An assessment of the past and present distribution status of the Whale Shark (*Rhincodontypus*) along the west coast of India

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ABBREVIATION

AF	-	Active Fishermen
BNHS	-	Bombay Natural History Society
CIFE	-	Central Institute of Fisheries Education
CIFT	-	Central Institute of Fisheries Technology
CITES	-	Convention on International Trade in Endangered Species
CMFRI	-	Central Marine Fisheries Research Institute
DST	-	Department of Science and Technology
EEZ	-	Exclusive Economic Zone
FSI	-	Fishery Survey of India
IUCN	-	International Union for Conservation of Nature
ITK	-	Indigenous Technical Knowledge
ICAR	-	Indian Council of Agricultural Research
MFF	-	Mangroves for the Future
MOEF	-	Ministry of Environment and Forest
MFIS	-	Marine Fisheries Information Service
RF	-	Retired Fishermen
SFB	-	Seasonal Fishing Ban
SPSS	-	Statistical Package for the Social Science
TEK	-	Traditional Ecological Knowledge
UNCLOS	-	United Nations Convention on the Law of the Sea
WTI	-	Wildlife Trust of India
WPA	-	Wildlife Protection Act (1972)

1. EXECUTIVE SUMMARY

To understand the historical and present occurrence and distribution patterns of whale sharks along the west coast of India in the Arabian sea, Traditional Ecological Knowledge (TEK) and Indigenous Technical Knowledge (ITK) questionnaire surveys were conducted during May 2012 to March 2013. The survey was conducted in the maritime states of Maharashtra, Goa, Karnataka, Kerala and the union territory of Lakshadweep during the fishing holiday season (May – Aug). The broad objectives of the questionnaire survey were to:

- Understand the distribution patterns of Whale Sharks across the west coast of India and the range of threats they face
- Develop a draft recovery plan for the Whale Shark in collaboration with the respective range states

The survey was targeted at active and non-active fisher-folk between the ages of 25 and 90 years to obtain information on historical and current presence of whale sharks in fishing territories across the West Coast.

A total of 1703 fisher folks in 118 fishing villages were interviewed using an improvised structured questionnaire developed from the standard TEK and ITK questionnaires. The summarized outcome of the survey are as follows,

- Over 60% of the interviewed fishermen reported having sighted the Whale shark in the Arabian Sea along the west coast during their fishing activities between 20-100 km from the shoreline. Sightings were most frequent in the Lakshadweep Sea followed by the coastal waters of Maharashtra, Karnataka and Goa.
- Four major whale shark aggregation locations in the Arabian Sea were identified close to the coast of Malvan in Sindhudurg district of Maharashtra, Netrani Island in Uttar Kannada of Karnataka, Minicoy and Kavaratti Island in Lakshadweep and along the Saurashtra coast of Gujarat.

- The whale shark aggregation locations that were identified as a result of this study are found to overlap with key marine resource productivity areas, such as paste shrimp *(Acetessp*) abundance zones based on the response of fisher-folks.

- The most common human induced threats to the whale sharks in the Arabian Sea along the west coast of India were found to be incidental catch of this species in three types of fishing gears (Gill net, Purse net & Trawl net).

- The incidental capture of whale shark in fishery operations over the last few years were notably high along the Kerala coast followed by Maharashtra.

- The survey results indicate a lack of awareness amongst the fishing community of the whale shark being a protected species and the ban on their capture and trade; emphasizes the need to launch an intensive awareness campaign along the west coast of India.

2. ACKNOWLEDGMENTS

This survey project was funded by the small grant program of the Mangrove for Future (MFF). We are grateful to Dr. N. M. Ishwar, National Coordinator, MFF and Ms. Nisha D'Souza, Small Grant Officer, MFF for facilitating and funding this project.

We are thankful to the CMFRI and the state fisheries departments in each state along the west coast of India for providing us the fish landing center data, fishing village names district-wise for designing the ethnographic field survey of traditional as well as technical knowledge of fisher folk about Whale Shark along the west coast of India including the status of Whale Shark fisheries.

We are grateful to Mr. Tapajit Bhattacharya, Technical Officer, Wildlife Trust of India for contributing his idea and suggestion for analysis of the questionnaire data and generating the statistical graphs to make the report meaningful.

We are thankful to Dr. Jeyabaskaran, Senior Scientist, CMFRI for providing us their Indigenous Technical Knowledge (ITK) Marine Mammal survey questionnaire which helped us to develop the west coast Whale Shark survey questionnaire.

We are thankful to Dr. Deepak Apte, Deputy Director- Conservation, BNHS for providing us Whale Shark landing information in Mumbai coast and also for providing some media reports on Whale Shark along the Maharashtra Coast from the BNHS library.

We are thankful to Dr. Harilal B Menon, Head of Department, Department of Marine Science, Goa for providing us Whale Shark information in Goa waters.

We are thankful to Mr. VenkateshCharloo of Barracuda Diving Center, Goa for providing us underwater Whale Shark photographs taken in Netrani Island and Thailand waters.

We are thankful to Dr. Madhan, Professor, Department of Statistics, Madras Christian College for providing the guidance and SPSS software for analyzing the survey data.

We are thankful to Mr. Roa from Karnataka for providing us the entire coastal village map from Udupi to Mangalore.

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3. INTRODUCTION

The Whale Shark (*Rhincodontypus*)in the order Orectolobiformes is a monotypic taxon in the family Rhincodontidae. It does not have any close relatives but it does share some common features with sharks belonging to the order Orectolobiformes like the nurse shark (*Ginglymostomacirratum*) and the zebra shark (*Stegostomafasciatum*). The Whale Shark (*Rhincodontypus*) is a slow-moving filter feedingshark and the largest known extant fish species in the wild. There are two other large filter feeding sharks, the basking shark (*Cetorhinusmaximus*) and megamouth shark (*Megachasmapelagios*), however they are in the orderLamniformes and are not closely related to the Whale Shark.

Whale Sharks live in all tropical and warm-temperate seas except the Mediterranean. It is thought to be primarily pelagic (preferring an open-ocean habitat) but seasonal feeding aggregations do occur at several coastal sites throughout the tropics. The Whale Shark is known to occur in the waters of over 130 countries (Turnbull and Randell 2006b) and some of the most well documented sites ofWhale Shark occurrence are in the Gulf of Mexico, Gulf of California, Belize, Honduras, Western Australia, the Galapagos, New Zealand, Philippines, Indonesia, Madagascar, Mozambique, Kenya, India, Pakistan, Maldives, Seychelles, Indonesia, and Thailand.

The first historic account describing a Whale Shark (*Rhincodontypus*) was from Seychelles waters in an entry in theship's log of the Marion Dufresne Expedition in 1768, just 12years after the first settlement of these islands (Lionnet, 1984).The first record of a Whale Shark being fished is also from thesewaters, in the 1805 log of Captain Philip Beaver (Smyth, 1829),which foretold the fate of this species in the Indian Ocean.Despite these early records and the first scientific recordof the species being from the Indian Ocean by Andrew Smith in1828 and 1829 (Smith, 1829), very little is known onthe biology ofWhale Shark, its distribution range and status in this region (Fowler, 2000).Targeted fisheries in the northern Indian Ocean have resulted in a dramaticdecline of the species (Hanfee, 2001) which prompts the need for an urgentreview of the status of the species in this region.

Whale Sharks are generally of limited value to fisheries. However, since the early 1990s an increasing demand for Whale Shark flesh and fins in some Southeast Asian countries, especially

Taiwan (Chen et al. 1997) led to an increase in targeted fish landings of the species in some countries, particularly the Philippines, India and Taiwan. Artisanal fishing for Whale Sharks has existed in a number of countries, such as Indonesia, Philippines, Iran, Maldives, India and Pakistan (Anderson and Ahmed 1993; Hanfee 2001; Compagno 2002; Rowat 2007; White and Cavanagh 2007). The surface swimming behavior of Whale Sharks has also led to mortality from collisions with boats;these incidences are not often reported but presumably a regular occurrence in some areas (Rowat 2010). Strandings are also relatively common in some areas, particularly off the South Africancoast where it is thought that the Whale Sharks are possibly dying or stunned by sudden chilling due to cold water masses (Beckley et al. 1997).

In the last two decades, a number of countries have banned fishing of Whale Sharks including Maldives in 1993 (Anderson and Ahmed 1993), Philippines in 1998 (Pine et al. 2007), Honduras in 1999 (Compagno 2002), Thailand in 2000 (Fishing Act B.E. 2490), India in 2001 (Wildlife Protection Act, 1972), Palau and Belize in 2003 (Graham 2007), Seychelles in 2004 (Wild Animals Bill), and Taiwan in 2008.

The increased global fishing effort and targeted fishing for elasmobranchs have initiated a concern over the sustainability of several vulnerable species including Whale Sharks, particularly in relation to their low productivity. International legislation relating to conservation and protection of Whale Sharks include the species in the Appendix II of Convention for the Conservation of Migratory Species of Wild Animals in 1999 (CMS 1999), Appendix II of CITES (Convention on International Trade in Endangered Species) (CITES 2002) (Fowler 2000), Annex 1 (Highly Migratory Species) of the United Nations Convention on the Law of the Sea (UNCLOS), and the Convention on Biological Diversity. Despite their protected status in many countries, illegal and incidental capture of the species continues to be reported (Kasinathan et al. 2006; Riley et al. 2009) almost everywhere.

Although a ban on the fishing killing and possession of Whale Shark products in India has been in place since 2001, incidental by catch of the species has continued along the Indian coast (Romanov 2002; Choudhary et al. 2008; Sajeela et al. 2010) and presumably many incidents go unreported along the extensive coastline of India. This is partly due to the lack of awareness of the imposed legislation, lack of education on vulnerability of the species, and the high cost of

rescuing and releasing an accidentally netted Whale Shark, including the establishment of a stranding and rescue operation network in India.

3.1. OCCURRENCE OF WHALE SHARKS IN INDIAN OCEAN

In terms of their spatial distribution, Whale Sharks occur in the following Indian Ocean states: Australia (Western Australia), Bangladesh, Djibouti, India, Indonesia, Kenya, Madagascar, Malaysia, the Maldives, Mauritius, Mozambique, Seychelles, Somalia, South Africa, Sri Lanka, Tanzania and Thailand (Irvine and Keesing, 2007; Norman unpublished). Whale Sharks are regarded as a broad ranging species and globally have been found in many areas with surface sea water temperatures ranging between 18–30° C (Fowler, 2000). However, they have also been recorded in latitudes with far cooler temperatures as far as 41°N and 36.5° S (Wolfson, 1986). Other studies have shown that they are commonly found in temperatures of 28–32° C (Eckert and Stewart, 2001).

There is some published information on the variability in their temporal occurrence across the region, such as from the Maldives where they are found in the west during the Northeast monsoon, and in the east during the Southwest monsoon (Anderson and Ahmed, 1993). There exists some good information on the timing of their occurrence at Ningaloo where they feed on krill during periods of mass spawning of coral (Taylor, 1994; Wilson and Newbound, 2001).

A number of targeted fisheries have developed within the Indian Ocean.Some of these fisheries originated from traditional roots; for instance in India, Pakistan and the Maldives Whale Sharks were caught for their liver, from which oil was extracted to waterproof boats (Anderson and Ahmed, 1993; Hanfee, 2001). Targeted capture of whale sharks escalated, especially in India during the 1990s,in response to the demand from Taiwan for "Tofu Shark", or Whale Shark meat.Reported figuresof Indian fishery indicate highest catch of Whale sharks individuals was 279 in 1999, but that despite increased effort only 160 were taken in 2000 (Hanfee, 2001). This fishery was closed in 2001 when the species received protected status (Irvine and Keesing, 2007). The fishery in the Maldives previously took 20–30 Whale Sharks per year (Anderson and Ahmed, 1993) but this proved unsustainable with declining catches and the whale shark fishery was stopped in 1995 (Colman, 1997).

3.2. WHALE SHARKS ALONG THE INDIAN COAST

Occurrences of Whale Sharks from Indian watershave been reported in the published literature foralmost a centurywith early records fromBuist, (1850), Pillai(1929), Prater (1941), Kulkarni (1948) and Chackoand Mathew (1954). In fact, much of theinformation on Whale Sharks available from India werefrom reports of beached or strandedWhale Sharks.Many of the publishedrecords of Whale Sharks in Indian waters havebeen based on single landings at one or more ofthe various fish landing sites along the Indian coast.Whale Sharks have been reported along the entireIndian coastline extending from Gujarat in the westto West Bengal in the east (Silas 1986; Pravin 2000;John 2010).

In recent decades sightings of Whale Sharks have been reported from almost all maritime states of India including Gujarat (Hanfee., 2001), Maharashtra (Jadhav*et al.* 2005), Karnataka (Kemparaju*et al.* 2002), Kerala (Paul 2006), Tamil Nadu (Rajapackiam*et al.* 2006), Andhra Pradesh (Rao 1992), West Bengal and Goa (Pravin 2000; Choudhary 2008). In recent years, there have been further records of Whale Shark sightings off the Orissa coast as documented by Bar (1998) and Rao (2004).

3.3. WHALE SHARK EXPLOITATION IN INDIA

Whale Sharks were not commercially exploited until the early 1880's with most landings beingincidental are either discarded or thrown back into the sea. (Pravin2000)However, the mid 1980's saw the world's largest fish become a regular fishery for their liverwhich was used to extract oil for coating fishing vessels(VivekanandanandZala 1994; AsokKumaret al 1996, in Pravin2000).The demand for their meat, fins, liver, skin and cartilage grewin countries like Taiwan (Chen and Phipps 2002), as well as Japan, Singapore and Hong Kong (Alava2002, in Norman, Catlin2007) especially after the ban on Whale Shark hunting in countries suchas Maldives in 1995 and Phillipines in 1998 (Chen and Phipps 2002);Whale Shark huntingbecame a targeted and specialized fishery in itself and the Whale Shark began to be hunted foralmost all its parts. This resulted in extremely large and unsustainable numbers of Whale Sharks being caught, with the maximum recorded landings of 279 sharks in Dec 1999 alone in Gujarat India (Hanfee, 2001). In the same report for TRAFFIC India, Hanfee, (2001) reported as many as 40 Whale Shark landings recorded in a single day (September 15, 2001) along the Gujarat Coast. It is

estimated that approximately 1,000 Whale Sharks were caught off the Gujarat Coast of India during 1998 (CITES 2002). Cured Whale Shark meat and liver oil have a good market in India and fins, frozen meat and skins from Whale Sharks caught in India have good markets in Singapore, Korea and Taiwan (White and Cavanagh 2007). India is the world's fourth largest fishing nation, accounting for 4.4% of the global output (Radhakrishnan*et al.* 2009).In 1999-2000, the export of 4,65,000 kg of Whale Shark meat from Veraval in Gujarat brought in approximately INR 2,18,000 (Hanfee,2001. The Whale Shark fishery was thus a source of huge economic profit andprovided a sizeable income to the fishermen who depended solely on fishing for their livelihood.Hanfee (2001) described two predominant methods of Whale Shark capture. The first oneinvolved mechanized trawler boats fitted with large hooks/harpoons. The second predominant method involved by artisanal fishermen using small wooden dugout or fiber canoes fitted with outboard motors. These similarly usehooks tied to large empty PVC barrels for buoyancy. This method led to the locals calling the fish 'Barel' after the barrels. This strongly indicates that Whale Shark hunting was atargeted fishery across all the fishing communities in Saurashtra Coast in Gujarat. And while the larger commercial fishers mayhave recovered from the loss in income due to the ban on Whale Shark hunting it is possible thatthe Whale Shark ban may have affected the smaller fishermen in a more pronounced way. This needed further study, particularily if it was to be believed, that people who were heavily involved in Whale Shark hunting and trade are currently unemployedand/or under heavy debts.

