Aquatic Mammals 2016, *42*(4), 462-465, DOI 10.1578/AM.42.4.2016.462

Short Note

Abundance Estimates of Indo-Pacific Humpback Dolphins (*Sousa chinensis*) in Kuching Bay, East Malaysia

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Indo-Pacific humpback dolphins (*Sousa chinensis*, Osbeck, 1765) occur in shallow coastal waters from the east coast of India to central China and throughout Southeast Asia (Jefferson & Rosenbaum, 2014). While the species has been studied extensively in Hong Kong (e.g., Jefferson, 2000), China (Zhou et al., 2007; Chen et al., 2009, 2010), and Taiwan (Wang et al., 2007; Wang & Yang, 2011), very little is known about populations in Borneo, of which Sarawak is a part (Minton et al., 2016).

Prior to the current study, only a few researchers had reported on or reviewed the occurrence of humpback dolphins in Sarawak (e.g., Gibson-Hill, 1950; Beasley & Jefferson, 1997; Beasley, 1998; Jaaman, 2004; Minton et al., 2011). None of these sources provided any detail about the species' fine-scale distribution, ecology, or abundance estimates in Sarawak waters.

In the Kuching Bay, Irrawaddy dolphins (*Orcaella brevirostris*, Owen in Gray, 1866), finless porpoises (*Neophocaena phocaenoides*, Cuvier, 1829), Indo-Pacific bottlenose dolphins (*Tursiops aduncus,* Ehrenberg, 1833), and humpback dolphins occur in sympatry (e.g., Beasley & Jefferson, 1997; Minton et al., 2011, 2013). In line-transect surveys conducted in 2010-2011, Irrawaddy dolphins and finless porpoises were the two most frequently encountered species for which abundance estimates were generated—Irrawaddy dolphins: 149 individuals (CV = 28%, 95% confidence interval [CI] 87 to 255) and finless porpoises: 135 individuals (CV = 31%, 95% CI 74 to 246) (Minton et al., 2013). Humpback dolphins, however, were less frequently encountered, and the number of sightings was insufficient for population estimation using *DISTANCE* (Buckland et al., 2001). Herein, the results of a 2-y mark-recapture study on this species using photo-identification data are presented.

Photo-identification studies of humpback dolphins were conducted concurrently with line-transect surveys in the nearshore waters of the Kuching Bay (see Minton et al., 2013). Boat surveys were conducted on four consecutive days per month during the dry season between March 2010 and October 2011 (Figure 1).

Standard photo-identification protocols were followed during each dolphin sighting (e.g., Parra, 2006; Minton et al., 2013). Photographs of left or right sides of dorsal fins (LDFs and RDFs) were cropped, digitally enhanced, and entered into a custom-designed *Microsoft Access*® database. Photographs of LDFs and RDFs of dorsal fins were treated as two separate datasets due to the inability, in most cases, to definitively link the LDFs and RDFs of individual dolphins. All photographs were catalogued based on identifiable features (e.g., dorsal fin shapes, colouration, and scarring), regardless of quality and distinctiveness. Unique identification codes were assigned to each new individual that could not be matched to existing photographs in the database.

Each photograph was assigned scores based on four categories for photo quality and distinctiveness of dorsal fins (Minton et al., 2013). To minimise the bias that could be caused by failure to recognise individuals because of poor photo quality or lack of distinctiveness or "marking," only good quality photographs of distinctive individuals were used for mark-recapture analysis (see Minton et al., 2013). For each sighting event, the proportion of "marked" individuals was calculated by dividing the number of individuals meeting the distinctiveness criteria by the total number of individuals photographed that day. This proportion

