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CETACEAN DIVERSITY AND HABITAT PREFERENCES IN TROPICAL WATERS OF EAST KALIMANTAN, INDONESIA

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***ABSTRACT.* –** East Kalimantan was chosen as a site to investigate cetacean diversity because of its probability as a migratory pathway for cetaceans from the Pacific to the Indian Ocean through the Sulu-Sulawesi Seas and Makassar Straits. The Berau Archipelago in the northeast of East Kalimantan Province provided the highest species diversity and cetacean abundance compared to two other coastal areas of equal coastline length and nearly similar area size in East Kalimantan. A total of 10 species and subspecies were found along the entire coastline of which 8 were found in the Berau Archipelago. High cetacean diversity in this area is due to the abundant islands and reefs, in which habitat 60% of all taxa were encountered and which had the highest relative cetacean abundance of all habitat types, i.e. offshore and near shore waters, bay and delta. Most sightings were made within 5 km of islands and reefs, so a 5-km-radius protection zone off islands and major reefs may be one conservation recommendation. First sighting records for Indonesia of *Stenella l. roseiventris* were made.

***KEYWORDS.* –** cetacean diversity, East Kalimantan, Indonesia, *Orcaella brevirostris*, *Stenella l. roseiventris*, *Tursiops aduncus.*

INTRODUCTION

The coastal waters of East Kalimantan form the western part of the Indo-West Pacific centre of maximum marine biodiversity (Voris, 2000). Historical and ecological perspectives support this hypothesis. During the last ice age (17,000 yrs ago), sea level was 120 m lower than present (MacKinnon, 1997). Shelf seas (e.g., the Java Sea) had disappeared and Kalimantan was part of the South East Asian continental mainland. The Indonesian through-flow (Gordon & Fine, 1996) continued to pass east of Kalimantan, through the Sulu-Sulawesi Seas and Makassar Strait carrying larvae and plankton from the Pacific to the Indian Ocean. Similarly, these seas most likely represent a migratory pathway for whales and dolphins. East Kalimantan has a wide range of habitats such as major rivers, deltas, mangroves, island/ reefs and deepwater offshore habitat, which are all inhabited by cetaceans (this article).

The Indonesian Archipelago contains some 5 million km^2 of territory (including water and land), of which 62% consists of seas within the 12-mile coastal limit (Polunin, 1983). At least 29 species of cetaceans are reported to occur in the seas of the Indonesian Archipelago (Rudolph et al., 1997). However, only a few dedicated studies have been conducted on the abundance, distribution and conservation of cetaceans in Indonesia. Cetaceans are threatened with local extinction in many parts of the world, but nowhere more obviously than in Asia (Reeves et al., 1997). Growing human populations are putting an increasing pressure on natural resources and rivers, estuaries and coastal marine waters are becoming increasingly unhealthy ecosystems for wildlife. Modification and degradation of the habitats of dolphins and porpoises have often resulted in dramatic declines in their abundance and range (Reeves et al., 1997).

The present survey involves a preliminary assessment of cetacean diversity in the waters off the East Kalimantan coast and provides the basis for future conservation-orientated research on cetaceans in this area. The objectives of the preliminary survey were to assess the diversity and occurrence of cetaceans and identify important cetacean areas in terms of species diversity and abundance.

METHODS

***Survey area.* –** Near-shore (< 50 m depth), (island) offshore

waters (> 50 m depth), bays and deltas were surveyed along a total strip of 700 km of coastline. This coastline was divided into three survey areas of equal length, ca. 230 km (Fig. 1).

Survey area 1 in the south included Balikpapan Bay (mangrove), near-shore waters, and the inner and outer Mahakam Delta area (mangrove). Total survey area was 2467 km^2. The shallow, near-shore strip (< 50 m depth) is quite wide (5 -10 km).

