Local Ecological Knowledge Resulting from Turtle-Fisher Interactions at Sagareshwar Beach, Vengurla

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2018

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CERTIFICATE

This is to certify that the work incorporated in this report entitled ***"Local Ecological Knowledge Resulting from Turtle-Fisher Interactions at Sagareshwar Beach, Vengurla"*** submitted by the undersigned Research Team was carried out under my mentorship. Such material as has been obtained from other sources has been duly acknowledged.

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ABSTRACT

Sea turtles are an important component of India's natural heritage, and five species- the green, hawksbill, leatherback, loggerhead and olive ridley turtles- feed in its coastal waters and nest on the mainland and island beaches. As sea turtles spend most of their life at sea, studying their biology is challenging. Sea turtles are vulnerable to a number of threats, the largest of which are impacts from fisheries. The majority of recent research on sea turtle biology and threats in India have been focused on populations of the east coast, so knowledge gaps exist in all of these areas for west coast populations.

Local ecological knowledge (LEK) from turtle-fisher interactions can be used to collect information about sea turtle abundance and distribution, threats from small-scale fisheries, and fishers' attitudes towards turtles. Structured interviews with 93 male fishers at Sagareshwar Beach, Vengurla, in the Sindhudurg District of Maharashtra, revealed accounts of observations of all five sea turtle species in local waters. Importantly, this was a new record of loggerhead turtles for the Sindhudurg District coast, and leatherback turtles had not been reported for 20 years. Fishers did not contribute LEK about sea turtle abundance and distribution from the waters they fished, but did report perceived decreases in the size of local populations.

At least one sea turtle per year had been accidentally caught by 67.1% of the respondents, and fishers also described increasing numbers of turtles entangled in their fishing gear over the last 5 years and their lifetime. The predominant use of gill nets while fishing (72.5% of fishers) likely contributed to this capture rate. Sea turtles observed floating at sea (72.1% of fishers) or stranded on the shore (75.6% of fishers) were most likely suffering the effects of being entangled in fishing gear and/or inhaling sea water. Recommendations that could potentially aid the reduction of turtle bycatch include alterations to, or change of, fishing gear, and usage of simple and inexpensive technology such as net illuminators.

Lost or discarded fishing gear was abundant in local waters (observed by 75.3% of respondents), and sea turtles were observed (40.5% of fishers) entangled in such ‘ghost gear’ at sea. Its most likely source is fishers at Sagareshwar Beach and adjacent fishing villages, as 30.0% of respondents disposed of their nets on the beach or at sea. Ghost gear has been a known contributor to sea turtle entanglement and mortality globally, especially in the Indian Ocean, and suggested methods for mitigation of this threat include physical removal from the ocean, appropriate disposal of nets, and economic incentives for the same.

Many of the fishers were Hindu (76%) and believed that the sea turtle was *Kurma*, an incarnation of the deity Lord Vishnu, which potentially facilitated conservatory practices such as releasing entangled turtles (100% of respondents). Economic incentives also played a role in shaping such behaviours, and most fishers (65.9%) were aware of the legal protection of sea turtles. However, respondents described illegal consumption of sea turtle meat and eggs among members of the fishing community, indicating that legislation was not always abided by. This threat should be immediately quantified and addressed by conservation action.

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CHAPTER 1. INTRODUCTION AND METHODOLOGY

1.1 INTRODUCTION

India has a rich cultural heritage; it is an amalgamation of thousands of communities, religions, languages, cuisines, dance, music, arts and architecture, shaped by a history that dates back 5,000 years. An often overlooked part of its heritage is India's natural heritage, encompassing the country's varied landforms, geology, and biodiversity.

Sea turtles constitute an important part of the national biodiversity as India's coasts and islands are home to five (green, leatherback, olive ridley, loggerhead, hawksbill) of the seven species found around the world (World Wildlife Fund, 2013). However, four of the sea turtle species found in Indian waters have undergone significant population declines (Andhare & Hatkar, 2015), and all five species feature on the IUCN Red List of Threatened Species (Gray & Kennelly, 2018).

In recognition of the importance of the sea turtle to India's biodiversity and heritage, measures have been taken by both governmental and non-governmental organisations and groups to protect these threatened species. All sea turtles are also listed under Schedule 1 of the Indian Wildlife (Protection) Act (1972), which gives them maximum protection under the law via restrictions on hunting, trade, transport and possession of wild animals and punishment of offenders of the same. India's CRZ (Coastal Regulation Zone) Notification of 2011 (notified under the Environment Protection Act of 1986) declared the beaches on which sea turtles nest to be Ecologically Sensitive Areas (Sachithanandam, Mageswaran, Sridhar, Arumugam, & Ramesh, 2015).

There are several non-governmental conservation organisations such as the Students Sea Turtle Conservation Network (SSTCN) in Chennai, Tamil Nadu (Shanker & Kutty, 2005), and the Sahyadri Nisarga Mitra in Chiplun, Maharashtra (Sanaye & Pawar, 2009), that undertake extensive local conservation action. Twenty-seven NGOs collaborate and cooperate as part of the nation-wide Turtle Action Group (Shanker, Manoharakrishnan, &

Namboothri, n.d.) which provides a platform for the exchange of information regarding sea turtles of the Indian subcontinent.

Unfortunately, despite conservation efforts, sea turtle species in India still face grave threats akin to those faced by sea turtles globally: direct take of sea turtles and their eggs, coastal development, pollution and pathogens, global warming, and the activities of, both, commercial and artisanal fisheries (IUCN SSC Marine Turtle Specialist Group, 2010). Research focus had been earlier placed on large scale fisheries with respect to sea turtle bycatch rates. However, the levels of sea turtle bycatch in small-scale fisheries were determined to be similar to those of larger commercial ones, if not greater (Casale, 2011; Lewison & Crowder, 2007) (as cited in Gray & Kennelly, 2018). There is a critical knowledge gap about the extent of this, and other, threats to sea turtle populations in the Indian Ocean, including Indian waters (Hamann et al., 2010; Rees et al., 2016; Wallace et al., 2011). To encourage effective, local conservation action, more information about the distribution, abundance, and threats to local sea turtle populations is required.

There are two main ways by which relevant information for such a study can be collected. One is to collect primary data on-field via scientific research and monitoring. This, however, can be resource intensive. The other is to investigate the available local ecological knowledge (LEK). Local ecological knowledge refers to "a set of perceptions and experiences of traditional communities regarding its surrounding natural environment, this knowledge being handed-down through generations by cultural transmission" (Bender et al., 2014).

It is important to note that LEK consists of knowledge of how an indigenous community interacts with nature. It strengthens information obtained by other research by enhancing knowledge specific to a locality. It also enables conservationists and other researchers to potentially collaborate with the locals of that specific area, encouraging exchange of knowledge and promoting shared responsibility (Drew, 2005). LEK also helps in formulating

conservation measures and policies as well as detecting long-term changes over time, as mentioned previously (Pilcher et al., 2017).

Examples of LEK, often used to improve understanding of the biology and threats to species, include conservationists collaborating with the I-Kiribati tribe in the Tarawa to help mitigate the depletion of bonefish, the tribe's traditional food source, and the creation of Gladden Spit, a part of the Mesoamerican Barrier reef, as a marine reserve. The knowledge provided by the local fishing community helped identify this area (Drew, 2005).

Therefore, researchers interviewing local fishing communities to collect information on marine life is an example of utilising LEK to enhance the understanding of the species. This method of data collection is important as it helps fill any knowledge gap present in such areas and potentially develop solutions (Pilcher et al., 2017).

Similar studies were carried out in West Africa to understand if interviewing fishers was an effective way to study fishing efforts and sea turtle bycatch. More than 6,100 fishers in seven countries were interviewed in less than a year, which resulted in comprehensive findings about the high bycatch rates in artisanal fisheries (Moore et al., 2010).

In Southern Bahia, Brazil, researchers used fisher's LEK to better understand sea turtle biology and fisher attitudes towards conservation and bycatch. Detailed semi-structured interviews of thirty experts were conducted using the snowball sampling method. The interviews provided demographics on sea turtles, the fishers' lifestyles, histories, habitats, and other cultural interactions between the two (Braga & Schiavetti, 2013).

In India, 80 respondents in Chennai and Nagapattinam were asked about the increasing sea turtle mortalities in these areas. These interviews took place in net mending areas, at fisher's houses, boat landing areas and fish landing centres. A majority of the interviewees believed that the most probable cause of sea turtle mortality was fishing activities, including boat strikes and entanglement in gill nets. Others suggested that the sea turtles could have also fallen prey to some larger marine predator (Sachithanandam et al., 2015).

These examples prove that LEK is a reliable and valid form of research. Further, interviewing fishers to collect information about their interactions with sea turtles, fishing efforts and resulting bycatch has also effectively contributed to research on sea turtles.

1.2 RESEARCH AIM AND OBJECTIVES

This study aims to use local ecological knowledge (LEK) resulting from sea turtle interactions with fishers from Sagareshwar Beach, Vengurla, to enhance our understanding of their distribution, abundance and threats in the Sindhudurg District of Maharashtra, India.

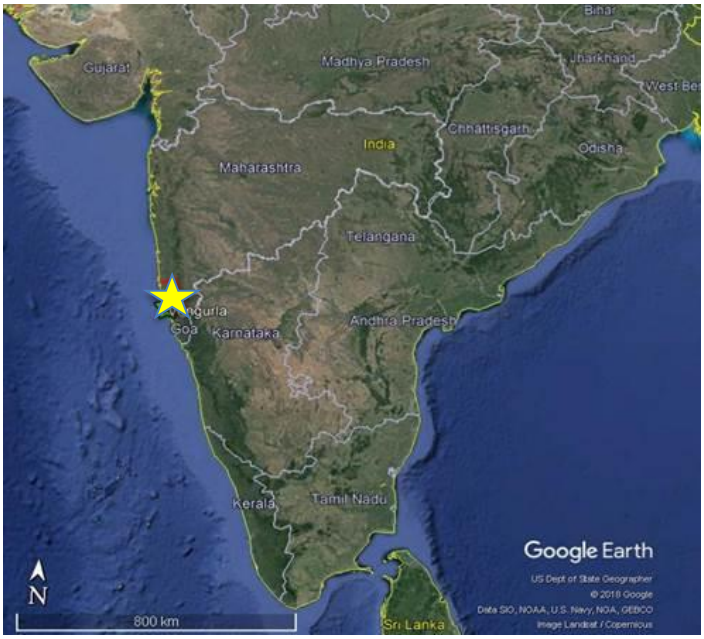
The research objectives are to:

1. Identify sea turtle species, feeding grounds, breeding habitat, and abundance
2. Describe fishing practices and gear
3. Estimate the rates and describe the outcomes of turtle bycatch
4. Compile observations of ghost gear
5. Relate sociocultural beliefs and legal awareness to fisher attitudes towards sea turtles

1.3 STUDY LOCATION

Sagareshwar Beach, adjacent to the Vengurla village in the Sindhudurg District of Maharashtra (Map 1.1), supports small-scale commercial and artisanal fishers and has a dock

for boat mooring and to receive and sell fisher's catch. As the fishing community at Sagareshwar Beach operates similar fishing gear and practices as other fishing communities in the Sindhudurg District and Maharashtra itself (Central Marine Fisheries Research Institute [CMFRI], 2010), the findings of this study may potentially be scaled-up to apply at a district level. Sagareshwar Beach was also deemed a suitable location for this DIP study as the group members were capable of conversing in the various languages spoken by fishers at this location, including Marathi, Hindi, and Konkani.



Map 1.1.Location of Sagareshwar Beach, Vengurla, Sindhudurg Dictrict, Maharashtra.

(Google Earth, n.d)

The state of Maharashtra, on the west coast of India, has a coastline spanning 720 km. Five of its 36 districts are coastal districts; namely Sindhudurg, Ratnagiri, Raigad, Thane and the urban area of Mumbai (Sanaye & Pawar, 2009).

Sindhudurg District lies to the south-west of Maharashtra's coast and, according to the 2010 Marine Fisheries Census, it had a fisher population of 33,178 people which comprised 9% of

the state's fishing population. There were 83 fishing villages in Sindhudurg at the time of the census, with a total of 7,277 families engaged in fishing as an occupation. The craft owned by these fishing communities consisted of 724 mechanised boats, 721 outboard boats, and 1611 non-motorised boats (CMFRI, 2010).

Mechanised boats, also known as motorised boats, referred to fishing boats with engines installed for propulsion and mechanical devices for operating fishing gear (Ziener, 1958). The fishing boats included trawlers, gillnetters, purse seiners, and ring seiners (CMFRI, 2010). Outboard motors are mounted on the stern, whereas inboard motors are built into the body of the boat (Watabe et al., 2005). Conversely, non-motorised boats did not have any engine or other mechanical devices. This category included vessels such as dugout canoes, catamarans, and outrigger canoes (CMFRI, 2010).

The 121km coastline of Sindhudurg District is divided into three blocks: Deogad, Malvan and Vengurla, which run from north to south respectively (Sanaye & Pawar, 2009). Vengurla, the southernmost coastal town in the district and the location for this study, houses 611 fisher people in 150 fisher families, of which 145 are traditional fishers. 'Traditional' fisher families are those engaged in historic fishing practices involving bag nets (*dol* net), drift gill nets (*tarti* or *daldi*), bottom set gill nets (*budi*), long lines (*khanda*) and shore seines (*rampani*), and are therefore differentiated from other fisher families (Deshmukh, 2013). Of the total fishing families, 115 fished full time in 2010, while 34 engaged in part-time fishing (CMFRI, 2010). The fishing community operated 30 mechanised boats, 27 outboard boats, and 22 non-motorised boats (CMFRI, 2010).

1.4 RESEARCH METHODOLOGY

Quantitative methods of research by means of structured, face-to-face interviews were used to collect responses from fishers at Sagareshwar Beach between 1st-5th October 2018. Since interviews were conducted within a single time frame, the survey was cross-sectional.

1.4.1 Survey Design

The survey tool was a modified version of that designed and validated by Pilcher et al. (2017) for the United Nations Environmental Programme Convention on Conservation of Migratory Species (UNEP CMS). The survey tool was adapted and additional questions were sourced from the Olive Ridley Project-Ghost Net Data protocol (www.oliveridleyproject.org) to meet this project's research objectives (Table 1.x). The final survey tool (see Appendix A) comprised 51 open and close-ended questions in three categories:

Interviewee Background

Questions in this section collected information about respondent demographics and their fishing background and experience. To avoid religious and caste dynamics from influencing the interviewees responses, religion and/or caste was inferred by the interviewer based on their last name and comments and discussion during the interview and following conversation. Enthoven (1990) aided in determining caste.

Interviewees were asked whether their parents or grandparents were fishers as well, and how long they themselves had been fishing for. These questions played an integral role in the research as they helped validate the traditional ecological knowledge the fishers possessed. Questions about the dimensions of the boat, its motor, and the number of crew members were also asked to better understand the scale of fishing practiced by the interviewee. These included:

What is your main occupation?

Fishing ☐ Tour Guide ☐ Boat Captain / Crew ☐ Retired ☐ Other ☐

Please describe:

How long have you been fishing in Vengurla? _____

Were your parents' fishers? Yes ☐ No ☐ Grandparents? Yes ☐ No ☐

*How long is the boat?*_____

Is the boat motorised? Yes ☐ No ☐ (if yes) Inboard ☐ Outboard ☐

*What is the horsepower of the motor?*_____

Fishery Information

The second section asked about fishery information. This allowed recognition of the different kinds of fishing gear the interviewees used. Questions in this section were specific about the dimensions, disposal and use of different fishing gear. This helped obtain an understanding of gear used in different areas, for different species and the habitat it was used in. Questions regarding the dimension of the gear were asked to ascertain the likelihood of a sea turtle getting caught in the gear; webbing and mesh dimensions could determine the possibility of sea turtles getting caught in the net. Some questions focused on the disposal and repair of damaged gear. The survey tool categorised gear into five main types: gill nets, purse seines, beach seines, trawl nets, longlines and hook and lines. Nets that were not any of the aforementioned were termed as 'other' and interviewees were asked to describe them. These have helped link the gear used by individual fishers to the turtle bycatch due to ghost gear in the Arabian Sea.

Questions included:

What type of fishing gear do you use?

Gill or trammel nets Only ☐ Mostly ☐ Sometimes ☐ Months:_____

Habitat:_____Target Species:_____

Do you tend the nets when they are in the water? Yes ☐ No ☐

How long do you leave the nets in the water?_____ hours

Do you fish during the day ☐ or night ☐? Both ☐?

What is the position of the gear?

Surface ☐ Mid-water ☐ Bottom ☐ Full water depth ☐

Describe the net: Length :_____ Depth : _____ Mesh size :_____

Mesh measurement:

<1 finger ☐ 1 finger ☐ 2 fingers ☐ 3 fingers ☐ 4 fingers ☐ Fist ☐

Clasped Fist ☐ Open Hand ☐ >Open Hand ☐

Webbing dimension: _____mm

Net construction: Knotless ☐ Knotted ☐ Twine doubled up ☐

Type of twine: Twisted ☐ Braided ☐ Monofilament twine ☐

Number of strands: _____

Type of material: Natural fibre yarn (soft) ☐ Synthetic fibre yarn (hard) ☐

Diameter of twine: _____mm

Net colour: Blue ☐ Green ☐ Yellow ☐ Red ☐ Transparent ☐ White ☐ Black ☐ Blue/Yellow ☐ Other ☐ Please Describe: _____

Floatation attachments: Floating device ☐ Bottles ☐ Bags ☐ Bamboo ☐ Other ☐ Please Describe: _____

Have you ever seen discarded fishing gear floating out at sea? When? Where? What did you do with it?

What do you do with your own nets when they are damaged? ☐ Repair ☐ Dispose ☐Other

Is there anywhere to dispose of nets if you want to?

Measurements given in feet or the local measurement of *waaw* were converted to metric using the conversion factors of 1 *waaw* being 6 feet and 3 feet the equivalent of 1 metre.

Sea Turtle Observations, Catch and Bycatch

The last section of the survey consisted of questions regarding sea turtles, including observations about their biology and distribution, population trends, and catch and bycatch rates. Interviewees were asked if they could identify different species of sea turtles and describe their distribution. These questions contributed to the understanding of sea turtle biology in that specific region and the potential threats that these species could encounter. This helped to understand the rates and outcomes of bycatch by different kinds of fishing gear. Such questions also assessed the fishers' perceptions of sea turtle population, based on frequency of sighting. Questions included were:

Have you ever found ☐ or heard of ☐ turtles stranded on the shore? Yes ☐ No ☐

Or have you ever found ☐ or heard of ☐ turtles dead in our waters? Yes ☐ No ☐

Were the dead turtles tangled up in fishing gear or floating free?

Do you think there will always be turtles in our waters? Yes ☐ No ☐ Don't Know ☐

(if yes or no) Why?

Do you think having turtles around is important? Yes ☐ No ☐ Why?

Recognising that some questions were about sensitive topics, they were framed to receive an approximate answer about the same. These questions were about the potential death or capture of the animal, and thus, to avoid participant discomfort or legal implications, they were framed as:

Do people <u>from other</u> villages / communities catch turtles?

Yes ☐ No ☐ Don't Know ☐

(if yes) How many (people)?_____ What village?_____

Is the catch accidental or on purpose? Accidental ☐ On purpose ☐ Both ☐

Do people <u>in your</u> village / community catch turtles? Yes ☐ No ☐ Don't Know ☐

(if yes) How many (people)?_____ For how long?_____

Is the catch accidental or on purpose? Accidental ☐ On purpose ☐ Both ☐

Did <u>you</u> personally catch any turtles in the last year? Yes ☐ No ☐

(if yes) How many in the last year? 1-2 ☐ ≤10 ☐ >10 ☐ Specifics (if available)__

Table 1.1. Survey questions mapped to research objectives.

Question Focus	Survey Questions
Interviewee background	1-9
Objective 1. Identify sea turtle species, feeding grounds, breeding habitat and abundance	23-34, 44-46
Objective 2. Describe fishing practices and gear	10-20, 22
Objective 3. Estimate the rates and describe the outcomes of turtle bycatch	35-43
Objective 4. Compile observations of ghost gear	21
Objective 5. Relate sociocultural beliefs and legal awareness to fisher attitudes towards sea turtles	47-50
Other species	51

1.4.2 Survey Methods

The method used to recruit participants in this survey was convenience sampling, a non-probability method that involved approaching potential participants with close proximity and easy accessibility to Sagareshwar Beach. Surveys were conducted in Marathi, Hindi, Kannada and Konkani depending on the preference of the interviewee. Responses were recorded on hard copies of the survey tool so as to refrain from using digital recording methods to avoid participant discomfort about answering sensitive questions regarding the potential capture or death of sea turtles. All interviews were conducted after obtaining informed verbal consent from the participant using the following statement:

> *My name is _____. I am a student at FLAME University in Pune. A group of us are doing a project to understand turtle-fisher interactions in coastal fisheries of Vengurla. The goal of this project is to learn more about sea turtles from your observations of them. We would like to ask you some questions about your fishing experience, turtles you have seen, what fishing gear you use, and where you fish. We have maps and pictures that can be used to help answer the questions. The*

questions will take between 30 to 45 minutes to complete. ***Your participation in this survey is voluntary and confidential. We will not record your name or any personal information you share with us without your approval. Responses from everyone who participates in our survey will be combined and reported on as a group to provide a general summary, and we will not share your individual answers with anyone outside of the research team. You do not have to answer questions you do not want to. THANK YOU FOR YOUR HELP!***

Similarly, informed consent about the inclusion of recorded material in a documentary or exhibition was obtained before participants were recorded, repeating their responses to specific questions at the end of the interview.

If asked personal questions, some interviewers gave a false last name to avoid indicating their personal caste and status so as to reduce the potential influence of social dynamics on interviewees responses. When individual interviews were finished, interviewers recorded their perceptions of fisher engagement with the interview, and honesty and certainty when answering questions, especially those relating to potentially sensitive issues.

1.4.3 Sample Population

As the population size of fishers at Sagareshwar Beach was unknown and, therefore, a sample size calculator could not be used to estimate the required sample size for the study, surveys were conducted according to the principle of saturation (Newing, 2011) i.e. until when additional surveys revealed no new information relevant to the research objectives. An informal, conservative estimate indicated that fishers from >80% of the vessels on Sagareshwar Beach were interviewed during the survey period.

1.4.4 Data Analysis

Excel was used to calculate descriptive statistics (e.g. mean, standard deviation and range) and generate graphs that, respectively, statistically and visually, represented the participants responses. Preliminary inferential statistics (Chi-squared Test and Fisher's Exact Test) were calculated with the software SPSS (Statistical Package for the Social Sciences), to look for differences in responses among fishers of different castes. As fishers used different gear and practices throughout their fishing career and sometime used different types of gear within the same time period, rates of bycatch for different types of gear could not be calculated.

1.4.5 Potential Biases

Potential biases of the participants and their responses to questions included Non-Response Bias and Social Desirability bias. Non- Response Bias would occur if fishers who had caught sea turtles declined to participate or answer questions such as, "How many sea turtles have you caught?" or "What do you do if you catch a sea turtle?" This type of bias could have resulted in an underestimation of captures. Social Desirability Bias would occur if fishers provided responses that they thought would be favourably viewed by the interviewer. Examples of this type of bias may have included claims to have never caught sea turtles or to have seen many sea turtles in the water, and could have resulted in an underestimation of captures or an overestimation of abundance.

To compensate for potential biases, survey questions included inquiries about the capture of sea turtles by fishers from other villages or by members of the same village which encouraged responses to questions they would have otherwise hesitated to furnish about themselves and therefore provided a more accurate indication of threats to sea turtles.

1.4.6 Dissemination of Findings

A summary of the LEK contributed by fishers at Sagareshwar Beach to this study has been prepared to share with leaders of the fishing community for dissemination (draft content in Appendix B; to be translated to Marathi and Hindi). Net characteristics and other relevant information will be shared with the Olive Ridley Project to aide their efforts in identifying the source of ghost gear in the Indian Ocean (draft content in Appendix C). A compilation of both summaries will be sent to the Maharashtra Forest Department offices in Vengurla and Mumbai, and Dakshin Foundation to inform conservation efforts.

CHAPTER 2. LITERATURE REVIEW

2.1 BIOLOGY OF SEA TURTLES

Sea turtles primarily inhabit tropical and temperate ocean waters and are highly migratory in nature. They perform important functions like maintaining healthy and diverse coral reefs, beach dune habitats, seagrass beds (Meylan, 1988; Bouchard; Bjorndal, 2000; Leon and Bjorndal, 2002; Bjorndal and Jackson, 2003), and providing balanced nutrition that facilitates the abundance of other commercial marine species (Houghton et al., 2006; Lynam et al., 2006) (as cited in Alexander, Agyekumhene, & Allman, 2017).

There is a general life cycle for all sea turtle species (Figure 2.1), beginning when females come to the beaches at night to dig their nest and lay eggs. On an average, they lay between 100-150 eggs. The eggs hatch in 40 to 60 days, depending upon the species and environmental conditions. The hatchlings are independent from the day they emerge from the nest and crawl towards the sea as fast as they can. Some of them do not end up in the sea as they are captured by predators along the way. Young turtles spend the first few years of their life drifting with the currents in the open ocean and feeding on small animals and algae in the water before settling in an inshore feeding ground. Sea turtles take 10 to 20 years to mature. When ready to breed, they migrate to their mating grounds in coastal waters. Female sea turtles usually return to the general area where they were born to lay eggs every 2 to 3 years, while males migrate annually from their feeding grounds to their mating grounds. Due to high predation rates, less than 1 out of 1,000 hatchlings sea turtles survive to adulthood (SToI, 2011). Since sea turtles spend the majority of their life in the water, little is known about their biology during this period and is an important knowledge gap that reduces the effectiveness of conservation efforts in their in-water habitat.

