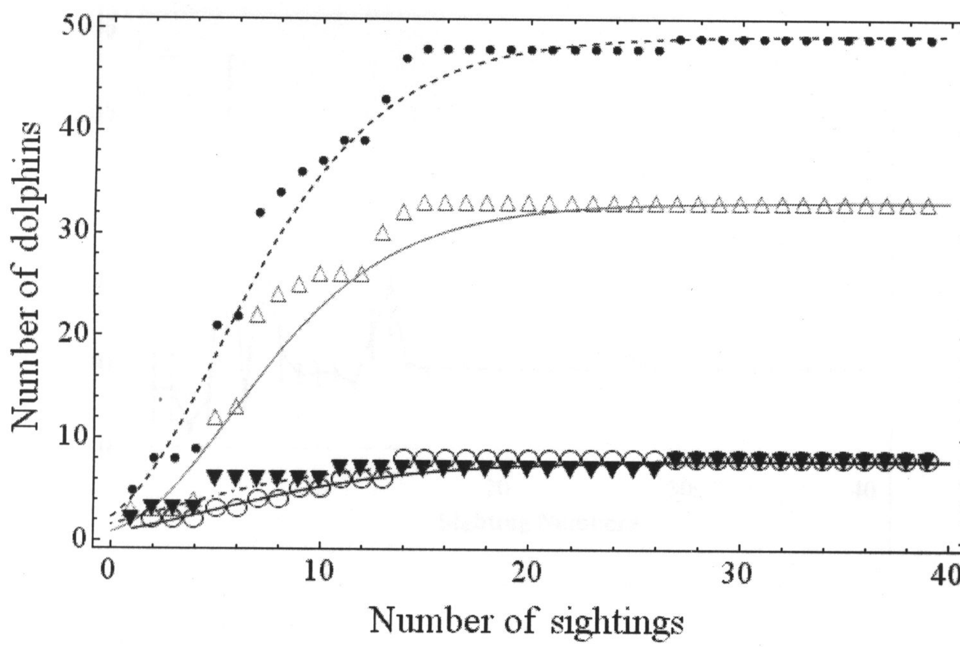
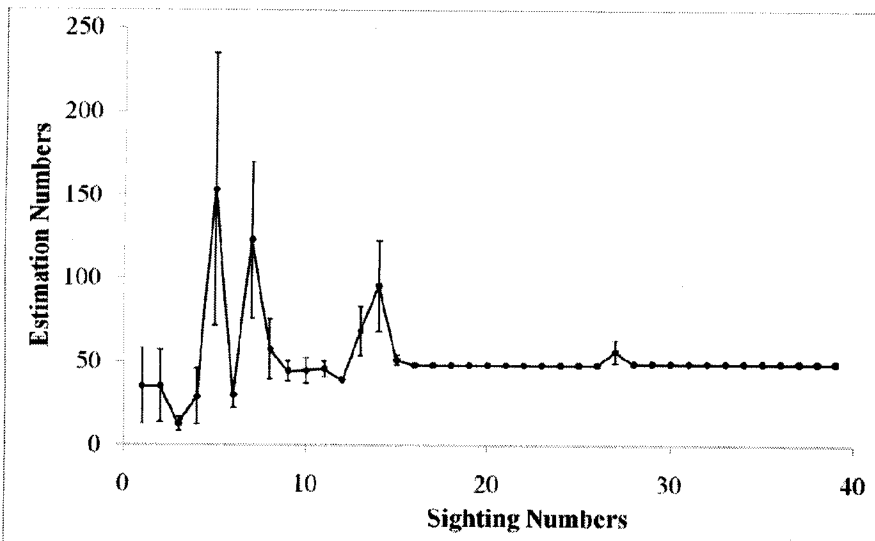


Figure 11. Cumulative number of identified dolphins and time with exponential power fit equation. ● = all individuals, △ = adults, ▼ = juveniles, O= calves.

Population estimation

Forty nine identified individuals had been photographed from this population. The estimated abundance of this population was made using Capture-Recaputer method. We tested three close population models: (1) Peterson, (2) Schumacher-Eschmeyer, (3) Schanabel and one open population model: Jolly-Seber Model. Estimated Indo-Pacific humpback dolphin population size at Khanom Sea were 49 dolphins from Peterson model, 49 dolphins Schumacher-Eschmeyer model, 53 dolphins for Schanabel model and 49 dolphins from Jolly-Seber model (Figure 12a-d) . The results showed that the all models estimated similar population size (i.e. 49-53 dolphins).

(a)



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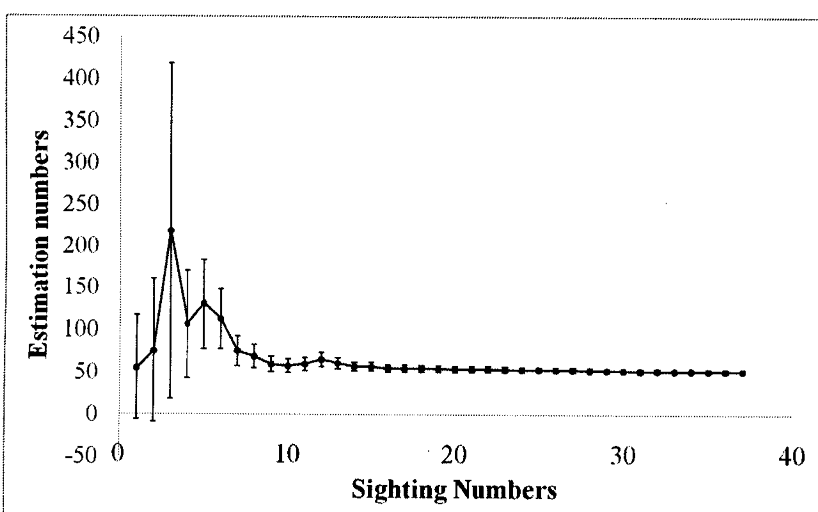

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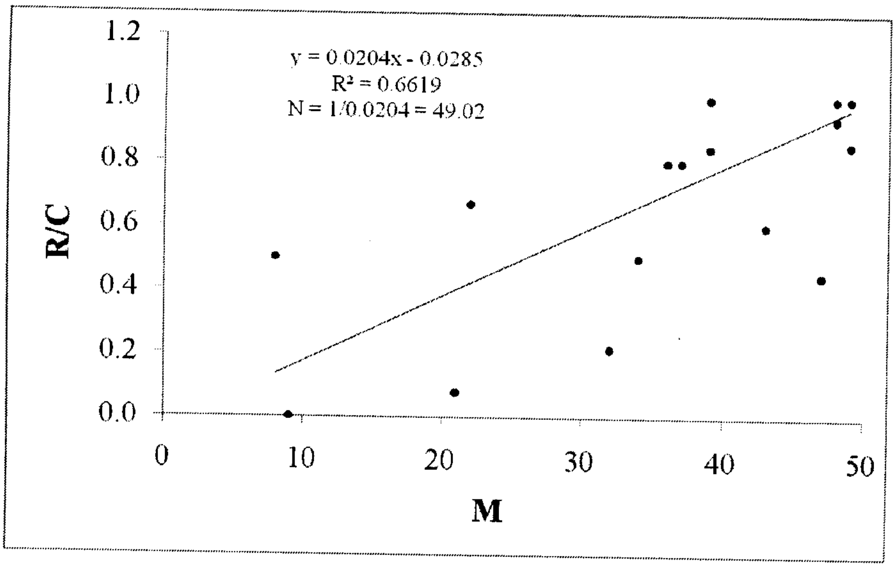


(d)

