Marine Mammal Science

MARINE MAMMAL SCIENCE, **(*): ***–*** (*** 2017)
© 2017 Society for Marine Mammalogy
DOI: 10.1111/mms.12466

Living with dolphins: Local ecological knowledge and perceptions of small cetaceans along the Sindhudurg coastline of Maharashtra, India

Ketki Jog, Mihir Sule, Isha Bopardikar, The Konkan Cetacean Research Team, 9/A Balaji Apartments, Dutta Raul Marg, Dadar (W), Mumbai, 400028, India; **Vardhan Patankar,** The Konkan Cetacean Research Team, 9/A Balaji Apartments, Dutta Raul Marg, Dadar (W), Mumbai, 400028, India, National Centre for Biological Sciences, GKVK Campus, Bangalore, 560 065, India, and Centre for Wildlife Studies, 1669, 31st Cross, 16th Main, Banshankari, 2nd Stage, Bangalore, 560 070, India; **Dipani Sutaria,** The Konkan Cetacean Research Team, 9/A Balaji Apartments, Dutta Raul Marg, Dadar (W), Mumbai, 400028, India and College of Marine and Environmental Sciences, James Cook University, Townsville, Queensland 4811, Australia.

Abstract

Two near shore small cetaceans occur commonly along the Maharashtra coast, the Indian Ocean humpback dolphin and Indo Pacific finless porpoise. These cetaceans frequently interact with fisheries in this region due to overlap in space and resource use. Besides stranding records, little ecological information is available about these species from Maharashtra. We conducted 143 semistructured interviews to document local ecological knowledge and community perceptions of small cetaceans in 30 coastal fishing villages in Sindhudurg. Perceptions of finless porpoises were largely neutral, whereas humpback dolphins were negative. A classification regression tree (CART) analysis (root node error: 60%) showed that the annual cost of gear damage was an important predictor variable of humpback dolphin perceptions, followed by occupation (gear type) and age. Entanglements were reported for both species in large and small gill nets, and shore seines. Perceived net damage and catch loss due to humpback dolphins was six times greater than that of finless porpoises. However, finless porpoises were reportedly more frequently entangled in gear than humpback dolphins. We provide an insight into the perceptions of cetaceans in the local community and the fisheries-cetacean interactions that shape them.

Key words: *Sousa plumbea*, *Neophocaena phocaenoides*, local ecological knowledge, perceptions, cetacean-fisheries interactions, competition, marine mammals.

Coexistence of humans and wildlife and the overlap in space and resource use between them is especially evident in coastal ecosystems (Peterson *et al.* 2010). Global expansion of marine fisheries and coastal development (Read 2008, Pauly 2009) subjects these ecosystems to serious structural and functional changes, leading to unwanted pressures on a range of marine species, including cetaceans (DeMaster *et al.* 2001). Cetacean interactions with fisheries have been documented from many parts of

[1]Corresponding author (e-mail: ketki.jog@gmail.com).

the world (Zollet 2009). However, from areas where limited data exists, local ecological knowledge (LEK) (Uprety *et al.* 2012) can provide valuable baseline information and augment ecological data (Frans *et al.* 2016, Martinez-Levasseur *et al*. 2016).

Scientific publications and other records of cetaceans along the Maharashtra coast are meager. Newspaper reports of strandings and a few fishermen's accounts were the only evidence of cetacean presence, primarily two near-shore small cetacean species, namely, *Sousa plumbea* (Osbeck, 1765) (Indian Ocean humpback dolphin) and *Neophocaena phocaenoides* (G. Cuvier, 1829) (Indo-Pacific finless porpoise), along the Sindhudurg coast.

S. plumbea has recently been recognized as a distinct species (Jefferson and Rosenbaum 2014). The IUCN currently includes this as a subspecies under *Sousa chinensis* with a status of "Near Threatened" (Reeves *et al.* 2008). However, given its taxonomic distinctness, if reassessed, *S. plumbea* could be classified as "Endangered" (Braulik *et al.* 2015). *N. phocaenoides* has been assessed as "Vulnerable" (Wang and Reeves 2012) by the IUCN. Both these species are legally protected under the Indian Wildlife Protection Act (1972), Schedule II (Part I, Section 3C). Their habitat use, behavior, and foraging ecology along the Indian coast, however, remains understudied.

