

Agenda Item 7.1

Cooperation with other Bodies

Report by the Secretariat, Parties and
Partners

Information Document 7.1a

Report of the IWC Workshop on Bycatch
Opportunities in the Western Indian Ocean
and Arabian Sea

Action Requested

Take Note

Submitted by

International Whaling Commission



Note:

Delegates are kindly reminded to bring their own document copies to the meeting, if needed.

Report of the IWC Workshop on Bycatch Mitigation Opportunities in the Western Indian Ocean and Arabian Sea

8-9th May, 2019, Nairobi, Kenya



Participants at the IWC Workshop on Bycatch Mitigation Opportunities in the Western Indian Ocean and Arabian Sea



INTERNATIONAL
WHALING COMMISSION

Table of Contents

Acronyms and definitions	5
Executive summary	6
1. Introduction	12
1.1 Introductory items	12
1.2 Opening remarks.....	12
1.3 Introduction to the Bycatch Mitigation Initiative	12
1.4 Workshop objectives and focal area.....	14
2. Regional Overview of cetacean bycatch and Fisheries Management	15
2.1 Current state of knowledge of cetacean bycatch in the Indian Ocean.....	15
2.1.2 Fisheries management in the Indian Ocean region	16
3. National perspectives on bycatch.....	17
3.1 India	17
3.1.1 Bycaught cetacean species and main fishing gears involved.....	17
3.1.2 Relevant work on bycatch.....	17
3.1.3 Challenges and Barriers - political, technical, cultural etc.	17
3.1.4 Opportunities and needs for tackling bycatch.....	18
3.2 Sri Lanka	18
3.2.1 Bycaught cetacean species and main fishing gears involved.....	18
3.3 Pakistan.....	18
3.3.1 Bycaught cetacean species and main fishing gears involved.....	18
3.3.2 Relevant work on bycatch.....	18
3.3.3 Challenges and Barriers - political, technical, cultural etc.	19
3.3.4 Opportunities and needs for tackling bycatch.....	19
3.4 Oman.....	20
3.4.1 Bycaught cetacean species and main fishing gears involved.....	20
3.4.2 Relevant work on bycatch.....	20
3.4.3 Challenges and Barriers - political, technical, cultural etc.	20
3.4.4 Opportunities and needs for tackling bycatch.....	21
3.5 Tanzania	21
3.5.1 Bycaught cetacean species and main fishing gears involved.....	21
3.5.2 Relevant work on bycatch.....	22
3.5.3 Challenges and barriers - political, technical, cultural etc.	22
3.5.4 Opportunities and needs for tackling bycatch.....	23
3.6 Kenya.....	23
3.6.1 Bycaught cetacean species and main fishing gears involved.....	23

3.6.2	Relevant work on bycatch.....	23
3.6.3	Challenges and Barriers - political, technical, cultural etc.	23
3.6.4	Opportunities and needs for tackling bycatch.....	24
3.7	Madagascar.....	24
3.7.1	Bycaught cetacean species and main fishing gears involved.....	24
3.7.2	Relevant work on bycatch.....	24
3.7.3	Challenges and Barriers - political, technical, cultural etc.	24
3.6.4	Opportunities and needs for tackling bycatch.....	24
3.8	South Africa.....	25
3.8.1	Bycaught cetacean species and main fishing gears involved.....	25
3.8.2	Relevant work on bycatch.....	25
3.8.3	Challenges and Barriers - political, technical, cultural etc.	25
3.8.4	Opportunities and needs for tackling bycatch.....	25
3.9	France - La Reunion.....	25
3.9.1	Bycaught cetacean species and main fishing gears involved.....	25
3.10	Maldives.....	25
3.10.1	Bycaught cetacean species and main fishing gears involved.....	25
3.10.2	Relevant work on bycatch.....	26
3.10.3	Opportunities and needs for tackling bycatch.....	26
4.	Existing solutions and approaches for tackling bycatch - transferability to Indian Ocean.....	26
4.1	Electronic Monitoring	26
4.2	Mitigation.....	26
4.2.1	Acoustic deterrents or ‘pingers’.....	27
4.2.2	Net illumination	27
4.2.3	Economic factors for mitigation.....	27
4.3	Using low-tech, low-cost methods to reduce entanglement in gillnets.....	28
4.4	GIS tools to assess bycatch risk in endangered populations of nearshore cetaceans.....	29
4.5	Tackling data gaps through an innovative crew-based observer programme	30
4.6	Incentivising fisheries to trial and adopt mitigation measures.....	31
5.	Discussion and recommendations	32
5.1	Priorities for tackling cetacean bycatch in the Indian Ocean	32
5.2	Holistic approach for tackling bycatch in Indian Ocean.....	34
5.3	Design of bycatch reduction programmes.....	34
5.4	Participatory approaches to engage with fishing communities	35
5.5	Research, development and trials of low-cost technical solutions	36
5.6	Spatial/temporal measures for reducing bycatch	36

5.7 Alternative gears to reduce bycatch	37
5.8 Alternative livelihoods	37
5.9 Promotion of cetacean conservation - compensation schemes for fishers	37
5.10 Integrating economics into bycatch mitigation programmes.....	37
5.11 Incentivising fishers - participation in bycatch reduction programmes	38
5.12 Directed cetacean catch.....	38
5.13 Legal ramifications leading to bycatch under-reporting.....	39
5.14 Information on bycatch from strandings data	39
5.15 Remote Electronic Monitoring tools.....	39
5.16 Opportunities for engaging with the IOTC on cetacean bycatch.....	40
5.17 Additional opportunities for regional/international collaboration on bycatch.....	41
9. References	42
10. Annexes.....	44
Annex 1 IWC Bycatch Mitigation Initiative Workshop Programme.	44
Annex 2 Workshop participant list	46
Annex 3 List of meeting documents	47
Annex 4 Structure of IWC Bycatch Mitigation Initiative	48
Annex 5 Workshop national perspectives panel discussion.....	49
Annex 6 Questionnaire on bycatch completed by participants in relation to national situation .	49
Annex 7 Workshop breakout group questions	49
Annex 8 Bycatch hotspots/high-risk areas by country	50
Annex 8.1 India and Sri Lanka	50
Annex 8.2 Pakistan	51
Annex 8.3 Oman	52
Annex 8.4 Kenya and Tanzania	53
Annex 8.5 Madagascar and France - La Reunion.....	54
Annex 8.6 South Africa.....	55
Annex 9. Opportunities for the BMI to assist efforts in Indian Ocean	56

This report records the discussions and material presented and provided by the invited experts during the workshop - Bycatch Mitigation Opportunities in the Western Indian Ocean and Arabian Sea - the views expressed do not necessarily reflect the official views of national governments within the region.

ACRONYMS AND DEFINITIONS

ABNJ - Areas beyond national jurisdiction

BMI - The IWC's Bycatch Mitigation Initiative

BMIS - Bycatch Management Information System

Bycatch - the accidental capture of marine life in fishing gear, i.e. non-target catch.

ByRA - Bycatch Rapid Risk Assessment toolbox

CMS - Convention on Migratory Species

Depredation - damage or removal of target fish or bait from fishing gear by predators

EEZ - Exclusive Economic Zones

Entanglement - typically considered a type of bycatch, which occurs when fishing gear (e.g. ropes, buoys, nets, fish aggregating devices) and marine debris become wrapped around the animal, weighing it down or hampering its movement - often leading to the animal's death, or serious welfare issues

FAO - Food and Agriculture Organisation of the United Nations

GWERN - IWC's Global Whale Entanglement Response Network

GGGI - Global ghost gear initiative

IMMA – Important Marine Mammal Areas identified by the IUCN Marine Mammal Task Force

IOTC - Indian Ocean Tuna Commission

IWC - International Whaling Commission

Marine mammal - in this report it is used to include cetaceans, dugongs, seals, sea lions etc.

Mitigation measure - in this report we include 'technical' fishing gear modifications and time/area/effort management which can bring about bycatch reductions

REM - Remote Electronic Monitoring

RFMO - Regional Fisheries Management Organisation

SPC-OFP – Sustainable Pacific Community Oceanic Fisheries Programme

SWIOFC - Southwest Indian Ocean Fisheries Commission

t-RFMO - tuna Regional Fisheries Management Organisation

WWF – World Wide Fund for Nature (also known as World Wildlife Fund for Nature)

WPEB – IOTC's Working Party on Ecosystems and Bycatch

Fishing gear and industry definitions and descriptions from FAO

Driftnet - <http://www.fao.org/fishery/geartype/220/en>

Estuarine set bagnet - <http://www.fao.org/3/ad823e/ad823e00.pdf>

Gillnet - <http://www.fao.org/fishery/geartype/107/en>

Longline - set longlines <http://www.fao.org/fishery/geartype/232/en> drifting longlines-
<http://www.fao.org/fishery/geartype/233/en>

Purse seine - <http://www.fao.org/fishery/geartype/249/en>

Small-scale fisheries - no current definition for small-scale fisheries is available, so the workshop used expert knowledge to discriminate between medium-scale, small-scale and commercial-scale fisheries.

Trammel net - <http://www.fao.org/fishery/geartype/223/en>

Trawl - <http://www.fao.org/fishery/geartype/103/en>

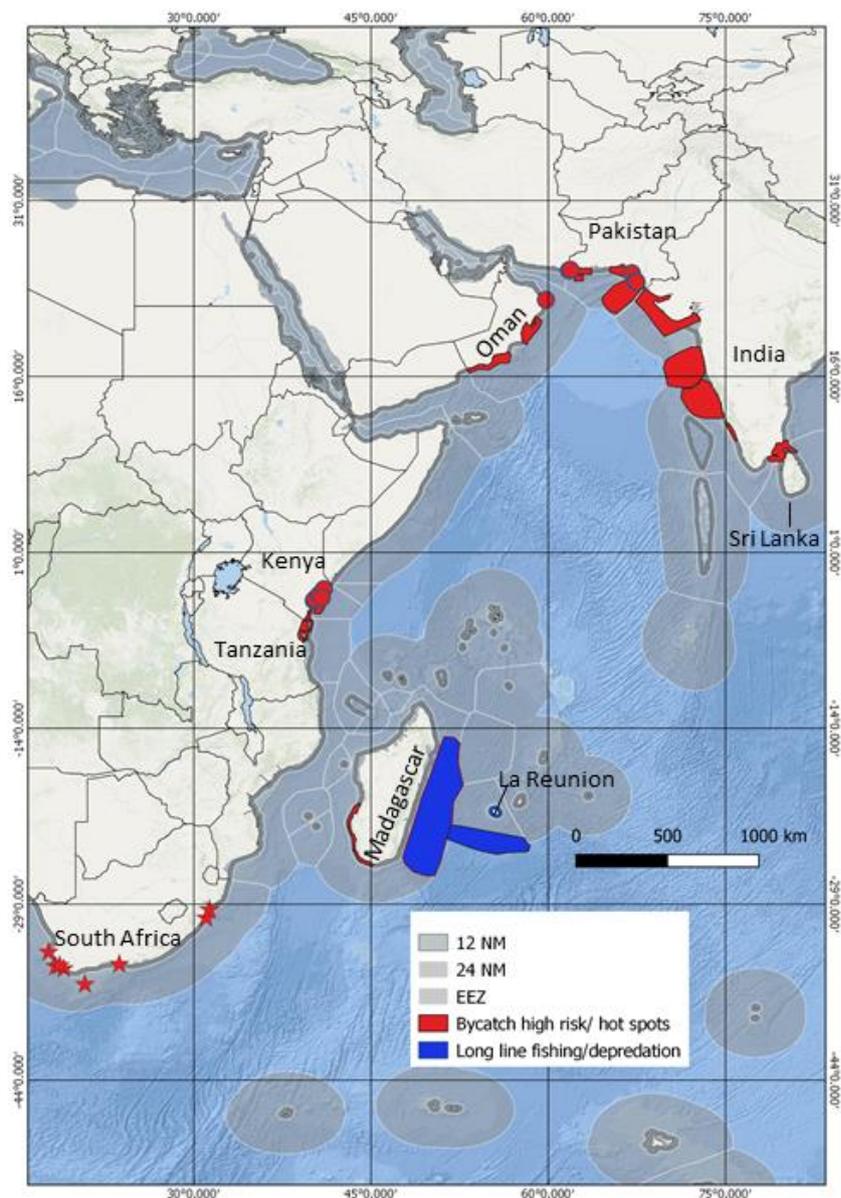
EXECUTIVE SUMMARY

The International Whaling Commission (IWC) held a technical workshop on Bycatch Mitigation Opportunities in the Western Indian Ocean and Arabian Sea from 8-9 May 2019 in Nairobi, Kenya. The workshop was attended by 50 participants working in 17 different countries, with half of the participants coming from within the Indian Ocean region. Workshop participants included national government officials working in marine conservation and fisheries management, cetacean and fisheries researchers, fisheries technologists, socio-economists and representatives from Regional Fisheries Management Organisations (RFMOs), inter- and non-governmental organisations. The focal region of the workshop extended from South Africa, north to the Arabian Sea and east to Sri Lanka, including coastal areas, national waters and high seas. The primary objectives of the workshop were to (i) develop a broad-scale picture of cetacean bycatch across the North and Western Indian Ocean region in both artisanal and commercial fisheries; (ii) explore the challenges and opportunities related to the monitoring and mitigation of cetacean bycatch in the western and northern Indian Ocean (Arabian Sea); (iii) identify key gaps in knowledge and capacity within the region and tools needed address these gaps; (iv) introduce the Bycatch Mitigation Initiative (BMI) to Indian Ocean stakeholders and assess how the initiative can be of use; (v) identify potential locations which could serve as BMI pilot projects; (vi) start building collaborations to tackle bycatch at national, regional and international level.

Presentations included the status of bycatch knowledge at the Indian Ocean scale and current tools available to assess, monitor and tackle cetacean bycatch. A panel discussion and breakout group sessions allowed for more in-depth discussion of the knowledge, gaps and challenges to addressing bycatch shared across the region. Priority areas where cetacean bycatch is known to be occurring – or considered likely to be occurring - were identified across the region (see summary map below).

The workshop **recognised** that bycatch is one of the most significant threats to cetacean species and populations in the Indian Ocean region and concluded that there was an urgent need to raise awareness of cetacean bycatch at local, national, regional and international scales. The best available information suggests that very high numbers of animals are caught in medium-scale tuna gillnet fisheries in the Indian Ocean and Arabian Sea region. Furthermore, despite the general lack of data on cetacean bycatch regionally, it is likely that high numbers of cetaceans, including vulnerable species and populations, are caught in the extensive coastal artisanal and small-scale fisheries (net, trap and line) across the region. The workshop **concluded** that within the Indian Ocean region there was a need to focus on gillnets (set and drifting) as the fishing gear most likely to be causing the highest and most significant bycatch of cetaceans, and for which few effective solutions currently exist.

It was **recognised** that cetacean bycatch is generally very poorly documented in the region and that this presents a major barrier to understanding the scale of the issue and making progress towards bycatch reduction. The workshop **concluded** that a more systematic assessment of bycatch information is critical, particularly for small-scale and medium-scale fisheries.



Summary Figure 1. Bycatch hotspots, or potential high-risk areas for bycatch or depletion (La Reunion) in the Indian Ocean and Arabian Sea region identified during the workshop.

A number of common barriers to tackling bycatch were identified, including: under-reporting of bycatch by fishers; lack of standardised monitoring programmes which are suitable and financially viable for small-medium-scale vessels; lack of capacity to carry out bycatch monitoring and reduction programmes; lack of reporting through RFMOs; lack of sustainable funding to carry out bycatch reduction programmes; lack of awareness and political will to tackle the issue; lack of capacity and clarity at national level on the steps, tools and approaches to tackle bycatch; lack of baseline information on cetacean distribution and abundance; and lack of technical solutions proven to work on the fisheries in the region.

Given the prevalence of small to medium-scale fisheries using passive fishing gears (gillnets, traps, etc) across the Indian Ocean region, and the lack of financially viable and effective mitigation solutions for these gears, the workshop **concluded** that further work to develop and trial low-cost and low-tech solutions was urgently needed. The utility of existing tools and approaches for assessing and

monitoring bycatch in the numerous small to medium-scale fleets was also recognised, including rapid bycatch risk assessments, remote electronic monitoring and crew-based observer schemes. The workshop **concluded** that bycatch reduction efforts should aim to apply multi-disciplinary and multi-taxa approaches wherever possible.

The workshop **recognised** the need for strong collaboration with fishing communities and the importance of integrating and collecting information on socio-economic aspects of bycatch into bycatch reduction programmes. Direct engagement with the seafood supply chain, certification schemes and the culinary community can be a part of rewarding fishers who are working to reduce bycatch, thereby incentivising participation in bycatch mitigation programs. The workshop concluded that bycatch reduction programmes should aim, as far as is possible, to support the livelihoods of fishing communities, and that this should also be considered when exploring options for alternative livelihoods. It was also recognised that within this region that cetaceans can be the target of directed catch, or that incidentally caught cetaceans can be used as bait or food, meaning that the term ‘bycatch’ is less well defined.

The workshop participants acknowledged the vital role for Regional Fisheries Management Organisations (RFMOs) in tackling bycatch and that raising the profile of cetacean bycatch, and the need to address it, within the context of the Indian Ocean Tuna Commission (IOTC), and the Southwest Indian Ocean Fisheries Commission (SWIOFC) and their contracting parties should be prioritised. It recognised that underreporting of bycatch at IOTC remains a challenge. The workshop **concluded** that there was an opportunity for the BMI to act as a catalyst to ensure more engagement on cetacean bycatch and to communicate the relevant research priorities at future meetings.

The workshop noted that the regional focus of the meeting had helped collate existing information on bycatch and that such an approach was potentially useful for other regions. It **agreed** that until now there had not been an international body to champion cetacean bycatch mitigation, and that the IWC’s Bycatch Mitigation Initiative could collaborate with and where appropriate assist other organisations, RFMOs and national governments interested in tackling bycatch in a number of ways. The suggested role and activities for the BMI includes the collaborative development of a regional road map for tackling cetacean bycatch and a framework for more sustainable funding of bycatch work, strengthened engagement with RFMOs in the region (e.g. IOTC and SWIOFC) and the provision of training and technical assistance and development of toolboxes. These activities are envisaged as part of a collaboration between the IWC and other relevant bodies and organisations that are already working to tackle bycatch (e.g. the FAO, RFMOs, other IGOs and NGOs) and relevant national governments and experts.

In light of these conclusions the workshop made the following recommendations as the next steps across the region in order to progress cetacean bycatch reduction efforts.