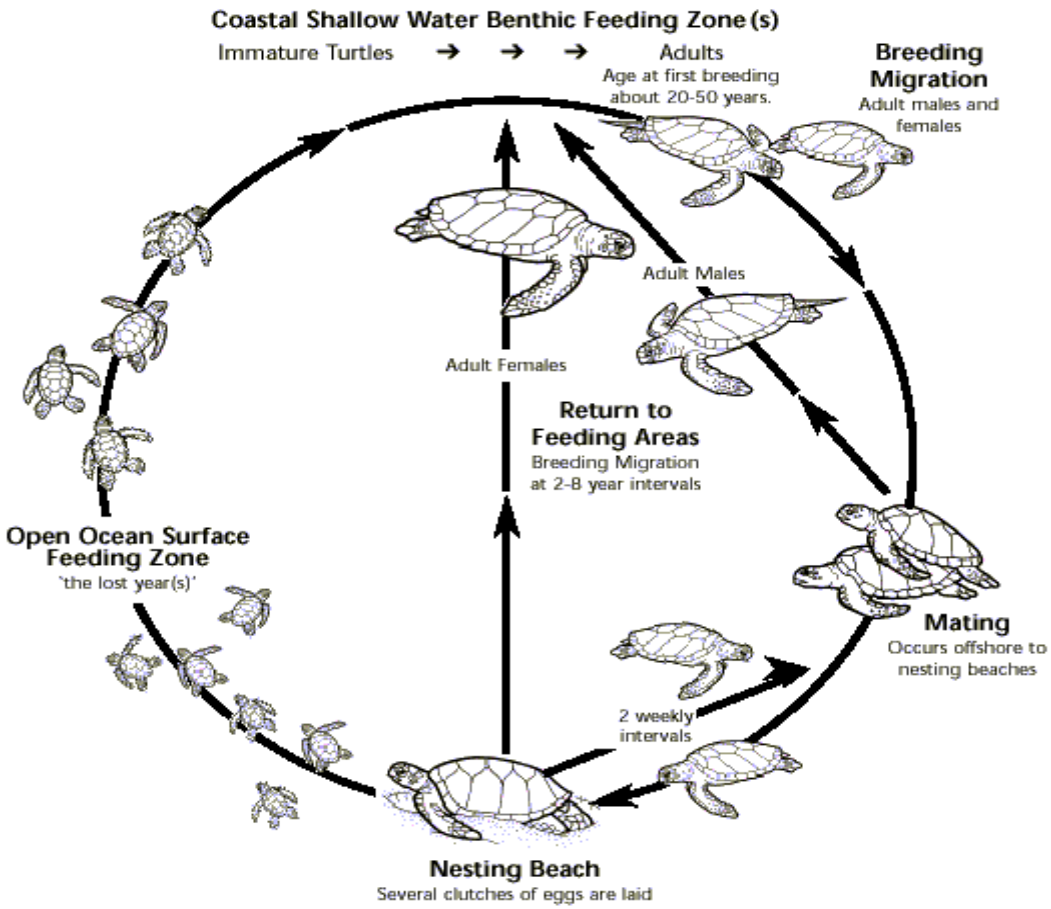


Figure 2.1. General life-cycle of a sea turtle

(Lanyon, Limpus & Marsh, 1989)

2.1.1 Sea Turtles in India

Of the seven species of sea turtles found worldwide, five are found in India and its territories. The biology of these species is summarised in Table 2.1.

Table 2.1. Biology of sea turtles found in India and its territories.

Turtle Common Name	Scientific Name	Size (Length, Weight)	No. of eggs per clutch	Diet	Preferred Habitat
Olive Ridley	*Lepidochelys olivacea*[a]	Adults 60-70cm; 70kg. Hatchlings ~25mm; 15-20g	90-130	A variety of crustaceans such as shrimp and crabs, molluscs, tunicates and fish[b]	Tropical and subtropical oceans, inshore habitat usually in estuaries or coastal bays.
Green	*Chelonia mydas*[a]	Adults 80-120cm; 300kg. Hatchlings 30-40mm; 25-30g[c]	80-120	Herbivorous; mostly seagrass[a]	Tropical oceans and subtropical oceans, inshore habitat often near islands, coral reefs, seagrass beds, and mainland beaches.
Hawksbill	*Eretmochelys imbricata*[a]	Adults 75-90cm; 150kg. Hatchlings ~30mm; 13.5-19.5g[c]	120-200	Sponges, crabs and molluscs[a]	Tropical oceans, especially near coral reefs
Loggerhead	*Caretta caretta*[a]	Adults 70-100cm; 200kg. Hatchlings ~25mm; 15-20g[c]	80-120	Crab, fish and benthic animals[a]	Temperate and tropical oceans, and large mainland beaches and barrier islands.
Leatherback	*Dermochelys coriacea*[a]	Adults 140-160cm; 300-1,000kg. Hatchlings ~50 mm; 40-50g[c]	50-90 eggs per clutch[c]	Exclusively soft-bodied animals, e.g., jellyfish[b]	Extremely migratory, and found all over the world, including the cold Northern waters.

[a]Rajagopalan, Vivekanandan, Pillai, Srinath, & Fernando (1996). [b]www.seaturtlesofindia.org. [c]IUCN SSC Marine Turtle Specialist Group (2010b).

Sea turtles nest along all ~8,000 kms of the Indian mainland and island coastline. One of the world's largest olive ridley nesting populations is located in Odisha so the focus of most long-term sea turtle research in India has been largely on its east coast. Due to this, there exist knowledge gaps about sea turtles on the west coast of India, which includes the state of Maharashtra.

2.1.2 Sea Turtles in Maharashtra

Four out of the five species of sea turtles nesting in India are found in the coastal districts in Maharashtra (Raigad, Ratnagiri, Thane, Palghar and Sindhudurg). These are the green, hawksbill, leatherback, loggerhead and olive ridley turtles (Sanaye & Pawar, 2009).

The most common is the olive ridley turtle which is found in all local waters and nests between December-March along the coast of Maharashtra. Most fishers in Sindhudurg District reported encounters with sea turtles after September, in the post-monsoon season (Kakodkar, 2006) when olive ridley turtles congregated for courtship and mating (Rajagopalan, Vivekanandan, Pillai, Srinath, & Fernando, 1996). The number of nesting olive ridley turtles have declined to <100 per year in the State (Giri & Chaturvedi, 2006). Green turtles were more commonly found in the waters in the Vengurla and Malvan districts than in the Devgad district, but only sporadically nest along the entire Maharashtra coast. Encounters with leatherback turtles were uncommon, but those reported were usually from the waters of Malvan district (Giri & Chaturvedi, 2006). A considerable decrease in this sea species has been attributed to excessive poaching in the 1970s (Rajagopalan et al., 1996) and the Sindhudurg District has not seen a leatherback turtle in the last 20 years. There have been rare sightings of young hawksbill turtles during the monsoon period in Devgad but no reported nesting (Andhare & Hatkar, 2015).

In the Sindhudurg District, leatherback turtles are locally known as *Kurma*, olive ridleys are known as *Tupalo* and other sea turtles are generally known as *Kasai*. The use of local names implies that olive ridleys and leatherback turtles are more commonly seen by fishers, and/or they can distinguish them from other species (Kakodkar, 2006).

2.2 SOCIOCULTURAL BELIEFS AND PRACTICES INVOLVING SEA TURTLES

In India, sea turtles hold great sociocultural importance (Patyal, 1995). When considering the country's mythology and colloquial language, one should keep in mind that the terms 'turtle' and 'tortoise' are used interchangeably.

2.2.1 Religious/Spiritual

Among Hindus, the sea turtle is commonly associated with the second avatar of Lord Vishnu, the Kurma avatar (Patyal, 1995; Williams, 1992). The most famous Hindu belief about these animals is that the world rests on the back of a turtle (Miller, 1974; Patyal, 1995; Williams, 1992). Since sea turtles are seen to rest between land and water, they are also regarded as a symbol of consciousness, referring to life and the earth that nourishes it (Miller, 1974; Williams, 1992). In Bengal, a turtle is the representation of righteousness (Patyal, 1995).

On the Bengre coast in Mangalore, Karnataka, the fishing community worships turtles as an incarnation of Lord Vishnu and does not consume turtle meat (Madhyastha, Sharath, & Rao, 1986). In Sindhudurg and Raigad districts of Maharashtra, most fishers release sea turtles when they are caught for the same reason, while also performing a prayer (Giri, 2001).

Through beliefs and mythological tales that have been carried forward for generations, there also exist some superstitions and taboos regarding catching or rearing of sea turtles. For instance, a few of the fishers interviewed in Tamil Nadu believed that a turtle entangling itself in a net would bring them bad luck (Sachithanandam et al., 2015).

These beliefs are not just restricted to India. For example, in a study conducted in Cambodia, some of the participants mentioned that they adorned a sea turtle with Buddhist offerings before releasing it. Most of the participants also believed that the sea

turtle was spiritual and could bring good or bad luck. The act of releasing sea turtles caught as bycatch is believed to earn the fishers good luck (Diamond, Blanco, & Duncan, 2012).

2.2.2 Consumption

Sea turtle meat is considered to be a delicacy by some coastal dwellers in many regions in India (Kar & Bhaskar, 1982), including Maharashtra. However, due to prevalent religious (Dash & Kar, 1990) and political taboos, there is barely any reported consumption of turtle meat and eggs (as cited in Tripathy & Choudhury, 2007). Studies from Pakistan have also reported that consumption of sea turtle meat is considered a bad omen. Thus, in most cases of entanglement, they are disentangled and released alive (Khan & Nawaz, 2015).

2.2.3 Medical

There are several practices around the consumption of turtle products and its apparent medicinal value. Some of the folk medicines used by fishers include the use of sea turtles. Superstitions regarding its medicinal value of curing bone disorders still prevail around Sindhudurg (Kakodkar, 2006). Green turtle blood holds high demand in various regions of South India as it is believed to be an elixir (Tripathy & Choudhury, 2007).

Some fishers who belong to specific castes use the calipee, a gelatinous substance found over the lower shell (Calipee, 2018), of the turtle. This, however, is limited to the northern region of the coast of Andhra Pradesh. The calipee is procured from a freshly caught turtle and is ground into a black paste, which is then stored. This is believed to be a great cure for joint pain and problems faced by pregnant women. The dosage is generally administered by a community priest who is from the fisher community itself. It is locally known as Seshakattu. An extract of sea turtle liver and bile is also used to treat issues related to pregnancy and pneumatic diseases in a few fishing villages along the coast (Priyadarshini, 1998). Turtle fat and oil have been used as traditional medicine to

treat convulsions, asthma, skin diseases, and body pain (Murthy, 1981; Tripathy & Choudhury, 2001) (as cited in Tripathy & Choudhury, 2007).

Parallels can be drawn from studies abroad as well. In a study in Brazil, the use of turtle lard oil was mentioned as a remedy for rheumatism, asthma, muscle aches, fatigue, and bronchitis (Braga & Schiavetti, 2013).

2.2.4 Trade

Sea turtles and turtle meat were not openly traded for the fear of being legally punished. In the Malvan area of Maharashtra, the cost of an entire turtle was estimated at 250-500 rupees. Turtle eggs were also reported to sell for anywhere between 2 to 5 rupees per egg. Reportedly, turtles found in nets may also be killed on board for their meat, since leftovers can be disposed of at sea without arousing suspicion (Kakodkar, 2006). Local fishers preserved olive ridley eggs in large quantities by following the traditional practice of drying them under the sun (Tripathy & Choudhury, 2007).

Trade in turtle products other than meat was very common along the Sindhudurg coast and there was almost no place where turtle trade was not practiced. Sea turtles have been utilised for local consumption along with other commodities such as turtle bone, shells and leather for many years by the coastal people (Murthy & Menon, 1976). It was reported that hawksbill turtles were indiscriminately hunted for their tortoise shell in the Lakshadweep Islands (Ayangar, 1922). Ornamental articles are made largely using hawksbill shells in Visakhapatnam, Andhra Pradesh (Chari, 1964) (as cited in Tripathy & Choudhury, 2007).

In Agatti, Kavaratti, and Minicoy Islands, young hawksbill turtles were killed, stuffed, and sold as curios. These are then sold to tourists on the respective islands or in Mangalore, Calicut, and Cochin. Fat from green turtles is used as a sealant and

waterproofing agent on small boats. In the Lakshadweep Islands, the practice is called *Odhum* (Tripathy & Choudhury, 2007).

2.3 THREATS TO SEA TURTLES

The IUCN SSC Marine Turtle Specialist Group (2010a) identified five main threats to sea turtles worldwide: impact of fisheries, direct take of sea turtles and their eggs, coastal development, pollution and pathogens, and global warming. Fishery-related mortality is potentially the largest cause of sea turtle mortality in Indian waters and likely to increase with ongoing growth in the fishing industry (Rajagopalan, Vijayakumaran & Vivekanandan, 2006) but a knowledge gap for many populations of sea turtles in India and especially those on the west coast.

2.3.1 Incidental Capture of Sea Turtles in Fishing Gear

Incidental mortality of sea turtles in fishing gear in India was first described as a major threat to sea turtles by E.G. Silas, the Director of the Central Marine Fisheries Research Institute in 1984, and was reported throughout the 1980s. Incidental catch of sea turtles in fishing gear such as trawl nets and gill nets was a major threat which still persists off the Indian coastline (Rajagopalan et al., 1996; Braga & Schiavetti, 2013; Sanaye & Pawar, 2009; Sanaye, 2009). In Odisha, India, usage of small shrimp trawlers ia a major factor resulting in the bycatch of sea turtles (Kar, 1980) (as cited in Sridhar, 2005). There are several other fishing methods that pose threats: prominently pelagic (floating) longline, gill net and driftnet fisheries. Although driftnet fisheries are prohibited in India, some continue to exist illegally (Shanker, Namboothri & Choudhury, 2012). Illegal, unreported and unregulated fisheries (IUU) pose a major threat to sea turtles (Bourjea, Nel, Jiddawi, Koonjul, & Bianchi, 2008).

Sea turtles may be caught accidentally in fishing gear intended for the capture of other species but was used in specifically turtle habitats (Dash & Kar, 1990; James et al., 1989; Pandav et al., 1994; Pandav et al., 1997) (as cited in Shanker et al., 2012). They may become entangled in gill nets when they try to seek or/and feed on fish captured in the

nets (Ekanayake, 2015). If unable to free themselves, entangled sea turtles may drown or may sustain serious injuries, which make them easy prey (Shanker et al., 2012). If hauled onto the ship alive, they may be very aggressive (Ekanayake, 2015).

Gill nets and trawl nets are described as the fishing gear that results in the most cases of turtle death by drowning (James et al., 1989; Pandav et al., 1997; Pandav et al., 1998; Pandav et al., 1999; Chadha & Kar, 1999; Shankar, 1999; GOI, 2000) (as cited in Sridhar, 2005). The rates and causes of incidental capture may vary by location, but incidental capture has been described as a major threat to sea turtles across the world. Listed below are mortality and bycatch rates from different countries. The extent of studies shows the large scale concern and potential impact of fisheries on sea turtles:

Pakistan

A study was conducted in Pakistan by sending observers offshore on multiple gill net vessels. The 2012 study showed that sea turtles comprise about 0.6% of the total catch in tuna gillnetters. On an average, 1-2 green turtles and 3-8 olive ridley turtles were caught or entangled in tuna gill nets per fishing trip. Fortunately, only a 3-5% mortality of sea turtles was observed; many turtles were found alive and, in most cases, fishermen released the trapped sea turtles (Khan & Nawaz, 2015).

Ghana

A project carried out in Ghana revealed that of the total fishers surveyed (n=41), 85% of them acknowledged that they have caught sea turtles while fishing, but most of them quickly added that it was unintentional. Most fishers expressed that rates of sea turtle capture were very low. The rate of occurrence was approximately one every 1-3 months or even two years. Thus, weekly by-catch rates could not be determined. From all the sites surveyed only, 15% of the fishers reported that they caught sea turtles during every trip. The chance that an artisanal fishing vessel captured a turtle on every fishing trip is unlikely (Alexander et al., 2017).

A majority of the fishers (93%) reported that sea turtles were captured during the Christmas period or the dry season and not year-round (Alexander et al., 2017). Olive ridley, green, and leatherback turtles were captured with an incidence rate of 75-85% across all sites. Fishers were most likely to capture breeding females as the dry season coincides with Ghana's primary sea turtle nesting season. Even a low rate of capture could have dire consequences on the sea turtle population of the region if the fishers captured disproportionately large numbers of gravid females (Alexander et al., 2017).

Most respondents did report bycatch but a considerable amount of fishers indicated release of sea turtles from the nets. Fishers expressed how captures were mostly unintentional and undesirable as captured sea turtles damage nets by tearing holes in them which are very expensive to fix.

Brazil

A study conducted in Ilhéus, Brazil (n=30) revealed that 66% fishers reported that on their last capture they used fishing lines as the fishing gear. It was also found that 94% of the sea turtles captured were without any injury and alive. The depth where they were last sighted was 36m.

Even though most interviewees attributed their most recent captures to fishing lines, experts said that it was fishing nets that picked up most sea turtles in Ilhéus and not lines/long-lines, which rarely captured them. When the fishers (n=30) were asked about how they could reduce bycatch, 73% responded by suggesting avoiding the use of fishing nets. A majority of the expert fishers who were interviewed also used a bottom line (Braga & Schiavetti, 2013).

The study concluded that shrimp and lobster trawling gear should be modified and restricted in some ecosystems where the probability of capturing sea turtles was high (Braga & Schiavetti, 2013).

Sri Lanka

A survey in Sri Lanka analysed the attitudes and thoughts of the fishing community (n=509) on conservation of sea turtles and bycatch reduction. The survey results showed that bycatch occurs at considerable levels. More than half of the respondents reported having sea turtle encounters on their fishing trips. The maximum number of sea turtles encountered a day were 20 and the minimum number were 1-2 sea turtles. An additional survey was carried out to count the remnants of the sea turtles killed for consumption and the amount of dead turtles which were washed ashore. In the area where the survey was conducted, 26 turtle carapaces and 21 carcasses were counted (Ekanayake, 2015).

Cambodia

A study was carried out in the Koh Rong Archipelago off the Cambodian coast. The use of fishing nets was stated as the reason for the decline of the sea turtle population by all fishers interviewed in the Koh Toch village (n=7). The villagers stated trawler nets as another threat to the sea turtle population. A former fisher made a comment on the fishing techniques which caused the most turtle fatalities: “There has been a rapid decrease (in sea turtle population) due to trawling nets, crab nets, and fishing by local people and the Vietnamese diving fishermen” (Diamond, et al., 2012).

Bangladesh

In Bangladesh, reported rates of turtle bycatch in fishing gear were regarded as low (Alam, 1996) (as cited in Rashid & Islam, 2005), but numbers might be under-reported as shrimp imported from any country to USA must be caught by vessels using Turtle Excluder Devices (TEDs) (Rashid & Islam, 2005) (as cited in Phillott et al., 2015).

Of the fishers surveyed in a study in Chittagong (n=47), approximately 80% did not report catching any sea turtles in the last year, 5 years or in their lifetime. Almost all fishers knew what happened with sea turtles that were captured - about half of the survey participants indicated that dead turtles were discarded and about 82% said live sea turtles

were released. It was also found that fishing in water less than 10m deep with seine nets in parallel array to the shore (Islam, Ehsan, & Rahman, 2011) may result in capture of sea turtles.

Around 65% of the fishers thought that the number of sea turtles in the wild and the number of sea turtles they caught had declined rather than increased or stayed the same (about 10% each) (Phillott et al., 2015).

Kenya

A study conducted on turtle-fisher interactions in the Western Indian Ocean revealed that the rate of mortality from incidental entanglement in fishing gear in Kenya was 18% (Bourjea et al., 2008). The rate of bycatch in shrimp trawls was 2-3 sea turtles per day (Mueni & Mwangi, 2001; Mwatha, 2003), but when TEDs were not in use, the rate of turtle capture was 100-500 sea turtles per day (Wamukoya et al., 1997) (as cited in Bourjea et al., 2008).

The relative mortality of sea turtles due to fisheries (targeted or incidental) was 95% of all documented turtle mortalities in Kenya (Wamukoya et al., 1997). Approximately 58% of sea turtles were killed due to entrapment in fishing nets (Okemwa et al., 2004) (as cited in Bourjea et al., 2008).

Madagascar

Mortality due to fishery bycatch takes place in artisanal and industrial fisheries in Madagascar (Lilette, 2006). No records of capture were available from Madagascar because there was a lack of effort to document incidental capture of marine turtles (Randriamiarana et al., 1998) (as cited in Bourjea et al., 2008).

Maldives

Fishery-related mortality of sea turtles in the Maldives has been largely undescribed but coastal reef fisheries were not believed to pose a significant threat to sea turtles. Long-line fisheries by foreign licensed vessels potentially represented a greater threat to sea turtles and their populations (Bourjea et al., 2008).

France

Less than 4 sea turtles per 1000 hooks were caught over 3 years by a small offshore longline fishery off the French islands (Poisson & Taquet, 2001; Miossec & Bourjea, 2003). Rare cases of handline bycatches were recorded in the last 6 years (Bourjea et al., 2008).

Seychelles

Fishery-related mortality of sea turtles is associated with longline and purse seining in Seychelles. Seychelles has a small longline fishery (for which there is less data available) and an important European purse seine fleet. Olive ridley turtles were highly impacted by the fishery and most of the bycatches occurred in the north-west Indian Ocean up to the equator (Bourjea et al., 2008).

Tanzania

'Jarife' (6-inch mesh) and 'sinia' (12-inch mesh) nets posed a major threat to sea turtles in Tanzania. Every turtle captured due to artisanal and commercial shrimp fisheries is killed (Haule et al., 1998) (as cited in Bourjea et al., 2008).

Egypt

Around a dozen sea turtles were killed in Sinai every year, mainly due to accidental capture in nets. Bycatch in fishing nets was the major form of capture (Frazier, 1980).

India

Odisha

On the east Indian coast, the biggest threat to olive ridleys was accidental bycatch (Tripathy & Choudhury, 2007). If trawling were left unchecked, E.G. Silas predicted "Orissa will become the world's biggest graveyard for sea turtles" (Arthur & Shanker, 2010).

In the past 20 years, over 10,000 sea turtles have been found dead on Odisha's coast every year, either due to trawl or gill nets. This adds up to over 100,000 dead turtles over the past ten years (Arthur & Shanker, 2010). Durations spent by olive ridley turtles in the coastal water of Orissa make them the most vulnerable to accidental bycatch. The high chances of coincidence with fishing nets and subsequent potential capture is the main reason for the same (Sridhar, 2005).

The primary cause of deaths of the olive ridley turtles in Odisha is the use of gill nets by mechanised fishing boats (Kale, 2014). Adult and juvenile sea turtles travel across the ocean (Luschi et al., 2003; Plotkin, 2003; Polovina, 2004; Morreale et al., 2007) which may make them vulnerable to ocean fisheries like tuna longlining, purse seining and pelagic gillnetting (Frazier et al., 2007) (as cited in Anderson et al., 2009). The use of FADs by tuna purse seine fleets is a major threat to sea turtles and their populations . (Chanrachkij & Loog-on, 2003; IOTC, 2007) (as cited in Anderson et al., 2009).

The turtle season often overlaps with the fishing season in Odisha. Turtle mortality due to incidental capture during this season has been reported from the 1970s, and turtle mortality has been as high as 10-15,000 annually since 1999 (Sridhar, 2005).

At Gahirmatha, a nesting beach in Odisha, 7500 dead olive ridley turtles washed ashore during 1983. The main proponents were the entanglement during fishing operations off the Odisha coast (Rajagopalan et al., 1996). B. Pandav of the Wildlife Institute of India,

Dehradun, reported thousands of stranded carcasses on Gahirmatha as well as its surrounding beaches in the 1990s. This was attributed to the high incidental mortality caused by offshore trawling, leading him to advise immediate remedial action (Pandav & Choudhury, 1999; Pandav, 2000) (as cited in Shanker et al., 2012).

Between 1985- 1995, Indian coasts (excluding Gahirmatha) were witness to the incidental capture of 335 sea turtles. There is no record on the number of sea turtles which were caught and discarded in the sea, leading to a higher incidental catch count than the reported 335 (Rajagopalan et al., 1996).

Tamil Nadu and Andhra Pradesh

Fishing activities in Nagapattinam contribute majorly to turtle deaths (Sachithanandam et al., 2015). Earlier reports by Bhupathy and Karunakaran (2003), state that due to fishing activities, there were a number of turtle deaths on the Tamil Nadu (total length of coastline: 906.9 km) and Andhra Pradesh (total length of coastline: 973.7 km) coasts during the turtle nesting period (as cited in Sachithanandam et al., 2015). It was recorded that around 200 turtle carcasses (mainly female in number with male-female ratio being 1:3) washed ashore between December 2000 and April 2001 (Bhupathy & Karunakaran, 2003). The Chennai coast saw 135 deaths of olive ridley turtles from incidental catch in fishing gears (Bhupathy et al., 2007) and the Nagapattinam coast saw 109 sea turtle carcasses (Saravanan et al., 2012) (as cited in Sachithanandam et al., 2015). These carcasses had clear signs of where fishing gear (hooks/net marks) had been caught on the body and many were seen entangled in gill nets along the coastline (Sachithanandam et al., 2015).

Maharashtra

Despite fishing being an intensive activity proliferating along the Maharashtra coast and records of sea turtles entrapped in the nets, the majority of local fishers claimed that they are released almost immediately when found entangled in fishing gear. Fishers were aware of the legal protection and punishments in place for sea turtles and their capture

(Sanaye & Pawar, 2009). Fishers in the regions of Sindhudurg and Raigad went on record to claim that they release sea turtles if caught in nets (Sanaye, 2009). However, in regions of the Sindhudurg District and most regions in Ratnagiri district, the capture of sea turtles was carried out with the intention of meat harvest (Giri, 2001; Sanaye, 2009).