The Sindhudurg coastline (Fig. 1) in Maharashtra hosts a wide variety of fisheries operations, ranging from shore-based seines to industrial trawlers, in the range of these two cetacean species. Shore seines are nonmechanized and operated within few hundred meters of the shore. Small handheld gear, like hook and line and cast nets, are operated in the shallows and in estuaries. Small gill nets and mini purse nets are operated in coastal waters, rarely venturing beyond 20 m deep, using 2–8 m wooden or fiberglass crafts with outboard engines. Some small gill nets are operated from nonmechanized boats. Large gill nets generally operate beyond 30 m deep, using 7–11 m mechanized fiberglass boats. Trawl nets and purse seines operate beyond 36 m deep, using 10–18 m mechanized fiberglass or wood vessels. (KJ, personal observation).

S. plumbea are commonly seen foraging in near-shore and estuarine areas (Sutaria *et al.* 2015) rich in prey, such as oil sardine (*Sardinella* spp.), mackerel (*Rastrelliger kanagurta*), and pomfret (*Pampus* spp.) (Jefferson and Karczmarski 2001, Jefferson and Hung 2004). The preferred prey for *N. phocaenoides,* such as, crustaceans, cephalopods, and demersal species of small fish (Barros *et al.* 2002, Jefferson and Karczmarski 2001, Jefferson and Hung 2004) are also found in abundance in these waters (Srinath 2003, Bhathal and Pauly 2008).

Given the overlap in space use and resource competition, these two cetacean species are presumed to interact with coastal fisheries. Sindhudurg also hosts seasonal tourist traffic, with dolphin-watching being a newly emerging activity (Chakravarty 2003, Chakravarty *et al.* 2008, Sutaria *et al.* 2015). Due to its lucrative nature, since 2009, many fishermen are now also involved part-time in the dolphin watching tourism. As a result, encounters between dolphins and vessel traffic in Sindhudurg are also on the rise.[2]

In this study, we examine the local perceptions of fishermen towards these mammals and gain an insight into the fishermen-cetacean interactions that shape these views. We discuss the practicality of using interviews to collect data on species diversity, habitat, and ecology to augment vessel-based surveys.

[2]Sule, M., K. Jog, I. Bopardikar, V. Patankar and D. Sutaria. 2016. The status of cetaceans along the coast of Sindhudurg, Maharashtra. Report submitted to the Government of India, GoI-GEF-UNDP Sindhudurg Cetacean Project [unpublished].

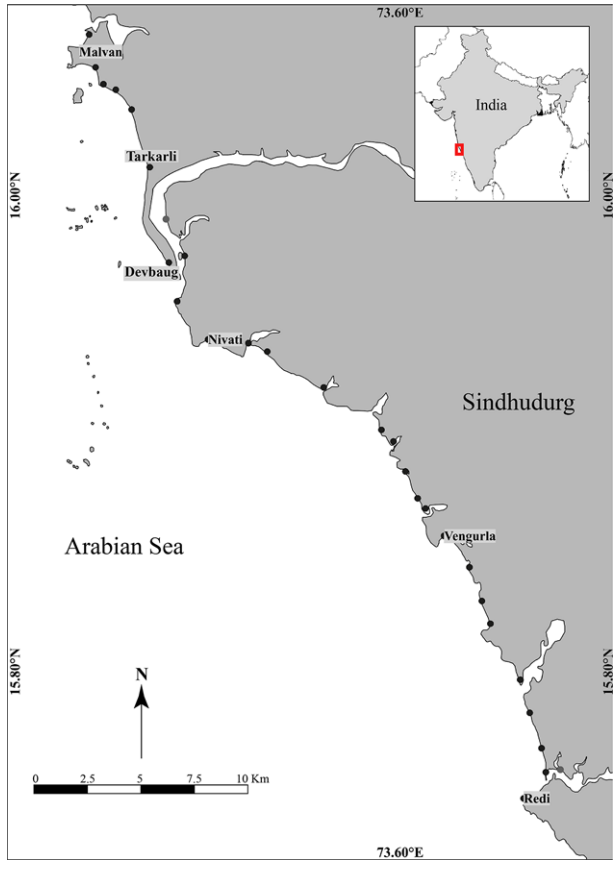


Figure 1. Map of the study area.

Methods

Study Area

The study covered 30 coastal fishing villages along 65 km of the Sindhudurg coast in Maharashtra, India, from Malvan in the north (16°4′12.07″N, 73°27′56.73″E) to Redi in the south (15°44′3.70″N, 73°42′35.98″E) (Fig. 1). The substrate in this region is sandy and muddy, dotted with rocky outcrops and submerged islands, with a large nutrient influx in its near-shore waters from small rivers.