Survey area 2 had an area of 2732 km^2 and included the near-shore waters north of the Mahakam Delta, small delta areas of minor rivers, Sangkulirang Bay (mangrove) and offshore island reefs as far as the Mangkaliat Peninsula. The shallow coastal strip was very narrow (on average < 1 km) in the area north of the Mahakam Delta until Sangkulirang Bay and even narrower along the coast farther eastwards to the Mangkaliat Peninsula (< 100 m).

Survey area 3 included the Berau Archipelago with an area of 3339 km^2, which contains a high density of islands and reefs, the Berau Delta (mangrove), near-shore waters (>2 km < 4 km north of Kaniungan Islands and < 100m from Mangkaliat Peninsula until Kaniungan Islands) and offshore deepwater habitat (< 900 m deep). The southern Mangkalihat Peninsula narrows the passage between Sulawesi Island and Borneo Island and a shallow shelf is absent.

Field methods. **–** Cetaceans were visually searched for along a strip of 700 km of coastline during vessel-based surveys in six different survey periods, each lasting two weeks on average between May 2000 and October 2003. Total search effort by boat was 4481 km (362 h) during 80 days. Area 1 was surveyed during all seasons (governed by winds from all directions), whereas area 2 was surveyed during eastern wind (calm sea) conditions and area 3 during a transition period from south-western to northern wind conditions with days of mirror-like sea surface alternated with days of Beaufort 5 sea state. Only sightings made during days with an average beaufort sea-state of 3 or less were used for relative abundance analysis. Pre-determined survey transects were designed to provide representative survey coverage of various habitats. Searches were conducted alternatively from 2 wooden boats of different lengths, i.e., 16 m and 12 m, and horsepower 16 hp and 26 hp respectively, depending on sea conditions and habitat. When surveying deep, offshore waters and remote survey areas, the latter boat was used, which had an additional outboard engine and was used only off-effort for a fast return to shore. The 3-person- observer team followed a routine survey protocol for observation and data recording, in which the first observer scanned continuously with 7x50 binoculars, the second observer searched for dolphins unaided, and recorded all sighting effort data and environmental and geographical conditions using a GPS every 30 minutes, and the third observer searched at the rear by unaided eye and occasionally used binoculars. Positions changed every 30 minutes. Observer's eyeheight was c. 3 m above sealevel. One transect was surveyed in one day, and double sightings on the same transect were avoided by 1) asuming groups to be different when best estimates were outside the minimum and maximum group size estimates for earlier sightings, 2) groups were assumed different if the age-class composition was different, 3) in addition to which sightings of groups composed of individuals with characteristic marks that were identified during earlier sightings, were assumed similar. If no easily identifiable individual was present the first two criteria alone were used.

Upon making a sighting, radial distance between boat and dolphins was estimated, and compass bearing of the boat and of the dolphins and coordinates of the sighting location were recorded. Sightings were identified to species level. If more than one species was observed, it was recorded whether these species mixed. Groups were considered to mix if the distance between different species was less than 30 m**.**

If the species did not mix, the mean distance between the single-species groups was recorded. Minimum, maximum and best estimates were made of group size and of the number of calves and juveniles. We attempted to photograph each sighting for confirmation of species identification. Depth at sighting location was determined from an official sea map of the area for study area 3. For the other two study areas, a fish finder was used for depth measurement.

The following habitat types were defined: near-shore (< 50 m depth coastal contour line, > 5 km off islands and reefs), offshore (> 50 m depth coastal contour line, > 5 km off islands and reefs), bay, delta, and islands/ reefs (< 5 km from islands and reefs).