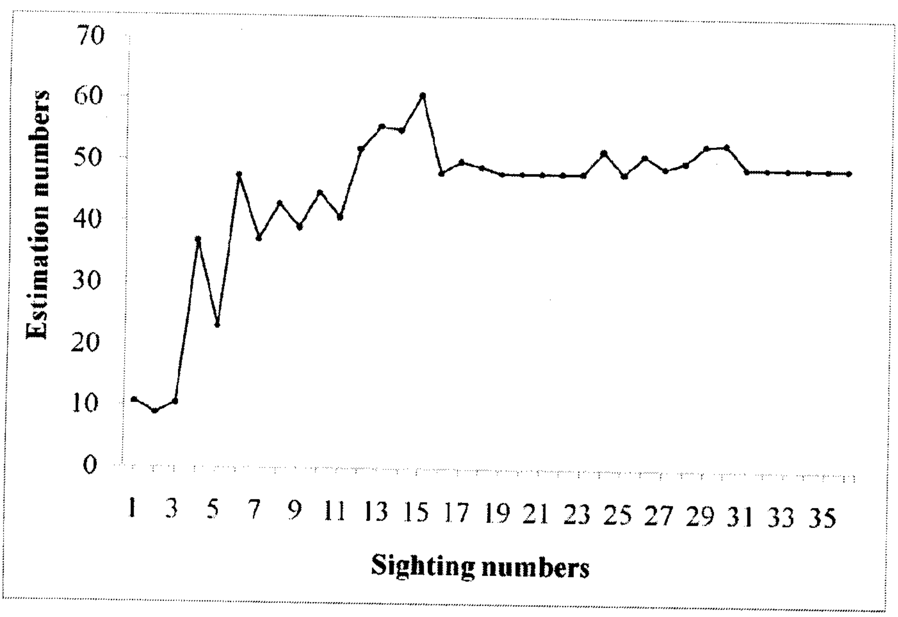
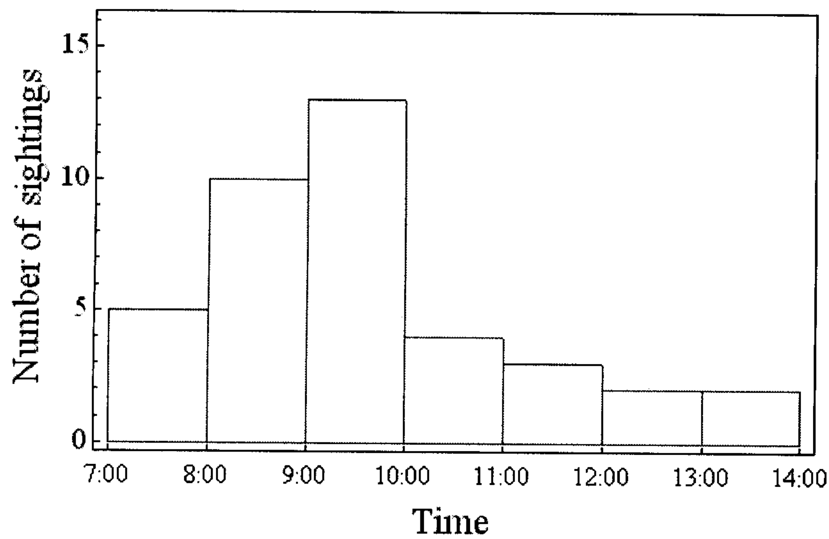


Figure 12. Close population estimation methods (a) Peterson Method, (b) Schnabel method and (c) Schmacher-Eschmeyer method, Open population method (d) Jolly-Seber method.

Seasonality and time of day

Daily and seasonal variations in Khanom dolphin distribution: Indo-Pacific humpback dolphins were observed in Khanom coastline throughout the observation time and year. They were mostly found during 0900-1000 hr (Figure 13a,b). The number of sightings varied monthly but they were mostly found in July 2008 (Figure 13b).

(a)



(b)

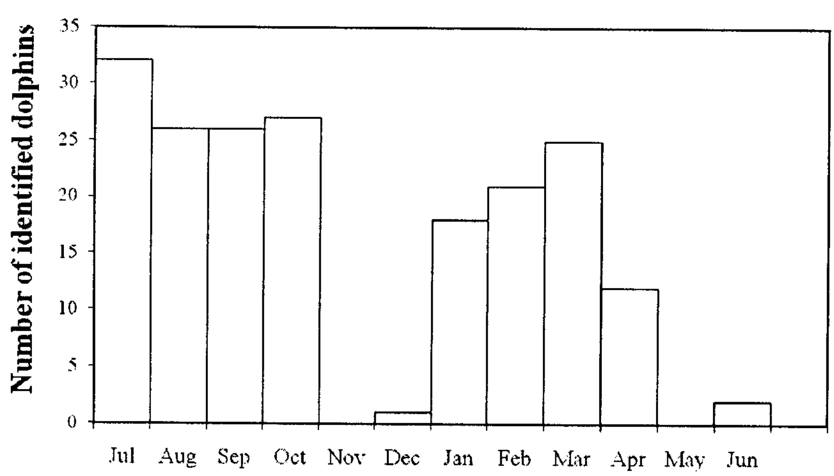


Figure 13. (a) Daily variation and (b) seasonal variations of Indo-Pacific humpback dolphins at Khanom coastline from July 2008-June 2009.

Discussion

Our results support the previous findings that Indo-Pacific humpback dolphins tend to distribute in highly restricted inshore occurrence (reviewed by Ross et al. 1994, Karczmarski et al. 1999a, 2000, Hung and Jefferson 2004, Wong et al. 2004, 2007). The population inhibits the shallow waters (mostly < 7.5 m deep) within approximately 0.37 km from shore along a Khanom coastline from Nang Kham Bay to Thong Ching bay. Humpback dolphins at Algoa Bay were observed within 150-400 m of the shore and only two groups from three year observation duration that ventured about 1-1.5 km offshore and moved back inshore after a short period (Karczmarski et al. 1999a, 2000). Eastern Taiwan Strait dolphin population was observed within 2 km from shore Wong et al. (2007). The distribution of Khanom population seems to resemble that of Taiwan and South Africa population where there are small river estuaries entering a shallow coastal waters along a linear coastline (Saayman and Tayler 1979, Karczmarski et al. 2000, Wong et al. 2007). On the other hand, some dolphin populations prefer large river estuaries such as in Pearl River Estuary, People's Republic of China (Hung and Jefferson 2004, Jefferson and Hung 2004).

Daily and seasonal variation

Our results show that Indo-Pacific humpback dolphins presented throughout the observational period (i.e. 0700-1400 hr) and mostly found during 0900-1000 hr. The Khanom population seems to show seasonal variability in occurrence and distribution. Karczmarski et al. (1999b) showed that 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 (Selzer and Payne 1988, Reilly 1990, Karczmarski et al. 1999a).

Group size

The percentage of solitary humpback dolphins in Khanom population was slightly less than that at Algoa Bay (15.4%) and the Kwa Zulu-Natal coast (20%), South Africa (Durham 1994, Karczmarski et al. 1999a). The range group size was also similar to other populations in South Africa: Algoa population with a mean group size of seven animals (Karczmarski and Cockcroft 1999, Karczmarski et al. 1999a), Natal coast population and Cape Coast population (Saayman and Tayler 1979) with a mean group size of seven animals.

Our results support previous findings (Saayman and Tayler 1979, Karczmarski 1999) that nursery groups were larger than non-calf groups. This could be due to two main possible reasons. First, Indo-Pacific humpback dolphins form allomaternal care for their offspring (Saayman and Tayler 1979, Karczmarski 1999). Karczmarski et al. (1997) reported that humpback dolphins from Algoa Bay formed temporary alliances of nursing females for calf-care function. Second, larger group size would provide better protected and learning environment for calves (Wells et al. 1987).

Capture-recapture analysis of photographically-identified individuals is a common approach to estimate abundance. Our results support previous beliefs that 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. (2001) 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 its plateau. This would indicate that the Khanom population might be a close population and strong site fidelity with little or no immigration from other populations nearby. Humpback dolphins show varying degrees of site fidelity (Jefferson and Karczmarski 2001). In South Africa, Algoa, KwaZulu-Natal and Eastern Cape coast populations displayed a low level of site fidelity (Durham 1994, Karczmarski 1996, 1999). In Mozambique (Maputo Bay population), Hong Kong (Pearl River Estuary population) and Australia, humpback dolphins display a high degree of site fidelity, occur in discrete and geographically localised populations (Guissamulo 2000, Hung and Jefferson 2004, Parra et al. 2004).

It is instructive to compare abundance and density of the Khanom population to those of other known population in Asia (Jefferson and Hung 2004, Wang et al. 2007). There were 80, 99 and 1500 individual dolphins at Jiulong River Estuary (JRE), Eastern Taiwan Strait (ETS), and Pearl River Estuary (PRE), respectively (Jefferson and Hung 2004, Wang et al. 2007). The PRE population densities varied from 60-280 individuals per 100 km^2 in high density areas, 15-50 in medium density areas and <10 in low density area (Wang et al. 2007). The Khanom population density of 49 individuals per 73 km^2 is at the lower end of the PRE high density areas (i.e. 67 individuals per 100 km^2). This suggests that densities in Khanom coastline are high.

Our results clearly demonstrate that Khanom population is highly vulnerable to treats from rapid coastal degradation from 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 did not occur in Thailand for over 50 years (Adulyanukosol 1999). Without effective and precautionary conservation efforts from the Khanom population of Indo-Pacific humpback dolphins, their existence in the Thai coastal waters is minimal. Applying the IUCN Red List criteria (IUCN 2001), the Khanom population would fall into the category of "Critically Endangered". This category represents an extremely high risk of extinction and underscores an immediate need for effective measures to reduce the impacts of existing and impending harmful human activities to this population.

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Appendix

Field survey of dolphins at Khanom sea.