The fisher folk of Gujarat based on their Traditional Ecological Knowledge (TEK) of the marine environment and Indigenous Technical Knowledge (ITK) on specific target species for harvest claimed that they knew exactly when and where to find the Whale Sharks (Hanfee, 2001). Such knowledge isof utmost importance for research studies on habitat andecology of the Whale Shark; these should thus be undertaken in collaborationwith local fishermen.

Only one long term research and conservation project on Whale Shark has been initiated in India so far. This ongoing project, initiated by the WTI in the year 2003 along with the Gujarat Forest Department and TATA Chemicals Limited, focuses on spreading awareness of the plight of the species, rescue of incidentally captured Whale Sharks, understanding Whale Shark biology through rescues and feasibility studies on community basedWhale Shark tourism for its long term survival. In 2008, using TEK method the WTI conducted a survey along the 1600km coast

of Gujarat to understand the past and present status of Whale Shark and found Veraval, Sutrapada and Dhamlej to be the major aggregation areas for Whale Sharks along the Gujarat Coast (Praveen et al, 2008. unpublished report). The project also focuses on understanding the biology, demography and migration ecology of the species . Satellite tagging of aWhale Shark in Gujarat in 2011 has yielded some firsthand information on the local movement of this animal between different coastal states along the west coast (WTI, unpublished data).

WTI's efforts over the last 10 years have helped to not only identify large aggregates of Whale Sharks along the Gujarat coastlines, but also to put an end to the mindless slaughter of the Whale Sharks. Under this continued effort to stop the organized hunting of the species in the Indian waters, additional data from all other maritime states other than Gujarat is required, pertaining to hunting, beaching as well as just temporal presence. Additionally, these surveys are expected to help draftWhale Shark Conservation Action Plans for each Indian maritime state, and which will form part of the National Action Plan for Whale Shark Conservation. In this background the MFF programmeof IUCN – India supported WTI in implementing a small grant projectto compile information on the status of Whale shark along the west coast of India.

3.4. RATIONALE OF THE PRESENT PROJECT

Whale Sharks are highly mobile animals spending most of their lives out of reach of humans, making any long-term observation of their behavior in the wild very difficult and prohibitively expensive. It is therefore, understandable that science has little understanding of the Whale Sharks life history. However, fisher-folks across the world with their Traditional Ecological Knowledge (TEK) do have a fairly adequate Indigenous Technical Knowledge (ITK) about Whale Shark in the marine environment. Such indigenous knowledge of fisher-folks have been used by marine research, conservation and management scientists across the world, (Drew, 2005; Stacey et al, 2008; Swathi et al, 2007; Rinkevich et al, 2011). The present project therefore aims to use the TEK and ITK of the marine environment and other resources including Whale Shark of the fisher-folks operating in the Arabian Sea along the west coast of India in the maritime states of Maharashtra, Goa, Karnataka, Kerala and Lakshadweep Islands to understand the past and present status of Whale Shark, their aggregation hotspots and other aspects of their off take in the Arabian Sea.

The rationaleforcontemplating the project is to fill in the gap of information about theWhale Shark along the west coast of India except in the state of Gujarat (for which a similartype of fishermen survey was completed by WTI in 2008). Through a questionnaire surveys in the coastal villages along the west coast of India,it is expected that a better understanding will be gleaned ofthe hotspots of Whale Shark sighting locations, season and frequency of sighting, areas where most sightings have occurred, frequency and abundance of Whale Shark encounter during the fishing activity and the frequency and possible location of other marine mammal sightings in association with Whale Shark.

Based on the present and earlier Whale Shark landing information and the present west coast survey outputs, we can also single out the Whale Shark aggregation hotspots in the west coast of India requiring immediate conservation action. Aggregation hotspots refer to geographic locations where Whale Sharks have been sighted, or where they are believed to aggregate or migrate. This information will form the basis of a Conservation Action plan for Whale Shark Recovery along the west coast of India and the whole coastline.

4. OBJECTIVES OF THE PROJECT

The objectives of the project are:

1. To understandWhale Shark distribution across west coast of India and the range of threats they face
2. To develop draft recovery plans for the whale sharks in collaboration with the respective Indian range states

5. PROJECT AREA

The west coast of India spans five maritime states and one archipelago, and has a coastline of 3300 km from Gujarat to Kerala 846 fishing villages with 8,99,332 fisher - folk (excluding Gujarat) actively fish in the Arabian Sea (FSI information, 2011). Fishing activities along the west coast of India are undertaken usingmotorised and mechanized fishing boats. The fishing grounds off the West coast of India extend upto average depth of 80 meters and the continental shelf extends upto 50 Nautical Miles from the coast. The 91 meters depth fishing ground off the Maharashtra coast extends upto nearly 100 Nautical Miles from the coast. Heavy fishing activity is observed during thepost monsoon period (October to December). A fishing ban has been imposed by the Govt. of India for a period of nearly two months during the monsoons which varies from state to state,as given below, every year. However, traditional and artisanal fishing boats are permitted to carryout fishing during the ban period.

Table 1.Seasonal fishing ban or holiday along maritime states in west coast of India

State/Union Territory	Year of Introduction	Notified Period	Days	Type of Fishing ban	Type of fishing permitted
Maharashtra	**1990**	**10 June – 15 August**	**67**	**All Craft**	**Nil**
Goa	**1989**	**10 June – 15 August**	**67**	**All Craft**	**Nil**
Karnataka	**1989**	**15 June – 29 July**	**45**	**All except motorized OBM/IBM vessels up to 25 hp engine**	**Motorized up to 25 hp engine**
Kerala	**1988**	**15 June – 31 July**	**47**	**Mechanized vessels/ motorized craft > 10 hp engine**	**All traditional and motorized crafts of OBM/IBM up to 10 hp engine**

Source: Vivekananda et al., 2010, Marine fishery Policy Brief - 2

The climatic condition in the Arabian Sea is characterized by the two monsoons – the South-West and the North-East. The South-West monsoon lasts from May to September and the latter from September to May. The best time for regular fishing is during the winter months when oceanographic conditions are relatively stable. The currents are slow and the waters above the continental shelf do not change very much as far as temperature and other physical or chemical

factors are concerned. The present questionnaire survey was conducted in all the states of west coast of India (except Gujarat), including Lakshadweep Island between May 2012 and March 2013.

5.1. Maharashtra coast

Maharashtra has a 720 km long coastline with a continental shelf of 112000 km^2 and 406 fishing villages in five coastal districts.Overall 152 fish landing centers in Maharashtra support 23,508 fishing crafts of which 13,053 are mechanized, 3382 are motorized and 7073 are traditional crafts. According to the 2011 state fisheries statistics, the total number of fisher-folk in Maharashtra numbered 3,19,397. Based on the reviewed records of historical Whale Shark landing, CMFRI and State Fisheries Department fishermen census data, the project selected 21 major landing centers nearby fishing villages in Maharashtra for conducting the questionnaire based fishermen survey to document their TEK and ITK on Whale Sharks (Fig. 1).

5.2. Goa coast

Goa has a 104 km long coastline with a continental shelf of 10000 km^2 and 39 fishing villages in two coastal districts.34 fish landing centers in Goa support2551 fishing crafts of which 1087 are mechanized, 932are motorized and 532 aretraditional crafts. As per the 2011 state fisheries statistics, the total number of fisher-folk in Goa numbered 10668. Based on the reviewed records of historical Whale Shark landing, CMFRI and State Fisheries Department fishermen census data, the project selected 12 major landing centers nearby fishing villages in Goa for conducting the questionnaire based fishermen survey to document their TEK and ITK on Whale Sharks (Fig. 2).

5.3. Karnataka coast

Karnataka has a 300 km long coastline with a continental shelf of 27000 km^2 and 156 fishing villages in three coastal districts.88 fish landing centers in Karnataka support15,655 fishing crafts of which 4373 are mechanized, 3705are motorized and 7577 aretraditional crafts. According to 2011 state fisheries statistics, the total number of fisher-folk in Karnataka numbered 170914. Based on the reviewed records of historical Whale Shark landing, CMFRI and State Fisheries Department fishermen census data, WTI selected 23 major landing centers

nearby fishing villages in Karnataka for conducting the questionnaire based fishermen survey to document occurrence and distribution of Whale Sharks in the Karnataka coast (Fig. 3).

5.4. Kerala coast

Kerala has a 590 km long coastline with a continental shelf of 40000 km^2 and 222 fishing villages in nine coastal districts.178 fish landing centers in Kerala support29,177 fishing crafts of which 5504 are mechanized, 14,151are motorized and 9522 aretraditional crafts. According to 2011 state fisheries statistics, the total number of fisher-folk in Kerala numbered 602234. Based on the reviewed records of historical whale shark landing, CMFRI and State Fisheries Department district wise census data, we selected 57 major landing centers nearby fishing villages in Kerala for conducting the questionnaire based fishermen survey to document their TEK and ITK on Whale Sharks (Fig. 4).

5.5Lakshadweep (Union Territory)

Lakshadweep has a 132 km coastline with a continental shelf of 4000 km^2 and 20 fishing villages in ten inhabited islands.19 fish landing centers in Lakshadweep support2384 fishing crafts of which 667 are mechanized, 376are motorized and 1341 aretraditional crafts. As per the 2011 state fisheries statistics, the total number of fisher-folk in Lakshadweep numbered 40328. Based on the reviewed records of historical Whale Shark information and Agatti Forest Department data, WTI selected five important islands in Lakshadweep for conducting the questionnaire based fishermen survey to document their TEK and ITK on Whale Sharks (Fig. 5)