On average, the estimates for trawlers' incidental catch of sea turtles was 4 to 5 turtles per trawler per annum in Maharashtra (Giri, 2001; Sanaye, 2009). The absence of strict implementation of TED legislation and its ineffective use, despite its mandation has been a threat to marine sea turtles in the state (Sanaye, 2009). Leatherback and olive ridley turtles have also been caught in dragnets at Deobag taluk in the Sindhudurg District, in the morning and at night time (Kakodkar, 2006). It can be inferred from these observations of incidental capture in fishing gear, and records of stranded juveniles, that fishing activity remains a threat to sea turtles (Kale, 2014) in Maharashtra. However, information about rates of capture in different types of gear is a key knowledge gap in understanding the size of this threat.

2.3.2 Incidental Capture of Sea Turtles in Ghost Gear

Another major threat to sea turtles is incidental capture in ghost gear. Ghost gear can be defined as any discarded, lost, or broken fishing gear in the marine environment (National Oceanic and Atmospheric Administration Marine Debris Program, 2015), and poses threats to marine life by entangling, injuring, and potentially killing them by drowning or starvation.

Instances of entanglement in ghost gear have increased due to the use of monofilament nets. Due to the increasing demand for seafood, local artisans and fishers have changed their equipment to that made of more durable materials, such as monofilament mesh, which help increase the quantity captured. Even though this type of equipment is made of synthetic fibre and is less environmentally friendly, it economically benefits the fishers. Hence, the use of synthetic fibre and durable nets has increased which has increased the rate of entanglement in ghost gear (Stelfox, Hudgins & Sweet, 2016). As monofilament

nets are fragile, they get trapped in rocks and submarine structures easily (Khan & Nawaz, 2015).

The factors which contribute to entanglement are many, but one of the main ones is the material used and evolution of fishing gear. Initially, natural fibre was the main raw material for making gill nets. These fibres included cotton and hemp. Now, nylon and plastic are being used to make these nets. Such nets are generally made up of polyamide mono or high-density polyethylene. According to The Odisha Traditional Fish Workers Union (OTFWU) these gill nets cause entanglement. The material with which such nets are made accounts for how much it contributes to entanglement. For example, if these nets are made using multifilament or HDPE material, then the chances entanglement increases, especially when laid in turtle congregation areas (Sridhar, 2005).

The types of fishing gear that added to the increased amount of ghost gear in the ocean are driftnets, longlines, gill nets, purse seines and local artisanal nets. Fishing gear is however different in different parts of the world. The types of nets that resulted in turtle entanglement in the Maldives were gill nets (from India or Sri Lanka), netting from purse seine FADs, and unidentified netting and plastic flotsam (Anderson et al., 2009). There were also reports of sea turtles that were either entangled in ghost gear or incidentally caught in oceanic driftnets or longlines (Shanker, 2004) (as cited in Bourjea et al., 2008). Ghost fishing is not caused solely by fishing nets and other FADs, but also due to traps.

An increase in the use of fishing gear has added to the rapid increase of ghost gear in marine environments. The life cycle of fishing gear is shortened due to its ability to get abandoned, lost or broken. Bio-fouling is the process when sessile organisms accumulate on the gear. This accumulation makes the net more visible and in turn results in the drop of catch (fish) entanglement rates. Floating gear with a considerable amount of bio-fouling may attract small animals, which in turn would attract larger predators such as sea turtles, sharks, etc. (Carr, 1987). Hence, biofouling potentially leads to entanglement of sea turtles in ghost gear. The amount of biofouling on any net can be used as a tool to

calculate approximate drifting times of the net and its approximate origin (Stelfox et al., 2016).

Several assumptions have been made about the origins of ghost gear in the Indian Ocean. Studies show that net fragments in Maldivian waters originate elsewhere as there are no trawl, pelagic gillnet or purse seine fisheries in the Maldives (Anderson et al., 2009). This implies that debris from anywhere can entangle a turtle anywhere. Indian and Sri Lankan fisheries are the most likely sources of netting and debris during the Northeast Monsoon as the currents are most likely to carry debris towards the Maldives. FADs of Seychelles are the most likely source of floating netting in the Indian Ocean during the Southwest Monsoon (Anderson et al., 2009). Based on studies and research done in the past, it can be said that ghost gear with entangled turtles may have originated along the Indian coastline during nesting and mating periods and were found in other countries or coasts due to the seasonal currents.

Sea turtles exhibit behaviour that makes them particularly vulnerable to entanglement in ghost gear. For example, young sea turtles usually seek shelter from predators under various floating objects, most of which can be marine debris. They also tend to congregate at oceanic fronts, convergences, rips, and drift lines where marine debris is commonly found. These areas also serve as a source of food, as other small marine animals also gather there. Therefore, sea turtles are likely to get entangled in various marine debris that can form loops and openings that trap them (National Oceanic and Atmospheric Administration Marine Debris Program, 2014).

Of all the marine animals, sea turtles have the second highest entanglement rate. As per a study that contained observations of more than 1,500 free-swimming sea turtles across the world (Bjorndal & Bolton 1995), the percentage of entanglements of all sea turtles is 5% (as cited in National Oceanic and Atmospheric Administration Marine Debris Program, 2014). Sea turtle-ghost gear interactions are of concern especially in three turtle habitats: nesting beaches, reefs and open oceans. Firstly, ghost gear threatens female sea turtles that lay eggs on the beaches as it obstructs the hatchlings' route to the sea. Secondly, the

monofilament fishing nets are very thin and undetectable; hence they pose a greater threat to the sea turtles in the reefs. Thirdly, nets in the open waters are dangerous as the turtles spend first 3 to 5 years floating in the ocean currents. It is difficult to quantify entanglement and lost fishing gear, but data provided estimates around 640,000 tons of gear is lost in the world, annually, which makes ghost gear approximately 10% of the total marine debris floating in the oceans (Macfadyen et al., 2009) (as cited in Stelfox et al., 2016).

There have been reports from across the world of all seven species of sea turtle being entangled in marine debris (SCBD, 2012) (as cited in National Oceanic and Atmospheric Administration Marine Debris Program, 2014). However, olive ridley turtles are entangled more easily than other turtle species because they spend most of their lives in the open waters. Either they are floating in the ocean currents for the first five years of their life or are travelling to breeding grounds. Additionally, they have a habit of basking at the shore which may make them susceptible to boat impacts and net entanglements. (Pitman, 1993) (as cited in Stelfox, Hudgins, Ali, & Anderson, 2014).

The locations around the Indian Ocean where entanglement observations have been made are around the coasts of India, Pakistan and Maldivian waters.

Pakistan

Many sea turtles were observed to be caught in ghost gear in coastal and offshore waters, which resulted in many deaths. Instances of such ghost fishing has increased because of the use of monofilament nets which are fragile (Khan & Nawaz, 2015).

Maldives

The Maldives have recorded a total of 45 observations of all olive ridley turtles entangled in netting and other debris (reviewed up to March 2003 by Anderson et al., 2003). Entanglement in ghost gear and discarded plastic was reported for 25 olive ridley turtles.

Since 1999, of 24 records, 71% were entangled in discarded gear or other debris (Anderson et al., 2009).

Almost all the observations of the sea turtles in the Maldives were in the size range of 15-61 cm, meaning that most of the olive ridley turtles present are juveniles (Anderson et al., 2009). Occurrences of juvenile olive ridley turtles entangled in ghost nets suggest that this is a significant and previously undocumented source of mortality for olive ridley sea turtles in the tropical Indian Ocean (Anderson et al., 2009). Hence, it can be said that this is a very significant knowledge gap.

In the Maldives, 84% of entangled sea turtles recorded were between December and April, while the remaining 16% were found between May and November (Anderson et al., 2009). Many olive ridley turtles, both adults and juveniles, enter Maldivian waters from the East. Juveniles may also come from anywhere in the northern Indian Ocean basin. The high rate of entanglement of adult olive ridley turtles in the Maldives from December to March can be attributed to it being the prime breeding period on the east coast of India (Shanker, 1995; Shanker et al., 2004; Tripathy et al., 2003) (as cited in Anderson et al., 2009).

These results provide reason to study the impact of ghost gear in the Indian subcontinent as well, to identify the effect of ghost gear on sea turtle populations.

CHAPTER 3. FINDINGS

In total, 93 fishers gave informed consent and participated in the study. However, not all fishers contributed responses to all questions for reasons such as the answers potentially revealed illegal activity or other sensitive information, the respondents had other work to attend to, or they were not interested in continuing the interview. The findings presented below provide the proportion (as a %) of responses, the mean, standard deviation (StDev) and range, and the number of respondents (n=*x*) to each question as appropriate.

The caste of Hindu respondents varied between the northern and southern stretches of the beach, but the only difference in respondent demographics, fishing background, fishing gear and practices, observations or sea turtles, capture of sea turtles, and outcomes of interactions with sea turtles was in the use of a specific type of gear by one caste only; this is described below. As no further variation in responses was detected by calculation of preliminary inferential statistics, data is presented as a single set for the location (Sagareshwar Beach) and not divided by caste.

3.1 RESPONDENT DEMOGRAPHICS

All 93 respondents were male. Data regarding age was collected for 90 fishers, most of whom were equally distributed between 26-50 and 51-75 (Figure 3.1). A large proportion of the respondents were Hindu (76.1%, n=92, Figure 3.2). The names of fishers indicated the majority of Hindu respondents at the northern end of Sagareshwar Beach were Maharastrian Gowd Saraswat (GSB) Brahmins, and this community described themselves as primarily business-people who turned to fishing because land ownership was not giving them enough returns. Hindu respondents at the southern end of the beach were predominantly Gabit (Maratha). Some members of each community lived in the same location as their work while other travelled to opposite ends of the beach for fishing, so caste divisions in their working and living environment were not always clear.

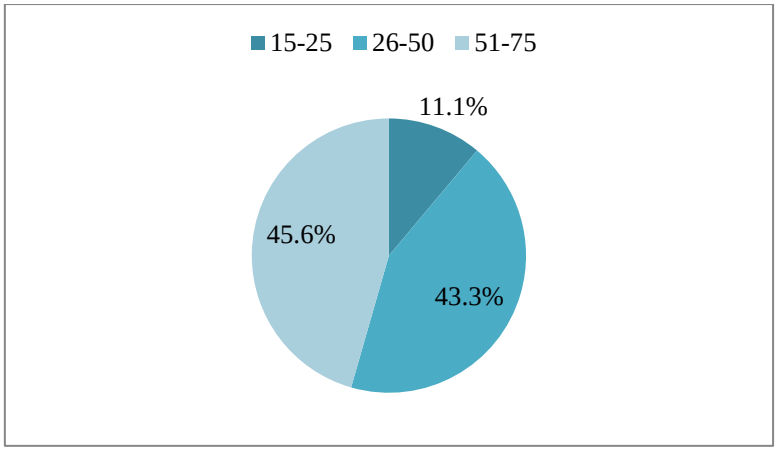


Figure 3.1. Age distribution of fishers (n=90) at Sagareshwar Beach, Vengurla.

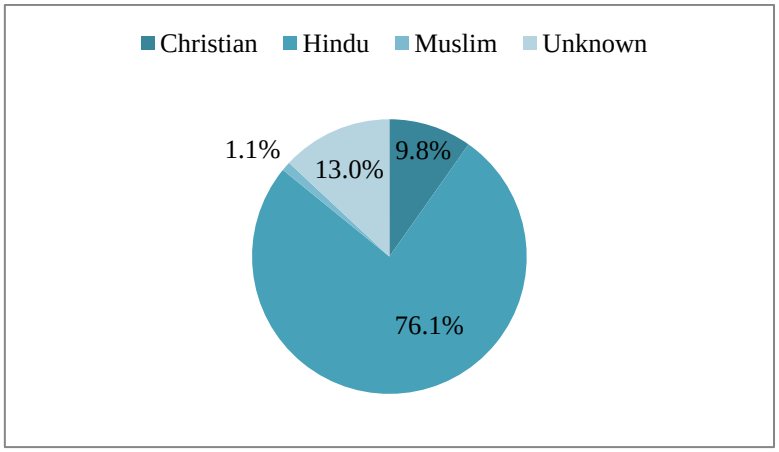


Figure 3.2. Inferred religion of fishers (n=92) at Sagareshwar Beach, Vengurla.

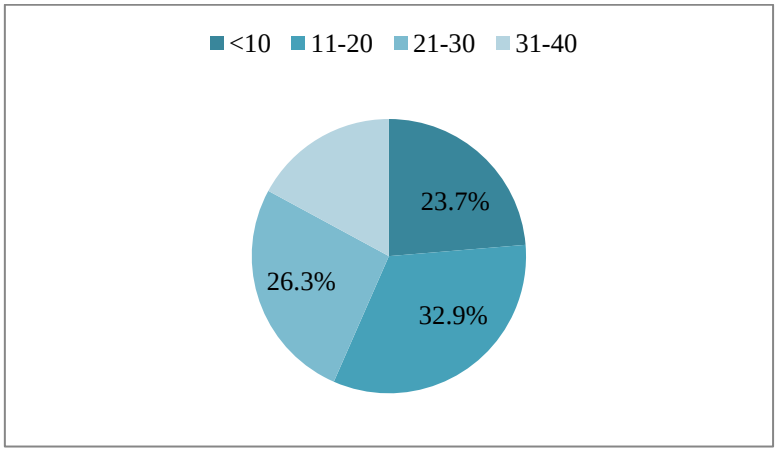


Figure 3.3. Years fishing (n = 92 fishers) at Sagareshwar Beach, Vengurla.

3.2 FISHING BACKGROUND

Fishing experience at Sagareshwar Beach ranged from 1 to 62 years in a respondent's lifetime, with the largest cohort (25.8%, n=92) having fished local waters for 11-20 years (Figure 3.3). Respondents were second-generation (88.2%, n=93) or even third-generation (11.8%, n=93) fishers in their families. Fishing was the main occupation of 95.7% of the respondents and the only activity of 82.8% (n=92). The most common role of respondents (48.4%) was as boat crew, with the remaining assuming roles of captain, or other (Figure 3.4).

3.3 FISHING GEAR AND PRACTICES

More than 64.0-100.0% of the respondents (n=91) fished throughout the year, except during the months of June and July when the activity is much lower (Figure 3.5). The mean number of days fished each week during the low season was 4.7 days (StDev=2.6, Range 0-7 days, n=87) and during the high season was 6.9 days (StDev= 0.5, Range 4-7, n=91). On average, there were 8.9 fishers on each boat (StDev 6.8, Range 2-33, n=90).

Most fishing boats were >5 metres in length and motorised (Figure 3.6) with 8 -10 horsepower motors (Figure 3.7). The predominant gear used by fishers at Sagareshwar Beach (n=91) were gill nets (72.5%; vertically held panels of net, that are either suspended at the surface or touching the seafloor) followed by purse seines (26.4%; nets used to encircle the target species, forming a purse-like net around them), and beach seines (17.6%; nets that are dragged out in shallow waters by hand or boat and then hauled back in) (Fisheries Research and Development Corporation, n.d.). Purse seines were only used by fishers at the northern end of the beach. Trawl nets (nets towed behind a boat), hook and line, bottom longline (long mainline with baited hooks on attached, short lines) and cast nets (small, circular net thrown by hand) were used by very few fishers (Figure 3.8) (Fisheries Research and Development Corporation, n.d.).

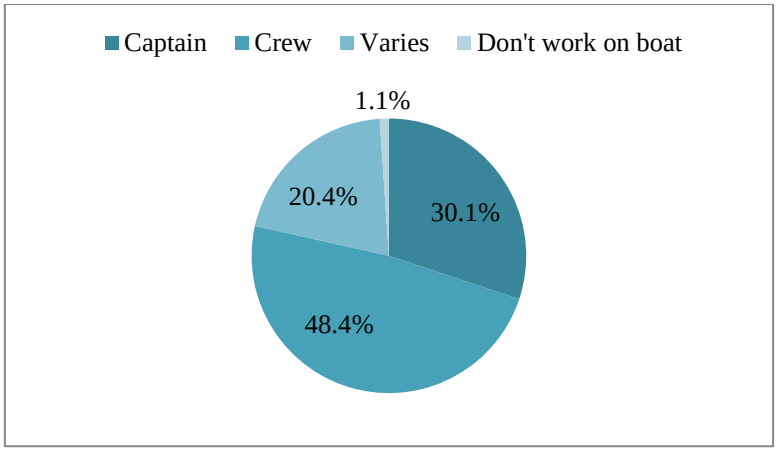


Figure 3.4. Roles of respondents (n=92) during fishing activities at Sagareshwar Beach, Vengurla.

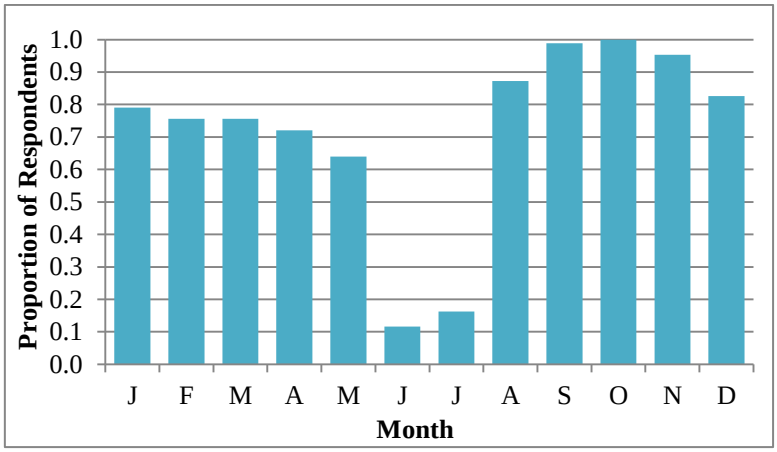


Figure 3.5. Fishing activity during the year (n=86) by fishers at Sagareshwar Beach, Vengurla.

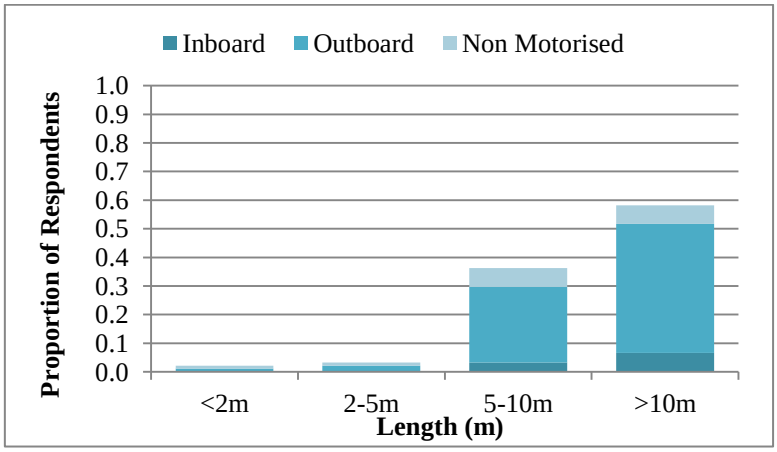


Figure 3.6. Length and motorisation of boats used by fishers (n=91) at Sagareshwar Beach, Vengurla.

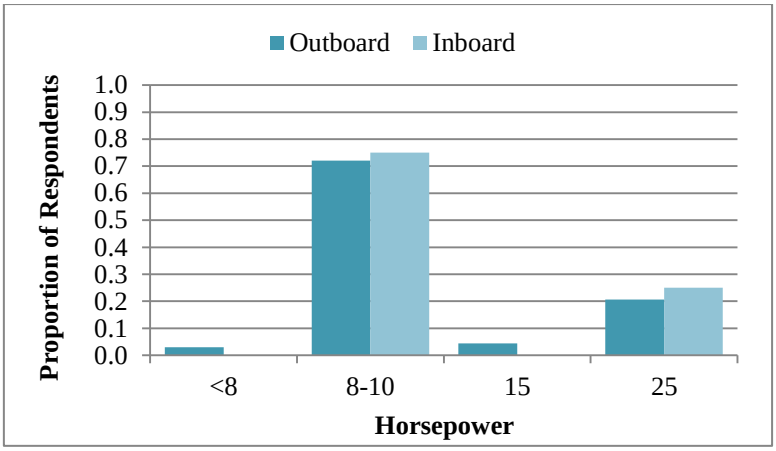


Figure 3.7. Horsepower of boat motors used by fishers (n=68) at Sagareshwar Beach, Vengurla.

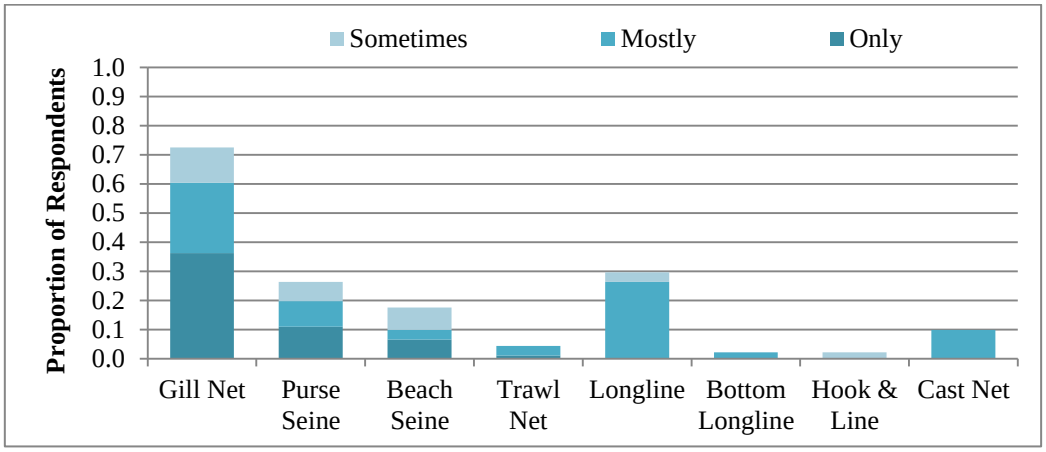


Figure 3.8. Fishing gear used by fishers (n=91) at Sagareshwar Beach, Vengurla.

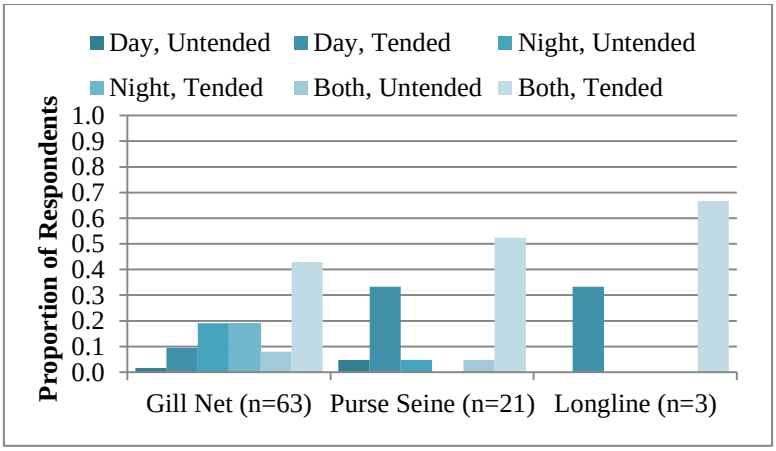


Figure 3.9. Time of day fished and tending of gear by fishers (n=63) at Sagareshwar Beach, Vengurla.

Map 3.1 is a composite of all fishing areas indicated on a map by survey respondents (n=53). Fishers also reported distance and/or time traveled to indicate their general fishing area: the average distance travelled from shore was 19.5km (StDev 19.4km, Range 0.4-100.0km, n=53), and the average travel time was 89.9min (StDev 46.09min, Range 1.5-210.0min, n=46). Fishers who used gill nets, purse seines and longlines mostly fished over fine sediments in shallow waters, whereas trawl nets were only used in deep waters (Table 3.1).