Table 1: Field survey physical data when Indo-Pacific humpback dolphins were encountered at Khanom Sea

No.	Month	Date (d/m/yy)	Description	Number of sighting	Sighting Code	Lat	Long	Depth (m)	Distance from Shore(m)	Distance (Mile)	Distance (Km)	ObservedArea (Km^2)	All dolphins from sighting	Temp	Visibility (cm)	Calves	Juveniles	Adults	Group Size (Total)	% Calves / group size	% Juveniles / group size	% Adults/ group size	Cumulative Calves	Cumulative Juveniles	Cumulative Adults	Cumulative All
1	Jul	6/7/08	7/6/2008 9:06	3	210	9°18'12.28"N	99°50'31.54"E	4.80	575.39	39.80	63.68	31.84	10	30.70	110.00	2	0	3	5	40.00	0.00	60.00	2	0	3	5
			7/6/2008 9:34		211	9°17'44.41"N	99°50'36.13"E	4.20	166.60			0.00		33.00	118.00	1	2	0	3	33.33	66.67	0.00	1	2	0	3
			7/6/2008 12:34		213	9°18'32.93"N	99°49'39.88"E	2.30	21.70			0.00		29.10	107.00	1	0	1	2	50.00	0.00	50.00	0	0	0	0
2		13/7/08	7/13/2008 7:48	4	221	9°19'8.19"N	99°47'9.46"E	1.30	159.44	27.30	43.68	21.84	32	28.70	68.00	1	0	1	2	50.00	0.00	50.00	0	0	1	1
			7/13/2008 8:29		222	9°19'30.29"N	99°46'2.70"E	3.00	31.71			0.00		29.40	83.00	4	1	8	13	30.77	7.69	61.54	3	1	8	12
			7/13/2008 9:37		223	9°19'49.48"N	99°44'47.11"E	4.40	143.03			0.00		31.00	67.00	0	0	3	3	0.00	0.00	100.00	0	0	1	1
			7/13/2008 12:38		224	9°15'45.71"N	99°50'58.07"E	4.10	399.86			0.00		31.60	155.00	1	1	12	14	7.14	7.14	85.71	0	1	9	10
3	Aug	10/8/08	8/10/2008 9:16	4	199	9°19'35.04"N	99°45'50.31"E	3.30	385.36	39.20	62.72	31.36	32	30.20	95.00	1	1	2	4	25.00	25.00	50.00	0	0	2	2
			8/10/2008 10:33		200	9°19'1.23"N	99°48'48.16"E	3.20	850.35			0.00		29.40	127.00	2	3	5	10	20.00	30.00	50.00	0	1	1	2
			8/10/2008 11:35		201	9°17'34.11"N	99°50'43.86"E	5.20	263.76			0.00		33.80	137.00	2	0	3	5	40.00	0.00	60.00	0	0	1	1
			8/10/2008 13:50		202	9°17'53.67"N	99°50'27.41"E	5.20	384.82			0.00		30.60	122.00	6	1	6	13	46.15	7.69	46.15	1	1	0	2
4		24/8/08	8/24/2008 7:56	1	204	9°19'19.49"N	99°48'8.88"E	4.50	343.04	35.00	56.00	28.00	3	29.10	99.00	0	0	3	3	0.00	0.00	100.00	0	0	0	0
5	Sep	13/9/08	9/13/2008 9:45	2	257	9°15'54.03"N	99°50'47.46"E	3.60	184.85	29.90	47.84	23.92	19	31.10	159.00	2	0	8	10	20.00	0.00	80.00	0	0	4	4
			9/13/2008 11:32		258	9°11'34.51"N	99°52'43.37"E	6.30	368.51			0.00		30.70	210.00	1	2	6	9	11.11	22.22	66.67	0	2	2	4
6		27/9/08	9/27/2008 9:59	1	261	9°12'10.99"N	99°52'47.89"E	7.50	428.86	31.10	49.76	24.88	16	29.90	176.00	3	1	12	16	18.75	6.25	75.00	0	0	1	1
7	Oct	5/10/08	10/5/2008 7:44	1	263	9°15'54.25"N	99°50'57.79"E	4.10	493.86	33.70	53.92	26.96	18	31.20	149.00	6	4	8	18	33.33	22.22	44.44	0	0	0	0
8		19/10/08	10/19/2008 9:57	2	264	9°19'46.22"N	99°46'12.87"E	4.10	370.51	32.80	52.48	26.24	21	29.20	88.00	1	2	0	3	33.33	66.67	0.00	0	0	0	0
			10/19/2008 10:32		265	9°19'38.48"N	99°44'52.84"E	2.20	374.83			0.00		29.90	69.00	5	4	9	18	27.78	22.22	50.00	0	0	0	0
	Nov		Storm NA									0.00				0	0	0	0				0	0	0	0
9	Dec	6/12/08	(Not found) NA							29.38	47.00	23.50	0			0	0	0	0				0	0	0	0
10		24/12/08	12/24/2008 10:00	1	271	9°16'15.80"N	99°51'5.16"E	5.00	728.46	34.40	55.04	27.52	1	30.50	256.00	0	0	1	1	0.00	0.00	100.00	0	0	0	0
11	Jan	9/1/09	1/9/2009 8:25	3	275	9°19'52.53"N	99°44'47.83"E	4.80	250.22	29.00	46.40	23.20	9	31.00	67.00	0	0	3	3	0.00	0.00	100.00	0	0	0	0
			1/9/2009 9:13		276	9°19'5.60"N	99°47'9.13"E	1.20	62.33			0.00		28.70	68.00	0	0	1	1	0.00	0.00	100.00	0	0	0	0
			1/9/2009 11:39		277	9°18'5.65"N	99°50'23.34"E	5.00	336.06			0.00		30.70	110.00	2	0	3	5	40.00	0.00	60.00	0	0	0	0
12		24/1/09	1/24/2009 8:35	3	280	9°19'3.79"N	99°47'8.75"E	1.10	21.34	44.30	70.88	35.44	12	29.00	68.00	2	1	1	4	50.00	25.00	25.00	0	0	0	0
			1/24/2009 8:58		281	9°19'4.05"N	99°47'47.62"E	2.00	69.95			0.00		29.40	91.00	0	0	1	1	0.00	0.00	100.00	0	0	0	0
			1/24/2009 9:40		282	9°16'10.14"N	99°50'57.67"E	4.60	508.00			0.00		30.80	148.00	2	3	2	7	28.57	42.86	28.57	0	0	0	0
13	Feb	12/2/09	2/12/2009 8:16	2	293	9°19'26.18"N	99°45'48.75"E	2.10	431.90	34.70	55.52	27.76	10	29.40	83.00	1	0	2	3	33.33	0.00	66.67	0	0	0	0
			2/12/2009 9:09		295	9°19'15.17"N	99°47'45.87"E	3.60	343.99			0.00		29.50	89.00	2	3	2	7	28.57	42.86	28.57	1	0	0	1
14		18/2/09	2/18/2009 8:39	3	297	9°18'46.72"N	99°49'17.55"E	2.90	805.17	27.00	43.20	21.60	16	28.70	97.00	1	4	4	9	11.11	44.44	44.44	0	0	0	0
			2/18/2009 9:17		299	9°18'48.20"N	99°49'58.65"E	5.60	490.42			0.00		30.10	117.00	0	0	1	1	0.00	0.00	100.00	0	0	0	0
			2/18/2009 10:50		300	9°18'10.66"N	99°50'19.15"E	4.50	194.96			0.00		32.40	114.00	3	1	2	6	50.00	16.67	33.33	0	0	0	0
15	Mar	28/3/09	3/28/2009 8:53	1	312	9°15'35.17"N	99°51'22.39"E	4.80	802.48	46.10	73.76	36.88	20	30.20	153.00	6	3	11	20	30.00	15.00	55.00	0	0	0	0
16		29/3/09	3/29/2009 7:59	2	313	9°19'22.54"N	99°46'4.14"E	2.90	102.23	29.59	47.35	23.68	9	29.20	81.00	1	1	1	3	33.33	33.33	33.33	0	0	0	0
			3/29/2009 9:10		314	9°19'14.90"N	99°47'59.29"E	3.30	195.83			0.00		32.20	90.00	4	2	0	6	66.67	33.33	0.00	0	0	0	0
17	Apr	19/4/09	4/19/2009 9:03	2	320	9°19'20.99"N	99°47'45.30"E	3.70	514.28	34.00	54.40	27.20	3	31.00	89.00	2	1	0	3	66.67	33.33	0.00	0	0	0	0
			4/19/2009 13:29		321	9°12'23.85"N	99°52'40.27"E	1.60	75.79			0.00		33.80	205.00	1	0	4	5	20.00	0.00	80.00	0	0	0	0
18		30/4/09	4/30/2009 8:47	3	323	9°15'21.81"N	99°51'37.36"E	5.60	363.15	30.08	48.12	24.06	7	32.40	153.00	2	0	1	3	66.67	0.00	33.33	0	0	0	0
			4/30/2009 9:37		324	9°13'45.64"N	99°52'31.83"E	6.10	419.78			0.00		31.00	177.00	2	0	1	3	66.67	0.00	33.33	0	0	0	0
			4/30/2009 10:29		325	9°17'24.93"N	99°50'53.81"E	5.50	656.87			0.00		33.80	148.00	0	0	1	1	0.00	0.00	100.00	0	0	0	0
19	May	25/5/09	(Fishery boat) NA							32.25	51.60	25.80	0										0	0	0	0
20		27/5/09	(Fishery boat) NA							33.00	52.80	26.40	0										0	0	0	0
21	Jun	6/6/09	6/6/2009 8:42	1	331	9°19'32.96"N	99°45'23.23"E	2.50	1021.2	34.38	55.00	27.50	2	30.3	87	1	0	1	2	50.00	0.00	50.00	0	0	0	0
22		13/6/09	(Fishery boat) NA							33.13	53.00	26.50	0										0	0	0	0
																						Total	8	8	33	49