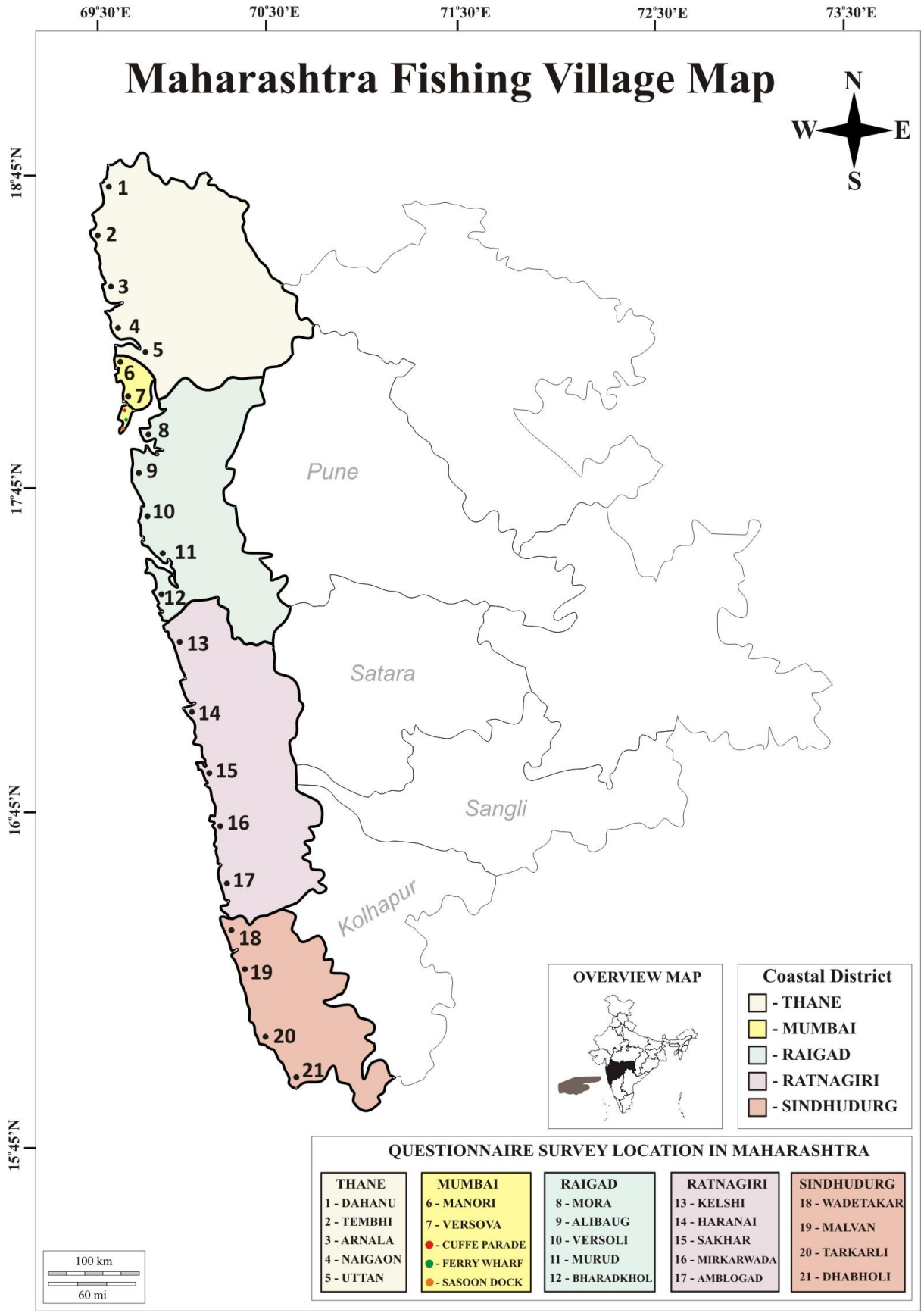

Fig.1 Location of communities visited in Maharashtrafor questionnaire survey

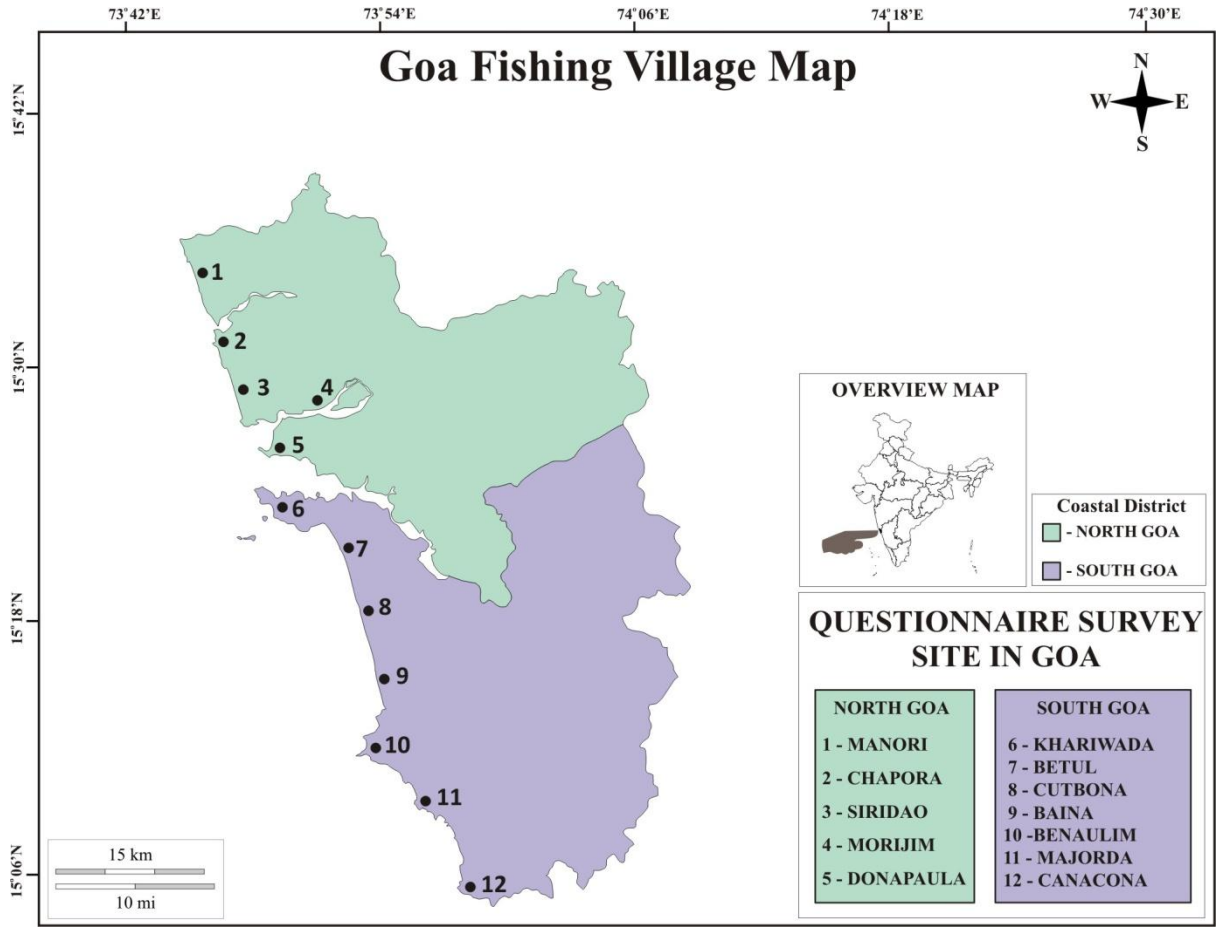

Fig.2 Location of communities visited in Goa for questionnaire survey

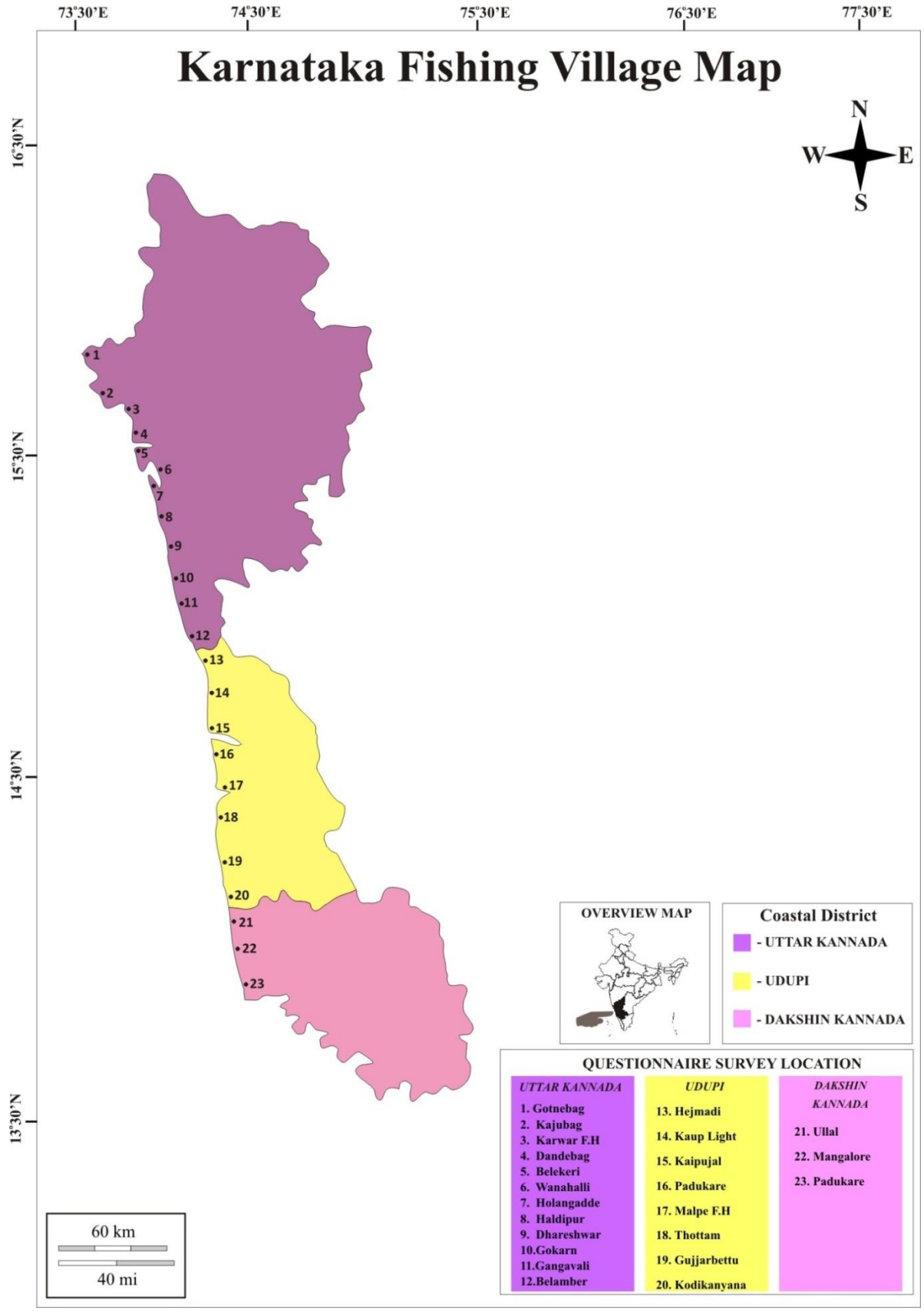

Fig.3 Location of communities visited in Karnataka for questionnaire survey

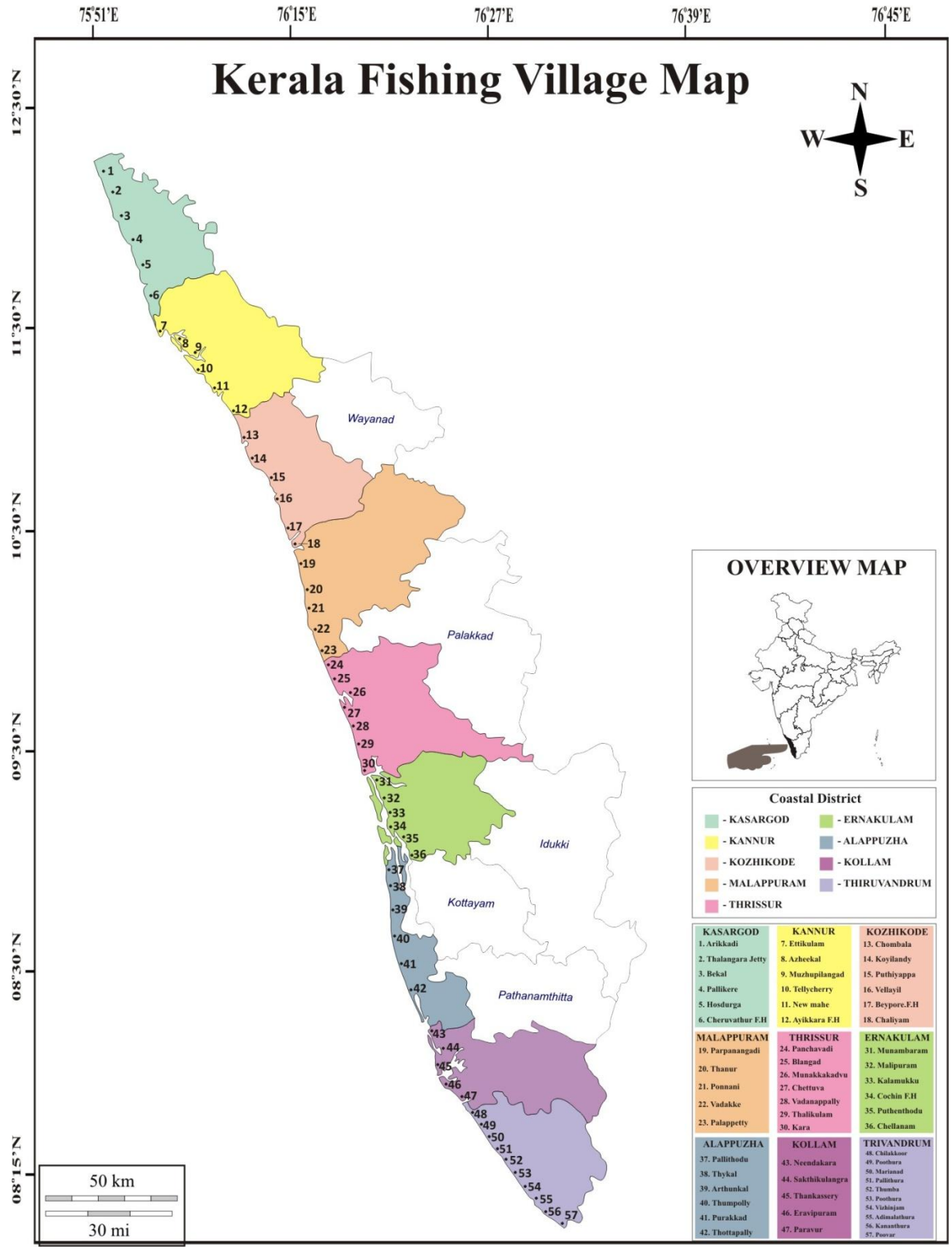

Fig. 4 Location of communities visited in Kerala for questionnaire survey

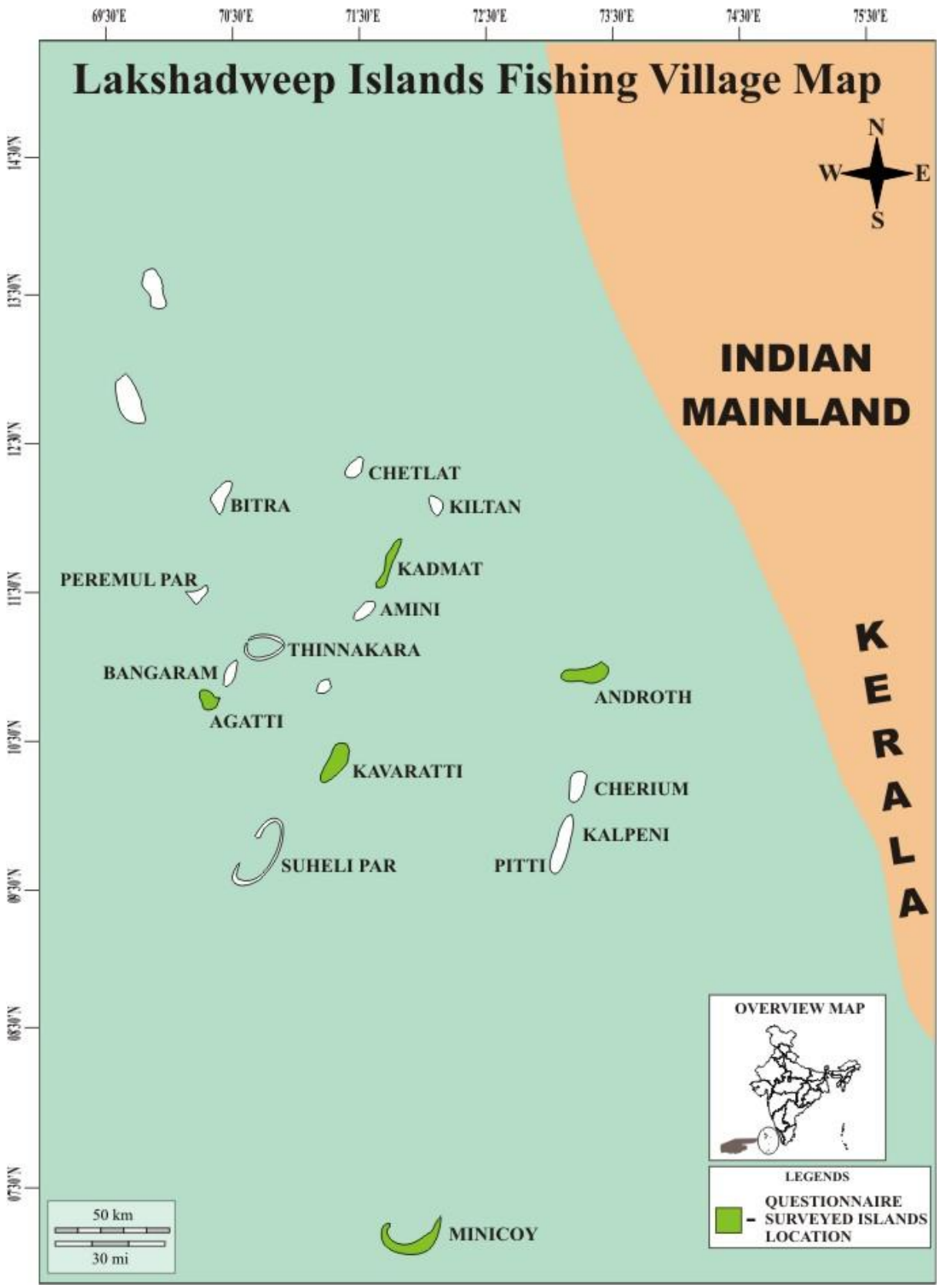

Fig. 5 Location of communities visited in Lakshadweep Island for questionnaire survey

6. PROJECT DESIGN AND METHODOLOGY

6.1. Literature Review

The first phase of the project involved a review of existing Whale Shark information in two major areas of interest:

- published literature to understand scientific information on Whale Shark along the west coast of India
- grey literature to the past and present status of Whale Sharks along the west coast of India Media reports that provide the threat information about the Whale Sharks in each of the individual states were also reviewed.