The workshop recommended that:	To be actioned by:
The workshop recommends that governments in the Indian Ocean region establish or strengthen bycatch assessment and reduction programmes as a matter of urgency, with priority on bycatch hotspots areas identified across the region (including those identified during the workshop in Annex 8). Associated actions could include rapid risk assessments, on-board data collection, mitigation trials (experimental and existing measures) and/or implementation of effective management measures.	National governments in the Indian Ocean region
The workshop recommends that governments and other relevant stakeholders in the Indian Ocean region carry out cetacean sampling surveys to collect information on species abundance and distribution	National governments in the Indian Ocean region; research community

at national and regional scales and encouraged that this information could be shared with the IWC Scientific Committee.	
The workshop recommends that the IWC (including through its Conservation Committee) develop and communicate recommendations to governments on the importance of addressing bycatch through policies and other measures that support bycatch mitigation efforts, and of more coherent approaches across government departments with different mandates; and promotes the sharing of information and experience between its contracting members.	IWC Conservation Committee; IWC Commission
The workshop recommends that the BMI assist bycatch reduction efforts in the Indian Ocean region, including through: <ul style="list-style-type: none"> • raising awareness and prioritisation of addressing cetacean bycatch in small to medium-scale gillnet fisheries through its engagement with member countries and other IGOs and NGOs; • developing a regional road map for bycatch reduction (including assessment, monitoring and mitigation) in collaboration with other relevant bodies (e.g. FAO, IOTC, CMS, national governments); • providing technical assistance to countries to assess different aspects of cetacean bycatch (e.g. monitoring, assessment, mitigation) and support and promote multidisciplinary monitoring (e.g. social science techniques, economics) and mitigation approaches, including through capacity building; • exploring means of more consistent and sustainable approaches for funding of bycatch mitigation efforts. 	Bycatch Mitigation Initiative (in collaboration with other organisations)
The workshop recommends that bycatch reduction efforts employ a multi-disciplinary and multi-taxa approach at local, national and international scales.	National Governments in the Indian Ocean region; scientific research community; Bycatch Mitigation Initiative
The workshop recommends that the BMI provides technical assistance to governments and other relevant stakeholders within the Indian Ocean region in the design of experimental mitigation trials that are both scientifically rigorous and which supports the livelihoods of fishing communities, as far as is possible.	Bycatch Mitigation Initiative
The workshop recommends that the IWC (through the BMI and through its conservation and scientific committees) assist efforts to communicate scientific and conservation advice to decision makers in collaboration with other inter-governmental organisations and non-governmental organisations.	Bycatch Mitigation Initiative; IWC Conservation Committee; IWC Scientific Committee; FAO; CMS; RFMOs
The workshop recommends to governments and other relevant stakeholders in the Indian Ocean region that bycatch monitoring and reduction efforts use (where appropriate) crew-based approaches for collecting data on bycatch and mitigation measures (including where observer programmes are not feasible due to the size of vessel, the large numbers of small and medium-scale fishing vessels, trip length, safety concerns etc).	National Governments in the Indian Ocean region
The workshop recommends that the BMI assist national efforts by developing a toolbox of more effective tools for communication with	Bycatch Mitigation Initiative

fishing communities and associations including the promotion of fisher-exchanges to share experiences of bycatch mitigation efforts and efficacy.	
The workshop recommends renewed efforts by the research community and fisheries technologists in the research and development of low-cost bycatch mitigation and monitoring solutions, particularly for gillnet fisheries and the scaling-up of testing of existing measures (e.g. lights and acoustic deterrents, and experimental low-tech tools) in different fisheries and locations.	Scientific research community; industry
The workshop recognised the importance of capturing socio-economic information as part of a holistic and multi-disciplinary approach, and therefore recommends to countries that monitoring and mitigation programmes should also integrate collection of economic data (CPUE, catch value etc) to be collected and analysed alongside bycatch information.	National governments in the Indian Ocean region
The workshop recommends that governments in the Indian Ocean region consider pro-active reassurance to fishers that there will not be negative consequences in response to reporting bycatch and furthermore recommends to use fisher reported data for monitoring and bycatch management purposes rather than for compliance and enforcement.	National governments in the Indian Ocean region
The workshop recognised the growing importance of REM methods and the possibility for cost-effective monitoring at a fleet-scale, and therefore recommends that governments and relevant stakeholders in the Indian Ocean region engage in trialling REM approaches for bycatch monitoring, including low-cost methods for small and medium-scale vessels (and in other vessels as appropriate).	National governments in the Indian Ocean region; scientific research community
The workshop recommends that the BMI provide technical assistance upon request on the REM systems available and their applicability to a specific situation.	Bycatch Mitigation Initiative
<p>The workshop concluded that there was an important need to raise the profile of cetacean bycatch and promote bycatch reduction efforts within the context of RFMOs, and specifically within the Indian Ocean and it therefore recommends that:</p> <ul style="list-style-type: none"> • The BMI engage more formally and more regularly with the IOTC, the South West Indian Ocean Fisheries Commission (SWIFOC) and other relevant RFMOs, including in collaboration with other relevant organisations, to encourage more discussion and action of cetacean bycatch monitoring and mitigation in the fisheries under their management. This could be achieved through direct observer status and/or the appointment of regional representatives/contacts to maintain an overview of relevant RFMO meetings and opportunities to participate and/or present information. • IWC Contracting Governments undertake further efforts to improve the quality and quantity and reliability of cetacean bycatch data reported to the IOTC and to other bodies (including the IWC national reports) and for small-scale fisheries. 	Bycatch Mitigation Initiative; IWC Conservation Committee; IWC Secretariat; National governments in the Indian Ocean region

- | | |
|---|--|
| <ul style="list-style-type: none">• That the BMI support where appropriate contracting and non-contracting governments in the exchange of cetacean bycatch information and experiences between neighbouring countries and support the development of transboundary approaches including through BMI engagement with RFMOs• That the BMI explore its potential to assist countries in fulfilling their reporting requirements under IOTC, as well as the potential for greater sharing of information on bycatch between the IWC and FAO/the RFMOs. | |
|---|--|

This workshop was funded by generous contributions from the Government of France, the US Marine Mammal Commission, the Pew Foundation, the Western Indian Ocean Marine Science Association (WIOMSA), and WWF International.

1. INTRODUCTION

1.1 Introductory items

The workshop was held from 8-9 May 2019 at the Safari Park Hotel, Nairobi, Kenya. The workshop agenda, participants list, and meeting documents list are in Annex 1-3. Ellen Hines and Rob Enever were appointed Co-Chairs of the workshop and Gianna Minton and Sarah Smith were appointed rapporteurs.

1.2 Opening remarks

The workshop Co-chairs welcomed participants to the meeting and invited some short opening remarks.

Susan Imende, Assistant General Director of the Kenya Fisheries Service, Kenyan State Department for Fisheries, Aquaculture and Blue Economy welcomed participants to Kenya and to Nairobi on behalf of the Kenyan government. She thanked the IWC Secretariat and Bycatch Standing Working Group for making this meeting possible, welcoming the exploration of means to mitigate bycatch within the region and globally. She noted Kenya's commitment to the Blue Economy and that Kenya are currently spearheading policies and mechanisms towards a vibrant marine economy. Kenya has taken several steps to protect cetaceans and the marine environment through legislation (e.g. Fisheries Management and Development Act, 2016), regulations (e.g. the transposing of the Indian Ocean Tuna Commission Resolutions 13/04 and 13/05 on conservation of cetaceans and whale sharks into national draft regulations; the prohibition of large-scale drift gillnets) and other means such as the declaration of marine sanctuaries in Kenyan waters, where it is prohibited to take, kill, harass or chase with intent to kill any marine mammal or turtle. Imende noted Kenya's interest in further strengthening capacity with respect to bycatch including through improvements in monitoring and data collection and enforcement.

Stephanie Langerock, Chair of the IWC Bycatch Standing Working Group welcomed participants to the meeting. She thanked Gianna Minton (Bycatch Coordinator-maternity cover), Marguerite Tarzia (Bycatch Coordinator) and Sarah Smith (IWC Head of Programme Development) for all their work in organising the workshop. She gave a brief background to the establishment of the Bycatch Mitigation Initiative (BMI) in 2016, highlighting the ambitious nature of the initiative which aims to apply a multi-disciplinary approach, and foster new collaborations beyond the usual sphere of the IWC to address this significant threat to cetaceans. She noted that the initiative has a ten-year strategic plan and two-year workplan [available at www.iwc.int/bycatch].

The workshop paid tribute to Joanna Toole (most recently FAO) who tragically lost her life in the recent Ethiopian airlines crash and who would have been present at the workshop, recognising her significant contribution to bycatch mitigation efforts.

Marguerite Tarzia, IWC Bycatch Coordinator thanked all of the workshop funders including the Pew Foundation, the Western Indian Ocean Marine Science Association (WIOMSA), WWF International, the Government of France, the US Marine Mammal Commission and all of the organisations that have supported the participation of their representatives, including the Indian Ocean Tuna Commission. She also thanked the Government of Kenya for their hospitality and assistance in organising the meeting.

1.3 Introduction to the Bycatch Mitigation Initiative

Tarzia provided an introduction to the IWC Bycatch Mitigation Initiative (BMI), including its structure and components within the IWC (see Annex 4), and an outline of the priorities and phased approach

in the initiative’s strategic plan (Figure 1). The initiative was created in recognition of the importance and extent of cetacean bycatch globally and the need for collaborative and coordinated, multi-disciplinary action to tackle the many challenges associated with cetacean bycatch. The BMI plans to focus predominantly on cetacean bycatch in gillnets, particularly in small to medium-scale fisheries. Within the next ten years the BMI aims to be recognised as an expert advisory body, offering practical, technical advice on cetacean bycatch monitoring, assessment, and mitigation to contracting and non-contracting governments and fisheries management bodies.



Figure 1. Diagram showing the phased approach that the BMI is taking in implementing its 10-year strategic plan.

In developing the BMI, the IWC recognises that there are other experts and organisations working on cetacean bycatch around the world, and there appears to be growing interest in tackling the issue. Most notably at a global level, the UN Food and Agriculture Organisation (FAO) is working to develop draft voluntary technical guidelines on marine mammal bycatch mitigation, see [here](http://www.fao.org/3/I9993EN/i9993en.pdf) [http://www.fao.org/3/I9993EN/i9993en.pdf]; and the Convention on Migratory Species has resolutions and programmes focused on bycatch of multiple taxa (see [here](https://www.cms.int/en/page/bycatch) [https://www.cms.int/en/page/bycatch]). The US Marine Mammal Protection Act Import Provisions are highly relevant to many fisheries around the world that export fish products to the US and the Lenfest-supported [Ocean Modelling Forum Working Group](http://oceanmodelingforum.org/working-groups/marine-mammal-bycatch-working-group/) [http://oceanmodelingforum.org/working-groups/marine-mammal-bycatch-working-group/] is working to help develop scientific capacity to support countries seeking to comply with these trade provisions. At the regional level, bycatch monitoring and mitigation is being addressed through RFMOs, through multi-country project partnerships and by inter-governmental and non-governmental organisations (see section 5.17 for further examples).

The BMI seeks to develop collaborations with others, wherever possible, and assist, promote and build on existing efforts. Despite recognition that cetacean bycatch poses a very significant threat to many species and populations, there are few effective solutions to reduce cetacean bycatch to date. There are few examples of a multidisciplinary approach to the issue, and regional and international understanding of bycatch remains patchy. While previously there were almost no global organisations championing the cause, there is growing momentum to collaborate to address this most pressing threat to cetaceans. With its long history of convening cetacean scientists and expertise from around the globe, the IWC is well placed to make a difference on this issue and welcomes the increased interest in addressing bycatch given its critical role in recovery of cetacean populations around the world.

The BMI aims to gain experience in implementing multi-disciplinary approaches to bycatch through the development of pilot projects in collaboration with participating governments and other local partners. Pilot projects might address *inter alia* risk assessments of bycatch, monitoring, incentivising the fishing community, building community consensus of technical mitigation measures. Pilot projects will be locally led and focused on priority locations where bycatch is occurring at high enough levels to detect statistically significant changes where mitigation measures are tested, and where a conservation concern exists for the population. The duration of projects is likely to vary depending on objectives and local circumstances but may be up to a few years. This workshop provides an opportunity to identify such locations in the Indian Ocean region.

1.4 Workshop objectives and focal area

The main objectives of the workshop were to:

- Develop a broad-scale picture of cetacean bycatch across the North and Western Indian Ocean region in both artisanal and commercial fisheries
- Explore the challenges and opportunities related to the monitoring and mitigation of cetacean bycatch in the western and northern Indian Ocean (Arabian Sea)
- Identify key gaps in knowledge and capacity and tools needed to fill them within the region
- Introduce the Bycatch Mitigation Initiative to Indian Ocean stakeholders and assess how the initiative can be of use.
- Identify potential locations which could serve as BMI pilot projects
- Start building collaborations to tackle bycatch at national, regional and international level.

The focal region of the workshop extended from South Africa, north to the Arabian Sea and east to Sri Lanka, including coastal areas, national waters and high seas (see Figure 2)

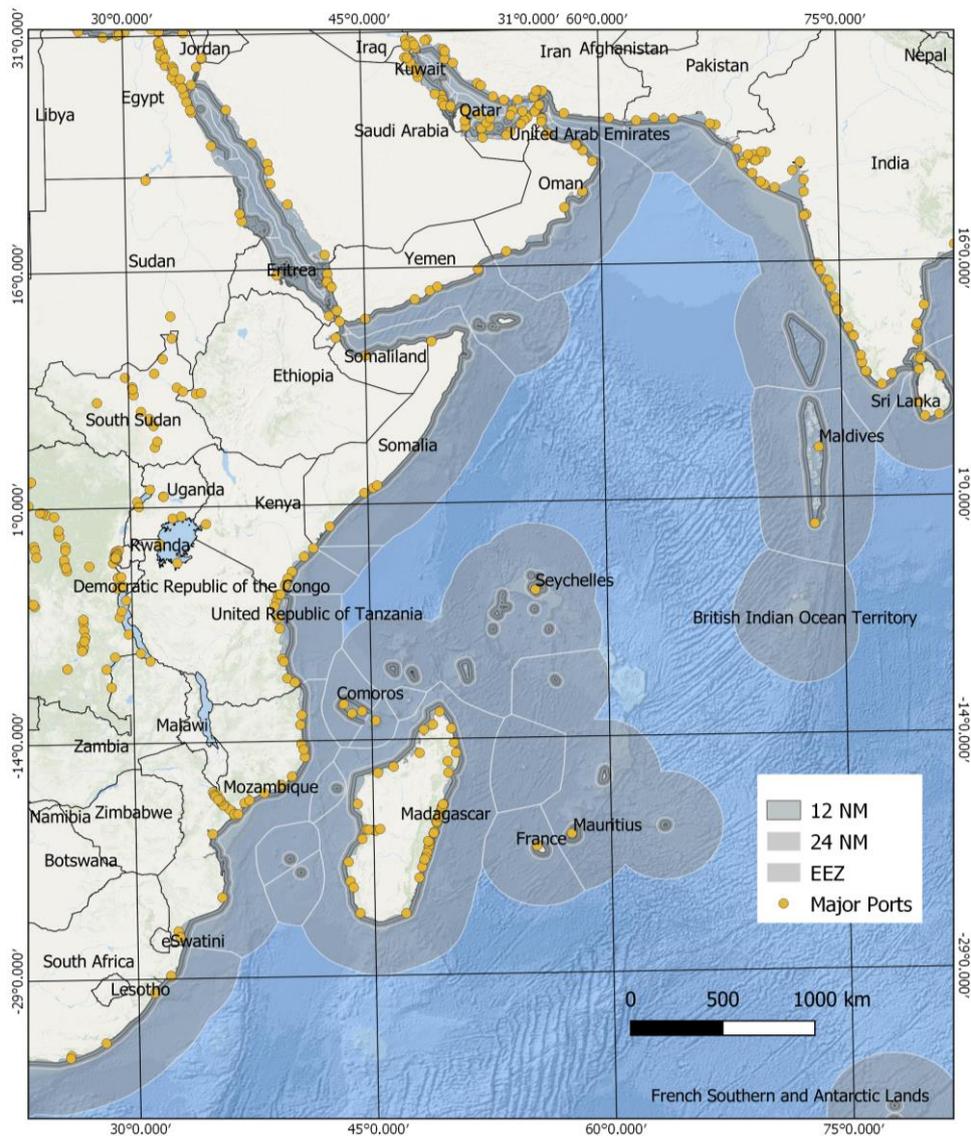


Figure 2. Map of focal region considered by the workshop - the Indian Ocean and Arabian Sea - with Exclusive Economic Zones, territorial waters and major ports indicated (port data from the World Food Programme, boundaries from Marineregions.org).

2. REGIONAL OVERVIEW OF CETACEAN BYCATCH AND FISHERIES MANAGEMENT

2.1 Current state of knowledge of cetacean bycatch in the Indian Ocean

Jeremy Kiszka presented an overview of the current state of knowledge in relation to cetacean bycatch in the Indian Ocean with a focus on fisheries of concern, hotspots and data gaps. Kiszka reviewed available information on cetacean bycatch in commercial (tuna fisheries) and small-scale fisheries in the western Indian Ocean and the Arabian Sea. Industrial and small-scale fisheries are of major socioeconomic importance throughout the Indian Ocean, and information on cetacean bycatch is limited to a few studies. Information on cetacean bycatch in industrial pelagic longline and purse seine

tuna fisheries is limited, but recent studies suggest relatively low bycatch levels (Garcia and Herrera, 2018). Bycatch in pelagic longlines has been recorded, but seems to be rare, and involve mostly medium-sized delphinids such as short-finned pilot whales (*Globicephala macrorhynchus*), Risso's dolphins (*Grampus griseus*) false killer whales (*Pseudorca crassidens*) which engage in depredation (on either bait or catch) (Rabearisoa et al. 2018). Areas of high co-occurrence of cetaceans and purse seine fisheries have been identified, particularly east of the Seychelles and in the Mozambique Channel. However, cetacean mortalities have been rarely reported. Both semi-industrial and artisanal drift gillnet fisheries are active throughout the western Indian Ocean region, and seem to be increasing, posing a major threat to cetaceans. Preliminary estimates based on gillnet bycatch reported to the IOTC suggest that about 60,000 cetaceans are caught annually in tuna gillnet fisheries in the western and central Indian Ocean (Anderson et al 2014). However, further investigations are required to refine these estimates.

This ocean-basin wide estimate does not account for bycatch that occurs in small-scale gillnet fisheries in the coastal waters of the region, which have only been quantified in a small number of places in the SW Indian Ocean (e.g. see Temple et al. 2018 for a review of small-scale fisheries and megafauna bycatch and Temple et al. 2019). Where studies have been conducted, evidence suggests that bycatch is unsustainable for many small populations of coastal dolphins, such as in Zanzibar (Amir, 2010). Overall, cetacean bycatch is very poorly documented in the region and more systematic assessment is critical (Temple et al. 2018), particularly for those fisheries that use gear known to entangle or entrap cetaceans; gillnets are of greatest concern.

2.1.2 Fisheries management in the Indian Ocean region

Sylvain Bonhommeau, Chair of the Indian Ocean Tuna Commission (IOTC) Working Party on Ecosystems and Bycatch (WPEB) provided an overview of reporting requirements, regional observer schemes, new data collection and bycatch mitigation strategies within the IOTC. Bonhommeau gave a brief overview of the global tuna fisheries and the different management bodies, focusing on the five tuna Regional Fisheries Management Organisations (t-RFMOs). The IOTC is responsible for the management of tuna and tuna-like species across the Indian Ocean and Arabian Sea area. Since 2010, this organisation has developed a regional observer scheme to monitor tuna fisheries and their bycatch. A 5% observer coverage of fishing activities is required by IOTC however this has been difficult to implement for small-scale/artisanal fisheries. Detailed data collection and reporting [protocols](#) have been developed [<https://www.iotc.org/data-and-statistics>]. Different pilot projects have been initiated in the IOTC area of competence to facilitate the implementation of this programme and improve knowledge on tuna fisheries and their bycatch. For example, [cetacean identification cards](#) [<https://www.iotc.org/news/cetacean-identification-guide-indian-ocean>] were developed and distributed in multiple languages, and member states (e.g. Sri Lanka) have been developing alternative (tablet/Application-based) data collection methods.

The IOTC's WPEB meets once a year and is responsible for the monitoring and assessing the stock status of bycatch. To date, there are few estimates of the impact of tuna fisheries on the population status of cetacean species and so there is a critical need for more thorough scientific analyses to be undertaken and presented within this working group. Few marine mammal experts have attended this meeting, which limits the capacity of the group to provide state-of-the-art scientific knowledge and sound recommendations to the IOTC Commission. The WPEB strongly encourages the involvement of the marine mammal scientific community to the group. Links have now been established between IOTC and IWC regarding bycatch mitigation issues. Collaborations developed through the BMI will be essential to provide solutions to limit tuna fishery impact on marine mammals in the Indian Ocean.

3. NATIONAL PERSPECTIVES ON BYCATCH

The workshop explored more in-depth perspectives on cetacean bycatch across the region through a panel of national and regional representatives from Indian Ocean countries (Annex 5), a brief questionnaire on bycatch information for each country (Annex 6) and a break-out group discussion on the challenges and barriers and identification of hotspots (Annexes 7 and 8). These discussions are synthesised below and presented by country.

3.1 India

3.1.1 Bycaught cetacean species and main fishing gears involved

India has a vast coastal and marine area, with an estimated 4 million fishers working on roughly 168,000 vessels along its coastline (Indian Ocean proper, including the Bay of Bengal), of which ~45% or 80,000 use gillnets (Kuppusamy, 2019). Gillnets are identified as the major threats to cetaceans followed by purse seines/set nets and longlines in India. More than 30 species of cetaceans are found in Indian waters. A 2009 study (Yousuf et al. 2009) which interviewed 60 fishers from three ports (Chennai, Kakinada and Mangalore) estimated between 9,000-10,000 cetaceans are bycaught annually across India in mechanised vessels using gillnets. Ten species are regularly caught as bycatch, and the most commonly caught are spinner dolphins, finless porpoises (*Neophocaena phocaenoides*), Indian Ocean humpback dolphins (*Sousa plumbea*), Bryde's (*Balaenoptera edeni*) and blue whales (*Balaenoptera musculus*) (Yousef et al. 2009; Kuppusamy, 2019). Indo-Pacific bottlenose dolphins (*Tursiops aduncus*), common dolphin and Risso's dolphins and pan-tropical spotted dolphins (*Stenella attenuata*) have also been recorded (Yousef et al. 2009). Bycatch of whales, dolphins and porpoises have all been recorded as bycatch in gillnets, whilst purse seines (not a commonly used fishing gear) and longlines are known to have bycatch of dolphins. It is believed that the majority of bycatch occurs in the artisanal gillnet fleet, however there is no data to confirm this. Bycatch hotspots and high-risk areas were identified and are presented in Annex 8.1.

3.1.2 Relevant work on bycatch

A number of relevant initiatives are underway across India. Various state governments have implemented fisheries closures for 6 to 8 weeks each year to facilitate fish recruitment, and these measures are also helping to reduce marine mammal bycatch. Indian researchers have established a 'Marine Mammal Research and Conservation Network of India' to fill the gaps in research and conservation of marine mammals including bycatch mitigation. There is also a marine mammals citizen science network with fishers, experts, managers, etc. A network of 130 Marine Protected Areas (MPAs) have been used to protect marine mammal habitat, and ~10 Important Marine Mammal Areas (IMMAs) have been recently identified in the waters around India. Cetacean species recovery programs, such as for the Arabian Sea population of humpback whale have also been initiated at the national level. The national and state governments have invested in awareness-raising programmes in relation to bycatch, although these have previously particularly focused on dugongs. This includes innovative approaches such as the dugong scholarship programme to support the education of school-going children of fishers and dugong ambassadors who then champion for their conservation within their family context. There are incentives for releasing incidentally captured marine mammals and a mobile phone application for reporting bycatch.

