

NOTES ON TWO CETACEAN SURVEYS IN THE GULF OF TONKIN, VIETNAM

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ABSTRACT. – During 17-26 October 1999, we searched for cetaceans along 665 km of trackline in coastal and offshore waters of the Gulf of Tonkin. We had five cetacean sightings: two of Indo-Pacific humpbacked dolphins *Sousa chinensis*, one of finless porpoises *Neophocaena phocaenoides*, one of a mixed school of pantropical spotted dolphins *Stenella attenuata* and probable spinner dolphins *S. longirostris* (subspecies unknown), and one of a probable bottlenose dolphin *Tursiops* sp. During 2-11 April 2000, we searched along 1,146 km of trackline in the same waters. We had four sightings: one of bottlenose dolphins (*Tursiops* sp.), one of spinner dolphins (probable dwarf form – *S.l. roseiventris*) and two of Indo-Pacific humpbacked dolphins. Although sighting conditions were often poor, our results indicate that cetaceans occur in low (but un-quantified) densities in Vietnamese waters of the Gulf. Possible reasons for this include historically sparse populations due to natural ecological conditions in the Gulf or population declines caused by anthropogenic impacts, including accidental entanglement in gillnets, reduced prey availability from overfishing, and mortality caused by fishing with explosives. During the surveys we observed push-net fishing vessels using explosives near the mouth of Halong Bay and the partial carcass of a finless porpoise that appeared to have been cut in half to extract it from a gillnet.

KEY WORDS. – Cetaceans, Gulf of Tonkin, Vietnam, China, dolphin, porpoise.

INTRODUCTION

Shipboard sighting surveys in four disparate areas of the Vietnamese coast (total 1,121 km searched), including nearshore waters of the Gulf of Tonkin, inside and near Halong Bay, during spring and fall of 1995 recorded very few cetacean sightings: two of Indo-Pacific humpbacked dolphins *Sousa chinensis*, one of an unidentified small whale (probably Cuvier's beaked whale *Ziphius cavirostris*), and one of an unidentified delphinid (Smith et al., 1995, 1997). Little information is available on the status of cetaceans in Chinese waters of the Gulf, but evidence from other regions

of China (e.g., Liaoning, Hebei, Shandong, Jiangsu and Fujian Provinces) indicates that bycatch is an increasing problem (Zhou & Wang, 1994), particularly for finless porpoises *Neophocaena phocaenoides* (Parsons & Wang, 1998). These considerations and recommendations made at the Workshop on the Biology and Conservation of Small Cetaceans and Dugongs of Southeast Asia, Dumaguete, Philippines 1995 (Perrin et al., 1996) provided the background for conducting an investigation on the distribution and abundance of cetaceans in the Gulf of Tonkin and for making observations on conservation threats.

Table 1. Details of cetacean sightings during 17-26 October 1999 survey of the Gulf of Tonkin.

Sight #	Date (Oct)	Time	Position	Species	Group Size	Comments
1	17	11:08	20°45.17'N 106°52.12'E	Indo-Pacific humpbacked dolphin	2-4-2*	Mother/young pair. Larger one creamy white with a hint of pink and blue/gray speckles on dorsal surface. Smaller one all dark gray. Small possibility that a resighting after turning the vessel was of a separate pair – thus the high estimate of four individuals.
2	18	14:42	20°42.90'N 107°20.35'E	Finless porpoise	2-2-2	Sighting made in Beaufort 5 conditions.
3	22	11:56	19°27.58'N 106°56.27'E	Pantropical spotted dolphin (80%) and probable spinner dolphin (subspecies ?) (20%)	50-70-100	Sighting made in Beaufort 5 conditions. A small proportion of the school had distinctively more triangular fins. No other distinguishing features of spinner dolphins were observed before we lost sight of the group. Several neonates were present.
4	25	16:17	20°01.14'N 106°37.69'E	Bottlenose dolphin (?)	1-1-1	Sighting made off effort in Beaufort 7 conditions. Identification tentative.
5	26	13:14	20°49.90'N 106°47.56'E	Indo-Pacific humpbacked dolphin	3-3-3	Sighting made off-effort in the rain but conditions later cleared giving us clear views of the animals. Two dolphins appeared similar to those in sighting# 1. Other animal was medium length and had a white – blue/gray blotchy appearance. Thought to be a subadult.