These desktop reviews covered various disciplineson Whale Shark science which includesconservation biology, anthropology,marine ecology and conservation. The review covered a wider scope in geographical coverage than the west coast of India to include the Maldives and Qatar regions. Sources included published andunpublished literature gathered through library searchers via catalogues, databases and theinternet. The results of the literature review is summarised according to key themes relating to Whale Shark ecology and migration, uses, threats and traditional and technical knowledge acrossgeographic regions and cultural perspectives. The literature reviewwasprimarily a desk top textual analysis of information, identifying topics and analysing themes aswell as establishing a framework for the study.

6.2. Consultation with professional institution and organization

In the second phase of project, the survey team started collecting existing information on Whale Shark landing, stranding and sighting records in west coast of India from different scientific institutions, government and Non-Governmental Organization (NGO) working in the coastal states along the west coast.

6.3. Developing the TEK and ITK based survey questionnaires

Refining the existing Traditional Ecological Knowledge (TEK) of Whale Shark survey questionnaire used in eastern Indonesia by Stacey et al,(2008) and Indigenous Technical Knowledge (ITK) questionnaire by CMFRI for their marine mammal field survey by

Vivekanandan et al (2012),a new structural questionnaire was developed (see appendices 9.2).Questions and topics in the questionnaire related broadly to the following themes:

i. Understanding of Whale Shark distribution across the west coast of India

ii. Range of threats experienced by Whale Shark along the west coast of India

6.4. Planning and finalizing the fish landing sites and villages for survey

The Central Marine Fisheries Research Institute (CMFRI) provided the information on major and minor fish landing center along the west coast of India. These landing centers have been categorized into 3 stratums by CMFRI, the details are provided in the table below,

Stratum No.	Title	Details, Boat type
Stratum 1	Major Landing centres	Centres with Jetty construction, Trawlers and Mechanised boats
Stratum 2	Minor Landing centres	Mechanised boats and traditional fishing boats
Stratum 3	Lesser minor landing centres	Traditions fishing boats only

Additional information on Whale shark landings were gathered from the website, Marine Fishery Information Service (MFIS). The respective state fisheries department provided project staff with the coastal village data along with hand drawn maps. All these information were taken into consideration and the villages were selected on the following criteria.

- All Major landing fishing centers in the state (based on CMFRI data)
- Landing centers with previous records of Whale shark landing or sightings
- Minor landing centers surrounding the major landing centers and landing centers with records of whale shark sighting.

The present study was carried out in all the coastal statesalong the west coast of India except Gujarat. The total length of the study area covered approximately 1846 km which also includes five major Lakshadweep Islands. Based on the CMFRI district wise fish landing centers and

fisheries department data the project selected 118 major fish landing centers nearby villages for the questionnaire survey along the west coast and Lakshadweep Island (see Appendices 9.1).

6.5. Stratifying possible interviewees

The questionnaire survey was mainly targeted at male fisher-folks. We categorized the male fisher-folks into two groups i.e., Retired Fishermen (>55 age) and Active Fishermen (<55 age). Importance of focusing the questionnaire survey on retired fishermen was to gather previous historical information about the Whale Sharks in their area of operation, and active fishermen was to gather the present information about the Whale Sharks in their area of operation.

6.6. Conducting the questionnaire survey

The results of the literature review were used to define the field survey design key topics and interview questions. Two members of the survey team were involved in conducting the questionnaire survey in each village. The questionnaire were translated in five different language i.e., Marathi, Kannada, Malayalam, Hindi and English targeted for each maritime states and focused for conducting the questionnaire survey (Appendix 9.2). Along with the translated questionnaire,WTI also carried some resources materials like Whale Shark miniature rubber models, Whale Shark pictures taken from different angle which were shown to the target audience for basic identification. The questionnaire survey with a single respondent lasted between 30-45 min. Public gathering location such as fish landing center, local fishermen society and local tea shop were mostly targeted wherereaching out to the fisher-folks was easier (see appendices 9.3) .

6.7. DATA ANALYSIS

The results of the literature review and field interviews were analyzed qualitatively and written up as records of conversations in data sheet, as well as literal translations of interviews recorded digitally. Data were analysed using SPSS version 16.0 and Excel.

7. RESULTS

7.1. Literature Review of Whale Sharks

Based on the published journals (35), grey articles (5) and media reports (7)the project tabulated the following information of Whale Shark sighting, landing and scientific studies along the west coast of India.

Table: 2. Details of published literature and media reports reviewed for co-ordinating the questionnaire survey by the WTI project.

Location of Whale Shark sighting information	DATE	SOURCE OF INFORMATION
PUBLISHED JOURNALS		
Near Trivandrum, Kerala	1938	Pillai RS (1929).
Bombay, Maharashtra	1941	Prater, S. H., (1941).
Mumbai, India	1948	Kulkarni CV (1948)
Malabar Coast, Kerala	1954	Chacko PI, Mathew MJ (1954)
Suratkal, 16 km north of Mangalore, Karnataka	1959	Kaikini, A. S., *et al.*(1959)
Vizhinjam, Kerala	1960	Silas (1986)*Mar. Fish. Infor.*Sen)., *T andE*Sen,No. 66
Off Cannanore, landed at Thayyil, Kerala	1963	Thomas, M. M. and K.Kartha (1964)
Calicut, Kerala	1970	Seshappa, G. *et al.* (1972)
Vizhinjam, Kerala	1972	Kuthalingam, M. D. K.*etal.* (1973)
Cuffe Parade, Bombay, Maharashtra	1978	Pai M. V. *et al.* (1983)
Cuffe Parade, Bombay, Maharashtra	1980	Karbhari, J. P. (1986)
Hejmadi,Malpe, Mooloor, Kaup South Karnataka	1980	SatyanarayanaRao, K.(1986) Seven Whale Shark Landed in 8th November to 27th December, 1980.
Anjadiv Is., Karwar,	1981	Pai M. V. *et al.* (1983)

Karnataka		
Anjuna, Goa	1981	Doiphode, P. V. (1986)
Karwar, Karnataka	1983	Dhulkhed, M.H.(1983)
Cochin, Kerala	1984	Somasekharan Nair*et al.* (1986)
Cuffe Parade, Bombay, Maharashtra	1985	Karbhari, J. P. and C. J. Josekutty (1986)
Cuffe Parade, Bombay Maharashtra	1985	Shriram, M. (1986)
Panathura, near Vizhinjam, Kerala	1988	Lazarus *et al.*(1988)
Makarabagh, Malvan	1992	Maikar (1992)
Cooperage,Mumbai	1993	Sriram et al (1994)
Madaban, Ratnagiri	1995	Katkar (1986)
Dakti.Dhanu	1999	KambleandRane (2001)
Versova, Mumbai	2004	Jadhav et al (2005)
Vizhinjam	2005	Marine fisheries information service 1128
Kollam	2006	Marine Fisheries Information Service CMFRI 1207
Karwar, Karnataka	2007	Sreeram et al, CMFRI, Karwar
Kochi, Kerala	2008	Akilesh et al, CMFRI
Thalassery, Kannur	2008	Sajeela et al, 2010
Ankola, Karnataka	2009	Sreeram et al, CMFRI, Karwar
New Ferry Wharf, Maharashtra	2009	Das et al, 2009
Kochi, Kerala	2010	Akilesh et al, CMFRI
Kollam, Kerala	2010	P.T. Mani, 2010
Kochi, Kerala	2011	Akilesh et al, Four whale shark landed from January to August 2011 in Kochi
GREY ARTICLES		
Gujarat Coast, India	2008	Praveen et al, 2008 (Unpublished

		report)
Turning the Tides	2008	Wildlife Trust of India
Vizhinjam, Kerala	2007	Sabu, WTI
Calicut, Kerala	2007	Sabu, WTI
Niwati, Maharashtra	2008	SarangKulkarani
MEDIA REPORTS		
Vizhinjam, Kerala	2002	Media article : Hindu news paper (26th January 2002
Trivandrum, Kerala	2002	Media article : Times of India (26st January 2002)
Mumbai	2005	Deccan Herald News Paper
Pallithura, Kerala	2005	MalayalaManoroma
Kollam	2006	The Hindu news paper
Kasargode	2007	Media article: Times of India
Khariwado, Goa	2007	Herald news paper cutting

7.2. Range of information gathered from professional institutions and Non-Governmental Organizations

Table 3: Institutionsand NGOs visited in west coast of India for the Survey

Organization Visited	**Kinds of information gathered**
Central Marine Fisheries Research Institute, Cochin (CMFRI)	Fish landing centers across the west coast of India
Bombay Natural History Society, Mumbai (BNHS)	Reported information in Maharashtra coast of Whale Shark landings
National Institute of Oceanography, Goa (NIO)	Whale Shark information from Goa
Goa University	Whale Shark information from Goa
Karwar University	Whale Shark information from Karnataka
State Fisheries Department	Fishing villages names and route map in the each state across the west coast of India

7.3. Results based on Questionnaire Survey in West Coast of India

Overall, 1703 interviews were conducted between May 2012 to November 2012 and March 2013 with the fisher folk in fourStates (Maharashtra, Goa, Karnataka, and Kerala) and one Union Territory (Lakshadweep Islands) (Table 2). All the analysis was carried out using SPSS 16.0 and Microsoft Excel 2007. Findings on similar aspects (such as Whale Shark sighting in lifetime or time period of Whale Shark sighting) for five different survey regions were represented graphically for easy comparison and subsequent formulation of recovery plan for each state.

Table: 4Number of surveyed villages and respondents along the west coast of India

Survey activities undertaken	Number of villages visited in each state	Number of fishermen interviewed in each state	Time-period when survey was conducted
Maharashtra	21	424	10th May – 25thJune, 2012
Goa	12	178	2ndJuly – 25th July, 2012
Karnataka	23	400	1st August – 25th September, 2012
Kerala	57	600	1st October – 25th November, 2012
Lakshadweep	5	101	1st March – 25th March, 2013

7.3.1. WHALE SHARK SIGHTING

Among (n=1703) the respondents interviewed along the west coast of India, 62% respondents (n=1033)reported to have sighted the Whale Shark in the Arabian Sea during their fishing operation. The highest proportion of respondent fishermen who encountered Whale Shark (Figure 1) were in Lakshadweep (28%, n= 91) followed by Maharashtra (20%, n= 274), Karnataka (19%, n= 236), Kerala (18%, n= 350) and Goa (15%, n= 82). The result indicated that

the possibility of Whale Shark sighting was highest in the Lakshadweep during fishing operations. This is perhaps because the Lakshadweep archipelago which is close to the Maldives, where Whale Shark tourism has been developed under a national level researchprogrammes thus improving their status and numbers. (Rees et al2012). The maximum respondents in the northern part of Maharashtra reported to have sighted the Whale Shark near Saurashtra coast, Gujarat as their fishing operation extended to that coast and rest of the respondents reported to have sighted the Whale Shark within 20- 40 km offshore from Malvan coast in Maharashtra.

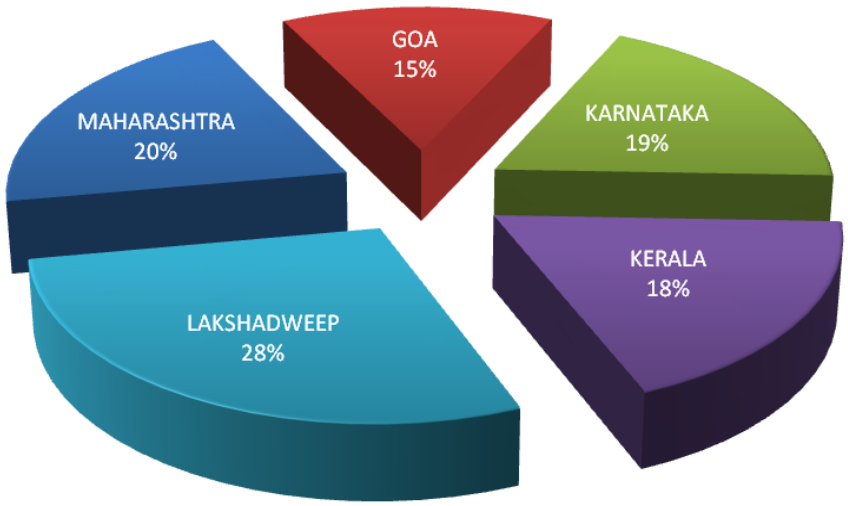

Fig.6 Percentage of interviewees who reportedWhale Shark sighting

7.3.2. Time-period of Whale Shark sighting by the respondents over the decades (from five survey regions)

For over a decade,Whale Sharks have been sighted or landedalong the west coast of India. All the responses collected from five survey regions were categorized into four time periods as recent as 2011-12,(n= 184), comparatively recent as 2009-10,(n= 227), during the last decade 2000-2008,(n= 212) and in the decade up to 1999, the last decade (n= 410). To test the statistical significance of the differences among the number of fishermen who indicated different time periods of Whale Shark sighting over the decades, non-parametric Kruskal-Wallis χ^2 test (Sokal and Rohlf 1981) was applied after testing the distribution (normality) of the data. The result depicted that mean number of respondents (in each village) who has seen Whale Shark before 1999 were significantly higher (Kruskal-Wallis χ^2 74.65, degrees of freedom 3, p= 0.00) than the

mean number of respondents (in each village) who had seen the species in other time periods of later decades (Fig. 7).

However, when the data was analyzed using the responses of active fishermen (presently engaged in fishing) only (n=460), the mean number of respondents (in each village) who has encountered Whale Shark 3-5 years back was significantly higher (Kruskal-Wallis χ^2 204. 24, df 4, $p<0.05$)than the mean number of respondents (in each village) who has seen the species recently or decades back (Figure 8). This overall trend of Whale Shark sighting by active fishermen between 3-5 years back was observed in each of the survey States barring Lakshadweep where the mean number of respondents who has encountered Whale Shark recently or 1-2 years back or 3-5 years back was similar (Figure 9).