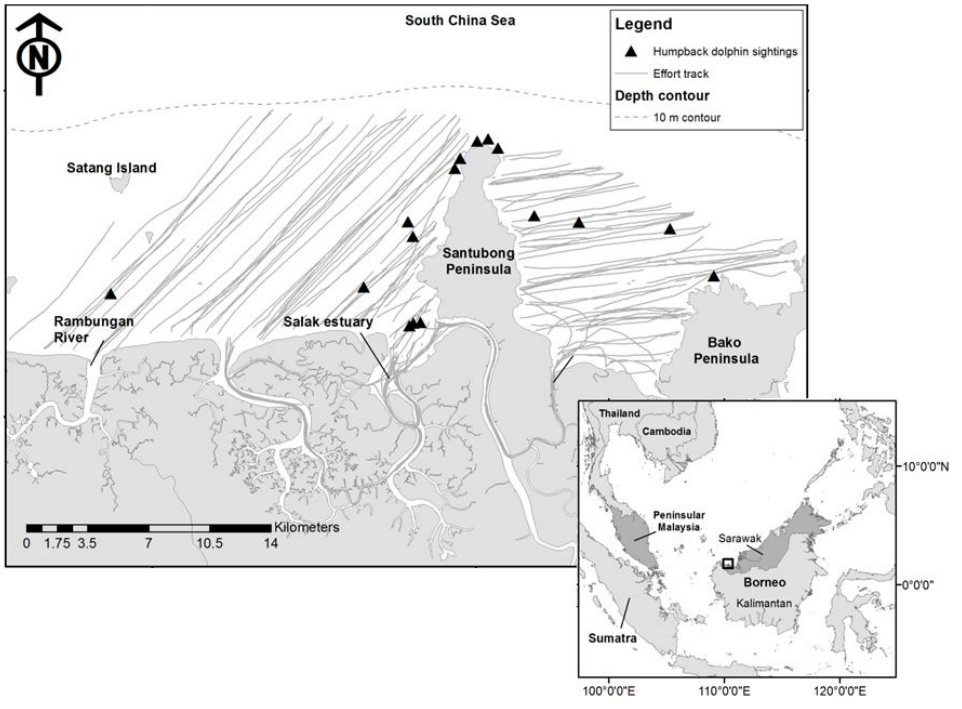

Figure 1. Map of Kuching Bay showing actual survey tracks and sightings of humpback dolphins encountered from March 2010 through October 2011

was averaged over all 12 capture occasions to generate a total proportion of marked individuals (p).

Datasets were tested for population closure using *CloseTest* (Stanley & Richards, 2005), and results suggest that the Kuching Bay population is closed with little or no permanent immigration.

Data were pooled into 12 capture occasions for which sightings from a single day represented one capture occasion. Identified individuals sighted twice in the same day were only counted once for that capture occasion. Abundance estimates of marked humpback dolphins ($\widehat{N}$) were calculated using the closed capture model in Program *MARK 6.1* (White & Burnham, 1999). Different data filtering criteria and different models were tested, and the model with the lowest Akaike Information Criterion (AIC) was selected. The best resulting estimate from this process was corrected for total population size ($\widehat{N}_{total}$), which was calculated using the formula

$$\widehat{N}_{total} = \frac{\widehat{N}}{p}$$

The final population size was calculated by combining both estimates of LDF and RDF as an inverse CV-squared weighted average following Wilson et al. (1999).

A total of 101 individuals of all levels of distinctiveness and photo quality were assigned catalogue ID numbers based on the LDF side, and 87 individuals were catalogued based on the RDF side. Of these, 77.2 and 67.8%, respectively, were catalogued during the first year.

Based on the mark-recapture analysis of marked individuals, the abundance estimates were 44 (CV = 15.3%, 95% CI = 36 to 65) for the LDF photos and 37 (CV = 14.0%, 95% CI = 31 to 54) for the RDF photos. Estimates of the proportion of marked individuals within the population were 0.575 (CV = 14.5%) for LDFs and 0.386 (CV = 26.3%) for RDFs. Abundance estimates corrected for the proportions were 77 (CV = 20.9%, 95% CI = 51 to 115) and 96 (CV = 26.3%, 95% CI = 58 to 159), respectively. Therefore, the best estimate of humpback dolphins in the Kuching Bay using inverse CV-squared weighted mean was 84 (CV = 16.4%, 95% CI = 61 to 116).

