MAPPING CETACEAN OCCURRENCE AND BYCATCH IN INDIAN WATERS: BRIDGING KNOWLEDGE GAPS THROUGH FISHER COMMUNITY NETWORKS

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EXECUTIVE SUMMARY

Bycatch is one of the greatest and best-documented threats to cetaceans globally (Reeves et al., 2005). In the Indian Ocean, cetacean bycatch is known to be high, yet there are huge gaps in our existing knowledge on the extent to which bycatch poses a threat to cetaceans in this region (Kiszka et al., 2009; Anderson et al., 2020). Particularly along the coast of India, very little is known about cetacean bycatch, with little or no monitoring in place (Leaper & Calderan, 2018). A recent study estimates that the number of cetaceans caught due to bycatch in pelagic gill-net fisheries along the Indian coast is approximately 10,704 individuals annually (Anderson et al., 2020), and a prior study estimates that approximately 9000-10,000 cetaceans are caught due to bycatch in gillnet fisheries annually (Yousuf et al., 2009). Nevertheless, information on the spatio-temporal extent of cetacean bycatch in fisheries, and a comprehensive understanding of the gear and species involved are lacking.

This project was designed to collect cetacean occurrence and bycatch data from a network of voluntary, active fishers along the west coast of India, to bridge the above information gaps. This is an important step towards mapping the spatio-temporal patterns of cetacean presence and bycatch, with gear specificity, so that better management decisions to conserve cetaceans can be made in the future. To begin with, the project focused on collecting baseline information on fisher-cetacean interactions through interview surveys along the west coast of India. Following this, community outreach sessions were conducted among fishers to create awareness on cetacean diversity by distributing cetacean identification charts. Further, community-driven data collection was enhanced through the creations of a smartphone application called “Cetacean Tracker”, so that fishers could easily report on cetacean occurrence and bycatch. Reported data will be used to create a GIS model, to predict bycatch risk from specific pelagic fisheries along the west coast. This project covered sample sites in three west coast states in India – Maharashtra, Goa, and Karnataka, with offshore purse seiners and bottom/mid-water trawlers as fishery types. The 2019-20 period of this project was funded by the New England Aquarium’s Anderson Cabot Center for Ocean Life at the New England Aquarium's Global Fund for Marine Mammal Bycatch Solutions.

GENERAL BACKGROUND

INTRODUCTION

Bycatch is considered to be one of the greatest and best-documented threats to cetaceans globally (Reeves et al., 2005); yet very little is known about it in India, with little or no monitoring in place (Leaper & Calderan, 2018). Information on the spatio-temporal extent of cetacean bycatch in fisheries, and a comprehensive understanding of the gear and species involved are lacking. For example, even in the few places where data on gear and affected species exist, the spatio-temporal details and nature of fisher-cetacean encounters and bycatch events are not fully known; this makes it difficult to devise and trial any bycatch mitigation strategies. Such data, if collected even opportunistically, have the potential to provide at least a minimal yet crucial picture of the scale and nature of cetacean bycatch along the coast.

This project therefore aimed to initiate the collection of cetacean occurrence and bycatch data from a network of active fishers along the west coast, to bridge the above information gaps - an instrumental step towards informing conservation decisions in the future. Our plan was to also engage directly with communities to understand how cetacean bycatch could be addressed in a feasible, practical, and sustained way.

SCOPE OF THE PROJECT

The broad scope of this project was to enable and encourage cetacean occurrence and bycatch data collection by active fishers, across three states along the west coast of India. We aimed to achieve this through a combination of awareness and outreach activities with fishing communities, and by developing a smartphone application that would enable fishers to collect primary cetacean data at sea. The data collected will be used to map bycatch risk prediction GIS models along the west coast, to inform future fisheries management and cetacean conservation, so that conservation-oriented fishing communities may avoid or reduce their cetacean bycatch overall.

STUDY SITES

This project was carried out at major fishing sites in Maharashtra (Mumbai), Goa (Vasco), and Karnataka (Karwar), along the west coast of India. Of our chosen sites, we conducted satisfactory interview surveys at four sites (including two sites in Mumbai, one in Karwar, and one in Goa). We also achieved preliminary outreach and community partnerships in Mumbai, Goa, and Karwar and conducted smartphone application training workshops in each of these locations. The activities in Mumbai were also further promoted at the local chosen sites in that region.

REFLECTIONS ON SUCCESS AND FAILURES

OBJECTIVE 1

To understand spatio-temporal overlaps and direct encounters between cetaceans and fishing operators.

ACTIVITY 1.1

Creation and distribution of a smartphone-based application (linked to an online database), targeted at 20 fishing vessels, each at 5 sites on the west coast of India.

SPECIFIC BACKGROUND

Digital applications (henceforth “app”) for collecting data at wide scales have the potential to be very useful in areas where data are scarce (Davidson et al., 2019). Moreover, it is a cost-effective means of collecting broad-scale data while fostering stewardship (Embling et al., 2015). An app for recording cetacean data, suited to the fisher and prioritizing ease of use, may significantly improve voluntary bycatch and sightings reporting. Using a standardized app-based approach ensures that data collection follows a uniform format across all users, thereby minimizing ambiguity. This method also eliminates the need for manual data transcription (barring exceptional cases that are expected to be uncommon), thus almost eliminating potential human error. With additional data fields pertaining to fishing operations and catch, this approach has the added advantage of doubling up as a digital log for the fishers themselves in the future.

