Final Report for the Society for Marine Mammalogy: Small Grants in Aid of Research (2020-2022)

Title: Social-Ecological significance of interactions between humpback dolphins and small-scale fisheries along the Sindhudurg coast in Maharashtra, India

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1. **Project Summary:** Interactions between fisheries and Indian Ocean humpback dolphins (*Sousa plumbea*) are a cause of concern off the Sindhudurg coast of southern Maharashtra, an important area for humpback dolphins. Humpback dolphins interact with a range of fisheries, some of which cause dolphin injury and mortality, and also economic losses to fishers. In this study, I used a multi-methods ethnographic approach to: (i) understand how interactions with dolphins affect fishers economically, and (ii) to inform adaptive management of these interactions in Sindhudurg.

2. **Introduction:** The Sindhudurg district, along the west coast of India, extends to 120 km from Vijaydurg to Redi (Figure 1). With several small seasonal and perennial rivers acting as nutrient influxes, there is an abundance of prey species like mullet, sardines, mackerel and pomfret. This area along the coast is ideal habitat for prey species, a range of fisheries and humpback dolphins.

   Sindhudurg hosts about 25,375 fishers (Government of Maharashtra 2003). Fishery operations include artisanal mechanized and non-mechanized crafts, using cast-nets, shore-seines, gillnets (mono/multifilament, mesh-size: 0.5 cm -38 cm) and commercial mechanised gear like trawlers and purse-seines (FAO 2001-2016). Gillnet operations are evenly distributed. Trawlers are common in the north and central region. Purse-seines are common in the southern part of the district and shore-seines, along the central region.

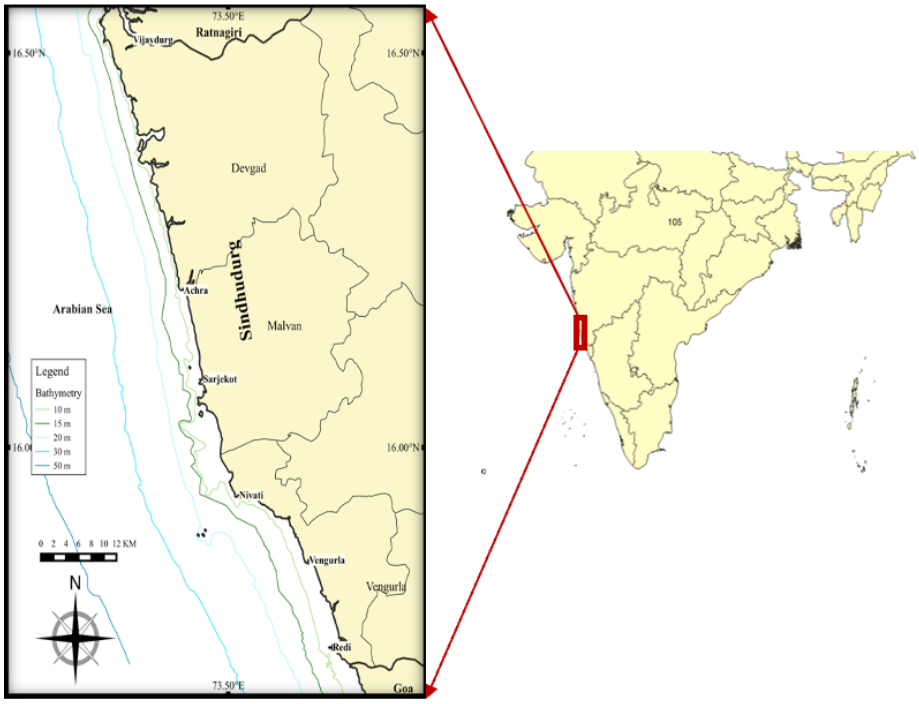

Figure 1 Study Area

Dolphin interact with and often damage gillnet, shore-seine and purse-seine fisheries targeting common fish like mullet, pomfret (*Pampus sp.*), mackerel (*Rastrelliger kanagurta*) and sardines (*Sardinella sp*.). These interactions lead to considerable economic loss due to net damage and catch loss, and strong negative perceptions of dolphins (Jog et al. 2018). Fishers describe instances where dolphins habituate to gillnets fishing for mullet, sardine and mackerel. Similar habituation is observed in harbours where dolphins associate with vessels bringing in the day's catch, having learned to exploit the discards (personal observations).These behaviours suggest that local fisheries are shaping the foraging strategies of at least some individual dolphins. Given their ease in exploiting highly concentrated food sources from fishing gear, such short-term benefits to dolphins appear to outweigh the cost of interacting with fishing nets potentially leading to dolphin mortality. Studies also indicate that local dolphin populations have high site fidelity, adding to the likelihood of local extinctions (Braulik et al. 2015, Sutaria et al. 2015).

This study aimed to understand the nature of these interactions. Current management strategies are based on patchy documentation of interactions, e.g., the state government of Maharashtra announced a compensation scheme in 2018, promising an amount of ~US$400 for the safe release of entangled dolphins (Mumbai Mirror 2018). Systematic understanding of the causes of interactions that lead to negative outcomes and the characterisation and distribution of such interactions, however, is lacking. Moreover, there is an urgent need to quantify the effects on fishers' livelihoods to inform an adaptive management process. The study tries to fill these gaps along the Sindhudurg coast of Maharashtra to inform their management.

3. Research questions and objectives

The main aim of this project is to inform the management response to direct interactions between dolphins and fisheries in Sindhudurg, by studying the and socio-economic aspects of the problem through the following objectives:

a. To characterise negative interactions between dolphins and different fishing gear.
b. To identify the impact of interactions between dolphins and fishers on fisher livelihoods.
c. To characterise and understand the fishers' views of management decisions to mitigate interactions.

