SULAWESI SEA CETACEAN PROJECT 2007-2008

Conservation and diversity of marine cetaceans in the Berau Archipelago, East Kalimantan, Indonesia

TECHNICAL FINAL REPORT

FIELDWORK PERIOD: OCTOBER 2007 & APRIL 2008

T. aduncus by Budiono

Project executed by

RASI CONSERVATION FOUNDATION

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Sponsored by Ocean Park Conservation Foundation

PREFACE AND ACKNOWLEDGEMENTS

The results presented in this technical final report are still preliminary and not to be cited without prior approval from the author. This survey was conducted by the local Indonesian NGO, RASI Conservation Foundation (YK-RASI). The project is in collaboration with and/or with approval from the University of Mulawarman, RISTEK (Ministry of Research and Technology), BKSDA (East Kalimantan Nature Conservancy Agency). Field surveys were conducted by Danielle Kreb, Budiono, Imelda Susanti, Syachraini (all from YK-RASI), Robert L. Pitman, Lisa T. Balance (SFSC, NOAA Fisheries), Fu Cheuk Chi (Molly) and But Lok Wai (William) (Hong Kong University, OPCF), Erik (from local NGO Bestari), Amat M.Y., Achmad, (BKSDA seksi Berau), Jay and Jarwo (free-lance observers). Biopsy samples were collected by Robert L. Pitman. Every field observer is thanked gratefully and also our boat drivers/ crew Pak Kasino, Pak Bachtiar and Pak Anto. I would like to thank the following persons for their hospitality: Pak Kasino (and family) and villagers at Derawan Island and conservation staff of Turtle Foundation at Sangalaki Island and Mataha. Finally, I owe a great deal of gratitude to the sponsor of this project, the Ocean Park Conservation Foundation Hong Kong.

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ABSTRACT

Observation surveys were conducted in the marine protected area of the Berau archipelago in East Kalimantan in order to obtain information on cetacean diversity, relative abundance, distribution patterns and threats during 33 boat days in October 2007 and April 2008. The area encompasses a diversity of habitat (delta, reef, shelf and slope waters) and marine life and supposedly provides a migratory passage for larger whales between the Pacific and Indian Ocean. Fifteen different cetacean species were encountered during the current surveys and preliminary survey in 2003, as well as dugongs, including a remarkably long-beaked form of supposedly *D. capensis tropicalis*. Biopsy samples were collected for five species to shed light on their taxonomic status including *Stenella longirostris, Stenella attenuata*, *Tursiops truncatus, Tursiops aduncus, Sousa chinensis* and *Stenella l. roseiventris*. Sightings concentrated within 5-km radius of reefs. *S. attenuata* and *S. longirostris* were most often encountered and in largest numbers. *T. aduncus* was also frequently observed but in small group sizes, whereas *T. truncatus* was observed once in a large group size. Sightings of mixed species composition involved up to one-third of all sightings per survey and mostly involved mixing groups of *S. attenuata* and *S. longirostris.* The observation of calves for several species during all three surveys indicates that these species may have a year-round presence in the area. Threats involve illegal fishing practices, such as blasting, trawling, overfishing and direct, illegal captures of dolphins for the international market, which stresses the need for an intensified patrolling in the area. For the species in the delta, such as *Orcaella brevirostris, Sousa chinensis* and *Neophocaena phocaenoides* and reef dependent cetacean species (and dugongs), protection of mangrove and riparian forest is essential to reduce sedimentation and guarantee enough fish resources.

INTRODUCTION

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). However, in spite of this extensive water mass only few reports on cetacean diversity are available. Rudolph *et al.* (1997) reported at least 29 species of cetaceans to occur in the seas of the Indonesian Archipelago but only a few dedicated studies have been conducted on the abundance, distribution and conservation of cetaceans in Indonesia such as long-term research conducted in Komodo National Park waters and the Mahakam River in East Kalimantan (Kahn *et al.*, 2000; Kreb, 2005a). Cetaceans are threatened with local extinction in many parts of the world, but nowhere more obviously than in Asia. 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). Hunting is largely unregulated throughout most of Indonesia, and environmental degradation proceeds unchecked. Investigation of the status of cetaceans in the Indonesian archipelago is one of the research projects recommended in the 2002-2010 Action Plan by the IUCN/SSC/Cetacean Specialist Group (Reeves *et al*., 2003)

East Kalimantan has been elected 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. 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. Preliminary investigations along most part of the East Kalimantan coastline indicated that the Berau Archipelago in the northeast of East Kalimantan Province, which is part of the Sulu-Sulawesi Marine Eco Region, 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 (Kreb & Budiono, 2005b). The preliminary research identified 8 species and two sub or possibly new species, i.e. the dwarf spinner dolphin, *Stenella l. roseiventris* and a short-beaked form of *Stenella longirostris*, which represent first records for Indonesia.

This research a.o. aims to shed light on the systematic status of all spinner dolphins and bottlenose dolphins (common and Indo-Pacific) found in this area. Reliable information was obtained that some direct threats exists to the dolphins through the use of dolphin meat as bait for shark long-line fisheries and export of dolphin meat. Another threat forms underwater acoustic pollution as a result of blast fishing. In this research, an assessment will be made to the

extent of these practices. The research projects further aims to collect data on cetacean diversity hotspots, relative abundance and distribution patterns of cetaceans, which will be vital for the design the recently established MPA for sustainable eco-tourism activities and if required necessary additional patrolling in core areas. Furthermore, support will be looked for in order to be able to conduct education awareness campaigns in coordination with local NGOs related to sustainable use of natural marine resources and conservation of cetaceans in particular.

This project also fits within the action plans of the IUCN (i.e. IUCN 2002-2010 Conservation Action Plan for the World's Cetaceans) and UNEP/ CBD Regional Action Plan for SE Asia's Small Cetaceans and its Indonesia Country Report in particular.