METHODOLOGY

Cetacean Tracker app

A smartphone app was built for Android phones named "Cetacean Tracker", so that fishers could easily collect data on cetacean occurrence and bycatch (Figure 1). It features a simple user interface with a streamlined stepwise report creation module, a home screen displaying all submitted reports, a map interface to visualize user-specific sighting locations, and menu with help and feedback options. The app makes automatic use of the device's GPS sensor and date/time, so as to minimize manual data entry, even when the device is offline during distant fishing trips. Reports submitted when offline are cached in the device, and uploaded once smartphone connectivity is restored. The necessary fields may be filled in by the app user including videos and photos of cetaceans, a drop down menu to identify which species was sighted, the GPS location of the sighting, the number of animals spotted during the sighting, the behavior of the animals sighted, and whether the animals sighted were free ranging or caught in a net. A complete and simple user manual of the app may be viewed in Appendix I, and a wireframe of the way in which the app functions may be viewed in Figure 2. Over several iterations of trials, the app was updated to include translations into two regional Indian languages (Kannada and Marathi) in addition to English, with built-in guidelines on which buttons to press the first three times the app is used, and the addition of a map feature to visualize previously uploaded sightings. During the app trialing, the data entry process was also improved by simplifying a few input fields, thereby minimizing error or ambiguity. Further, any app crashes specific to certain smartphones were addressed during the trials.

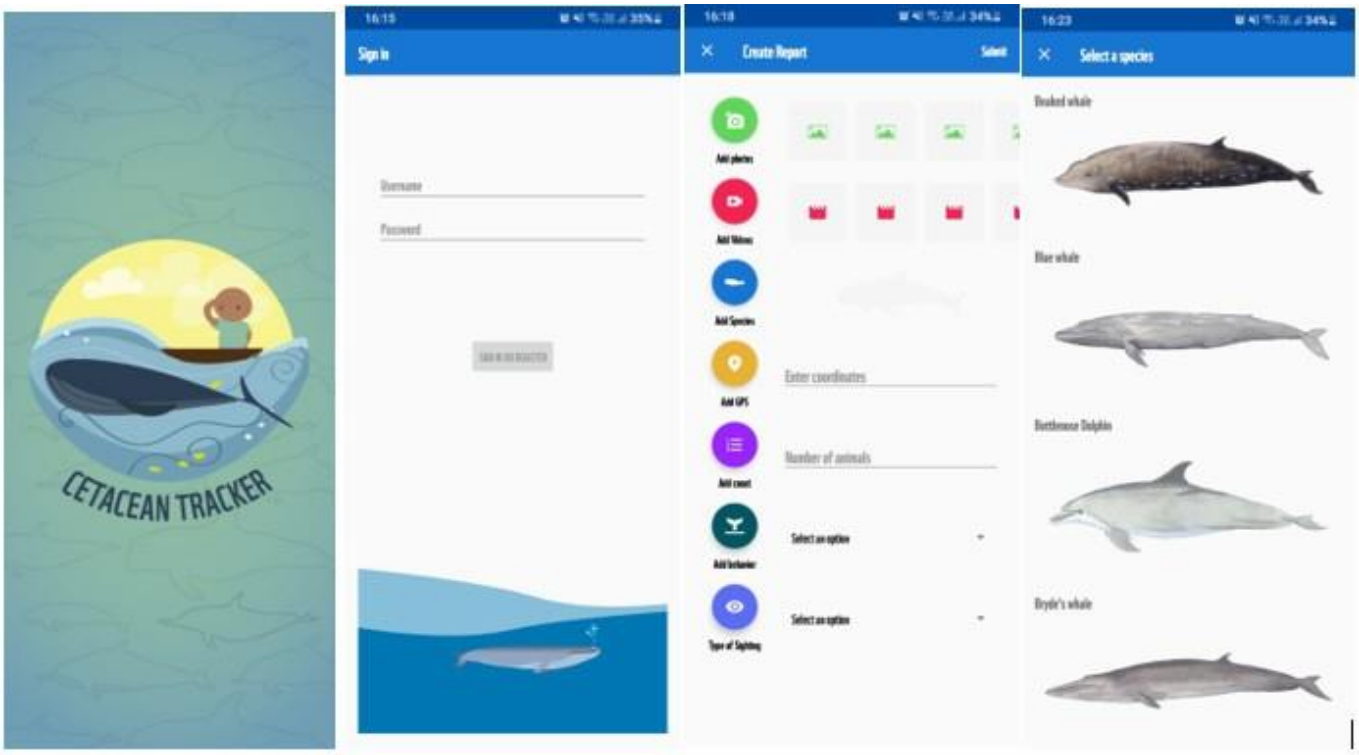


Figure 1: Screens of the "Cetacean Tracker" application, used to collect data on cetacean occurrence and bycatch.

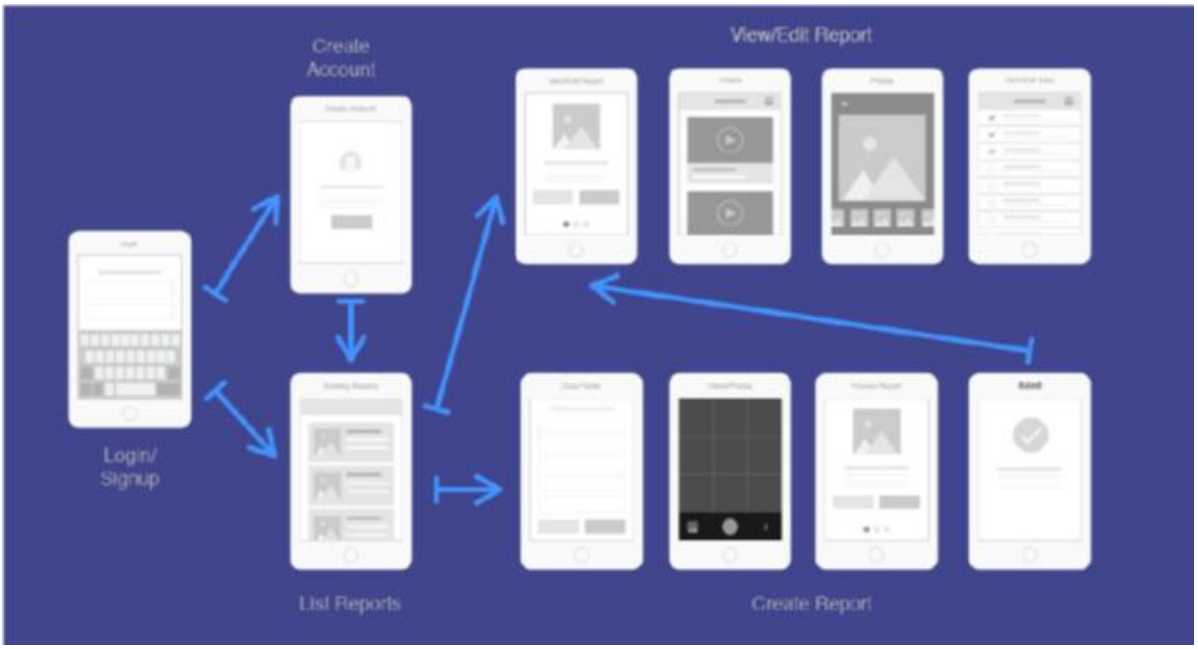


Figure 2: Wireframe of "Cetacean Tracker" application.