RESULTS

Species identification. **–** A total of 112 independent sightings were made in the 700-km long- survey strip (2° 20' N, 119° E – 1°50' S, 116°50 E) in a total survey area of 8.538 km^2 (Fig. 1). A total of 868 individual cetaceans of 9 different species, one sub-species and one additional tentatively identified sub-species were encountered (Table 1). Five sightings of the dwarf spinner dolphin sub-species, *Stenella l. roseiventris*, represent the first records for Indonesia and first record of occurrence for the Sundai region[1] (Fig. 2). The dwarf spinner dolphins were estimated to be the size of the more pelagic Gray's dolphin, *Stenella l. longirostris* (Fig. 3). Their colour pattern (consisting of two elements) was dark-gray as for bottlenose dolphins, *Tursiops truncatus*. Near the abdomen, a not very distinct layer of lighter dark-gray was visible. They lacked the tripartite base pattern and distinct pectoral stripes of the larger pelagic spinner dolphins that we observed. Juvenile dwarf spinner dolphins were also observed. The dwarf spinner dolphins usually occurred in small groups (mean n = 8 individuals) and were observed in mixed aggregations (within 30 m distance) in three out of five sightings. In the sightings with Gray's spinner dolphins, their group formation remained intact. During the other two sightings the dwarf spinner dolphins were observed in close proximity with other species but did not mix, i.e. the distance between different species was more than 30 m. Three sightings were made in deep water (50-400 m) but in relatively close proximity to islands (< 10 km).

Three sightings were made of a variant form of larger pelagic spinner dolphins; these had a shorter beak and may represent an undescribed sub-species. These were identified during one single-species sighting, one mixed aggregation with dwarf spinner dolphins and pantropical spotted dolphins, *Stenella attenuata*, and one sighting in close proximity (c. 100 m) to dwarf spinner dolphins and bottlenose dolphins. Their mean group size was 34 individuals.

One sighting was made of a small group of dolphins tentatively identified as Indo-Pacific bottlenose dolphins, *Tursiops aduncus* (n = 7 individuals), which could be distinguished from common bottlenose dolphins by having a more slender body, longer beak and slightly smaller body size. This small group occurred in area 3 in a mixed species group with an average distance of ca. 50 m from common bottlenose dolphins and c. 50 m distance from spinner dolphins, which then occasionally approached. General bottlenose behaviors included slow travel, milling and feeding, and there were many small tuna in the area. The remaining *Tursiops* sightings in area 2 and 3 were made near islands and reefs, and offshore waters, and appear to have been of *T. truncatus*. In area 1, *Tursiops* sightings were made near-shore, but no positive species identification could be made, so all the bottlenose dolphin sightings in this area are referred to as *Tursiops* sp. No unidentified sightings were made.

Relative species abundance and habitat occurrence. – The most abundant species observed was the common bottlenose dolphin (0.25 dolphins per habitat specific search effort in km). Other abundant species were the pantropical spotted dolphin (0.21 dolphins/ km) and the spinner dolphin (0.17 dolphins/ km). The spotted dolphin was only sighted once, but in a large group of 55 individuals. The species ocurring in lowest densities were the finless porpoise, *Neophocaena phocaenoides*, and the Indo-Pacific bottlenose dolphin (0.009 & 0.013 dolphins/ km, respectively).

The dwarf spinner dolphin, common bottlenose dolphin, and the Irrawaddy dolphin, *Orcaella brevirostris*, were recorded in the greatest range of habitats as each species occurred in three marine habitat types. The latter species actually occurred in 4 habitat types when including the freshwater habitat (Mahakam River). Depths at sighting locations varied between a minimum of 2 m, recorded for finless porpoises and Irrawaddy dolphins in near-shore habitat, and a maximum of 350-400 m, recorded for spinner dolphins, dwarf spinner dolphins, bottlenose dolphins, Indo-Pacific bottlenose dolphins, false killer whales (*Pseudorca crassidens*) and melon-headed whales (*Peponocephala electra*) in island and offshore habitat.

Relative cetacean abundance by habitat and survey area. – The habitats with highest relative abundance of cetaceans were island and reef (0.82 dolphins/ km searched), followed by, offshore (0.529 dolphins/ km) and bay (0.219 dolphins/ km) (Table 2). Delta and near-shore areas were rather poor by comparison (0.023 and 0.071 dolphins/ km, respectively). Near-shore areas and offshore habitats were moderately rich in species occurrence (40% of total number species encountered in both). Island/ reef habitats had the highest species diversity (60% of total no. species) recorded during this study. The bays and delta habitats were only frequented by one species, the Irrawaddy dolphin. Coastal Irrawaddy dolphins, in and near, the Mahakam delta were sighted offshore of the delta at low tide, whereas one inshore sighting at 10 km upstream of the mouth was made at high tide. The mean salinity of 12 ppt (SD = 10; range = 4.6-19.3 ppt) measured at dolphin positions in the delta is associated with brackish waters.