Interview Surveys

We conducted 143 semistructured interviews with active fishermen in 30 coastal fishing villages between Malvan and Redi (Fig. 1), between February 2012 and September 2013. All respondents were male since fishing is an entirely male occupation in this area. The questionnaire was designed based on a discussion conducted by the authors with five community elders that have extensive knowledge of the study area and the fishing practices employed. All the interviews were conducted in one of

two regional languages, *Marathi* or *Malvani*, and lasted for 20–120 min. On completing an interview, the interviewees were requested to lead us to other potential respondents. In each village, at least 1% of the active fishing population encompassing all the gear types were interviewed.

The interviews commenced with questions about the background of the respondents and their occupation. They were then shown a photographic key of various cetacean species recorded in this area. Questions were asked pertaining to the species that the respondent identified from the key and were then aimed at understanding the attitude towards these species, the nature of interactions with and awareness about these cetaceans. Some questions were open-ended due to the descriptive nature of the answers expected. Oral history records from about 20 yr ago were documented as anecdotal evidence mainly from respondents aged >40 yr. The temporal scale of these data was within the context of historical milestones (*e.g.*, before the road to this village was built; when "X" was the chief minister; the year outboard motors were introduced by the government in the district). Due to the sensitive nature of certain questions (*e.g.,* deliberate culling, hunting; direct takes; the fate of live stranded individuals; carcasses, *etc.*) most interviewees were approached through a mutual contact to build a rapport and increase the possibility of honest answers.

Before commencing the interviews, respondents were informed of the purpose of the study and ensured that their responses would be kept confidential. Personal information was collected only for the purpose of records and analysis. All interviews were voluntary and the participants were given the option to eliminate their responses from the study at any time during or after the interviews.

Analysis

Data were categorized according to age classes (Fig. 2); involvement in dolphin tourism (yes or no); and occupation or the type of fishing gear used (large gill nets, small gill nets, shore seines, mini purse seines, and trawlers). Large and small gill nets fall under the broad category of gill nets, but are segregated based on mesh size (large gill net mesh size: >8 cm, small gill net mesh size: <8 cm) and usually correspond

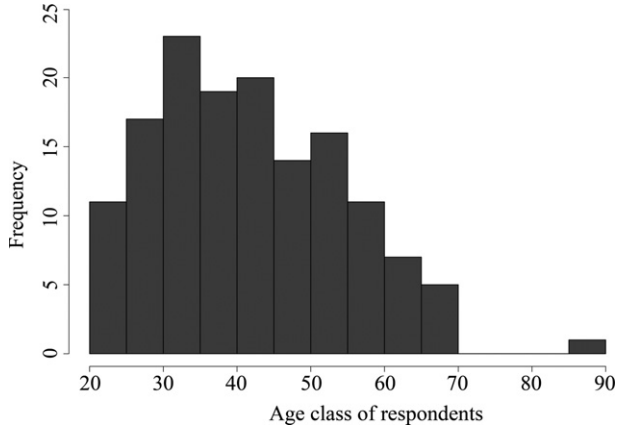


Figure 2. Age demographics of the respondents.

with their areas of operation; large gill nets are used in deeper waters (24 m and beyond) and small gill nets are used in shallower (up to 24 m) near coastal waters (KJ, personal observation).

Descriptive statistics of percent perception types (positive, negative, neutral) are presented as clustered bar graphs (Fig. 3, 4). A classification and regression tree analysis, CART (Breiman *et al*. 1984) was used to analyze the factors influencing perception towards *S. plumbea*. There was insufficient spread in the *N. phocaenoides* data for a CART analysis.

CART, being a nonparametric method, is not limited to a particular data distribution type. It can be used for building prediction models by recursively partitioning the data and fitting the models within these partitions that can be graphically represented as a decision tree. Moreover, CART allows many explanatory variables to be processed and the most important variables to be identified. The classification tree was constructed using the *rpart* package in RStudio (Version 0.99.903, 2009–2016) with the following factors as variables: age, occupation, frequency of catch loss, frequency of damage to nets, and annual cost of damage to nets (Fig. 5).

RESULTS

The age distribution of the 143 respondents is shown in Figure 2, with the largest percentage of individuals between 31 and 40 yr old (minimum: 20 yr, maximum 90 yr, mean: 42.7 yr).