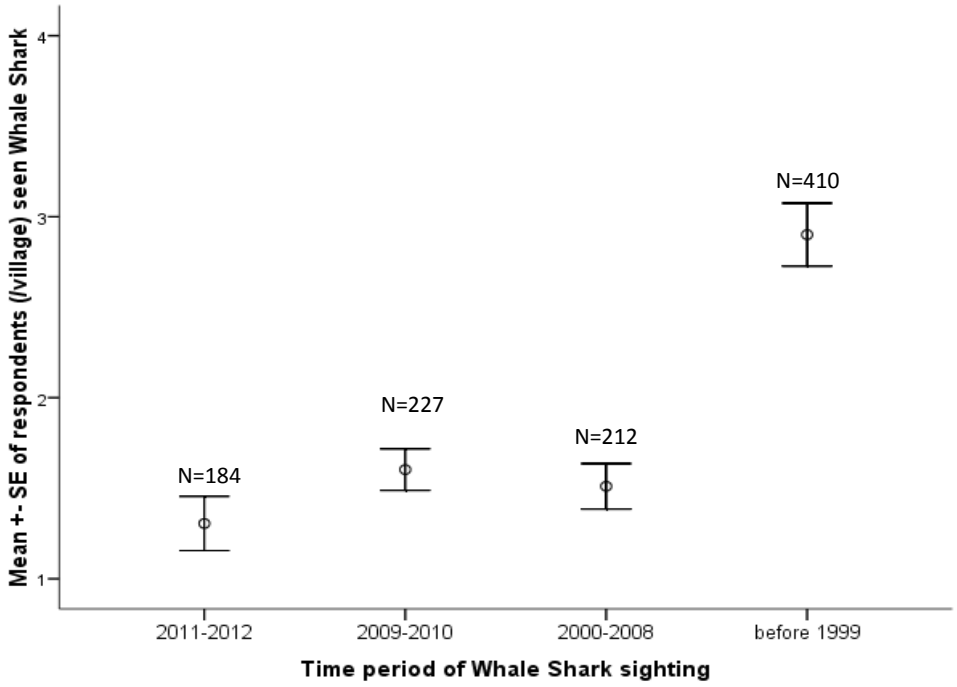

Fig. 7 Significance difference of Whale Shark sighting over the decades

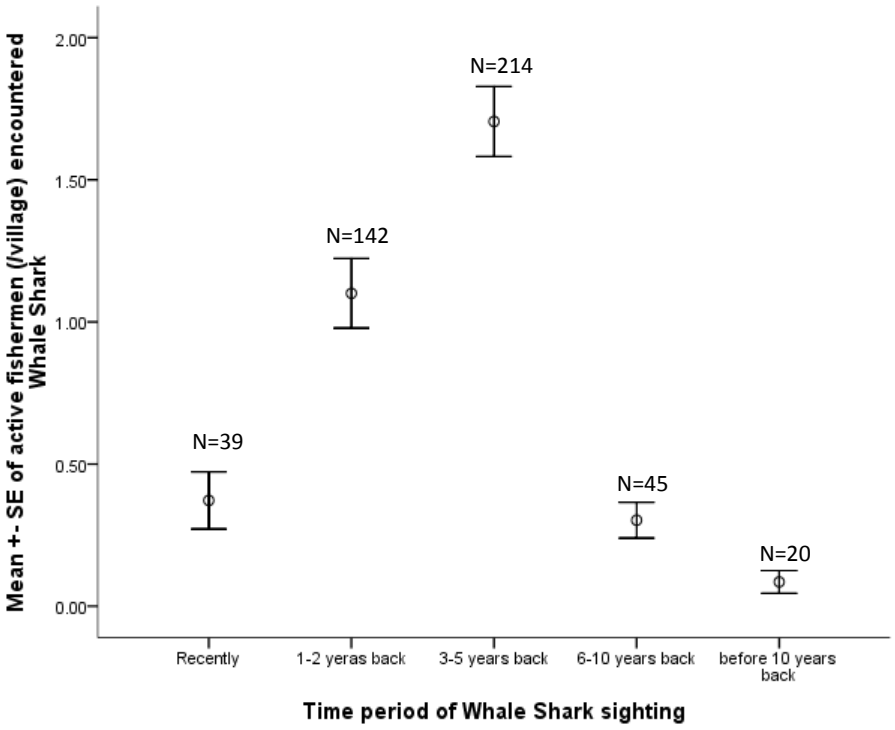

Fig. 8Variation in number of active fishermen/village encountered Whale Shark in different time period over a decade

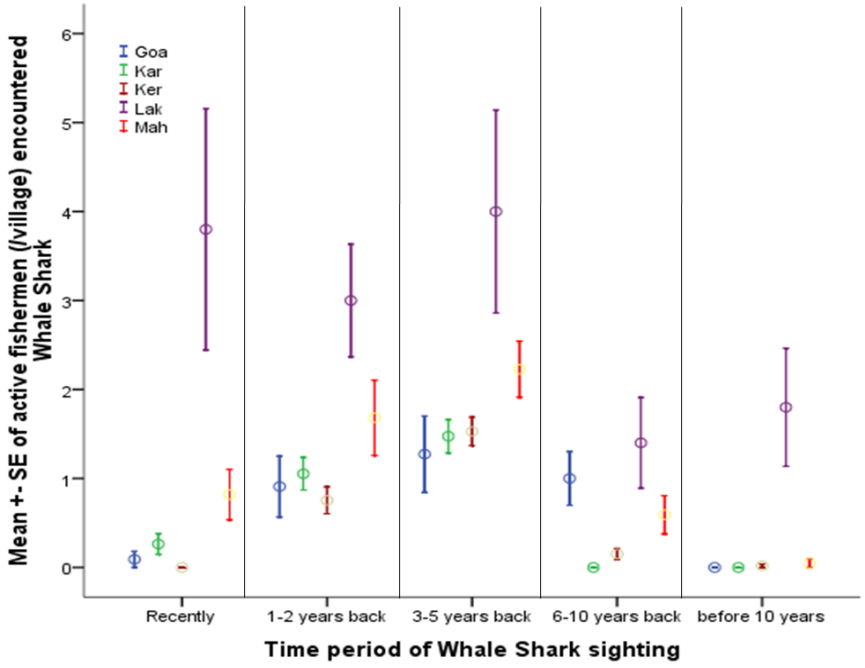

Fig. 9Variation in number of active fishermen/village encountered Whale Shark in different time period over a decade in different survey regions

7.3.3. FREQUENCY IN WHALE SHARK SIGHTING OVER A YEAR

Over a calendar year, Whale Sharks were sighted by the fishermen in different months in the Arabian Sea. The variations in number of sightings in different months of the year were assessed and the peak season when most of the fishermen encountered Whale Shark in Arabian Sea was also pointed out.

When asked about the season of Whale Shark sighting, the fishermen indicated different segments of the year. To present the result in more realistic way, cumulative number of respondents for each month of the year was calculated and represented (Fig. 11). The graph also depicted the state wise variation in period of Whale Shark sighting in a year along with the overall trend of the entire West Coast of India. Among all the five states, only in Lakshadweep, Whale Shark was observed by the respondents throughout the year, and for all other States, winter months were reported as the best time for Whale Shark sighting.

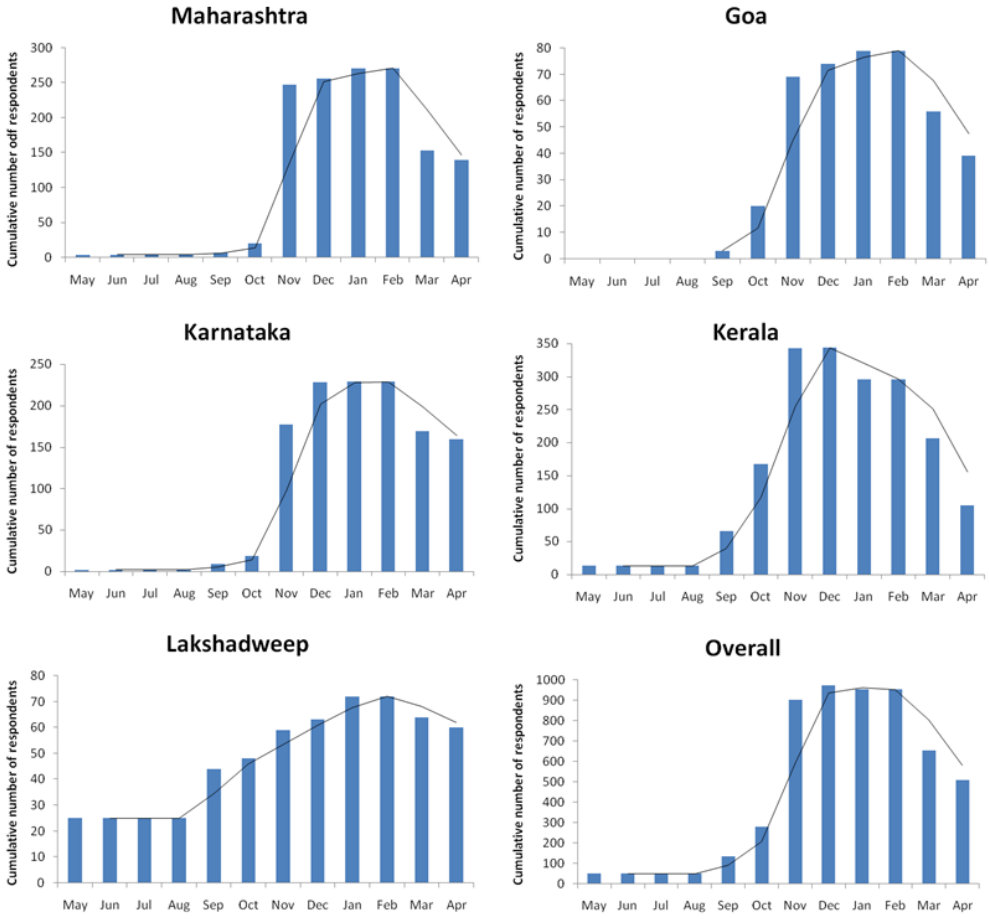

Fig.10 Frequency of whale shark sighting during different months of the year

7.3.4. NUMBER OF WHALE SHARK SIGHTED IN THE LIFETIME OF A FISHERMEN

Based on the respondents fishing experience and number of Whale Shark encounters in a lifetime, six encounter ranges were selected based on the respondent's data from each state; the ranges start from 1-5 and upto more than 21 encounters. To test the significance of the differences among the numbers of respondents who indicated according to different categories of number of Whale Sharks seen in lifetime, non-parametric Kruskal-Wallis χ^2 test was applied after testing the distribution (normality) of the data. The result depicted that the mean number of respondents (in each village) who had seen 6-10 Whale Sharks in their lifetime were significantly higher (Kruskal-Wallis χ^2 336.61, df 5, $p < 0.05$) than the mean number of respondents (in each village) who had seen more or less number of Whale Sharks in their lifetime (fig. 12).

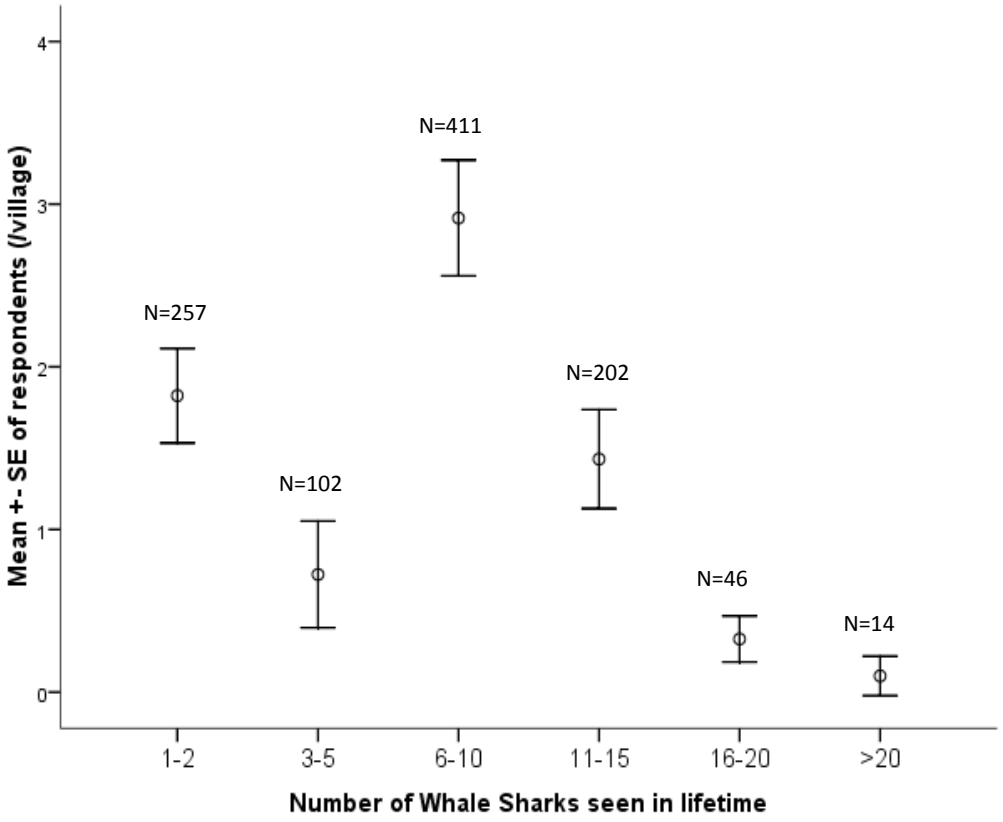

Fig. 11 Number of whale shark sighted in a fishermen lifetime

The graph (fig.13) depicts the state-wisevariation in number of fishermen for different categories of total number of Whale Sharks seen in their lifetime. Only in Lakshadweep, a considerable number of fishermen (n= 13) had seen more than 20 Whale Shark in their lifetime.