Relative cetacean abundance also varied by survey area: survey area 3, the Berau Archipelago, recorded both the

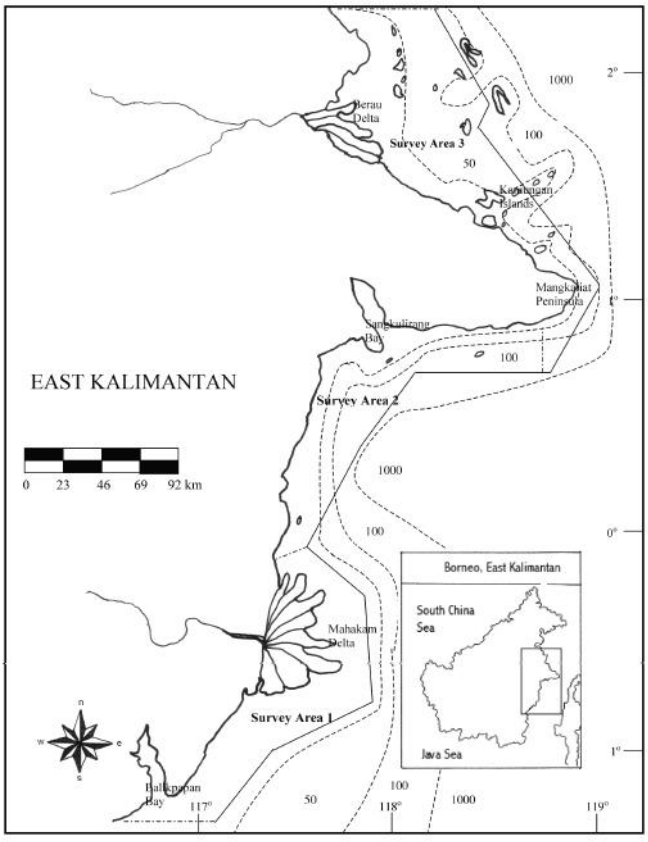

Fig 1. Map of survey areas along the East Kalimantan coastline, Indonesia.

Fig 2. Three dwarf spinner dolphins, *Stenella l. roseiventris* with obscure, lateral color pattern, photographed in the Berau Archipelago, October 2003. Photo: Budiono.

Table 1. Encounter rates of individual cetacean species by habitat type and habitats combined in decreasing order of abundance.

(Sub)species	Sighting habitat	Mean depth & range (m) of sightings	n[a]	Mean group size	Search effort (km)[b]	Encounter rate[b] (dolphins/ km)	Mean encounter rate
Tursiops truncatus	offshore	172 (50-400)	6	18	261	0.291	
	island/reefs	103 (5-300)	6	13	537	0.204	0.248
Stenella attenuata	island/reefs[c]	280	1	55	261	0.210	0.210
Stenella longirostris	offshore[d]	365 (300-400)	2	45	537	0.168	0.168
Stenella longirostris,	offshore	50	1	45	537	0.083	
sp. (with short beak)[e]	islands	75 (35-115)	2	28	261	0.107	0.095
Orcaella brevirostris	near shore	6.9 (2-23)	18	3	1616	0.029	
	delta	5.6 (3-10)	5	4.8	1010	0.019	0.085
	bay	14.3 (2.5-30)	67	3.4	1057	0.220	
Stenella l. roseiventris	near shore	23	1	2	1616	0.002	
	offshore	260 (50-400)	3	10.7	537	0.060	0.030
	island	35	1	8	261	0.030	
Tursiops sp.	nearshore[f]	12.5 (11-14)	4	9	1616	0.028	0.028
Pseudorca crassidens	island	400	1	7	261	0.027	0.027
Peponocephala electra	island	400	1	4	261	0.015	0.015
Globicephala macrorhynchus	island	280	1	4	261	0.015	0.015
Tursiops aduncus	offshore	350	1	7	537	0.013	0.013
Neophocaena phocaenoides	near shore	6.3 (2-10)	3	4.7	1616	0.009	0.009