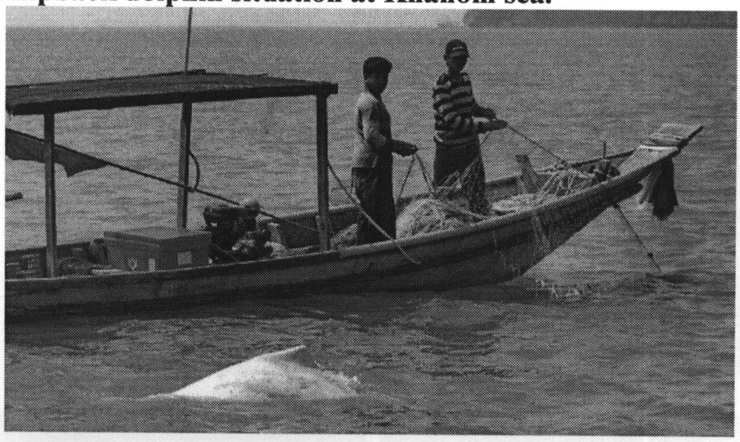
Table 2: Indo-Pacific Humpback Dolphins encountered at Khanom Sea

No.	Month	Date (d/m/yy)	Description	Calves								Juveniles								Adults																																
				01 Angle	02 Arrow	03 Baby Oily	04 Newey	05 Ribbon	06 Scratchy	07 Baby Saw	08 Ribbonny	09 Shadow	10 Triangle	11 Eagle	12 Fuji I	13 Japan	14 Opener	15 Splashy	16 Stony	17 Alien	18 Alicia Key	19 Alien II	20 Alien III	21 Angle Alien	22 Axey	23 Big Ass	24 Eaglely	25 Fuji III(Stabby)	26 Fuji Litty	27 Fuji Real	28 Hanger	29 Heart	30 Hiller	31 Key	32 Marble	33 Marblery	34 Monkey	35 Mountain	36 Netty	37 Opener Pinky	38 Pinkest	39 Pinky I	40 Pinky Larva	41 Sorbet	42 Step up	43 Stony II	44 Strawberry	45 Strawberry II	46 Sunday	47 Wanky	48 Wavey	49 Red Marky
1		6/7/08	7/6/2008 9:06	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
			7/6/2008 9:34	0	1	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
			7/6/2008 12:34	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	Jul	13/7/08	7/13/2008 7:48	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
			7/13/2008 8:29	1	0	1	0	1	0	1	0	0	0	0	0	0	0	1	0	0	0	1	1	0	0	0	0	0	0	0	1	0	1	0	0	0	1	0	0	0	0	1	0	1	1	0	0	0	0	0	0	0
			7/13/2008 9:37	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
			7/13/2008 12:38	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0	1	1	1	0	0	1	0	1	1	0	0	1	1	0	0	1	0	0	0	1	0	1	0	0	0	0
3		10/8/08	8/10/2008 9:16	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0
			8/10/2008 10:33	0	1	0	0	1	0	0	0	0	1	1	0	0	0	1	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	1	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
	Aug		8/10/2008 11:35	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0
			8/10/2008 13:50	1	1	1	0	1	1	0	1	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	1	1	0	0	0	0	0	1	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0
4		24/8/08	8/24/2008 7:56	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0
5		13/9/08	9/13/2008 9:45	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	1	0	1
	Sep		9/13/2008 11:32	0	0	0	0	0	0	1	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	1	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	1	0
6		27/9/08	9/27/2008 9:59	0	0	1	0	1	0	0	1	0	0	0	0	1	0	0	0	1	1	0	0	0	1	0	1	0	1	1	0	0	0	1	0	0	0	1	1	0	0	1	0	0	0	0	0	0	1	0	1	0
7		5/10/08	10/5/2008 7:44	1	1	1	0	1	1	0	1	1	0	0	1	1	0	0	1	1	0	0	0	0	1	0	0	1	1	1	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0
8	Oct	19/10/08	10/19/2008 9:57	0	0	0	0	1	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
			10/19/2008 10:32	1	1	1	0	1	1	0	0	0	1	1	1	1	0	0	0	1	1	0	0	1	0	0	0	1	0	0	1	0	0	0	1	1	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0
	Nov	1/11/2008	Storm NA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9	Dec	6/12/08	(Not found) NA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10		24/12/08	12/24/2008 10:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
11		9/1/09	1/9/2009 8:25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
			1/9/2009 9:13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
	Jan		1/9/2009 11:39	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0
12		24/1/09	1/24/2009 8:35	0	0	0	0	0	1	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
			1/24/2009 8:58	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
			1/24/2009 9:40	0	0	0	0	1	0	0	1	0	0	1	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
13		12/2/09	2/12/2009 8:16	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0
			2/12/2009 9:09	0	0	0	1	0	0	0	1	0	0	0	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1
14	Feb	18/2/09	2/18/2009 8:39	0	0	0	0	0	1	0	0	1	1	1	0	0	1	0	0	1	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
			2/18/2009 9:17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
			2/18/2009 10:50	1	0	0	0	0	0	1	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0
15		28/3/09	3/28/2009 8:53	1	1	1	0	1	0	1	1	1	1	0	0	1	0	0	0	1	1	0	0	0	1	0	1	0	0	0	0	1	0	0	1	0	0	1	0	0	0	0	0	0	0	0	1	1	0	1	1	0
16	Mar	29/3/09	3/29/2009 7:59	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
			3/29/2009 9:10	0	0	0	0	1	1	1	1	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17		19/4/09	4/19/2009 9:03	1	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
			4/19/2009 13:29	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0
18	Apr	30/4/09	4/30/2009 8:47	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
			4/30/2009 9:37	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
			4/30/2009 10:29	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
19	May	25/5/09	(Fishery boat) NA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
20		27/5/09	(Fishery boat) NA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21	Jun	6/6/09	6/6/2009 8:42	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
22		13/6/09	(Fishery boat) NA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		Total		11	6	8	1	19	10	7	9	4	4	7	6	8	7	3	2	9	11	1	2	3	7	1	4	7	6	4	2	3	2	4	6	4	1	4	6	7	7	5	3	3	2	1	5	5	2	2	4	7

0 = Absented, 1= Presented

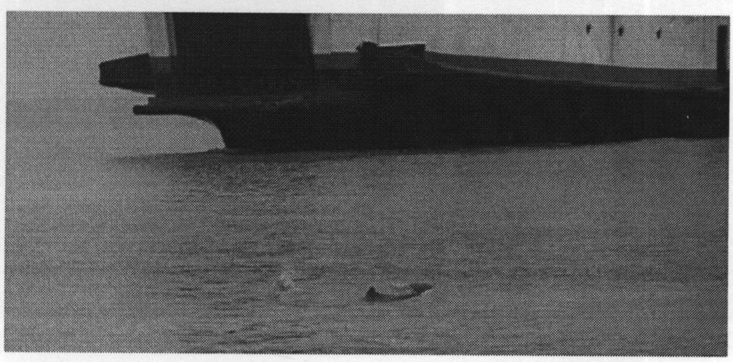
Indo-Pacific humpback dolphin situation at Khanom sea.

(a)



(b)

(c)



(d)

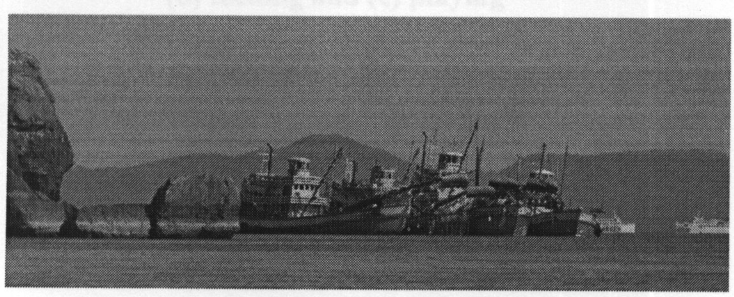
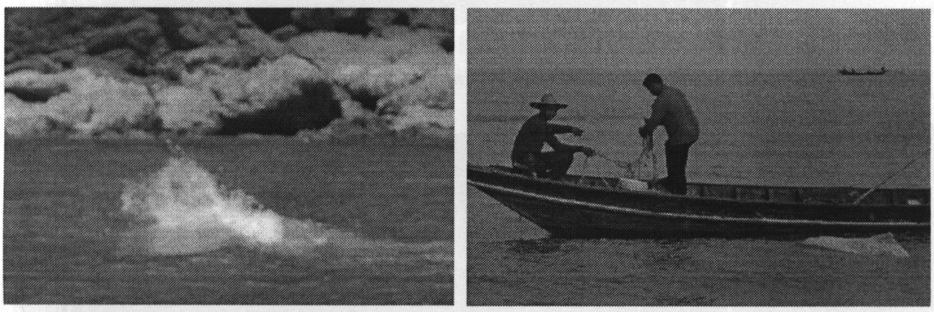


Figure 14. Dolphin situations at Khanom coastline: (a) Fisherman gillnet risk, (b) tourist boat, (c) ferry boat and (d) Big fishing boat.