Observed group sizes ranged from seven to 45 individuals, with a mean of 18 (SD = 13.33). Thirty-three percent (n = 5) of observed groups contained more than 20 individuals. Fourteen out of 15 dolphin groups observed contained at least one calf, with six being the highest number of calves encountered in a group.

Possible violations of mark-recapture assumptions were minimised through the application of strict quality and distinctiveness criteria to avoid failure to recognise individuals. Efforts to take as many photographs of as many individuals in the group as possible without preference towards certain more distinctive individuals or those associating with the boat should also have minimised the possible heterogeneity of capture probability (Wilson et al., 1999; Bearzi et al., 2008).

While the abundance estimate is fairly low, incidental sighting reports indicate that there are communities of humpback dolphins in adjacent waters northeast of the study area around the Bako peninsula. It is not yet known whether the animals observed in our study region are a subset of a bigger population that includes neighbouring communities or whether this is the entire population for which the home range may extend outside the limits of the survey area. Therefore, there is a need to further understand their movement and ranging patterns in and beyond the boundaries of the study area. It is also not yet possible to determine a population trend as mark-recapture surveys need to be continued over several years to evaluate the status of the population as to whether it is stable, increasing, or decreasing. Such a long-term study is considered critical to the monitoring and conservation of this community.

Documented anthropogenic threats to the humpback dolphin populations throughout the species' range include coastal development which leads to habitat degradation (Jefferson et al., 2009), heavy boat traffic (Ng & Leung, 2003), pollution (Jefferson et al., 2006), and fisheries bycatch (Razafindrakoto et al., 2004; Jefferson et al., 2006). All of these threats are also present in Kuching Bay (Jaaman et al., 2009; Ling et al., 2010).

Entanglement in fishing gear presents the greatest threat to cetaceans globally (Read, 2008). Although the magnitude of bycatch in the Kuching area is unknown, incidental catches of humpback dolphins in gillnets elsewhere in Malaysia occasionally have been reported (Jaaman et al., 2009). Throughout the study period, observations of human activities around the dolphin groups (e.g., presence of fiberglass fishing boats with gillnets) were rare. Ten of 15 sightings were recorded without any observed human activities within a radius of approximately 500 m. While this means that the level of impact to this community from fisheries might be lower than for other small cetaceans living in the area (e.g., Irrawaddy dolphins and finless porpoises; Minton et al., 2013), studies have shown that populations of fewer than 100 individuals have a high probability of extinction (Thompson et al., 2000; Slooten, 2007), even when mortality rates are low. Future work should include an investigation into the relationship between the dolphins and fisheries by mapping the overlap between the dolphin core areas and fishing grounds as defined through direct observation and engagement with fishing communities.

Finally, genetic sampling of the species in the Kuching Bay and other parts of Borneo and/or Peninsular Malaysia is urgently recommended. Such sampling would help determine whether the population is truly isolated or still in breeding contact with other neighbouring communities—vital information for understanding the population's conservation status and vulnerability to decline in light of documented threats. Furthermore, Borneo represents a significant geographical gap in recent studies redefining the taxonomy of *Sousa* sp. (Jefferson & Rosenbaum, 2014). Data gained through genetic sampling of the Kuching community would be an important contribution to understanding the taxonomy of the species and the geographical boundaries between one species of *Sousa* and another.

Acknowledgments

The Sarawak Dolphin Project surveys were made possible through funding from the Ocean Park Conservation Foundation Hong Kong (OPCFHK) and the Ministry of Science, Technology and Innovation (MOSTI), Malaysia. We would like to thank both the Sarawak Forestry Department for the relevant permissions to conduct dolphin surveys in the Kuching Bay and the Permai Rainforest Resort for providing logistical support.

Literature Cited

Bearzi, G., Agazzi, S., Bonizzoni, S., Costa, M., & Azzellino, A. (2008). Dolphins in a bottle: Abundance, residency patterns and conservation of bottlenose dolphins *Tursiops truncatus* in the semi-closed eutrophic Amvrakikos Gulf, Greece. *Aquatic Conservation: Marine and Freshwater Ecosystems*, *18*(2), 130-146. http://dx.doi.org/10.1002/aqc.843

Beasley, I. (1998). *Research on the Irrawaddy dolphin (*Orcaella brevirostris*) in East Malaysia*. Report to the Ocean Park Conservation Foundation.