DETAILED OBJECTIVES

On a global scale, the conservation status of most cetacean species is Data Deficient according to the IUCN Red List. Furthermore, assessment of cetacean species in Indonesia has been described as a priority project within the "IUCN 2002-2010 Conservation Action Plan for the World's Cetaceans". Therefore the objectives of the present research project are to conduct a series of systematic at-sea surveys during a period of one year to:

1. Assess cetacean species diversity in the Berau archipelago waters based on positive species identifications primarily based on digital photographs of external morphology and if deemed necessary through biopsies and genetic analysis.
2. Estimate relative abundance, i.e. in terms of sighting and encounter rates (and if possible densities) per season per species and per habitat.
3. Identify cetacean distribution patterns: Identify which areas have a year-round or seasonal importance for cetaceans in terms of their relative abundance, i.e. number of sightings and total number of cetaceans and number of species encountered and which areas are important in terms of cetacean's particular activities (e.g. calving, resting, feeding).
4. Identify threats to the local marine mammal communities and which species are most at risk. In particular, investigate the extent of use of dolphin meat as bait for shark long-line fisheries, gillnet entanglements and deliberate kills of dolphins for meat (export).
5. Draft conservation recommendations and provide input for the spatial design of the future Marine Protected Areas (i.e. define areas/seasons where and when strict conservation rules should apply and where, when and in which way sustainable ecotourism activities may take place). Inform local and national authorities, NGO's and local university of the results of the study.

FIELD METHODS AND ANALYSIS

Cetaceans were visually searched for along in near shore, offshore and near-islands habitats in the marine protected waters of the Berau district in Northeast Kalimantan during vessel-based surveys conducted during a three-week period between 5 and 25 October 2007. Total search effort by boat was 1093 km (89 h 35 min) during 16 days. This month involved 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 and wind directions changing within days and within one day. Therefore, only transects in the northern section of the survey area with close proximity to islands or reefs could be surveyed. A second survey was conducted between 1st and 26th of April 2008 with a total search effort of 1110 km (90 hr) during 17 boat days. This survey included the southern section of the protected area. Weather conditions during the survey in this section were sub-optimal and only allowed for a total of five effective observation days. Only on-effort sightings with positive species identification were used for the analysis

Pre-determined survey transects were designed to provide representative survey coverage of various habitats but the factual course of each transect was adjusted according to the field conditions, i.e. wind, current and wave conditions. Searches were conducted from a wooden boat of 12 m length, and with an onboard diesel engine of 22 hp, which moved at an average speed of 11.5 km/hr during the October survey, whereas in April an additional outboard engine of 15hp was added to increase speed (mean = 12.2 km) and search distance needed due to cope with the stronger currents/ wind in April. The survey team varied between 4 and 6

members, including one to two front observers at 2.5-3m eye-height above sea level, scanning continuously within a 180^{o} angle from the beam, one observer searching for dolphins unaided, one to two observers at maximum 4m eye height above sea level, mostly searching unaided. Finally, a data recorder that was also facing rearwards, recorded all sighting effort data and environmental and geographical conditions using a GPS every 30 minutes, including speed, clouds, beaufort, visibility, tide. In addition, each day we also recorded the moon positions referred to as *sorong*, which counts from 1 to 28 after each new moon and influences tidal height, current speed and duration length between low and high tide. The track-line and effort data was also directly stored in the Garmin eTrex Vista CX. Positions changed every 30 minutes. One transect was surveyed in one day, and double sightings on the same transect were avoided by 1) assuming groups to be different if the age-class composition was different in combination with large differences in group size, 2) in addition to which sightings of groups composed of individuals with characteristic marks that were identified during earlier sightings, were assumed similar.

The total observation time during the October survey was 10 h, and the mean observation time per sighting was 38 min, whereas during the April sighting total observation time was 19 hours (mean = 38 min). Upon making a sighting, the 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. Distance estimation and 'calibration' among observers was exercised by regularly estimating distance to fixed waypoints (light beacons etc) and check with the distance estimated by the GPS to this waypoint. 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 and photo-identification of conspicuous dorsal fins. In addition, video footage was made. Depth at sighting locations with a depth < 100m was measured with a fish finder and the depth for deeper locations was determined after the survey by plotting the sighting coordinates on an official sea map of the area with bathymetrical data.

During the April 2008 survey, biopsy samples were obtained for six species with a total maximum of 5 samples per species. Comparisons of population genetics of these local populations with those elsewhere will help put the community in the Berau archipelago into a global context. All biopsy samples were obtained using a simple crossbow that fires small floating darts especially designed for small animals. The skin sample is about the size of a top pencil eraser. A minimum response to biopsies has been recorded for several cetacean species (Krutzen /et al. /2002; Gauthier & Sears 1999). The biopsies were executed by the associated investigator, by Dr. Robert L. Pitman, who has over 20 years experience in collecting these samples. Dr. Pitman has taken biopsy samples using the same methods from over 30 species of whales and dolphins without any incidence of injury to the animals. Analysis of m-DNA will take place at the US National Marine Fisheries Service/ Southwest Fisheries Center, La Jolla, CA, with whom already established contacts and exchange and analysis of genetic material exists.

The following habitat types were defined: **shelf waters** (0-200m depth, > 1 km distance off islands and reefs), **slope waters** (>200 m < 2000m depth, > 1 km distance off islands and reefs), **delta** (delta area extended until the 10m depth contour line off the outer sea arms of the delta), and **reefs** (≤ 1 km from reefs). To define the habitat type for each sighting location and the amount of effort conducted in a certain habitat type, the sightings and track-lines were plotted on an official sea map with bathymetrical data.

Informal interviews were held with fishermen and ex-dolphin hunters to find out the current status and occurrence of dolphin hunting.

In order to compare relative abundance between species, sighting rates and encounter rates will be calculated per km linear transect per season and habitat type (nearshore, offshore, islands/ reefs, delta, bay/ inlets). Because some species were only sighted once (during the October survey), we did not calculate densities per species. Instead we compared encounter rates.

PRELIMINARY RESULTS

Observation surveys

Two surveys were conducted in the marine protected area of the Berau archipelago of which the first one was conducted for 16 days in October 2007 covering a total distance of 972 km (89 h 35), whereas the second survey lasted 17 days in April 2008 and covered a total distance of 1225 km (90 h). Total group observation effort during both surveys was 29 hours. A total number of 51 on-effort sightings with positive species identification were made that involved observations of one up to four different species. Search effort was distributed over four different habitat types, i.e. delta, near shore, off-shore and near islands/ reefs (Table 1).