METHODOLOGY

App training workshops

Training and demonstration workshops were conducted in-person with fisher groups at each of the three sites – Mumbai (Maharashtra), Vasco (Goa), and Karwar (Karnataka) to introduce them to the app. All three sites are major fishing harbors on the west coast of India, and serve as bases for mechanized fisheries (dominated by purse seiners and trawlers) off the northern west coast of India. Most of these fishers conduct offshore multi- day fishing trips, during which cetacean encounters in the form of sightings and bycatch occur frequently, as evidenced by anecdotal records and sighting reports submitted to us by the fishers during the initial phases of this project.

The app was distributed among participant fishers across these study sites over the course of the workshops, and was loaded on to the Samsung M01 model, which is equipped to efficiently run all the app's features. The phones were also set up with automatic administrative control over the smartphone, to update the app as it is improved, and to prevent accidental uninstallation of the app. The phones were distributed with a verbal disclaimer to this effect.

At all three sites, the workshops were conducted through consultation with the local fishing associations, who also hosted and facilitated the sessions. Participants comprised crew members working aboard fishing boats (the majority being purse seiners, along with a few trawlers). Each crew member attending the workshops belonged to a different boat, to ensure that we reached as many independent fishing vessels as possible. The participants were shortlisted and recommended to us by the fishing associations, so as to avoid any bias towards a particular subgroup, and in some cases based on the participants' previous contributions and interest in the project.

The workshops followed the following general agenda:

- Introduction to the project: A brief introduction to the objectives, methods and expected outcomes of the

project at a broader scale; previous activities done with fisher groups in collaboration; introducing the Cetacean Tracker application to refine the data collection process.

- App training: Distribution of smartphones to the listed participants; application demonstration and mock report submission by each user.
- Discussion: Troubleshooting; a round of questions & answers; suggestions from fishers about potential improvements to the application.

RESULTS AND ACHIEVEMENTS

The app was distributed to a total of 100 fishers across the three study sites (Mumbai, Vasco, and Karwar). Field teams at each site conducted app demonstrations, with hands-on report creation by each participant. This included one-on-one assistance, and the submission of mock reports by participants, during which common mistakes with respect to data entry were identified and resolved. A large portion of the participants required minimal assistance, which was attributed to the intuitive nature of the app interface.

The workshops concluded with discussion and feedback sessions, including additional information on data usage terms and responsible use of the distributed devices.

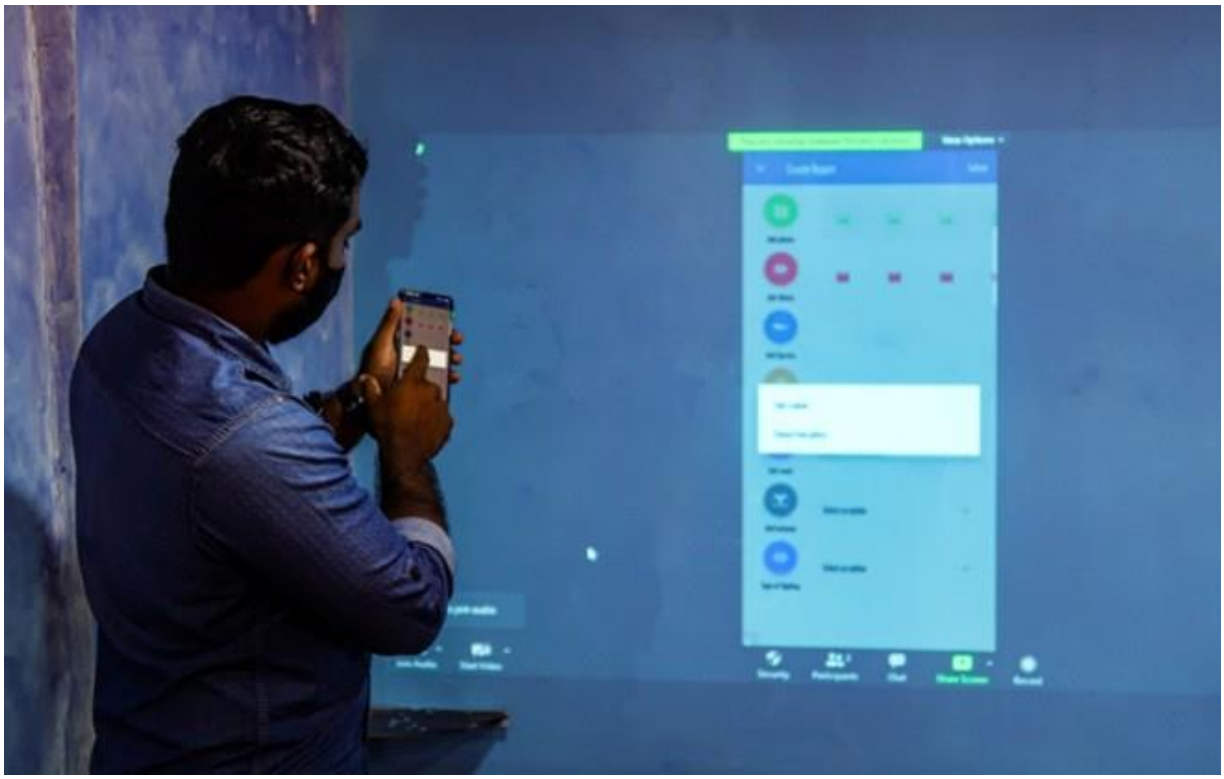
The fishers at each site also provided technical feedback on the app; which were mostly incorporated into the subsequent update.

