Marine Mammal Research in India Symposium – Part 2
Multispecies Cetacean Line-Transect Survey Training off Kochi, India
15-18 December 2017 (Cruise# 368)

FINAL CRUISE REPORT

Mridula Srinivasan, Kate Stafford, Suzanne Yin, Ernesto Vázquez, Mark Baumgartner, Ajith Kumar, Divya Panicker, Avik Banerjee, and N. Saravanane

U.S. Department of Commerce
National Oceanic and Atmospheric Administration
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NOAA Technical Memorandum NMFS-F/SPO-182
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U.S. Department of Commerce
Wilbur L. Ross, Jr., Secretary

National Oceanic and Atmospheric Administration
RDML Tim Gallaudet, Ph.D., USN Ret., Acting NOAA Administrator

National Marine Fisheries Service
Chris Oliver, Assistant Administrator for Fisheries

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Introduction

Marine mammals are charismatic predators that play a fundamental role in maintaining marine ecosystem functions and processes. They serve as ocean sentinels and ecosystem indicators of ocean productivity and biodiversity. Collapse of marine mammal populations inevitably has cascading effects in the food web and ultimately can affect human societies that rely on marine resources for sustenance and economic revenue through ecotourism, fishing, or resource exploration. Accordingly, understanding trends in marine mammal abundance and distribution patterns can lead to informed decisions about using marine resources sustainably. At present, knowledge about the abundance and distribution of most Indian cetacean species is sparse and discontinuous, with limited to no data from deeper (> 200m) shelf-break, slope, and oceanic waters.

Without the necessary scientific groundwork, it is difficult to address ocean management challenges for economic and conservation benefit in the Indian Exclusive Economic Zone (EEZ). At a minimum, we need to know how many cetaceans there are (both number of species and abundance of species), their distribution, what they eat, and how they overlap with, and may be impacted by, human activities. In the long-term, safeguarding vulnerable marine habitats from destructive practices and instituting mitigation measures to reduce human impacts will help to conserve and recover at-risk species. Further, risk assessments based on sound scientific data will allow multiple users of the marine environment to make coordinated decisions about sustainable marine resource use.

To tackle present and future conservation challenges in the marine environment and to accomplish both economic and ecological goals, India needs a robust nationwide program to systematically assess marine mammal populations in its waters and protect marine biodiverse areas. The foundation of any assessment program is the systematic collection of animal data by trained individuals. To that end and as part of the 2017 Marine Mammal Research in India Symposium hosted by the National Centre for Biological Sciences (NCBS), Bengaluru, a multispecies cetacean systematic survey training was conducted on the 70m *FORV Sagar Sampada* from December 15th to 18th, 2017, off Kochi, India.

This first-of-its-kind training for a broad-scale, line-transect survey equipped 10 participants from various institutions across India with the skills to systematically collect, record, and report cetacean visual data (see Appendix A for survey personnel list). To our knowledge, this is also the first time a systematic offshore survey of cetaceans has been conducted in the Arabian Sea off the west coast of India.

This initiative is an example of a successful Indo-U.S. collaboration. Participating organizations from India included the Centre for Marine Living Resources and Ecology (CMLRE), the Ministry of Earth Sciences (MoES), the Wildlife Conservation Society, and the National Centre for Biological Sciences (NCBS). From the United States, NOAA Fisheries, Woods Hole Oceanographic Institution (WHOI), and the University of Washington participated.

Training Structure and Outcomes

We structured the training to include two classroom sessions focused on pre- and post-survey briefings and hands-on training at sea (see Agenda in Appendix B). During the pre-survey

classroom lectures on 14 December 2017, participants learned about the basics of species identification and data collection using the WINCRUZ software developed by Robert Holland at the NOAA Fisheries Southwest Fisheries Science Center. Trainees were given a primer on distance-sampling and abundance estimation, and were taught the importance of conducting systematic marine mammal surveys for marine resources management and species conservation.

During the nearly three days at sea, trainees received instruction on the methods used to detect and record marine mammal observations. These methods are widely used globally to determine abundance estimates of marine mammal populations (Kinzey et al. 2000, Kaschner et al. 2012).