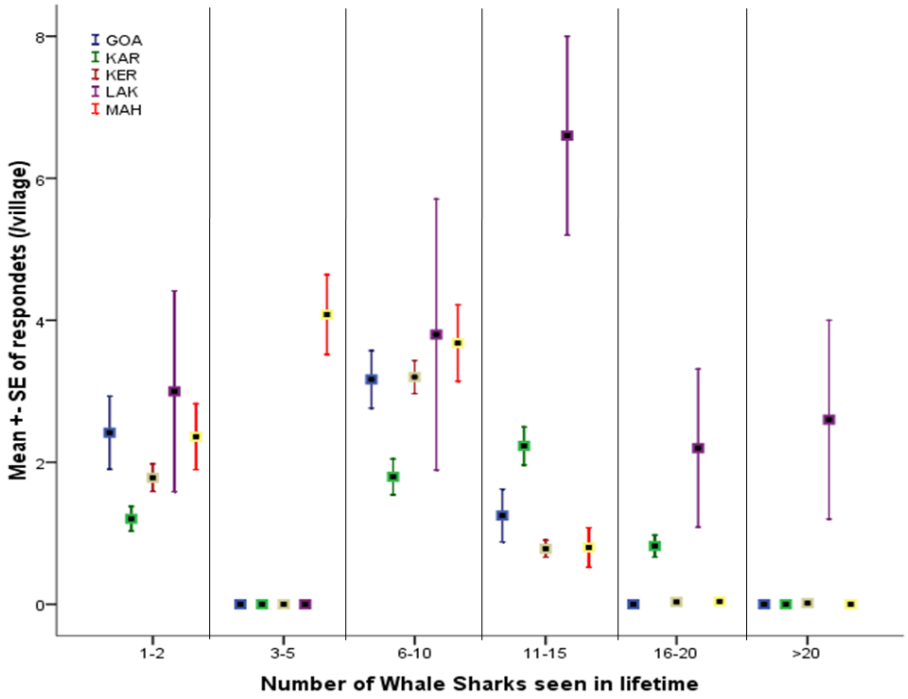

Fig. 12 State-wise number of Whale Shark sighted in a fishermen lifetime

7.3.5. WHALE SHARK INCIDENTAL CATCH

Incidental catch of Whale Sharks is a matter of concern worldwide. Incidental catch is one of the major threats to the Whale Shark populations. Among several kinds of fishing gears used, gillnets and purse seines have been identified as the main gears that cause Whale Shark incidental catch along the west coast of India.

Based on the responses of fishermen on lifetime incidental catch of the Whale Shark, it was found that Maharashtra contributes 29% (n=196), Karnataka contributes 28% (n=180), Kerala contributes 26% (n=254) and Goa contributes 17% (n=47) [Figure 14].

Of the (n=196) respondents who incidentally caught the Whale Shark in Maharashtra, Gill net was responsible in 122 cases, Purse-seine was responsible in 71 cases and trawler was responsible in three cases only. Of the (n=47) respondents who incidentally caught the whale

shark in Goa, Gill net contributes the (n=35) in majority of the cases followed by Purse-seine (n=9) and trawler (n=3). Of the (n=180) respondents who incidentally caught the Whale Shark in Karnataka, Gill net was responsible in 124 cases, Purse-seine was responsible in 40 cases and trawler was responsible in 16 cases. Of the (n=254) respondents who incidentally caught the Whale Shark in Kerala, Gill net contributed in most of the cases (n=208) followed by Purse-seine (n=33) and trawler (n=13). In overall, Gill net contributed 72% (n= 489), Purse-seine 23% (n= 153) and Trawler contributed 5% (n= 35) of incidental Whale Shark catches all along the west coast of India (Figure 14). Of the 101 respondents interviewed in Lakshadweep, not even a single fisherman had come across any incidentalWhale Shark catch in their lifetime. This is mainly because of their fishing method for which they usetraditional types of crafts and gears for fishing such as rowing crafts and fishing gears like hand lines, cast nets, wounding gears and harpoons. However, it is to be noted that a few mechanized boats were also operating in Lakshadweep seas, especially to fish tuna.

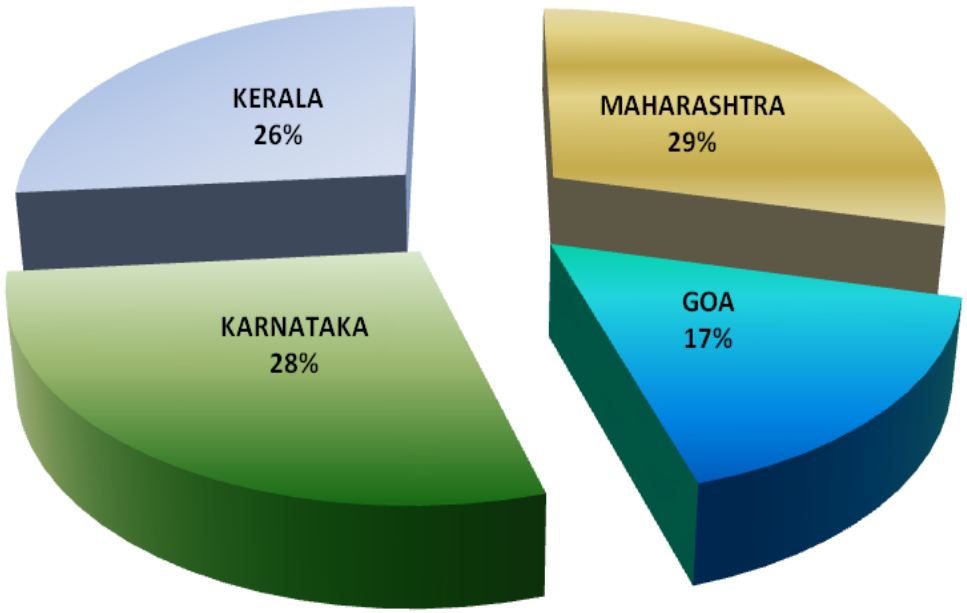

Fig. 13 Percentage of Whale Shark incidental catch

To depict the significance of the difference among the number of respondents who had incidentally caught Whale Shark by using three different types of nets (Gill net, Purse- siene and Trawl net), non-parametric Kruskal-Wallis χ^2 test (Sokal and Rohlf 1981) was applied after

testing the distribution (normality) of the data. The result depicted that mean number of respondents (in each village) who had caught Whale Shark using Gill net were significantly higher (Kruskal-Wallis χ^2 218.56, df 2, $p < 0.05$) than the mean number of respondents (in each village) who had caught the species using either Purse-seine or Trawl net (Figure 15).

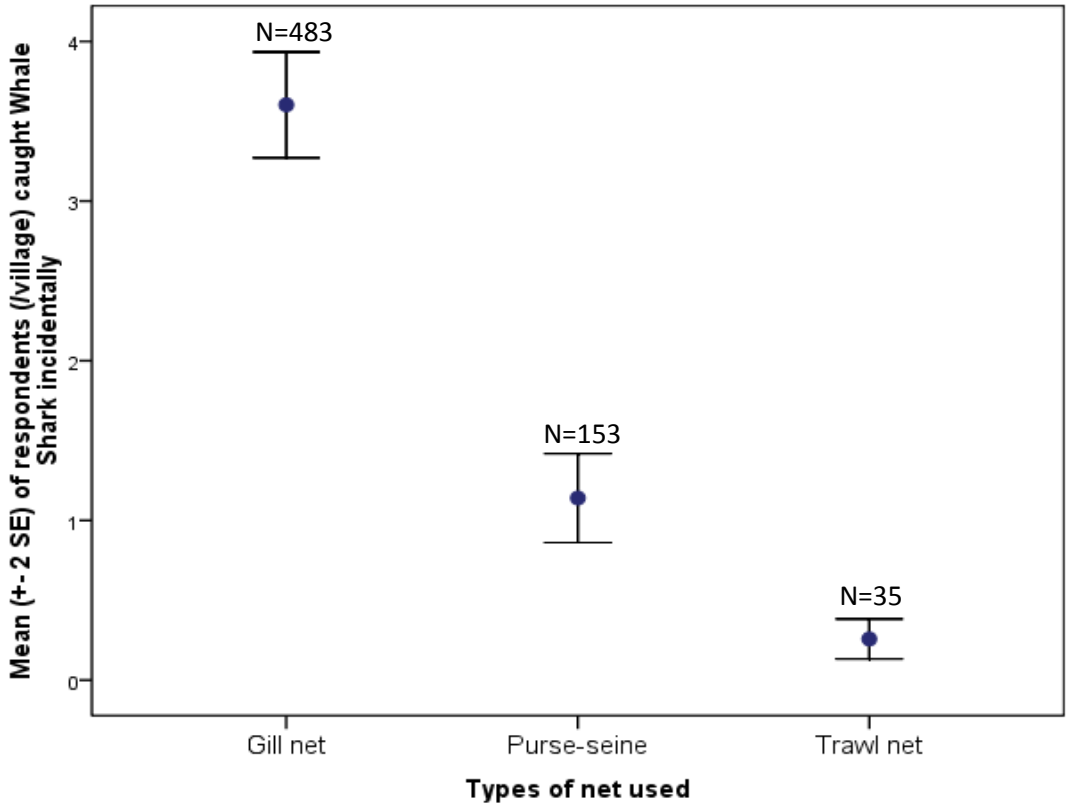

Fig. 14.Differences in mean of respondents caught Whale Shark incidentally using different types of net

7.3.6. VOLUNTARY RELEASE OF WHALE SHARK BY FISHERMEN

Based on the information of Whale Shark incidental catch, the question of disposal of the entangled Whale Sharkwas raised to the fishermen. It was found that 677 respondents who caught Whale Shark incidentally, voluntarily released the entangled Whale Shark. State wise comparison (Figure 16) of this data revealed that fishermen in Goa contributed 50% (n=40) of the voluntarily release followed by Maharashtra 21% (n=69), Kerala 17% (n=72) and Karnataka 12% (n= 36). This voluntary release of Whale Shark was largely to save the net and also fishing time and space which they otherwise would loose if the large size Whale Shark remains entangled in the net.

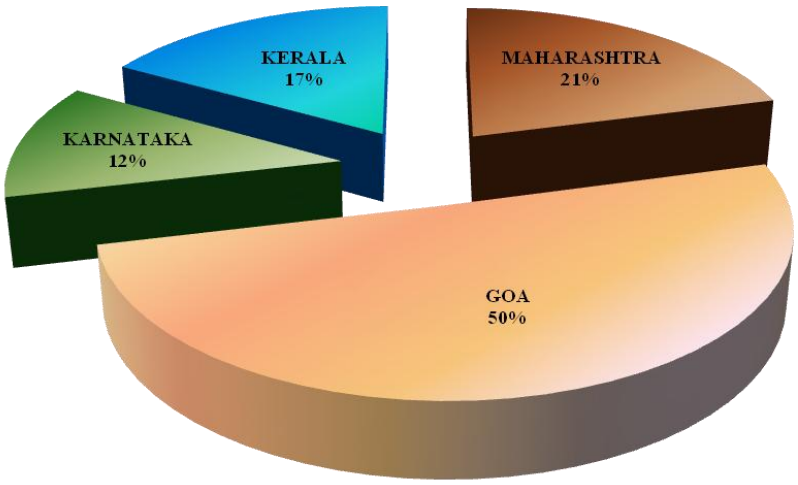

Fig. 15 Percentage of Whale Shark release

7.3.7. CORRELATION BETWEEN NUMBER OF FISHERMEN WHO RELEASED WHALE SHARK AND NUMBER OF FISHERMEN AWARE ABOUT THE BAN ON WHALE SHARK

Spearman rank correlation (Sokal and Rohlf 1981) coefficient (rho, for non-normal data) was computed to assess the relationship between number of fishermen who release Whale Shark (incidentally caught) and number of fishermen who are aware of about the ban on Whale Shark fishing. In case of Goa, there was a good positive correlation between these two variables (rho= 0.76, p=0.004, n= 12). However, in case of Maharashtra, Karnataka and Kerala no significant correlation was present between these two variables (rho= 0.31, p= 0.13, n= 25; rho= 0.19, p=0.24, n= 39 and rho= -0.15, p= 0.24, n= 59 respectively).

7.3.8. VILLAGE LEVEL COMPARISON OF STATES IN TERMS OF EFFECTIVENESS OF THE AWARENESS REGARDING BAN ON WHALE SHARK FISHING

To depict the position of each village (State wise) in terms of awareness of fishermen regarding the ban on Whale Shark fishing and corresponding action taken when a Whale Shark is incidentally caught, two indices were calculated from the data on action taken to the Whale Shark which is incidentally caught and from the data on awareness of the ban. The first one, "release index" included standardized value of percent dragged to the shore subtracted from percent of release for each village. The second one, "Awareness index" included standardized

value of percent unaware subtracted from percent aware about the ban on Whale Shark fishing. A scatter plot (Fig. 17) summarizes the result. The plot can be divided into four quadrates (1. +ve release index and +ve awareness index, 2. +ve release index and –ve awareness index, 3. –ve release index and –ve awareness index, 4. –ve release index and +ve awareness index). Fishermen of the villages situated in Karnataka and Kerala were generally aware about the ban, however, were reluctant to release the Whale Shark. On the other hand, fishermen of Goa were generally not aware about the ban but they had released the Whale Shark on most of the occasions. Data of fishermen residing in Lakshadweep were not included in the analysis as no incidental catch of Whale Shark was reported from this Union Territory. In case of fishermen of Maharashtra, no particular trend was visible in the scatter plot as the awareness level of most of the villages were negative and the fishermen had either released or dragged the incidentally caught Whale Shark to the shore in almost equal proportion.