The table below indicates additional details of the Cetacean Tracker app training workshops at each site:

Site/Venue	Dates	Number of participant fishers	Facilitating community member	Workshop team
Vasco (Goa) – Vasco Fishing Jetty	7th, 8th, 15th Dec 2020	30	Jose Phillip D'Souza (President, All Goa Fishing Boat Owners Association)	WWF-India Goa office staff
Karwar (Karnataka) – Baithkol Fishing Jetty	10th, 11th Dec 2020	40	Vaman Loku Harikanta (President, Karwar Purse Seine Boat Association)	WWF-India Goa office staff and Karnataka University volunteers
Mumbai (Maharashtra) – Sassoon Dock	10th Dec 2020	30	Ganesh Nakhawa (Pres-ident, Karanja Fisheries Society)	WWF-India hired consultant and volunteers

Figure 3 (above): Senior Programme Coordinator Dr. Coralie D'lima introduces the cetacean project to purse seiners at Vasco, Goa.

Figure 4 (below): A volunteer explains the app at the training workshop in Vasco, Goa.



WWF India holds workshop for fishermen to track cetaceans

DISTRIBUTES PHONES WITH CETACEAN-TRACKING APP

THE GOAN | NETWORK

VASCO

Amid plans to work with communities to track cetaceans in Indian waters, World Wildlife Fund (WWF) India conducted a training program for fishermen in Kharewaddo to track whales and dolphins at sea.

The training programme was conducted in the presence of Goa Fishing Boat Owners Association (GFBOA) President and former minister Jose Philip D'Souza on Tuesday.

Having also initiated a series of training workshops with fishing communities in Karwar and Mumbai, WWF India also distributed mobile phones to fishermen with a cetacean-tracking app.

During the training programme, Dr Coralie D'Lima, Senior Programme Coordinator, WWF India, said these large mammals, collectively referred to as cetaceans, are frequently spotted by fishers during fishing trips.

"Now that 100 fishermen across Maharashtra, Goa and Karnataka have been trained to use the Cetacean Tracker application, we will focus on ensuring that cetacean data are reported accurately."

"Once we build a significant database, we will map regions where cetacean species are most commonly found and their potential risk of specific threats."

"We hope to continue working with local fishing communities through ongoing conversations and future collaborations, so that fishers continue to fish, while simultaneously conserving cetaceans," said Dr D'Lima. Dr D'Lima said India is estimated to host over 28 species of cetaceans, but there was very little understanding of habitat use, behaviour and extent of bycatch due to various fishing gear of these mammals.

WWF officials along with GFBOA President Jose Philip D'Souza while distributing mobile phones to fishermen at Kharewaddo. Vikram Nayak

> Collaborating with coastal communities is invaluable to build baseline information on the presence and diversity of cetaceans in India. Capitalising on the interest among fishing communities, WWF India developed the Cetacean Tracker application, to help fishers collect verifiable data, in a time-efficient and scientifically sound way."
> —Dr Coralie D'Lima

"Collaborating with coastal communities is invaluable to build baseline information on the presence and diversity of cetaceans in India. Capitalising on the interest among fishing communities, WWF India developed the Cetacean Tracker application, to help fishers collect verifiable data, in a time-efficient and scientifically sound way."

"The application allows an individual to quickly record cetacean sightings through photographs and videos and also provide information on sighting coordinates, behaviour observed, numbers and species sighted."

"Data collected from the app will be used to map cetacean hotspots, identify areas of potential or existing bycatch risk and create frameworks for sustainable coexistence," said Dr D'Lima.

Figure 5 (top left): Training workshop in progress in Vasco, Goa.
Figure 6 (top right): Media coverage on the training workshops in Goa.
Figure 7 (below): Training workshop in progress in Mumbai.

OBJECTIVE 1

To understand spatio-temporal overlaps and direct encounters between cetaceans and fishing operators.

ACTIVITY 1.2

Creation of a live database coupled with a GIS for the visualization of collected data.

METHODOLOGY

The reports submitted via the Cetacean Tracker app are uploaded to the backend of the app, and the data are collected in a live database, from where such data can be checked as required, downloaded, and analyzed. The app itself has a mapping function to view locations of previously submitted reports. Nevertheless, all the GIS data submitted are uploaded to the live database, and can be used later to create maps and predictive risk assessment models.
The backend of the app is controlled using two platforms, and the phones distributed are being controlled using one platform as follows:

(1) Amazon Web Services (AWS)

This platform collects information from the reports submitted, and stores all the data submitted via the Cetacean Tracker app (e.g., photos and videos) in the cloud in a report database. The platform also manages login, access, and powers the capability of the app.
The AWS account was solely created for the Cetacean Tracker application. Of the many services offered on this platform, we used only a few, including DynamoDB or the main database, S3 or the storage, AppSynch, which provides a framework to develop the app integrated with Amazon, and Cognito which helps manage the users in the system. Every time a user signs in, the information is also collected in a database on this platform. This function allows one to disable and even delete specific rogue users if required. Each user is assigned a unique ID, which is linked to the database on reports, so one can track specific reports submitted by users.

(2) Firebase (Google's cloud infrastructure)

This platform is being used to monitor user data analytics and potential crashes of the Cetacean Tracker app. It can be used to analyze how users are navigating the app, for instance, what feature is used the most, levels of user engagement, etc. It can also be used to track exactly where users are making submission errors.

RESULTS AND ACHIEVEMENTS

The app is working well, and there have been no reported crashes since it was rolled out in December of 2020. The live database on reports and GIS data is functional. As part of Phase II of this project, follow up app training workshops will need to be conducted with specific users to ensure that all users have understood how to use the app. Once adequate data are collected it will be used to create maps and risk assessment models.

OBJECTIVE 1

To understand spatio-temporal overlaps and direct encounters between cetaceans and fishing operators.

ACTIVITY 1.3

Creation of regional cetacean identification charts to improve reporting.