* Ordered according to best, high, and low estimates.

Our investigation consisted of a three-day training program for scientists from China and Vietnam on cetacean field identification and survey techniques and two shipboard surveys of the Vietnamese side of the Gulf during autumn and spring. During the surveys we also made opportunistic observations of conservation threats and estimated the density and abundance of fishing vessels according to type. This last activity was conducted as a preliminary attempt to establish a baseline for future assessments of trends in fishing effort and potential impacts on the availability of cetacean prey and magnitude and distribution of cetacean bycatch. The methods and results for this component are reported in Appendix 1. We were unable to obtain permission for conducting surveys on the Chinese side of the Gulf.

During the study, we examined data on cetacean catches from a gillnet study conducted by the Ministry of Fisheries in Vietnam and the Japan International Cooperation Agency to assess the relative abundance of 'large-sized pelagic resources' within the south and south-central waters of the country's Exclusive Economic Zone. Although this study was conducted just south of the Gulf, we present the information in Appendix 2 because threats from gillnet entanglement are likely to be similar.

STUDY AREA

The Gulf of Tonkin, referred to as Beibu Wan in China and Vinh Bac Bo in Vietnam (between 17° and 20° north and 105° and 109° east), is less than 100 m deep throughout and conditions are strongly influenced by the northeast monsoon

from December to February, and the southeast monsoon from June to August. During the northeast monsoon, productive upwelling occurs along the mainland shelf (Meth & Helmer, 1983). Halong Bay National Park, which was designated a UNESCO World Heritage Site in 1994, is located in the northern portion in Vietnam. The park encloses about 3,000 small limestone islands and includes mangroves, fringing coral reefs, rocky shores and enclosed bays. The remaining coastline of the Gulf, including Hainan Island, comprises mostly sand beaches and mangrove forests, with coral reefs

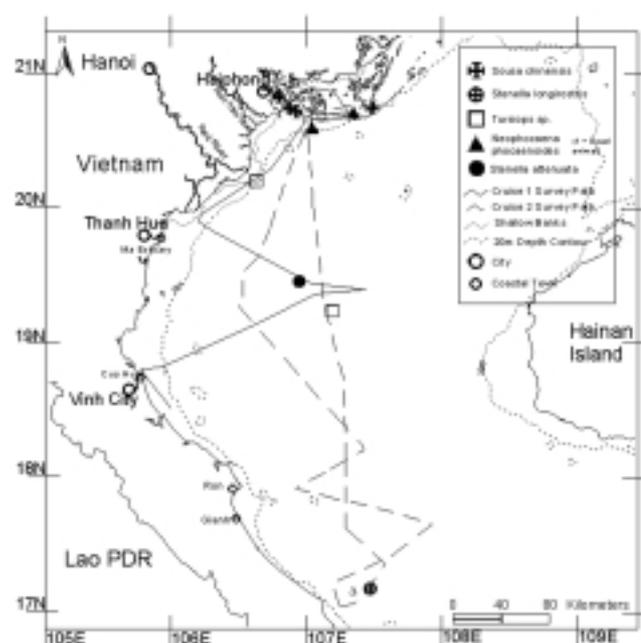


Fig. 1. Map of the Gulf of Tonkin showing survey tracklines and the location of cetacean sightings made during this study.

Table 2. Details of cetacean sightings during 2-11 April 2000 survey of the Gulf of Tonkin.