During the October survey, highest sighting rates were made in reef habitat, whereas highest encounter rates were found in slope waters. Although during the October survey the number of independent sightings per km transect was higher in reef habitat, pod sizes were smaller and therefore highest densities were recorded for offshore habitat (1.47 dolphins/km) and secondly for reef habitat (0.05 dolphins/km). In April, reef dependent sightings were absent except for one unidentified sighting and highest sighting ànd encounter rates were found for slope waters. Mean sighting and encounter rates were higher during the April survey. The mean distance to reefs for the October survey (including all 18 on effort sightings) is 3.7 km (median=4.25), whereas the mean distance to reefs in April sightings is 5.7 (median=4.35). In October, 74% of all sightings were made within 5 km distance of reefs, whereas in April 57% of sightings were within this distance. Three dugong sightings were made within 0-1.75 km of islands/ reefs. Mean depth of sighting locations of both surveys combined is 218 m (1.5-685 m).

Table 1. Number of cetacean sightings made and individuals encountered in different habitats

Habitat	Search effort (km)		No of sightings (n)*		Total no. individual cetaceans		Sighting rate (sightings/km)		Encounter rate (dolphins/ km)		No. of cetacean species	
	Oct	April	Oct	April	Oct	April	Oct	April	Oct	April	Oct	April
Delta[1]	50	128	1	4	1	40	0.02	0.031	0.02	0.312	1	2
Shelf water[2]	195	432	3	10	11	174	0.015	0.023	0.056	0,402	2	2
Slope water[3]	485	438	9	19	920	2436	0.018	0.043	1.896	5,56	7	4
Reefs[4]	242	227	5	0	84	0	0.02	0	0.347	-	4	0
Total/ mean	**972**	**1225**	**18**	**33**	**1015**	**2650**	**0.018**	**0.026**	**1.044**	**2.16**	**10****	**7**

***** excluding double sightings on the same transect day and only include on-effort sightings with positive species identification/ group size information.
**note: the total no. of species ≠ sum of the no. of species per habitat, because one species could occur in more habitats
[1] = delta area including area off the outer delta arms until 10m depth contour line
[2] = 0-200m depth, > 1 km distance off islands and reefs, excluding delta habitat ([4])
[3] = >200 m < 2000m depth, > 1 km distance off islands and reefs
[4] = ≤ 1 km distance of islands and reefs

During the October survey at least 10 cetacean species were observed and *Dugong dugon*, whereas during the April survey only 7 species were observed including two species that have not been observed during the October survey, bringing the total number of cetacean species identified during both surveys to 12 species (Table 2). Total numbers per km transect surveyed of all species, which were encountered during both surveys were sighted, were conspicuously higher during the second survey. During the first survey, highest encounter rates were observed for *Stenella longirostris*, whereas during the second survey *Stenella attenuata* was observed in the largest numbers per km transect surveyed.

Species that typically occurred in slope habitat (200m-2000m) and/ or in combination with reef habitat included *Stenella longirostris, Stenella attenuata, Tursiops truncatus, Pseudorca crassidens, Delphinus capensis tropicalis, Stenella coeruleoalba, Feresa attenuata*, whereas *Tursiops aduncus* typically occurred in more shallower shelf waters (0-200m), but was also encountered in reef habitat (210m) surrounded by deep, slope waters, which they would have to cross in order to get there. *Stenella l. Roseiventris* occurred in both shelf and slope waters. Delta habitat was occupied by *Neophocaena phocaenoides, Orcaella brevirostris* and *Sousa chinensis*, whereas dugongs were always sighted in close proximity to reefs.

Table 2. Encounter rates of individual cetacean species by habitat type and habitats combined in decreasing order of relative abundance during October 2007 and April 2008 survey.

Species + Red List[c]	Sighting habitat	Mean depth & range (m) of sightings	n[a]	Mean best group size & range	Search effort (km)[b]	Encounter rate (dolphins/ km)[b]	Mean encounter rate (habitat combined)
October 2007 survey							
Stenella longirostris (NE)	SLOPE REEF	265 (42**-360) 141 (71-210)	7 2	71 (6-170) 17 (5-28)	626 264	0.793 0.128	0.596
Stenella attenuata (LR (cd))	SLOPE	307 (216-360)	4	58 (2-190)	626	0.370	0.370
Tursiops truncatus (DD)	SLOPE	393	1	140	626	0.223	0.223
Tursiops aduncus (DD)	REEF SHELF	89 (30-210) 37	5 1	9 (5-22) 8	264 145	0.170 0.055	0.129
Pseudorca crassidens (LC)	SLOPE	210	1	13	626	0.020	0.020
*Delphinus capensis tropicalis** (NE)	SLOPE	42**	1	6	626	0.009	0.009
Neophocaena phocaenoides (NE)	REEF DELTA	19 (9-30) 1.5	2 1	1 (1-1) 1	264 57	0.007 0.001	0.009
Stenella l. roseiventris (NE)	SLOPE	254 (42**-360)	3	14 (12-15)	626	0.083	0.008
Stenella coeruleoalba (LR (cd))	SLOPE	360	1	4	626	0.006	0.006
Feresa attenuata (DD)	SLOPE	360	1	1	626	0.001	0.001
Dugong dugon (Vu)	REEF	24 (9-34)	3	1	-	-	-
April 2007 survey							
Stenella attenuata (LR (cd))	SLOPE	384 (210-685)	14	135 (3-600)	438	3.019	3.019
Stenella longirostris (NE)	SLOPE	322 (210-520)	6	52 (6-110)	438	0.712	0.712
Tursiops truncatus (DD)	SLOPE	373 (238-520)	4	56 (42-85)	438	0.511	0.511
Tursiops aduncus (DD)	SHELF	35 (14-69)	6	14 (2-39)	432	0.194	0.194
Sousa chinensis (DD)	DELTA	2.5	2	13 (11-15)	128	0.203	0.203
Stenella l. roseiventris (NE)	SHELF SLOPE	64 (39-84) 360	4 1	23 (10-45) 9	432 438	0.212 0.02	0.116
Orcaella brevirostris (DD)	DELTA	4.5 (4-5)	2	7 (3-11)	128	0.109	0.109

[a] = number of groups sighted
[b] = habitat specific
SLOPE = > 1 km distance of islands and reefs, > 50m depth coastal contour line
REEF = >10 m depth coastal (delta) contour line, < 1 km distance off islands and reefs
SHELF = < 50 m depth coastal contour line, > 1 km distance off islands and reefs
DELTA = < 10 m depth coastal contour line.
* = Tentative identification of *D. capensis tropicalis* until further DNA examination reveals otherwise
** = One mixed species sighting was made in a small, slightly shallower patch within slope water habitat of 42m depth, but this was regarded as slope water sighting.
[c] = Red List designation: DD = Data Deficient; LR (cd) = Lower Risk (conservation dependent); LC = Least concern; NE = Not Evaluated; Vu = Vulnerable