METHODOLOGY

Pictorial identification charts were an essential part of the data collection toolkit provided to fishers. These charts were minimalistic, with limited text, and contained species likely to be encountered in the region, based on verifiable historical records. The rationale behind using these charts was to encourage detailed and accurate identification of cetaceans by fishers to the extent possible in the field, and to aid systematic data collection from these encounters.

We prepared cetacean identification charts in vernacular languages and suited for use at sea, for sightings of free-ranging cetaceans as well as identification of bycatch. These are primarily pictorial charts, with text for identification pointers, species names, and a list of data to collect when they are encountered at sea.

RESULTS AND ACHIEVEMENTS

The charts have been distributed since early 2019, and are well-received by most fishers using them. We initially distributed approximately 70 charts over the course of our initial interview surveys (prior to 2019). In 2019, we scaled up this initiative by partnering with fishing associations for distribution, and subsequently around 400 copies were distributed in Maharashtra.

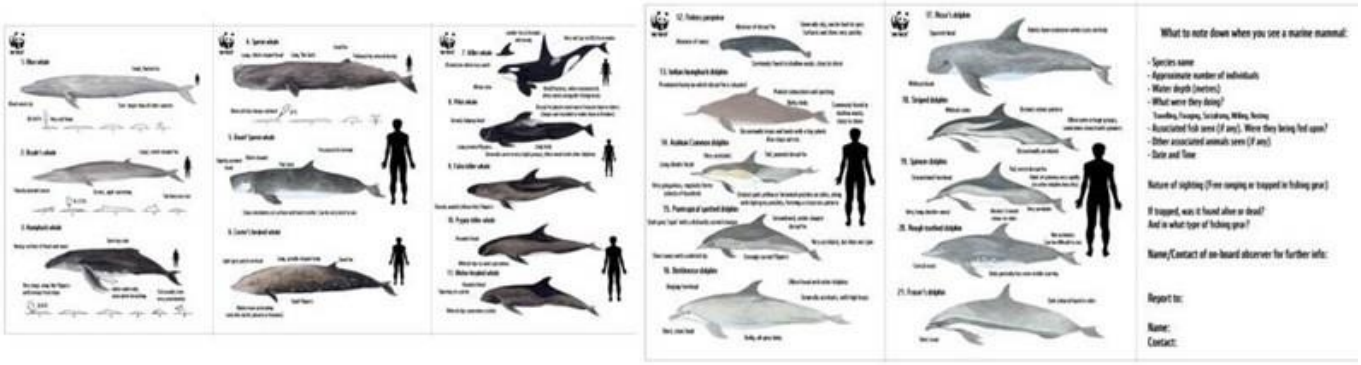


Figure 8 (Top): Cetacean identification charts created by WWF India
Figure 9 (Bottom): Participants at the cetacean identification training workshop in Mumbai.

OBJECTIVE 2

To facilitate shifts towards cetacean-safe fishing practices, through community-led initiatives

ACTIVITY 2.1

Facilitation and co-organization of on-site meetings and discussions between communities that have had varying awareness and success addressing cetacean bycatch issues.

SPECIFIC BACKGROUND

Some fishing associations on the western Indian coastline were already well-informed about the threats to cetaceans from fisheries, with some of these voluntarily moving towards better practices with conservation-based ideas. We hoped to highlight these community-driven efforts and bring them to wider notice, and increase the reach of this awareness via networking between various fishing communities. Further, some communities though not actively engaging in cetacean-friendly fishing, do have a traditional and cultural sense of respect or reverence for cetaceans. We aimed to create and facilitate networks where fisher groups who were a step ahead in this regard could share their experiences and practical ideas with other groups.

METHODOLOGY

We conducted these workshops as open discussions about cetacean encounters and the feasibility of bycatch mitigation methods. This was done via on-site sessions where representatives of fishing communities could interact and have dialogues, with inputs from us. We also conducted brief training sessions on cetacean data collection, in conjunction with broader meetings that these communities regularly have.

RESULTS AND ACHIEVEMENTS

We participated in a large community meeting in Guhagar, Maharashtra in July 2019, where we presented our project's aims to an audience of around 400 fishing boat captains. This meeting was facilitated by community leaders we work with in Mumbai, and effectively extended our reach beyond the planned sites. The session included an introduction to the project and a primer on cetacean identification and data collection by project staff, and was followed up with a talk by the fishing community leaders about the importance of

cetacean bycatch mitigation. Our efforts at this event were also supported by partner organizations working on similar parallel conservation initiatives in the region. Follow up meetings were also conducted in December 2020, along with the app training workshops in Maharshtra, Goa, and Karnataka.

OBJECTIVE 2

To facilitate shifts towards cetacean-safe fishing practices, through community-led initiatives.

ACTIVITY 2.2

Interview-based perception surveys to understand attitudes towards bycatch, within each community/group.

METHODOLOGY

Perception surveys were conducted by the field team at select major fishing sites in Maharashtra and Goa. A total of 40 fishers were interviewed to gauge their perceptions towards and level of awareness on cetaceans, while attempting to understand the frequency of bycatch. The surveys were conducted opportunistically based on the availability of respondents. Most respondents interviewed were purse seiners and trawl fishers.

RESULTS AND ACHIEVEMENTS

Our results indicated that fishers said they had encountered a number of cetacean species while fishing, and some species were sighted more frequently than others.

