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Utilizing interview-based data to measure interactions of artisanal fishing communities and cetacean populations in Kuching Bay, Sarawak, East Malaysia

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ABSTRACT

Kuching Bay is a significant area for artisanal fishing activities as well as an Important Marine Mammal Area (IMMA) for coastal cetaceans. A total of 286 fishers from eight fishing communities were interviewed between 2011 and 2019 to determine the nature and extent of cetacean-fishery interactions in the area. The main types of fishing gears recorded were gillnets, trammel nets, trawl nets, longlines, handlines and crab traps, with the use of gears varying by season and target species. Depredation, net damage, and entanglements in fishing gear were the most frequently reported negative interactions with cetaceans. Thirty-six percent of fishers reported having experienced a cetacean entanglement in their fishing gear at least once. More than half (58.1%) of the respondents who experienced bycatch were able to disentangle and release the animals alive. The more conservative calculated bycatch rate of 0.36 cetaceans per fisher over a fishing career indicates that a minimum estimated average of 19 cetaceans are involved in bycatch annually in Kuching Bay, with as many as nine of these incidents likely resulting in mortality. However, a less conservative method yields a bycatch rate of 0.57 per fisher, and estimated an average of 30 bycaught cetaceans per year. Irrawaddy dolphins (*Orcaella brevirostris*) were reported to be at the highest risk (72.9% of reported incidents), with an estimated minimum of seven individuals caught and killed per year. Despite the negative interactions, 77.2% of respondents reported a generally positive attitude toward cetaceans based on their value for tourism and as indicators of fish presence and a healthy ecosystem. Mutualistic relationships between fishers and cetaceans were documented, with 53% of respondents reporting that they feed discarded fish to cetaceans. The results of this study can be used to guide effective mitigation measures, which should focus on training fishers in safe handling and release of entangled cetaceans, and, more importantly, methods to prevent interactions with gillnets.

1. Introduction

In areas where fisheries activities overlap with cetacean distribution, interactions can typically occur in many forms. Positive interactions include cooperative fishing between cetaceans and fishers (e.g. Smith et al., 2009), while negative interactions range from depredation (catch or bait consumption from the fishing gear) (Bearzi et al., 2011; Santana-Garcon et al., 2018; Pardalou and Tsikliras, 2020), to damage to fishing gear (Pardalou et al., 2022), depletion of cetaceans' prey (Bearzi et al., 2006), perceived reduction in quality of fishers' target catch (Bearzi, 2002), or entanglement in gear (bycatch) (Smith and Jefferson, 2002; Reeves et al., 2008, 2013; Jaaman et al., 2009; Gray and Kennelly, 2018). Bycatch in fisheries is known to be the leading cause of human-induced mortality to cetaceans worldwide (Read, 2008) and is one of the most significant challenges for cetacean conservation (Northridge et al., 2017). Small coastal cetaceans such as Irrawaddy dolphins (*Orcaella brevirostris*), Indo-Pacific finless porpoises (*Neophocaena phocaenoides*), Indo-Pacific humpback dolphins (*Sousa chinensis*) and Indo-Pacific bottlenose dolphins (*Tursiops aduncus*) are particularly vulnerable to bycatch in artisanal fishing gears especially

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as coastal construction and shrimp culture are degrading water quality in the area (Ling et al., 2010). According to Rosli et al. (2012), water quality in the tributaries along the Salak River is moderately or slightly polluted. High levels of Chemical Oxygen Demand (COD) and lead (Pb) were recorded, which may originate from untreated or partially treated sewage systems. Additionally, a 2014 study documented a high prevalence of skin disease in Irrawaddy dolphins in the Kuching Bay, possibly linked to environmental degradation that leaves dolphins vulnerable to bacteria and pathogens in sewage discharge, which enter through wounds and prey ingestion resulting in decreased fitness and death (Van Bressem et al., 2014).

Respondents reported that they most frequently observe cetaceans along the coast of Salak-Santubong Bay, throughout the Bako-Buntal Bay and along the coast of Muara Tebas village (Fig. 1). These sighting locations reported by the fishers mirror the distribution of cetaceans as reported by Minton et al. (2011), Minton et al. (2013), Peter et al. (2016b) and Zulkifli Poh et al. (2016), which demonstrated that Irrawaddy dolphins have a statistically significant affiliation with shallow estuarine habitats that are influenced by tidal shifts, while finless porpoises, humpback dolphins and bottlenose dolphins are found in more saline waters slightly further offshore. The areas indicated by the fishers also overlap with the areas identified as the areas of highest bycatch risk in a 2020 assessment using the Bycatch Risk Analysis GIS toolbox (Hines et al., 2020). These are the areas that should be prioritised for management measures.