[a] = number of groups sighted
[b] = habitat specific search effort
[c] = < 5 km distance of islands and reefs
[d] = > 50 m depth coastal contour line, > 5 km distance off islands and reefs
[e] = tentative identification of possible sub-species of *Stenella longirostris*
[d] = < 50 m depth coastal contour line, > 5 km distance off islands and reefs

highest encounter rate (0.64 individuals/ km searched in area 3) as well as greatest species diversity, i.e., eight species, which was 2.7 times higher than the species diversity in the other two areas, whereas the area surveyed was only 1.2 and 1.3 times larger than the other areas (Table 3). The minimum area size within which all eight species of this area were found was ca.170 km^2.

***Species composition of sightings.* –** Sightings of mixed species involved 20% (n = 8) of all sightings in habitats where more than one species was observed (n = 40) (Table 4). However, the percentage of sightings of groups which actually mixed was 12.5% (n = 5). The remaining 7.5% (n = 3) involved dependent sightings (i.e., during oneobservation another new sighting was made) of groups, which did not mix (minimum distance range = 30 m and 100 m). All identified species mixed at least once with other groups, except for the short-finned pilot whale (n = 10 = 91% of all species). Dwarf spinner dolphins were most often sighted in mixed-species aggregations (n = 3), followed by spinner dolphins (n = 2), whereas all other species were seen to mix only once. Although Indo-Pacific bottlenose dolphins were observed at a close distance (15-20 m) from common bottlenose dolphins, they remained in group formation. In all sightings of mixed groups the different species of dolphins were within close range of each other, but they maintained their own group formation.

Fig 3. Two Gray's (pantropical) spinner dolphins, *Stenella longirostris* with distinctive tripartite color pattern, photographed in the Berau Archipelago, October 2003. Photo: Budiono.

DISCUSSION

***Species identification.* –** Although dwarf spinner dolphins are usually associated with shallow in-shore waters (Perrin et al., 1999), their observation in deep waters in the Berau Archipelago is not so unusual since the area is very rich in islands and reefs, and deeper waters are interspersed with shallow reefs. Also, all deep-water sightings in this study were

Table 2. Number of individuals and cetacean species encountered in different habitats.

Habitat	Search effort (km)	Total no. individual cetaceans	Encounter rate (dolphins/km)	No. of (sub)species	% of total no. of (sub)species (n = 10)[a]
Bay	1057	231	0.219	1	10
Delta	1010	24	0.023	1	10
Near shore	1616	115	0.071	4	40
Offshore	537	284	0.529	4	40
Islands/reefs	261	214	0.820	6	60
Total	4481	868			

[a] = tentative identification of the variant form of Gray's spinner dolphin with short beaks is excluded

Table 3. Diversity of cetacean (sub-)species and relative individual- and species abundance per survey area.

Survey areas	(Sub)species	Surveyed habitats	Distance surveyed (km)	Encounter rate (dolphins/km)	Survey area (km^2)	Species diversity[a]
Area 1	*Neophocaena phocaenoides* *Orcaella brevirostris* *Tursiops* sp.	nearshore; bay; large delta (outer & inner)	3216	0.12	2467	3
Area 2	*Orcaella brevirostris* *Stenella l. roseiventris* *Tursiops truncatus*	nearshore; bay; small delta; offshore; islands	549	0.21	2732	3
Area 3	*Globicephala macrorhynchus* *Pseudorca crassidens* *Peponocephala electra* *Stenella attenuata* *Stenella longiristris* *Stenella longirostris* sp. *Stenella l. roseiventris* *Tursiops aduncus* *Tursiops truncatus*	nearshore; large delta (outer); offshore; islands	714	0.64	3339	8