3.1.3 Challenges and Barriers - political, technical, cultural etc.

The main challenges and barriers were perceived to be the lack of information on cetaceans and fisheries and on bycatch occurrence. It was reported that fishers fear the legal ramifications of reporting bycatch and entanglement, given that it is illegal to catch and bring cetaceans to shore - punishable with heavy fines. This is a major barrier for acquiring more accurate information on bycatch. It is not illegal to catch cetaceans offshore of the 12nm zone (and they are used as shark bait). Incidental bycatch is therefore regularly discarded overboard, and not recorded or reported. Acquiring data through on-board observers is challenging due to the small vessel size of artisanal fleets. It was

reported that there is a lack of technical capacity within India in relation to understanding and dealing with cetacean bycatch, including a lack of capacity within the veterinary sector to identify bycatch as a cause of death in stranded animals. It was reported that there is a general lack of trained marine mammal scientists specialised to work on bycatch issues. Workshop participants felt that improvements to national coordination (state governments, national government departments and agencies) in relation to fisheries and marine environmental management would provide opportunities for increased coherence in bycatch/fisheries management and the ability to work in a transboundary (e.g. India/Sri Lanka) approach.

3.1.4 Opportunities and needs for tackling bycatch

The main needs identified by workshop participants for India included an official body to cut across different agencies and levels of government, facilitating coordination; change in policy in relation to the 'illegality' of cetacean bycatch, and clear communication of this to fishing communities in order to facilitate the reporting of bycatch events. Improved capacity in marine mammal science was identified as an important need, including for veterinarians and stranding responders in identifying bycatch as a cause of death. It was thought that official encouragement to collect data from stranded and bycaught (and landed) individuals could also help in improving the quality and quantity of data collected. Workshop participants reported that bycatch work in the small-scale fishing sector would be more feasible if approached with a broad-scale, rapid risk assessment first to identify the most important areas, followed by equipping vessels in these high risk areas with remote electronic monitoring systems and subsequently also work on mitigation measures (such as lowering drift nets in the water column etc).

3.2 Sri Lanka

3.2.1 Bycaught cetacean species and main fishing gears involved

Bycatch in Sri Lanka was not discussed in detail due to a lack of participants from the country. Professor Hines, who has carried out a rapid bycatch risk assessment for marine mammals in Sri Lanka provided some insights (Hines et al. 2019). High risk areas for bycatch are identified in Annex 8.1.

3.3 Pakistan

3.3.1 Bycaught cetacean species and main fishing gears involved

Cetacean bycatch is known to occur in Pakistani tuna drift gillnets, coastal bottom-set gillnets, shrimp trawls and estuarine set bagnets. Both artisanal/small-scale fisheries and semi-industrial vessels are involved. Bycatch is most significant in the pelagic semi-industrial tuna driftnet gillnet fisheries (e.g. vessels up to 24m) in which net length can extend from 4-7km (U.Shahid, pers. comm). Pelagic gillnets largely impact cetaceans in offshore/high seas whereas bottom set nets are predominantly in coastal areas (see Annex 8.2). Bycaught species include spinner dolphins (*Stenella longirostris*), bottlenose dolphins (*Tursiops truncatus*), common dolphins (*Delphinus delphis*), Risso's dolphins, humpback whales (*Megaptera novaeangliae*), and several deep-diving whale species.

3.3.2 Relevant work on bycatch

Some previous bycatch assessment work was carried out in 2003-2007 and 2010-2012, however bycatch data were relatively scarce and only collected opportunistically. WWF-Pakistan started a crew-based observer programme using fishing crews (boat captains) to collect data in an effort to increase observer coverage as per IOTC requirements. In 2012 five vessel captains from four vessels were trained to collect data on both target-catch and cetacean bycatch. Since then the programme has expanded to include participation from over 75 vessels and monitoring has also included collection of cetacean sighting data. The project produced bycatch estimates for the Pakistani coast however these estimates are currently being revised and a new peer-reviewed publication is expected shortly. The project has also tested mitigation measures (see section 4.5). This approach has proven to be

effective in significantly reducing dolphin bycatch in tuna drift gillnets, which is a major achievement with implications for fisheries across the region. Overall it was reported that participating captains felt valued and are proud to collect data using their phones and with cameras provided by the project. They often share reports on social media championing the process.

3.3.3 Challenges and Barriers - political, technical, cultural etc.

Workshop participants reported that bycatch has long been known to be a major issue in Pakistan's gillnet tuna fisheries, however cetacean species are routinely discarded back at sea whether alive or dead, which has made it difficult to assess the scope and scale of the problem. Aside from the crew-based observer programme led by WWF-Pakistan, it was reported that the local fishing industry is not particularly engaged in bycatch efforts, and it was suggested that engagement of the broader fleet remains a challenge, although the instances of entanglement in other fishing gears seems to be insignificant. It was reported that levels of cetacean depredation on target fish catch is unknown, as are the levels of cryptic cetacean mortality (e.g. where a cetacean is caught in a fishing net but falls out before it is hauled).

Workshop participants reported that the initial, very high bycatch estimates from the gillnet tuna fishery were based on extrapolating the small amount of collected data during the earlier years of the WWF project, to the whole Pakistani coast. The high bycatch estimated is a serious and concerning issue, and it was noted by the workshop participants that further information on the methodology used in this work will be shared by the authors at the IWC's Scientific Committee (Non-Deliberate Human-Induced Mortality of Cetaceans sub-committee) in 2019 and 2020, considering that cetacean populations might have had a higher relative abundance during this period in the Arabian Sea.

It was reported by the workshop participants that there are no specific cultural barriers to tackling cetacean bycatch in Pakistan, and indeed catching cetaceans is considered to bring bad luck. It was reported however that there is little or no incentive for fishers to change behaviour in relation to bycatch, nor to improve their reporting of bycatch information, leading to under-reporting of cetacean bycatch. It was perceived that political will to tackle the issue could be lacking and that improvement of data collection would also have significant financial implications. Although some fisheries in Pakistan may be affected by the US Marine Mammal Protection Act and its [import rule](https://www.fisheries.noaa.gov/foreign/marine-mammal-protection/noaa-fisheries-establishes-international-marine-mammal-bycatch-criteria-us-imports) [https://www.fisheries.noaa.gov/foreign/marine-mammal-protection/noaa-fisheries-establishes-international-marine-mammal-bycatch-criteria-us-imports], it was perceived that mitigation measures may not be effectively applied given that fisheries enforcement in general is challenging.

3.3.4 Opportunities and needs for tackling bycatch

The WWF crew-based observer scheme has been very successful and can provide new opportunities to work with fishers. Funding to continue this work beyond 2019 is being sought (e.g. through Phase 2 of the Common Oceans (ABNJ) Tuna Project). The preliminary results from the analysis of the experimental mitigation data (moving driftnets 2m below the surface) appears very promising, and once analysis of the data is complete this will provide opportunities to continue testing the successful modifications/gear to other vessels and scale up the project.

More generally, opportunities exist through international laws/regulations to incentivise the collection at national level of data on bycatch. It was noted that it would help if the information on bycatch collected initially was only used for understanding the scale of the issue rather than for compliance issues. WWF-Pakistan is keen to explore market-based incentives and tools to expand the reach of the project to the broader industry and bring about change from within the fishing industry in relation to bycatch data collection. Furthermore, WWF-Pakistan is actively exploring mitigation measures for the tuna driftnet fishery (see section 4.5), with a focus on reducing cetacean bycatch and yielding high quality tuna which can receive a premium price.

3.4 Oman

3.4.1 Bycaught cetacean species and main fishing gears involved

Currently fishing in Oman is >95% artisanal ([FAO, 2013 \[http://www.fao.org/fishery/facp/OMN/en\]](http://www.fao.org/fishery/facp/OMN/en)), with a range of different artisanal and small-scale gears including traps, pole lines, trolling lines, gillnets, driftnets, beach seines, and longlines. As with elsewhere in the region, cetacean bycatch is likely associated with use of gillnets in both drifting and set net configurations. These nets are operated from both small vessels less than 8m and those up to and greater than 15m. There is scarce information on cetacean distribution, and most available information is on the Arabian Sea population of humpback whale (e.g. Minton et al. 2011). Potential high-risk areas for cetacean bycatch (based on knowledge of fisheries and cetacean occurrence) are presented in Annex 8.3.

3.4.2 Relevant work on bycatch

Vessel based cetacean surveys in Oman have generated a sighting and encounters-based photo database of Arabian Sea humpback whales. Previous studies have been conducted using photos to evaluate the incidence of animals exposed to fisheries interactions (2008). This study is currently being revised as part of a broader health assessment for the population and is funded by the IWC Scientific Committee.

Dedicated and ad-hoc beach stranding surveys have been undertaken in Oman since the late 70's. Data protocols include assessing stranded specimens for external signs of entanglement or interaction with fisheries. Data is stored in the Oman Stranding Database which is managed under the national stranding committee chaired by the Ministry of Environment and Climate Affairs. Efforts of the committee have included hosting IFAW and IWC experts for beach stranding response training and whale disentanglement training (2016). The committee also host a social media group that keeps in frequent contact regarding stranding related events along the coast which have also included bycatch events.

Localised work has been undertaken on Masirah Island in response to an evaluation of turtle population declines. Preliminary work included high level interviews with leading fishers and authorities on the island regarding artisanal fisheries on the island (2010). A detailed community-based questionnaire survey was subsequently undertaken (2012) to both characterise the fishery (seasonal effort, distribution, gear types used and species encountered) and account for turtle bycatch. In 2016 a study was launched to refine the method for logging of fishing effort and bycatch using the vessel captains and crew as reporters using log books. This programme evolved to a remote electronic monitoring observer system using time-lapse cameras and GPS equipment to produce data on vessel effort and bycatch events around the island. This more recent data includes cetaceans in the bycatch evaluation. GIS analysis has also been completed to show the co-occurrence between fishing effort and turtle distribution around the island. The Masirah project is led by a partnership formed by the Environment Society Oman, Five Oceans Environmental Services, US Fish and Wildlife Service, US Southwest Fisheries Science Center, Ministry of Environment and Climate Affairs and permitted by the Ministry of Agriculture and Fisheries. Most recently on the island, a project led by the Environment Society of Oman has been using a conservation psychology 'behaviour change' approach to address the disposal and loss of fishing net by the artisanal fishing fleet. The study engages with fisher contacts made on previous projects.

3.4.3 Challenges and Barriers - political, technical, cultural etc.

The breakout group identified a number of perceived challenges for tackling bycatch and the lack of available information. In relation to data collection this included a perceived lack of incentives for fishers to change behaviour or report bycatch; and that improving data collection through observer

programmes or REM would have financial implications. The group reported that there could be cultural challenges involved, including the interplay between vessel owners (mainly Omani nationals), fishing crews (predominantly foreigners such as from India or Bangladesh) and bycatch researchers (predominantly westerners) meaning that three different cultures are involved. It was reported that the foreign fishing crews may have few incentives to collaborate on bycatch work. Furthermore, there are many different fisheries operating in Omani waters and this changes seasonally. This makes the process more time consuming to identify fisheries that are potentially a high risk for bycatch. The group also reported that there could be potential political barriers to tackling the issue, given addressing bycatch could be interpreted by the industry as a restriction on fisheries productivity. This could result in a reluctance to raise the profile and address the bycatch issue. These considerations place management authorities in a difficult situation where they are positioned between the aspirations of fishing communities and obligations of international agreements which include those of the Indian Ocean Tuna Commission and US Marine Mammal Protection Act. Such agreements have obligations that might work well for industrial fisheries but may not be suited to small scale artisanal fisheries where it is difficult to find methods and resources to evaluate bycatch and find solutions to problems. There is currently an absence of capacity to address the requirements of these obligations. Developing successful bycatch monitoring methods has been time consuming, with a research and development process, which has revealed solutions need to be very specific depending on the type of fishery, boat, gear and competency of crew. Using a generic 'one size fits all' approaches to bycatch, or direct transfer of methods from other fisheries is not considered entirely feasible based on current experience.

3.4.4 Opportunities and needs for tackling bycatch

There are opportunities to tackle bycatch through the community fisheries programme on Masirah Island. This project is endorsed by Oman's Ministry of Agriculture and Fisheries and there is the potential for the project to expand to a more cross taxa approach. The data from the low-cost REM has been processed for one season, but there is another season that needs to be processed- which is a major opportunity for making this work multi-taxa. This would include reviewing catch per unit effort of cetaceans based on GPS and camera data and also comparing fishing effort data with species distribution maps to assess the co-occurrence of cetaceans with fishing (as it has been done for turtles). There also needs to be some development work on the analysis of the REM data and development of algorithms for evaluating fishing effort from the GIS data. The results and community contacts made from this study will support the next step which will include creating a road map for dealing with mitigation of bycatch. In addition to the opportunities associated with bycatch evaluation in Masirah Island, there is the potential to follow up the behaviour change study carried out in the same location (with the Environment Society of Oman), using a conservation psychology approach and behaviour change methods to work with the same fisher community and examine how feasible the use of alternative gears could be.

3.5 Tanzania

3.5.1 Bycaught cetacean species and main fishing gears involved

It was reported that most cetacean research and bycatch monitoring in Tanzania has been conducted off the Zanzibar archipelago, with little data available from the mainland (e.g. Amir et al. 2002 and 2005; Temple et al. 2016; Braulik et al. 2017). Bycatch has been recorded of Indo-Pacific bottlenose dolphins, spinner dolphins, Risso's dolphins, Indian Ocean humpback dolphin, pan-tropical spotted dolphins and common bottlenose dolphins. A long-term project in Zanzibar (described in section 4.3) identified both drift nets and set gillnets as the most significant gears for bycatch. A recent study based on fisher surveys across the entire coast of the country found that 17.4% of gillnetters reported that they had caught dolphins in the last calendar year (Braulik et al. 2017). Based on this, an estimated national bycatch rate of 0.17 dolphins per gillnet boat per year was calculated. The highest reported bycatch rate in the country was the Pemba Channel, with 0.24 dolphins per gillnet boat per year,

almost five times higher than the lowest reported rates around Dar es Salaam and Mafia/Rufiji, which were 0.05 and 0.04 dolphins per boat per year, respectively. Direct hunts of cetaceans have occurred in the past, although the last reports were prior to 2000. High risk areas for bycatch were identified on the north and southwest coasts of Unguja island and in the Pemba Channel (see Annex 8.4).

3.5.2 Relevant work on bycatch

A series of interview surveys were conducted along the entire coast of the country and Pemba and Unguja to evaluate levels of bycatch, and Frame surveys were used to represent fishing effort (Braulik et al. 2017). Berggren and colleagues have been leading a long-term bycatch programme in Zanzibar for the past 20 years, commencing in 1999 with fisher questionnaires, which provided a broad overview of bycatch by different gear types (Amir et al. 2002). A self-reporting scheme was developed, compensating fishers for their time in reporting and providing dead animals and this enabled wider sampling and post-mortem analyses of stranded animals. The project focused on the southwest coast of Zanzibar, including Menai Bay Conservation Area (an MPA) with resident dolphin populations and an established dolphin eco-tourism programme and willing collaborators. The MPA does not have a management plan however it was established to curb some of the most destructive fishing practices such as dynamite fishing.

Abundance estimates based on photo identification were carried out for bottlenose dolphins and Indian Ocean humpback dolphins. Observer programmes on inshore bottom set gillnet fisheries established that the fishery was catching 5% of the humpback dolphin population annually, while an offshore active drift net fishery was catching 10% of Indo-Pacific bottlenose dolphin population each year (Amir et al., 2002 and 2005, Amir, 2010). Recent studies have indicated that Indian Ocean humpback dolphin populations have declined significantly in response to bycatch pressure, although the bottlenose dolphin population has remained stable at roughly 150 individuals, perhaps due to new animals coming in from other populations to occupy prime habitat (Sharpe, 2018). Workshop participants highlighted the urgency of the situation for the population of Indian Ocean humpback dolphins, as the current decline suggests that the population will not survive in the long term if significant mitigation measures are not taken (Sharpe, 2018).

In relation to bycatch mitigation measures, acoustic alarms/pingers were tested in controlled experiments, and a reduction in bottlenose dolphin bycatch was demonstrated in the offshore drift net fishery (Amir, 2010). However, no significant change in bycatch was detected in the inshore bottom set gillnets, due to small sample sizes. Despite the research, viable management policies in response have remained lacking, in part because some of the available mitigation methods are simply too expensive for fishers to use. This has led the research team to test low-cost mitigation measure alternatives as part of the regional Western Indian Ocean [BYCAM project](https://www.wiomsa.org/ongoing-project/by-catch-assessment-and-mitigation-in-western-indian-ocean-fisheries-bycam/) [https://www.wiomsa.org/ongoing-project/by-catch-assessment-and-mitigation-in-western-indian-ocean-fisheries-bycam/](2014-2018) (see section 4.3).

The long-term bycatch project has also fostered local capacity building with some of the local partners having progressed into management positions within the Tanzanian government. Studies have also been conducted on the impacts of tourism on the dolphins and documented some negative effects, so the researchers engaged in training of operators and encouragement of best practice (Berggren et al., 2007; Christiansen et al. 2010)

3.5.3 Challenges and barriers - political, technical, cultural etc.

It was reported that the concept of 'bycatch' is not well understood by the fishing community in Tanzania, given that cetaceans are considered food and so constitute 'catch' as much as fish. Furthermore, dolphins are used as bait in longline fisheries for sharks. This creates a challenge in engaging fishers to reduce the capture of cetaceans, as it is not seen as incidental. The paucity of data

on cetacean bycatch across the mainland and in Pemba is another challenge. Furthermore, there are challenges in relation to securing political traction to change fisheries management. Despite the long-term nature of the scientific work in Zanzibar (and results showing local population level impact and the efficacy of pingers), effective management based on the scientific findings remains lacking. Improved local capacity to explain the management implications of the research to coastal community and decision makers could potentially assist with this and bring about the necessary changes to management.

3.5.4 Opportunities and needs for tackling bycatch

(see section 3.6.4 - opportunities were discussed jointly with Kenya).

3.6 Kenya

3.6.1 Bycaught cetacean species and main fishing gears involved

Cetacean bycatch in Kenya is known to occur in artisanal and commercial gillnets (bottom set and driftnet), longline and occasionally in purse seines and in industrial trawl gear. The most commonly caught species include humpback whales (live entanglements and dead, stranded animals) and Indian Ocean humpback dolphins. Two artisanal fishers from Malindi, Kenya attended the workshop - Mohamed Hussein Ahamad and Farouq Ahmed Amin. Ahamad provided a detailed description of Kenyan artisanal fishing, including several types of gear such as large-mesh drifting 'shark' nets mainly targeting sharks (for food) and other large pelagic fish species. Nets can comprise up to 25 panels, each 60m long (e.g. up to 1500m of net). Avoiding cetacean bycatch in this gear is difficult. Recently a new handline fishery has started, roughly 70km offshore in water depths of up to 200m. There is also a longline fishery targeting different types of shark - hammerhead and tiger shark among others. Known areas with cetacean bycatch were identified and presented in Annex 8.4.

3.6.2 Relevant work on bycatch

Kenya has actively been engaging in marine megafauna bycatch issues through the regional BYCAM project, which collected data from key fishing locations where gillnets and longlines are used by small-scale fisheries (e.g. Temple et al. 2019). The artisanal fishers attending the workshop had been involved in bycatch mitigation trials alongside IWC Expert Panel members (Mueni and Berggren). Fishing effort information has been collected through the [FRAME surveys](https://www.oceandocs.org/handle/1834/8858?) [https://www.oceandocs.org/handle/1834/8858?]. There is an active Marine Mammal Network, which brings together marine mammal observers on seismic vessels, fishers, tour operators etc. to compile better information on marine mammals identified in Kenyan waters. The use of social media and instant messaging has also provided an inexpensive means of collecting data on cetaceans through citizen science reporting. Most cetacean sighting data has been collected during the humpback whale migration season, and from detailed surveys of resident Indo-Pacific Bottlenose and Indian Ocean humpback dolphins in the Kisite Mpunguti MPA in the Malindi-Watamu MPA.

A pilot project in Watamu (a small-town north of Mombasa with an MPA) was led by local NGO, Watamu Marine Association, in collaboration with fishers experiencing a significant cetacean depredation issue. The project focused on establishing trust and tapping into fisher's valued knowledge about the marine environment. This led to an increased willingness to become engaged in contributing and collecting data on cetaceans and bycatch. As of 2018, participating fishers seem to have overcome their hesitation and fear of legal reprisals to report stranding or bycatch events and a reporting network has been firmly established. The project has also facilitated connections between local teams and a global network of researchers including the IWC strandings initiative.