Beasley, I., & Jefferson, T. A. (1997). Marine mammals of Borneo: A preliminary checklist. *The Sarawak Museum Journal*, *51*, 193-216.

Buckland, S. T., Anderson, D. R., Burnham, K. P., Laake, J. L., Borchers, D. L., & Thomas, L. (2001). *Introduction to distance sampling: Estimating abundance of biological populations*. Oxford, UK: Oxford University Press.

Chen, B. Y., Zheng, D. M., Yang, G., Xu, X. R., & Zhou, K. Y. (2009). Distribution and conservation of the Indo-Pacific humpback dolphin in China. *Integrative Zoology*, *4*(2), 240-247. http://dx.doi.org/10.1111/j.1749-4877.2009.00160.x

Chen, T., Hung, S. K., Qiu, Y., Jia, X., & Jefferson, T. A. (2010). Distribution, abundance, and individual movements of Indo-Pacific humpback dolphins (*Sousa chinensis*) in the Pearl River Estuary, China. *Mammalia*, *74*(2), 117-125. http://dx.doi.org/10.1515/mamm.2010.024

Gibson-Hill, C. A. (1950). The whales, porpoises and dolphins known in Sarawak waters. *The Sarawak Museum Journal*, *1*, 288-296.

Jaaman, S. A. (2004, September). A review of current knowledge on marine mammals in Malaysia and adjacent waters. *ASEAN Review of Biodiversity and Environmental Conservation (ARBEC)*. 34 pp.

Jaaman, S. A., Lah-Anyi, Y. U., & Pierce, G. J. (2009). The magnitude and sustainability of marine mammal bycatch in fisheries in East Malaysia. *Journal of the Marine Biological Association of the United Kingdom*, *89*, 907-920. http://dx.doi.org/10.1017/S002531540800249X

Jefferson, T. A. (2000). Population biology of the Indo-Pacific hump-backed dolphin in Hong Kong waters. *Wildlife Monographs*, *144*. 65 pp.

Jefferson, T. A., & Rosenbaum, H. C. (2014). Taxonomic revision of the humpback dolphins (*Sousa* spp.), and description of a new species from Australia. *Marine Mammal Science*, *30*(4), 1494-1541. http://dx.doi.org/10.1111/mms.12152

Jefferson, T. A., Hung, S., & Lam, P. (2006). Strandings, mortality and morbidity of Indo-Pacific humpback dolphins in Hong Kong, with emphasis on the role of organochlorine contaminants. *Journal of Cetacean Research and Management*, *8*(2), 181-193.

Jefferson, T. A., Hung, S., & Würsig, B. (2009). Protecting small cetaceans from coastal development: Impact assessment and mitigation experience in Hong Kong. *Marine Policy*, *33*(2), 305-311. http://dx.doi.org/10.1016/j.marpol.2008.07.011

Ling, T. Y., Michelle, C. M., Nyanti, L., Norhadi, I., & Justin, J. J. E. (2010). Impacts of aquaculture and domestic wastewater on the water quality of Santubong River, Malaysia. *Journal of Environmental Science and Engineering*, *4*(4), 11-16.

Minton, G., Peter, C., & Tuen, A. A. (2011). Distribution of small cetaceans in the nearshore waters of Sarawak, East Malaysia. *The Raffles Bulletin of Zoology*, *59*(1), 91-100.