Table 3. Positive species-id sightings and species/ abundance composition

Sighting date	Sighting number	Species sighted	Best estimated group size	Groups mixing or not?[a]
05/10/07	D0	- *Neophocaena phocaenoides*	1	-
07/10/07	D1	- *Stenella l. roseiventris* - *Feresa attenuata*	15 1	Mixing
08/10/07	D2	- *Tursiops aduncus* (1) - *Stenella longirostris* (2) - *Pseudorca crassidens* (3)	22 28 13	Not mixing; >300m distance between species 1 & 2; >600m distance between species 1 & 3 and 2 & 3.
10/10/07	D3	- *Tursiops aduncus*	8	-
11/10/07	D4	- *Stenella longirostris*	5	-
14/10/07	D5	- *Stenella longirostris* - *Stenella l. roseiventris* - *Stenella attenuata* - *Stenella coeruleoalba*	150 15 190 5	All species mixing
	D6	- *Tursiops truncatus*	140	-
	D7	- *Tursiops truncatus**	140	-
15/10/07	D8	- *Stenella longirostris* - *Stenella attenuata*	170 2	Mixing
16/10/07	D9	- *Stenella longirostris*	35	-
	D10	- *Stenella longirostris*	6	-
20/10/07	D11	- *Stenella longirostris* (1) - *Stenella l. roseiventris* (2) - *Delphinus c. tropicalis* (3)	13 12 6	Not mixing; 100-200m distance between species 1 & 2 and 200m distance between species 1 &3.
	D12	- *Tursiops aduncus*	7	-
21/10/07	D13	- *Neophocaena phocaenoides*	1	-
22/10/07	D14	- *Tursiops aduncus* - *Neophocaena phocaenoides*	5 1	Involuntarily mixing because *N. phocaenoides* was being harassed by *T. aduncus*
23/10/07	D15	- *Stenella longirostris* - *Stenella attenuata*	55 15	Mixing
	D16	- *Stenella longirostris* - *Stenella attenuata*	65 25	Mixing
24/10/07	D17	- *Tursiops aduncus*	6	-
25/10/07	D18	- *Tursiops aduncus*	5	-
02/04/08	S2	- *Stenella attenuata*	600	-
	S3	- *Stenella attenuata*	75	-
03/04/08	S4	- *Stenella longirostris* - *Stenella attenuata*	100 3	Mixing
	S5	- *Stenella attenuata*	6	-
	S6	- *Tursiops truncatus* - *Stenella attenuata*	42 4	Mixing
	S7	- *Stenella attenuata* - *Stenella longirostris*	240 60	Mixing
	S8	- *Tursiops truncatus*	45	-
	S9	- *Stenella longirostris* - *Stenella attenuata*	110 6	Mixing
	S10	- *Stenella attenuata*	90	-
04/04/08	S13	- *Tursiops aduncus*	2	-
	S14	- *Tursiops aduncus*	4	-
	S15	- *Stenella l. roseiventris*	10	-
05/04/08	S16	- *Stenella attenuata*	400	-
	S17	- *Tursiops truncatus* - *Stenella attenuata*	50 4	Mixing
	S18	- *Stenella l. roseiventris*	9	-
07/04/08	S19	- *Orcaella brevirostris*	11	-
08/04/08	S20	- *Stenella attenuata*	180	-
	S22	- *Tursiops truncatus*	85	-
09/04/08	S23	- *Stenella attenuata* - *Stenella longirostris*	240 6	Mixing

	S26	- *Stenella longirostris*	12	-
	S27	- *Stenella attenuata*	40	-
11/04/08	S28	- *Stenella attenuata*	7	-
	S29	- *Stenella l. roseiventris*	13	-
	S30	- *Tursiops aduncus*	14	-
12/04/08	S31	- *Sousa chinensis*	11	-
14/04/08	S32	- *Stenella longirostris*	22	-
19/04/08	L1	- *Tursiops aduncus*	39	-
22/04/08	L2	- *Stenella l. roseiventris*	25	-
	L3	- *Stenella l. roseiventris*	45	-
	L4	- *Tursiops aduncus*	4	-
23/04/08	L6	- *Tursiops aduncus*	18	-
26/04/08	L7	- *Sousa chinensis*	15	-
	L8	- *Orcaella brevirostris*	3	-

[a] = groups were considered to mix if the distance between different species was less than 50 m
* = involving double sighting on the same transect day

Sightings of mixed species composition during the October survey involved 31% (*n* = 6 out of 19) of all sightings, whereas during the April survey mixed species sightings were lower, i.e. 18% (*n* = 6 out of 33 sightings)(Table 3). Moreover, during the first survey, additional sightings of 'mixed' species composition were made of species that did not really mix, but were observed at several hundreds of meters of each other. Species that were observed to actually mix with other species are *Stenella l. Roseiventris*, *Feresa attenuata, Stenella longirostris, Stenella attenuata*, *Stenella coeruleoalba, Tursiops aduncus, Neophocaena phocaenoides, Tursiops truncatus.* Most frequent interspecies interaction were between *Stenella longirostris, Stenella attenuata* (*n* = 8 of 12 mixed species sightings). One aggressive simultaneous sighting was made for *N. phocaenoides* and *T. aduncus*, as the first species was being harassed by the bottlenose dolphins.

The species that was most easy to use in our photo-identification study appeared to be *T. aduncus* and *Sousa* chinensis, but also several individuals of S*. longirostris*, *S. attenuata* and *T. truncatus* could be identified. However, this analysis has not yet been completed.

In October, calves have been observed for the following species, i.e. *Tursiops aduncus, Tursiops truncatus*, *Stenella longirostris*, *Stenella coeruleoalba*, whereas in April calves were observed for *Stenella l. roseiventris*, *Stenella longirostris, Stenella attenuata*, *Tursiops aduncus, Tursiops truncatus, Sousa chinensis* and *Orcaella brevirostris*.