Sight #	Date (Apr.)	Time	Position	Species	Group Size	Comments
1	4	13:45	19°14.39'N 107°08.69'E	Bottlenose dolphin <i>Tursiops</i> sp.	2-4-2	Appeared slightly more robust and with a shorter rostrum than <i>T. aduncus</i> . We did not get a sufficient look at the dolphins to make a positive identification to species.
2	6	15:06	17°10.49'N 107°17.59'E	Spinner dolphin <i>Stenella longirostris</i> (probably <i>roseiventris</i> subspecies)	90-60-110	Identified as dwarf spinners on the basis of small size (max. length estimated at 140cm) and abnormally large dorsal fins and flippers in comparison to body size of adult animals. Neonates present.
3	11	9:16	20°45.58'N 107°17.44'E	Indo-Pacific humpbacked dolphin	1-1-1	One adult dolphin (unspotted creamy white-pink coloration). Sighting more offshore than normal distribution.
4	11	13:32	20°43.28'N 106°55.24'E	Indo-Pacific humpbacked dolphin	2-2-2	One adult and one subadult (smaller and profusely spotted).

* Ordered according to best, high, and low estimates.

at the Sanya National Nature Reserve on the southern tip of Hainan Island, China.

METHODS

We conducted a visual search for cetaceans from a fishing vessel (length: 24.9 m, width: 5.3 m, engine: 300 Hp) following a roughly zig-zag course from nearshore waters to the approximate territorial limits of Vietnam, and south and north along the perimeter of the coast. Three observers searched for cetaceans, one on each of the port and starboard sides, with handheld binoculars (Fujinon 7X50 with an internal compass) and naked eye from the beam to about 10° past the bow, and one in the center searching about 20° directly in front of the bow. The center observer also served as the data recorder. The eye height of the observers above the waterline was about 12 m. Observers rotated through each position at 30-minute intervals, followed by a 30-minute watch for fishing vessels (see Appendix 1), before taking an hour break. At least one of the first two authors of the present paper (B.D.S. and G.B.), both of whom have had extensive experience conducting at-sea surveys for cetaceans in Southeast Asia and other tropical waters, were always part of the survey team and confirmed all species identification.

On a standardized effort log we recorded our position, speed, course and distance covered along the trackline using a Global Positioning System (GPS) and information on Beaufort sea-state, presence or absence of fog and/or rain, and estimates of visibility. Data entries were made after observer rotations and any substantial change in vessel course and sighting conditions. On a separate form, we recorded sighting information, which included the geographic position, estimated distance to the cetacean group, relative angle of the group from the bow, Beaufort sea-state, group size (best, high, and low estimates), and the diagnostic features that allowed us to identify the animals to species (or lowest taxonomic group). We also conducted more casual surveys in estuaries from a smaller fishing vessel.

RESULTS

During 17-26 October 1999, we searched for cetaceans along 665 km of trackline (mean vessel speed = 13.1 km/hr; see Fig. 1). Sighting conditions were generally poor, with effort conducted in Beaufort sea states of 1-3, 4-5, and 6-7 during 18.9%, 63.9%, and 17.2% of the total time (50.5 hr), respectively. Fog or rain compromised search effort during 12.1% of the total time. Search effort was suspended for three days and was conducted for less than two hours on the last day because of typhoon warnings, high sea-states and intense fog and rain. We had a total of five cetacean sightings: two of Indo-Pacific humpbacked dolphins *Sousa chinensis*, one of finless porpoises *Neophocaena phocaenoides*, one of a mixed school of pantropical spotted dolphins *Stenella attenuata* and probable spinner dolphins *Stenella longirostris* (subspecies unknown), and one of a probable bottlenose dolphin *Tursiops* sp. (see Table 1). Two of these sightings were made "off effort" while only casually searching for cetaceans during poor weather.

During 2-11 April 2000, we searched along 1,146 km of trackline (mean vessel speed = 11.9 km/hr; see Fig. 1). Sighting conditions were fair and effort was conducted in Beaufort sea states of 1-3, 4-5, and 6-7 during 49.5%, 38.6%, and 11.9% of the total time (96.2 hr), respectively. Fog or rain compromised search effort during 32.4% of the total time. We had a total of four sightings: one of bottlenose dolphins, one of spinner dolphins (probable dwarf form - *roseiventris* subspecies), and two of Indo-Pacific humpbacked dolphins (see Table 2).