Specifically, trainees were taught to:

1) Use long-range binoculars for scanning, tracking, and recording marine mammals at sea, including how to estimate the location of the mammal using reticle distance and bearings;
2) Understand differences between “Passing” vs. “Closing” survey modes;
3) Identify species at sea, including noting the differing characteristics of similar species;
4) Estimate group sizes of small and large, single and mixed-species schools of cetaceans;
5) Assess and record instantaneous cetacean behavior during surveys;
6) Record environmental conditions at sea and correctly enter these into WINCRUZ software;
7) Use best practices for approaching and tracking cetacean groups, completing sightings forms, and taking pictures for photo-identification and species determination.

The post-survey briefing on 19 December 2017 focused on sharing lessons learned, providing feedback on the training and the overall cruise experience, and finally, discussing plans for future cruises.

Survey Methodology

Distance-based sampling along line-transects is a universally accepted method for estimating abundance and density of cetaceans (Buckland et al., 2001). NOAA Fisheries uses the same methodology to conduct multispecies cetacean and ecosystem surveys in the United States Exclusive Economic Zone to achieve its legislative mandates under the Marine Mammal Protection Act (MMPA) (Kinzey et al. 2000).

During the training cruise, we followed distance-based sampling protocols and collected visual cetacean data using two 25 x 150 long-range binoculars (“Big Eyes”) positioned on either side (port and starboard) of the ship in front of the wheelhouse (Figure 1). A rotating group of six mammal observers, two independent observers (IO), and a secondary recorder/photographer maintained a watch for cetaceans during daylight hours. To maximize time on the flying bridge, each mammal observer completed a 90-minute rotation, manning each of the three primary stations for 30 minutes: a port side 25 x 150 Big-Eye station, a center data recorder position, and a starboard 25 x 150 binocular station. Each IO worked a one-hour rotation and searched for cetaceans with (7x) handheld binoculars.

The secondary recorder assisted the center recorder in WINCRUZ software data entry and also served as the designated photographer in case of any cetacean sightings. When sightings were made, the primary observer (the observer who made the sighting) provided bearing and reticle information to the recorder. When needed for identification, the secondary observer used the given bearing and reticle to attempt to corroborate the sighting and assist with species identification and group size estimates.

After a sighting was made, the observations switched from an “on-effort” to an “off-effort” mode if the sighted animals were within 3 nautical miles (nm) or less and could easily be approached and tracked. When “off-effort”, the ship deviated from the trackline to approach the animals in “closing mode”. During this period, primary observers continued to track the sighted animal(s) and reported to the center recorder any re-sights of the animal(s) as frequently as possible. Other observers on the platform assisted primary observers by focusing their full attention to re-sight and/or track the animal groups with the naked eye or hand-held binoculars and then report to the center recorder.

Animal behavior and distance from ship, weather conditions, and ship speed were all factors considered before the ship broke the transect line and turned toward a sighting. A sighting was considered complete after the necessary data were collected or if animals abruptly changed course, behavior, or could not be re-sighted. After each sighting, the ship returned to “on-effort” mode, i.e., returned to the trackline and resumed scanning. Any sightings that occurred during transits were considered to be “off-effort.”

Figure 1. Observers using "Big Eye" binoculars (L) and handheld binoculars (R) to survey for cetaceans at sea (photo credit: Mridula Srinivasan).

Survey Highlights

During the approximately two-and-a-half-day cruise, the ship covered a total distance of 205 nautical miles at an average speed of 5.9 knots. The total distance covered includes transit, deviation from trackline to search for animals, and trackline effort. Despite severe weather and visibility issues impeding survey efforts, 12 cetacean sightings were recorded over approximately 104 nautical miles of actual trackline covered "on effort". This is roughly one sighting every 9 nautical miles. Average visibility during the cruise was approximately 5.5 km and average Beaufort sea state was 3. Survey effort covered both shallow inner and middle-shelf waters (< 150 m) and deeper outer-shelf/slope waters < 2,000 m, which corresponded to a total trackline distance of about 200 nautical miles. (Figure 2).