Two additional days of boat surveys were conducted on 1 & 2 February 2008 in the area of Bontang, c. 100km north of the Mahakam Delta with a total search effort of c. 200 km. The survey was initiated after we got positive information from local fishermen about the presence of two humpback whales, *Megaptera noveangliae* 10-11 mil offshore two weeks earlier. However, during our observation effort in the area, where fishermen have frequently seen the whales for the last two years, no sighting was made. Wheather conditions during the survey were also sub-optimal with rainfall, western wind (3-4), waves (1.5-2m). According to several local fishermen the whales had long, white flippers and breached several times. The whales typically surfaced three times in a row with 5-10 minutes interval. They were usually observed at calm weather conditions after southern wind and at a steep depth slope of 75-400m.

Biopsy sampling

During the April 2008 survey in total 19 biopsy samples were collected of the following species: *Stenella longirostris* (5)*, Stenella attenuata* (5), *Tursiops truncatus* (4)*, Tursiops aduncus* (3)*, Sousa chinensis* (1) and *Stenella l. roseiventris* (1). Reactions of most species to the biopsy shots were minimal and after an initial startling response a few times the same individual has been observed to come back bowriding to the boat during that same sighting or another sighting, except for *S. l. roseiventris,* which dissapeared alltogether after a biopsy shot was fired. The samples await further DNA analysis.

Informal interview surveys

An informal approach was adopted to obtain possible sensitive information related to dolphin hunting. In this way, we found that until 2000 dolphins were regularly hunted to function as bait for shark fisheries. The fins of these sharks were cut off and sold abroad. Since shark fishing dropped drastically in 2000 and onwards, local hunters stopped hunting dolphins. This hunting was done by a small group of local fishermen, who also stopped hunting for other reasons, such as moral beliefs. During one hunting event the leading fishermen of this group noticed that a dolphin followed the boat, which had a badly wounded dolphins aboard and was just harpooned, for a very long time. The fisherman concluded for some reason that this must have been the 'spouse' of the dying dolphin. Afterwards, on many occasions, the man mentioned that he often dreamed of dolphins and that he could not put the sight and eyes of the dolphin, which followed the boat, off his mind because he felt that they had much in common with humans.

Nevertheless, illegal hunting of dolphins by other nationalities is still ongoing. During a patrol in June 2007, a ship from Taiwan was detained by the Marine Police and 70 dolphins, one whale species and many turtles were found dead onboard. The crew is still in prison until present.

DISCUSSION

Environmental conditions

The month October was characterized by a transition of southern wind domination (July – September) to northern wind domination (November – January). This caused variable weather conditions with occasional mirror-like sea surfaces, but also often high waves and changing winds. Due to the high waves, the eastern offshore habitats off the islands and the southern area of the marine protected area could not be surveyed, narrowing the originally planned survey area. These areas were covered during the April survey, but not as thoroughly as planned due to unexpectedly bad weather conditions for this month with southern wind conditions that affected wave action in the southern area of the protected area quite badly.
The higher species diversity in October may be due to the fact that during this transition month the shelf and slope waters in the Marine Protected Area offer higher fish resources as confirmed by fishermen than in the deeper waters on the eastern offshore side of the islands, and attracts more different cetacean species.

Conservation

During a preliminary survey in 2003, nine cetacean species were encountered of which some six similar species as observed in the current survey and three other species, i.e. *Peponocephala electra, Globicephala macrorhynchus* and a yet unidentified species of supposedly *S. longirostris* but with a short beak. Combining these species with the current ones, a total number of 15 species was found so far within the marine protected area (12.700 km^2 in size).

Two species had a conservation dependent status. Most other species have a data deficient Red List status or have not been evaluated yet such as the dwarf spinner dolphin, which has the most restricted range of occurrence being confined to shallow inner waters of South East Asia (Rudolph & Smeenk, 2002) although in this study the species also occurred in deepwater habitat. Also, the global listing for Irrawaddy dolphins is currently under review and likely to change from data deficient to vulnerable in the forthcoming update of the IUCN Red List. The observation of an extremely long-beaked form of supposedly long-beaked common dolphins also needs further study (DNA) to reveal its systematic position. Therefore, conclusively, all these species may deserve equal attention with regards to their conservation.

Based on the relatively high species richness and presence of species with a restricted range and a globally conservation dependent status, the waters near the Berau Islands have both a local and global biodiversity importance. For 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). 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 richness available. Most likely, only a proportion of the actual number of species which occur in the Berau Archipelago seasonally or year round were observed in 2003 and the current survey, so the species richness may be even higher. For example, sperm whales, *Physeter macrocephalus*; common dolphins, *Delphinus delphis*, killer whales, *Orcinus orca* were also observed to occur in the study area during earlier visits to the area (Budiono, *in verbis*). In addition, during the current survey, on three different locations dugongs, *Dugong dugon* were observed in near vicinity of reefs.

The observation of calves for several species during all three surveys (2003, 2007, 2008) indicates that this area may also be of significance in terms of breeding area.

Based on the sighting data of all three surveys, we found that between 57% and 74% of all sightings and species occurred within 5km distance off islands and reefs, so a 5km radius particular protection zone off islands and major reefs may be one of the conservation recommendations, with attention and law-enforcement of destructive and unsustainable fishing techniques, i.e. bombing, trawling. Patrolling in the entire marine protected area should be intensified to prevent further illegal attempts to capture cetaceans and turtles.

The delta area hosts three cetacean species and more research is needed to assess the fish availability and sustainability of fisheries in this area and patrol to counteract unsustainable fishing techniques such as trawling (with small boats). The protection and rehabilitation of upstream riparian forest as well as mangrove forest is necessary to reduce sedimentation that reduces fish resources and provide natural fish and shrimp spawning areas.

Also, fish aqua-culture techniques could be improved in relation to breeding of grouper fish, ikan *kerapu*, where currently juvenile groupers are caught from the wild, bred in cages and exported. With improved technology and support, grouper cultivation should include spawning in cages as well. Technical know-how or financial support for introducing other cultivation products such as seacucumber, *teripang* are needed to reduce the pressure on natural fish stocks in the area.

In terms of ecotourism, the marine protected area including the delta area offers a high potential for a responsible and controlled form of dolphin watching using instructed and responsible boats drivers.

Future project planning

Continue investigating cetaceans in the areas we already surveyed to understand long-term, local distribution patterns, relative species- and seasonal abundance and obtain biopsy samples for species for which the taxonomic status is still unclear. Finally, we aim to conduct local education/ awareness campaigns to increase the knowledge and sense of belonging/ care of the local communities for natural resources and cetaceans in particular.