All fishermen used more than one fishing gear to diversify their catch for economic stability. Small gill nets were the most commonly used gear type, with 79% (113) of the fishermen using them, while 38.5% (55) used large gill nets, 24.5% (35) operated shore seines, 6.3% (9) used mini purse seines, 4.9% (7) used trawlers and 0.7% (1) operated purse nets. Altogether, 27% (39) of the respondents were also involved in dolphin-based tourism in addition to fisheries.

Two species were most commonly reported from these waters, *S. plumbea* (Indian Ocean humpback dolphin) and *N. phocaenoides* (Indo-Pacific finless porpoise). All the interviewees were able to identify *S. plumbea* and 135 identified *N. phocaenoides*. Other species like *Tursiops* sp. (bottlenose dolphins), *Delphinus* sp. (common dolphins), and *Stenella longirostris* (spinner dolphins) were grouped together as offshore dolphins by 21% of the participants. Most respondents were unaware that cetaceans were mammals (92%) or that they breathe air (25%).

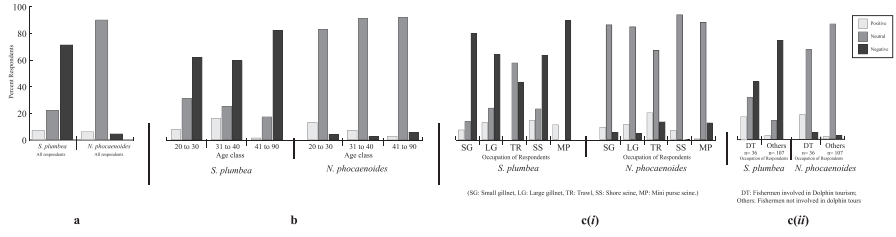
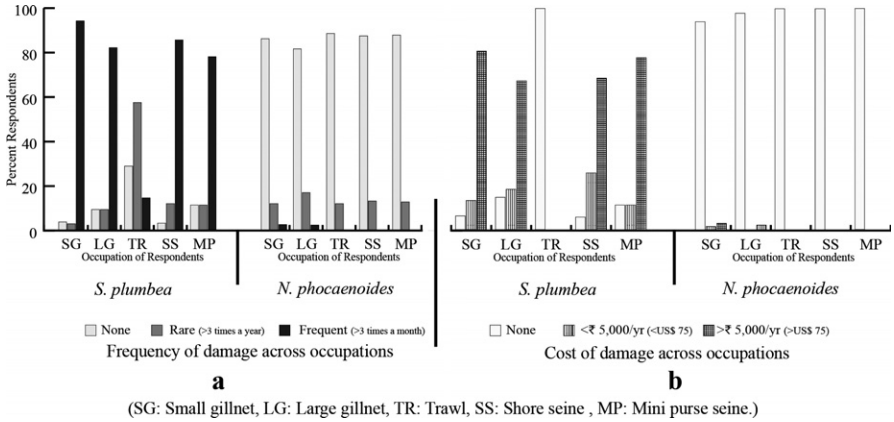
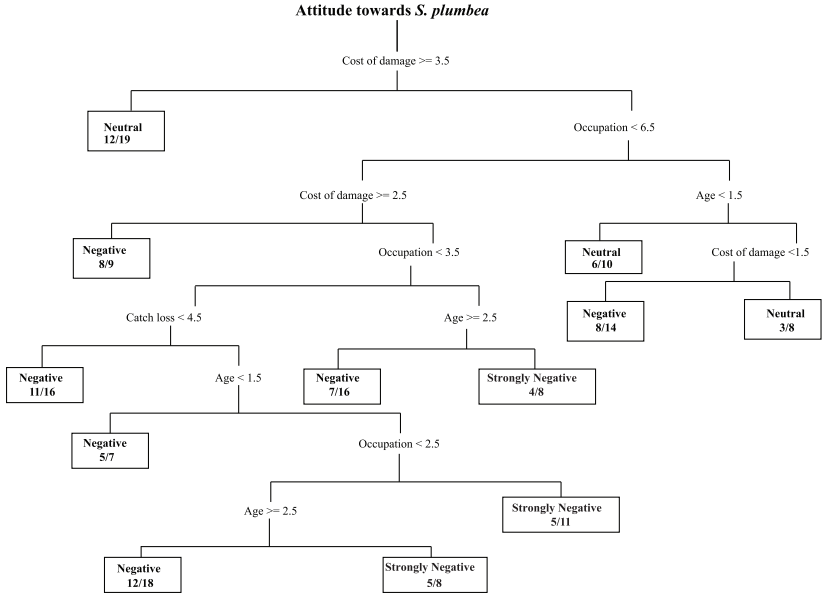


Figure 3. Fishermen's perceptions of cetaceans. (a) fishermen's perceptions of *S. plumbea* and *N. phocaenoides*; (b) fishermen's perceptions of cetaceans across age class of respondents; c(*i*) fishermen's perceptions of cetaceans across respondents' occupation (fisheries operations); c(*ii*) fishermen's perceptions of cetaceans across respondents' occupation (dolphin tour operators and others).