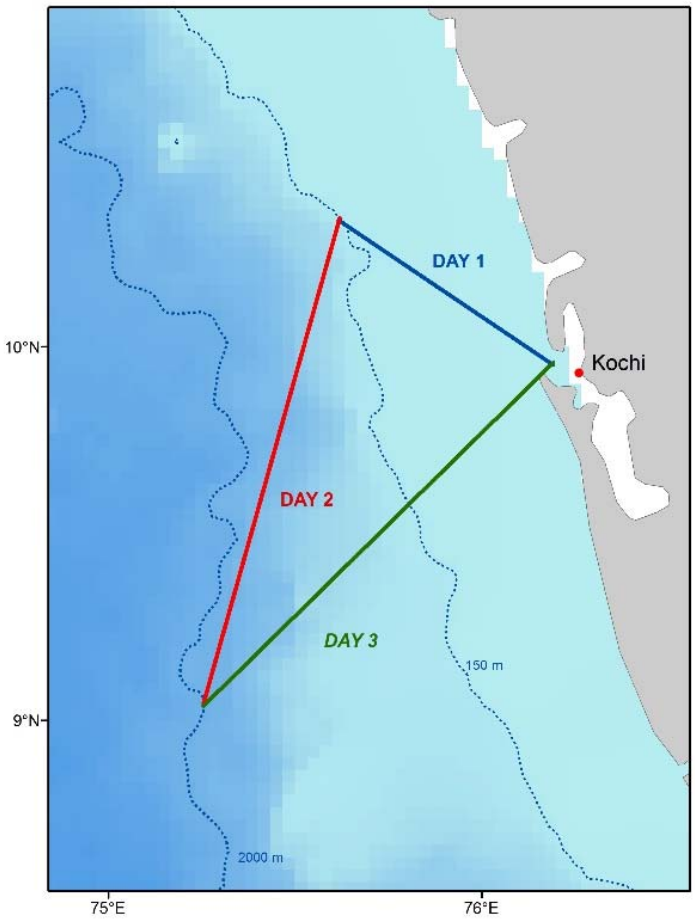

Figure 2 Survey area and planned transect lines for the training cruise off Kochi, India

Cetaceans sighted during the cruise included *Stenella longirostris* (spinner dolphin), *S. attenuata* (pantropical spotted dolphin), *Grampus griseus* (Risso's dolphins), *Globicephala sp.* (pilot whales), and *Balaenoptera edeni/Balaenoptera omurai* (Bryde's whale/Omura's whale), *Tursiops truncatus.* (bottlenose dolphin), as well as unidentified cetaceans (see Appendix C for a selection of people and cetacean photos).

A complete list of cetacean sightings recorded during the cruise with dates and locations are provided in Table 1. Ship trackline and cetacean sightings are shown in Figure 3. The majority of the sightings were past the shelf-break and in waters ≥ 150m.

While observers were instructed to estimate group sizes, there was considerable variability in how Best, High, and Low group size estimates were reported by observers in their notebooks. Group size estimates are made independently by the three primary observers (Right and Left observer on the Big-Eyes and the center recorder) and not shared with each other. Due to the low confidence in these numbers, group size estimates are not provided in this report.

The survey design for this training cruise was developed with the idea to cover both the inner and middle-shelf (≤150m) and outer continental shelf/slope waters (between 150m and 2,000m). However, due to navigational barriers and other restrictions, we were not able to commence the survey at the designated starting point of our transect line for Day 1. Also, due to the relatively shorter distance covered on Day 2 (40 nm; 80 nm total trackline distance) due to weather, vessel speed, and allotted cruise time, we had to transit overnight to a midway-spot on the Day 3 transect line. In total, we covered approximately 32 nm on Day 1, 40 nm on Day 2, and 32 nm on Day 3. Therefore, we did not cover the entire planned survey route. Future survey designs need to consider these limitations to maximize survey time.

Table 1 Summary information on cetacean sightings recorded during the training cruise.

Sighting No.	**Date**	**Time(local)**	**Latitude**	**Longitude**	**Species**
1	12/16/2017	15:06:52	9.9728	75.6043	Unidentified small dolphin
2	12/16/2017	16:03:21	9.9468	75.5762	*Grampus griseus* (Risso's dolphin)
3	12/16/2017	16:27:56	9.9372	75.5525	*Stenella longirostris* (Spinner dolphin)
4	12/17/2017	7:02:27	9.7853	75.4673	*Globicephala sp.* (pilot whale) & unidentified dolphin
5	12/17/2017	7:47:09	9.7715	75.4688	*Tursiops truncatus* (bottlenose dolphin)
6	12/17/2017	8:04:18	9.7477	75.4542	Unidentified medium dolphin
7	12/17/2017	10:32:44	9.4838	75.3835	Unidentified whale
8	12/17/2017	10:46:36	9.4707	75.3575	Unidentified medium dolphin
9	12/17/2017	14:42:34	9.1132	75.2810	*S.attenuata* (pantropical spotted dolphin) *and S. longirostris*
10	12/17/2017	16:22:46	9.0505	75.2748	Unidentified dolphin
11	12/18/2017	8:19:18	9.6383	75.8735	Unidentified dolphin
12	12/18/2017	11:47:33	9.8658	76.0980	*B. edeni/B. omurai* (Bryde's or Omura's whale)