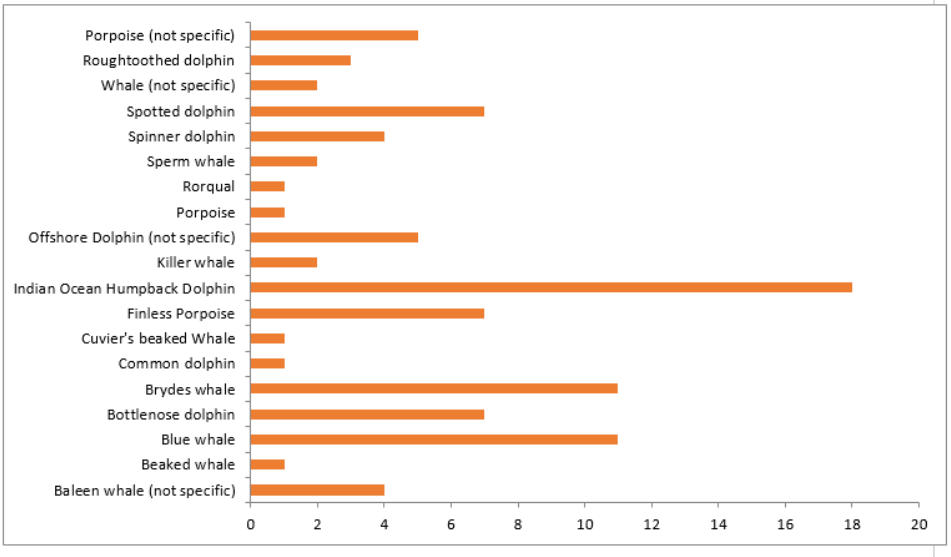


Figure 10: Frequency of species reported by fishers interviewed who said that they encountered cetaceans while fishing

Almost 70% of fishers interviewed said that bycatch of cetaceans did in fact occur

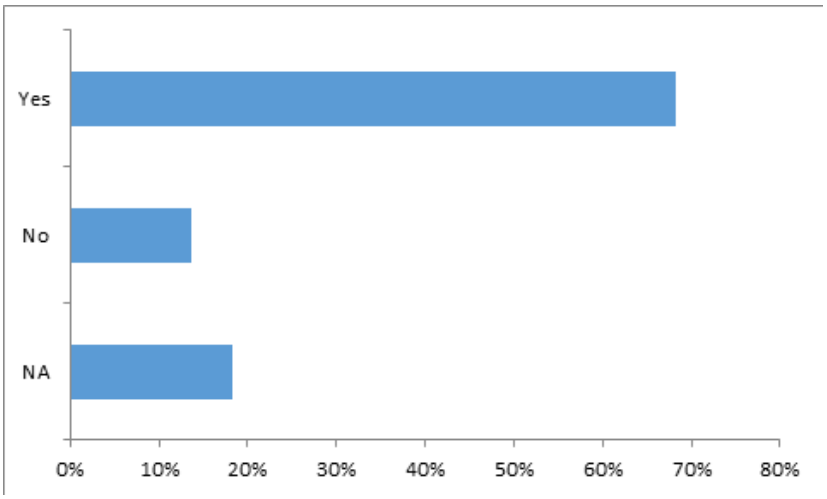


Figure 11: Proportion of fishers interviewed who said that bycatch of cetaceans occurred in nets

When queried on what species were most frequently caught in nets, it appears that smaller cetaceans including whale and dolphin species were the most frequent.

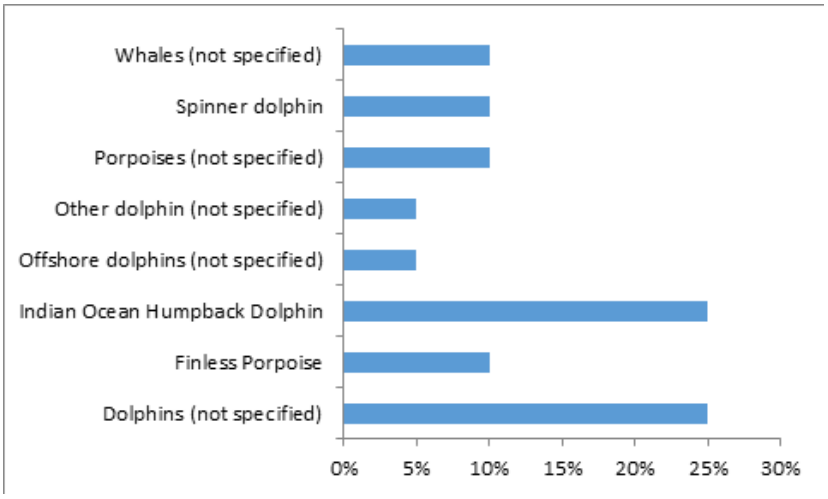


Figure 12: Proportion of cetacean species that were most often said to be caught in nets by interviewees

OBJECTIVE 2

To facilitate shifts towards cetacean-safe fishing practices, through community-led initiatives.

ACTIVITY 2.1

Non-monetary incentives to individuals actively involved in bycatch mitigation and data collection.

METHODOLOGY

In the State of Maharashtra, a bycatch release compensation scheme by the State Government and Mangrove Foundation (a regional NGO) was already in effect when we started conducting this project. This scheme was in the process of developing its own app. To avoid duplication, we engaged the Mangrove Foundation in a collaboration, with the intention of producing a combined app, to share certain data collected by our teams through this platform, and create an incentive for fishers to report on bycatch.

RESULTS AND ACHIEVEMENTS

Although we had several meetings to discuss the potential for this collaboration, it was causing a delay in the development of our app, so unfortunately we had to give up the idea of this collaboration in this phase of the project. We do however hope to proceed with this collaboration in the future if the opportunity to scale up the Cetacean Tracker app presents itself.

CHALLENGES, LESSONS LEARNED AND ADAPTIVE MANAGEMENT

One of the major challenges faced by this project has been the poor fishing seasons in 2018-19 and 2019-20. In 2018-19, fisheries on the west coast were affected by a drastic decrease in the presence of target catch species; this greatly reduced the number of fishing boats going out to sea. In 2019, the extended monsoon season, exacerbated by several major cyclones in the Arabian Sea, had the same effect on fisheries. As such, reporting of cetacean sightings and bycatch was lower than we had anticipated.

The ongoing COVID-19 pandemic, which first impacted India in March 2020 also took its toll on the fishing community. With limited outlets at which to sell their catch, fishers were forced to stop fishing operations. The pandemic, coupled with poor fishing seasons in the past years greatly reduced our interactions with active fishing communities (as they disperse during the inactive periods), and data collection by fishers was also very low owing to their inability to go out to sea.

While these were both unforeseen delays for all stakeholders involved, poor fishing seasons may have been easier to anticipate if our preliminary interview surveys with fishers (conducted prior to this project cycle) included more specific questions pertaining to very recent trends in fishing effort and production. While we did include fishery-related questions in our surveys, it is possible that information about recent/present trends were left out, and instead focused more on broader-scale and historic trends.