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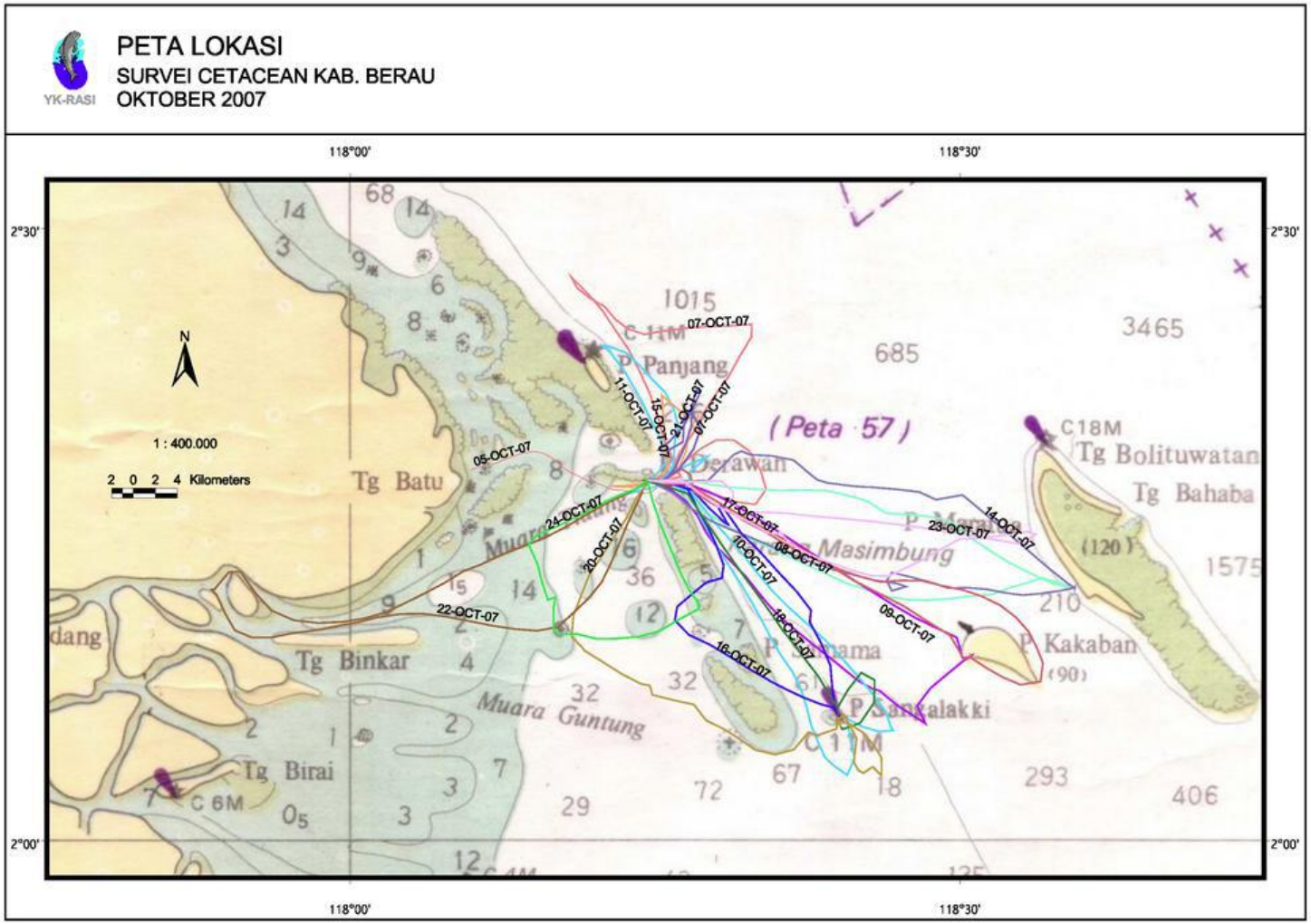
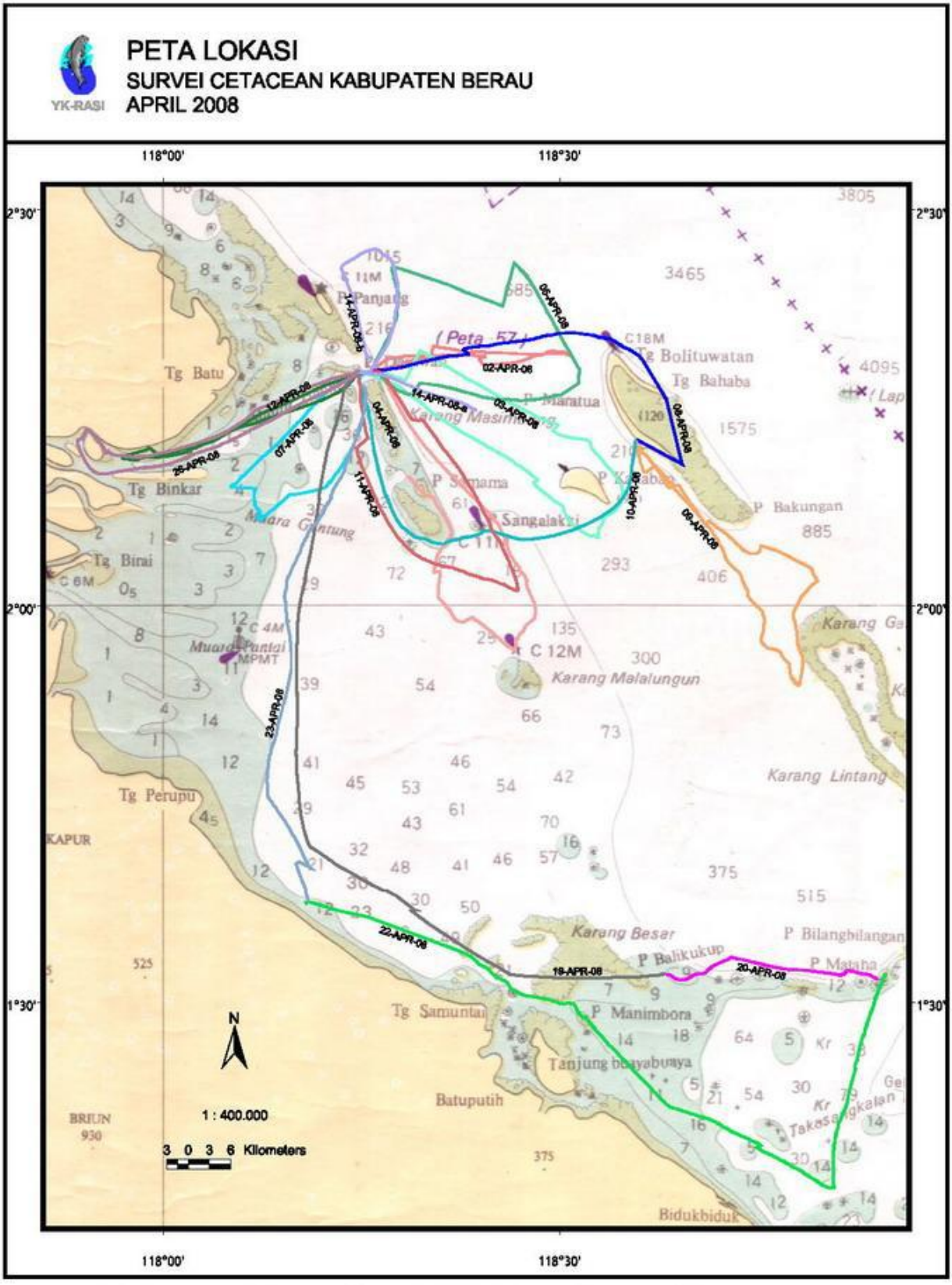
APPENDIX 1A. Map with October 2007 survey track