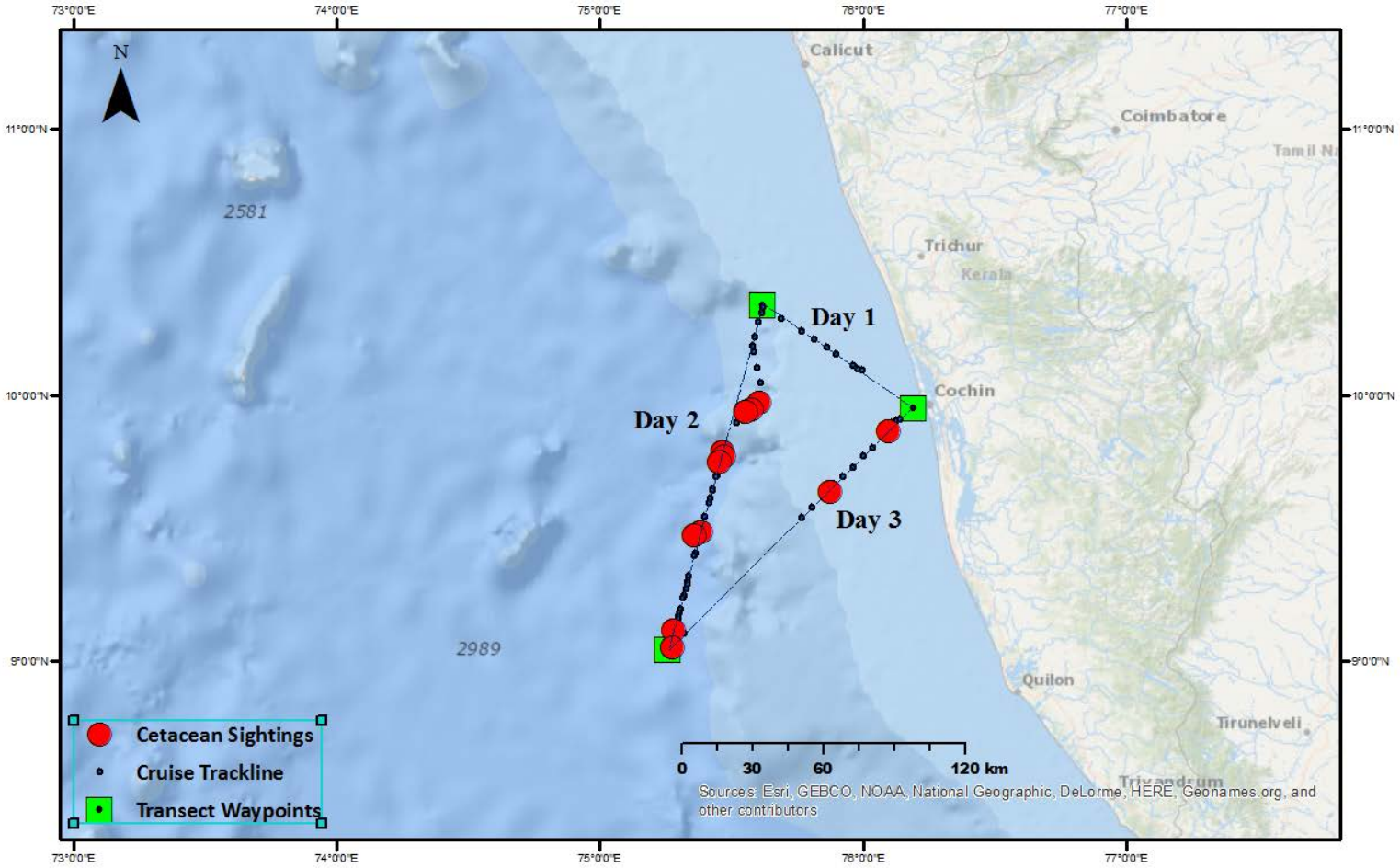

Figure 3 Map of cetacean sightings and actual trackline covered during the Kochi training cruise.