Indo-Pacific humpback dolphin behaviour observed at Khanom sea.

(a)

(b)



(c)

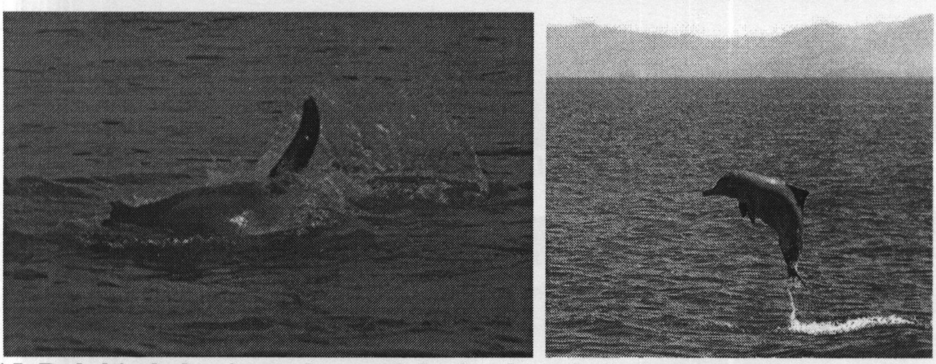
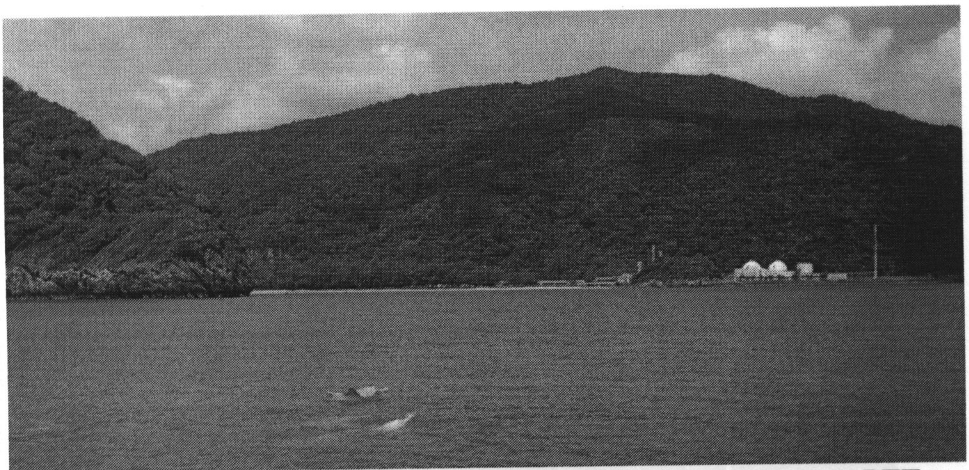
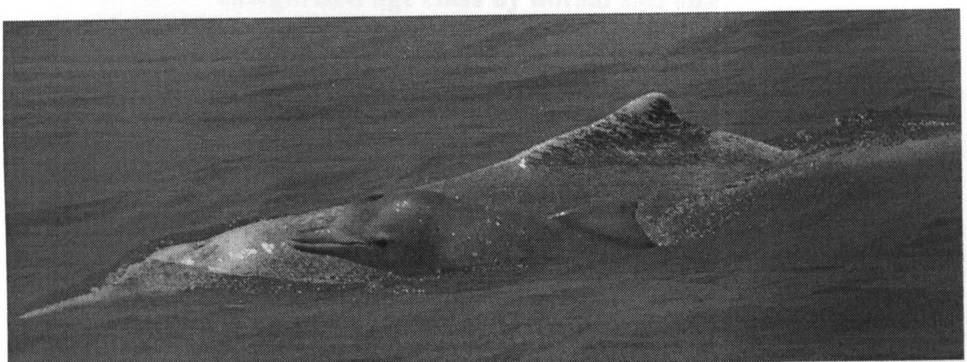


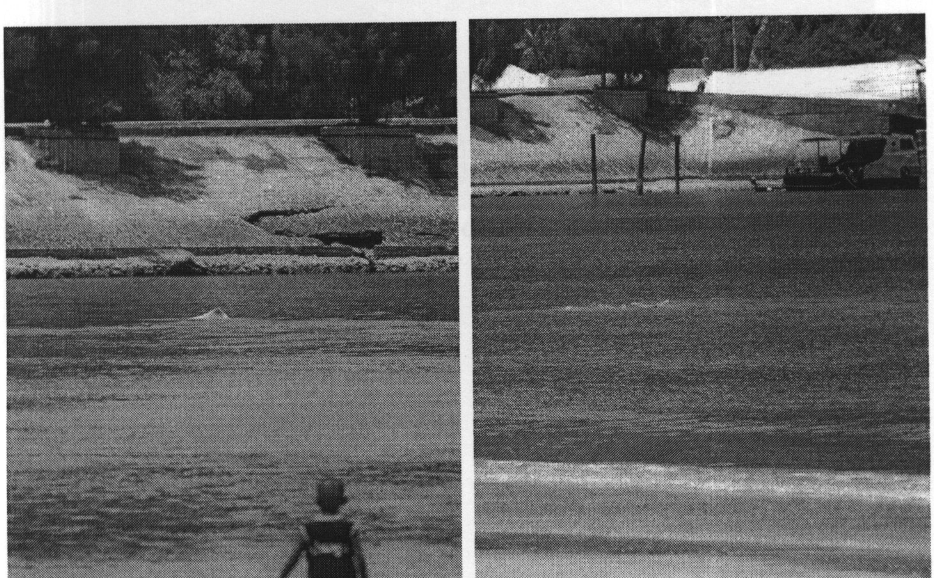
Figure 15. Dolphin behaviour observed during boat based surveys: (a) travelling, (b) feeding and (c) playing



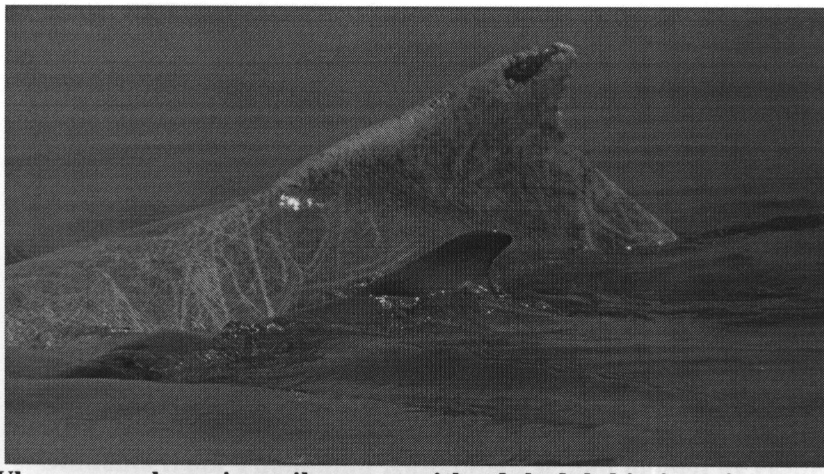
The group of dolphins swimming through Khanom estuary near PTT gas separated factory.



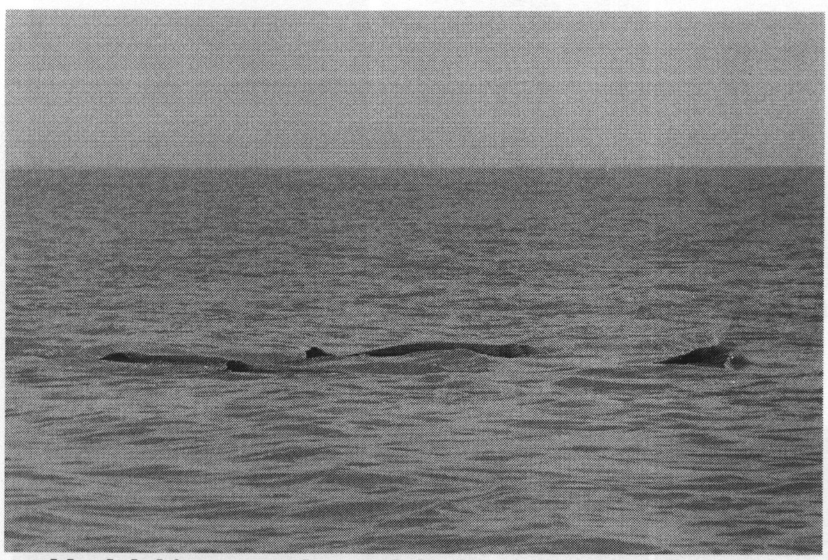
A pair of mother and a calf at Khanom sea



Dolphins swimming in shallow water near shoreline at Koh Kao beach, Khanom sea.