4. Summary of methods and timeline:

I used an ethnographic approach to collect qualitative information from fishers to understand the scale and fishers' views of marine mammal interactions with fisheries and their management. The field work was conducted between March 2022 and January 2023. In this duration, I have conducted: (i) 167 semi-structured interviews, (ii) 6 key-informant interviews, and (iii) 5 focus group meetings.

i) Semi-structured interviews:

a. Duration: March 2022 to November 2022

Initially I conducted three trials (13 semi-structured interviews) in three villages. These trials were conducted to test the questionnaire and finalise the same for: (i) the duration of the interviews, (ii) leading questions regarding the fishery interactions with dolphins, and (iii) sensitive topics related to local management practices. The information from the trial interviews will not be used in the final analysis.

After the trial surveys, I conducted 157 semi-structured interviews using the finalised questionnaire. The study area was segregated into three regions, North, Central and South, based on the observed diversity of fishery operations, i.e., the different gear types used (gillnet, trawl, purse seine, modified purse seine, and shore seine fisheries). These surveys were conducted across all the fishing villages in the study area (Table 1) to capture the diversity in fishing operations among the different regions.

In general gillnet fisheries were common across all three regions. Trawl and purse seine fisheries were more common in the central and northern regions. Shore seine were more common in the central and southern regions, and modified purse seine fisheries were common in the southern region of the study area.

Table 1 Villages across the North, Central and Southern regions of the study area where semi-structured interviews were conducted. The table shows the total number of interviews in each village and the number of fishing households in the region (data collected from key-informants and regional fisheries societies).

Region	Villages	Number of respondents interviewed	Number of fishing households for each region
North	Vijaydurg	1	~465-500
	Devgad	16	
	Taramumbri-Mithmumbri	5	
	Katwan-Kunkeshwar	4	
	Tambaldeg-Morwewadi	5	
	Mithbav	2	
	Aadbander Aapyewadi	3	
Centre	Achra	8	~1600-1680
	Talashil-Tondavli	10*	
	Sarjekot-Kolamb	11	
	Chivala	19	
	Rajkot-Medha-Dandi	8	
	Wayari	10	
	Tarkarli-Devbag	11	
South	Bhogwe	1	~1800-2000
	Kille Nivti	5	
	Sriramwadi	5	
	Medha Nivti	4	
	Aadvel Nivti	1	
	Khavane	7	
	Kalvi Bunder-Kelus Mobar	2	
	Kondura	1	
	Dabholi Wayangani	3	
	Dabhoswada-Navabaug	10	
	Mooth-Sagareshwar-Kurlewadi	5	
	Mochemaad	2	
	Sagartirth Aravali-Shiroda Velagar	2	
	Shiroda Kerwadi	4	
	Redi	2	
Total number of respondents		157	

*Trial surveys, not included in the final tally of total respondents.

ii) Key-informant interviews

Duration: November 2022 to December 2023

I purposively selected six fishers operating different fishing gears, specifically experienced fishers who could give an in-depth insight not only about the fishing operations but also current fisheries management practices and issues in the region.

iii) Focus group meetings
Duration: December 2022 to January 2023

I conducted six focus group meetings (Table 2) across the all the fishing gear types operated in the region, except the purse seine fishers. Focus group meetings were conducted mainly to understand the efficacy and implementation process of existing management measures, enforcement issues and possible suggestions of mitigation measures from the communities.

Table 2 Details of focus group meetings conducted across the study area.

Region	Focus group no.	Gear type	No. of attendees	Age group
South	1	Gillnet	9	29-66
	2	Mini Purse seine	11	33-76
Central	3	Gillnet + Shore seine	11	43-78
North	4	Gillnet	15	32-68
	5	Trawl	6	40-63

5. Data analysis and dissemination of results

I will use qualitative research methods to analyse these data, mainly to:

i) describe the events that take place during interactions between dolphins and different fishing gear types,
ii) to characterise the socio-economics of fisheries in this region,
iii) to assess the economic impacts of dolphins damaging and preying on fish inside gears, for different fisheries, and
iv) to collate fishers views on management of fisheries and possible suggestions for mitigating negative interactions

These data will provide a detailed documentation of the scale and negative impact of dolphin interactions on fisheries and how these interactions shape fishery operations in Sindhudurg. The results will inform the adaptive management of direct interactions along the coast of Sindhudurg.

I plan to publish two papers based on semi-structured interviews and focus group meetings, respectively, in peer reviewed journals. These two papers will also contribute two data chapters towards my doctoral thesis.
I also plan to write a report of the findings in English and in Marathi for dissemination among the key-informants and fisheries societies in the Sindhudurg district.

The resulting publications and reports will also be shared with the Society of Marine Mammalogy.

6. Budget

Item	Description	Allocated cost ($)	Cost utilized	Justification
Field vehicle	Fuel and maintenance for field vehicle.	$900	$600	Fuel costs were calculated at $1.5/liter at 100 liters for study duration, in the allocated cost. We utilised ~90 litres of fuel. The balance accounted for vehicle maintenance.
Living and sustenance costs	Food and lodging costs of PI on the field site.	$1100	$1400	The cost covered house rent allowance and sustenance for 10 months of field work (earlier allocated 6 months) at the rate of $155 per month for PI and field assistant. The extra costs were derived from the allocated budget for field vehicle allowance
Total		$2000		

Field work images

1. Interviews with gillnet fishers

2. Gillnet fisher illustrating the part of the gillnet reportedly damaged by dolphins

3. Interview with gillnet fishers

4. Focus group meeting with shore seine fishers

5. Focus group with gillnet fishers

6. Gillnets reportedly damaged by dolphins