[a] = including the sub-species *Stenella l. roseiventris*
_ (underline) = habitat in which dolphins were sighted

Table 4. Mixed species sightings

n	Mixed species sightings (+ dependent sightings)	Groups mixing or not?[a]
1	*Neophocaena phocaenoides*; *Orcaella brevirostris*	mixing
2	*Orcaella brevirostris*; *Stenella l. roseiventris*	not mixing; moving in other directions
3	*Stenella longirostris*; *Stenella l. roseiventris*; *Tursiops truncatus*; *Tursiops aduncus*	all species mixing
4	*Stenella longirostris*, sp.; *Stenella l. roseiventris*; *Tursiops truncatus*	not mixing; > 100 m distance among each species
5	*Stenella longirostris*, sp.; *Stenella l. roseiventris*; *Stenella attenuata*	all species mixing
6	*Pseudorca crassidens*; *Peponocephala electra*	mixing
7	*Globicephala macrorhynchus*; *Stenella attenuata*	not mixing; > 30 m distance among each species
8	*Stenella longirostris*; *Stenella l. roseiventris*	mixing

n = independent sightings during which more than one species was encountered
[a] = groups were considered to mix if the distance between different species was less than 30 m

made within 10 km of islands and reefs. The dwarf spinner dolphins observed in this area share some characteristics with small spinner dolphins occurring in the Arabian Sea of Oman (VanWaerebeek et al., 1999) and the Aden Gulf of the Republic of Djibouti (Robineau & Rose, 1983), mainly the size of both forms is smaller then that of pantropical (Gray's) spinner dolphins. Also, one of the two forms of spinner dolphins described for Oman has a dark dorsal overlay, obscuring the tripartite base pattern as seen in pantropical spinner dolphins, and such a dark, not well-distinguished, pattern was also seen in the dwarf spinner dolphins in East Kalimantan. The belly in both had a lighter colour, although the form in Oman described above were pink-bellied, whereas the bellies of dwarf spinner dolphins were still gray-coloured. Pink colour in cetaceans occurring in very warm waters may be an ephemeral feature caused by physiological heat management. The dwarf spinners in East Kalimantan share the two-coloured pattern, a dark cape and slightly lighter pectoral and ventral side with the spinner dolphins in the Aden Gulf. The Indo-Pacific bottlenose dolphins appeared distinguishable from common bottlenose dolphins, especially when they were encountered during the same sighting. The short-beaked form of spinner dolphins needs further study. However, the fact that these were identified during sightings when all individuals shared this trait, may indicate that this possibly represents a different form and perhaps a new sub-species. Also, the short beak form of spinner dolphins was never observed in mixed sightings with the pantropical-spinner dolphins. Photographic material may aid in the future identification of dwarf spinner dolphins, Indo-Pacific bottlenose dolphins and the short-beaked form of spinner dolphins in these waters.

***Species diversity*. –** In spite of the fact that survey effort (km) in area 1 was five times higher than in the other areas (whereas the inclusion of Beaufort sea states of ≤ 3 for analysis was equal for all areas) and was covered in all seasons, species diversity was 2.6 times lower than that found in area 3 and similar to that in area 2. Survey effort in areas 2 and 3 was only made during one season, so the actual species diversity there is likely to be higher than recorded. Based on the relatively high species diversity and the presence of species with a restricted range, i.e., dwarf spinner dolphins and with a globally conservation dependent status (see research recommendations), the waters near the Berau Islands have both a local and global biodiversity importance. In comparison, 14 species of cetaceans were identified in Komodo (identified as one of the richest marine diversity sites in the Indo-Pacific) National Park waters (1,214 km^2 surface waters) (Kahn et al., 2000), whereas in the Berau study area alone, eight species were encountered in an area of only c. 170 km^2. Although there are undoubtedly other areas of high cetacean diversity in Indonesia, such as reported for Solor and Lembata Island in eastern Indonesia (Weber, 1923; Barnes, 1980; Hembree, 1980), there are no comparative data on local species diversity available. Most likely only a proportion of the actual numbers of species that occur in the Berau Archipelago, seasonally or year round, were observed in this preliminary survey, so the species diversity may be even greater.