Minton, G., Zulkifli Poh, A. N., Peter, C., Porter, L., & Kreb, D. (2016). Indo-Pacific humpback dolphins in Borneo: A review of current knowledge with emphasis on Sarawak. *Humpback Dolphins (*Sousa *spp.): Current Status and Conservation: Part 2. Advances in Marine Biology (Journal of Cetacean Research and Management* (T. A. Jefferson & B. E. Curry, Eds.), *73*, 141-156. http://dx.doi.org/10.1016/bs.amb.2015.07.003

Minton, G., Peter, C., Zulkifli Poh, A. N., Ngeian, J., Braulik, G., Hammond, P. S., & Tuen, A. A. (2013). Population estimates and distribution patterns of Irrawaddy dolphins (*Orcaella brevirostris*) and Indo-Pacific finless porpoise (*Neophocaena phocaenoides*) in the Kuching Bay, Sarawak. *The Raffles Bulletin of Zoology*, *61*(2), 877-888.

Ng, S. L., & Leung, S. (2003). Behavioral response of Indo-Pacific humpback dolphin (*Sousa chinensis*) to vessel traffic. *Marine Environmental Research*, *56*, 555-567. http://dx.doi.org/10.1016/S0141-1136(03)00041-2

Parra, G. J. (2006). Resource partitioning in sympatric delphinids: Space use and habitat preferences of Australian snubfin and Indo-Pacific humpback dolphins. *Journal of Animal Ecology*, *75*(4), 862-874. http://dx.doi.org/10.1111/j.1365-2656.2006.01104.x

Razafindrakoto, Y., Andrianarivelo, N., & Rosenbaum, H. C. (2004). Sightings, catches, and other records of Indo-Pacific humpback dolphins in the coastal waters of Madagascar. *Aquatic Mammals*, *30*(1), 103-110. http://dx.doi.org/10.1578/AM.30.1.2004.103

Read, A. J. (2008). The looming crisis: Interactions between marine mammals and fisheries. *Journal of Mammalogy*, *89*(3), 541-548. http://dx.doi.org/10.1644/07-MAMM-S-315R1.1

Slooten, E. (2007). Conservation management in the face of uncertainty: Effectiveness of four options for managing Hector's dolphin bycatch. *Endangered Species Research*, *3*, 169-179. http://dx.doi.org/10.3354/esr 003169

Stanley, T. R., & Richards, J. D. (2005). Software review: A program for testing capture-recapture data for closure. *Wildlife Society Bulletin*, *33*(2), 782-785. http://dx.doi.org/10.2193/0091-7648(2005)33%5B782:SRAPFT%5D2.0.CO;2

Thompson, P. M., Wilson, B., Grellier, K., & Hammond, P. S. (2000). Combining power analysis and population viability analysis to compare traditional and precautionary approaches to conservation of coastal cetaceans. *Conservation Biology*, *14*(5), 1253-1263. http://dx.doi.org/10.1046/j.1523-1739.2000.00099-410.x

Wang, J. Y., & Yang, S. C. (2011). Evidence for year-round occurrence of the eastern Taiwan Strait Indo-Pacific humpback dolphins (*Sousa chinensis*) in the waters of western Taiwan. *Marine Mammal Science*, *27*(3), 652-658. http://dx.doi.org/10.1111/j.1748-7692. 2010.00422.x

Wang, J. Y., Yang, S. C., Hung, S. K., & Jefferson, T. A. (2007). Distribution, abundance and conservation status of the eastern Taiwan Strait population of Indo-Pacific humpback dolphins, *Sousa chinensis*. *Mammalia*, *71*(4), 157-165. http://dx.doi.org/10.1515/MAMM.2007.032

White, G. C., & Burnham, K. P. (1999). Program *MARK*: Survival estimation from populations of marked animals. *Bird Study*, *46*(S1), 120-139. http://dx.doi.org/10.1080/00063659909477239

Wilson, B., Hammond, P. S., & Thompson, P. M. (1999). Estimating size and assessing trends in a coastal bottlenose dolphin population. *Ecological Applications*, *9*(1), 288-300. http://dx.doi.org/10.1890/1051-0761(1999)009%5B0288:ESAATI%5D2.0.CO;2

Zhou, K., Xu, X., & Tian, C. (2007). Distribution and abundance of Indo-Pacific humpback dolphins in Leizhou Bay, China. *New Zealand Journal of Zoology*, *34*, 35-42. http://dx.doi.org/10.1080/03014220709510061