Respondents perceived entanglement in fishing gear as the second most likely factor to contribute to cetacean mortality, although studies elsewhere indicate that it is likely to be the most significant cause. While a minority of fishers reported negative encounters or issues with cetaceans, a majority reported positive perceptions, often described a mutually beneficial relationship, where cetacean presence is perceived to indicate fish availability which then guides the fishers in changing fishing grounds. This supports findings of other studies on *Orcaella* sp. in India (D'Lima et al., 2014), as well as Laos and Myanmar (Stacey and Hvenegaard, 2002; Smith et al., 2009). Together with the species' perceived ability to generate tourism income for coastal communities, the 'entertainment' they provide for fishers at sea, and long-held cultural lore, these positive perceptions should help motivate fishers to participate in bycatch mitigation trials and other efforts to address bycatch.

4.3. Implications for conservation management

The results of this study should be used to design and implement mitigation measures to reduce bycatch to a level at or below the calculated sustainable limits for these populations. Given the high rates of live-release from fishing gear, an immediate priority should be the provision of training and resources that promote safe handling and release of live bycatch. The collaboration with fishers participating in interviews and live-release training could also be leveraged to begin robust trials of mitigation methods. Although reducing bycatch in artisanal gillnet fisheries is notoriously difficult (e.g., Northridge et al., 2017; FAO, 2021), a number of methods have been trialled with some success. Management options in the gillnet fisheries in Kuching Bay could include time-area closures (e.g., Beest et al., 2017; FAO, 2021), similar to what is planned for the management of tiger prawns in Kuala Baram, Sarawak (Abdullah et al., 2022), switching to longlines (Berninsone et al., 2020), and making nets more 'visible' to cetaceans with acoustic deterrent devices or 'pingers' (e.g., Dawson et al., 2013; Amano et al., 2017), lights (Bielli et al., 2020) or reflective beads (Kratzer et al., 2020). Discussions are underway with the International Whaling Commission's Bycatch Mitigation Initiative to seek support for trials that would evaluate the effectiveness of acoustic deterrents (pingers) in conjunction with the use of sound traps or similar passive acoustic methods to monitor cetacean presence around nets (e.g., Omeyer et al., 2020; Yayasan Konservasi RASI, 2021). Based on the results of these trials, methods that effectively reduce bycatch can be scaled up to the entire fishery to reduce bycatch on these Endangered and Vulnerable cetacean populations.

Interview-based surveys are effective for obtaining large volumes of data on artisanal fisheries at a relatively low cost compared to direct observations at sea (e.g., Moore et al., 2010). In small-scale artisanal fisheries, such as those employed in the Kuching Bay, Sarawak, it may be the only cost-effective and feasible means of obtaining preliminary bycatch rates for endangered coastal cetacean populations. While this study has provided a rough minimum estimate of cetacean bycatch, empirical validation of the data derived from interviews through other methods is recommended. Additionally, continued collection of interview data with adaptations to allow more accurate estimation of bycatch mortality rates for the populations of cetaceans in Kuching Bay will allow the detection of trends in bycatch rates over time, an effort that should go hand-in-hand with continued line transect and photo-identification surveys to ensure that the impact of bycatch can be accurately assessed against up-to-date abundance estimates. This level of cetacean population and bycatch monitoring is an essential component of fisheries management that can help the fisheries sector to comply with Sarawak's Biodiversity Master Plan (Tang et al., 2022), Malaysia's National Policy on Biological Diversity 2016–2025 (Ministry of Natural Resources and Environment, 2016), as well as international fisheries import and export rules, such as the US Marine Mammal Protection Act (MMPA) Import rule (NOAA, 2016), which is posing a challenge for fisheries throughout the ASEAN region (e.g. Johnson et al., 2017; Kaewnuratchadasorn, 2023).

Author contributions statement

GM, CP and AAT conceived the ideas and designed methodology; SA, CP, JN, and ANZP collected the data; SA, CP, GM, and AM analysed the data; SA, CP, and GM led the writing of the manuscript. All authors contributed critically to the drafts and gave final approval for publication.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

The data that has been used is confidential.

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