***Conservation recommendations.* –** We found that most sightings and species occurred within 5 km of islands and reefs, so a 5-km-radius protection zone off islands and major reefs may be one conservation measure. Otherwise, the restricted range of 170 km^2 within which eight identified cetacean species in the Berau Archipelago (area 3) were observed has a good conservation potential to become a marine vertebrate sanctuary. The area also hosts a number of shark and turtle species, and during the present survey a sighting of a large group of manta rays, Manta birostris, was made (65 individuals). Also, one dugong, Dugong dugon, was observed. The area also includes four islands that are frequently visited by tourists, so the area has a high potential for eco-tourism. However, any intended dolphin/ whale watching should be controlled and guided by instructed and responsible boat operators.

The second area in East Kalimantan coastal waters recommended as a conservation site is Balikpapan Bay (area 1). A high density of Irrawaddy dolphins (0.22 dolphins/ km search effort) was observed in the bay, as well as occasional sightings of individual dugongs. Within 10 km off the bay, bottlenose dolphins and finless porpoises were observed in shallow waters. Since in this study area, four surveys were carried out in different seasons (northwestern wind; northern wind; southeastern wind; southern wind) and bottlenose dolphins and Irrawaddy dolphins occurred during all surveys in and oustide the bay, this suggested that this area has a year-round occurrence for these species. Finless porpoises were identified during two seasons during three sightings, which most likely represents an underestimation of their relative abundance in relation to the other species observed in this study. This is a result of the inconspicuous, although characteristically surfacing nature of this species, which was only sighted at Beaufort sea-states of two or less. Besides the extensive sedimentation due to mangrove conversion, which has caused a decrease in sea grass fields and fish resources, and pollution (oil and mining exploitation, local city sewages), no other major threats to cetaceans have been detected for this area.

***Research recommendations*. –** IUCN Red List designation of three species, i.e., pantropical spotted dolphin, spinner dolphin, and short-finned pilot whale is Lower Risk (conservation dependent) (Reeves et al., 2003). Conservation status for all other species is Data Deficient. The status of the dwarf spinner dolphin has not been evaluated, but it has the most restricted range, being confined to shallow inner waters of Southeast Asia (Perrin et al., 1989; Rudolph & Smeenk 2002) although in this study the species also occurred in deepwater habitat near shore. The lack of data on the status of the species in this study indicates the need for more research to assess each species' abundance, habitat quality, and fisheries interactions.

The freshwater population of Irrawaddy dolphins in the Mahakam River is listed as Critically Endangered (Reeves et al., 2003). Freshwater Irrawaddy dolphins were sighted between 180 km and 480 km upstream of the mouth (Kreb, 2002), whereas the most inshore occurrence of coastal

Irrawaddy dolphins is about 20 km upstream of the mouth at high tide according to interviews with fishermen and most inshore observations of the authors were at 10 km upstream of the mouth. Since the coastal dolphins have not been sighted or reported to move further upstream than 20 km from the mouth and only enter the delta at high tide, they are considered to belong to a different, coastal stock than the true Mahakam River population, which is considered an isolated population. Future research is needed to clarify their status and stock structure, focusing on collection of baseline data on their distributuion and abundance. In addition, the collection of biopsy samples and DNA analysis of coastal and freshwater Irrawaddy dolphins would aid in the identification of stock structure.

Future survey effort should focus particularly on the Berau Archipelago and involve investigating which areas have a year-round or seasonal importance for all target species and relating this to ecological and bio-geographical factors. More extensive data than those yielded by the present rapid assessment survey (only two weeks) should be collected in this area during at least one year, covering all seasons. These data are needed to prepare a conservation action plan for all threatened target species and their habitats if degraded, possibly through establishment of protected marine parks and local education/awareness campaigns and a long-term cetacean monitoring program.

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