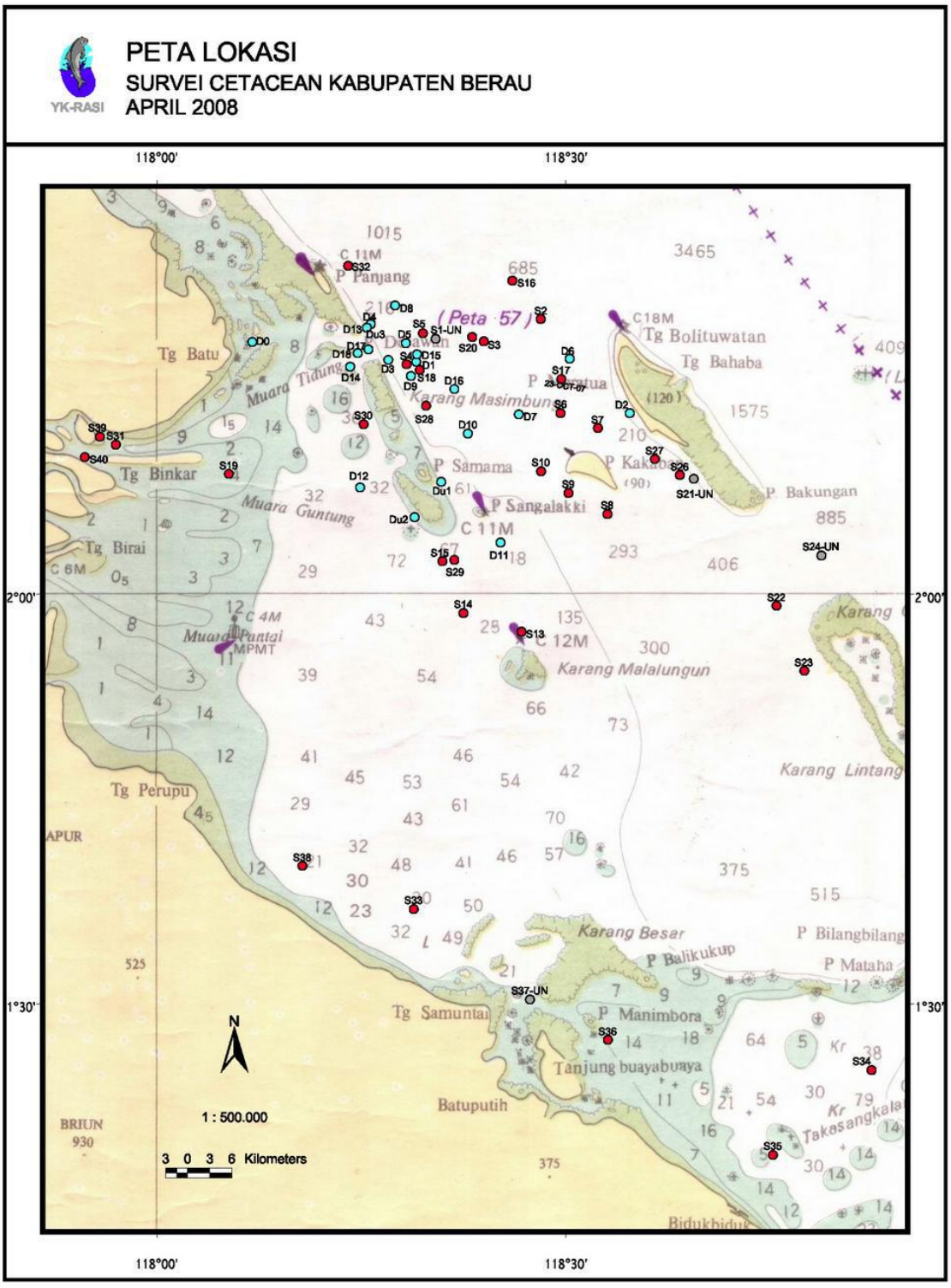


APPENDIX 1B. Map with April 2008 survey track



Sumber: Peta Kedalaman dan Ketinggian Laut Sulawesi (TNI-AL, Dinas Hydro-Oseanografi, 1993)