Table 3.1. Habitat fished by fishers at Sagareshwar Beach, Vengurla

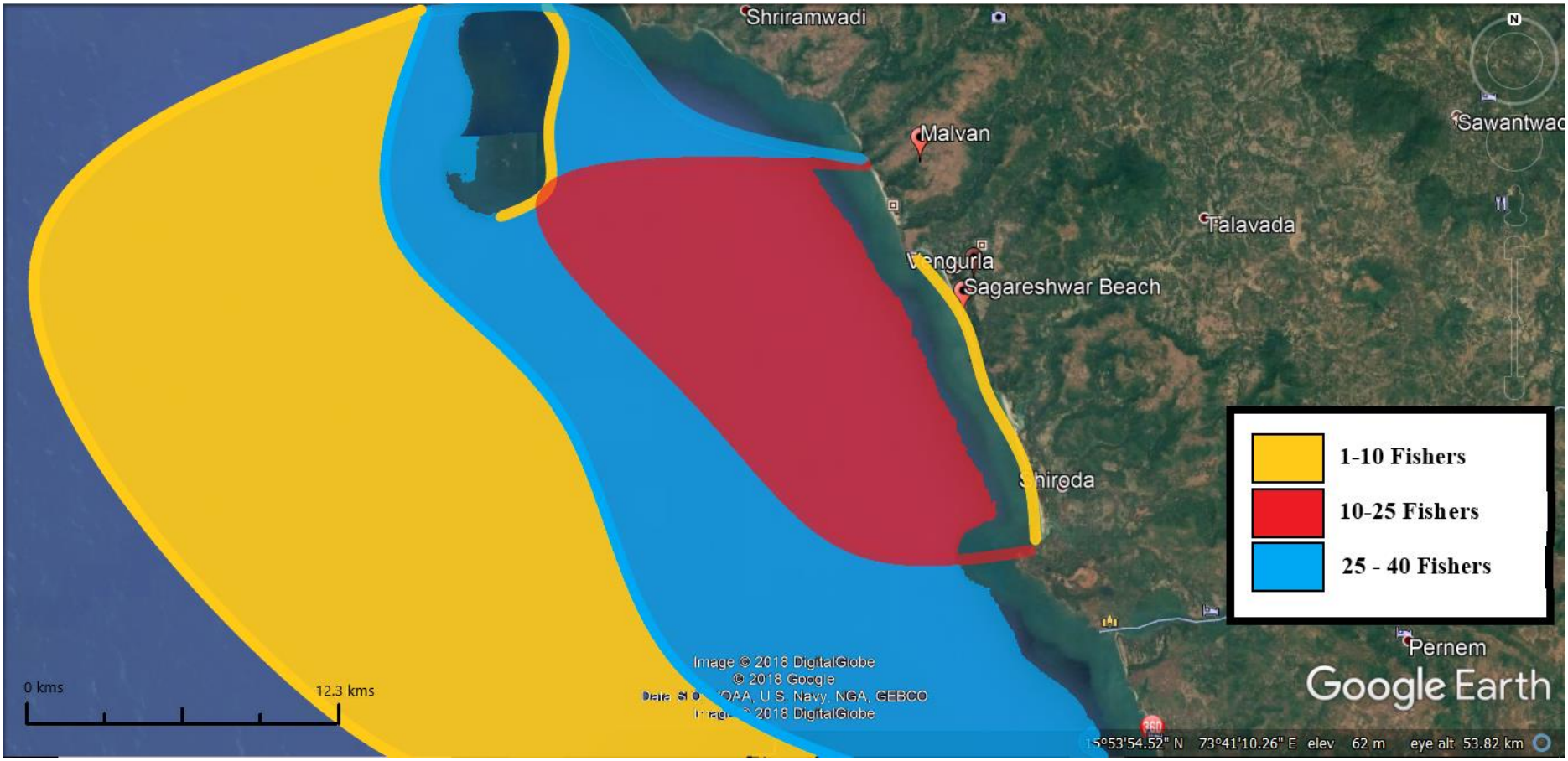
Habitat	Gill (n=65)	Purse Seine (n=24)	Trawl (n=4)	Longline (n=5)	Bottom Longline (n=2)
Deep water	20.0%	37.5%	25.0%	20.0%	0.0%
Inshore, fine sediment	50.8%	33.3%	0.0%	20.0%	0.0%
Unknown	29.2%	29.2%	75.0%	60.0%	100.0%

Fishing activity occurred both during the day and at night, and the majority of fishers tended to their gear while it was in the water (Figure 3.9). The soak time (length of time fishing gear was in the water) was usually <4 hr but went up to 6 hr for trawl nets and some purse seines (Figure 3.10). All fishing gear was positioned at all water depths (Figure 3.11); beach seines were not included on the figure as this gear was only used at full water depth.

The length of most fishing nets and lines ranged from 51-500m, with some gear exceeding 500m long (Figure 3.12). The greatest proportion of nets were of 11-100m in width (Figure 3.13). The mesh size and webbing dimension of the net varied with type of fishing gear, but was usually <57 mm (Figure 3.14 and 3.15). The unique combinations of other characteristics (e.g. net material, net construction) of all individual fishing gear described during the study is presented in Appendix C.

Map 3.1. Composite of all fishing areas visited by respondents (n=53) at Sagareshwar Beach, Vengurla.

(Base map Google Earth, n.d)



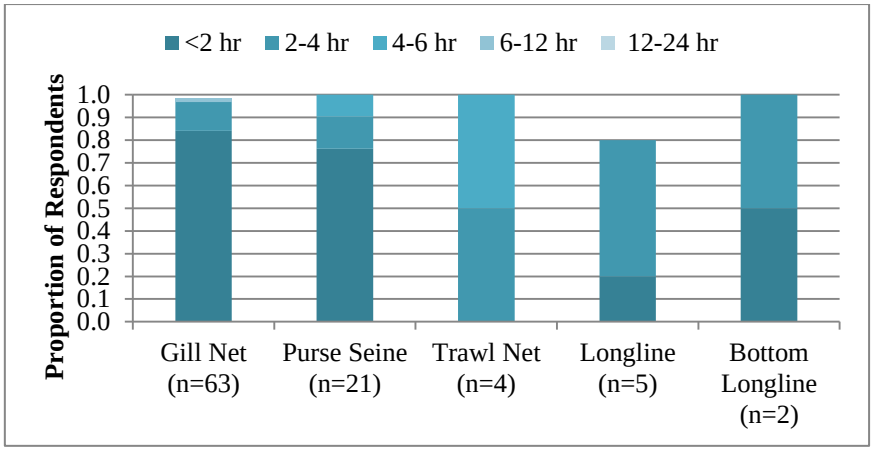


Figure 3.10. Soak times of different gear used by fishers at Sagareshwar Beach, Vengurla.

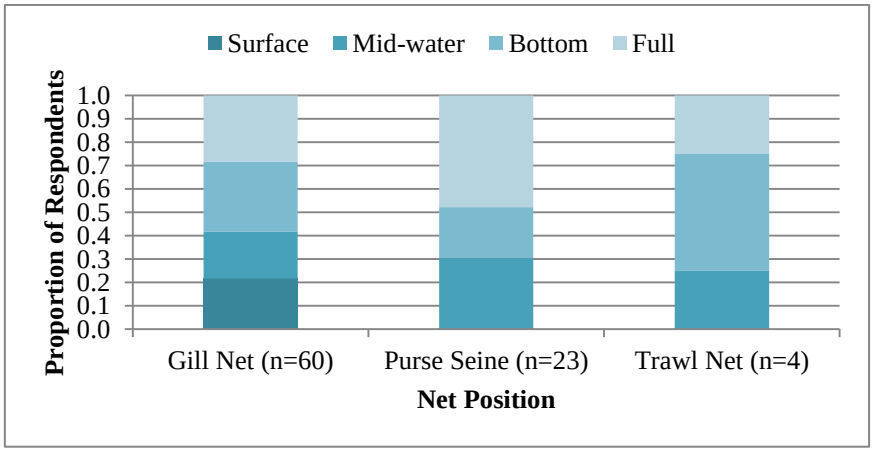


Figure 3.11. Net position used by fishers at Sagareshwar Beach, Vengurla.

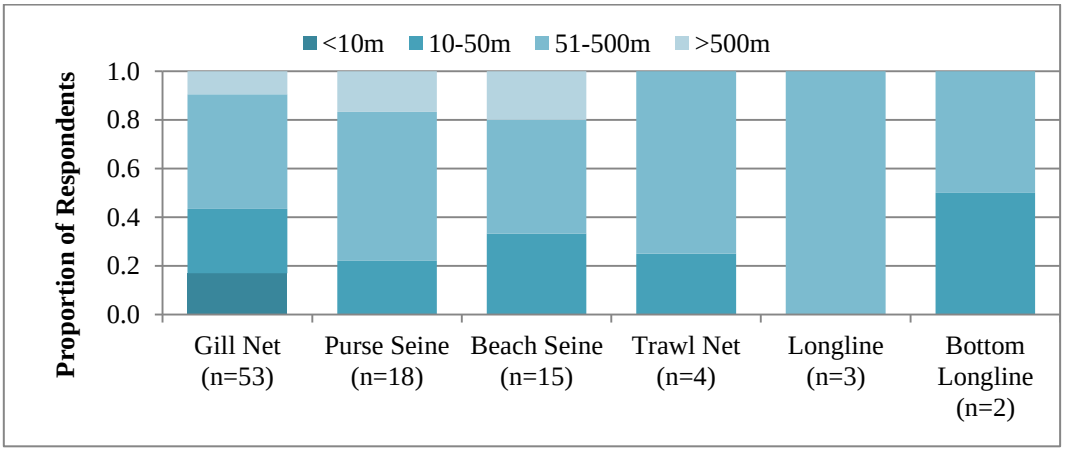


Figure 3.12. Length of nets and lines used by fishers at Sagareshwar Beach, Vengurla.

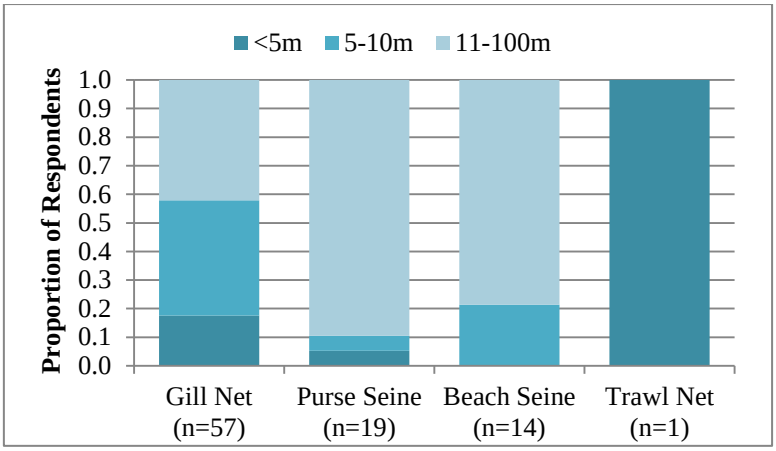


Figure 3.13. Width of fishing nets used by fishers at Sagareshwar Beach, Vengurla.

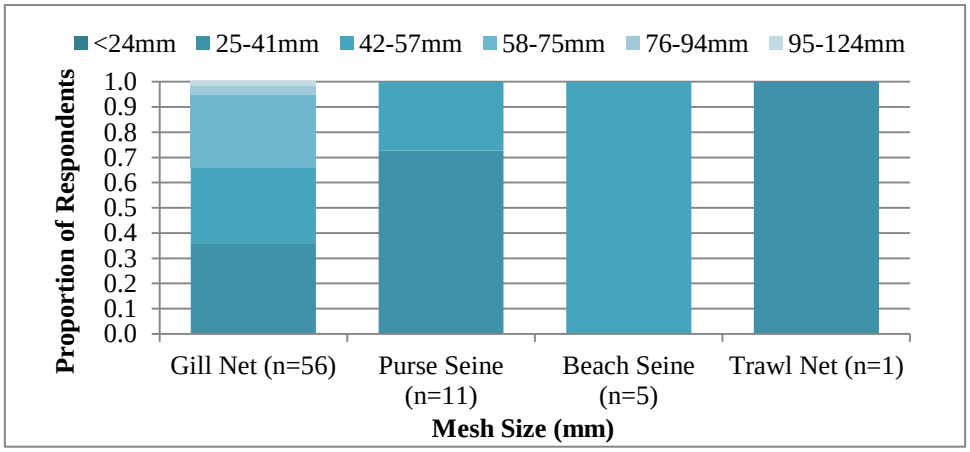


Figure 3.14. Mesh size of fishing gear used by fishers at Sagareshwar Beach, Vengurla.

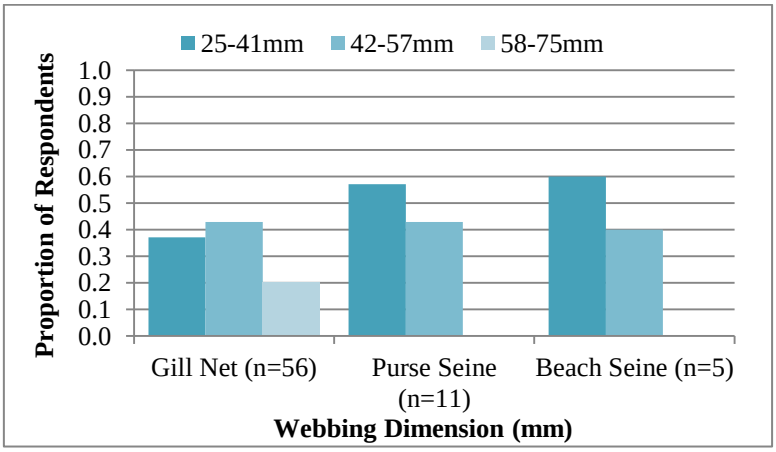


Figure 3.15. Webbing dimensions (stretched) of fishing gear used by fishers at Sagareshwar Beach, Vengurla.

The majority of respondents (71.9%, n=64) sold their fishing gear to a scrapyard once it was beyond repair, while 21.8% stated that they disposed of it on the beach or at sea (Figure 3.16). Ghost gear had been observed by 75.3% of respondents (n=89) while they were at sea.

3.4 OBSERVATIONS OF SEA TURTLES BY FISHERS AT SAGARESHWAR BEACH, VENGURLA

Sea turtles had been seen by the majority (96.5%, n=88) of respondents during their fishing career and many (n=85) were able to identify the sea turtle species they observed. Fishers most frequently observed the olive ridley (72.7%), followed by the hawksbill (62.5%) turtle. The leatherback turtle was the least frequently observed (18.2%) (Figure 3.17). Respondents (n=88) most commonly observed sea turtles while fishing (72.7%), when the sea turtles were accidentally caught in their nets (65.9%), or coming ashore to lay their eggs (64.8%). None of the respondents had observed sea turtles being hunted (Figure 3.18). The respondents who knew areas where sea turtles could be found (51.8%, n=85) named the adjacent turtle nesting beach, Dabholi Beach, and some (40.0%, n=55) thought turtle areas changed over time. Only 3 of 83 respondents (3.6%) had seen mating sea turtles.

The largest cohort (47.1%, n=87) had seen sea turtles frequently in their lifetime. Around a third (32.1%) of the respondents had seen sea turtles only a few times in their life, while only <6% had seen them either only once in their life or never. (Figure 3.19). When asked how frequently they saw sea turtles in the last year, the largest group of respondents (57.5%, n=80) responded that they had seen them several times (Figure 3.20). Very few respondents (n=27) identified the months when sea turtles were observed, with most sightings during August and September and the least from February to May (Figure 3.21). When asked to estimate the number of sea turtles in local waters, equal proportions of respondents indicated a population size of 10-100 or >100 (21.7% each category, n=83) but many fishers (39.8%) did not know (Figure 3.22).

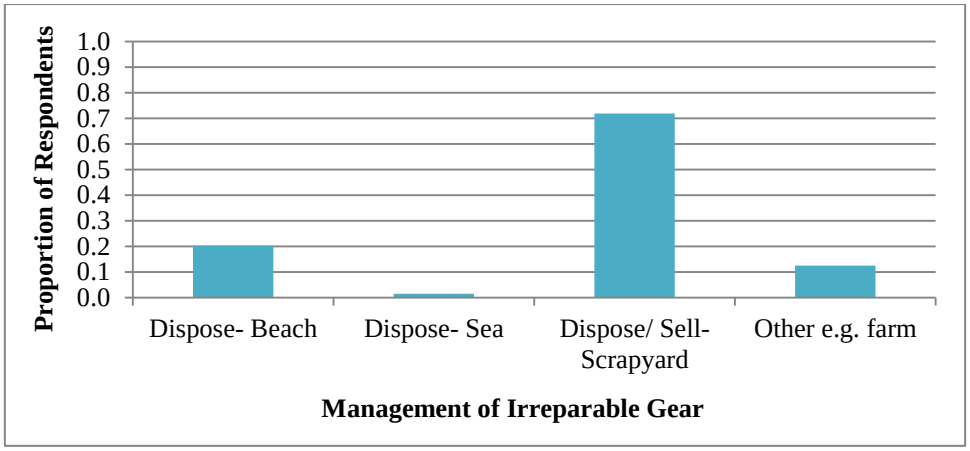


Figure 3.16. Management of irreparable gear by fishers (n=64) at Sagareshwar Beach, Vengurla.

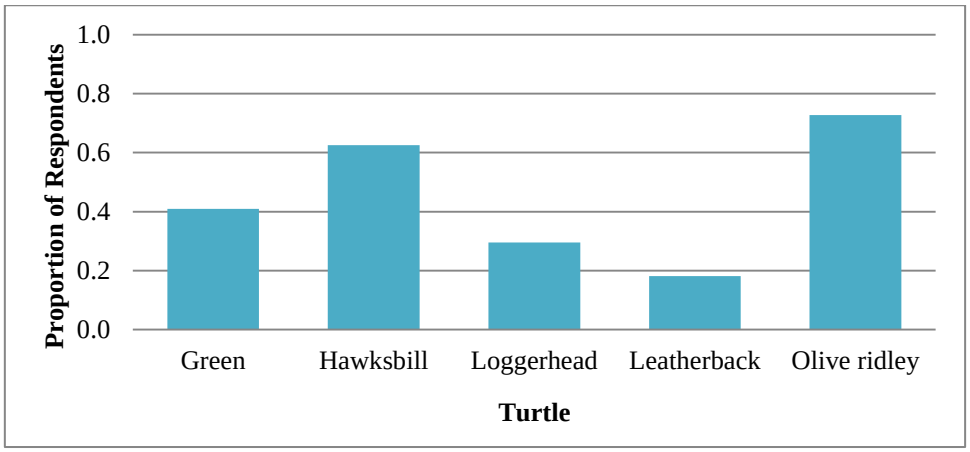


Figure 3.17. Species of sea turtle observed by fishers (n=85) at Sagareshwar Beach, Vengurla.

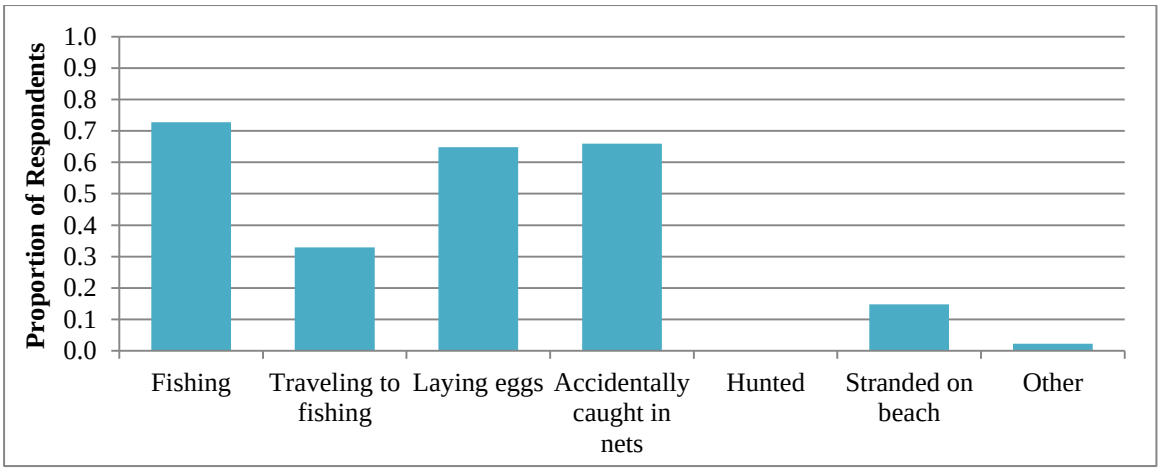


Figure 3.18. Activities during which sea turtles were observed by fishers (n=88) at Sagareshwar Beach, Vengurla.

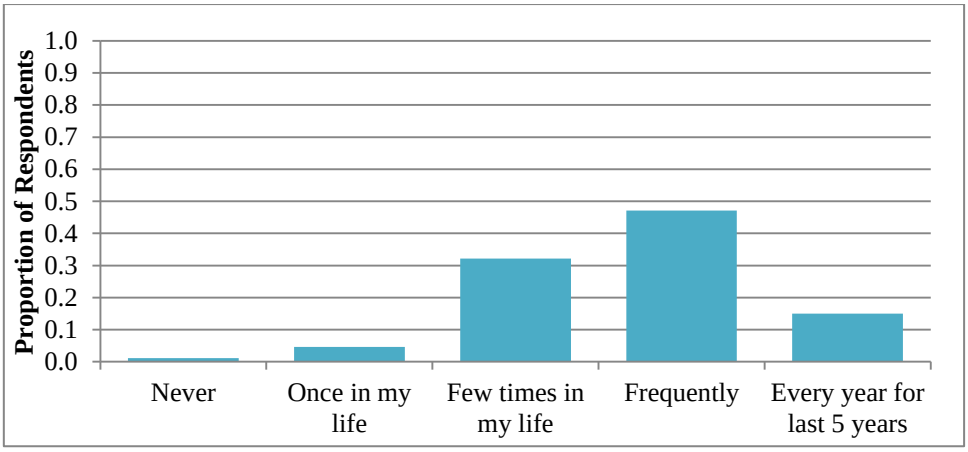


Figure 3.19. Lifetime observations of sea turtles by fishers (n=87) at Sagareshwar Beach, Vengurla.

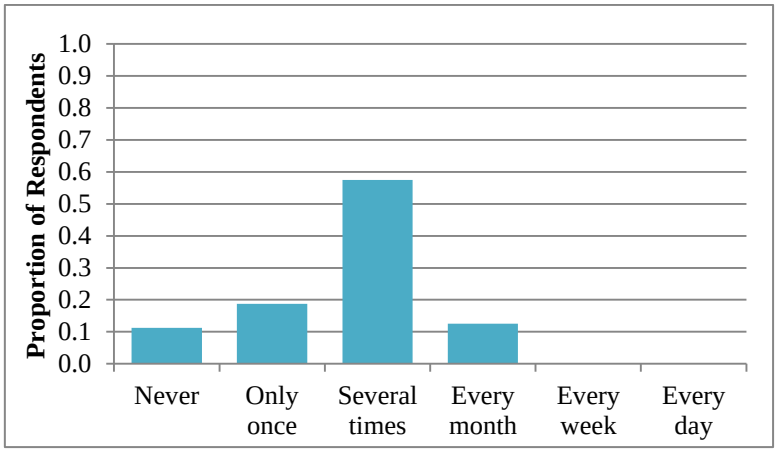


Figure 3.20. Observations of sea turtles in the last year by fishers (n=80) at Sagareshwar Beach, Vengurla.

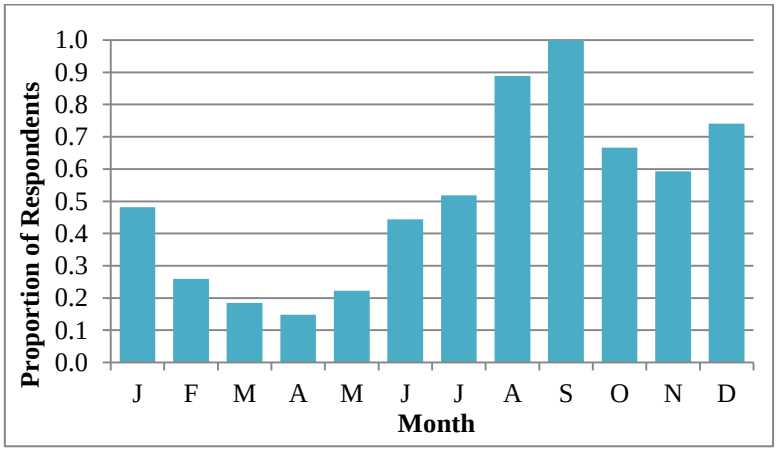


Figure 3.21: Seasonality of turtle observations by fishers (n=27) at Sagareshwar Beach, Vengurla

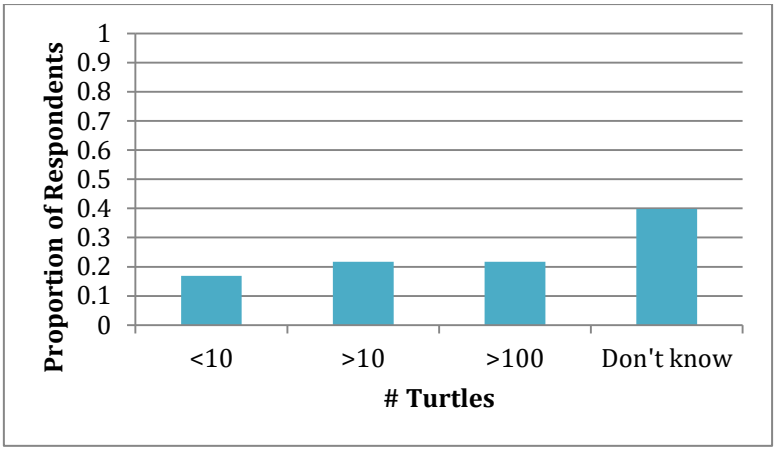


Figure 3.22. Perceptions of numbers of sea turtles in local waters by fishers (n=50) at Sagareshwar Beach, Vengurla.

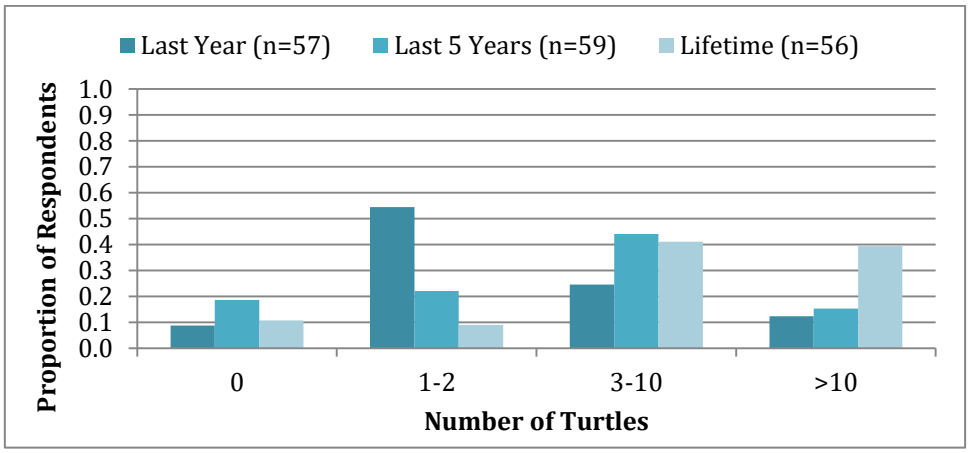


Figure 3.23. Number of sea turtles caught over time by fishers at Sagareshwar Beach, Vengurla.