(SG: Small gillnet, LG: Large gillnet, TR: Trawl, SS: Shore seine , MP: Mini purse seine.)

Figure 4. Frequency and cost of damage due to *S. plumbea* and *N. phocaenoides* across occupation of respondents. (a) frequency of damage due to *S. plumbea* and *N. phocaenoides* across respondents' occupation; (b) cost of damage across respondents' occupation due to *S. plumbea* and *N. phocaenoides*.



The 5 variables were given codes as follow: Age class: 20 – 30 yrs = 1, 31 – 40 yrs = 2, 41 – 50 yrs = 3, 51 – 60 yrs = 4, 60 yrs and above = 5. Frequency of damage to nets, and frequency of catch loss: varied response = 6, very frequent (> 3 times a week) = 5, frequent (> 3 times a month) = 4, rare (> 3 times a year)= 3, very rare (once a year or less) = 2, never = 1. Annual cost of damage to nets*: > ₹ 10,000/yr. = 1, ₹ 5000-10,000/yr. = 2, ₹ 1000-5000/yr. = 3, < ₹1000/yr. = 4, none = 5, varied response = 6. Occupation: small gillnetter = 1, large gillnetter = 2, gillnetter (both small and large) = 3, shore seiner = 4, trawler = 5, multi-gear = 6, dolphin tourism = 7, dolphin tourism and small gillnet = 8, dolphin tourism and multiple gear = 9, dolphin tourism boat and shore seine = 10.

* Approximate conversion rate at the time the interviews were conducted: 1 US$ = ₹ 65- 67 (INR).

Figure 5. CART for the factors influencing perceptions of *S. plumbea*.

All respondents noted that humpback dolphins commonly occurred in water <10 m deep. Out of the 66 fishermen who commented on humpback dolphin group sizes, 42 said that there were usually >20 animals in a pod. One hundred and thirty-five

respondents had observed finless porpoises in water up to 30 m deep, of which 40 said that pod sizes of >20 animals were common. Twenty-five fishermen believed that humpback dolphin sightings were more frequent between the months of November and January. Very few respondents (7) suggested any seasonal change in finless porpoise encounters.

Of the 143 respondents, 62 suggested a decrease in encounter rates and pod sizes of finless porpoises since the mid-1990s. Conversely, 92 individuals observed an increase in humpback dolphin encounters and 23 thought that pod sizes had also increased over the same timeframe.

Fishermen's Perceptions of Cetaceans Based on Interactions

A majority of the respondents (90%) had a neutral perception of *N. phocaenoides,* while 71% had a negative perception of *S. plumbea* (Fig. 3a).

Interactions with fishing gear were a major cause for this negative attitude of the fishermen towards humpback dolphins. About 92% of the respondents faced catch loss and gear damage due to humpback dolphins (Fig. 4a). About 98% (111) of the small gill net users reported gear damage and 95.6% (108) reported catch loss due to depredation. Shore seine users (97%, 34) also reported gear damage and catch loss, with 85% of the respondents claiming frequent damages (Fig. 4a). Fishermen observed that specific fish species, such as sardines (*Sardinella* spp.), mackerel (*Rastrelliger kanagurta*), mullets (*Mugil* spp.), and pomfrets (*Pampus* spp.) in their catch increased the chances of depredation by humpback dolphins.

The cost of damage incurred due to humpback dolphins was usually more than INR 5,000 (~US$75) annually for 76% of the respondents. This expenditure was approximately equivalent to the average monthly earnings of a small gill net user. Mini purse seines and small gill nets were damaged most often by humpback dolphins compared to other gears and these fishermen incurred the largest economic losses from depredation. Trawl fishermen did not incur catch loss or gear damage (Fig. 4b). Finless porpoises are rarely (21) or never (112) reported to depredate fishing gear. Most (84%) of the fishermen maintained that no catch loss or gear damage was caused by porpoises; with only 14% of the respondents reporting monetary losses and 1% claiming frequent damage (Fig. 4b).