3.6.3 Challenges and Barriers - political, technical, cultural etc.

It was reported that some of the biggest challenges in tackling bycatch in Kenya are perceived to be the lack of information on cetaceans and the lack of information on fishing effort and gear types.

Initially there was also a misunderstanding in the reporting of bycatch versus live entanglement (where the animal survives and drags the gear away, but likely dies). In relation to bycatch information, many fishers are afraid to report events as catching cetaceans is illegal and they fear legal punishment. There are also challenges around cultural and food security issues, with marine mammals (in particular dugongs, but also cetaceans) targeted as food or products used for medicinal purposes. Workshop participants felt that there is a particular lack of information on cetaceans (abundance, diversity, distribution) in the central and north east coast of Kenya (e.g. Kipini to Lamu).

3.6.4 Opportunities and needs for tackling bycatch

The workshop participants suggested that there could be opportunities to tackle bycatch in Kenya through establishing a formal, coherent government policy that fishers reporting bycatch would not be prosecuted, and the development of a long-term participatory monitoring plan. The current marine spatial planning process might represent an important opportunity to include information on high risk areas to inform fishery zoning. It was also thought that exploring alternative livelihoods through whale watching could be an opportunity for some fishing communities within the country. Opportunities are also likely to exist within the seafood supply chain and market, with further engagement, development of markets and access allowing the potential for incentives for bycatch management. The application of socio-economic data/models within fisheries management was considered as important, as was continued engagement with researchers on bycatch mitigation technology. The artisanal fishers reported that they would welcome assistance in mitigating cetacean bycatch in their shark nets.

3.7 Madagascar

3.7.1 Bycaught cetacean species and main fishing gears involved

It was reported that cetaceans have been subject to whaling and traditional exploitation in Malagasy waters as well as bycatch in fisheries. A number of species are both directly hunted and incidentally caught, including spinner dolphins, bottlenose dolphins (*Tusiops* spp), Indian Ocean humpback dolphins, Risso's dolphins, pilot whales (*Globicephala* spp) and humpback whales. Bottlenose dolphins and spinner dolphins are caught in the highest numbers. Both gillnets and longlines targeting sharks are known to catch cetaceans. Directed dolphin take also involves traditional fishing pirogues (small wooden vessels) equipped with gillnets and harpoons. In this case gillnets are actively used to encircle groups of dolphins. Areas with known bycatch from the long-term study are presented in Annex 8.5.

3.7.2 Relevant work on bycatch

A long-term study (2000-2018 and ongoing) has been carried out to assess marine mammal bycatch and direct hunting in the south west region of Madagascar. The objective of the study was the assessment of the importance of both hunting and bycatch in this region. The study, which used a questionnaires and fisher reporting form was carried out across villages in the south west coast of Madagascar, in Toliara and the region to the north and to the south of Toliara.

3.7.3 Challenges and Barriers - political, technical, cultural etc.

It was reported that there is no legal framework for the northern part of Madagascar in terms of cetacean protection, although a new legal framework has been implemented in the south of the country.

3.6.4 Opportunities and needs for tackling bycatch

The new legal framework being implemented in the south allows for the use of dolphins only if caught dead (e.g. as bycatch) and commercial sale of dolphin meat or carcasses is prohibited. If funding were made available, workshop participants suggested that there could be opportunities for collaboration with local researchers who have established relationships with fishers to improve monitoring, and trial mitigation measures.

3.8 South Africa

3.8.1 Bycaught cetacean species and main fishing gears involved

It was reported that bycatch and entanglement of cetaceans is known to occur in a number of commercial fisheries including the rock lobster fishery (line buoys, trap) both inshore and offshore and an experimental trap fishery for octopus. Entanglement in the lines of these static gears is prevalent for humpback whales, southern right whale and Bryde's whales. Entanglement also occurs in beach shark protection nets. The location of these fisheries and shark nets is presented in Annex 8.6.

3.8.2 Relevant work on bycatch

There is a national government fisheries observer programme run by an independent consultancy ([CAPFISH/CAPMarine](https://www.capmarine.co.za/copy-of-consulting) [https://www.capmarine.co.za/copy-of-consulting]). A bycatch working group has been established which includes the fishing industry in order to tackle bycatch.

3.8.3 Challenges and Barriers - political, technical, cultural etc.

In South Africa traps and pots have been identified as presenting the greatest risk to large whales, but it was reported that fishers are reluctant to engage in the recommended practice of linking traps with lines on the seafloor in order to minimize lines to the surface.

3.8.4 Opportunities and needs for tackling bycatch

The workshop participants reported that in South Africa, the Department of Agriculture and Fisheries is about to resume marine mammal bycatch monitoring and has appointed a contracting company (CAPFISH/CAPMARINE) to undertake observer programmes. This will provide an opportunity for the collection of standardised bycatch data. It was also reported that the South African Sharks Board have reduced the length of shark netting from 44 km in the mid-1990s to 20 km last year. This has been further reduced to 13 km in 2019 and it was thought that this measure should greatly reduce the risk of cetacean entanglement.

3.9 France - La Reunion

3.9.1 Bycaught cetacean species and main fishing gears involved

Cetacean bycatch in La Reunion was not discussed in depth, and attending experts stated that depredation by cetaceans on longlines was the main issue (Rabearisoa et al. 2018), which could occasionally lead to bycatch. The main longline fishing areas are identified in Annex 8.5.

3.10 Maldives

3.10.1 Bycaught cetacean species and main fishing gears involved

Cetacean bycatch in the Maldives was reported to be low as all major forms of net fishing are banned. Instead, there is a traditional pole and line fishery dating back hundreds of years targeting yellowfin tuna (*Thunnus albacares*) which incurs very little bycatch. The fishing gear is limited to catching smaller fish (30-50cm) and there is little-to-no interaction with cetaceans. Fishing catch and effort in this fishery are well documented. Recently a handline fishery for larger yellowfin tuna has been developed. The targeted tuna schools often associate with small cetaceans (e.g. spotted dolphins, spinner dolphins), and fishers use the dolphins to locate them. There is also a longline fishery in the Maldives targeting tuna, although it is unknown whether cetacean depredation and subsequent bycatch is an issue (e.g. with species such as false killer whales).

3.10.2 Relevant work on bycatch

Cetacean distribution information is available from dedicated surveys, although the analysis of these data is incomplete. Bycatch assessment work has mainly focused on bycatch of sharks, and to a lesser degree on turtles (where ghost fishing gear is thought to represent a significant issue).

3.10.3 Opportunities and needs for tackling bycatch

It was suggested that the lack of gillnet fisheries could make the Maldives a good control region in a broad-scale bycatch assessment, to compare with other fisheries across the region where large numbers of cetaceans are being caught in gillnet fisheries.

4. EXISTING SOLUTIONS AND APPROACHES FOR TACKLING BYCATCH - TRANSFERABILITY TO INDIAN OCEAN

4.1 Electronic Monitoring

Lotte Kindt-Larsen presented on the use of remote electronic monitoring (REM) as a tool to accurately and extensively document cetacean bycatch. Quantification of cetacean bycatch is important in the context of conservation and management of protected species. Using on-board observers has previously been the most reliable and accurate method to monitor bycatch. Many countries are required to monitor a representative proportion of their fishing fleets for bycatch (e.g. national law, or obligations through RFMOs), but many fail to do so due to the high proportion of vessel and effort coverage needed and high cost of observation.

To reduce price and increase coverage, closed-circuit television (CCTV) cameras have been used to document bycatch of marine mammals in Denmark. Beginning in 2010, six to fifteen Danish commercial gillnet vessels have every year been equipped with REM systems. The REM systems provide video footage, time and GPS position of all net hauls and catches. All fishers have participated on a voluntary basis but have received additional quotas for their participation. The results showed that REM system gave more reliable results compared to fisher self-reporting, as in many cases, the animal had already dropped out of the net before coming on board. Furthermore, very high coverage was obtained with REM. Harbour seals (*Phoca vitulina*), grey seals (*Halichoerus grypus*) and harbour porpoises (*Phocoena phocoena*) were easily identified on the video footage. With respect to seabird identification it was generally possible to identify most species from the video footage although good conditions were needed in the case of some species. The bycatch and fishing effort data collected by the REM system have been used to construct a simple model in order to explain the relationship between number of individuals bycaught and species density and fishing effort. The final model can thus be used as a tool to identify areas of bycatch risk and support the conservation and management of protected species.

4.2 Mitigation

Robert Enever presented on the currently available technical mitigation tools for reducing cetacean bycatch in gillnet fisheries. A large number of potential technical measures (58 types over 5 gear types) have been extensively trialled for a number of decades in different fisheries and gears, however very few measures show evidence that they effectively reduce bycatch or show promise (7 technical solutions have evidence or show promise across 5 gear types) (see Hamilton and Baker 2019). It is estimated that ~84% of bycaught cetaceans globally are caught in set/drift nets (Read et al. 2006). However, at the current time there are only two technical mitigation solutions with scientific evidence demonstrating that they effectively reduce cetacean bycatch in this gear type. These are acoustic deterrents (4.2.1) and net illumination (4.2.2).

4.2.1 Acoustic deterrents or 'pingers'

Enever provided a brief overview of acoustic deterrents as a cetacean bycatch mitigation measure. There is evidence available from fisheries in the US and Europe that acoustic deterrents have been effective in reducing incidental bycatch (as opposed to depredation caused bycatch) for some small cetacean species interacting with certain fishing gears. Evidence exists in particular for harbour porpoise, with some evidence for other species such as the franciscana (*Pontoporia blainvillei*), striped dolphins (*Stenella coeruleoalba*), Burmeisters porpoise (*Phocoena spinipinnis*) and for common dolphins and some beaked whale species (see Hamilton and Baker, 2019 and Leaper and Calderan 2017, for summaries). Pinger effectiveness appears to be fishery and species specific. There is evidence that acoustic deterrents will not effectively deter some cetacean species (including those depredating fish catch), and for those species listed above, effectiveness is not always consistent (Leaper and Calderan, 2017). There is also evidence that acoustic deterrents do not work as well in some gears (e.g. longlines, trawls). Evidence is inconclusive for the effectiveness of pingers in deterring baleen whales (Hamilton and Baker, 2012). Acoustic deterrents require maintenance (e.g. ensuring batteries are working) and the cost varies between units and suppliers. Some fisheries managers and scientists have raised concerns over the potential for negative impacts from widespread use of acoustic deterrents. This includes concerns that acoustic deterrents would contribute to underwater noise pollution (enonification) which could be detrimental to marine mammals and other marine life. A scientific paper is currently being prepared addressing these concerns. Other issues that have been raised about acoustic deterrents include the potential for cetacean species to become habituated to the sound and not deterred from approaching the fishing gear. More modern models of pingers have been developed to try and address this issue.

4.2.2 Net illumination

Enever provided information from recent experimental net light trials in Peru led by an NGO ([ProDelphinus](https://www.prodelphinusperu.org/) [https://www.prodelphinusperu.org/]) which have shown encouraging results, with 80% bycatch reduction for three taxa (seabirds, turtles and small cetaceans) in nets equipped with lights (Bielli et al. *In Press*). Despite this promising result, net illumination has the potential to cause impacts on other species, with evidence of increased catches of sharks and rays in the experimental trials. Depending on the fishery this could be a positive impact, with increased landings and money from catch, however it could have a significantly negative impact on shark conservation. This highlights the need for a holistic approach to bycatch mitigation which considers the impacts on other taxa. Furthermore, net lighting is still in the early days of experimentation and more research is needed on optimal spacing of the lights and whether a flashing light is effective (to see if battery use can be reduced).

4.2.3 Economic factors for mitigation

Enever highlighted the need to consider the economic reality of the fisheries and fishers, and that in many cases fishers may not have any incentive to solve their cetacean bycatch issue. The willingness of the fishing industry to use technical mitigation measures is vital, and it is important to remember that fishers are shrewd businessmen! Effective technical measures can be perceived as attractive to fishers as they enable fishers to continue their fishing operations whilst reducing interactions with cetaceans (and/or other bycaught species) and these measures can be rapidly implemented. Implementing effective mitigation measures across an entire fleet also brings significant cost. Using Peru as an example, with 3000 gillnet vessels, the cost to equip the entire fleet with pingers would cost \$USD 0.25 million or \$USD84 per vessel per year, or with (as yet experimental) lights \$USD1 million or \$USD350 per vessel. The conservation outcome of scaling either of these technical measures across the whole gillnet fleet could be estimated as a reduction of 50,000-70,000 bycaught small

cetaceans in the case of pingers, or in the case of net lights, a reduction of 80,000 small cetaceans 100,000 turtles and 10,000's seabirds being caught.

4.3 Using low-tech, low-cost methods to reduce entanglement in gillnets

Per Berggren provided a presentation on experimental trials of low-cost mitigation measures to reduce cetacean bycatch in gillnets. There are two main conditions to be met for fishers to use mitigation methods to reduce bycatch: firstly, that the method should not reduce catch of target species, and secondly that the method should have no or very low cost. Electronic acoustic alarms represent one possible solution to mitigate cetacean bycatch but the cost of fitting out fishing gear with devices limits their implementation, particularly in fisheries in developing countries. To address this, Berggren and colleagues developed low-cost (US\$0.25 per 100m net) solutions from recycled plastic and glass bottles to create passive acoustic reflectors and mechanical alarms (see Figure 3). Empty, recycled 500ml plastic bottles produce a -27dB acoustic reflection when exposed to a 70kHz broadband dolphin click. Recycled 350ml glass bottles with a suspended metal pendulum bolt produce a “clinking” sound ($\leq 10\text{kHz}$, 130-160dB re 1uPa/VHz @ 1m). The bottle reflectors and sound producers should facilitate gillnet detection by dolphins at sufficient distance to avoid entanglement.

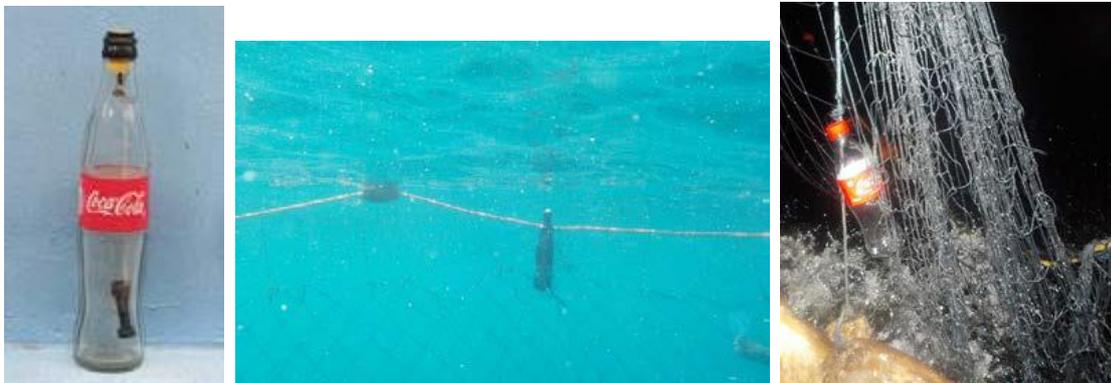


Figure 3. Examples of experimental glass bottle alarms (left and centre) and plastic bottle reflectors (right). Photos © Per Berggren.

The plastic and glass bottles were tested in a driftnet fishery in Menai Bay, south coast of Zanzibar, Tanzania, in January-March 2017. Previous observer programmes in the area indicated a bycatch rate of 0.02 Indo-Pacific bottlenose dolphin/driftnet haul. Furthermore, previous trials in the same fishery using electronic acoustic deterrents (10kHz, 132dB) had effectively reduced dolphin bycatch (Amir, 2010). Thirty-six driftnet vessels participated in the trials and were randomly assigned an independent observer to record fishing operation and catch. Vessels were randomly assigned either to a control group, or to equip their net with either glass bottle alarms every 50m on the headline, or plastic bottle reflectors every 50m on the sink-line. 1107 hauls were observed (401 control, 394 glass and 312 plastic). It was expected that eight dolphins would be caught across all the nets in the control group, however although dolphins were present in the fishing area during the trial, none were caught in either the control or experimental sets, making a comparison impossible. However, there was a significantly higher catch of target fish in nets with plastic bottles compared to control nets. The Zanzibar trials were therefore inconclusive as to whether the glass bottle alarms and/or the plastic bottle reflectors effectively reduce dolphin bycatch. The team has successfully secured further funding to conduct trials in fisheries and locations with consistently high cetacean bycatch (eg. funding from the US Marine Mammal Commission and NOAA BREP has allowed the team to conduct glass bottle trials in Peru in April 2019 in a driftnet fishery in collaboration with the NGO ProDelphinus; the plastic bottle reflectors and lights will be trialled in a bottom set gillnet fishery in Argentina starting in October 2019 in collaboration with AquaMarina). Work is also underway to develop a solar-chargeable LED

light. The team will also be conducting workshops to investigate potential barriers to implement mitigation methods. These will be held in Argentina, Peru and Zanzibar. Results from the trials will be reported to the BMI as soon as available.

4.4 GIS tools to assess bycatch risk in endangered populations of nearshore cetaceans

Hines presented on a toolbox for place-based risk assessment of marine mammal bycatch. Marine mammal bycatch, a major threat to sustainable populations, poses a particular challenge in developing countries. Yet, data to document bycatch and the effects of bycatch are often lacking as the research takes time, money, and training. A suite of tools for place-based risk assessment of marine mammal bycatch was designed that makes use of existing data and creates a framework for data acquisition. This is called the Bycatch Risk Assessment (ByRA) toolkit. The tools have open-source processing to guide scientists and managers through a process that results in a spatial risk analysis to support science-policy processes.

Within the ByRA toolkit, users are provided with methods to evaluate existing data, leading to mapping of distribution of fishing effort and the use of gear predominant in bycatch occurrences. ByRA assesses the risk of bycatch based on the spatial and temporal coincidence of ranked probabilities of overlap between species occurrence and fishing (see Figure 4). Risk to species caused by a stressor is calculated as the weighted average of exposure, or the degree a species experiences stress due to a human activity (spatial/temporal overlap, intensity, status of management strategies), and consequence, the species-specific resilience and sensitivity to a stressor (mortality, life stages affected, etc.). Exposure is the overlap between a species' distribution and the extent of a human activity in space and time. Consequence, in terms of sensitivity, is an expert assessment of how a population will respond to and recover from an impact. In terms of resilience, consequence is based on a scientific assessment of the population dynamics and life history of a species. The ByRA output is a series of GIS layers, showing these risk scores for each site or region, and a map layer for the species classified by the relative amount of risk (high/medium/low).

Hines presented the bycatch risk assessment methods that consider abundance survey design, spatial characterization of habitat, bycatch spatial patterns, estimates of analysis uncertainty, protected area design, and the incorporation of socio-cultural dynamics. The research teams have collected a range of data from three countries in Southeast Asia, including the eastern Gulf of Thailand, Sarawak and peninsular Malaysia and southwestern Vietnam. These locations all have similar coastal cetaceans and sirenians, small-scale and commercial fisheries, and support from either local universities or management agencies. Using these diverse sites as input has enabled the creation of an adaptable and scalable toolkit to support marine mammal conservation and inform fisheries management strategies. These methods will support practitioners to find effective measures to reduce that bycatch to sustainable levels. A fifth field site in NW Sri Lanka, showed how the toolbox could be used for multiple species as a rapid assessment method for assessing and mapping bycatch risk to shrimp fisheries (see Hines et al, 2019 for more information).

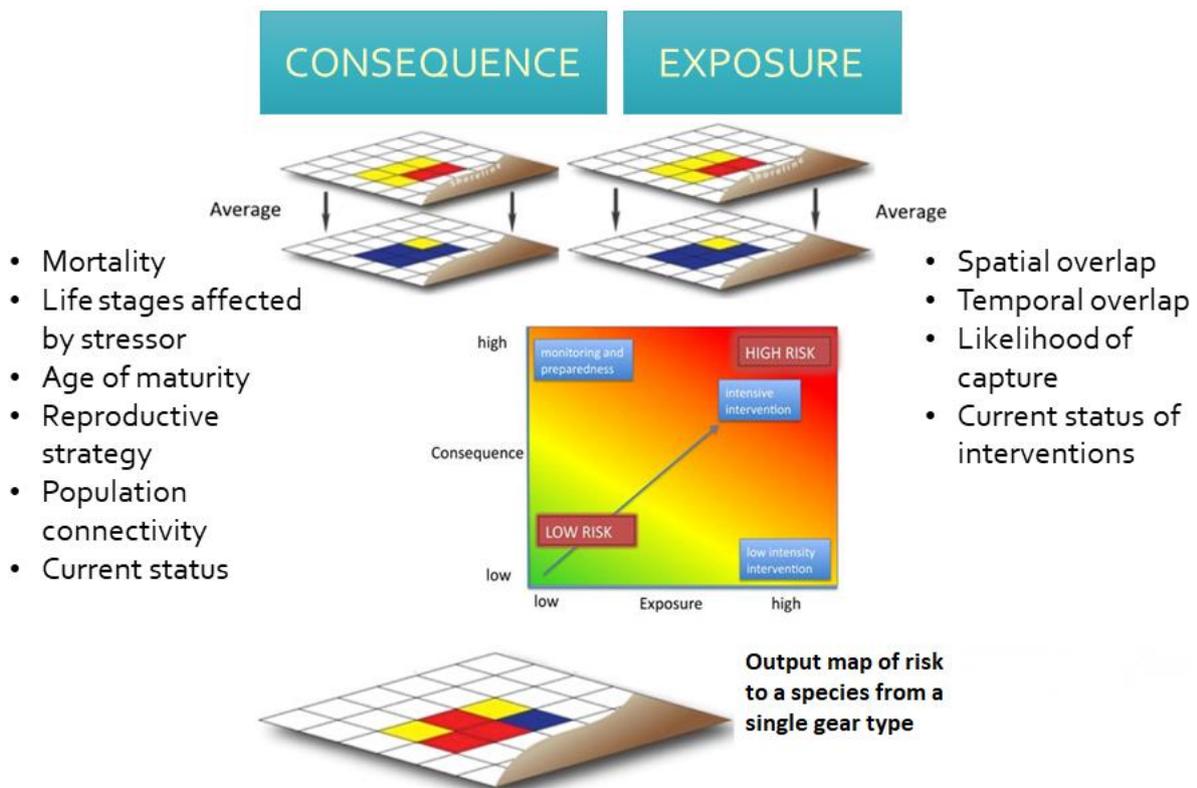


Figure 4. Conceptual diagram depicting how exposure and consequence criteria are combined to estimate risk for a species using the ByRA toolkit. Arkema et al. 2014.