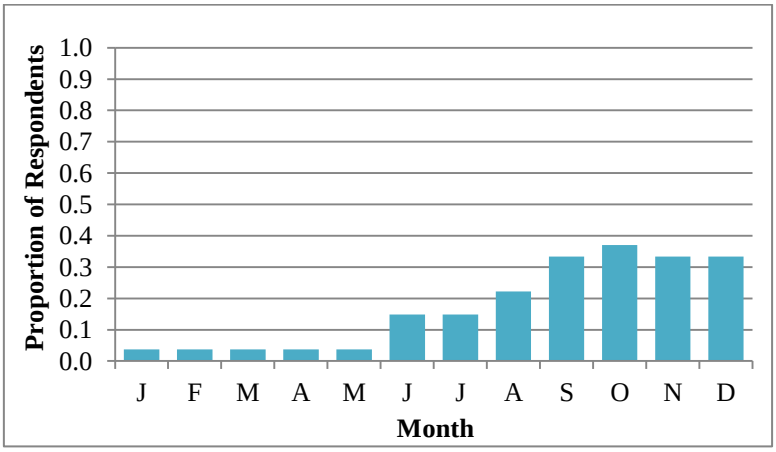


Figure 3.24. Seasonality of turtle captures by fishers (n=10) at Sagareshwar Beach, Vengurla.

3.5 CAPTURES OF SEA TURTLES BY FISHERS AT SAGARESHWAR BEACH, VENGURLA

In just the past year, 67.1% of respondents (n=82) had caught sea turtles in their fishing gear; the largest group (54.5%) had caught 1-2 sea turtles but 12.3% of respondents had caught >10. In the last five years, 81.4% of fishers (n=59) had caught sea turtles, and the largest group of respondents (44.1%) had caught 3-10 turtles with 15.3% catching >10 turtles. In the last 10 years, 89.3% of fishers (n=56) had caught turtles, many in the range of 3-10 sea turtles (41.1% of respondents) or >10 (39.3%) (Figure 3.23).

Of 93 interviewees, only 10 fishers reported the months of sea turtle capture. Most captures occurred in the monsoon (June to August) and winter (September to December), whereas from the end of winter to summer (January to May), the capture was considerably lower (Figure 3.24).

Respondents indicated that sea turtles were caught by fishers in other villages (45.2%, n=84) and by other fishers in their own village (49.4%, n=85) at a lower rate than their own capture rate of sea turtles (67.1%, n=82, Figure 3.25). This capture rate was described as typical by 71.1% of respondents (n=42). The number of sea turtles captured in fishing gear over the last year was described as having decreased by a majority of the respondents (42.9%, n=49). However, 34.7% believed that the number captured had not changed (Figure 3.26).

When asked about the trend of accidental bycatch of sea turtles in their gear when compared to their initial fishing years, the most common perception was that the rates had decreased (54.3%, n=81). A similar proportion of fishers (55.8%, n=77) also believed there were fewer sea turtles in local waters now (Figure 3.27). Fishers provided similar reasons for their perceptions about turtle population trends and bycatch rates. Those who reported a decrease in sea turtle population size attributed it to reduced fish populations, increased fishing activity, trawling and commercial boats, pollution (plastic and oil spills), diseases, storms, consumption of eggs, migration of sea turtles and entanglement

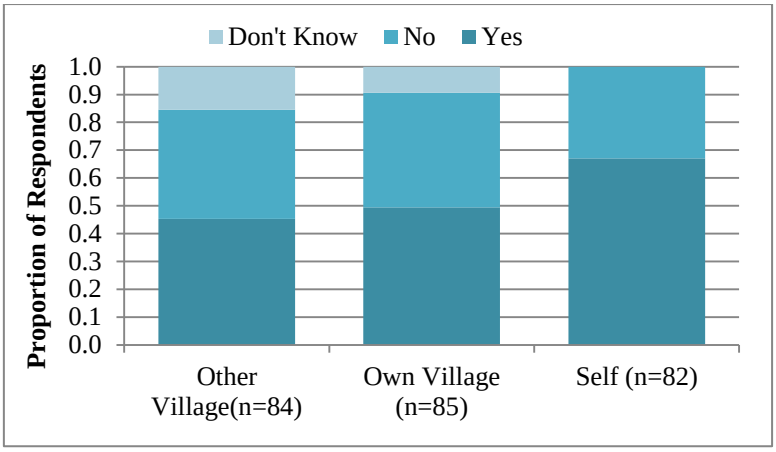


Figure 3.25. Rates of accidental sea turtle capture by fishers at Sagareshwar Beach, Vengurla.

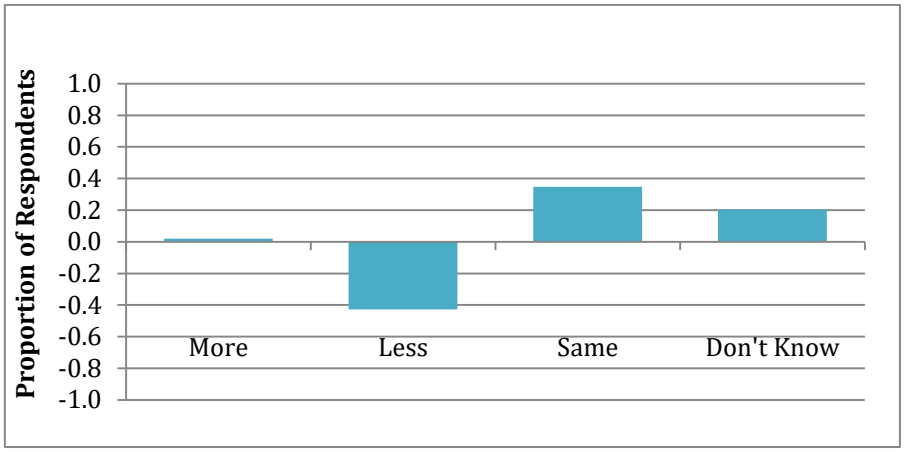


Figure 3.26. Trends in accidental captures of sea turtles in the last year by fishers (n=49) at Sagareshwar Beach, Vengurla.

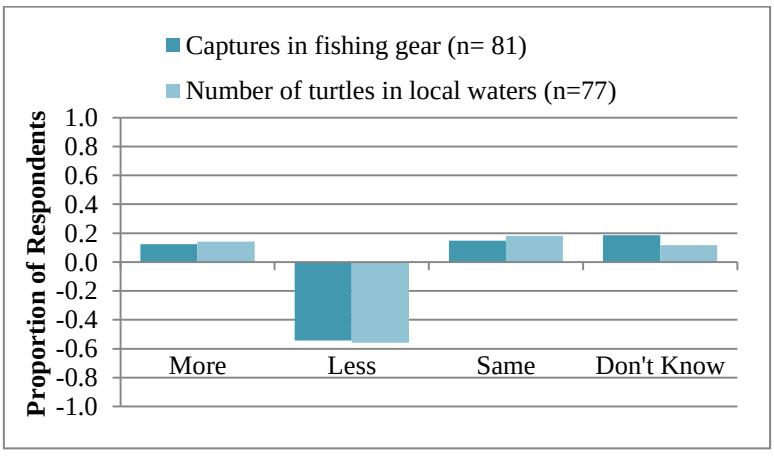


Figure 3.27. Perceived trends in numbers of sea turtles by fishers at Sagareshwar Beach, Vengurla.

in ghost gear. Fishers who indicated an increase in sea turtle numbers based their perceptions on increased conservation, breeding programmes, large numbers of eggs, the release of sea turtles and reduced consumption of turtle meat and eggs. The respondents that indicated no change in the number of sea turtles caught and unchanging population sizes provided reasons like no consumption or intentional capture/killing.

3.6 OUTCOMES OF SEA TURTLE INTERACTIONS WITH FISHERS FROM SAGARESHWAR BEACH, VENGURLA

Sea turtles entangled in fishing gear were reported to tear the nets or eat the catch (n=77 respondents). Respondents reported all of their own captures in the last year (n=54) and a high proportion of captures of sea turtles by fishers in their own village (95.9%, n=49, Figure 3.28) were accidental, but attributed up to 23.8% of captures by fishers from other villages (n=42, Figure 3.29) to be intentional. Of 85 respondents, 84 reported that they would release live sea turtles or discard dead ones that were caught in their fishing gear. One respondent said captured sea turtles might be eaten, but did not share if this would only occur with sea turtles that were already dead.

Fishers' observations of sea turtles stranded on shore (75.6%, n=82, Figure 3.30) and floating at sea (72.1%, n=79, Figure 3.31) were common. Of the respondents who observed sea turtles floating at sea, 59.5% (n=37) indicated the sea turtles were floating free while 40.5% reported sea turtles tangled in fishing gear. If respondents found a stranded turtle, 100.0% (n=80) said they would release a live turtle or bury a dead one.

3.7 KNOWLEDGE AND BELIEFS ABOUT SEA TURTLES AMONG FISHERS AT SAGARESHWAR BEACH, VENGURLA

Knowledge about the legal protection of sea turtles was high among survey respondents (65.9%, n=82). The majority of fishers indicated that intentionally killing a turtle was punishable (61.5%, n=78) but accidentally killing a turtle was not (56.8%, n=74) (Figure 3.32).

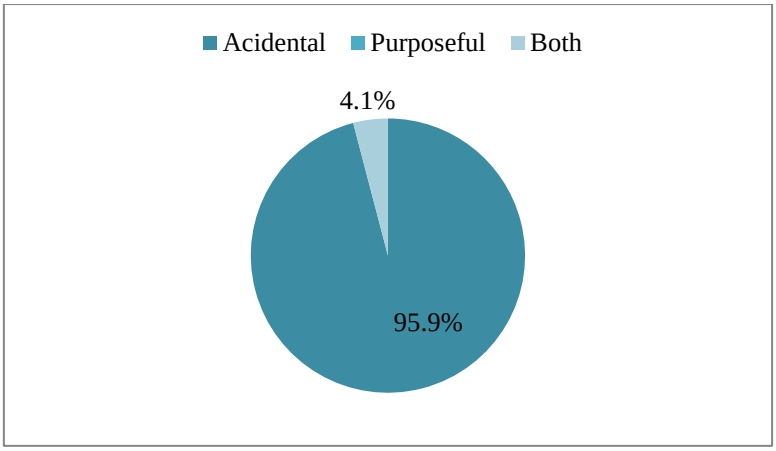


Figure 3.28. Capture of sea turtles by fishers in respondents own village (n=49).

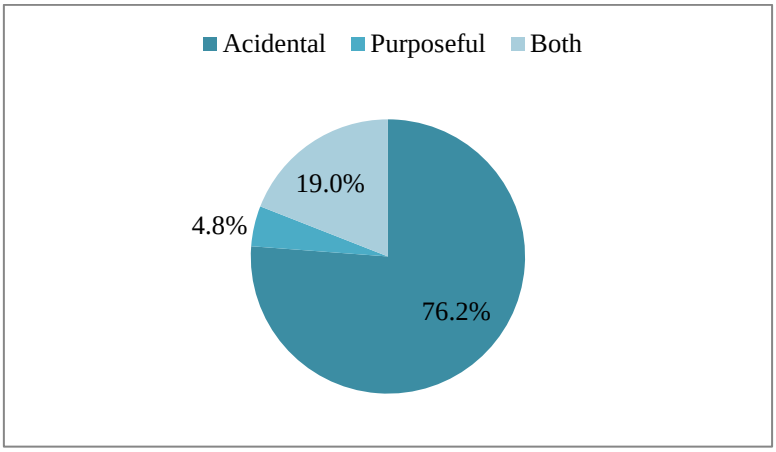


Figure 3.29. Capture of sea turtles by fishers in other villages (n=42).

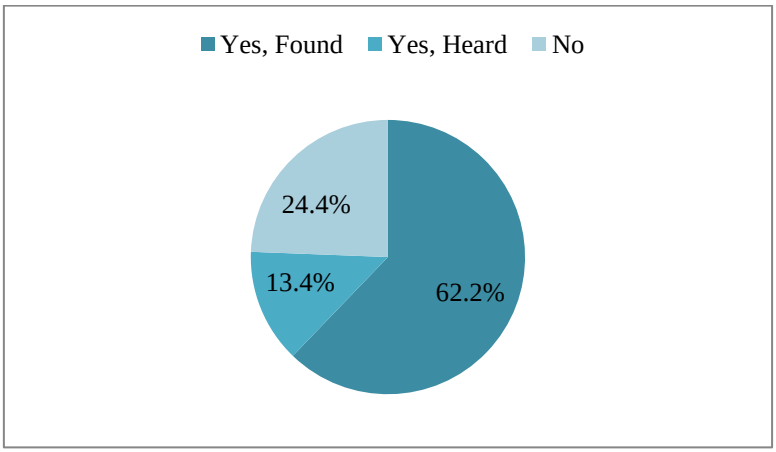


Figure 3.30. Reports of sea turtles stranded on shore by fishers (n=82) at Sagareshwar Beach, Vengurla.

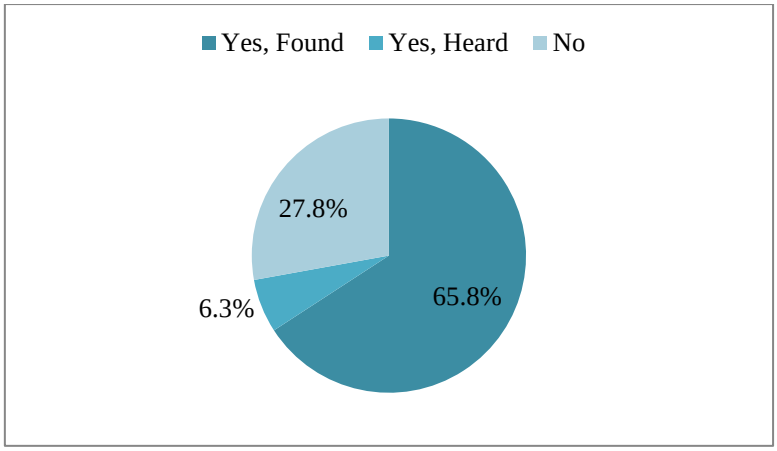


Figure 3.31. Reports of sea turtles floating at sea by fishers (n=79) at Sagareshwar Beach, Vengurla.

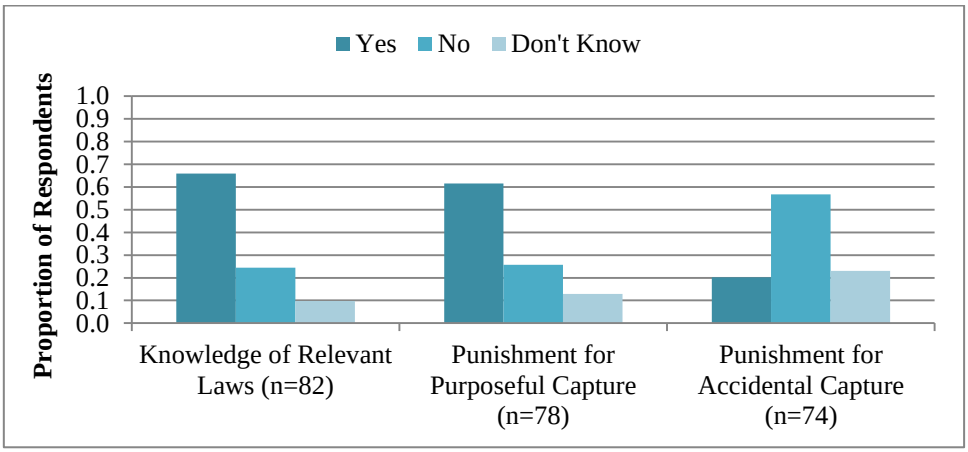


Figure 3.32. Knowledge about legislation relating to sea turtles among fishers at Sagareshwar Beach, Vengurla.

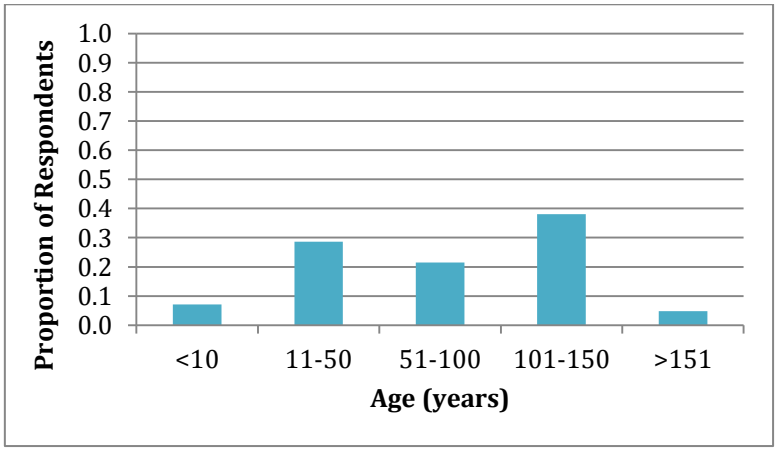


Figure 3.33. Estimations of sea turtle life spans made by fishers (n=42) at Sagareshwar Beach, Vengurla.

Most fishers (56.0%, n=75) believed that sea turtles would always exist in local waters, while equal proportions of the remainder of respondents did not think so or did not know. The life span of sea turtles was believed to be between 11 and 150 years by the majority of respondents (88.1%, n=42) (Figure 3.33). Most fishers (84.4%, n=77) believed that sea turtles were important in local waters, fulfilling functions of maintaining ecological balance and cleaning the waters.

Local sociocultural and religious beliefs about sea turtles were found to be common (69.5%, n=82). The most common beliefs described sea turtles as either incarnations or vehicles of Lord Vishnu, a deity in Hindu mythology. Other less common beliefs included that of a rare golden sea turtle with a square-shaped shell as the Kurma avatar of the deity. Some fishers even indicated that they either offered a prayer while releasing caught sea turtles or folded their hands in *namaskara* in apology. The association of the arrival of sea turtles with a full moon or when a halo appears around it was also common. Some fishers recalled the tale of *The Tortoise and The Hare* when asked if they had heard any stories about sea turtles. No respondents described the use of sea turtles as trade and <0.1% of fishers mentioned the medicinal value of sea turtle products.

3.8 POTENTIAL IMPACTS OF FISHERIES ON OTHER MARINE ANIMALS

Observations of additional marine wildlife (eg. dolphins, whales, whale sharks, sharks, sea snakes) while fishing were common (97.6%, n=84), and 50.0% of the same respondents reported capture of marine wildlife other than sea turtles in their fishing gear.

3.9 INTERVIEWEES PERCEPTIONS OF FISHERS AND THEIR RESPONSES

Very few fishers (7.9%) appeared to be uninterested during the survey (Figure 3.34). Moreover, fisher honesty in answering questions about capture of sea turtles was perceived to be around 64.0%, while dishonesty was perceived to be at 2.2% (Figure 3.35). Interviewers also reported low levels of uncertainty when responding to numerical questions (15.7%, Figure 3.36) and discriminating between sea turtle species (33.3%, Figure 3.37).

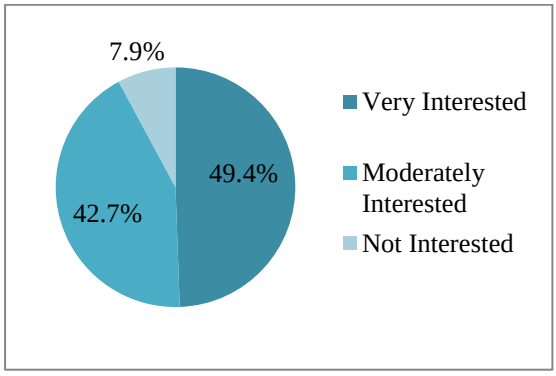


Figure 3.34. Interviewers' perceptions of interest of fishers during the survey.

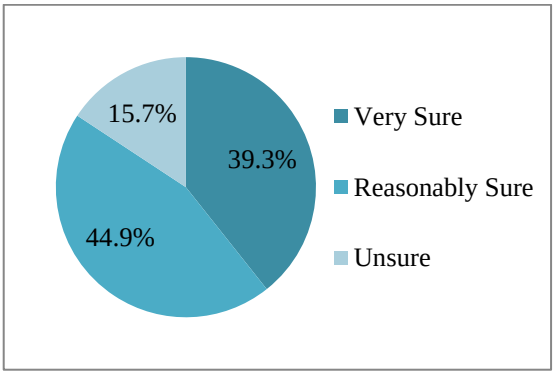


Figure 3.36. Interviewers' perceptions of fisher surety about responses to numerical questions.

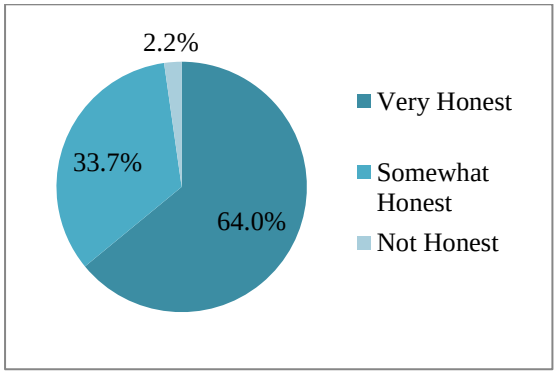


Figure 3.35. Interviewers' perceptions of fisher honesty in answering questions about rates of turtle capture.

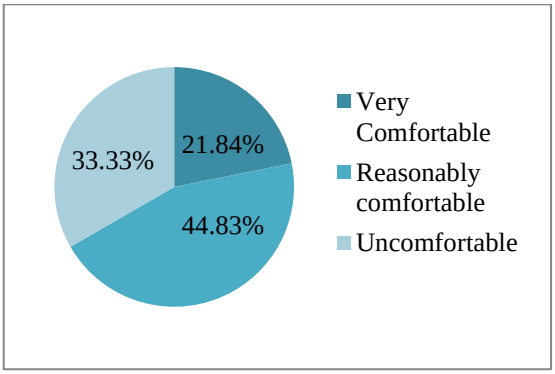


Figure 3.37. Interviewers' perceptions of fishers ability to discriminate among sea turtle species.

CHAPTER 4. DISCUSSION

The survey tool used in the study was a modified version of the UNEP/CMS survey (Pilcher et al., 2017), which also incorporated interviewers' perceptions of respondents' interest, certainty, and honesty during the interviews. Based on the interviewers' assessment of respondents and responses to the survey questions (Figures 3.1-3.33, Table 3.1) and the fishers' reported background (including years fishing experience, family history, and prevalent occupation), findings of the study can serve as indicators of sea turtle abundance, distribution and threats at Sagareshwar Beach. Sea turtles had been observed by many respondents (96.5%) throughout their fishing career but fishers' LEK contributed to this study does not fill all the knowledge gaps about turtle abundance and distribution. Therefore, findings should be complemented with research methodologies more directly focused on sea turtles and their habitats. However, the data collected about fishing gear (predominantly gill nets and purse seines) and practices (including 30.0% disposal of irreparable gear at sea or on the beach), bycatch rates (67.5%), observations of ghost gear (75.3%), entangled (40.5%), floating (72.1%) and stranded sea turtles (75.6%) could inform future threat mitigation and conservation activities within the fishing community. Factors that potentially shaped fishers' attitudes towards sea turtles, including sociocultural beliefs, legal awareness, and economic incentives, should be considered when designing conservation activities so as to improve their likelihood of success.

4.1 TURTLE BIOLOGY AND DISTRIBUTION

Over 95% of respondents said that they had seen sea turtles while fishing, reporting encounters with five species of sea turtles, of which four (green, hawksbill, leatherback and olive ridley) had been previously recorded to inhabit the coast of Maharashtra (Sanaye & Pawar, 2009). Olive ridley and hawksbill sea turtles were the most commonly identified species at Sagareshwar Beach, which was surprising as earlier reports had suggested that green turtles were commonly found in the Vengurla district (Venkataraman & Milton, 2003). Possible reasons for this discrepancy are the possibility that respondents confused hawksbill and green turtles, that the number of hawksbill turtles had been previously underestimated, or the numbers of green turtles have decreased. Validation of these reasons, and the respondent's sightings of previously unreported loggerhead turtles in the Sindhudurg District and long-unseen leatherback

turtles, would require boat surveys by researchers with greater experience in distinguishing between the turtle species.

Respondents could not indicate specific areas, such as turtle feeding or mating grounds, on maps so further information about turtle habitats also needs to be collected by focused turtle research. Very few fishers (3.6%) reported observations of mating sea turtles, which was unexpected as Sagareshwar Beach is immediately adjacent to a nesting beach and sea turtles usually mate 5-50 km offshore in waters adjacent to their nesting grounds (Rajagopalan et al., 1996). This could be because of the relatively low number of nesting sea turtles in the area (Giri & Chaturvedi, 2006) or that fishers on Sagareshwar Beach remain relatively close to shore (Figure x).

Sea turtles were most likely to be seen by respondents between the months of August and December. This corroborates Kakodkar's (2006) findings in which fishers from Sindhudurg District observed sea turtles in the post-monsoon season (after September). Turtle sightings at this time could be attributed to the commencement of turtle nesting season in December (Giri & Chaturvedi, 2006). Leading up to December, sea turtles may have been sighted travelling inshore to find mates, but may not have been observed in the act of mating.

The abundance of sea turtles in local waters cannot be accurately discerned through the use of respondent's LEK due to the wide disparity in fisher perceptions. While equal proportions of fishers believed that there were either more than 10 or more than 100 sea turtles in local waters, a majority of respondents did not know. The population size of feeding turtles would be most accurately estimated using boat or aerial surveys and trained observers, and could involve local fishers working with researchers.

Despite the largest group of fishers reporting reductions in local sea turtle population size (55.8% of respondents) and capture rates (54.3%), most (56.0%) believed that sea turtles would be present in local waters for a long time. This perception could be attributed to the religious idea that sea turtles are divine, i.e., they are an incarnation of Lord Vishnu, or attributed to the fishers' belief that sea turtles live for a long time, as most respondents

also reported that turtles lived for 11-150 years. This range includes the probable lifespan of sea turtles, which is estimated to be similar to humans, but there is no definitive due to the difficulty of estimating the age of sea turtles (Casale & Heppell, 2016). Fishers' perceptions of the environmental functions of sea turtles were that of maintaining ecological balance and cleaning the water, which were similar to the roles of turtles as described by scientists (Alexander et al., 2017).