Conclusion

We were able to successfully accomplish our goals in planning and conducting this pilot cetacean survey training cruise off Kochi, India, largely due to the commitment and resources provided by multiple institutions in India and the United States, exemplary trainers, as well as strong trainee interest and dedication. We are particularly grateful to CMLRE for providing the FORV *Sagar Sampada* to conduct the cruise and facilitating full access to the ship. By leveraging funds, resources, and local knowledge, we were able to negotiate unexpected bureaucratic and logistical challenges. Lessons learned from this effort will be instructive in future cruise planning and preparation. Another important outcome of the cruise is the training of early-career researchers on the basics of ship-based, broad-scale cetacean surveys. Such training helps recruit and train the next generation of Indian marine mammal scientists, especially women. Eventually, successive trainings over the next few years will help train and identify skilled and capable observers, who can operate independently with confidence. Therefore, it is vital that such training cruises and systematic surveys continue to be conducted within the India's EEZ, to build on the success of this pilot effort.

Historical accounts and literature confirm that the cetaceans sighted during the cruise commonly inhabit the tropical waters of the southeastern Arabian Sea. The survey off Kochi offers undisputed evidence of the occurrence of these species as well as novel ones, and marks the beginning of documenting cetacean populations within India's EEZ in a scientifically significant way. Using the data we collected, and building on that record with repeated and long-term surveys that are conducted in a scientifically rigorous manner will provide critical abundance and density assessments that will improve management of these sentinel marine species. Future cetacean surveys could also be conducted in combination with prey sampling, oceanographic, and acoustics studies and thereby provide a holistic profile of the marine ecosystem.

Data Availability and Access

Photos and sightings data have been shared with the cruise participants, CMLRE and NCBS via Google Drive. Data are freely available to share with other researchers and research outlets and with databases in India. Photos of cetaceans are also available for use with attribution under the Creative Common License for education, research, and training purposes but are not for commercial use. For data-related queries, please contact Dr. Srinivasan.

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Buckland, S. T., D.R. Anderson, K.P. Burnham, J.L. Laake, D.L. Borchers and L. Thomas. (2001). Introduction to distance sampling: estimating abundance of biological populations. Oxford University Press, Inc., New York, NY. 432 p.

Kaschner, K., N.J. Quick, R. Jewell, R. Williams and C.M. Harris. (2012) Global Coverage of Cetacean Line-Transect Surveys: Status Quo, Data Gaps and Future Challenges. PLoS ONE 7(9): e44075. https://doi.org/10.1371/journal.pone.0044075

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Acknowledgments

Funding for this training cruise was provided by NOAA Fisheries Office of Science and Technology. WHOI provided the two long-range binoculars and three handheld binoculars (7x) and other field support, and the University of Washington provided additional field supplies and technical support. NCBS provided logistics and technical support, and CMLRE/MoES provided the survey platform, *FORV Sagar Sampada*, as well as on-the-ground logistical support. Survey design was developed by Dr. Alex Zerbini, NOAA Fisheries Alaska Fisheries Science Center (AFSC). Dr. Jessica Redfern, of NOAA Fisheries Southwest Fisheries Science Center, provided valuable technical assistance throughout the cruise-planning phase. Dr. Uma Ramakrishnan, NCBS, provided critical help and guidance in securing the ONR Global grant award and facilitating the hosting of the symposium at NCBS. Dr. Sudharkar, Director, CMLRE, was tremendously supportive throughout the planning phase and ensured that all possible facilities and resources were available to survey personnel. Dr. Sherine Sonia, CMLRE, was incredibly helpful in completing administrative procedures, especially obtaining medical and immigration clearance. The Captain, engineers, and crew of FORV *Sagar Sampada,* provided complete support in equipment set up and survey protocols, and patiently responded to all ship-maneuver requests. They adroitly navigated toward sightings and provided access to ship's instruments.