We also searched for cetaceans in the Ca River mouth and adjacent coastal waters for 4.5 hr from a 15 m fishing vessel on 17 April 2000 and in the Ma River mouth and adjacent coastal waters for 3.5 hr from a 35 m fishing vessel on 19 April 2000. During both surveys, sighting conditions were good with a Beaufort sea state of two or less. No cetaceans were observed during either survey.

On 17 and 19 October, in the mouth of Halong Bay, we observed a large number of push-net vessels (8-12 m mechanized boats with a V-shaped net, spread with two wooden booms extending from the bow) fishing with explosives. A spotter atop the mast directed the boat to a 'breezer' and threw explosive charges into the surfacing fish school.

During the April 2000 survey, we found the partial carcass (anterior half) of a finless porpoise floating next to a gill net. The cut was extremely clean, suggesting that it may have been done with a knife, perhaps after the porpoise's tail had become wrapped in the nearby gillnet.

DISCUSSION

Species. – We had four sightings of Indo-Pacific humpbacked dolphins. Three of these were in the Nam Trieu River mouth and the other was in shallow water (<20 m) offshore of Cat Ba Island. One of the participating scientists (D.V.D) also reported sighting two humpback dolphins a few miles offshore of the Ca river mouth on 15 March 2000. The majority of our survey effort was conducted in marine waters unaffected by freshwater inputs, the apparent preferred habitat of this species in Southeast Asia (Jefferson 2000), so the density of humpbacked dolphins within their area of occupancy in the Gulf may be greater than indicated by the overall scarcity of sightings during our surveys.

During the October 1999 survey, we had one sighting of two finless porpoises in nearshore waters just north of Halong Bay. During the April 2000 survey we also found a partial carcass of a finless porpoise floating next to a gill net just south and offshore of the Nam Trieu river mouth. The caretaker of the Do Son Marine Station showed us photographs of two finless porpoises that were reportedly found stranded nearby in December 1998 and July 1999.

A dwarf form of spinner dolphin *S. l. roseiventris* has been described as occurring in shallow waters of inner Southeast Asia, replaced in deeper and outer waters by the larger *S. l. longirostris* (Perrin et al., 1989, 1999). We sighted spinner dolphins in the northern Gulf that we tentatively identified as coming from the *roseiventris* subspecies, due to their small size, and disproportionately large rostrum and dorsal and pectoral fins (in comparison to larger forms of the species). The first author of this paper has had extensive experience observing spinner dolphins in the Eastern Tropical Pacific on surveys conducted by the U.S. National Marine Fisheries Service, including the three other subspecies: *S. l. longirostris*, *S. l. orientalis* and *S. l. centroamericana*, and feels confident about the subspecies identification. However, recognizing that we have no photographic documentation of the sighting and that a confirmed record would constitute a significant range extension for the subspecies, previously only recorded from shallow waters of the Gulf of Thailand and Timor and Arafura Seas, we conservatively log the identification as tentative.

Pantropical spotted dolphins have a widespread distribution in tropical waters. We made a sighting of spotted dolphins in the central Gulf, possibly associated with spinner dolphins (subspecies unknown).

Two species of bottlenose dolphins have been recognized: *Tursiops truncatus*, which is widespread in temperate and tropical waters, and *T. aduncus*, occurring in shallow tropical waters along the coast of eastern Africa and westward to northern Australia (Rice, 1998).

Smith et al. (1995, 1997) reported a stuffed specimen of a bottlenose dolphin from a stranding in Halong Bay stored at the Research Institute of Marine Products (RIMP). The specimen was unidentified as to whether it was from *aduncus* or *truncatus* forms and it has since been discarded, due to poor preservation. The same researchers recorded nine bottlenose dolphin skulls stored at whale temples along the coast of south and south central Vietnam; all but one were considered to be from the *aduncus*-type. During our surveys in the Gulf we had one positive and one probable sighting of bottlenose dolphins. Due to poor sighting conditions we were unable to determine if these were from the *aduncus* or *truncatus* species.