4.5 Tackling data gaps through an innovative crew-based observer programme

Umair Shahid presented a case study on WWF’s crew-based observer programmes in Pakistan, to demonstrate the effectiveness of citizen science-based approaches (see Figure 5). In the northern Indian Ocean, tuna is primarily caught with drift gillnets. Although, the magnitude and impact of bycatch is unknown, bycatch rates are suspected to be high. In Pakistan, a network of trained captains (initially five captains, four 15-20 m vessels, and eventually captains of 76 participating vessels), systematically collected data on both targeted-catch (tunas) and cetacean bycatch from 2013 to 2017.



Figure 5. Crew-based observers monitoring and recording cetacean bycatch and fish catch in the tuna driftnet fishery as part of WWF-Pakistan’s project. Photos © WWF-Pakistan

Over the study period, a total of 3,874 drift-gillnet sets was monitored. Two fishing methods using multifilament gillnets were used: surface and subsurface gillnets. Surface gillnets were deployed at the surface, whereas subsurface gillnets were deployed at 2 m below the surface; net height varied from 10 to 14 m). Five captains operating four vessels over the study period between 2013 and 2017, recorded a total of 203 cetacean captures (involving 7 species) (representing 0.04% of all catch). Catch per unit of effort (CPUE) was calculated for both targeted species and cetaceans and were also compared between the two fishing methods used. Overall, tuna CPUE in surface and subsurface gillnets were not significantly different, whereas cetacean bycatch was significantly higher in surface gillnets than in subsurface gillnets. Although this study should be improved in its experimental design (to ensure that changes in bycatch rates are due only to changes in gear deployment and not changes in dolphin presence/density from one year to the next), and consider the use of other monitoring methods (e.g., electronic monitoring systems, use of independent observers), results from this study are encouraging and suggest that relatively minor changes in fishing practices can significantly reduce bycatch without affecting targeted species catches.

4.6 Incentivising fisheries to trial and adopt mitigation measures

Sarah Mesnick presented on market-based tools, which can incentivise fishers to adopt bycatch mitigation measures by engaging the seafood supply chain to make fisheries more sustainable and profitable. The presentation reviewed the case of the vaquita (*Phocoena sinus*), nearing extinction due to entanglement in gillnets targeting fish and shrimp, and the status of efforts to develop and implement non-entangling fishing gears.

The vaquita is found only in a small region of the northernmost Gulf of California, Mexico, and although vaquita habitat is protected and gillnets are currently banned by the Mexican government, illegal fishing with gillnets threatens the survival of the species. Illegal fishing is motivated by the high prices paid for the swim bladders of the endangered totoaba (*Totoaba macdonaldi*), which is prized in China. Neither fisheries management nor enforcement are effective in combating illegal activities, and thus bycatch continues to cause the decline of the vaquita population. Incentive-based approaches that support fishers willing to use alternative gears can be complementary to “command and control” or ‘top down’ approaches if efforts are made to establish profitable market connections with buyers and chefs interested in ‘vaquita-friendly’ products and these price and niche market incentives are transmitted to fishers. Technologically viable alternative gears are available but efforts to implement them have been hindered by a lack of legal permits, the local preference for gillnets and the perception that alternative gears will not allow profitable fishing.

Market data analyses for shrimp products from the region allow research to: (a) characterise the entire value chain to better understand where buyers/consumers could share the costs of conservation, (b) investigate market tools, such as a ‘vaquita-friendly’ brand or ecolabel that can improve potential earnings or profits and (c) analyse potential net earnings for the new gear fisheries. Analyses revealed large-size class shrimp found only in vaquita’s range have high value in the market and that eco-labelled products can increase marketplace prices by 10-40%, thereby offering evidence of the potential benefits of an incentivising approach. Engagement with the supply chain in the region, including chefs and seafood buyers on both sides of the U.S. – Mexico border revealed strong interest in ‘vaquita friendly’ products. The research documented current U.S. market value for all size classes of Mexican shrimp but it was not possible to calculate net earnings for potential new fisheries without more information on at-sea operation costs of alternative gears and the size, species, quantity and condition of shrimp landed. These data are critical to collect in order to assess the economic viability of new fisheries.

The situation in the upper Gulf of California shows that reliance on enforcement alone cannot abate the lucrative illegal trade for totoaba swim bladders or eliminate vaquita bycatch. Saving vaquita - and

other species threatened by entanglement in fishing gears - requires policy measures that create economic incentives that increase compliance and induce technological advances in fisheries, if profits can be transmitted to fishers. Engagement with the seafood supply chain and culinary community can support these efforts. Their culinary conservation approach aims to integrate and amplify efforts of fishers using non-entangling gears with the interests of chefs, processors, buyers and consumers in ways that benefit communities, biodiversity and local economies. The culinary approach also provides a way for consumers to support ocean conservation efforts they care about and for chefs and buyers to become known in this important and growing niche market for sustainably sourced seafood. The approach may be applicable in other regions around the globe in which small cetaceans are threatened by gillnet fisheries. The ultimate goal is to incentivise compliance through an increase in the value of fisheries harvested without endangering marine mammals. Ideally, branding products from fishers that provide proof can lead to market advantages, through improved efficiencies (such as new supply chains using direct marketing), improvements in quality/freshness or through higher prices, preferential market access or market distinction.

Market-based approaches to bycatch mitigation require time to develop and non-traditional collaborations with chefs, fishmongers, economists and industry. It was clear from the case of vaquita in the upper Gulf of California that these efforts must start early, as the prerequisite changes in fisheries management and fishing technology, culture and markets take time, time that vaquita no longer has left.

5. DISCUSSION AND RECOMMENDATIONS

This section summarises the workshop discussions and agreed conclusions and recommendations in relation to various themes over the two days.

5.1 Priorities for tackling cetacean bycatch in the Indian Ocean

The workshop recognised that bycatch is one of the most significant threats to cetacean species and populations in the Indian Ocean region. The best available information suggests that very high numbers of animals are caught in medium-scale tuna gillnet fisheries in the Indian Ocean and Arabian Sea region. Furthermore, despite the lack of data it is thought likely that high numbers of cetaceans, including vulnerable species and populations are caught in coastal artisanal and small-scale (net, trap and line) fisheries across the region (see Temple et al. 2018, Temple et al. 2019). The workshop concluded that there was an urgent need to raise awareness at local, national and regional and international scales on the need to address cetacean bycatch. The workshop also concluded that within the Indian Ocean region there was a need to focus on gillnets (set and drifting) as the fishing gear most likely to be causing the highest and most significant bycatch of cetaceans, and for which few technical solutions currently exist.

A number of common barriers to tackling bycatch were identified, including: under-reporting of bycatch by fishers (see section 5.13); lack of standardised monitoring programmes which are suitable and financially viable for small-medium-scale vessels; lack of capacity to carry out bycatch monitoring and reduction programmes; lack of reporting through RFMOs (section 5.16) ; lack of sustainable funding to carry out bycatch reduction programmes; lack of awareness and political will to tackle the issue; lack of capacity and clarity at national level on the steps, tools and approaches needed to tackle bycatch; and lack of baseline information on cetacean distribution and abundance; and lack of technical solutions proven to work on the fisheries in the region. The workshop recognised that cetacean bycatch is generally very poorly documented in the region and that this presents a major barrier to understanding the scale of the issue and making progress towards bycatch reduction. It concluded that a more systematic assessment of bycatch information is critical, particularly for small-scale and medium-scale fisheries. The workshop recognised that within the region there is the potential to use rapid bycatch assessment tools to identify the most important areas of

fishery/cetacean interaction. Participants identified areas within countries' territorial and exclusive economic zones which they assessed as 'high risk' for bycatch, or where significant cetacean bycatch was known to occur (see Annex 8). These areas could be used to prioritise bycatch reduction efforts. The workshop noted that the regional focus of the meeting had helped collate existing information on bycatch and that such an approach was potentially useful for other regions. It agreed that until now there had not been an international body to champion cetacean bycatch mitigation, and that the IWC's Bycatch Mitigation Initiative could collaborate with existing initiatives and assist countries, RFMOs and other bodies interested in tackling bycatch in a number of ways. The suggested role and activities for the BMI include the development of a regional road map for tackling cetacean bycatch and a framework for more sustainable funding of bycatch work, strengthened engagement with RFMOs in the region (IOTC and SWIOFC) and the provision of training and technical assistance and development of toolboxes in collaboration with other relevant bodies and organisations (e.g. the FAO, RFMOs, other IGOs and NGOs)- see Annex 9 and the recommendations below for further details.

The workshop **recommends** that governments in the Indian Ocean region establish or strengthen bycatch assessment and reduction programmes as a matter of urgency, with priority on bycatch hotspots areas identified across the region (including those identified during the workshop in Annex 8). Associated actions could include rapid risk assessments, on-board data collection, mitigation trials (experimental and existing measures) and/or implementation of effective management measures.

The workshop **recommends** that governments and other relevant stakeholders in the Indian Ocean region carry out cetacean sampling surveys to collect information on species abundance and distribution at national and regional scales and encouraged that this information could be shared with the IWC Scientific Committee.

The workshop **recommends** that the IWC (including through its Conservation Committee) develop and communicate recommendations to governments on the importance of addressing bycatch through policies and other measures that support bycatch mitigation efforts, and of more coherent approaches across government departments with different mandates; and promotes the sharing of information and experience between its contracting members.

The workshop **recommends** that the BMI assist bycatch reduction efforts in the Indian Ocean region including through:

- raising awareness and prioritisation of addressing cetacean bycatch in small-medium-scale gillnet fisheries through its engagement with member countries and other IGOs and NGOs;
- developing a regional road map for bycatch reduction (including assessment, monitoring and mitigation) in collaboration with other relevant bodies (e.g. FAO, IOTC, CMS, national governments);
- providing technical assistance to countries to assess different aspects of cetacean bycatch (e.g. monitoring, assessment, mitigation) and support and promote multidisciplinary monitoring (e.g. social science techniques, economics) and mitigation approaches, including through capacity building;
- exploring means of more consistent and sustainable approaches for funding of bycatch mitigation efforts.

5.2 Holistic approach for tackling bycatch in Indian Ocean

The workshop discussed the importance of establishing bycatch reduction programmes which are multi-disciplinary, consider multi-taxa effects, are collaborative and participatory, and which are ultimately viable for fishers and managers to implement.

Bringing about behavioural change on bycatch requires working with fishing communities and fisheries managers and other stakeholders. An integration of socioeconomic and socio-cultural factors alongside science and technology and conservation is needed. Even the most effective technical solution will likely not work if it is perceived as threatening livelihoods and not properly implemented.

Furthermore, if efforts across taxa (e.g. including sharks and rays, turtles, seabirds) are not coordinated there is the risk that technical mitigation measures which work for one taxon could have unintended impacts on another, or that fishers are overloaded with different mitigation measures or rules.

The workshop **recommends** that bycatch reduction efforts employ a multi-disciplinary and multi-taxa approach at local, national and international scales.

5.3 Design of bycatch reduction programmes

Participants discussed the challenges associated with carrying out mitigation trials, and the need for a scientifically rigorous experimental design. In many projects, bycatch monitoring has been undertaken for a number of years prior to mitigation trials. This can produce difficulties in comparing bycatch rates over different years/seasons/fishing trips, due to changes in fishing activity, cetacean populations and environmental effects etc. The workshop agreed that it was generally more effective to undertake simultaneous monitoring of both experimental gear and 'normal' control gear, in order to directly compare bycatch under the same conditions. This also enables research to more rapidly move towards mitigation scenarios, whilst still collecting vital monitoring information on baseline bycatch rates.

The workshop discussed the need for understanding the economic conditions of the fishery (see section 5.10) and the close participation of fishers in the design, testing and implementation of bycatch reduction approaches to ensure that they are feasible and viable for them to use and build confidence where appropriate that their target catch will not be affected.

The workshop **recommends** that the BMI provides technical assistance to governments and other relevant stakeholders within the Indian Ocean region in the design of experimental mitigation trials that are both scientifically rigorous and which supports the livelihoods of fishing communities, as far as is possible.

The workshop highlighted that many initiatives testing solutions for cetacean bycatch reduction do not always consider how communicate the scientific results to managers and decision makers, leading to a lack of implementation of solutions. It agreed that it was critical that such initiatives involve decision makers, and/or that there is capacity within research teams to communicate the information.

The workshop **recommends** that the IWC (through the BMI and through its conservation and scientific committees) assist efforts to communicate scientific and conservation advice to decision makers in collaboration with other inter-governmental organisations and non-governmental organisations.

5.4 Participatory approaches to engage with fishing communities

Throughout the workshop the importance of partnering with fishers in tackling bycatch was strongly emphasised. The workshop welcomed the description by the Kenyan artisanal fishers of small-scale fishing operations and their participation in the workshop and thanked Ahamad and Ahmed Amin for sharing some of their high-quality smoked fish with participants. The workshop agreed that it is vital to include fishers in these types of workshops and include them in all stages of tackling bycatch, in order to ensure that the issue is understood by the fishing community and solutions are effective and financially and operationally viable and effectively implemented over the long-term.

The workshop discussed engaging fisher participation in citizen science for the collection of bycatch monitoring data and experimental trials of mitigation gear. Projects in Pakistan, Kenya and India, provide powerful examples of the power of citizen science to address information gaps. Empowering fishers can lead to year-round data provision/collection and willingness to engage directly in bycatch reduction. However, it takes continual efforts to build and maintain trust (addressing concern about involvement of law enforcement agencies etc.) so that fishers will bring information without fear of punishment. The workshop noted the importance that technology can play in facilitating fisher citizen science. In India, for example researchers are testing technology to alert fishers to areas to avoid because fish shoals had been associated with turtles. There is potential to develop similar technology for cetaceans.

Despite initiatives to build partnerships and trust with fishing communities, the workshop noted the challenges (as managers, conservationists, scientists etc) in communicating to fishers the effectiveness of existing mitigation measures/approaches or the applicability of alternative gears. For example, many fishers believe that pingers will reduce target catch despite assurances or sensory research demonstrating the contrary. This misperception has persisted across many different fishing communities and is primarily a communication issue. The workshop noted that fishers are often reluctant to switch gears away from something that is familiar and provides a reliable catch.

The workshop discussed the potential for exchanges between fishers in different countries, or even regions within one country as an effective way to help convince fishers that shifts to gears or mitigation measures that cause less bycatch will not result in income loss (either because it does not reduce target catch or it can lead to higher quality catch that can command a higher value in the market). Within the Indian Ocean context, fishers using drifting gillnets for tuna could visit other fisheries where the switch had been made from gillnets to longlines. The low-cost mitigation measure project (see section 4.3.) will be funding and supporting a fishery exchange visit, with a fisher from a US fishery with dolphin bycatch visiting fisheries in Peru/Argentina to promote the low-cost methodologies.

The workshop observed a need for improved communication with fishers, in order to fully understand their perspective and economic reality in relation to bycatch; and to more effectively engage fisher communities and communicate the need for action, the positive impacts from mitigation/alternative gears or modified gears (e.g. market based incentives), and the efficacy of existing solutions. Communication tools such as fisher exchanges, citizen science and novel ideas such as working with children of fishing communities to promote conservation are all extremely useful and relevant to countries across the region.

The workshop **recommends** to governments and other relevant stakeholders in the Indian Ocean region that bycatch monitoring and reduction efforts use (where appropriate) crew-based approaches for collecting data on bycatch and mitigation measures (including where observer programmes are not feasible due to the size of vessel, the large numbers of small and medium-scale fishing vessels, trip length, safety concerns etc).

The workshop **recommends** that the BMI assist national efforts by developing a toolbox of more effective tools for communication with fishing communities and associations including the promotion of fisher-exchanges to share experiences of bycatch mitigation efforts and efficacy.

5.5 Research, development and trials of low-cost technical solutions

The workshop noted the importance of developing low-cost but effective mitigation technologies that do not reduce target fish catch. It welcomed the trials of low-cost experimental mitigation described by participants. It was noted in relation to experimental methods described in section 4.3 that commercial fisheries working in deeper waters may require the use of other materials (e.g. stainless steel rather than glass). The potential for glass bottle alarms to act as attractants for other taxa was discussed (e.g. seals and sea lions have been found to be attracted to the equivalent electronic 10kHz pinger). This is a potential area for future trial and modification. It also noted that in India, there has been some recent work to modify gillnets, promoting the use of non-nylon material and different mesh sizes to see if this can reduce cetacean bycatch by making the nets more obvious to echolocating cetaceans and less entangling.

The workshop agreed that there was a pressing need to see low-cost techniques trialled as much as possible, in order to get statistically significant results on their efficacy as a mitigation technique-noting that it is hard to obtain results/demonstrate success in areas where bycatch is low but the impacts on a population of conservation might be high. It was also agreed that more research and development is needed around existing successful set net technical measures (e.g. acoustic pingers and potentially lights) to reduce uncertainty over their effectiveness in different situations.

The workshop **recommends** renewed efforts by the research community and fisheries technologists in the research and development of low-cost bycatch mitigation and monitoring solutions, particularly for gillnet fisheries and the scaling-up of testing of existing measures (e.g. lights and acoustic deterrents, and experimental low-tech tools) in different fisheries and locations.

5.6 Spatial/temporal measures for reducing bycatch

The workshop noted the importance of spatial and temporal measures (e.g. fisheries closures, MPAs, reserves, marine spatial planning etc) in reducing bycatch in areas with high overlap between cetaceans and high-risk fishing gears. Tools such as the rapid spatial risk assessment toolbox provides managers and researchers with the opportunity to quickly identify high risk areas, which can be used for marine spatial planning/zoning and protection. In Pulau Sibul, Malaysia (see section 4.4) MPAs have been proposed that encompass key dugong habitat where fishing also presents a high risk of bycatch. The tool can also be used iteratively, to refine and update risk maps as new data are acquired, or management action becomes more urgent. The workshop also noted the potential value of marine spatial planning processes to explore designation of areas to minimise conflicts and interactions as well as the potential to shift gears from gillnets to those that induce less bycatch, like longlines.

5.7 Alternative gears to reduce bycatch

As there are very few technical solutions available to mitigate or reduce cetacean bycatch (or other taxa bycatch) in gillnets, the workshop acknowledged the importance of considering a switch to alternative gears which would still enable target catch to be caught but with a lower cetacean bycatch risk, for example handlines or pole and line. It discussed the example presented from Mexico (see section 4.5) and the need for consideration of additional (non-cetacean bycatch) impacts brought on by a gear switch. Any switch to alternative gears also needs to be economically viable for the fishery.

5.8 Alternative livelihoods

The workshop discussed the potential to explore alternative livelihoods (e.g. in eco-tourism) in collaboration with fishing communities where bycatch is particularly significant and where future management measures could restrict fishing activity. Examples from Watamu, Kenya, and Zanzibar, Tanzania were used to illustrate this issue ([see here for a full case study](https://wwhandbook.iwc.int/en/case-studies/kenya) [https://wwhandbook.iwc.int/en/case-studies/kenya]). Alternative livelihoods in the form of whale watching was considered by the Watamu fishing community and NGOs following a number of humpback whale entanglements during migration and breeding season. This had caused net damage and lost income for fishers. The Watamu Marine Association proposed that fishers stop fishing during this period and instead use their vessels and marine knowledge to offer whale watching to tourists. A number of fishers participated in this trial and reportedly found it to be economically viable. Those who did not offer tours on their own boats, could act as ‘middle-men’, bringing clients to the boats for whale watching, creating a new economy and viable alternative livelihoods. In Zanzibar, Tanzania, fishers also engaged in providing dolphin watching tours, which replaced direct hunting of dolphins. Studies showed that income from one day of tours was equivalent to that of several days of fishing effort. However, participants noted the importance of clear guidelines on best practice to avoid introducing additional sources of stress to the whale or dolphin populations and that the IWC’s [Whale Watching Handbook](https://wwhandbook.iwc.int/en/) [https://wwhandbook.iwc.int/en/] could be a useful resource. The workshop also concluded that there are cultural and food security issues within the region which should be carefully considered before engaging in discussions on alternative livelihoods.