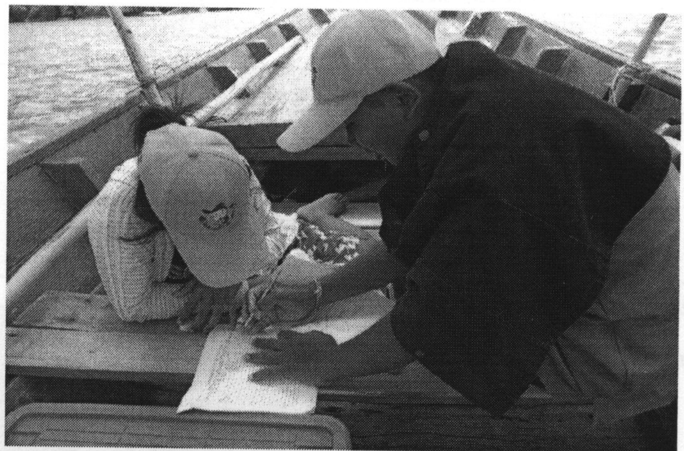


When a new born juvenile swam with adult dolphin in pair, we can categorised age class by dorsal fins size.



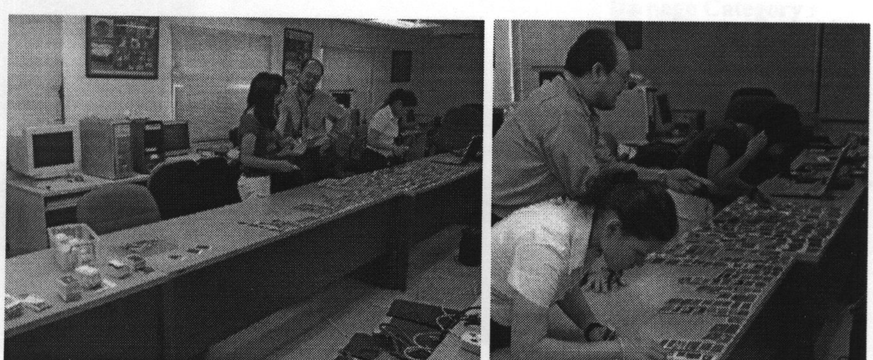
Irrawaddy dolphins were observed during our observations in January – May 2009.

LAB activities



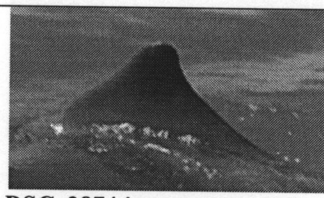
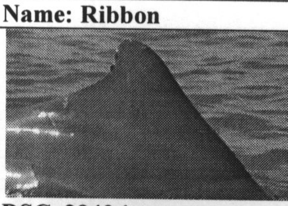
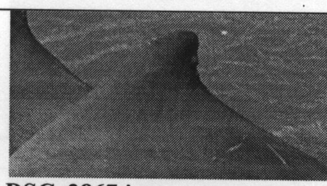
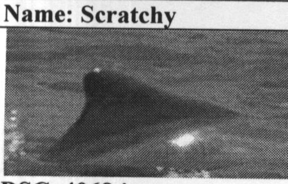
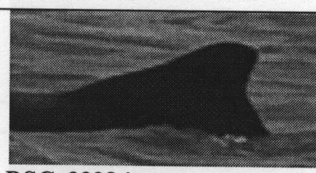
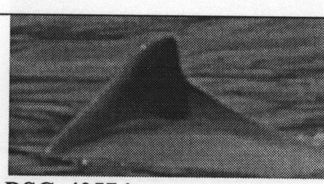
Students from Thongnian Kanapiban school helped us recorded data on data sheets during the field surveys.

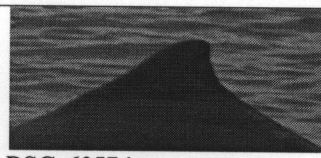
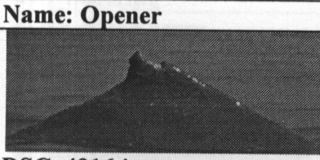
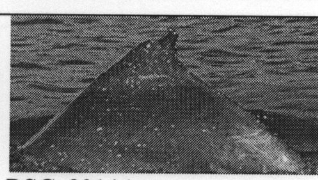
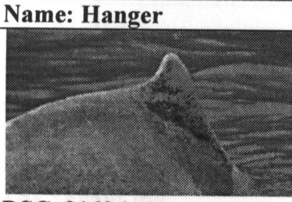
Students from Thongnian Kanapiban school helped us collected physical data: water depth, water visibilty and sea surface temperature.

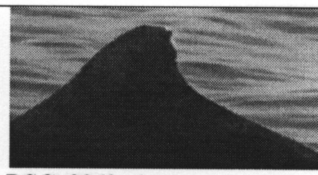
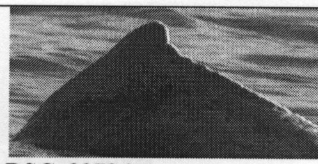
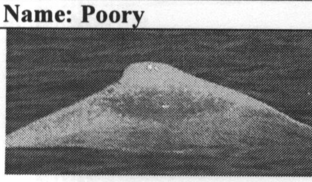
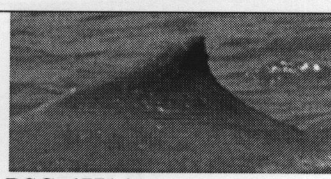
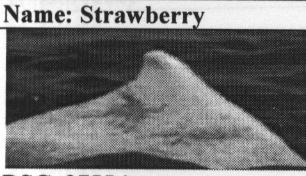
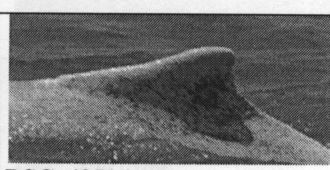
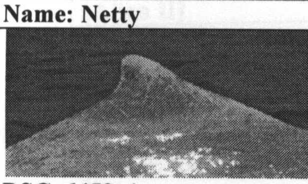


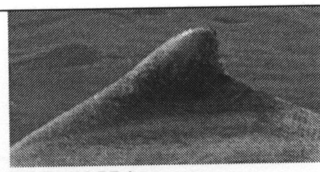
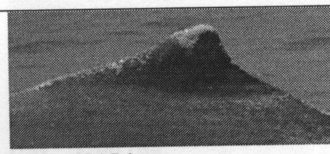
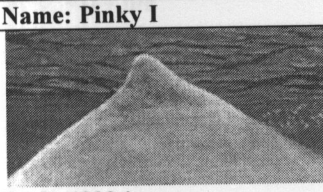
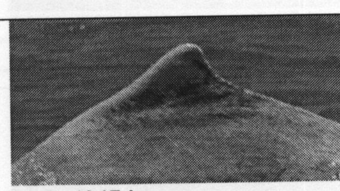
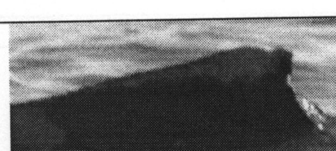
Dorsal fin pictures were rechecked by undergraduate students and suggestion from my advisor.

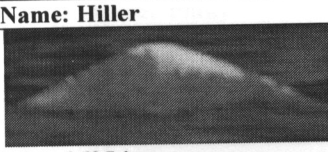
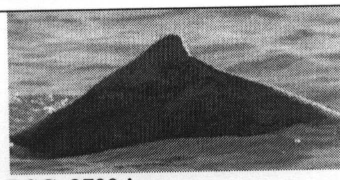
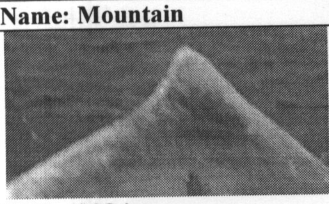
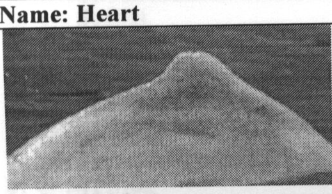
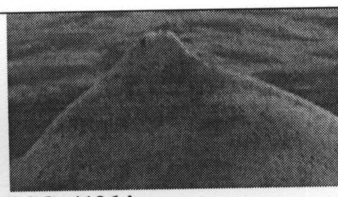
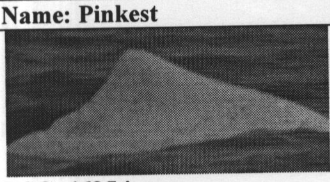
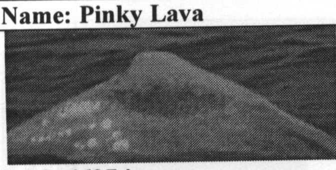
Table 2: Indo-Pacific humpback dolphin dorsal fin data catalog.