All four positive species identifications made during our surveys (Indo-Pacific humpbacked dolphins, pantropical spotted dolphins, finless porpoises, and spinner dolphins) represent new records for the Vietnamese side of the Gulf of Tonkin. Smith et al. (1995, 1997) documented all four of these species as occurring in Vietnam but those records were from the south and south-central waters of the country, which are characterized by different bathymetric and oceanographic conditions.

Cetacean Density. – The few sightings we made were clearly insufficient for estimating cetacean abundance, reporting meaningful encounter rates or describing distribution patterns. The paucity of cetaceans observed during these surveys, combined with similar results from surveys reported in Smith et al. (1995, 1997), indicates that cetaceans occur in low (although un-quantified) densities in Vietnamese waters of the Gulf of Tonkin. Possible reasons for this include that cetaceans were never found in high densities or that their numbers have been reduced by anthropogenic impacts (e.g., gillnet entanglement, and possibly prey declines as a result of overfishing).

Threats. – Accidental entanglement in gillnets is recognized as one of the dominant factors (or perhaps the foremost one; see Reeves & Reijnders, 2002) threatening small cetaceans worldwide (Perrin et al., 1994). The observation of half a carcass of a finless porpoise that was almost certainly caught in a gill net indicates that incidental catches of cetaceans may be a significant problem in the Gulf of Tonkin. We are also concerned about observations of push-net fishermen using explosives in waters just outside of Halong Bay. High sound levels and rapid pressure changes from explosions can result in the direct death of cetaceans or indirect killing from

permanent hearing damage that disables their primary sense of echolocation (Richardson et al., 1995). Fishing with explosives may also promote competitive interactions between fisherman and cetaceans, when both are attracted to fish that float to the surface. Competition for dwindling fish resources may ultimately undermine the venerated status that cetaceans enjoy among Vietnamese fishing communities (see Smith et al., 1995, 1997; Thai, 1996). Using explosives for fishing is illegal in Vietnam, but there appears to be little or no enforcement, as the activity could be observed from a far distance by the waterspout created by the explosion, which appeared similar to, but wider and more concentrated than the blow of a large whale.

Research and Conservation. – Conserving cetaceans in areas where they occur in low densities, whether due to anthropogenic effects or limited habitat, is a challenging task. From a research perspective, the results of our investigation argue against conducting further dedicated surveys, except perhaps specifically for humpbacked dolphins in the Nam Trieu river mouth. We do, however, recommend that information on cetaceans be collected routinely as a regular part of national fisheries and oceanographic research programmes conducted in the Gulf. We also suggest that a bycatch monitoring program be established at government fisheries offices in major fishing ports. This monitoring programme should document information on the number, species identification and morphometrics of cetacean carcasses brought into port by local fishermen. Efforts should be also made to reduce cetacean bycatch and laws prohibiting fishing with explosives should be strictly enforced as part of an overall strategy for managing sustainable fisheries.

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APPENDIX I

FISHING VESSEL SURVEY

While surveying for cetaceans, we used a strip transect method to estimate fishing vessel density. A separate observer stood watch and recorded sightings of active fishing vessels (i.e. fishing gear deployed and not just underway or at drift) when they were located perpendicular to the beam of either side of the vessel. On a standardized form, we recorded data on the geographic position, number and classification of fishing vessel(s), and estimated distance from our position. We classified fishing vessels as: 1) shrimp trawler: horizontal booms deployed on each side with one or more trawl nets deployed; 2) stern trawler: trawl nets deployed from the rear; 3) hang trawler: horizontal booms deployed on each side with vertical booms attached to the end of the horizontal ones and trawl nets deployed from these; 4) pair trawlers: two vessels travelling parallel about one km apart with trawl nets deployed from the stern; 5) gill netter: surface nets deployed with flags and buoys visible; 6) squid jigger: vessels with many large lights for attracting squid; 7) purse-seiner: large vessels with smaller skiff and net for encircling fish; or 8) long liner: long fishing lines with many hooks deployed from the stern of the vessels and buoys visible at the ends.