Appendix A. Survey Personnel

1. Ms. Ketki Jog (Konkan Cetacean Research Team)
2. Mr. Mihir Sule (Konkan Cetacean Research Team)
3. Ms. Mahi Mankeshwar (Independent Researcher)
4. Ms. Divya Panicker (University of Washington)
5. Dr. Divya Karnad (Foundation for Ecological Research, Advocacy and Learning, FERAL)
6. Mr. Avik Banerjee (National Centre for Biological Sciences)
7. Mr. Parthasarathi Mishra (Sálim Ali Centre for Ornithology and Natural History, SACON)
8. Mr. Abhishek Jamalabad (Independent Researcher)
9. Dr. Chandrasekar Krishnamoorthy (Centre for Living Marine Resources and Ecology, CMLRE)
10. Dr. Christopher Roy (Zoological Survey of India, ZSI)

Senior Marine Mammal Trainers: Ms. Suzanne Yin (NOAA Affiliate/Hawai`i Marine Mammal Consortium) and Mr. Ernesto Vázquez (NOAA Affiliate/Independent Consultant)

Chief Scientist: Dr. N. Saravanane, CMLRE

Cruise Lead/Deputy Chief Scientist: Dr. Mridula Srinivasan, NOAA Fisheries

Technical Advisors: Dr. Kate Stafford (UW) and Dr. Mark Baumgartner (WHOI)

Appendix B. Agenda

Thursday, 14th Dec 2017		
Time	**Topic**	**Lead**
9:00	Registration	
9:30	Welcome remarks	
9:45	Training workshop purpose and anticipated outcomes	Mridula/Mark/Kate
10:00	**Session 1**	
	Value of systematic studies in marine mammal research and conservation	
	Basic Introduction to Line Transect theory/DISTANCE software	Mark
11:00	**Coffee Break**	
11:30	Cruise overview	Mridula
	Session 2	
	Data Collection I • Reticle theory WINCRUZ • Factors that affect visibility (glare, Beaufort) • Group size estimation • Photo ID & species identification • Recording marine mammal behavior • Biological sampling	Yin/Ernesto
13:00:00 PM	Lunch	
14:00	Data Collection II • Field Orientation • Equipment • Forms • Protocols (number of observers, rotations, independent observers)	Yin/Ernesto
16:00	"Big Eyes" Training (depending on ship access)	
****End of first day****		
Friday 15th - Sunday 17th Dec 2017; Ship survey (18th buffer date)		
Monday, 18th Dec 2017 (or Tuesday 19th December)		
10:00	Post-survey debrief	Yin/Ernesto/Mridula
	Data collection in different situations - few observers, platforms of opportunity	
	Data management, archiving, and analysis	
13:00	Lunch	

14:00	Discussion: Establishing best practices for data collection, sharing, and reporting data, research priorities, survey frequency and area coverage (coastal vs. offshore), and continuing surveys.	Group Discussion
16:00	Wrap-up & Summary	Mridula/Mark/Kate
****End of Training Workshop****		

Appendix C. Species and People Photos

Figure 4. Spinner dolphin seen 16 Dec 2017 (photo credit: Suzanne Yin).

Figure 5. Pair of spinner dolphins seen 16 December 2017 (photo credit: Suzanne Yin).

Figure 6. Risso's dolphin seen 16 December 2017 (photo credit: Suzanne Yin).

Figure 7. Pilot whales seen 17 December 2017 (photo credit: Suzanne Yin).

Figure 8. Pantropical spotted dolphin seen 17 December 2017 (photo credit: Mihir Sule).

Figure 9. Suzanne Yin (seated L) and Ernesto Vázquez (seated R) sharing best practices for collecting marine mammal visual data (photo credit: Mridula Srinivasan).

Figure 10. Suzanne Yin discusses how to identify different species with Christopher Roy (L) and Chandru Krishnamoorthy (R) (photo credit: Mridula Srinivasan).

Figure 11. Observers on "Big Eyes" and handheld binoculars (photo credit: Mridula Srinivasan).

Figure 12. Suzanne Yin teaching Mahi Mankeshwar how to determine and measure wind direction (photo credit: Mridula Srinivasan).

Figure 13. Observers on watch (photo credit: Mridula Srinivasan).

Figure 14. Ketki Jog securing ropes to the "Big Eye" binoculars (photo credit: Mridula Srinivasan).

Figure 15. Ernesto Vázquez (L) and Divya Panicker (R) in discussion about the challenges of marine mammal surveys (photo credit: Mridula Srinivasan).

Figure 16. Trainees discussing species identification (photo credit: Mridula Srinivasan).

Figure 17. Chief Scientist, Dr. Saravanane looking through the "Big Eye" binoculars (photo credit: Mridula Srinivasan).

Figure 18. Trainees taking a break after the end of a survey day (photo credit: Mridula Srinivasan).