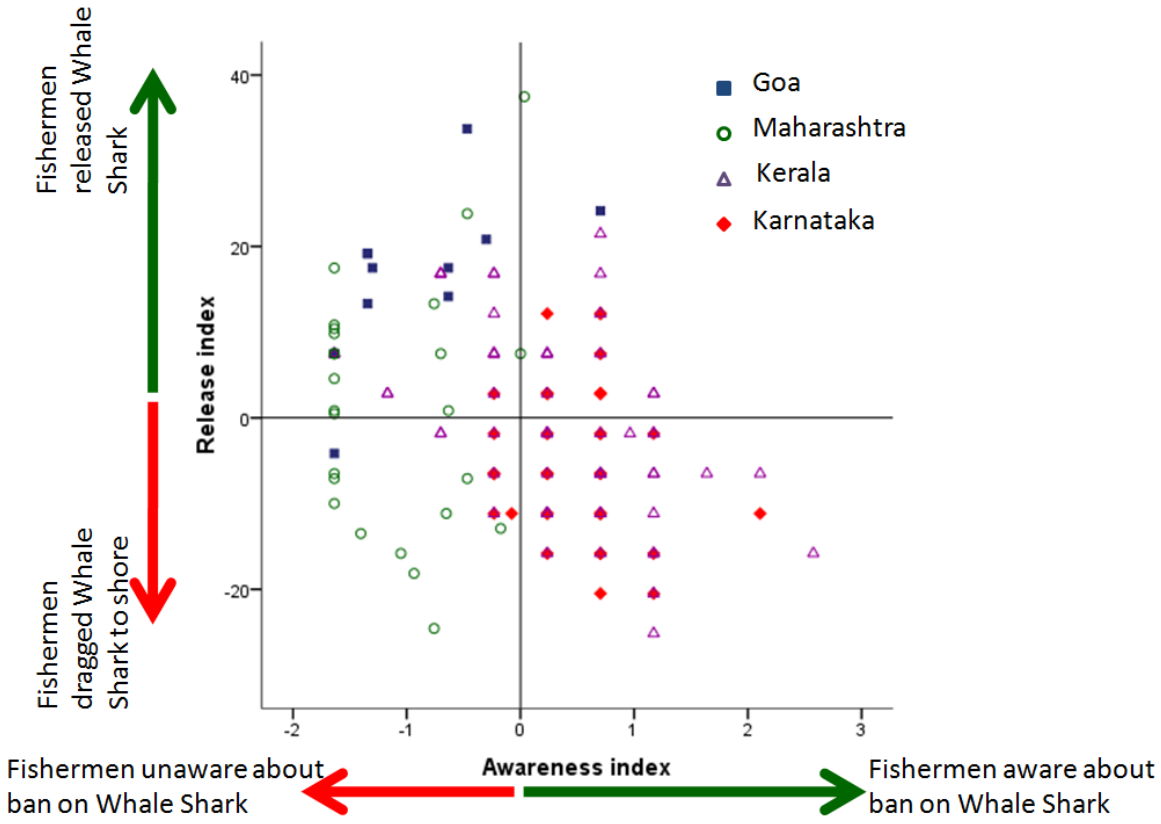

Fig. 16 Scatter plot showing the distribution of villages (of four different states of west coast of India) with respect to release of incidentally caught Whale Shark and awareness about the ban on Whale Shark fishing

7.3.9. HUMAN INDUCED THREATS TO WHALE SHARK IN WEST COAST OF INDIA

As far as threats to Whale Sharks in west coast of India are concerned, there is no conclusive evidence confirming the hunting or target fishing of Whale Shark. Threats are mainly due to incidental catch and the rate of incidental catch were found to be more in three type of fishing gears, Gill net contributing 72% (n= 489), Purse-seine contributing 23% (n= 153) and Trawler contributing 5% (n= 35) of incidental capture of Whale Shark all along the west coast of India (fig.15).

7.3.10. INDIGENOUS KNOWLEDGE ON WHALE SHARK ALONG THE WEST COAST OF INDIA AS COMPARED TO GLOBAL SCIENTIFIC INFORMATION

Based on the indigenous knowledge of fisher folks in the west coast of India about the Whale Shark and global scientific information, we generated the following comparison.

Table: 5 Indigenous knowledge on Whale Shark along the west coast of India and global scientific information

Fisher folk Indigenous Knowledge about Whale Shark	Scientific information about Whale Shark
During fishing operation the Whale Shark is often found swimming on the surface in the sea	Whale Sharks live in all tropic and warm-temperate seas except evidently the Mediterranean. It is thought to be primarily pelagic and to occur in the waters of over 130 countries (Turnbull and Randell 2006)
Whale Shark while swimming in the open sea suck large quantity of water through the mouth	Water flows over the gills of the Whale Shark simply by opening its mouth and swimming forward, a process termed as Ram Filter Feeding (Heyman et al, 2001). Whale Sharks extract oxygen from the water which flows over a five pairs of gills. Water flows from the brachial cavity to these gills through filtering pads.
Whale Sharks are often found along with the bloom of Paste Shrimp sp in west coast of India.	Whale Sharks are versatile filter feeders, filtering large amounts of water over their specially adapted gills, catching planktonic and nektonic organisms (Jarman and Wilson 2004).

7.3.11. GEOGRAPHIC LOCATIONS WHERE WHALE SHARKS HAVE BEEN SIGHTED, OR WHERE THEY ARE BELIEVED TO AGGREGATE

One of the outcomes from the west coast fishermen survey is that at least four Whale Shark aggregation sites along the west coast of India including Lakshadweep Island have been identified for the first time (Fig.18). Of the 274 respondents who reported to have sighted the Whale Sharks during fishing operation, 83 respondents from Mumbai, Thane, Raigad reported to have sighted Whale Sharks off Gujarat Coast especially near the Saurashtra coast and 55 respondents from Raigad, Ratnagiri and Sindhudurg reported to have sighted Whale Sharks off the Malvan coast of Maharashtra.

Of the 236 respondents who reported to have sighted the Whale Shark during fishing operation in Karnataka, 115 respondents from Uttar Kannada, Udupi and Dakshin Kannada reported to have sighted whale sharks more or less close to Netrani Island in Karnataka and 25 respondents from Uttar Kannada reported to have sighted whale sharks off the Malvan coast at Maharashtra.

Based on the Kerala and Lakshadweep fishermen observations, the Whale Shark sighting were reportedly more in the following group of Islands, Androth, Pitti, Suheli, Chinnapara, PeriyaparaBangaram and Minicoy. Most of Whale Sharks landed on the Kerala coast were reported by the interviewees to be mainly from Lakshadweep waters.

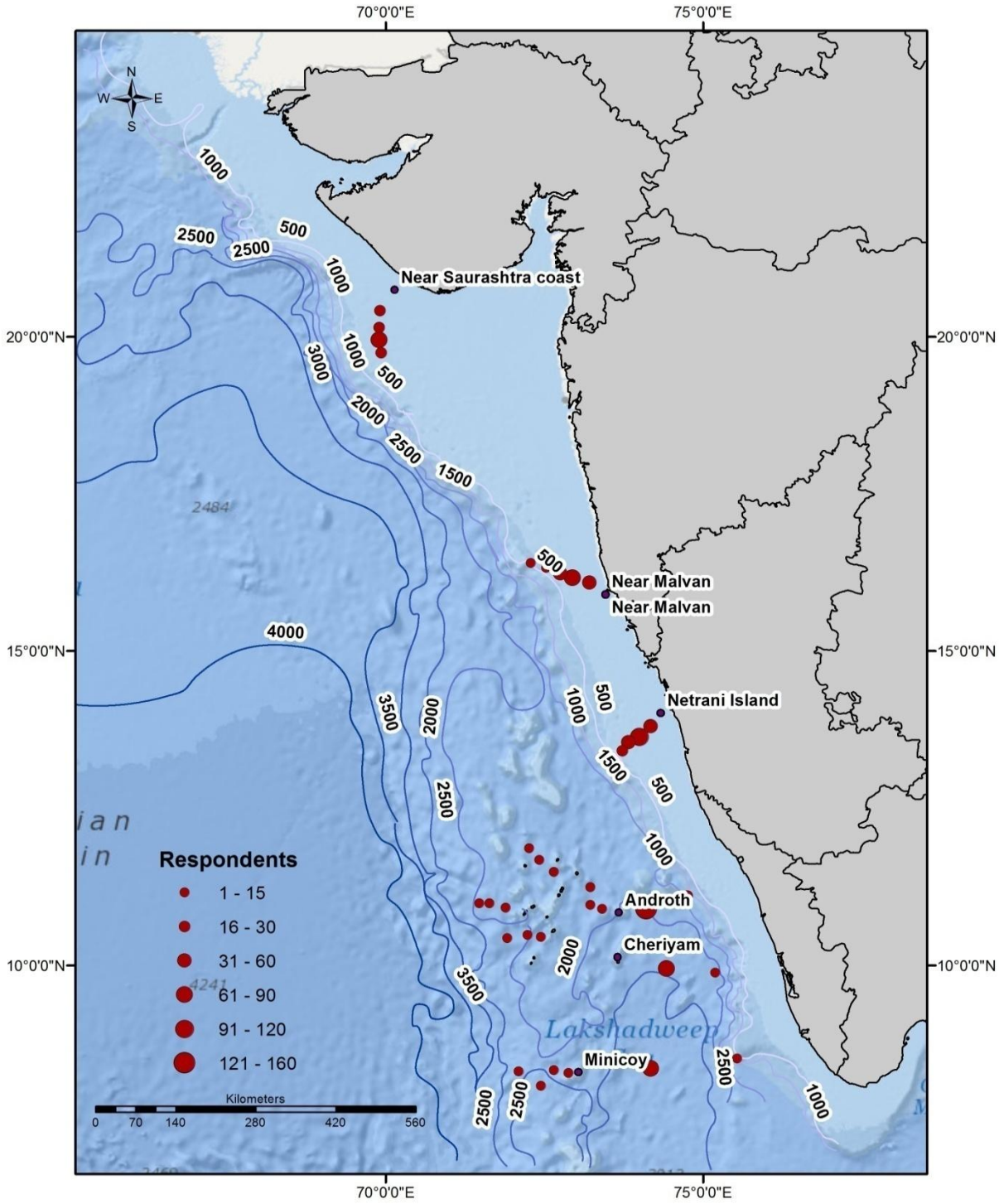

Fig. 17 Geographic locations where whale sharks have been sighted, or where they are believed to aggregate

8. DISCUSSION

The whale shark survey was executed basically to understand the past and present distribution of the species along the West coast of India, solely based on the Indigenous Technical Knowledge of the fisherfolk in their concerned fishing zones. This survey is part of a larger initiative of expanding the Whale Shark conservation strategy and action plan to other parts of the West coast which are presently confined to the state of Gujarat in the West coast of India.Cumulative number of 1602 interviews have been conducted in 113 fishing villages along 1714 km long coastal line of Maharashtra, Goa, Karnataka, and Kerala states (North to South) between the period of May (2012) and November (2012) and 101 interviewees had been conducted at five islands of Lakshadweep Archipelago (towards Western side) during March (2013) .Therefore, atotal of 1703 individual fisherman have been interviewed in a duration of 8 month along the west coast of India and Lakshadweep Islands. The result revealed that the percentage of Whale Shark sighting were high in Lakshadweep (28%) and low in Goa (15%). In reference to the sample size, the fishermen interviewed (n=600) in Kerala belonging to 57 villages were high compared to thefishermen interviewed in Lakshadweep (n=101) belonging to five islands. However the numbers of Whale Shark sightings in Kerala (350) were relatively low in number compared to Lakshadweep (28%), Maharashtra (20%), and Karnataka (19%) thereby reducing the overall percentage (18%). Arguably most of these whale shark sightings by Kerala fishermen were in Lakshadweep waters.

Occurrences of Whale Shark from west coast of India and Lakshadweep Islands have been reported in the published literature for almost a century, with early records of Whale Shark in Maharashtra by Prater, S. H., 1941, Goa by Doiphode, P. V. 1986, Karnataka by Kaikini, A. S., *et al.* 1959, Kerala by Pillai RS 1929 and Lakshadweep Island by Burton 1940 (Silas 1986). According toAkilesh et al2012, in the last 10 years Whale Shark landing were high in Kerala followed by Maharashtra and Karnataka, which matches with our survey results.Hehas further provided information on 6 small juvenile Whale Sharks ranging in length from 95 to 260 cm TL, found in by-catch ofgill nets off the Arabian Sea,landed in Kerala coast during the period 2008 to 2011. In Kerala among 600 respondents, 350 sighted the Whale Shark and maximum respondents from Kerala either sighted or incidentally caught the Whale Shark in Lakshadweep Islands. Earlier, Silas (1986) had provided information on whale sharks sighted in Lakshadweep

Islands, Ali Manikfan, formerly of the Central Marine Fisheries Research Institute, who hails from the Minicoy Island in the Lakshadweep Archipelago, informs that he has seen on at least three occasions whale sharks caught in Minicoy, but none of the specimens were longer than eight feet. Their occurrence is rare, but the local fishermen are well aware of its passive and harmless disposition, and call it 'Vori mas meer'. The name' Vori mass' is applied by them to species of ***Siganusstellatus*** (Forskal) which has got a blotched color pattern, from which probably the name of the shark is also derived(Silas 1986). Based on the active fishermen responses (n=460), who have encountered Whale Shark during their fishing operation, the gradual decline in Whale Shark sighting from 2010 to 2011 onwards along the west coast of India is confirmed, but that frequency has been sustained in the Lakshadweep group of Islands. Gradual decline in Whale Shark sighting frequency (Fig. 8) along the west coast of India is mainly due to the continuous changes and up-gradation of existing fishing technologies and increase in the efficiency of craft and gears. In recent years there has been considerable increase in activity of the motorized sector, especially the ring seine and mini-trawl fishery, causing concern for certain exploited species. There have also been dimensional changes in the gear and the time spent for fishing in the mechanized sector by undertaking voyage fishing and use of sophisticated electronic devices for fish finding has resulted in increased fishing pressure and fishing efficiency (Bindu, 2011).

According to the fishermen respondents who also operate traditional fishing boat, the decline in sighting of Whale Shark was mainly due to the sound emitted from the mechanized fishing vessels due to which the larger fishes like Whale Sharks move away from their native sighing grounds in the Arabian Sea. Unlike cetaceans, sharks do not use sound to communicate with each other. However, sharks do sense sound as pressure through their lateral line system, and it is possible that high decibel sounds may negatively impact on Whale Sharks. Experiments have demonstrated that sharks can hear sounds with frequencies ranging from about 10 Hertz to about 800 Hertz (Martin, 2004). The effects of very loud sounds on shark behaviour are not well documented; however it is possible that they could potentially disrupt normal behaviours such as feeding, mating, or migrating from one place to another (Whale shark recovery plan, Australia, 2005). According to whale shark recovery plan submitted to Common wealth of Australia (2005), the globalWhale Shark population decline has been attributed due to the fishing pressure in International waters esp., India, Taiwan and Philippines. InterestinglyWhale sharks are not

hunted around Lakshadweep group of Islands, in addition they practices traditional fishing methodslike using rowing boats andnon destructive fishing gears like hand lines, cast nets, wounding gears, harpoons possibly resulting in the increased Whale Shark sightings in the region. Only a few numbers of mechanized boats operate in Lakshadweep which are especially for fishing tuna.

Maximum number of Interviewees (≤ 900) suggested that the Whale Shark were sighted frequently along the west coast of India, between the months of November to April in a year. On the other hand, in west coast of India, the period from November- December to April is the time when sardines and mackerel occur in abundance, and as already noted, this period coincides with the occurrence of Whale Sharks in the coastal waters of that area. This is also the period when schools of bonitos, frigate mackerels, skiperels, skipjack and yellow-fin tunas visit the coastal waters along the west coast of India. It will be worth finding whether any such associations between these larger fish and the Whale Shark exist in our waters (Silas, 1986). In fact, off San Diego on the California coast, whenever the Whale Shark is sighted, fishermen know that it will be invariably surrounded by yellow-fin tuna and head for it (Gudger, 1941).