The width of the survey strip was determined post-hoc according to the distance that encompassed all observations of that vessel type. We assumed that all fishing vessels were observed in the survey strip and estimated fishing vessel density according to the total number of vessels of each type divided by the product of the strip width and length. An estimate of absolute abundance was calculated for each fishing vessel type according to the product of the density estimate and the area encompassed by one half the survey strip width outside of the trackline and the coast. The later was determined using a Geographical Information Systems (GIS) program. The CV for each abundance estimate was calculated according to the variation in the number of sightings among survey days.

Because of typhoon warnings and extremely poor weather conditions during the first survey, which adversely affected sighting conditions and resulted in many fishing vessels remaining in port, we only analyzed results from 1,072 km of search effort (90.5hr) conducted during nine days of the second survey (Fig. 2). During this time, weather conditions were judged to be calm enough so that fishing activity was normal and vessels could be observed for at least several kilometers. We recorded a total of 221 fishing vessels, including gill netters (68.3%), squid jiggers (4.5%), purse seiners (7.2%), pair trawlers (12.7%)¹, and unidentified (7.2%). No long liners or hang-, stern- or shrimp trawlers were observed. Of the gill netters, at least 17.9% were carrying floodlights, which indicated that they also fished

for squid at night. An unknown proportion of the other gill netters may have also carried lights, but these vessels were sighted at too great a distance to confirm their absence or presence.

For the sample of pooled vessel types, we calculated relative density and abundance estimates of 0.0172 vessels/km² and 823 vessels (CV = 0.34; total survey area = 47,920 km²), respectively. We then analyzed the abundance of fishing vessels according to type and found that, with the exception of gill netters, the CVs were too large (1.04-1.90) for the estimates to be meaningful. This was due to the small sizes of our samples (n=10-28) and the clumped distributions of vessel types. The relative and absolute abundance estimates for gill netters were 0.0117 vessels/km² and 562 vessels (CV=0.36), respectively. These data are particularly relevant to cetaceans, because gill netters probably account for the great majority of cetacean bycatch. In this analysis we did not include sightings made during the last day of 72 artisanal 'basket' boats used for inshore gillnetting and hand-line fishing. These were recorded between Cat Ba Island and the Nam Trieu river mouth, with vessel density particularly high inside the mouth (close to where we made three of the four sightings of Indo-Pacific humpbacked dolphins). Squid jiggers and gill netters were recorded in all offshore areas, particularly in the central Gulf. Pair trawlers were recorded operating in clumped aggregations, primarily in the southern offshore portion of the Gulf, while purse seiners were only observed in offshore waters.

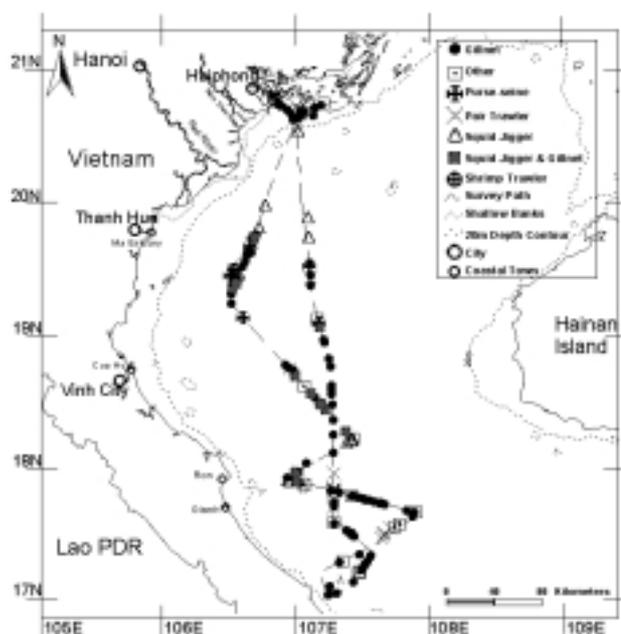


Fig. 2. Map of the Gulf of Tonkin, showing survey tracklines and the locations of fishing vessel sightings.