To navigate such issues in the future, we would have to engage directly with all stakeholders in the region early on in the project timeline, and conduct a more in-depth feasibility survey than we did earlier. While we are certainly taking a collaborative approach in this project as described in the sections above, it would help to enable these collaborations during the pilot phase, so as to avoid delays to the actual project timeline.

Overall however, we were satisfied with the Cetacean Tracker app, which we managed to roll out to 100 fishers along the west coast of India. We plan to conduct a Phase II of this project, to ensure that where required, fishers are provided with a refresher training to use the app, so that we can enhance bycatch data gathering and analysis of data collected through the app.

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APPENDIX I

Cetacean Tracker Smartphone Application User Manual

Getting Started

Set up account on smartphone

1) Once the Cetacean Tracker app is installed on your smartphone, you have to set up a profile.
2) Input a username and a password of at least 8 characters, click on the **Sign In or Register** button (Fig. 1)
3) For a first-time user, additional fields for name and phone number will appear to be filled out. (Fig. 2)

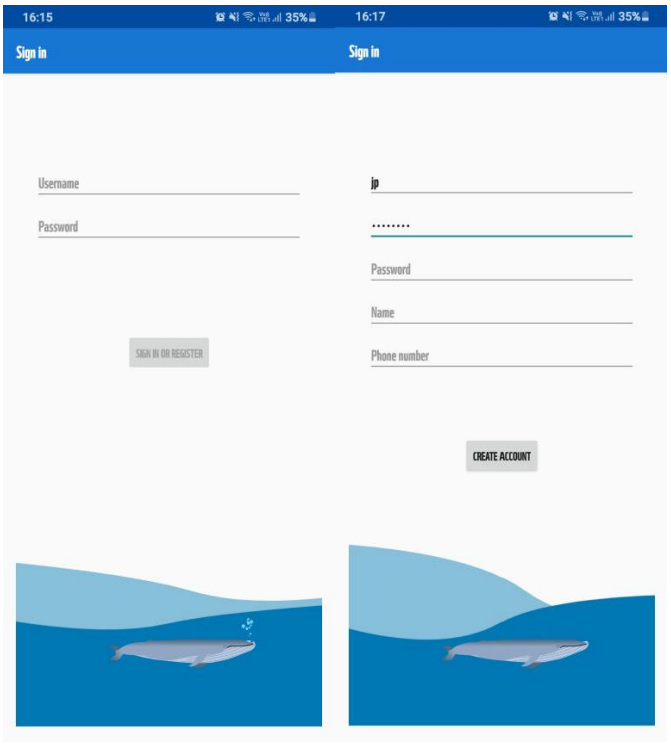

Figure 1- Sign in Screen

Figure 2- Registration screen

Home Screen

The home screen has the options for

1) Plus button for new sighting reports (Fig. 3).
2) A menu button with contact information for reporting of app errors (Fig. 4).
3) A map button that allows you to visualize the reports submitted (Fig. 5).
4) A dashboard of previous reports submitted by the user (Fig. 6).

Figure 3-New report button

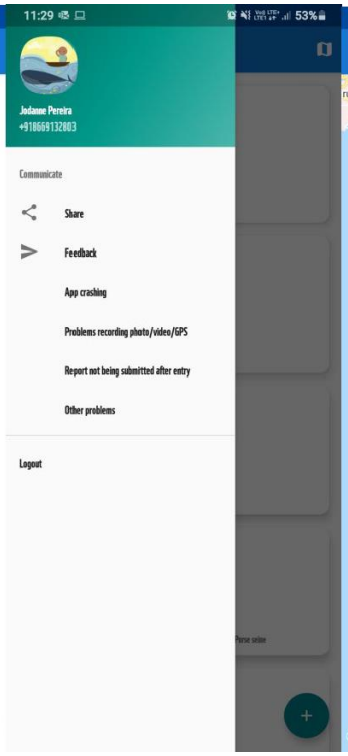

Figure 4-Contact information

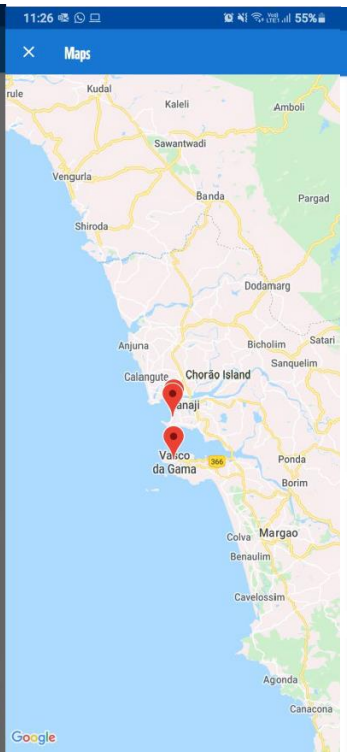

Figure 5- Map

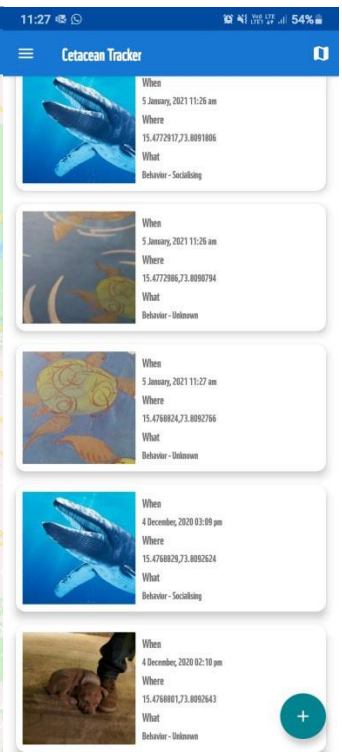

Figure 6-Previous reports

Creating a report

1) Click on the new report button to be taken to the report screen (Fig. 7).
2) There are fields for Photographs, Videos, Species, GPS, Count, Behaviour and Type of Sighting.
3) Click on the **Add Photo** button, when prompted select to either take a picture or choose one from the gallery (Fig. 8).
4) Species is a drop-down menu with illustrations of the different cetaceans found in Indian waters (Fig. 9).
5) Behavior and Type of Sighting is also a drop-down menu with the most common occurrences (Fig. 10-11).
6) Once all fields have been filled, press the **Submit** button in the upper right-hand side of the screen.
7) When prompted, confirm submission (Fig. 13).
8) Incomplete reports cannot be submitted and once a report is submitted it cannot be changed.