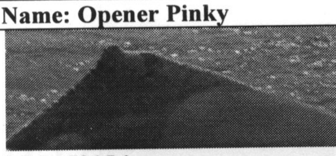
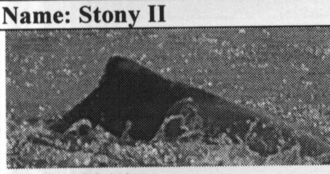
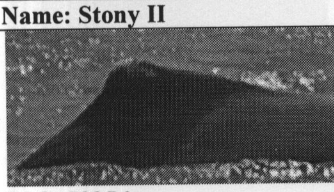
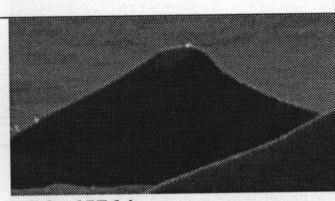
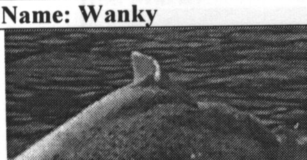
No	Right side	Left side	Details
1	**Name: Jedi**		☐ Juvenile ☑ Calves ☐ Adults
		 DSC_2874.jpg	Details : Damage Category :
2	**Name: Ribbon**		☐ Juvenile ☑ Calves ☐ Adults
	 DSC_2940.jpg	 DSC_2867.jpg	Details : Damage Category :
3	**Name: Scratchy**		☐ Juvenile ☑ Calves ☐ Adults
	 DSC_4068.jpg	 DSC_2867.jpg	Details : Damage Category :
4	**Name: Angle**		☐ Juvenile ☑ Calves ☐ Adults
		 DSC_3398.jpg	Details : Damage Category :
5	**Name: Baby Saw**		☐ Juvenile ☑ Calves ☐ Adults
	 DSC_3717.jpg		Details : Damage Category :
6	**Name: Baby Oily**		☐ Juvenile ☑ Calves ☐ Adults
	 DSC_3644.jpg	 DSC_4057.jpg	Details : Damage Category :
7	**Name: Triangle**		☐ Juvenile ☑ Calves ☐ Adults
	 DSC_4108.jpg		Details : Damage Category :

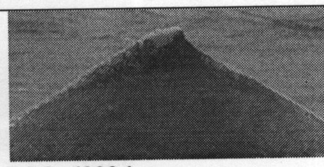
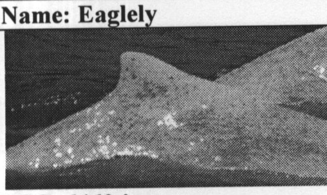
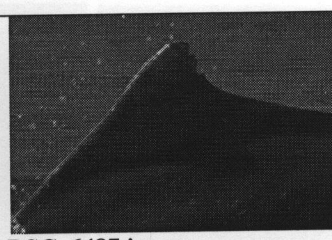
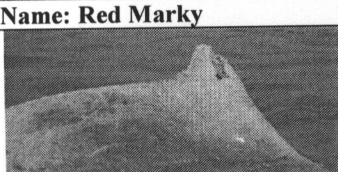
8	**Name: Arrow**  **DSC_4175.jpg**	 **DSC_4820.jpg**	**☐ Juvenile ☑ Calves ☐ Adults** **Details :** **Damage Category :**
9	**Name: Shadow**	 **DSC_6057.jpg**	**☐ Juvenile ☑ Calves ☐ Adults** **Details :** **Damage Category :**
10	**Name: Alien**  **DSC_2952.jpg**	 **DSC_5226.jpg**	**☐ Juvenile ☐ Calves ☑ Adults** **Details :** **Damage Category :**
11	**Name: Marblery**	 **DSC_2925.jpg**	**☐ Juvenile ☐ Calves ☑ Adults** **Details :** **Damage Category :**
12	**Name: Fuji I**	 **DSC_3005.jpg**	**☐ Juvenile ☐ Calves ☑ Adults** **Details :** **Damage Category :**
13	**Name: Opener**  **DSC_4916.jpg**	 **DSC_3014.jpg**	**☐ Juvenile ☐ Calves ☑ Adults** **Details :** **Damage Category :**
14	**Name: Hanger**  **DSC_3163.jpg**		**☐ Juvenile ☐ Calves ☑ Adults** **Details :** **Damage Category :**

15	**Name: Alien II**		**☐ Juvenile ☐ Calves ☑ Adults**
		 **DSC_3369g.jpg**	**Details :** **Damage Category :**
16	**Name: Step Up**		**☐ Juvenile ☐ Calves ☑ Adults**
		 **DSC_3373.jpg**	**Details :** **Damage Category :**
17	**Name: Poory**		**☐ Juvenile ☐ Calves ☑ Adults**
		 **DSC_3374.jpg**	**Details :** **Damage Category :**
18	**Name: Eagle**		**☐ Juvenile ☐ Calves ☑ Adults**
		 **DSC_6075.jpg**	**Details :** **Damage Category :**
19	**Name: Splashy**		**☐ Juvenile ☐ Calves ☑ Adults**
	 **DSC_3619.jpg**	 **DSC_4771.jpg**	**Details :** **Damage Category :**
20	**Name: Strawberry**		**☐ Juvenile ☐ Calves ☑ Adults**
	 **DSC_3755.jpg**	 **DSC_4051.jpg,**	**Details :** **Damage Category :**
21	**Name: Netty**		**☐ Juvenile ☐ Calves ☑ Adults**
	 **DSC_6459t.jpg**	 **DSC_7598.jpg**	**Details :** **Damage Category :**

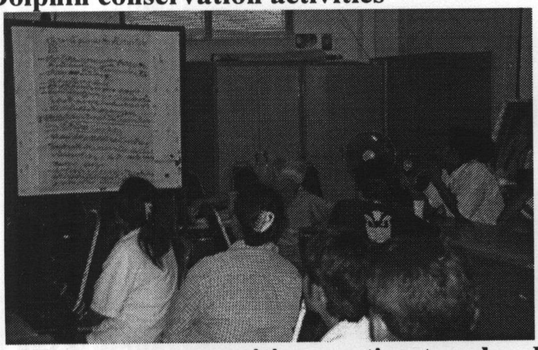
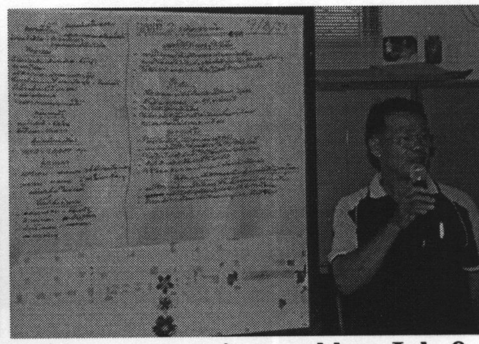
22	**Name: Key**	 **DSC_4055.jpg**	**☐ Juvenile ☐ Calves ☑ Adults** **Details :** **Damage Category :**
23	**Name: Fuji III (Stabby)**  **File name:DSC_4164.jpg,**	 **DSC_4815.jpg,**	**☐ Juvenile ☐ Calves ☑ Adults** **Details :** **Damage Category :**
24	**Name: Marble**  **DSC_4072.jpg**	 **DSC_4134.jpg,**	**☐ Juvenile ☐ Calves ☑ Adults** **Details :** **Damage Category :**
25	**Name: Fuji Litty**  **DSC_3774.jpg**		**☐ Juvenile ☐ Calves ☑ Adults** **Details :** **Damage Category :**
26	**Name: Pinky I**  **DSC_4032.jpg**	 **DSC_6243.jpg**	**☐ Juvenile ☐ Calves ☑ Adults** **Details :** **Damage Category :**
27	**Name: Axey**	 **DSC_4047.jpg,**	**☐ Juvenile ☐ Calves ☑ Adults** **Details :** **Damage Category :**
28	**Name: Alien III**	 **DSC_3368g.jpg**	**☐ Juvenile ☐ Calves ☑ Adults** **Details :** **Damage Category :**

No.			Category
29	**Name: Hiller**  **DSC_3695.jpg**		**☐ Juvenile ☐ Calves ☑ Adults** **Details :** **Damage Category :**
30	**Name: Monkey**	 **DSC_3700.jpg**	**☐ Juvenile ☐ Calves ☑ Adults** **Details :** **Damage Category :**
31	**Name: Mountain**  **DSC_4098.jpg**		**☐ Juvenile ☐ Calves ☑ Adults** **Details :** **Damage Category :**
32	**Name: Heart**  **DSC_4120.jpg**	 **DSC_4136.jpg**	**☐ Juvenile ☐ Calves ☑ Adults** **Details :** **Damage Category :**
33	**Name: Strawberry II**	 **DSC_4877.jpg**	**☐ Juvenile ☐ Calves ☑ Adults** **Details :** **Damage Category :**
34	**Name: Pinkest**  **DSC_4695.jpg**	 **DSC_4712.jpg,**	**☐ Juvenile ☐ Calves ☑ Adults** **Details :** **Damage Category :**
35	**Name: Pinky Lava**  **DSC_4697.jpg**		**☐ Juvenile ☐ Calves ☑ Adults** **Details :** **Damage Category :**