Based on the questionnaire based fishermen survey and historical Whale Shark information from published journals along the west coast of India, we assessed the level of threats faced by Whale Shark across the coastline of Arabian Sea. There is no conclusive evidence to confirm hunting or targeted fishing of whale shark. Our knowledge today is confined mainly to incidental captures, stranding or ramming by ships or boats which can be considered aspresent major threats to the Whale Shark along the west coast of India. Many of the respondents (n=677) have reported to have foundentangledWhale Shark caught incidentally in their fishing gears, specifically in three types of fishing gears viz., Gill net, Purse-seine and Trawl net. Among the three fishing gears, gill net (n=483) is found to be most predominant gear responsible for Whale Shark entanglement followed by Purse-seine (n=153), Trawl and other nets. While comparing the survey data with data of last ten years from published journal and articles on Whale Shark incidental catch;among a variety of fishing gears most records reported entanglement in gill nets. Though the protected status of Whale Sharks is in effect from 2001, reports of stranding due to human interactions(e.g. vessel collisions, releasing netted and injuredsharks), incidental landings (by catch)

andstranding/beaching are still being recorded(Akilesh et al, 2012). At the same time, sightings or captures of smaller Whale Sharks less than 2.5 m or 3 m are possibly going unreported.

Over the past five years Whale Shark landings have been reported in various states of west coast of India except in Gujarat primarily due to the level of awareness among fishermenon whale shark. In Gujarat the level of awareness increased up to 69%, after WTI and IFAW (International Fund for Animal Welfare) launched the Whale Shark Campaign in January 2004 in collaboration with the Gujarat Forest Department, Tata Chemicals and Gujarat Heavy Chemicals Ltd. Well-known religious leader, ShriMorariBapu supported the initiative leading to the grand success of the campaign. Success of launching a huge campaign for Whale Shark in Gujarat were reflected on the positive response among the civilian, fisher-folk and even to the Government. Now Whale Shark is one of the prides of Gujarat and many cities in Gujarat have adopted the Whale Shark as its city mascot. Presently the Gujarat fisher-folk community themselves are involved in conservation by the newly introduced scheme by WTI in collaboration with the Gujarat Forest Department, Tata Chemicals and David Shepherd Foundation for self-documenting the Whale Shark rescues of incidental catches. The photos of the release taken by the fisherman are used for a compensation of damaged fishing nets by Whale sharks from Gujarat Government. Theawareness campaign, compensationprogram and self-documentation scheme for releasing net-caught Whale Shark iscurrently limited to Gujarat only, which appears tohave had a positive impact and if such a program is extended to all coastal states, it would be a greatsupport to fishers, especially in Kerala and Karnataka where the fishermen report dragging the entangled Whale Shark to the shores for sale. Due to the protection status for Whale shark in the Indian Wildlife ProtectionAct 1972, the dragged whale sharks does not attract buyer, ultimately leading to the fishermen discarding the dead whale shark. At the same time, most fishers are sympathetic to anet-caught whale shark, butcutting the net to release the animal comes at a financialcost to the fishermen.Increasing the level of cooperation between the five coastal states along the west coast of India will result in a range state agreement to reduce the pressure on the Whale Shark in their waters.

Geographic locations on whale sharks sighting, or probable aggregation based on the fisher-folk response has been plotted on a bathymetric map, as result of which four wahle shark aggregation sites were identified in the Arabian Sea, i.e. Minicoy in Lakshadweep, Netrani in Karnataka,

Malvan in Maharashtra and Saurashtra Coast in Gujarat. Further in depth research and the frequent cruise surveys in these aggregation sites may provide valuable insight into Whale Shark lifecycle. Further to authenticating these findings there are previous reports of schooling behavior in 1998, when 16 juveniles of about 1m where reported to be swimming with a whale shark of 5.5m of Vizhinjam, India (Krishnapillai 1998). Other record of whale shark aggregation in Gujarat are based on the whale shark rescue data maintained by WTIin collaboration with the Gujarat Forest Department and Tata Chemicals from 2005 onwards, overall 372 whale shark were rescued by fishermen along the Saurashtra Coast of Gujarat (Veraval, Sutrapada and Dhamlej) and fishermen survey to document their TEK and ITK on Whale Shark in Gujarat Coast (Praveen et al., 2008 unpublished).Occurrences of whale sharksalong the west coast of India and Lakshadweep Islands appear to show some seasonalityaccording to published reports and our survey results. Whale sharksoccur off the Gujarat coast in the winter monsoonperiod, i.e. February to March (Rao 1986; Silas1986; Pravin 2000; Hanfee 2001) that is correlatedwith the winter cooling and high productivity of thenortheastern Arabian Sea (Haq et al. 1973; Paulinoseand Aravindakshan 1977). During the winter monsoon, seasonal cooling and convectivemixing in the northern Arabian Sea injects nutrients into surface layers, triggeringprimary production and a phytoplankton bloom (Bhattathiri et al., 1996; Prasannakumarand Prasad, 1996).Predictable aggregationshave been reported for whale sharks in other partsof the Indian Ocean, e.g. Djibouti (Rowat et al.2006), Kwa-Zulu Natal coast and Mozambique(Cliff et al. 2007), Seychelles (Rowat et al.2009), Ningaloo Reef in Western Australia andAndaman Sea off the west coast of Thailand (Colman1997) and the Maldives (Riley et al. 2010). Thelargest aggregations of whale sharks have beenreported from Mexican coastal waters (de la ParraVenegas et al. 2011). The Whale shark aggregation, rescues, awareness and involvement of corporate sector in conservation are all positive responses for marine species conservation.

The Present west survey has given us information about the status of whale shark in the Arabian sea, which is one of the Large Marine Ecosystem (LME) of the world. However, we have virtually little and no information about the status and threats to the Whale shark in the Bay of Bangal, the other large LME. There is an urgent need to initiate a survey along the East coast of India and the Andaman and Nicobar Island in the Bay of Bengal for a complete picture of the Whale Shark in the Indian water.

In the Asian region such detailed information on Whale Shark and a model conservation programme as has been in operation in India will paved the way for other Northen Indian Ocean countries to consider collaborating and initiating a regional Whale Shark conservation programme involving the fisher community in a big way. Marine species and habitat conservation is possible only with an inclusive management approach.

9. APPENDICES

9.1 Location visited along the west coast of India to conduct the TEK and ITK based questionnaire survey on Whale Shark.

MAHARASHTRA	GOA	KARNATAKA	KERALA	LAKSHADWEEP
THANE	NORTH GOA	UTTAR KANNADA	KASARGOD	AGATTI ISLAND
ARNALA	CHAPORA	BELAMBER	AJANOOR	ANDROTH ISLAND
DAHANU	DONAPAULA	BELEKERI	ARIKKADI	KADMATH ISLAND
NAIGAON	MALIM-	DANDEBAG	BEKAL	KAVARATHI ISLAND
TEMBHI	PANJIM	GABITHWADA	CHERUVATHUR	MINICOY ISLAND
UTTAN	MORIJIM	GANGAVALI	HOSDURGA	
MUMBAI	SIRIDAO	GOKARN	THALANGARA	
CUFFEE PARADE	SOUTH GOA	GOTNEBAG	KANNUR	
FERRY WHARF	BAINA	HOLANGADDE	AYIKKARA F.H	
MANORI	BENAULIM	KAGAL	AZHEEKAL	Kerala Continues……..
SASOON	BETUL	KAJUBAG	NEW MAHE	ALLEPEY
VERSOVA	CANACONA	KARWAR F.H	PUTHIYANGADI	ARTHUNKAL
RAIGAD	CUTBONA	MANJUGUNI	TELLYCHERRY	MANAKODAM
ALIBAUG	KHARIWADA	MUDGEAMDALLI	CALICUT	PALLITHODU
BHARADKHOL	MAJORDA	NOVBAG	BADAGARA	THOTTAPALLY
KARANJ		PAVINKURVE	BEYPORE F.H	THUMPOLLY
MORA		TADRI	CHALIYAM	THYKAL
MURUD		UDUPI	CHOMBALA	QUILON
VERSOLI		HEJMADI	KOLAVI	CHILLICKAL
RATNAGIRI		PADUBIDRI	PUTHIYAPPA	NEENDAKARA
AMBOLGAD		BADAYERMAL	QUILANDY	QUILON PORT
HARNAI		BIJADI	VELLAYIL	SAKTHIKULANGRA
KELSHI		GANGOLLI	MALAPPURAM	THANKASSERY
MIRKARWADA		GOPADI	KOOTAYI	WADI
SAKHAR		GUJJARBETTU	PARPANANGADI	TRIVANDRUM
SINDHUDURG		KAIPUJAL	PONNANI	MAMPALLY
DHABHOLI		KODARI	THANUR	CHILAKKOOR
MALVAN		KODIKANYANA	VADAKKE	VETTOOR
TARKARKLI		KUDAPURKODI	THRISSUR	ADIMALATHURA
WADETAR		MALPE F.H	MUNAKKAKADVU	CHERIATHURA
		MANOOR	CHETTUVA	POONTHURA
		MARAVANTHE	NATTIKA	PUTHENTHOPPU
		MATTUKOPPAL	AZEECODE	PUTHUKURICHI
		NAVUNDA	PALAPETTY	SANTHIPURAM
		PADUKARE	THALIKULAM	VALIAVELI
		SHIROOR	ERNAKULAM	VETTUTHURA
		THOTTAM	COCHIN F.H	VIZHINJAM
		TRASI	FORT KOCHI	
		DAKSHIN KANNADA	KALAMUKKU	
		MANGALORE	MUNAMBARAM	
		PADUKARE	NARAKKAL	
		ULIYARAGOLI	PUTHUVAIPU	
		ULLAL		

9.2*Whale Shark Survey Questionnaire in English (This was translated into Malayalam, Kannada, Konkani and Marathi)*

An assessment of the past and present distribution status of the *Whale Shark* *Rhincodon typus* along the west coast of India
Wildlife Trust of India (WTI)
B-13, Second Floor, Sector-6, Noida, Uttar Pradesh, 201301

Name of village: Date:
Name of fisherman: Occupation:
Religion: Contact no. :
Age: Educational Qualification:
Owner/employee: Type of boat & gear:

1. How far out into the sea do you go to fish?
2. How many days/time in a month/day do you fish? When is the fishing holidays / season when you don't fish in your area?
3. What Type of boat & gear?
4. Do you use GPS/Wireless for navigation or searching fishing grounds?
5. Are you aware of the Whale shark?
   AIDED
   PICTURE AIDED
6. Whale Shark is a "Whale" or "Shark"? What you call it locally (Local name) ?
7. Where do you most often see whale sharks?
   - Throughout the year / Specific season (Peek sighting season):
   - Reef area / Bay / Near estuary:
   - Water conditions:
   - How far offshore (km) –
   - Water depth (estimate) –
   - Time of the day – Morning / Noon / Afternoon/ Evening:
8. How do you see the whale shark i.e. with the fin out of the water? How do you find them single or in group? If you see them when sailing do they portent anything either good or bad for you?
9. Any change in the frequency of Whale shark sighting in last 10 years? Any change in their seasonal sighting or locations?
10. Do you know what a whale shark feed on? If "yes" what is that?
11. What fishes and animals (Turtles, sea birds, crabs etc) do you find most around Whale sharks?
12. Is it dangerous to humans?

    O Yes O No

13. Do you feel Whale shark is important for sea? Any specific religious association of whale sharks or sharks with your community?
14. Do you know from where whale shark comes and goes back?
15. Have you ever seen whale shark mating or giving birth to pups?

16. Had you ever seen baby/pups (46 -100 cm) of whale sharks? If yes how small, when and where?
17. If you see a whale shark in sea what you do?
18 . Do you often get whale shark as accidental catch: If so how often and how many?
19 In what types of gear do whale sharks get caught?
20 What you do with accidentally caught whale shark?
21 Did you ever hit to a Whale shark with your boat? If yes what happened to the whale shark?
22 Did you ever see any "TAG" or any kind of marking on whale shark around your area? If yes what kind of mark or tag?
23 . Have you ever hunted a whale shark? If Yes how many?
24. If yes what type of gears do you used to catch a Whale Shark?
25. Where did you sell it? What price did you get for it?
26. What are whale sharks used for (past and in the present) in your village?
27. Are you still in the practice of Whale shark hunting? Do you know anyone around your area who still hunts whale sharks?
28. Is there is any whale shark meat, oil or fin consumption in your area?
29. Recently did you find any demand of Whale shark meat, oil, fin or any other parts in the market?
30. What are levels of pollution, oil spills in your area? Had you ever seen any dead whale shark during oil spills or due to any pollution outbreak?
31. What is the visibility of water in your area ? In which season it increases ? Do Whale sharks also seen during high visibility season ?
32. How often you encounter beached whale shark ? What you do with them ?
33. Are you aware of Wildlife Protection Act and the fact the Whale Shark is protected under this law?

O Yes O No

34. Do you any other species of "shark" or marine animal protected under this law ?
35. Should the ban on whale shark catch be removed?

O Yes O No

36. Do you know anything about "Whale shark tourism" ?
37. Are you aware of the Whales/Dolphin/Dugong/Porpoise/Seaturtle?
38. How many times you have seen the Whales/Dolphin/Dugong/Porpoise/Sea turtle? How often?
39. If you see /Dolphin/Dugong/Porpoise/Sea turtle in sea, what you do?
40. Do you often get Whales/Dolphin/Dugong/Porpoise/Sea turtle as accidental catch: If so How often?
41. If you get catch what you do? In what types of gear do they get caught?

Other remarks:

9.3. Pictures taken during questionnaire survey conducted along the west coast of India

Conducting questionnaire based fishermen survey to document their TEK and ITK on Whale Shark all along the Maharashtra Coast

Conducting questionnaire based fishermen survey to document their TEK and ITK on Whale Shark all along the GoaCoast

Conducting questionnaire based fishermen survey to document their TEK and ITK on Whale Shark all along the KarnatakaCoast

Conducting questionnaire based fishermen survey to document their TEK and ITK on Whale Shark all along the KeralaCoast

9.4. Whale Shark pictures provided by various sorces along the west coast of India and Lakshadweep during the survey.

Video of free swimming Whale Shark (2011)in Minicoy Island, Lakshadweep, provided by fishermen during the survey

Pictures of free swimming Whale Shark (2005) in Netrani Island, Karnataka, provided by SCUBA diving instructor during the survey

Picture of free swimming Whale Shark (2009) in SaurashtraCoast, Gujarat, provided by Mumbai fishermen during the survey

Picture of Whale Shark landed (2007) in Karwar, Karnataka, provided by CMFRI staff during the survey

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