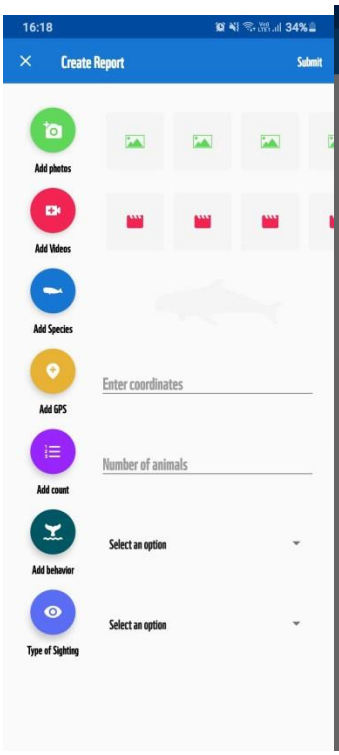

Figure 7- Report Screen

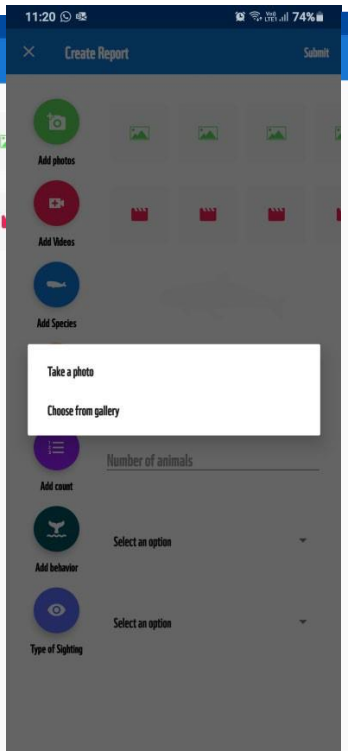

Figure 8- Photo Options

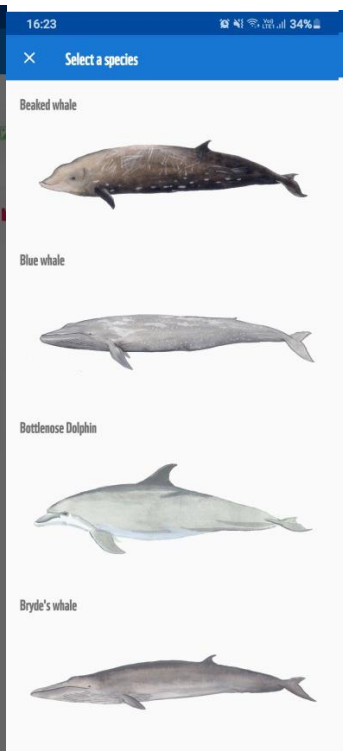

Figure 9- Species Menu

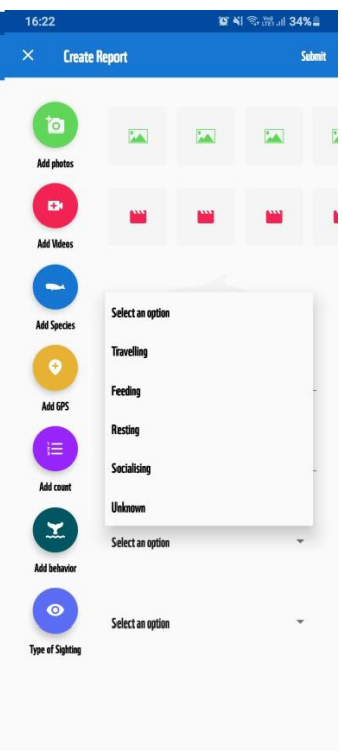

Figure 10- Behavior Menu

Figure 11- Type of Sighting Menu

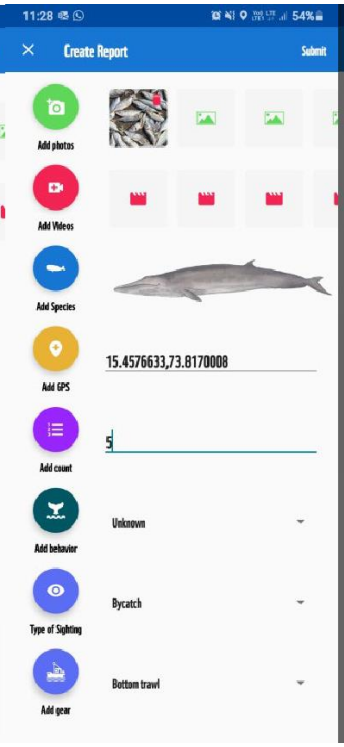

Figure 12- Completed Report

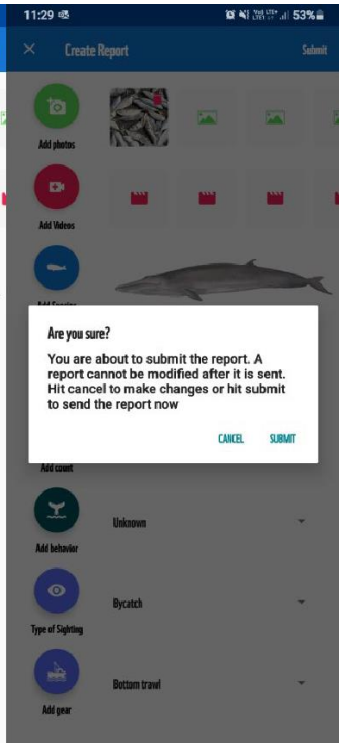

Figure 13- Submission Confirmation