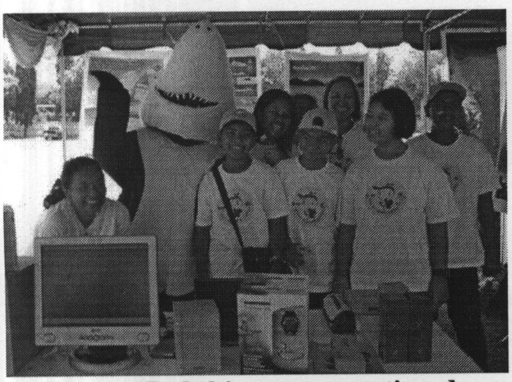
36	Name: Opener Pinky  DSC_5015.jpg	 DSC_5182.jpg	☐ Juvenile ☐ Calves ☑ Adults Details : Damage Category :
37	Name: Angle Alien  DSC_4883.jpg		☐ Juvenile ☐ Calves ☑ Adults Details : Damage Category :
38	Name: Stoney	 DSC_4991.jpg	☐ Juvenile ☐ Calves ☑ Adults Details : Damage Category :
39	Name: Sorbet  DSC_5011.jpg		☐ Juvenile ☐ Calves ☑ Adults Details : Damage Category :
40	Name: Stony II  DSC_5031.jpg		☐ Juvenile ☐ Calves ☑ Adults Details : Damage Category :
41	Name: Stony II  DSC_5035.jpg	 DSC_6576.jpg	☐ Juvenile ☐ Calves ☑ Adults Details : Damage Category :
42	Name: Wanky  DSC_7327	 DSC_5991.jpg	☐ Juvenile ☐ Calves ☑ Adults Details : Damage Category :

43	**Name: Big Ass**  **DSC_6259.jpg**	 **DSC_6055.jpg**	**☐ Juvenile ☐ Calves ☑ Adults** **Details :** **Damage Category :**
44	**Name: Fuji Real**  **DSC_7764.jpg**	 **DSC_6300.jpg,**	**☐ Juvenile ☐ Calves ☑ Adults** **Details :** **Damage Category :**
45	**Name: Eaglely**  **DSC_6460.jpg**		**☐ Juvenile ☐ Calves ☑ Adults** **Details :** **Damage Category :**
46	**Name: Sunday**  **DSC_6459.jpg**		**☐ Juvenile ☐ Calves ☑ Adults** **Details :** **Damage Category :**
47	**Name: Alicia Key** 	 **DSC_6487.jpg**	**☐ Juvenile ☐ Calves ☑ Adults** **Details :** **Damage Category :**
48	**Name: Newy**	 **DSC_4857e2.jpg**	**☐ Juvenile ☐ Calves ☑ Adults** **Details :** **Damage Category :**
49	**Name: Red Marky**  **DSC_4874.JPG**	 **DSC_4827.jpg**	**☐ Juvenile ☐ Calves ☑ Adults** **Details :** **Damage Category :**

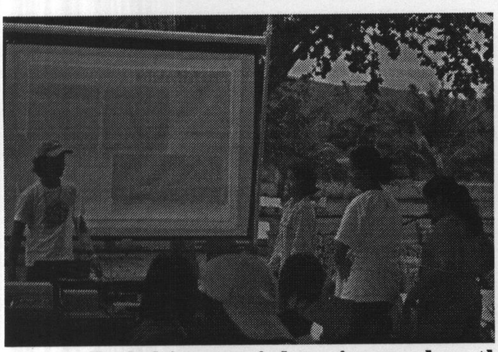
Dolphin conservation activities

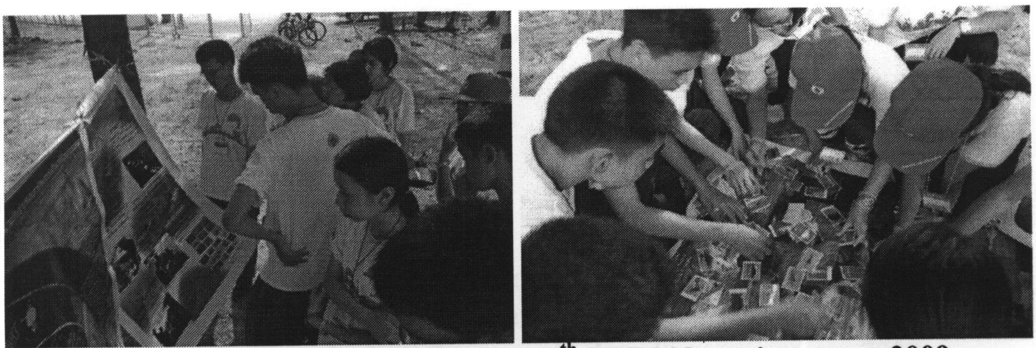
Khanom communities meeting to solve dolphin conservation problem July 8, 2008.



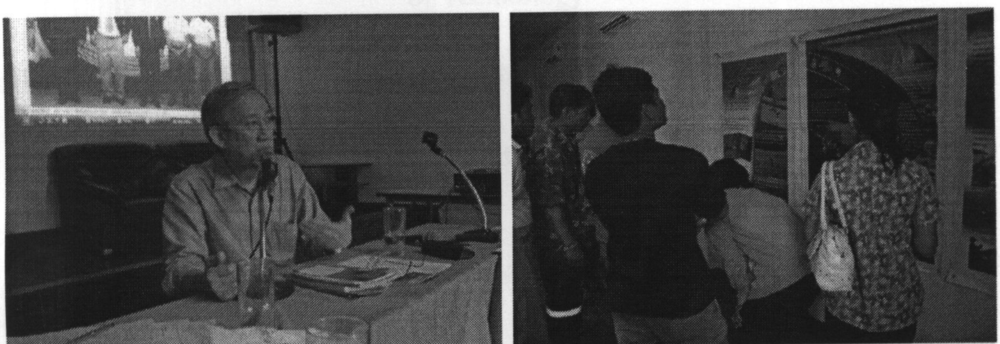

Khanom Dolphins conservation day at Khanom district on August 17, 2008.




Dolphin special topic speaker the 3rd PTT kid marine camp, 2008.



Dolphin special topic speaker at the 4th PTT kid marine camp, 2009.



Communities meeting with the marine and coastal resource research 4, Songkla and BRT.

Curriculum Vitae

Name Suwat Jutapruet
Birth Date May 1st, 1980
Birth Place Phatthalung Thailand
Educations

Degree	Institution	Year of Completion
Science-Math	Phatthalung School	1999
C.P.E. (Computer Engineering)	Suranaree University of Technology	2002

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Scholarships

1. Biodiversity Research and Training Program Grant BRT T351131, (2008-2009).
2. Walailak University Fund 04/2009.

Conferences

Jutapruet, S., Jaroensutasinee, M. & Jaroensutasinee, K. 2008. Estimating population size and distribution of Indo-Pacific humpback dolphins at Khanom. 12th BRT Annual Conference. Suratthanee, Thailand. 10th-12th October, 29.

Jutapruet, S., Jaroensutasinee, M. & Jaroensutasinee, K. 2009. Estimating population size and distribution of Indo-Pacific humpback dolphins at Khanom. 13th BRT Annual Conference. Chiangmai, Thailand. 12th-14th October. (The Second Prize Winner of BRT The Star).

Jutapruet, S., Jaroensutasinee, M. & Jaroensutasinee, K. 2009. Estimation of Indo-Pacific humpback dolphins population at Khanom. 35th Science Technology Annual Conference. Burapa University, Chonburi, Thailand. 14th-16th October, 49.

Experiences

- Training student to development Database system for Biodiversity, 2008.
- Online Learning Module in the part of Thinking for IPST., 2008.
- The guest speaker in the topics "Why we have to research dolphins?" in PTT's kid marine camp, 2008, 2009.
- Scientists staff for School coral project 2008-2009.
- Youth Scientist Competition (YSC) committee, 2009.
- Protective observer for marine mammals and cetacean in Nakhon Si Thammarat sea, 26-30 September 2009.
- Computer operation officer, Phatthalung Provincial court, 2007.
- Join the training, The extension to efficiency of operative computer officer training, 2006.
- The raw for justice processing translator training.
- Special teacher at Phatthalung Poly-technique college (Business computer)
- Special teacher at Technique Phatthalung college (Business computer)
- Website programmer training, Labour developing department, Phatthalung.
- Advance designer with Photoshop training, Sukhothai Thammathirat university.
- Project Co-operator , Suranaree Software Engineering (Ltd) co,.
- Team work training, SMEs Project, Suranaree University of Technology.
- Negotiate conversation technique training, SMEs Project, Suranaree University of Technology.
- Computer Operation chief, Sima Thani Hotel, Nakhon Rachasima.