4.2 FISHING PRACTICES AND GEAR AND RATES OF BYCATCH

Of the various types of fishing gear used on Sagareshwar Beach, gill nets and purse seines were the most commonly used. As 67.1% of respondents stated that they had caught sea turtles in the past year, both of these types of fishing gear could potentially contribute to sea turtle mortality in their respective ways. Observations of stranded sea turtles washed ashore (75.6%) or floating at sea (72.1%) were also common; such sea turtles were probably unable to swim after inhalation of water or injury while entangled in fishing gear. Even when released, sea turtles appear active and apparently uninjured, their health can be severely impacted by inhalation of seawater so they later wash ashore alive or dead (Food and Agriculture Organization of the United Nations, 2010).

The reported rate of capture of sea turtles among fishers at Sagareshwar Beach is higher than that described for France (Bourjea et al., 2008), Egypt (Frazier, 1980), Bangladesh (Phillott et al., 2015), similar to that in Ghana (Alexander et al., 2017), and less than that reported for Pakistan (Khan & Nawaz, 2015), Kenya (Bourjea et al., 2008) and Sri Lanka (Ekanayake, 2015). Difference in capture rates may be due to local gear type and fishing practices, and the size of local turtle populations.

4.2.1 Gill Nets

Gill nets, in comparison to other nets, are easier to use and are relatively cheaper, which makes them one of the most widely used fishing gears in small-scale fisheries (Northridge, 1991). Among fishers at Sagareshwar Beach, gill nets were the most common fishing gear, with 72.5% of the respondents using it. Characteristics of the gill

nets described by survey respondents were similar to those used in other regions of Maharashtra and other states of India (Pravin et al., 1998; Ramarao et al., 2002; Vijayan et al., 1993) (as cited in Kazi, Mohite, & Jadhav, 2010). Thus, bycatch rates at Sagareshwar Beach (67.1% fishers most commonly catching 1-2 sea turtles annually) may be scaled up to estimate likely rates at the District and State scale. Using the findings of this study, a conservative estimate of likely bycatch is 67% of fishing vessels using gill nets (gillnetters) catching 1 turtle per year. Therefore, the 403 gillnetters in Sindhudurg District may catch 270 sea turtles as bycatch each year. Similarly, for Maharashtra state, a total of 3,961 gillnetters could potentially catch 2,653 sea turtles annually (CMFRI, 2010). This is significantly lower than the annual rates of capture and mortality reported for Odisha (Rajagopalan et al., 1996), almost certainly due to the difference in turtle population size (Pandav et al., 2006).When adjusted for length of coastline surveyed, the rate of capture among fishers at Sagareshwar Beach was potentially similar to that described for gill nets used in Tamil Nadu (Bhupathy et al., 2007; Sachithanandam et al., 2015). As Sindhudurg District is believed to have comparatively small feeding and nesting sea turtle populations (Giri & Chaturvedi, 2006), bycatch of this magnitude may represent a significant threat.

Sea turtles caught in gill nets are at a higher risk of mortality (~100%) than those in other gear (Gilman et al., 2010). There are multiple factors that contribute to this, namely the soak time (Read, 2007), mesh sizes, and net positions (Gilman et al., 2010; Lucchetti et al., 2017; Wang et al., 2010) (as cited in Gray & Kennelly, 2018).

Gill nets are usually deployed overnight, and generally required longer soak times (Gray & Kennelly, 2018). Sea turtles can hold their breath for up to 7 hours when asleep but only 45 minutes during a single dive, and can only last a few minutes under stressful situations such as when they were caught in nets (Olive Ridley Project, n.d.). As the soak for gill nets at Sagareshwar Beach was 2 hours or more, entangled sea turtles are at risk of drowning. This risk may be reduced when fishers tend their nets, as entangled sea turtles would be observed and could be released. Effects on turtle mortality would be further compounded as ~20% of the fishers left their nets untended during this period.

Webbing dimensions for gill nets at Sagareshwar Beach were in the range of 24-124mm. These dimensions fall within the usual mesh sizes of gill nets, which is ~30-300mm (Hovgård & Lassen, 2000). As mesh dimensions of gill nets are known to be dangerous for larger marine animals, including sea turtles, this puts any turtles near the Sagareshwar Beach in danger (WWF-Australia, 2018). Most fishers from Sagareshwar Beach positioned their gill nets at the bottom or at full water depth range, within which sea turtles and other marine animals swim. Visibility at greater depths worsens and likely increases the risk of entanglement (Martin & Crawford, 2014). Further, fishers on Sagareshwar Beach used monofilament nets, which are often transparent and more difficult for sea turtles to identify in low light (Gilman et al., 2010) (as cited in Gray & Kennelly, 2018).

Alterations to characteristics of the gill net can potentially reduce bycatch rates. For example, the use of narrower (i.e. less wide) nets is an effective method for reducing sea turtle bycatch rates in gill nets (Price and Van Salisbury, 2007). However, making changes to these characteristics has proven to be challenging as nets are inherently nonselective. Therefore, alterations to gill nets might make it less profitable for the fishers by also reducing the target catch (Gilman et al., 2009) (as cited in Peckham et al., 2015). Previous studies have recommended the addition of visual cues, such as net illumination and the use of shark-shaped silhouettes, to reduce the incidental bycatch of sea turtles in gill nets. While both mitigative measures significantly reduced sea turtle bycatch, the latter caused an additional 45% decrease in the target fish species caught, whereas such a reduction in catch was almost negligible in illuminated nets (Wang et al. 2010, 2013).

4.2.2 Purse Seines

Purse seines have been reported to pose a relatively low threat to sea turtles in comparison to longlines and gill nets. The frequency of sea turtle bycatch in purse seines has been reported as <1% and and entangled sea turtles were described as easy to release (Food and Agriculture Organization of the United Nations, 2010; Hall & Roman, 2013). No data has been reported on the mortality rate within this low capture rate, but the number of impacted sea turtles can be assumed to be low.

Purse seines were the second most common gear (26.4% of respondents) used by fishers on Sagareshwar Beach. However, purse seines were banned across Maharashtra from January 1st, 2017, on the grounds of conserving the fish populations that were being exploited. This ban was sanctioned under the Maharashtra Marine Fisheries Regulation Act, 1981 (Chatterjee, 2017; Karnad, 2017), but a 2016 survey of fishers from the Sindhudurg District revealed the law has not been uniformly abided by. The ban on purse-seines led fishers to use 'mini-purse seines' as an attempt to bypass the prohibition. This was a result of customary laws taking precedence over state laws. This meant that different groups within fishing communities in Maharashtra imposed their own versions of state legislation. For example, the 2016 survey recorded the Brahmeshwar group banning the purchase and usage of trawl nets and purse seines, while other groups only banned purchase of the same (Karnad, 2017). Despite non-compliance with the purse seine ban, it is unlikely that ongoing usage of this gear would contribute to sea turtle bycatch rates and mortality at a greater rate than that recorded at other locations. However, this example of non-compliance with fishing laws could also be indicative of fisher attitudes to other laws, such as those regarding sea turtles and their conservation.

4.2.3 Recommendations for Further Studies on Sea Turtle Bycatch

Data collected by National Marine Living Resource Data Centre (NMLRDC) from 1985-95 across all Indian maritime states revealed that, in comparison to the large scale of captures in preceding years, the occurrences of sea turtle bycatch seemed to have drastically decreased. There were three main reasons believed to have contributed to the reduction of incidental capture. The first was the informed awareness of the fisher population. The second was the dire lack in the demand for turtle meat, even if acquired. The final reason was the legal provision, i.e. the ban on inshore fishing by mechanised trawlers and the ban on fishing activities during mass nesting, which resulted in lower mortality rates (Rajagopalan et al., 1996).

However, the lack of estimates of fishing activity which caused incidental capture of sea turtles proved to be a challenge. It was recommended that a mechanism must be developed to accurately assess the incidental catch of sea turtles caused by fishing gear

and that the CMFRI play an integral role in the evolution of the mechanism and subsequent implementation of the programme (Rajagopalan et al., 1996). This has not yet occurred for gill nets and purse seines, and the most appropriate methodology would be calculation of the bycatch-per-unit effort (BPUE) for each net, calculated as:

BPUE = the number of sea turtles captured/(net length/100 m) × (soak time of net/24 hours) (Peckham, 2015).

However, calculation of BPUE requires more rigorous data that can be collected using a survey such as Pilcher et al. (2017) and probably requires presence of an on-board observer as an independent verifier of bycatch rates.

Other research has also recommended the completion of data collection on sea turtles among forest offices and fisheries offices via post, and the execution of awareness campaigns in fishing villages along the coast of Maharashtra (Giri, 2001). Findings of this study support the need for a more intensive study on bycatch rates of sea turtles as the threat is not unsubstantial and the species of local sea turtles include those that are classified by the IUCN as Vulnerable (olive ridley, loggerhead, leatherback), Endangered (green), and Critically Endangered (hawksbill) (Gray & Kennelly, 2018).

4.3 THREATS FROM GHOST GEAR

Observations of ghost gear were not a rare phenomenon in waters off Sagareshwar Beach, as 75.6% of the respondents reported having seen discarded or lost gear while at sea. Since fishing activity mostly occurred within ~30km of the coast, the ghost gear observed would likely have originated from the survey respondents themselves and potentially contradicts the reported reparative and disposal practices that fishers described. Most fishers preferred to repair their gear regularly, and bought new gear only after the gear could not be repaired any further. Irreparable gear was usually sold to a scrapyard and occasionally recycled in their domestic spheres, but 20.0% of fishers disposed of their

permanently damaged gear on the beach and 10.0% reported disposing their nets at sea. Fishers reported occasionally retrieving unidentified ghost gear and usually repairing, reusing or recycling them. But remaining ghost gear may potentially have a threefold impact on sea turtle populations, namely in terms of their entanglement at sea, stranding on shore, and obstruction to nesting.

Gill nets comprised 72.5% of the gear used by fishers at Sagareshwar Beach, of which 50.0% were constructed of monofilament fibre. Both this type of gear and construction fibre are known contributors to sea turtle entanglement in ghost gear. Monofilament nets are fragile and easily tear when trapped on rocks (Anderson et al., 2009; Sridhar, 2005; Stelfox et al., 2016), which are part of the fishing locations and adjacent to turtle nesting beaches close to Sagareshwar Beach (Khan & Nawaz, 2015). Such nets are also very thin and undetectable, entangling and obstructing the movement and activity of sea turtles (Anderson et al., 2009; Sridhar, 2005; Stelfox et al., 2016).

Local turtles feeding in the area or nesting female sea turtles approaching Sagareshwar Beach or adjacent shores to lay eggs may, therefore, become entangled in local ghost gear. Our findings suggest this may be a serious local threat as 40.5% of the fishers reported seeing sea turtles floating at sea while entangled in netting. Over 75% of respondents had also observed sea turtles washed ashore; such stranded turtles are usually unable to swim after inhalation of water while entangled in fishing or ghost gear (Olive Ridley Project, n.d.).

The characteristics of fishing gear used by fishers at Sagareshwar Beach were similar to those found as ghost gear with entangled sea turtles in the Maldives (Stelfox et al., 2014) and may indicate one such source for this significant threat. The disposal of damaged gear into the sea or on the beach may have an effect on local sea turtles as well as populations elsewhere in the Indian Ocean.

Fishers should be encouraged to dispose of their gear at a scrapyard and not on the beach or at sea. Financial incentives by the net manufacturers or the Maharashtra Forest

Department could help inculcate this practice. Similar to the program coordinated by Olive Ridley Project in the Maldives and Pakistan (Olive Ridley Project, 2018), local NGO staff and volunteers could also be trained in safe ways to free entangled sea turtles and remove ghost gear from the water.

4.4 FISHER'S ATTITUDES TO SEA TURTLES AND THEIR CONSERVATION

All but one respondent reported that they would release live sea turtles or discard dead ones that were caught in their fishing gear and all fishers described that they would release a live turtle or bury a dead one found stranded on the shore. These conservation efforts could be influenced by religious or cultural beliefs and legal awareness about sea turtles that could be instrumental in shaping their attitudes toward sea turtles.

As the majority of the respondents were Hindu and likely considered the sea turtle to be sacred, their interactions with the same were likely to not be harmful, out of fear of divine punishment. A common belief, among Hindus and non-Hindus alike, is the association of the arrival of sea turtles with a full moon or when a halo appears around it (also described by Madhyastha, Sharath and Rao (1986) in a study with fishers from Mangalore, Karnataka); such beliefs indicate the presence of sea turtles in general fishing culture. Interestingly, fishers at Sagareshwar Beach used different local names when describing sea turtles (e.g. *Kurma* for loggerheads, but *Kaasav*, *Kachua* and *Kaso* interchangeably for other turtle species) to those of fishers in the Sindhudurg District interviewed by Kakodkar (2006). This observation could represent the commonly observed evolution in language over time, or a shift in the cultural position of sea turtles among the local community, and could be of interest to linguistic anthropologists.

Respondents had a high awareness of the legal protection given to sea turtles, and about specific repercussions related to the deliberate capture of them, i.e., punishment meted out in case of poaching, consumption of eggs or turtle meat and trade of sea turtles, and were sure about there being no repercussions for accidental bycatch and subsequent release. But despite their legal awareness, comments (on the record) made by fishers during and

between survey questions revealed that practices such as consumption of turtle meat and eggs still occur. This finding is supported by observations of a live turtle being carried from a fishing boat on Sagareshwar Beach into a nearby village (N. Kale, pers.comm., September 20, 2018) and offers of recipes for cooking turtle meat by women in Vengurla village (S. Korgaonkar, pers.comm., November 1, 2018). While turtle meat could mainly be sourced from recently dead sea turtles entangled in fishing gear, the eggs would most likely be poached. Sea turtles were also reported to be locally traded for high prices (S. Toraskar, pers.comm., October 6, 2018). Hence, the local consumption of turtle meat and eggs should be the focus of future research using specialised interview techniques that have been demonstrated to collect information on sensitive topics such as poaching to quantify its extent and source (for examples see Nuno & St John, 2015) Such future research should consider caste-based consumption of turtle meat and eggs, which, in the current study, was not possible to infer given the varied areas of residence and work of the fishers and hesitancy about describing illegal activities.

A CMS/IOSEA (2015) report described three factors contributing to the illegal capture and selling of sea turtles: socio-economic, cultural, and inadequate legislation. Trade of sea turtle meat and eggs occurs for several socio-economic reasons. Fishers struggling to maintain a steady income use the exorbitant rates paid for them to support themselves. Reportedly, a hawksbill turtle was sold for as much as Rs.1 crore in Vengurla (S. Toraskar, pers.comm., October 6, 2018). Members of the fishing community may use such sales to fulfill their demand for luxury goods. Low socio-economic households may rely on sea turtle meat and eggs to meet their dietary needs for the lack of affordable alternatives. A cultural affinity towards the consumption of the meat and eggs owing to pre-existing religious and social beliefs and practices may also be responsible for the illegal consumption of sea turtles, exacerbated by weak enforcement of measures for sea turtle conservation which contribute to the deliberate take and trade (CMS/IOSEA, 2015).

Outcomes of interviews conducted at Sagareshwar Beach and other sources of information indicated that economic incentives may play an equally, if not more, important role than sociocultural beliefs and legal awareness in the conservation of local turtles. Some respondents at Sagareshwar Beach mentioned that the Forest Department

offered payment for reporting or handing in injured sea turtles. Sanaye and Pawar (2009) reported that the Maharashtra Forest Department pays the fishers Rs. 500 in the event that they report a located nest. Local fisher and conservationist, Suhas Toraskar, as well as several other fishers who were interviewed, confirmed that these financial incentives have helped to encourage conservational efforts (S. Toraskar, pers.comm., October 6, 2018).

Toraskar also believed that though the economic incentives given by the Forest Department have been somewhat effective in promoting conservation, they are also used to forge political bonds between organizations and the local fishers. This monopolisation by the Forest Department of the nesting sites as well as treatment of injured sea turtles, despite lack of resources, limits local and personal conservation initiatives and slows down the effectiveness considerably (S. Toraskar, pers.comm., October 6, 2018).

4.5 POTENTIAL THREATS TO OTHER MARINE ANIMALS

Observation (97.6%) and capture (50.0%) rates for marine wildlife such as dolphins, whales, whale sharks, sharks, and sea snakes by fishers at Sagareshwar Beach suggest that similar methodology to that used in this study could provide baseline information about the biology, distribution and threats to species of interest.

CHAPTER 5. CONCLUSION

Fishers at Sagareshwar Beach identified five species of sea turtles (green, hawksbill, leatherback, loggerhead and olive ridley) from local waters. Observations of the loggerhead turtle is especially interesting, as it had been previously unreported for Sindhudurg District and believed to be uncommon in Maharashtra. There were unexpectedly few observations of green turtles, which may indicate incorrect identification or a declining population. Fishers did not identify specific sea turtle areas used for feeding or mating. The local population size of sea turtles could not be reliably estimated, as respondents were unsure or provided responses that varied greatly in magnitude. However, the most common perception was that local populations had decreased in size based on observations of sea turtles and rates of capture. Hence, the LEK collected from fishers at Sagareshwar Beach in this study did not conclusively fill all of the identified knowledge gaps about sea turtle abundance and distribution in the area, and these objectives may need to be addressed in the future by a different methodology of research.

However, fishers' responses to other survey questions identified that likely threats to sea turtle populations at Sagareshwar Beach included bycatch, ghost gear, and consumption of turtle meat and eggs. Bycatch presented as a potentially serious threat for the small local population, with capture rates of at least 1-2 sea turtles per year and observations of turtles stranded on shore and floating at sea by the majority of fishers. The most commonly used fishing gear at Sagareshwar Beach - gill nets - was likely responsible for the majority of sea turtle bycatch. Mitigation efforts could focus on the addition of visual cues, such as net illumination to reduce accidental entanglement.

Due to the high proportion of fishers who observed floating ghost gear and entangled sea turtles at sea, it emerged as a critical threat to sea turtles. A potential source of the ghost gear observed close to Sagareshwar Beach was identified to be the fishers themselves. This was due to disposal of irreparable gear at sea or on the beach where it is likely to be washed into the ocean. Efforts to reduce this threat could focus on encouraging or incentivizing other methods of the disposal of gear, such as sale or donation to a scrapyard, and its physical removal from the water.

Reference to the consumption of sea turtle meat and eggs in the local fishing community was made by survey respondents, but the extent of the threat could not be quantified by the methodology of this study. Appropriate studies using interview techniques specifically designed for sensitive issues should be used to confirm consumption patterns and evaluate the threat.

Respondents showed high legal awareness regarding sea turtle capture and consumption. Unfortunately, weak enforcement of laws in the region has likely led to the continuation of illegal consumption. The extent of this threat needs to be quantified and mitigated, potentially by leveraging sociocultural beliefs about sea turtles among the fishing community.

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APPENDIX A. Survey tool

FLAME University

Discover India Program

Using Ecological Knowledge Resulting From Turtle-Fisher Interactions to Enhance Our Understanding of Sea Turtle Biology and Threats

Vengurla, Maharashtra

STANDARDISED SEA TURTLE CATCH / BYCATCH QUESTIONNAIRE

Interviewer Name:_____Date:_____Data Sheet Serial Number: _____

Town:_____District:_____

INTRODUCTION STATEMENT

Note: Reading this statement to the interviewee is compulsory. It ensures all interviews are treated equally.

My name is _____. I am a student at FLAME University in Pune. A group of us are doing a project to understand turtle-fisher interactions in coastal fisheries of Vengurla. The goal of this project is to learn more about sea turtles from your observations of them. We would like to ask you some questions about your fishing experience, turtles you have seen, what fishing gear you use, and where you fish. We have maps and pictures that can be used to help answer the questions. The questions will take between 30 to 45 minutes to complete. **Your participation in this survey is voluntary and confidential. We will not record your name or any personal information you share with us without your approval. Responses from everyone who participates in our survey will be combined and reported on as a group to provide a general summary, and we will not share your individual answers with anyone outside of the research team. You do not have to answer questions you do not want to. THANK YOU FOR YOUR HELP!**

INTERVIEWEE BACKGROUND

Note: Please tick the boxes to the left of any questions not asked.

☐1. Name:_____

☐2. Age:_____ Gender: Male ☐Female ☐

☐3. Have you previously participated in interviews related to:

Fishing ☐Marine Mammals ☐MPAs ☐Ecotourism ☐Sea Turtles ☐Other ☐None ☐

When did you participate?_____

Can you describe the interviews? _____

Please tick the boxes to the left of any questions not asked. Provide appropriate ID charts and maps for interviewee to point to during the interview.

☐4. What is your main occupation?

Fishing ☐Tour Guide ☐Boat Captain / Crew ☐Retired ☐

Other ☐Please describe: _____

☐5. For how many years has this been your occupation?_____

☐6. Do you have a fishing background? Yes ☐No ☐

How long have you been fishing in Vengurla for? _____

☐7. Were your parents' fishers? Yes ☐No ☐ Grandparents? Yes ☐No ☐

(*Note to interviewer: If yes, follow up on their whereabouts and possibility of an interview*)

☐8. Is fishing the main way you earn a living? Yes ☐No ☐

☐9. Is fishing the only way you earn a living? Yes ☐No ☐

(if no) What is (or are) your other occupation(s)?_____

☐10. Which months do you normally fish (out of the last 12)?_____

(*if seasonal, indicate season start and end*)

☐11. How many days each week do you fish? __days (low season) _____days (high season)

☐12. What is your position on the boat? The captain ☐A crew member ☐We have no fixed positions ☐

I do not work on a boat ☐(*skip next questions if person does not work on a boat*)

☐13. How many fishers, including yourself, work on the boat?_____

☐14. How long is the boat?_____

(*Note to interviewer: convert and provide answer in meters*)

☐15. Is the boat motorized? Yes ☐ No ☐ (if yes) Inboard ☐Outboard ☐

☐16. What is the horsepower of the motor?_____

Please tick the boxes to the left of any questions not asked. Provide appropriate ID charts and maps for interviewee to point to during the interview.

FISHERY INFORMATION

Note to interviewer: Respondent should answer these questions to describe his/her individual experience, not that of their community. Use illustrations to assist where necessary.

Habitat Codes: (D) Deep Water; (C) Coral; (S) Seagrass; (F) Fine Sediments; (M) Mangroves; (R) Rocks; (E) Estuaries; (U) Unknown

☐17. What type of fishing gear do you use? (*Indicate what months*)

Gill or trammel nets

Only ☐Mostly ☐Sometimes ☐Months:_____

Habitat:_____Target Species:_____

Do you tend the nets when they are in the water? Yes ☐No ☐

How long do you leave the nets in the water?_____ hours

Do you fish during the day ☐or night ☐? Both ☐?

What is the position of the gear? Surface ☐Mid-water ☐Bottom ☐

Full water depth ☐

Describe the net: Length :_____ Depth :_____ Mesh size :____

Mesh measurement: <1 finger □ 1 finger □ 2 fingers □ 3 fingers □ 4 fingers □ Fist □ Clasped Fist □ Open Hand □ >Open Hand □

Webbing dimension: _____mm

Net construction: Knotless □ Knotted □ Twine doubled up □

Type of twine: Twisted □ Braided □ Monofilament twine □

Number of strands: _____

Type of material: Natural fibre yarn (soft) □ Synthetic fibre yarn (hard) □

Diameter of twine: _____mm

Net colour: Blue □ Green □ Yellow □ Red □ Transparent □ White □ Black □ Blue/Yellow □ Other □ Please Describe: _____

Floatation attachments: Floating device □ Bottles □ Bags □ Bamboo □ Other □ Please Describe: _____

Purse seine (*or surround nets*)

Only ☐Mostly ☐Sometimes ☐Months:_____

Habitat:_____Target Species:_____

Do you tend the nets when they are in the water? Yes ☐No ☐

How long do you leave the nets in the water?_____ hours

Do you fish during the day ☐or night ☐? Both ☐?

What is the position of the gear? Surface ☐Mid-water ☐Bottom ☐

Full water depth ☐

Describe the net: Length :_____ Depth :_____ Mesh size :___

Mesh measurement: <1 finger □ 1 finger □ 2 fingers □ 3 fingers □ 4 fingers □

Fist □ Clasped Fist □ Open Hand □ >Open Hand □

Webbing dimension: _____mm

Net construction: Knotless □ Knotted □ Twine doubled up □

Type of twine: Twisted □ Braided □ Monofilament twine □

Number of strands: _____

Type of material: Natural fibre yarn (soft) □ Synthetic fibre yarn (hard) □

Diameter of twine: _____mm

Net colour: Blue □ Green □ Yellow □ Red □ Transparent □ White □ Black □

Blue/Yellow □ Other □ Please Describe: _____

Floatation attachments: Floating device □ Bottles □ Bags □ Bamboo □ Other

□ Please Describe: _____

Beach seine

Only ☐Mostly ☐Sometimes ☐Months:_____

Habitat:_____Target Species:_____

Do you fish during the day ☐or night ☐? Both ☐?

Full water depth ☐

Describe the net: Length :_____ Depth :_____ Mesh size :___

Mesh measurement: <1 finger □ 1 finger □ 2 fingers □ 3 fingers □ 4 fingers □

Fist □ Clasped Fist □ Open Hand □ >Open Hand □

Webbing dimension: _____mm

Net construction: Knotless □ Knotted □ Twine doubled up □

Type of twine: Twisted □ Braided □ Monofilament twine □

Number of strands: _____

Type of material: Natural fibre yarn (soft) □ Synthetic fibre yarn (hard) □

Diameter of twine: _____mm

Net colour: Blue ☐ Green ☐ Yellow ☐ Red ☐ Transparent ☐ White ☐ Black ☐ Blue/Yellow ☐ Other ☐ Please Describe: _____

Floatation attachments: Floating device ☐ Bottles ☐ Bags ☐ Bamboo ☐ Other ☐ Please Describe: _____

Trawl nets (*or other towed net*)

Only ☐Mostly ☐Sometimes ☐Months:_____

Habitat:_____Target Species:_____

How long do you leave the nets in the water?_____ hours

Do you fish during the day ☐or night ☐? Both ☐?