5.9 Promotion of cetacean conservation - compensation schemes for fishers

The workshop discussed the role of fisher compensation schemes when gear is damaged or lost from an interaction with a cetacean, reducing the likelihood of future retaliation. The suitability of this approach for Kenyan fishers was discussed, and the workshop noted that microfinancing schemes and gear marking might help fishers get compensation for nets lost at sea. However, participants agreed that as a priority, efforts should be first made to reduce interactions between cetaceans and nets.

5.10 Integrating economics into bycatch mitigation programmes

The workshop discussed specific aspects of the economics of bycatch including the need for bycatch reduction programmes and management measures to be financially feasible for the fishing community. It also discussed opportunities involved in examining seafood supply chains and ‘culinary conservation’ and the non-market benefits of reducing bycatch. Workshop participants agreed that these economic aspects are all part of the bigger picture in addressing bycatch.

The workshop noted the need for integration of economics within bycatch mitigation work. It agreed that for any project exploring bycatch reduction alternatives (e.g. through gear modification, alternative gears, temporal/spatial methods) it is critical to collect basic economic (financial) data when conducting gear trials (or changes in fishing activity) so that it is possible to determine the change in *net* revenues (Total sales – Total costs) of fishing using the modified gear (or fishing activity) – compared to status quo. Net revenues might be modified due to changes in the volume of catch and also the value, since the price could be higher if there is a reward such as an eco-label or alternative

gear can result in better quality of catch. The reduced costs to fishers from gear damage or loss should also be considered in the comparative analysis, if avoiding cetaceans means less interactions with gear.

The workshop also noted that there is a whole field of study on the non-market value of protected species, for example the financial benefits of the reduction in cetacean mortality and the increase of healthy cetacean populations. Thriving cetacean populations imply a greater economic contribution from ecotourism activities such as whale/dolphin watching.

The workshop recognised the importance of capturing socio-economic information as part of a holistic and multi-disciplinary approach, and therefore **recommends** to countries that monitoring and mitigation programmes should also integrate collection of economic data (CPUE, catch value etc) to be collected and analysed alongside bycatch information.

5.11 Incentivising fishers - participation in bycatch reduction programmes

The workshop noted that incentivising behaviour change for bycatch reduction can be done in a number of ways, such as offering some compensation or 'offset' – likely monetary – for taking action to address bycatch. Collaboration from fishers to implement alternative practices or mitigation gear will in many cases also require a market incentive - such as higher prices for target catch that is caught without bycatch. In Vietnam, for example a shift in gears (from longlines to handlines) in the tuna fishery posed less of a bycatch risk and resulted in fresher/higher quality fish that was worth 5-10 times as much in the market (Shahid, pers. comm). In California, a shift from drift gillnets for swordfish to deep-set buoy gear further reduced marine mammal and bycatch of other protected species while decreasing the soak time, thus increasing value, from ca. US\$3-\$5/lb to ca. US\$5-\$8/lb, although at volumes only for the high quality, niche markets (Mesnick, Sepulveda and Fukushima, pers. comm.). Direct engagement with the seafood supply chain and culinary community can help to promote fishers that are working to reduce marine mammal bycatch, incentivising participation in bycatch mitigation programs. Compensation could also be offered in the form of wholesale changes such as a different target species/fishery, or alternative livelihood.

The workshop noted that that several fisheries in East Africa (e.g. Kenyan lobster fishery, Tanzanian Octopus fishery and Mozambique shrimp fishery) are undergoing Fisheries Improvement Projects (FIPs) that will eventually lead to some certification and increased market access and premium prices for certified seafood products (see [Fishery Progress](https://fisheryprogress.org/) [https://fisheryprogress.org/] for examples of FIPs). More support is needed to introduce similar schemes throughout the region, to ensure bycatch is being considered and ensure uptake by seafood supply chain actors and consumers.

5.12 Directed cetacean catch

The workshop noted that in several countries across the Indian Ocean region the term 'bycatch' is not clearly defined, especially where marine mammals are targets of fisheries for bait and for human consumption. The workshop noted that in other parts of the world (e.g. Southeast Asia) marine mammals are also used as food (Mintzer et al. 2018, Consentino and Fisher, 2016) however they are often also revered in traditional folklore and/or for medicinal purposes or good luck charms (Porter and Lai, 2017). It might be appropriate in some East African countries to use the cultural importance of the animal to motivate local fishers and populations to conserve them. However, the workshop agreed that there is a need to recognise the cultural importance (and in some cases food and nutritional need) of consuming cetaceans in any discussion about 'bycatch reduction' or suggestions of 'alternative livelihoods' designed to reduce bycatch.

5.13 Legal ramifications leading to bycatch under-reporting

At many points in the workshop the issue of lack of reporting of bycatch due to fishers' fear of legal ramifications (due to cetacean protection and fines for capture) was discussed, and participants perceived this as a major barrier to collecting bycatch data and improving national and regional understanding of bycatch. This was a shared concern across many of the Indian Ocean countries.

The workshop **recommends** that governments in the Indian Ocean region consider pro-active reassurance to fishers that there will not be negative consequences in response to reporting bycatch and furthermore recommends to use fisher reported data for monitoring and bycatch management purposes rather than for compliance and enforcement.

5.14 Information on bycatch from strandings data

The workshop discussed the lack of capacity in some countries, such as in India, to determine bycatch as the cause of death in stranded animals. It noted that there is a particular need for training within some countries, including of veterinarians to recognise where bycatch has caused the death of an animal, and that this could also facilitate improved data collection of bycatch events. It highlighted that the IWC's Stranding Initiative could assist countries in delivering training and capacity building in stranding response, including necropsy techniques for determining cause of strandings.

5.15 Remote Electronic Monitoring tools

The workshop discussed the use of REM tools for improving the quality and quantity of bycatch monitoring. Discussion focused on the time investment needed to analyse REM data collected from fishing vessels. Kindt-Larsen explained that time investment for REM analysis will depend on taxa, but overall in comparison to an observer programme it can reduce the time needed by a magnitude of five, as software can be used to automate identification of bycatch events and thus a qualified person needs only to review the images/video associated with net hauls, and video can be reviewed at higher speeds. A five-year pilot study has also recently been conducted in the Netherlands (see Scheidat, et al. 2018) using REM to monitor bycatch of harbour porpoise in Dutch bottom set gillnet fisheries, further demonstrating the effectiveness of this method.

Participants were interested in the cost of REM systems and the possibility of low-cost systems. The workshop noted that automated electronic monitoring can be done quite cheaply depending on the sophistication of the technology needed ((see also the reference to [Shellcatch](https://shellcatch.com/welcome/) [https://shellcatch.com/welcome/] systems for small-scale fisheries in the IWC Scientific Committee Report, 2019). In Oman researchers have used an inexpensive time-lapse camera in a waterproof housing and a GPS tracker to monitor fishing effort and landings. The workshop briefly discussed the standardisation of approaches and noted that the set up and methodology will depend on circumstances but it is advantageous to minimise the number of cameras on board and thus keep the complexity of the system and quantity of data down to the minimum required, particularly in less automated systems when manual upload and review of data is required.

The workshop recognised the growing importance of REM methods and the possibility for cost-effective monitoring at a fleet-scale, and therefore **recommends** that governments and relevant stakeholders in the Indian Ocean region engage in trialling REM approaches for bycatch monitoring, including low-cost methods for small and medium-scale vessels (and in other vessels as appropriate).

The workshop **recommends** that the BMI provide technical assistance upon request on the REM systems available and their applicability to a specific situation.

5.16 Opportunities for engaging with the IOTC on cetacean bycatch

The workshop discussed the challenges of bycatch estimation at the Indian Ocean regional-scale, particularly given the major data gaps present in many countries. The workshop noted that work is currently underway to refine estimates based on updated, available data, and that this will be very relevant and useful when complete. Despite the uncertainty around the region-wide estimates, it was agreed that cetacean bycatch in the Indian Ocean tuna fisheries is likely to be higher in comparison to tuna fisheries in other regions due to the predominance of drifting gillnets rather than longlines and trawl gear (see SPC-OFP, 2012 as a comparison with the Western Central Pacific region).

The workshop participants acknowledged that underreporting of bycatch at IOTC remains a challenge. It noted that countries were consistently not prioritising their IOTC observer programmes, or enforcement of observer coverage at the national level, and as a consequence the observer programme has only had limited success in collecting bycatch data across the region. In some cases, observer programmes exist but the data are not shared with the IOTC. At the same time, the workshop noted that the IOTC has taken some direct measures to monitor and mitigate cetacean bycatch (e.g. the successful ban on cetacean encirclement).

The workshop noted that the IOTC's WPEB devotes time to material that is presented to the meeting each year. Traditionally papers have predominantly focused on bycatch of sharks and birds. For example, Birdlife International have invested significantly in placing observers on vessels and to participate in meetings., However marine mammals have traditionally been overlooked as there has been little or no effort to present data or information at meetings (although recently more papers have focused on gillnet bycatch). The workshop further noted the political challenges in achieving progress within the RFMOs on bycatch mitigation. The workshop recognised the importance of raising the profile of cetacean bycatch within the context of the IOTC and its contracting parties, and that there is an opportunity for the BMI to act as a catalyst to ensure more engagement on cetacean bycatch and to communicate the relevant research priorities at future meetings.

The workshop concluded that there was an important need to raise the profile of cetacean bycatch and promote bycatch reduction efforts within the context of RFMOs, and specifically within the Indian Ocean and it therefore **recommends** that:

- The BMI engage more formally and more regularly with the IOTC, the South West Indian Ocean Fisheries Commission (SWIFOC) and other relevant RFMOs, including in collaboration with other relevant organisations, to encourage more discussion and action of cetacean bycatch monitoring and mitigation in the fisheries under their management. This could be achieved through direct observer status and/or the appointment of regional representatives/contacts to maintain an overview of relevant RFMO meetings and opportunities to participate and/or present information.
- IWC Contracting Governments undertake further efforts to improve the quality and quantity and reliability of cetacean bycatch data reported to the IOTC and to other bodies (including the IWC national reports) and for small-scale fisheries.
- That the BMI support where appropriate contracting and non-contracting governments in the exchange of cetacean bycatch information and experiences between neighbouring countries and support the development of transboundary approaches including through BMI engagement with RFMOs
- That the BMI explore its potential to assist countries in fulfilling their reporting requirements under IOTC, as well as the potential for greater sharing of information on bycatch between the IWC and FAO/the RFMOs

5.17 Additional opportunities for regional/international collaboration on bycatch

The workshop noted that there are a number of other initiatives that are of direct relevance to tackling cetacean bycatch within the Indian Ocean region and that collaboration with these initiatives and bodies should be encouraged. A number of these initiatives were described above (e.g. the development of FAO voluntary technical guidelines on marine mammal bycatch mitigation; and work of individual RFMOs). In addition the workshop noted the work of international NGOs on multi-taxa bycatch such as WWF, Whale and Dolphin Conservation Pew Foundation, BirdLife International (and others, including at national level across the region as highlighted in other sections); research consortia on small-scale fisheries such as [Too Big to Ignore](http://toobigtoignore.net/) [http://toobigtoignore.net/] and the work of national agencies and the fisheries technology industry. In particular, the workshop noted possible opportunities to work on cetacean bycatch through the second phase (commencing in 2021) of the [Common Oceans \(ABNJ\) Tuna Project](http://www.fao.org/in-action/commonoceans/projects/tuna-biodiversity/en/) [http://www.fao.org/in-action/commonoceans/projects/tuna-biodiversity/en/]. This multi-partner project includes t-RFMOs, and the first phase has been working to improve sustainability of tuna fisheries, including a number of relevant work areas (e.g. the Bycatch Management Information System - [BMIS](https://www.bmis-bycatch.org/) [https://www.bmis-bycatch.org/ and understanding the scale of bycatch of sharks and turtles in multiple regions, and for cetaceans in Pakistan). The workshop noted the potential of joining up work between the [Global Ghost Gear Initiative](https://www.ghostgear.org/) [https://www.ghostgear.org/] (GGGI - which aims to reduce the amount of lost and abandoned fishing gear in the world's oceans) and the IOTC, however the IOTC is currently more focused on the threats presented by abandoned Fish Aggregating Devices (FADs). The BMI plans to continue working to develop collaborations with these initiatives.

9. REFERENCES

- Amir, O.A., Berggren, P., Jiddawi, N.S., 2002. The Incidental Catch of Dolphins in Gillnet Fisheries in Zanzibar, Tanzania. *Western Indian Ocean J.Mar. Sci.* 1, 155–162.
- Amir, O.A., Jiddawi, N.S., Berggren, P., 2005. The occurrence and distribution of dolphins in Zanzibar, Tanzania with comments on the differences between two species of Tursiops. *Western Indian Ocean J. Mar. Sci.*, 4: 85-93. <https://doi.org/10.4314/wiojms.v4i1.28476>
- Amir, O. 2010. Biology, ecology and anthropogenic threats of Indo-Pacific bottlenose dolphins in east Africa. Phd Thesis, University of Sweden.
- Anderson, R. C., 2014. Cetaceans and Tuna Fisheries in the Western and Central Indian Ocean. IPNLF Technical Report 2, International Pole and Line Foundation, London. 133 pages.
- Arkema, K.K., Verutes, G., Bernhardt, J.R., Clarke, C., Rosado, S., Canto, M., Wood, S.A., Ruckelshaus, M., Rosenthal, A., McField, M., de Zegher, J., 2014. Assessing habitat risk from human activities to inform coastal and marine spatial planning: a demonstration in Belize. *Environmental Research Letters* 9, 114016. <https://doi.org/10.1088/1748-9326/9/11/114016>
- Atkins, S., Cliff, G., Pillay, N., 2013. Humpback dolphin bycatch in the shark nets in KwaZulu-Natal, South Africa. *Biological Conservation* 159, 442–449. <https://doi.org/10.1016/j.biocon.2012.10.007>
- Bielli, A., Alfaro-Shgueto, J., Doherty, P., Godely, B.J., Oritz, C., Pasara, A., Wang, J.H., Mangel, J.C. In press. *An illuminating idea to reduce bycatch in the Peruvian Small-Scale Gillnet Fishery*
- Braulik, G.T., Kasuga, M., Wittich, A., Kiszka, J.J., MacCaulay, J., Gillespie, D., Gordon, J., Said, S., Hammond, P.S., 2017. Cetacean rapid assessment: An approach to fill knowledge gaps and target conservation across large data deficient areas *Aquat. Conserv: Mar Freshw Ecosyst*, 1-15
- Christiansen F, Lusseau D, Stensland E, Berggren P. 2010. Effects of tourist boats on the behaviour of Indo-Pacific bottlenose dolphins off the south coast of Zanzibar. *Endangered Species Research*, 11: 91-99.
- Cosentino, AM., Fisher, S. 2016. The Utilization of Aquatic Bushmeat from Small Cetaceans and Manatees in South America and WestAfrica. *Front. Mar.Sci.*3:163. doi: 10.3389/fmars.2016.00163
- Fishery and Aquaculture Country Profiles. Oman., 2013. Country Profile Fact Sheets. In: *FAO Fisheries and Aquaculture Department* [online]. Rome. Updated 2015. [Cited 29 May 2019]
- Garcia, A., Herrera, M., 2018. Assessing the Contribution of Purse Seine Fisheries to Overall Levels of Bycatch in the Indian Ocean. Report to the IOTC Working Party on Data Collection and Statistics. IOTC-2018-WPDCS14-26_Rev1. <https://www.iotc.org/documents/WPDCS/14/26-PSBycatch>
- Hamilton, S., Baker, G., 2019. Technical mitigation to reduce marine mammal bycatch and entanglement in commercial fishing gear: lessons learnt and future directions. *Reviews in Fish Biology and Fisheries*. <https://doi.org/10.1007/s11160-019-09550-6>
- Hines, E., Verutes, G., Ponnampalam, L., 2019. Marine megafauna bycatch in swimming crab nets in north-western Sri Lanka. A final report for Monterey Bay Aquarium Seafood Watch.
- IWC, 2019. Report of the Scientific Committee. Annex J. Report of the Sub-Committee on Non-Deliberate Human-Induced Mortality of Cetaceans. Nairobi, Kenya, 10-23 May 2019. 30pp. (unpublished). [Available online at: <https://archive.iwc.int/?r=9570>]
- Kuppusamy, S., 2019. Status and management of marine mammals bycatch in India. Poster presented as background document for IWC Bycatch Workshop, Nairobi, May 8-9.

Leaper, R., Calderan, S., 2017. Review of methods used to reduce risks of cetacean bycatch and entanglements. UNEP/CMS/COP12/Inf.15. <https://www.cms.int/en/document/review-methods-used-reduce-risks-cetacean-bycatch-and-entanglements>

Meÿer, M.A., Best, P.B., Anderson-Read, M.D., Cliff, G., Dudley, S.F.J., Kirkman, S.P., 2011. Trends and interventions in large whale entanglement along the South African coast. *African Journal of Marine Science*, vol 33, 3.

Minton, G., Collins, T. J. Q., Findlay, K. P., Ersts, P. J., Rosenbaum, H. C., Berggren, P., Baldwin, R. M., 2011. Seasonal distribution, abundance, habitat use and population identity of humpback whales in Oman. *Journal of Cetacean Research and Management, Special Issue on Southern Hemisphere Humpback Whales*(3), 185–198

Mintzer, V.J., Diniz, K., Frazer, T.K., 2018. The Use of Aquatic Mammals for Bait in Global Fisheries. *Front. Mar. Sci.* 5. <https://doi.org/10.3389/fmars.2018.00191>

Porter, L., Lai, H.Y., 2017. Marine Mammals in Asian Societies; Trends in Consumption, Bait, and Traditional Use. *Front. Mar. Sci.* 4. <https://doi.org/10.3389/fmars.2017.00047>

Read, A.J., Drinker, P., Northridge, S., 2006. Bycatch of Marine Mammals in U.S. and Global Fisheries: Bycatch of Marine Mammals. *Conservation Biology* 20, 163–169. <https://doi.org/10.1111/j.1523-1739.2006.00338.x>

Rabearisoa, N., Sabarros, P.S., Romanov, E.V., Lucas, V., Bach, P., 2018. Toothed whale and shark depredation indicators: A case study from the Reunion Island and Seychelles pelagic longline fisheries. *PLOS ONE* 13, e0202037. <https://doi.org/10.1371/journal.pone.0202037>

Sharma, A., Feir, A., Chassot, O. 2019. Remote electronic monitoring of marine turtle bycatch in the Eastern Pacific. Report by Shellcatch submitted to the IWC Scientific Committee 68A. Human Induced Mortality sub-committee. SC_68A_06.

Sharpe, M.J. 2018. Abundance and Conservation Assessment of Indo-Pacific Bottlenose and Indian Ocean Humpback Dolphins off the South Coast of Zanzibar. MPhil-thesis. Newcastle University, UK 122pp.

Scheidat, M., Couperus, B., Siemensma, M., 2018. Electronic monitoring of incidental bycatch of harbour porpoise (*Phocoena phocoena*) in the Dutch bottom set gillnet fishery (September 2013 to March 2017). Wageningen Marine Research, IJmuiden. <https://doi.org/10.18174/466450>

Temple, A.J., Tregenza, N., Amir, O.A., Jiddawi, N., Berggren, P., 2016. Spatial and Temporal Variations in the Occurrence and Foraging Activity of Coastal Dolphins in Menai Bay, Zanzibar, Tanzania. *PLOS ONE* 11, e0148995. <https://doi.org/10.1371/journal.pone.0148995>

Temple, A.J., Kiszka, J.J., Stead, S.M., Wambiji, N., Brito, A., Poonian, C.N.S., Amir, O.A., Jiddawi, N., Fennessy, S.T., Pérez-Jorge, S., Berggren, P., 2018. Marine megafauna interactions with small-scale fisheries in the southwestern Indian Ocean: a review of status and challenges for research and management. *Reviews in Fish Biology and Fisheries* 28, 89–115. <https://doi.org/10.1007/s11160-017-9494-x>

Temple, A.J., Wambiji, N., Poonian, C.N.S., Jiddawi, N., Stead, S.M., Kiszka, J.J., Berggren, P., 2019. Marine megafauna catch in southwestern Indian Ocean small-scale fisheries from landings data. *Biological Conservation* 230, 113–121. <https://doi.org/10.1016/j.biocon.2018.12.024>

Yousuf, K. S. S. M., Anoop, A.K., Anoop, B., Afsal, V.V., Vivekanandan, E., Kumarran, R.P., Rajagopalan, M., Krishnakumar, P.K., Jayasankar. P., 2009. Observations on incidental catch of cetaceans in three landing centres along the Indian coast. *Marine Biodiversity Records* 2:e64. doi: 10.1017/S175526720900075X

10. ANNEXES

Annex 1 IWC Bycatch Mitigation Initiative Workshop Programme.