CART for Perceptions of S. plumbea

The classification tree was constructed using the four variables (cost of damage, gear type, age, and catch loss) with a predictive accuracy of 60% (Fig. 5). The most important predictor variable for attitude towards *S. plumbea* was the annual cost of damage to nets, followed by gear type used (occupation) and age.

A neutral attitude towards *S. plumbea* was most influenced by the cost of damage and the age class of respondents. Respondents involved in multigear fisheries and dolphin tourism between 20 and 30 yr old were more likely to have a neutral attitude. A strongly negative attitude was most influenced by the age and gear used by respondents. Respondents involved in multigear fisheries along with dolphin tourism were more likely to have a negative attitude if they were older than 30 yr and incurred an annual catch loss of more than INR 5,000. Respondents in the age classes of >40 yr were more likely to have a strongly negative attitude towards *S. plumbea*, regardless of the gear type they used. Respondents younger than 30 yr were likely to have a negative attitude if they were involved solely in fisheries, more so if the gear included

small or large gill nets or both. Fishermen not involved in dolphin tourism, incurring an annual catch loss of more than INR 5,000 had a negative attitude towards the animals (Fig. 5).

Entanglements in Fishing Gear

While perceived net damage and catch-loss was six times greater with *S. plumbea* than *N. phocaenoides*, the latter was more commonly entangled in fishing gears, particularly in gill nets. Being cryptic, most data on this species from the interviews was in the form of mortality and stranding records. Twenty-three fishermen believed that finless porpoises were more prone to entanglements in gear owing to their smaller size, blunt teeth, and absence of a snout, thus preventing them from gnawing their way out of gear, resulting in drowning.

Of the 143 respondents, 141 suggested that *S. plumbea* rarely, if ever, get entangled in gear, whereas 92 of 135 respondents thought *N. phocaenoides* entanglements were more common (>3/yr). Entanglements were reported for both species in large and small gill nets and shore seines. None of the respondents had seen cetacean entanglements in trawlers, mini purse nets, or purse nets. Respondents (5) believed that *S. plumbea* entanglements, though rare, happened most frequently in small gill nets when the animal was entangled in the top rope of the net. Reportedly, *N. phocaenoides* was most commonly entangled in large gill nets (17). A few cases of mortalities in small gill nets (4) and shore seines (10) were also reported. Of these reports, four instances involved entire pods of *N. phocaenoides* (4–12 dolphins) being caught in shore seines. In all cases but one, the porpoises reportedly drowned before they could be released.

Discussion

The local ecological knowledge described above provides information on the stakeholder perceptions of the two most commonly encountered coastal cetacean species along the Sindhudurg coastline of Maharashtra.

Despite encountering humpback dolphins and finless porpoises frequently, the fishermen had limited knowledge of their biology and life history. Group size reports from respondents seemed highly variable, with gross overestimates (thousands/hundred thousand), particularly when larger groups were observed during fishing gear interactions. A suggested increase in humpback dolphin encounters over the past few decades could be related to a decrease in prey causing them to forage more frequently from nets. Future research on foraging ecology and interactions with gears will help answer these questions.

Finless porpoise sightings and mortalities have supposedly declined in the past four decades. The fishermen believe this may be due to the fatal entanglements of this species in gillnets and shore seines. Studies across the species' range support the fact that finless porpoises are highly susceptible to accidental entanglement (Jefferson and Curry 1994, Yang *et al.* 1999, Collins *et al.* 2005, Jaaman *et al.* 2009, Braulik *et al.* 2010). The high number of reported mortalities and entanglements from the study area (13 *N. phocaenoides* as compared to 4 *S. plumbea* mortalities between 2012 and 2016)[3] stresses the need for focused studies and long-term monitoring of finless porpoises.

[3]See footnote 2 above.

The high economic costs of gear damage and catch loss due to depredation are the main drivers of negative perceptions of this species. Fishermen state that these dolphins are intelligent enough to forage prey in gill nets, they are more aware around nets and always keep their flukes away from the gear while foraging near them. Shore seine operators also recounted instances where dolphins had entered the nets, foraged near the cod end and then escaped by depressing the float-lined top ropes and leaping out. Interviews with fishermen from other parts of the Indian coastline also show negative perceptions towards humpback dolphins (Sutaria *et al.* 2015).