What is the position of the gear? Surface ☐Mid-water ☐Bottom ☐

Full water depth ☐(*normally in shallow waters*)

Describe the net: Length :_____ Depth :_____ Mesh size :____

Mesh measurement: <1 finger ☐ 1 finger ☐ 2 fingers ☐ 3 fingers ☐ 4 fingers ☐ Fist ☐ Clasped Fist ☐ Open Hand ☐ >Open Hand ☐

Webbing dimension: _____mm

Net construction: Knotless ☐ Knotted ☐ Twine doubled up ☐

Type of twine: Twisted ☐ Braided ☐ Monofilament twine ☐

Number of strands: _____

Type of material: Natural fibre yarn (soft) ☐ Synthetic fibre yarn (hard) ☐

Diameter of twine: _____mm

Net colour: Blue ☐ Green ☐ Yellow ☐ Red ☐ Transparent ☐ White ☐ Black ☐ Blue/Yellow ☐ Other ☐ Please Describe: _____

Floatation attachments: Floating device ☐ Bottles ☐ Bags ☐ Bamboo ☐ Other ☐ Please Describe: _____

Longline (*many hooks*)

Only ☐Mostly ☐Sometimes ☐Months:_____

Habitat:_____Target Species:_____

Do you tend the lines when they are in the water? Yes ☐No ☐

How long do you leave the lines in the water?_____ hours

Do you fish during the day ☐or night ☐? Both ☐?

Please tick the boxes to the left of any questions not asked. Provide appropriate ID charts and maps for interviewee to point to during the interview.

Full water depth ☐(*normally in shallow waters*)

Describe the line: Length :_____

Bottom longline (*many hooks set at depth*)

Only ☐Mostly ☐Sometimes ☐Months:_____

Habitat:_____Target Species:_____

Do you tend the lines when they are in the water? Yes ☐No ☐

How long do you leave the lines in the water?_____ hours

Do you fish during the day ☐or night ☐? Both ☐?

Full water depth ☐(*normally in shallow waters*)

Describe the line: Length :_____

Hook and line (*one or few hooks*)

Only ☐Mostly ☐Sometimes ☐Months:_____

Habitat:_____Target Species:_____

Do you fish during the day ☐or night ☐? Both ☐?

What is the position of the gear? Surface ☐Mid-water ☐Bottom ☐

Full water depth ☐(*normally in shallow waters*)

Describe the line: Length :_____

Traps

Only ☐Mostly ☐Sometimes ☐Months:_____

Habitat:_____Target Species:_____

Do you tend the traps when they are in the water? Yes ☐No ☐

How long do you leave the traps in the water?_____ hours

Do you fish during the day ☐or night ☐? Both ☐?

What is the position of the gear? Surface ☐Mid-water ☐Bottom ☐

Full water depth ☐

Describe the traps: Length :____ Width :_____ Height :_____

Other (describe):_____

Only ☐Mostly ☐Sometimes ☐Months:_____

Habitat:_____Target Species:_____

Do you tend when they are in the water? Yes ☐No ☐

How long do you leave in the water?_____ hours

Do you fish during the day ☐or night ☐? Both ☐?

What is the position of the gear? Surface ☐Mid-water ☐Bottom ☐

Please tick the boxes to the left of any questions not asked. Provide appropriate ID charts and maps for interviewee to point to during the interview.

Full water depth ☐

Describe:

☐18. In what places do you normally fish?_____

(*Use prepared map and have interviewee point out areas and mark on map as #18*)

☐19. How many kilometers do you usually go offshore for the places that you fish? How long does it take to get there?

☐20. Do you use different fishing gear in different areas? Yes ☐No ☐If yes, please describe:_____

(*Use prepared map and have interviewee point out areas and mark points #18 with name of gear*)

☐21. Have you ever seen discarded fishing gear floating out at sea? When? Where? What did you do with it?

(*Ask them to point out the specific area on the map and mark on map as #21*)

☐22. What do you do with your own nets when they are damaged? ☐Repair ☐Dispose ☐Other

Is there anywhere to dispose of nets if you want to?

SEA TURTLE CATCH / BYCATCH

☐23. Have you ever seen sea turtles? Yes ☐No ☐Do you have another name for them?

☐24. What species of turtles do you see?

Green ☐ Hawksbill ☐ Olive Ridley ☐ Loggerhead ☐ Leatherback ☐ Don't know ☐

(*Note to Interviewer; Show ID chart or graphics*)

☐25. Do you know the difference between these turtle species? Yes ☐No ☐Don't know ☐

(*Note to Interviewer; Show ID chart or graphics*)

Please describe:

Do they have different names? (if yes) Please list:

(*determine for each species*)

☐26. How long do you think a turtle lives?_____Don't know ☐

Please tick the boxes to the left of any questions not asked. Provide appropriate ID charts and maps for interviewee to point to during the interview.

☐27. How do you see turtles? Seen while fishing ☐ Seen while travelling to fishing areas ☐

Coming ashore to lay eggs ☐ Accidentally caught in nets ☐ Hunted ☐ Stranded on the beach ☐

(*Note to interviewer: Refer to and complete attached table and mark all locations on maps*)

☐28. How frequently have you seen turtles?

Never☐ Once in my life☐ Only a few times in my life☐ Frequently☐ Every year for the last five years ☐

In the last year: Only once ☐ Several times ☐ Every month ☐ Every week ☐ Every day ☐

☐29. When do you see turtles? (*indicate months or seasons*):_____

☐30. When was the last time you saw one?_____(*if long time ago note the year*)

☐31. Do you know of any areas where turtles are regularly seen? Yes ☐No ☐

If yes, what do you see the turtles doing?

(*Note to interviewer:* Regular *means certain times of year when they are always found*. *Indicate on maps*)

☐32. Do these turtle areas change over time? Yes ☐No ☐Don't Know ☐

☐33. How many turtles do you think might live in these areas? <10 ☐>10 ☐>100 ☐Don't Know ☐

☐34. Do you see mating turtles? Yes ☐No ☐When?_____Where (*use maps*)?_____

☐35. Do people from other villages / communities catch turtles? Yes ☐No ☐Don't Know ☐

(*if yes*) How many (people)?_____What village?_____

Is the catch accidental or on purpose? Accidental ☐On purpose ☐Both ☐

☐36. Do people in your village / community catch turtles? Yes ☐No ☐Don't Know ☐

(*if yes*) How many (people)?_____For how long?_____

Is the catch accidental or on purpose? Accidental ☐On purpose ☐Both ☐

☐37. Did you personally catch any turtles in the last year? Yes ☐No ☐

(if yes) How many in the last year? 1-2 ☐ ≤10 ☐ >10 ☐ Specifics (*if available*):_____

Please tick the boxes to the left of any questions not asked. Provide appropriate ID charts and maps for interviewee to point to during the interview.

Was this a typical number to catch in a year? Yes ☐No ☐

(if no) Was it higher or lower than usual? Higher ☐Lower ☐

Was the catch accidental or was it something you were fishing for? Accidental ☐Hunted ☐Both ☐

☐38. Did you catch any turtles in the last five years? 0 ☐ 1-2 ☐ ≤10 ☐ >10 ☐ Specifics (*if available*):_____

How many in your life? 0 ☐ 1-2 ☐ ≤10 ☐ >10 ☐ Specifics (*if available*):_____

☐39. How did you catch them? Harpoon ☐ Nets ☐ Other ☐ Please describe:_____

When did you catch them?_____(*what month(s)?*) Where?

(*ask interviewee to show on maps and mark on maps as #39*)

☐40. Compared to when you started fishing, are there more ☐, less ☐, or the same number of ☐turtles captured in your fishing gear? Don't Know ☐ (*Note: based on actual numbers, not perception*)

(if more or less) Why do you think this?_____

☐41. What do you (or would you) do with a sea turtle if you caught one on purpose?

Eat ☐Sell ☐As Bait ☐Other Use ☐: _____

(Note: do not lead interviewee)

☐42. What do you (or would you) do with a sea turtle if you catch one accidentally?

Discard (*dead*) ☐Release (*alive*) ☐Eat ☐Sell ☐As Bait ☐Other Use ☐: _____

(Note: do not lead interviewee)

☐43. What do captured turtles do to your fishing gear?

☐44. Have you ever found ☐or heard of ☐turtles stranded on the shore? Yes ☐No ☐

Or have you ever found ☐or heard of ☐turtles dead in our waters? Yes ☐No ☐(*explain stranded*)

Were the dead turtles tangled up in fishing gear or floating free?

Or have you ever found ☐or heard of ☐turtles with cut marks on their backs? Yes ☐No ☐(*explain*)

Please tick the boxes to the left of any questions not asked. Provide appropriate ID charts and maps for interviewee to point to during the interview.

(if yes) Where, when and how many? (*ask interviewee to show on maps and mark on map as #43*)?

What happened to the turtle(s)?

☐45. What would you do or did you do if you found a stranded turtle?

☐46. Compared to when you started fishing, do you think there are more turtles ☐, less ☐, or the same number of turtles ☐in local waters? I don't know ☐

(if more or less) Why do you think this?_____

(*Note to interviewer: Try to determine what other impacts may be driving the trend*)

☐47. Do you think there will always be turtles in our waters? Yes ☐No ☐Don't Know ☐

(if yes or no) Why?

☐48. Do you think having turtles around is important? Yes ☐No ☐Why?

☐49. Do you know if there are any laws about turtles? Yes ☐No ☐Don't know ☐

It is allowed to intentionally kill a turtle? Yes ☐No ☐Don't know ☐

What about accidentally killing a turtle (maybe caught in a net unintentionally)? Yes ☐No ☐Don't know

☐50. Do you know any local customs, beliefs, legends or rituals or stories related to turtles?

Yes ☐No ☐ (if yes) Please describe:

Where / from whom did you hear this?

☐51. Do you see any other animals while fishing? Yes ☐No ☐

If yes, what are they? ☐Sharks ☐Dugongs ☐Dolphins ☐Whale sharks ☐Sea snakes ☐Other

Do you catch any other animals while fishing? Yes ☐No ☐

If yes, what are they? ☐Sharks ☐Dugongs ☐Dolphins ☐Whale sharks ☐Sea snakes ☐Other

Please tick the boxes to the left of any questions not asked. Provide appropriate ID charts and maps for interviewee to point to during the interview.

CONFIDENTIAL INTERVIEWER COMMENTS

52. How open and honest did the fisher seem about answering bycatch questions?

Very open/honest ☐Somewhat open/honest ☐Not honest ☐

53. How interested and engaged did the fisher seem with interview?

Very interested ☐Moderately interested ☐Bothered/ Not interested ☐

54. How certain did the fisher seem about answers to numerical questions?

Very sure ☐Reasonable sure ☐Unsure ☐

55. How comfortable were you about the respondents' ability to discriminate between the species

Very comfortable ☐Reasonable ☐Not comfortable ☐

56. Why do you think this?_____

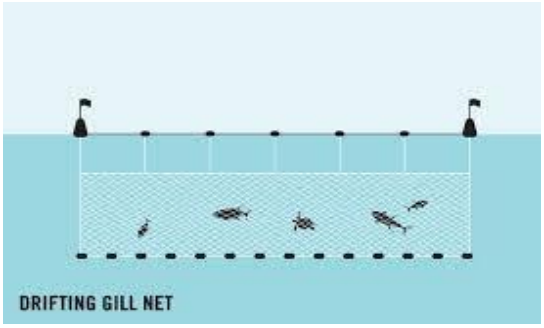
_____

57. Please indicate why (if any) questions were not asked _____

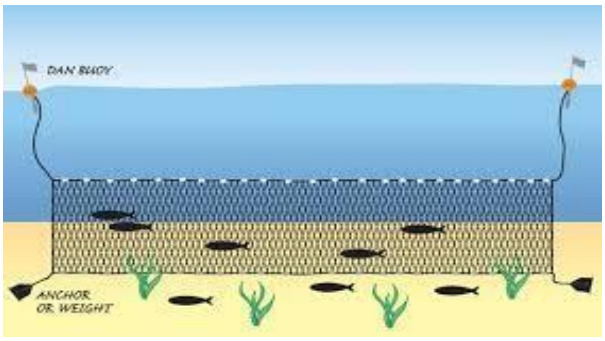
Please tick the boxes to the left of any questions not asked. Provide appropriate ID charts and maps for interviewee to point to during the interview.

GILL OR TRAMMEL NETS

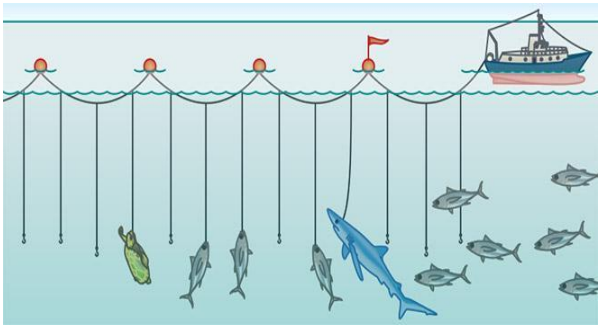
Drift gill net[1]



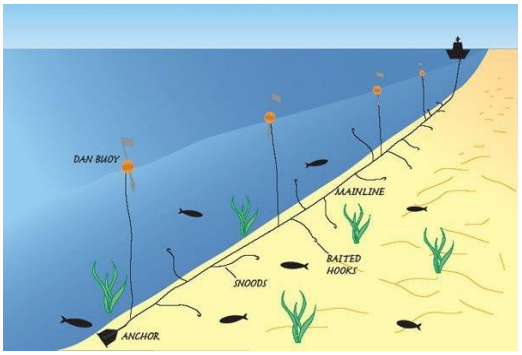
Set gill net[2]



LONGLINE[3]



BOTTOM LONGLINE[4]



[1] https://oliveridleyproject.org/what-are-ghost-nets

[2] http://agritech.tnau.ac.in/fishery/fish_fishingtech_passivegears.html

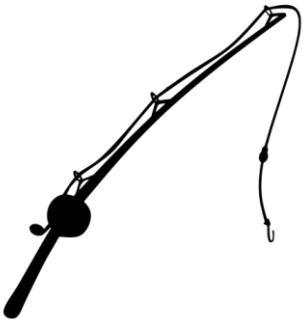
[3] https://worldoceanreview.com/en/wor-2/fisheries-policy/mangement/2/

[4] http://vikaspedia.in/agriculture/fisheries/marine-fisheries/capture-fisheries/passive-fishing-gears

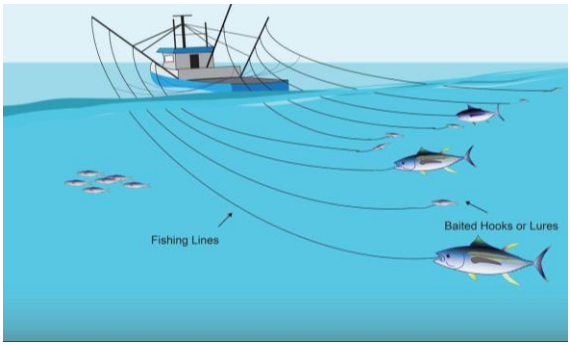
Please tick the boxes to the left of any questions not asked. Provide appropriate ID charts and maps for interviewee to point to during the interview.

HOOK AND LINE

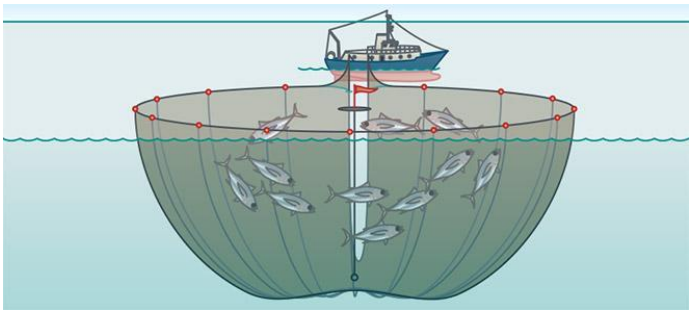
Single hook[5]



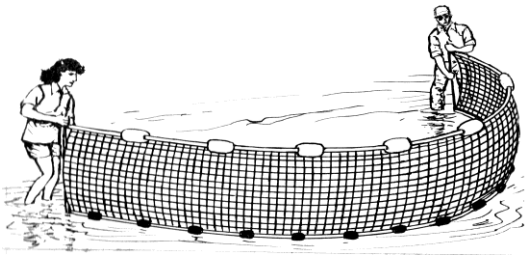
Multi-hook[6]



PURSE SEINE NET[7]



BEACH SEINE NET[8]



[5] https://svgsilh.com/image/1862011.html

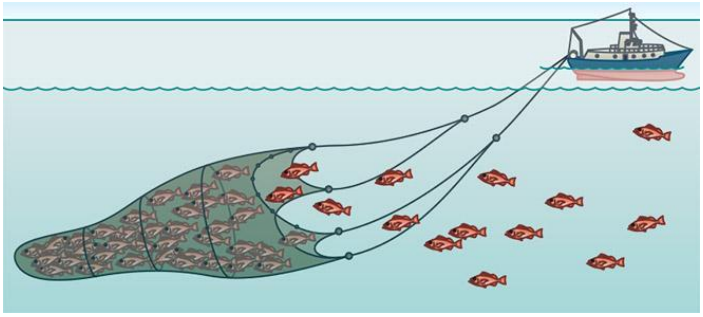
[6] http://www.afma.gov.au/portfolio-item/minor-lines/

[7] https://worldoceanreview.com/en/wor-2/fisheries-policy/mangement/2/

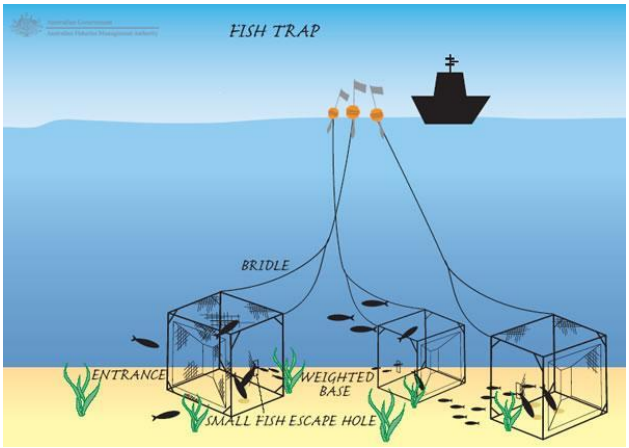
[8] https://upload.wikimedia.org/wikipedia/commons/6/6a/Seine_%28PSF%29.png

Please tick the boxes to the left of any questions not asked. Provide appropriate ID charts and maps for interviewee to point to during the interview.

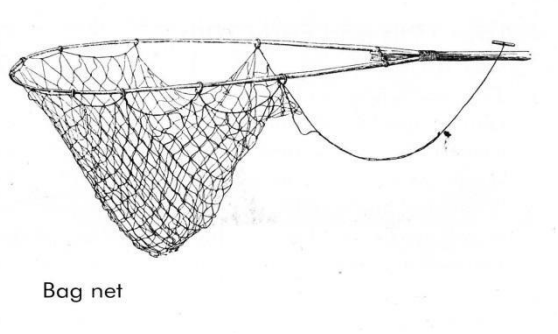
TRAWL NET[9]



FISHING TRAPS[10]



BAG NET[11]



[9] https://worldoceanreview.com/en/wor-2/fisheries-policy/mangement/2/

[10] http://fs2.american.edu/vconn/www/seafood/techniques.html

[11] http://shuswappassion.ca/history/the-first-nation-traditional-salmon-fishery-was-sustainable/

Please tick the boxes to the left of any questions not asked. Provide appropriate ID charts and maps for interviewee to point to during the interview.

Green turtle[12, 13]

Hawksbill turtle[14, 15]

[12] https://commons.wikimedia.org/w/index.php?curid=2483099

[13] Michael White and www.seaturtle.org

[14] https://upload.wikimedia.org/wikipedia/commons/b/ba/Hawksbill_Turtle.jpg

[15] https://upload.wikimedia.org/wikipedia/commons/0/03/A_male_Hawksbill_turtle.jpg

Please tick the boxes to the left of any questions not asked. Provide appropriate ID charts and maps for interviewee to point to during the interview.

Leatherback turtle[16, 17]

Loggerhead turtle[18, 19]

[16] https://upload.wikimedia.org/wikipedia/commons/b/b3/Leatherback_sea_turtle_on_the_beach_Tinglar_%285839996429%29.jpg

[17] www.amigosdomarnaescola.com

[18] https://upload.wikimedia.org/wikipedia/commons/d/d9/Loggerhead_Sea_turtle.jpg

[19] Alan F. Rees and www.seaturtle.org

Please tick the boxes to the left of any questions not asked. Provide appropriate ID charts and maps for interviewee to point to during the interview.

Olive Ridley[20, 21]

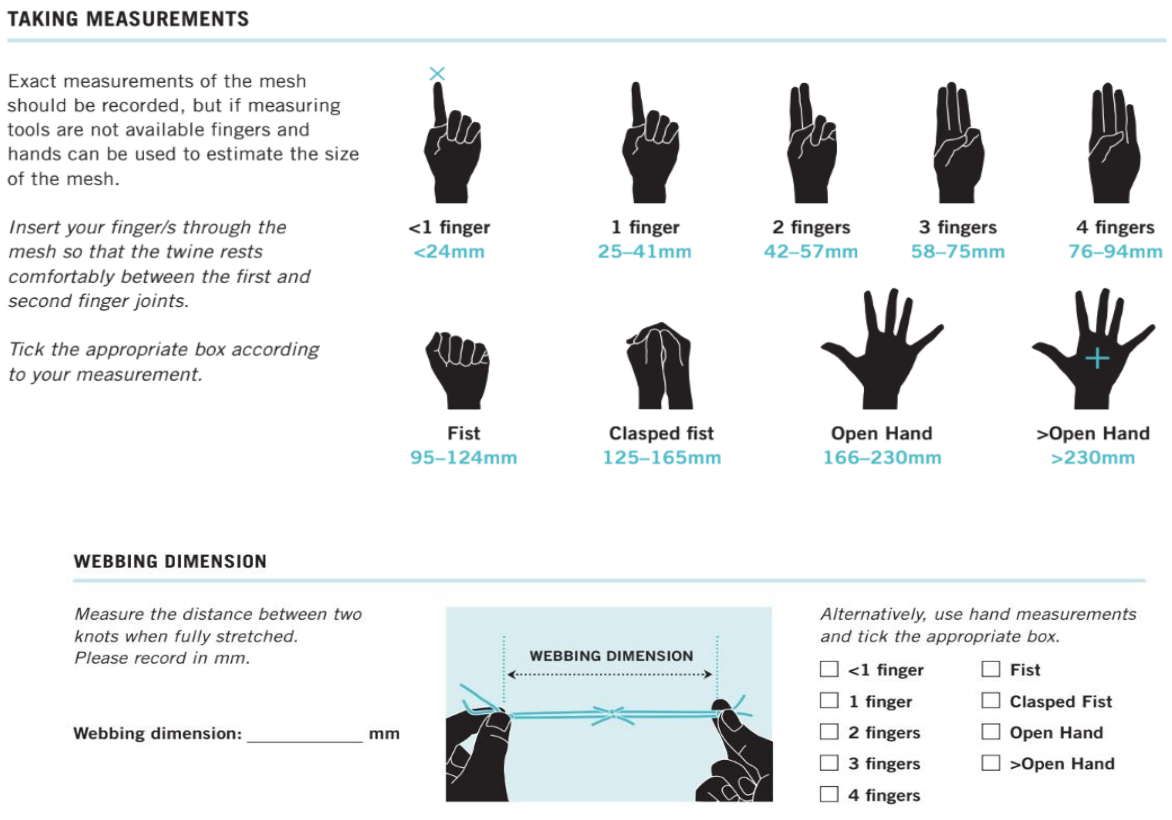
[20] https://commons.wikimedia.org/w/index.php?curid=49367375

[21] Michael Jensen and www.seaturtle.org

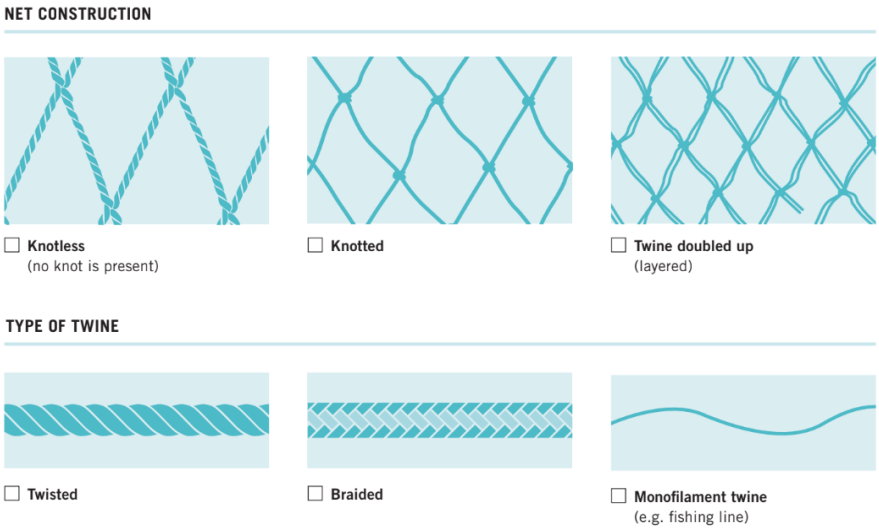
Please tick the boxes to the left of any questions not asked. Provide appropriate ID charts and maps for interviewee to point to during the interview.