Bycatch Mitigation Opportunities in the Western Indian Ocean and Arabian Sea 8th – 9th May 2019,
Safari Park Hotel, Mount Elgon room

Wednesday, May 8th, 2019	
Objectives: 1) Engage local stakeholders; 2) Provide general overview of what is known of bycatch and mitigation options in the region; 3) Introduce the Bycatch Mitigation Initiative as a collaborative effort to reduce bycatch globally	
Session 1. Welcome and introduction	
14:00-14:15	Meeting opening by co-chairs Official welcome: <ul style="list-style-type: none"> • <i>IWC Bycatch Standing Working Group Chair, Stephanie Langerock,</i> • <i>Director General, Kenya Fisheries Services, Susan Imende</i>
14:15-14:30	Bycatch Mitigation Initiative and workshop objectives – <i>Presentation by IWC Bycatch Coordinator, Marguerite Tarzia</i>
Session 2. Setting the scene	
14:30-15:10	Existing solutions to bycatch monitoring and prevention: broad overview of strategies and tools that can be used to more accurately document and mitigate cetacean bycatch - <i>Presentation by IWC Expert Panel members, Lotte Kindt-Larsen and Robert Enever</i>
15:10-15:30	Current state of knowledge - cetacean Bycatch in the Indian Ocean: Cetacean bycatch in the Indian Ocean - fisheries of concern, hotspots and data gaps - <i>Presentation by IWC Expert Panel Jeremy Kiszka</i>
15:30-15:40	Questions and discussion
Session 3. Fisheries management	
16:00-16:20	Opportunities and incentives for reporting bycatch in the Indian Ocean: Reporting requirements, regional observer scheme, and new data collection and/or mitigation strategies - <i>Presentation by chair of IOTC Working Party on Ecosystems and Bycatch, Sylvain Bonhommeau</i>
16:20-16:30	Questions and discussion
Wednesday, May 8th, 2019 contd.	
Session 4. Local perspectives on bycatch	
16:30-17:45	Panel discussion: Bycatch in the Western Indian Ocean and Arabian Sea - shared experience from a range of national representatives of what is known about bycatch across the region and the main gaps and challenges to tackle the problem.
17:45-19:00	TBA <i>Before breaking for the day, workshop participants to decide on break out groups for session 6 tomorrow. Participants will be provided with questions to think about overnight.</i>

Thursday, May 9th, 2019	
<p>Objectives: Focus on the Western and Northern Indian Ocean - 1) Share models for solutions - projects underway in the region and/or projects that could be replicated/trialed in the Indian Ocean; 2) Identify key needs for bycatch mitigation in the Indian Ocean 3) identify and map opportunities for bycatch mitigation projects in the Indian Ocean</p> <p>Planned outcome: Identify specific locations/fisheries where the BMI and/or collaborating organisations could assist in tackling bycatch. Identify the type of assistance or type of work needed.</p>	
8.30-8.40	Chair's introduction to the day
Session 5. Case studies - Building collaborations	
8:40-8:55	Case study: Tackling data gaps through an innovative crew-based observer programme - <i>Presentation by WWF-Pakistan, Moazzam Khan</i>
8:55-9:10	Case study Incentivizing fisheries to trial and adopt mitigation measures. <i>Presentation by IWC Bycatch Expert Panel member, Sarah Mesnick</i>
9:10- 9:20	Questions and discussion
Session 5 contd. Case studies - Solutions in low data, low-tech situations	
9:20- 9:35	Case study: GIS tools to assess bycatch risk in endangered populations of nearshore cetaceans - <i>Presentation by IWC Bycatch Expert Panel member, Ellen Hines</i>
9:35- 9:50	Case study: Using low-tech, low-cost methods to reduce entanglement in gillnets - <i>Presentation by IWC Bycatch Expert Panel member, Per Berggren</i>
9:50-10:00	Question and discussion
Thursday, May 9th, 2019 contd.	
Session 6. Break-out session	
10:30-13:00	<p>Identifying needs and opportunities across the region: Break out group session. Participants to divide into four sub-groups to consider specific questions including:</p> <ul style="list-style-type: none"> • What are the main bycatch issues in your country/region/fishery? What are the potential challenges to better assess and mitigate this bycatch? • What are the main mechanisms and opportunities to assess and mitigate bycatch in this region/fishery? What would be needed to enable better assessment/mitigation? <p><i>Sub-groups will be provided with templates and questions to shape this discussion and allow them to share their results with the wider group. A rapporteur will need to be nominated per group</i></p>
13:00-14:00	Lunch break , served in Café Kigwa
14:00-15:00	Report back from break-out groups. Synthesize maps of bycatch hotspot areas, data poor areas, and fisheries where opportunities exist to trial mitigation measures. Highlight where capacity to tackle the issue could be further developed. <i>15 minutes each from 4 groups.</i>
15:30-16:00	Tea/Coffee break
Session 7. Next steps	
16:00-16:30	Moving Forward: Identifying opportunities for future collaborative work at national and regional level, including through the Bycatch Mitigation Initiative Workplan (e.g. potentially identifying pilot projects, or capacity needs in the Western Indian Ocean and Arabian Sea).
16:30-17:00	Conclusion and thanks

Annex 2 Workshop participant list

Name	Affiliation and position	Country
Gill Braulik	Independent researcher	Tanzania
Stephanie Langerock	Senior International Relations Office, Directorate-General for Environment, and Chair of IWC Standing Working Group on Bycatch	Belgium
Lotte Kindt Larsen	National Institute of Aquatic Resources, Technical University of Denmark, IWC Bycatch Expert Panel member	Denmark
Heidrun Frisch-Nwakanma	Convention on Migratory Species (CMS)	Germany
R. Gopinath	Joint Director (Wildlife) Ministry of Environment, Forest and Climate Change, Wildlife Division	India
Sivakumar Kuppusamy	Department of Endangered Species Management, Wildlife Institute of India, Scientist and Professor	India
Shelley Clarke	Common Oceans (ABNJ) Tuna Project, Food and Agriculture Organization of the United Nations (FAO)	Italy
Farouq Ahmed Amin	Beach management Unit leader	Kenya
Mohmed Hussein Ahamad	Artisanal Gillnet fisher	Kenya
Tim Collins	Wildlife Conservation Society (WCS Kenya), IWC Bycatch Expert Panel Member	Kenya
Edward Kimakwa	WWF Kenya	Kenya
Edward Kimani	Chief Scientist, Fisheries Programme. Kenya Marine and Fisheries Research institute (KMFRI)	Kenya
Jane Njeri Kinya	Deputy Director of Fisheries State Department of Fisheries, Aquaculture and the Blue Economy	Kenya
Elizabeth Mueni	Assistant Director of Fisheries, Kenya Fisheries Service, IWC Bycatch Expert Panel member	Kenya
Mike Mwangi'mbe	Watamu Marine Association (WMA), Marine Mammal Project Coordinator	Kenya
Stephen Ndegwa	Chief Fisheries Officer, Kenya Fisheries Service, & Chair IOTC Working Group on Data and Statistics	Kenya
Johnstone Omukoto	Kenya Marine and Fisheries Research institute (KMFRI)	Kenya
Jane Spilsbury	Watamu Marine Association	Kenya
Arthur Tuda	Assistant Director, Kenya Wildlife Service, Assistant Director	Kenya
Beth Wagude	Executive Secretary, Kenya Fish Processors & Exporters Association (AFIPEK)	Kenya
John Wanyoike Karungo	Principal Fisheries Officer, Kenya Fisheries Service	Kenya
Sylvain Bonhommeau	Chair IOTC Working Party on Ecosystems and Bycatch; Ifremer, Researcher	France- La Reunion
Norbert Andrianarivelo	University of Toliara, Lecturer in marine science	Madagascar
Charles Anderson	Independent consultant	Maldives
Gianna Minton	Consultant and Coordinator WWF Cetacean Initiative and Arabian Sea Whale Network	Netherlands
Arne Bjorge	Institute of Marine Research, (IMR)- Principal Scientist, & IWC Bycatch Expert Panel member	Norway
Andrew Willson	Five Oceans Environmental Services	Oman
Umair Shahid	WWF Indian Ocean Tuna focal point, IWC Bycatch Expert Panel member	Pakistan/ Mozambique
Steven McCue	Department of Environmental Affairs	South Africa
Mdu Seakamela	Marine mammal scientist, Department of Environmental Affairs	South Africa
Anne-Marie Svoboda	Department of Nature & Biodiversity, Ministry of Agriculture, Nature and Food Quality (The Netherlands), Senior Policy Officer	Netherlands
Per Berggren	Newcastle University- Senior Lecturer; IWC Bycatch Expert Panel Member	UK
Sarah Dolman	Whale and Dolphin Conservation (WDC), IWC Bycatch Expert Panel Member	UK
Robert Enever	Fishtek Marine, Head of Science & Uptake, IWC Bycatch Expert Panel member	UK
Russell Leaper	IWC Bycatch Expert Panel member, chair of the IWC Subcommittee on Human Induced Mortality	UK
Rebecca Lent	IWC, Executive Secretary	UK
Sarah Smith	IWC, Head of Programme Development	UK
Marguerite Tarzia	IWC, Bycatch Coordinator	UK
Grantly Galland	Officer, Global Tuna Conservation, The Pew Charitable Trusts	USA
Ellen Hines	San Francisco State University, IWC Bycatch Expert Panel member	USA

Jeremy Kiszka	Florida International University, IWC Bycatch Expert Panel Member	USA
David Mattila	IWC, Large Whale Entanglement Response Coordinator	USA
Sarah Mesnick	NOAA Fisheries Southwest Science and Fisheries Centre, & IWC Bycatch Expert Panel Member,	USA
Alexandre Zerbini	Marine Mammal Laboratory Alaska Fisheries Science Center/NOAA; Vice Chair of IWC Scientific Committee	USA
Lorenzo Rojas Branco	Head of Marine Mammal Research and Conservation, National Institute of Ecology and Climate Change in Mexico; Chair of IWC Conservation Committee	Mexico
Vincent Ridoux	Faculté des Sciences et Technologie, Université de La Rochelle	France
Robert Suydam	Senior Wildlife Biologist, Alaska North Slope Borough. Chair of IWC Scientific Committee	USA
Othniel Mwabili	Principal Fisheries Officer, Kenya Fisheries Service, IWC focal point	Kenya
Susan Imende	Director General, Kenya Fisheries Services	Kenya

Annex 3 List of meeting documents

Bycatch Mitigation Workshop Agenda - IWC Secretariat

Information for Workshop Participants - IWC Secretariat

IWC Bycatch Mitigation Initiative - Background Context for Workshop-IWC Secretariat

Background documents:

Food and Agriculture Organisation of the United Nations (FAO), 2018, Report of the expert workshop on means and methods for reducing marine mammal mortality in fishing and aquaculture operations. Rome, Italy. <http://www.fao.org/3/I9993EN/i9993en.pdf>

Garcia, A., Herrera, M., 2018. Assessing the Contribution of Purse Seine Fisheries to Overall Levels of Bycatch in the Indian Ocean. Report to the IOTC Working Party on Data Collection and Statistics. IOTC-2018-WPDCS14-26_Rev1. <https://www.iotc.org/documents/WPDCS/14/26-PSBycatch>

Hall, M., Gilman, E., Minami, H., Mituhasi, T., Carruthers, E., 2017. Mitigating bycatch in tuna fisheries. *Reviews in Fish Biology and Fisheries* 27, 881–908. <https://doi.org/10.1007/s11160-017-9478-x>

Hamilton, S., Baker, G.B., 2019. Technical mitigation to reduce marine mammal bycatch and entanglement in commercial fishing gear: lessons learnt and future directions. *Reviews in Fish Biology and Fisheries* 29, 223–247. <https://doi.org/10.1007/s11160-019-09550-6>

Hines, E., Verutes, G., Ponnampalam, L., 2019. Marine megafauna bycatch in swimming crab nets in north-western Sri Lanka. A final report for Monterey Bay Aquarium Seafood Watch.

Kuppusamy, S., 2019. Status and management of marine mammals bycatch in India. Poster presented as background document for IWC Bycatch Workshop, Nairobi, May 8-9.

Leeper, R., Calderan, S., 2017. Review of methods used to reduce risks of cetacean bycatch and entanglements. UNEP/CMS/COP12/Inf.15. <https://www.cms.int/en/document/review-methods-used-reduce-risks-cetacean-bycatch-and-entanglements>

Lewis, R.L., Crowder, L.B., Wallace, B.P., Moore, J.E., Cox, T., Zydelski, R., McDonald, S., DiMatteo, A., Dunn, D.C., Kot, C.Y., Bjorkland, R., Kelez, S., Soykan, C., Stewart, K.R., Sims, M., Boustany, A., Read, A.J., Halpin, P., Nichols, W.J., Safina, C., 2014. Global patterns of marine mammal, seabird, and sea turtle bycatch reveal taxa-specific and cumulative megafauna hotspots. *PNAS* 111, 5271–5276. <https://doi.org/10.1073/pnas.1318960111>

Temple, A.J., Kiszka, J.J., Stead, S.M., Wambiji, N., Brito, A., Poonian, C.N.S., Amir, O.A., Jiddawi, N., Fennessy, S.T., Pérez-Jorge, S., Berggren, P., 2018. Marine megafauna interactions with small-scale fisheries

in the southwestern Indian Ocean: a review of status and challenges for research and management. *Reviews in Fish Biology and Fisheries* 28, 89–115. <https://doi.org/10.1007/s11160-017-9494-x>

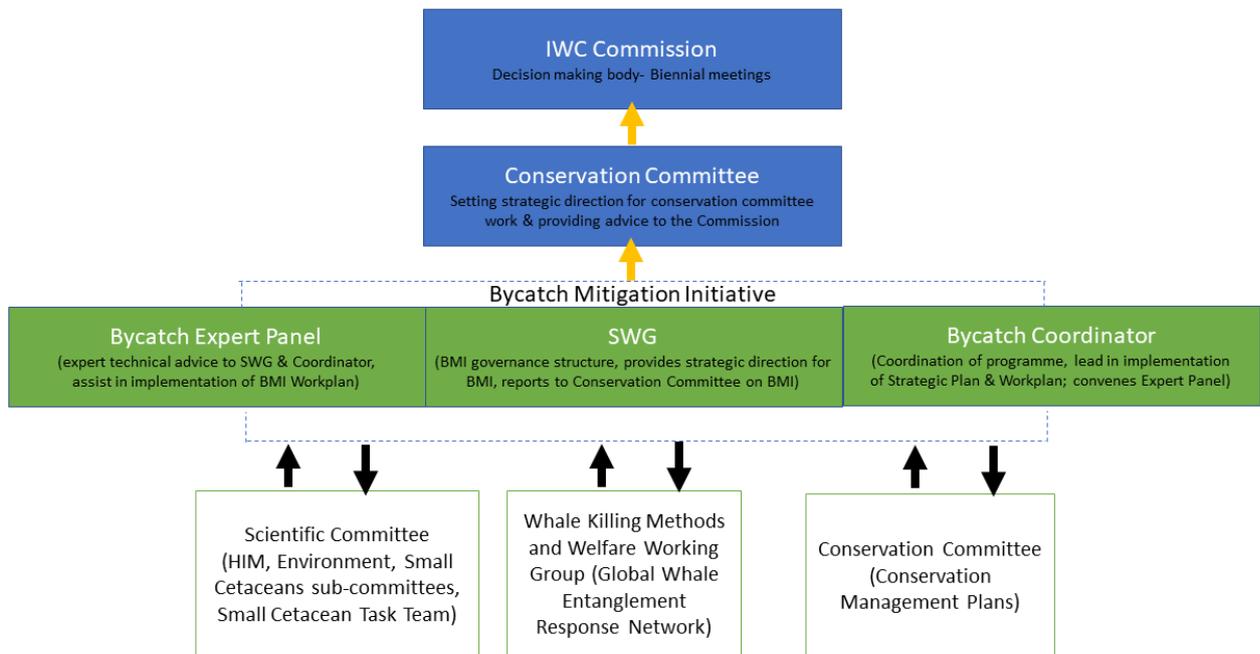
Temple, A.J., Wambiji, N., Poonian, C.N.S., Jiddawi, N., Stead, S.M., Kiszka, J.J., Berggren, P., 2019. Marine megafauna catch in southwestern Indian Ocean small-scale fisheries from landings data. *Biological Conservation* 230, 113–121. <https://doi.org/10.1016/j.biocon.2018.12.024>

Thorne, L.H., Baird, R.W., Webster, D.L., Stepanuk, J.E., Read, A.J., 2019. Predicting fisheries bycatch: A case study and field test for pilot whales in a pelagic longline fishery. *Diversity and Distributions* 25, 909–923. <https://doi.org/10.1111/ddi.12912>

Punt, A., Francis, R.B., Siple, M., Williams, R., The Ocean Modelling Forum Working Group on the Marine Mammal Protection Act Import Provisions.

SPC-OFP. 2010. Summary information on whale shark and cetacean interactions in the tropical WCPFC purse seine fishery - <https://www.wcpfc.int/node/2670>

Annex 4 Structure of IWC Bycatch Mitigation Initiative



Annex 5 Workshop national perspectives panel discussion

The workshop included a panel discussion chaired by Elizabeth Mueni, Associate Director of the Kenyan Fisheries Service and BMI expert panel member. The panel presented national perspectives on bycatch and served to identify shared experiences and the main gaps and challenges to tackle the problem. Panel members included:

- Umair Shahid, WWF Mozambique (but based in Pakistan), focused on issues related to tuna fisheries in the Indian Ocean.
- Charles Anderson, fisheries consultant based in the Maldives and studying tuna fisheries throughout the Indian Ocean.
- Sivakumar Kuppusamy of the Wildlife Institute of India.
- Per Berggren, of the University of Newcastle (UK), principal investigator of the WIOMSA funded BYCAM project studying bycatch in the Western Indian Ocean.
- Norbert Andrianarivelo, Lecturer, University of Toliara in Southern Madagascar.
- Mike Mwango'mbe, of the Watamu Marine Association on the coast of Kenya.

Annex 6 Questionnaire on bycatch completed by participants in relation to national situation

1. What are the main fisheries/gears that are known to be involved with cetacean bycatch/entanglement? Are these artisanal or commercial operations?
2. Which cetacean species are most usually involved in bycatch events?
3. Is any quantitative data available on cetacean population sizes? Is there detailed information on cetacean distributions? (if yes, please explain your answer)
4. How much information is collected and available on fishing effort and fishing gear types? Describe for both artisanal and commercial
5. Has there been any previous research already done to investigate bycatch of marine mammals (including cetaceans), or turtles, sharks, seabirds in your national fisheries? This could include quantifying bycatch, surveying fishers, working on mitigation trials etc. If so, please provide any information on what/where and whom
6. Is there any work underway to work with local fishing industry to mitigate or reduce cetacean bycatch?
7. How willing do you think the fishing industry (Artisanal or commercial) would be to work on bycatch mitigation?