APPENDIX 2. Map with cetacean and dugong sightings

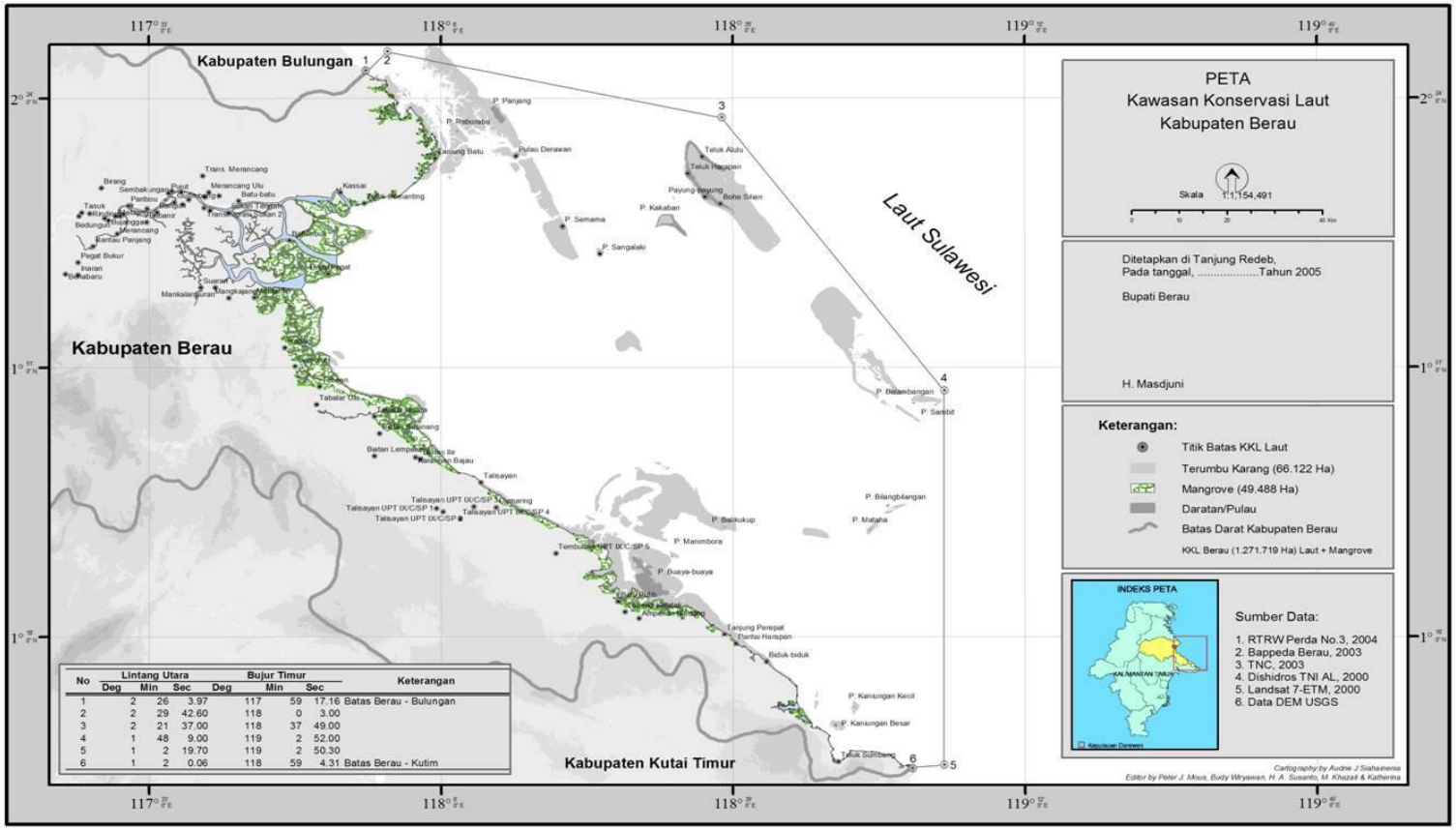


Sumber: Peta Kedalaman dan Ketinggian Laut Sulawesi (TNI-AL, Dinas Hydro-Oseanografi, 1993)

= positive species identification sightings-October 2007
= positive species identification sightings-April 2008
= unidentified on effort sightings

APPENDIX 3. Map of Marine Protected Area and boundaries

Lampiran: Peraturan Bupati Berau
No:.....Tahun 2005
Tanggal,.....Tahun 2005
Tentang Kawasan Konservasi Laut Kabupaten Berau



No	Lintang Utara			Bujur Timur			Keterangan
	Deg	Min	Sec	Deg	Min	Sec	
1	2	26	3.97	117	59	17.16	Batas Berau - Bulungan
2	2	29	42.60	118	0	3.00	
3	2	21	37.00	118	37	49.00	
4	1	48	9.00	119	2	52.00	
5	1	2	19.70	119	2	50.30	
6	1	2	0.06	118	59	4.31	Batas Berau - Kutim

APPENDIX 4. Pictures

Tursiops aduncus

by Danielle Kreb

Distinctively longer beaks compared to T. truncatus ***By Danielle Kreb***

Distinctive darker cape and lighter lateral body colour patterns ***By Budiono***

S. attenuate - A high variation in degree of spotting was observed within individuals

By Danielle Kreb

By Danielle Kreb

Feeding in late afternoon together with brown boobies, Sula leucogaster

By Danielle Kreb

Stenella longirostris

By Budiono

Herd of spinners near Derawan island

By Danielle Kreb

S. longirostris with cookie cutter shark bite

By Robert L. Pitman

T. truncatus

By Robert L. Pitman

By Robert L. Pitman

T. truncatus calf with deviant body colouring pattern

By Danielle Kreb

D. capensis tropicalis?- extremely long-beaked common dolphin

By D. Kreb

Orcaella brevirostris

By Robert L. Pitman

Sousa chinensis

By Danielle Kreb

By Danielle Kreb

Biopsy sampling- Note small hole in the blubber

By Lisa. T Balance

Survey observation teams

Dramatic landscape of the Berau coastline

Survey Expenses, October2007- April 2007

Currency	Indonesian Rupiah	HongKong Dollar
Available amount of funding	Rp110.786.000	HKD 99.968
Budget line/item		
Traveling cost (survey team):	Rp14.740.000	HKD 13.266
Accommodation, Food, Aqua	Rp13.000.500	HKD 11.700
Equipment/Maintenance/Consumables	Rp8.236.500	HKD 7.413
Boat rent (34 days X Rp. 1000.000)	Rp34.000.000	HKD 30.600
Communication (Satellite sim card)	Rp1.000.000	HKD 900
Insurance (4 persons)	Rp2.300.000	HKD 2.070
Exporting samples	Rp1.000.000	HKD 900
Honor principal investigator (including survey, analysis, reporting Indonesian/ English)	Rp23.225.000	HKD 20.903
Honor research assistants (3)	Rp14.700.000	HKD 13.230
TOTAL RESEARCH	**Rp112.202.000**	**HKD 100.982**