Interestingly, the respondents' age gave some insight into the historical roles of dolphins in the fishing community. The marked negative bias towards the dolphins by older fishermen could be due to three main reasons. The older fishermen have spent more time using nonmechanized boats; their limited range might have led to a greater area overlap with the dolphins. Moreover, this generation used hand-woven nets made of natural fibers that could easily tear and were labor intensive and expensive to repair. Finally, it is noteworthy that since the colonial era until about 1966, the District Fisheries Department had decreed a bounty on humpback dolphins, reinforcing this belief. A strong resentment towards this species may, therefore, have been prevalent in the fishing community for generations. The recent introduction of engines has led the younger generation to move to deeper waters, beyond *S. plumbea* habitat. In addition, modern mass-produced nets are less prone to damage and are cheaper, faster, and easier to repair with prefabricated patches. While the monetary gains from tourism may have made younger fishermen more tolerant towards these dolphins today, the deep-rooted resentment of the elders seems unaffected.

Quantifying catch loss or frequency of fisheries cetacean interactions from interviews is biased due to the negative nature of these interactions. Responses to certain questions on sensitive topics like the use of carcasses and deliberate culling (see Appendix S1) had to be discarded as some of the answers seemed unreliable. The 60% reliability of the CART analysis, implies other factors, not examined in this study, that influence the perceptions of fishermen towards dolphins for. However, the attitudes of fishermen towards the small cetaceans did not appear to affect the outcome of entanglements.

Despite the drawbacks of collecting secondary data, this study has provided a platform for future cetacean research and valuable insights into the fisheries-cetacean interactions from the Sindhudurg coast.

Acknowledgments

This study was funded by the Rufford Small Grants Foundation, U.K. (application no:11232-1, Received on 20 February 2012) and Idea Wild, U.S.A. (equipment grant, received on 24 February 2012). We thank the Offices of the Maharashtra Forest Department and Maharashtra Police-Oros and Malvan for their support and cooperation. We are grateful to the following for support on and off the field site; the late Mr. Gopal Bodhe, Mr. Bibhas Amonkar, Mr. Vibhav Manjrekar, Mr. Dada Kubal, Mr. Vasant Tandel, Mr. Shekhar Jadhav, Mr. Shiv Naik, Mr. Dada Muthe, Mr. Gopinath Tandel, Mr. Subodh Khadapkar, Mr. Anvay Prabhu, and Mr. Rupesh Prabhu, and the fisheries societies in Malvan and Vengurla. Many thanks to Mrs. Priscilla and Mr. Gerwin D'Souza. We thank the fishing community in Sindhudurg for their wholehearted support and cooperation. All standard ethical norms for socio-economic research as per the guidelines set by the EU code of ethics were adhered to (http://www.respectproject.org/ethics/412ethics.pdf).

Literature Cited

Barros, N. B., T. A. Jefferson and E. C. M. Parsons. 2002. Food habits of finless porpoises (*Neophocaena phocaenoides*) in Hong Kong waters. Raffles Bulletin of Zoology Supplement 10:115–123.

Bhathal, B., and D. Pauly. 2008. 'Fishing down marine food webs' and spatial expansion of coastal fisheries in India, 1950–2000. Fisheries Research 91:26–34.

Braulik, G. T., S. Ranjbar, F. Owfi, T. Aminrad, S. M. H. Dakhteh, E. Kamrani and F. Mohsenizadeh. 2010. Marine mammal records from Iran. Journal of Cetacean Research and Management 11:49–64.

Braulik, G. T., K. Findlay, S. Cerchio and R. Baldwin. 2015. Assessment of the conservation status of the Indian Ocean humpback dolphin (*Sousa plumbea*) using the IUCN Red List criteria. Advances in Marine Biology 72:119–141.

Breiman, L., J. Friedman, C. J. Stone and R. A. Olshen. 1984. Classification and regression trees. CRC Press, Boca Raton, FL.

Chakravarty, I. 2003. Marine ecotourism and regional development: A case study of the proposed Marine Park at Malvan, Maharashtra, India. Pages 177–197 *in* B. Garrod and J. C. Wilson, eds. Marine ecotourism: Issues and experiences. Channel View Publications, Clevedon, U.K.

Chakravarty, I., B. Prideaux, D. J. Timothy and K. Chon. 2008. Heritage tourism and community participation: A case study of the Sindhudurg Fort, India. Pages 189–202 *in* B. Prideaux, D. J. Timothy and K. Chon, eds. Cultural and heritage tourism in Asia and the Pacific. Routledge, New York, NY.