¹ A pair was counted as only a single vessel.

Appendix 2-Table 1. Details of cetaceans caught during marine resources study.

No.	Date	Species	Count	Position	Mesh Size (mm)	Comments
1	13/5/96	Striped dolphin <i>Stenella coeruleoalba</i>	2	12°29'N 111°27'E	150	Identification photo-confirmed
2	27/5/96	Fraser's dolphin <i>Lagenodelphis hosei</i>	1	8°52'N 109°27'E	150	Identification photo-confirmed. Stuffed specimen held at RIMP museum.
3	11/6/96	Pantropical spotted dolphin <i>Stenella attenuata</i> (?)	1	13°35'N 110°15'E	150	Identification tentative.
4	20/9/96	Pantropical spotted dolphin (?)	2	12°30'N 109°52'E	160	Probable mother/young pair. Identification tentative.
5	26/9/96	Pantropical spotted dolphin (?)	1	11°25'N 110°10'E	160	Identification tentative.
6	27/9/96	<i>Stenella</i> sp.	1	11°41'N 109°30'E	123	Juvenile. Identification tentative.
7	5/10/96	Pantropical spotted dolphin (?)	2	9°49'N 109°10'E	160	Both animals were neonates or juveniles. Identification tentative.
8	8/10/96	Short-finned pilot whale <i>Globicephala macrorhynchus</i> (?)	1	8°32'N 111°28'E	150	Found alive and released. Identification tentative.
9	18/10/96	Pantropical spotted dolphin (?)	1	109°40'N 14°13'E	150	Neonate or juvenile. Identification tentative.
10	31/5/97	Spinner dolphin <i>Stenella longirostris</i> (probably <i>longirostris</i> subspecies)	3	9°49'N 108°42'E	160	Identification photo-confirmed. Stuffed specimen held at RIMP museum.

APPENDIX 2

MARINE RESOURCES GILLNET STUDY IN SOUTH AND SOUTH-CENTRAL VIETNAM

During 1995 and 1996, the Ministry of Fisheries of Vietnam and the Japan International Cooperation Agency conducted a study of marine resources in the offshore waters of Vietnam exceeding 40m in depth. A major component of the at-sea portion of the study was an investigation of the relative abundance of "large-sized pelagic resources within the Vietnam Exclusive Economic Zone" (Fuyo Ocean Development & Engineering, 1997). The study area extended from 8° to 18° north latitude and as far as 113° east longitude, and was divided into one-degree latitudinal and longitudinal quadrangles. The study consisted of two phases:

- **Phase one:** A surface gillnet, five km long and 10 m deep, consisting of five panels of equal length and mesh sizes of 77 mm, 95 mm, 123 mm, 150 mm, and 160 mm, respectively, was set in the middle of each quadrangle from sunset to sunrise.
- **Phase two:** A surface gillnet, 4.5 km long and 10 m deep, consisting of six panels of equal length with the same

mesh sizes as the first phase, but with an additional one having a 100 mm mesh size, was set in the middle of each quadrangle from sunset to sunrise. During the second phase a second gillnet, 750 m long and 10 m deep with a mesh size of 100 mm, was also set 10 m below the surface.

Fifteen cetaceans from probably six different species were caught during the study (see Appendix 2-Table 1). Identifications of pan-tropical spotted dolphins and pilot whales are tentative. Both these species were found in "whale temples" along the south and south-central Vietnam coast by Smith et al. (1995, 1997) and spotted dolphins were observed during our survey in the Gulf of Tonkin. Their occurrence in gillnet catches would, therefore, not be surprising. It is perhaps relevant that all cetaceans, except for one, were caught in surface gill nets with mesh-sizes of 150 mm or greater. The exception was a probable *Stenella* sp. caught in the next smaller size mesh of 123 mm. Although smaller mesh size nets may be less selective with regards to catching large-size fish, thereby possibly affecting the availability of dolphin prey, use of the larger mesh nets apparently resulted in a higher rate of cetacean mortality from accidental entanglement.