Measurements For Nets[22]

(Use as Reference)



About Net Construction and Type of Twine[22]

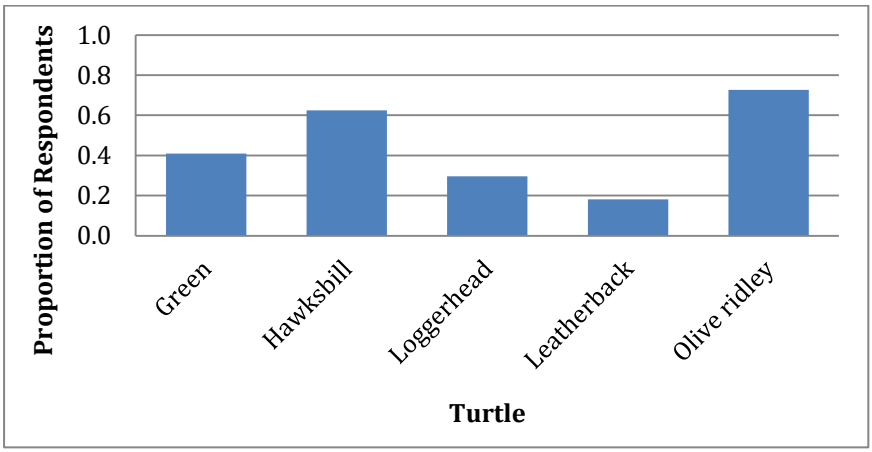


[22] Olive Ridley Project Protocol Ghost Net Data Input Survey

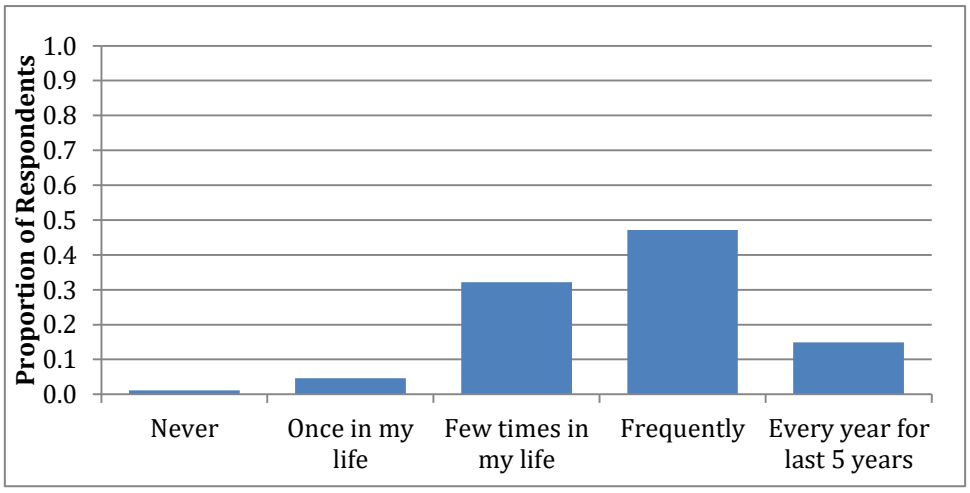
APPENDIX B. Draft summary of local ecological knowledge about sea turtles and their habitats to be shared with survey participants from Sagareshwar Beach, Vengurla, Dakshin Foundation, and the Maharashtra Forest Department.

English, Marathi and Hindi versions of the summary will be distributed by email or WhatsApp attachment.

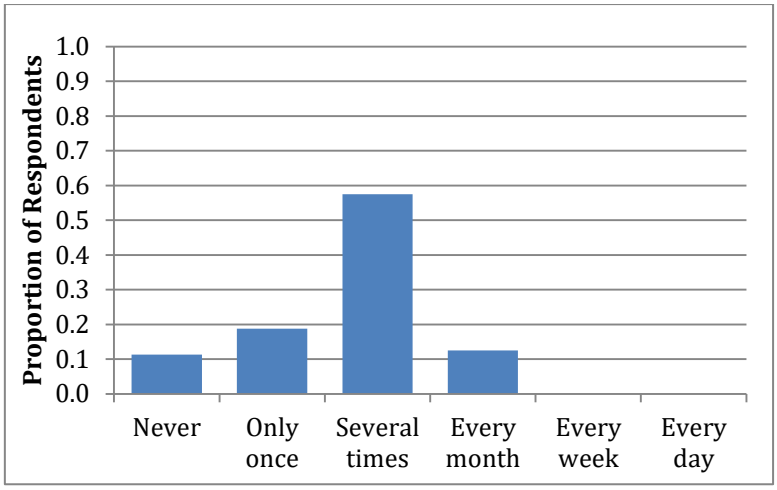
91 fishers from Sagareshwar Beach, Vengurla, contributed their local ecological knowledge of sea turtles to this summary.



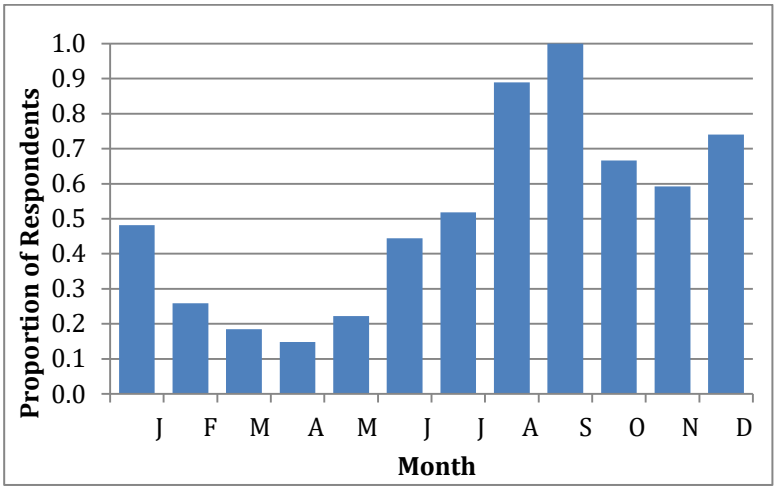
Olive ridley and hawksbill turtles were most commonly seen, while the leatherback turtle was the least frequently observed. Observations of leatherbacks and loggerheads may be

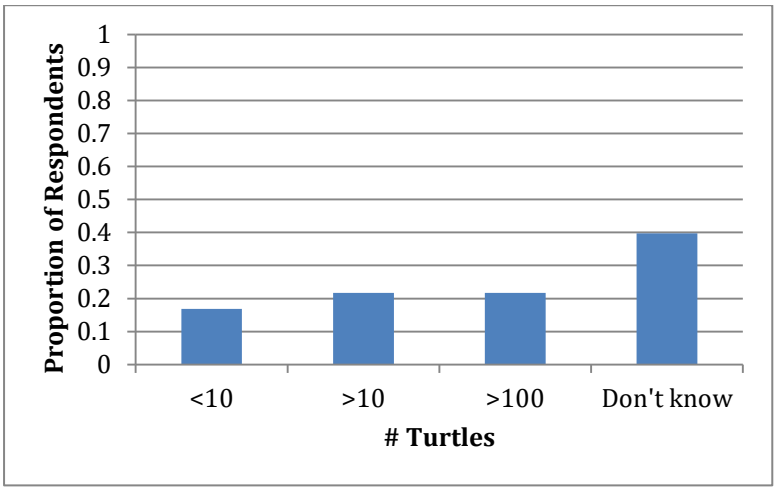


In their lifetime, most fishers had seen turtles frequently and some had observed them every year for the last 5 years. In the last year, the largest group of fishers had seen turtles several times, but smaller groups had observed turtles more frequently (every month) or less frequently (only once in the last year).

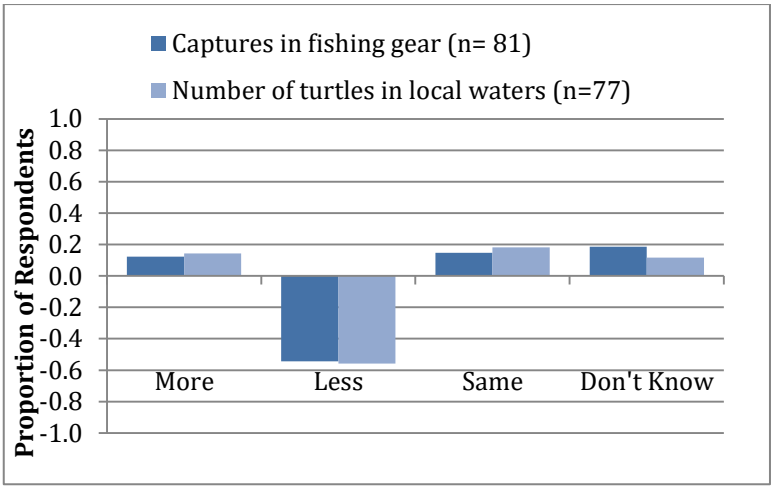


Turtles were most likely to be spotted in the months of August and September (while probably preparing to breed) and least in the months of March and





The number of turtles in local waters was believed by some fishers to be in the 10s or >100. However, many were not certain.



The trend in turtle captures in fishing gear is the same as fisher's ideas about the population trend for turtles in local waters. These are probably related; fishers catch less turtles because there are less turtles.

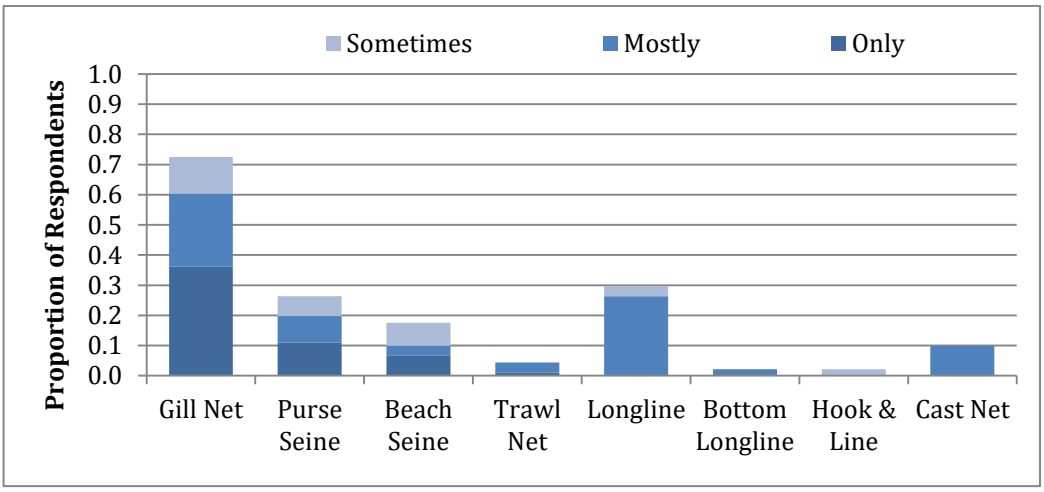
APPENDIX C. Draft summary describing fishing gear and practices at Sagareshwar Beach, Vengurla, to be shared with the Olive Ridley Project, Dakshin Foundation and the Maharashtra Forest Department

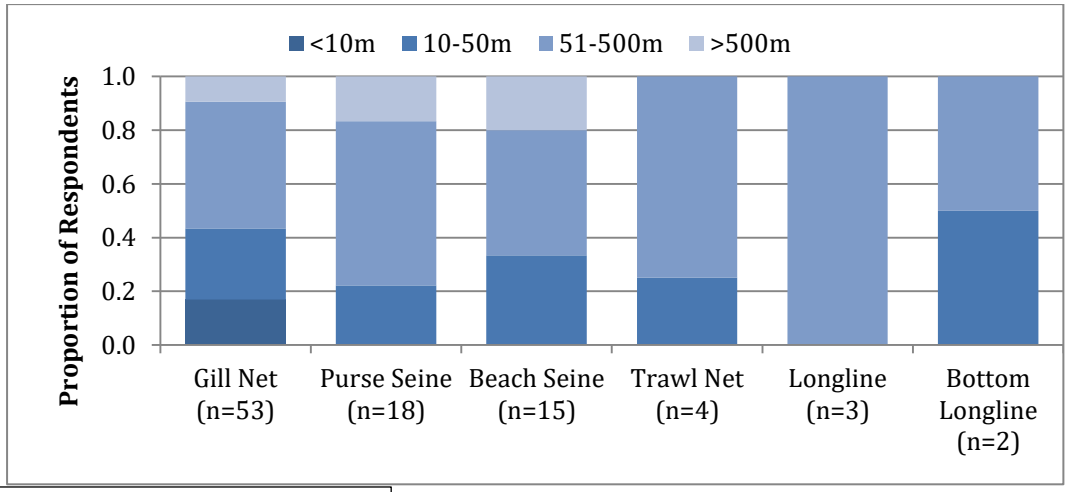
English and Marathi versions of the summary will be distributed by email or WhatsApp attachment.

93 fishers at Sagareshwar Beach, Vengurla of the Sindhudurg district in Maharashtra, India, were interviewed in October, 2018, to document common fishing gear and practices and observations of ghost gear.

Fishing Gear

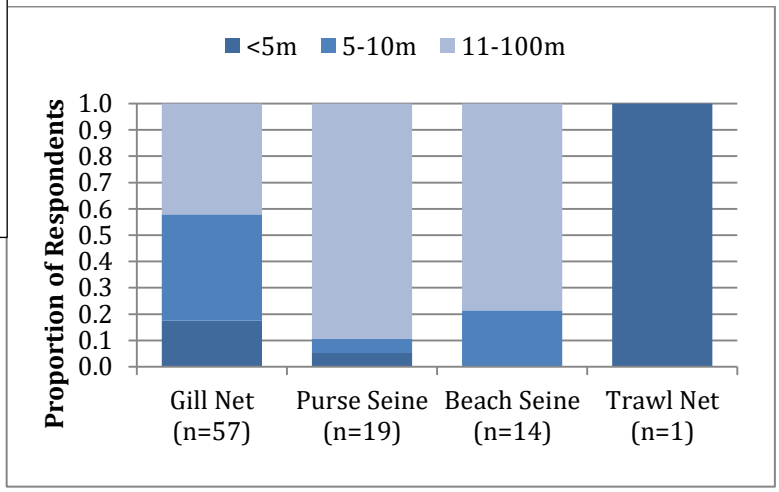
The predominantly used gear were gill nets followed by purse and beach seines.

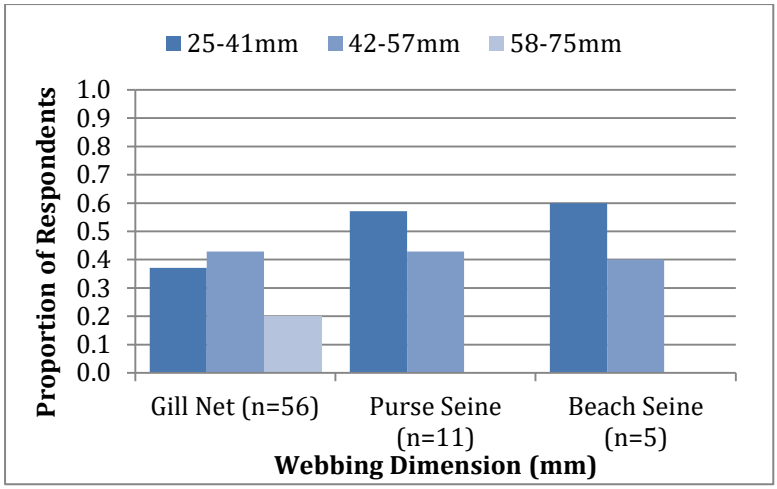




Net Dimensions

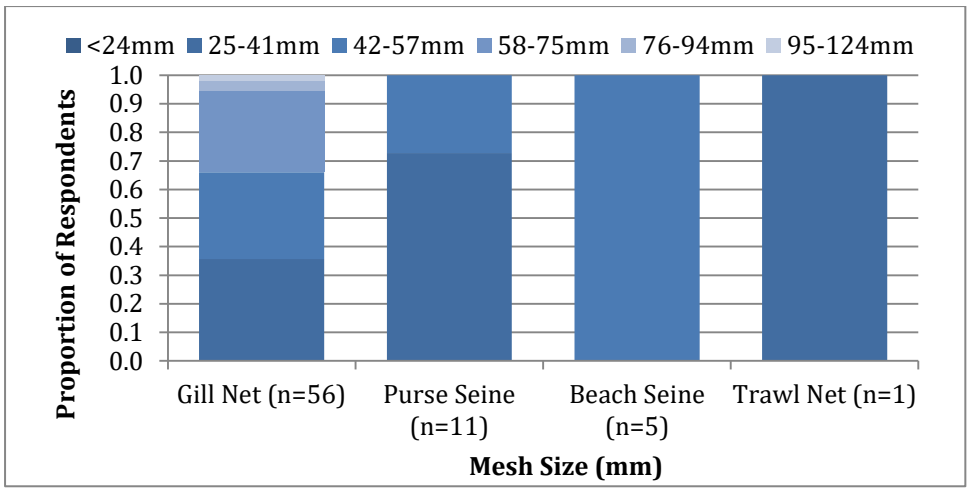
Fishing gear length ranged from 51-500m and width from 11-100m.





Mesh & Webbing Dimensions

Mesh size and webbing dimensions varied but was usually >57mm.



Management of Gear

70% of fishers sold or donated their irreparable gear to a scrapyard. Other fishers left it on the beach or disposed of damaged

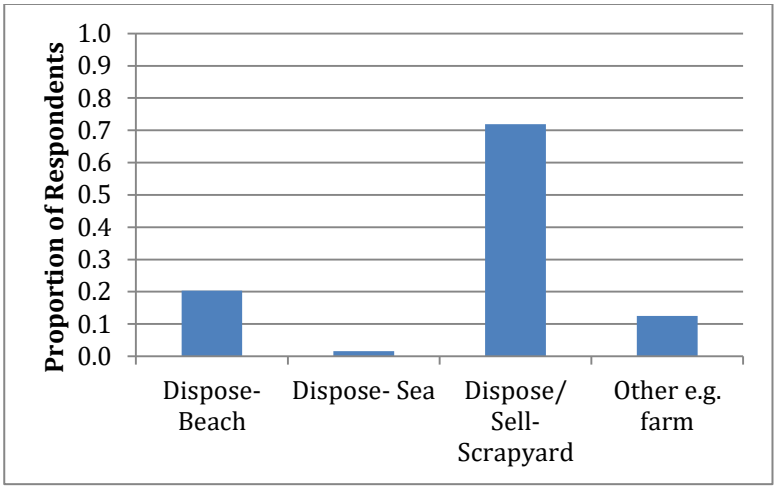


Table C.1 Characteristics of nets used by fishers at Sagareshwar Beach, Vengurla

[1]Net construction: kd – knotted, kl – knotless, td – twine doubled up; [2]Twine type: t – twisted, b – braided, m – monofilament; [3]Twine material: n – natural fibre yarn, s – synthetic fibre yarn; [4]Net colour: bu – blue, g – green, y – yellow, r – red, t – transparent, w – white, ba – black, br – brown, bu/y – blue/yellow, go – golden, o – other; U – unknown; na – not asked

Gear Type	Mesh Size (mm)	Webbing Dimension (mm)	Net Construction[1]	Twine Type[2]	# Twine Strands	Twine Material[3]	Twine Diameter (mm)	Net Colour[4]
Gill	<24	U	kl	t	2	n	U	bu
Gill	<24	42-57	kd	m	1	s	U	t
Gill	<24	U	kd	m	2	s	2	bu, g, w
Gill	<24	U	kd	b	U	s	U	bu, g, w
Gill	<24	U	kd	b	U	s	U	bu, g, w
Gill	25-41	25-41	kd	m	1	s	0.5	t
Gill	25-41	25-41	kd	m	1	s	0.5	t
Gill	25-41	42-57	kd	m	1	s	0.5	t
Gill	25-41	25-41	kd	m	1	s	0.5	b, t, w
Gill	25-41	U	kd	t	U	s	U	w
Gill	25-41	U	kd	b	U	s	U	bu
Gill	25-41	<24	kd	t	2	s	U	bu
Gill	25-41	U	kd	m	1	s	0.5	t
Gill	25-41	<24	kd	m	1	s	0.5	t
Gill	25-41	25-41	kl	t	U	s	U	bu, g, w

Gill	25-41	25-41	kd	m	U	s	U	t
Gill	25-41	25-41	kd	m	U	s	U	t
Gill	25-41	58-75	kd	t	2	n	2	bu, g, w
Gill	25-41	25-41	kd	m	2	s	2	t
Gill	25-41	25-41	kd	m	U	s	U	g
Gill	25-41	U	kd	m	U	s	4	br
Gill	25-41	U	kd	m	U	s	U	bu
Gill	25-41	25-41	kd	m	1	s	0.5	t
Gill	25-41	25-41	kd	m	1	s	0.5	t
Gill	25-41	25-41	kd	m	1	s	0.5	t
Gill	42-57	<24	kd	m	U	s	0.5	t
Gill	42-57	42-57	td	m	1	s	U	t
Gill	42-57	42-57	kl	b	1	s	U	g, w
Gill	42-57	42-57	td	m	U	n	3	r
Gill	42-57	U	kd	t	U	s	3	bu,g
Gill	42-57	U	kl	t	U	s	U	g
Gill	42-57	42-57	kd	t	U	s	6	bu
Gill	42-57	<24	kd	t	U	s	4	t
Gill	42-57	58-75	kd	t	2	s	U	t
Gill	42-57	42-57	kd	m	2	s	2	t
Gill	42-57	42-57	kd	t	1	s	U	w
Gill	42-57	U	kd	t	2	s	2	w
Gill	42-57	42-57	kd	t	1	s	U	bu, y
Gill	42-57	25-41	kd	m	U	s	U	bu, t
Gill	42-57	U	kd	t	2	s	1	w

Gill	42-57	42-57	kd	m	1	s	U	t
Gill	42-57	42-57	kd	m	1	s	0.2	g
Gill	58-75	U	kd	m	1	s	0.5	bu, r
Gill	58-75	U	kd	t	U	s	U	g
Gill	58-75	58-75	kd	t	U	s	U	t
Gill	58-75	58-75	kd	m	1	s	0.5	go, o, w
Gill	58-75	42-57	kl	t	2	s	U	t
Gill	58-75	<24	td	b	U	s	U	bu
Gill	58-75	42-57	kd	m	1	s	0.5	t
Gill	58-75	U	kd	m	U	s	U	bu
Gill	58-75	U	kd	t	1	s	2.25	bu,g
Gill	58-75	U	kd	t	U	s	U	g
Gill	58-75	U	kd	t	U	s	U	g
Gill	58-75	58-75	kd	t	U	s	U	g
Gill	58-75	58-75	kd	t	U	s	U	bu
Gill	58-75	58-75	kd	t	U	s	U	t
Gill	58-75	U	kd	m	1	s	na	t
Gill	58-75	42-57	kd	m	1	s	2	bu
Gill	76-94	25-41	kd	t	2	s	2	bu
Gill	76-94	42-57	kd	m	1	s	U	g
Gill	95-124	U	kd	b	U	s	U	bu, g, w
Gill	>230	>230	kd	m	1	s	0.5	g
Gill	U	U	kd	m	1	s	0.5	bu, g, w
Gill	U	U	kd	t	U	s	U	U
Gill	U	U	kd	t	U	s	U	t

Gill	U	U	kd	b	U	s	U	t
Purse	<24	<24	kd	b	3	n	1	t
Purse	<24	U	kd	t	U	s	1	o
Purse	<24	<24	kd	t	2	U	U	g,r
Purse	<24	<24	kd	t	2	s	U	o, r, w
Purse	<24	<24	kd	t	U	n	U	g, r
Purse	<24	<24	td	t	2	s	U	r
Purse	<24	U	kd	m	1	s	2.1	r
Purse	<24	U	kd	t	3	s	U	ba, bu, g, r
Purse	<24	U	kd	t	U	s	1	o
Purse	<24	<24	kd	t	2	s	U	g, r, w
Purse	<24	<24	kd	m	U	s	1.5	r, w
Purse	<24	<24	kd	t	1	s	3	r
Purse	<24	<24	kd	t	3	s	3	g, r
Purse	25-41	<24	td	t	2	s	U	bu
Purse	25-41	<24	kl	t	2	s	U	br, g, r
Purse	25-41	25-41	kd	t	2	s	U	t
Purse	25-41	25-41	kd	t	3	s	U	r
Purse	25-41	U	kd	t	2	s	U	r
Purse	25-41	25-41	kl	b	U	s	U	g, y
Purse	25-41	<24	kd	t	U	s	U	r
Purse	25-41	25-41	kd	t	U	s	U	r
Purse	42-57	42-57	kd	t	U	n	U	y
Purse	42-57	42-57	kd	b	U	n	U	g
Purse	42-57	42-57	kd	b	2	s	2	t

Beach	<24	<24	kd	b	6	n	0.5	bu
Beach	<24	<24	kd	b	6	n	0.5	bu
Beach	<24	<24	kd	b	6	n	0.5	w
Beach	<24	25-41	kd	m	1	s	U	br
Beach	<24	U	kd	t	U	s	2	U
Beach	<24	<24	kd	t	2	n	3	w
Beach	<24	<24	kd	t	2	n	1	ba
Beach	<24	25-41	kd	b	U	s	U	g,r
Beach	<24	25-41	kd	b	U	s	U	r
Beach	42-57	42-57	kd	m	U	s	U	w
Beach	42-57	<24	kd	t	3	s	0.5	br
Beach	42-57	42-57	kd	t	2	s	U	g, w
Beach	42-57	<24	kd	t	U	s	U	r
Beach	42-57	U	td	t	U	s	U	bu, r, w
Beach	U	U	kd	t	U	n	U	bu
Beach	U	U	kd	b	U	s	U	g, r
Trawl	25-41	U	kd	t	2	s	U	bu