Collins, T., A. Preen, A. Willson, G. Braulik and R. M. Baldwin. 2005. Finless porpoise (*Neophocaena phocaenoides*) in waters of Arabia, Iran and Pakistan. International Whaling Commission, Scientific Committee Document SC/57/SM6.

DeMaster, D. P., C. W. Fowler, S. L. Perry and M. F. Richlen. 2001. Predation and competition: The impact of fisheries on marine-mammal populations over the next one hundred years. Journal of Mammalogy 82:641–651.

Frans, V. F., and A. A. Augé. 2016. Use of local ecological knowledge to investigate endangered baleen whale recovery in the Falkland Islands. Biological Conservation 202:127–137.

Jaaman, S. A., Y. U. Lah-Anyi and G. J. Pierce. 2009. The magnitude and sustainability of marine mammal by-catch in fisheries in East Malaysia. Journal of the Marine Biological Association of the United Kingdom 89:907–920.

Jefferson, T. A., and B. E. Curry. 1994. A global review of porpoise (Cetacea: Phocoenidae) mortality in gillnets. Biological Conservation 67:167–183.

Jefferson, T. A., and S. K. Hung. 2004. A review of the status of the Indo-Pacific humpback dolphin (*Sousa chinensis*) in Chinese waters. Aquatic Mammals 30:149–158.

Jefferson, T. A., and L. Karczmarski. 2001. Sousa chinensis. Mammalian Species 655:1–9.

Jefferson, T. A., and H. C. Rosenbaum. 2014. Taxonomic revision of the humpback dolphins (*Sousa* spp.), and description of a new species from Australia. Marine Mammal Science 30:1494–1541.

Martinez-Levasseur, L. M., C. M. Furgal, M. O. Hammill and G. Burness. 2016. Towards a better understanding of the effects of UV on Atlantic walruses, *Odobenus rosmarus rosmarus*: A study combining histological data with local ecological knowledge. PLOS ONE 11(4):e0152122.

Pauly, D. 2009. Beyond duplicity and ignorance in global fisheries. Scientia Marina 73:215–224.

Peterson, M. N., J. L. Birckhead, K. Leong, M. J. Peterson and T. R. Peterson. 2010. Rearticulating the myth of human–wildlife conflict. Conservation Letters 3:74–82.

Read, A. J. 2008. The looming crisis: Interactions between marine mammals and fisheries. Journal of Mammalogy 89:541–548.

Reeves, R. R., M. L. Dalebout, T. A. Jefferson, *et al*. 2008. *Sousa chinensis*. The IUCN Red List of Threatened Species 2008:e.T20424A9197694. Available at https://doi.org/10.2305/iucn.uk.2008.rlts.t20424a9197694.en. Downloaded on 4 October 2017.

Srinath, M. 2003. Appraisal of the exploited marine fishery resources of India. Pages 1–17 *in* M. Mohan Joseph and A. A. Jayaprakash, eds. Status of exploited marine fishery resources of India. Central Marine Fisheries Research Institute, Kochi, India.

Sutaria, D., D. Panicker, K. Jog, M. Sule, R. Muralidharan and I. Bopardikar. 2015. Humpback dolphins (Genus *Sousa*) in India: An overview of status and conservation issues. Advances in Marine Biology 72:229–256.

Uprety, Y., H. Asselin, Y. Bergeron, F. Doyon and J. F. Boucher. 2012. Contribution of traditional knowledge to ecological restoration: Practices and applications. Ecoscience 19:225–237.

Wang, J. Y., and R. Reeves. 2012. *Neophocaena asiaeorientalis*. The IUCN Red List of Threatened Species 2012:e.T41754A17599353. Available at https://doi.org/10.2305/iucn.uk.2012.rlts.t41754a17599353.en. Downloaded on 1 June 2017.

Yang, G., K. Zhou, X. Xu and S. Leatherwood. 1999. A survey on the incidental catches of small cetaceans in coastal waters of China. Chinese Journal of Applied Ecology 10:713–716.

Zollett, E. A. 2009. Bycatch of protected species and other species of concern in US east coast commercial fisheries. Endangered Species Research 9:49–59.

Received: 9 January 2017
Accepted: 13 October 2017

Supporting Information

The following supporting information is available for this article online at http://onlinelibrary.wiley.com/doi/10.1111/mms.12466/suppinfo.

Appendix S1. Questionnaire used to interview fishermen.