Annex 7 Workshop breakout group questions

Workshop breakout groups on cetacean bycatch hotspots and challenges across Indian Ocean Region. Questions considered by each group

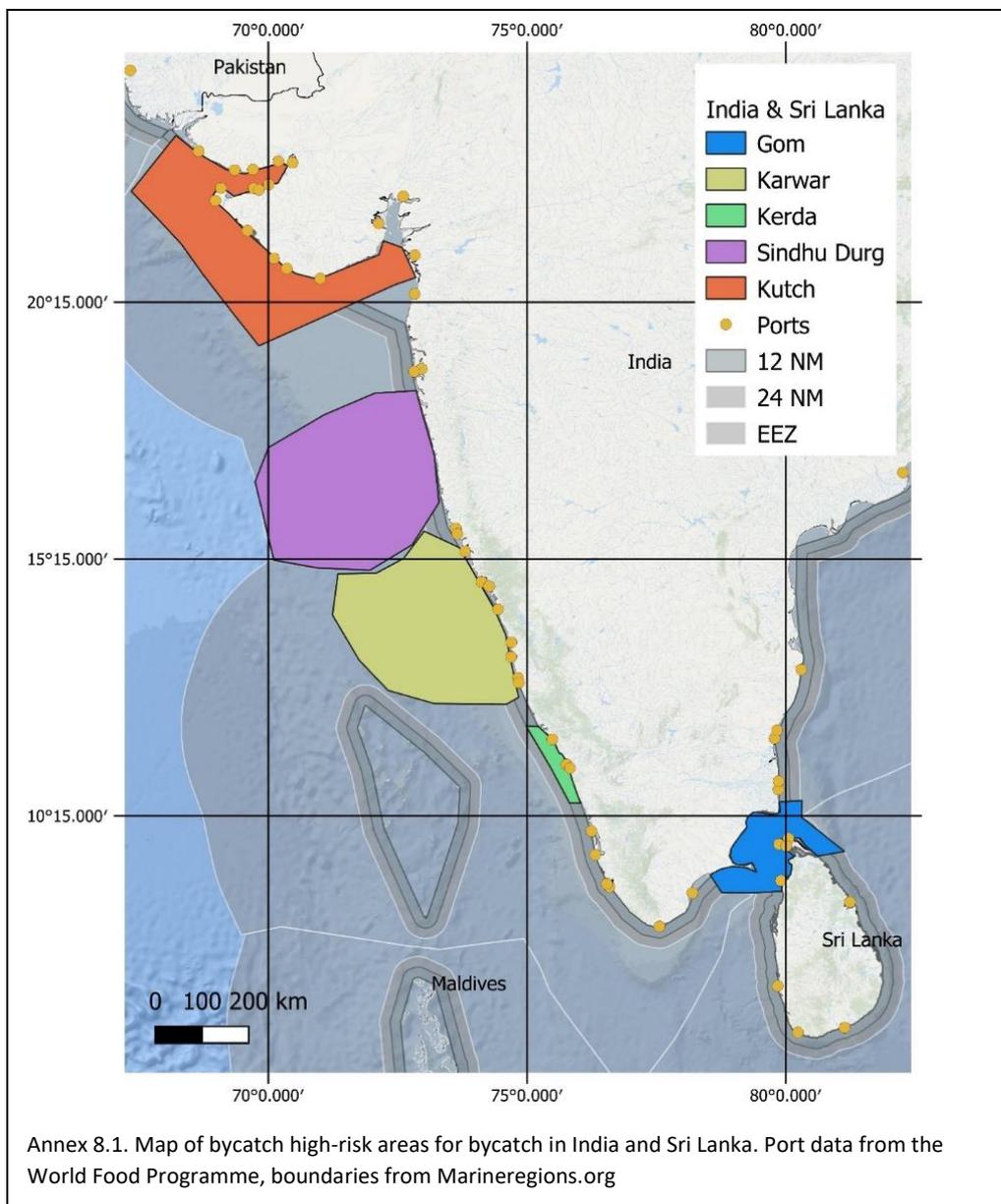
- 1) Have any geographical areas been identified as potential 'hotspots' or high-risk areas for interactions? Please mark these on the maps provided
- 2) What are the main (cultural/political/practical) challenges or barriers to understanding cetacean bycatch, or testing or implementing mitigation measures in your country?
- 3) Are there any unique opportunities that could help to start working on cetacean bycatch monitoring or mitigation?
- 4) What do you think the IWC's Bycatch Mitigation Initiative, and the BMI expert panel, could help with (if anything)

Annex 8 Bycatch hotspots/high-risk areas by country

Workshop participants worked in groups to identify known areas (based on qualitative or quantitative information) of bycatch, and/or areas where bycatch risk was thought to be high based on information on the fishing effort and/or cetacean presence. These areas were then drawn onto paper maps and subsequently digitised. These maps (Annexes 8.1-8.6) therefore reflect the best available information to workshop participants at the current time.

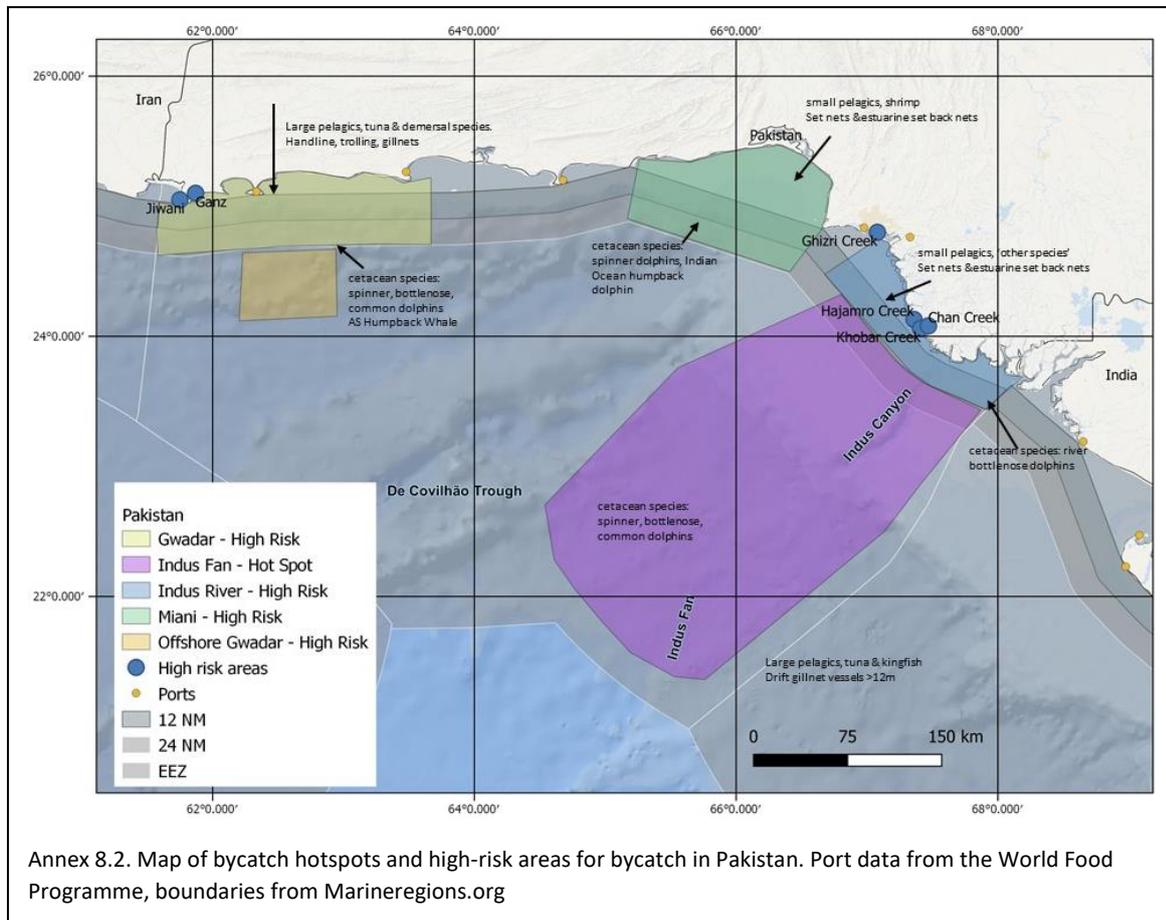
Annex 8.1 India and Sri Lanka

Bycatch hotspot areas were identified in India including a transboundary site between both India and Sri Lanka. There were no representatives from Sri Lanka at the workshop, however Hines has just carried out work alongside colleagues in the country (see Hines et al. 2019). It was emphasised that more bycatch assessment work is needed in order to identify additional bycatch high risk areas.



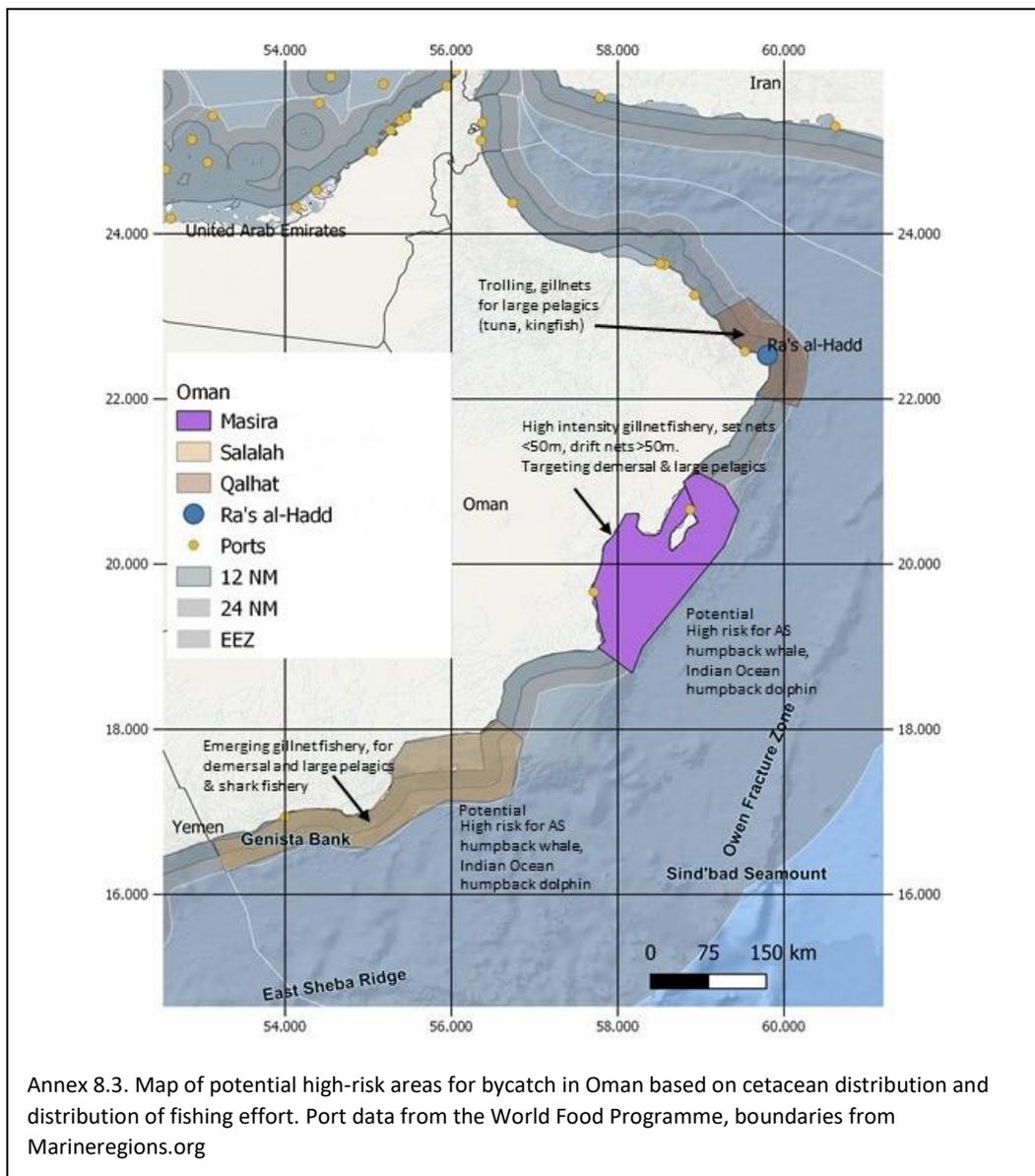
Annex 8.2 Pakistan

Areas identified as bycatch hotspots/high interaction with fisheries include (in order of importance) the Indus Canyon (identified as a Convention on Biological Diversity Ecologically and Biologically Significant Area - [Khori Great Bank](#)), the area towards the border with Iran including Giwani and Gwadar and Sur (pelagic and bottom nets for tuna, mackerel and high numbers of small cetaceans); Astola island (no information available on the risk of bycatch, although the area is important as a foraging ground for blue whales and for Arabian Sea population of humpback whales); the western coast of Sonmiani Bay, with an isolated population of Indian Ocean humpback dolphins and small pelagic fisheries, and handline and boat seines. This region has a community designated protected area and a good system of monitoring; other potential areas that are important for cetaceans but where bycatch risk is not known include Gunz and four major creeks: Chann; Hajamro; Khober; Gizri where small-scale artisanal, monofilament gillnets and estuarine set bagnet are targeting shrimp but also other small fish.



Annex 8.3 Oman

Potential high-risk areas for cetacean bycatch were identified based on information on high density and distribution of cetaceans and high level of fishing activity. The Gulf of Masirah is considered one of Oman's most productive fishing areas. It is considered critical habitat for loggerhead turtles, Arabian Sea humpback whales and Indian Ocean humpback dolphins and also hosts other cetacean species including Bryde's Whales, false killer whales, common dolphins and bottlenose dolphins. Arabian Sea humpback whales are most frequently encountered in this area between November-February, although they are known to be present year-round. The area has been documented as a nursery area where breeding and feeding related behaviours have also been observed. The region of Dhofar and Salalah also appears to be important for humpback whales during November-February and at least 18 of the 21 cetacean species recorded in the country pass through this area at some point during the year. Artisanal fishing effort is more limited than the Gulf of Masirah, although it is apparent that operations are expanding with larger vessels using net based methods. Other potentially important cetacean areas that require investigation include Ra's al-Hadd (at the entrance of the Gulf of Oman), with a monsoonal gyre bringing upwelling and large diversity of animals including tuna. Tuna fishing activity within this area uses both nets and line fishing.



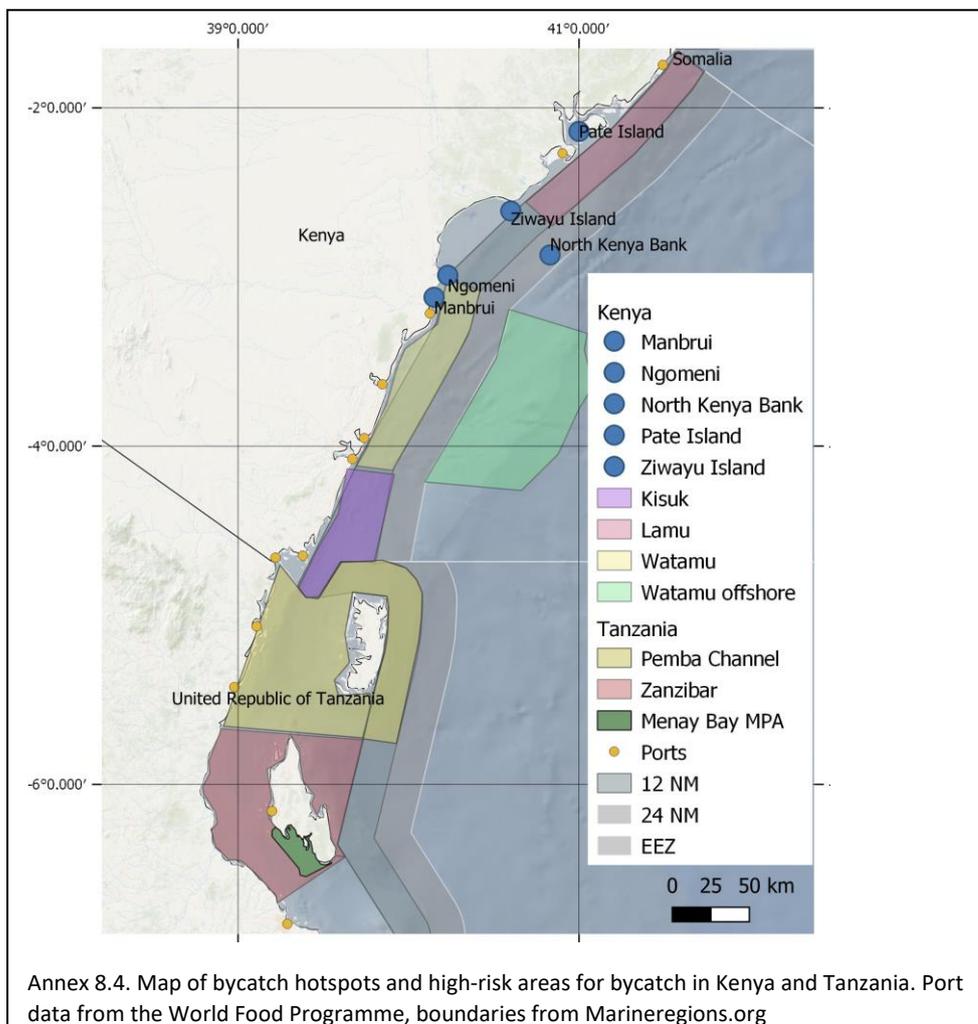
Annex 8.4 Kenya and Tanzania

Kenya

Whale bycatch has been reported in both gillnet and longline gears with known hotspot areas between Mambri to Ngomeni Ziwayuu, believed to be a migratory pathway for humpback whales between July and October; known areas also include the Watamu Banks; Shimoni area. Dolphin bycatch has been reported in the Kenya North Banks in August, September and October; and within the boundaries of the Watamu - Malindi MPAs (aggregations of bottlenose dolphins); in the Malindi and Mambri MPA for Indian Ocean humpback dolphins; and Lamu Mada -Patte Ziwayuu for Indo-Pacific bottlenose.

Tanzania

Bycatch is known to occur across the island of Zanzibar, including within the Menai Bay MPA (Indo-pacific bottlenose dolphins and Indian Ocean humpback dolphin). High cetacean bycatch is also known to occur in the Pemba Channel, which is considered high-risk due to its importance for cetaceans (Braulik et al. 2018). In a recent study based on fisher surveys, the bycatch rate on the islands of Pemba and Unguja, collectively 0.24 dolphins per gillnet boat per year, was two and half times greater than from the mainland Tanzania coast (0.10 dolphins per gillnet boat per year) (Braulik et al. 2017).



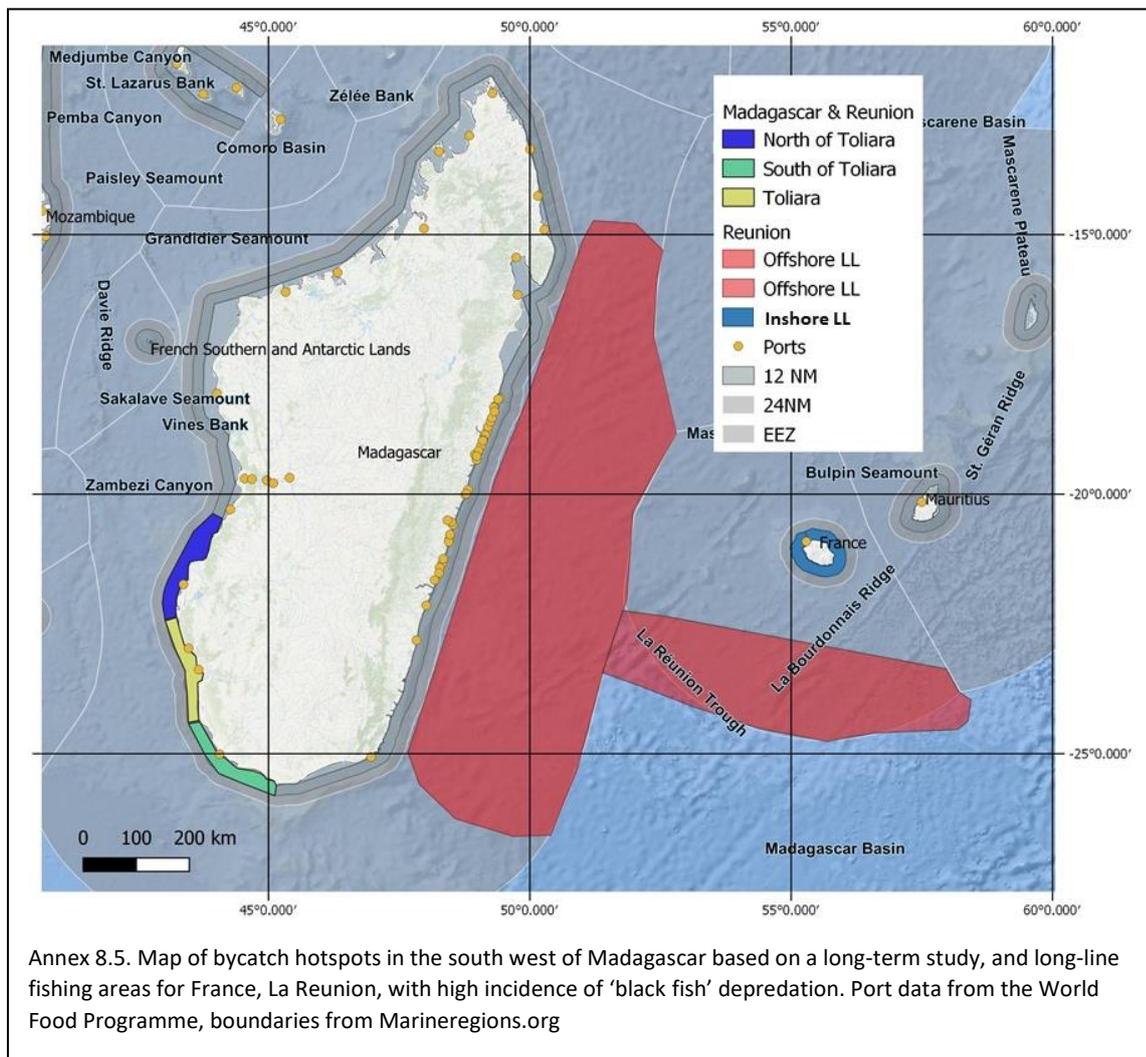
Annex 8.5 Madagascar and France - La Reunion

Madagascar

Known areas of bycatch were identified from a long-term study in the south-west of the country where small-scale gillnet fisheries (targeting shark) operate. Gillnets are typically 100m wide and fishers use 4-10 nets in a set. A total of 1250 small-scale vessels operate in the three main areas of south-western Madagascar - to the South of Toliara (Anakao, Soalara, Saint Augustin); Toliara (Ankiembe, Mahavatse, Belitsake) and North of Toliara (Befandefa).

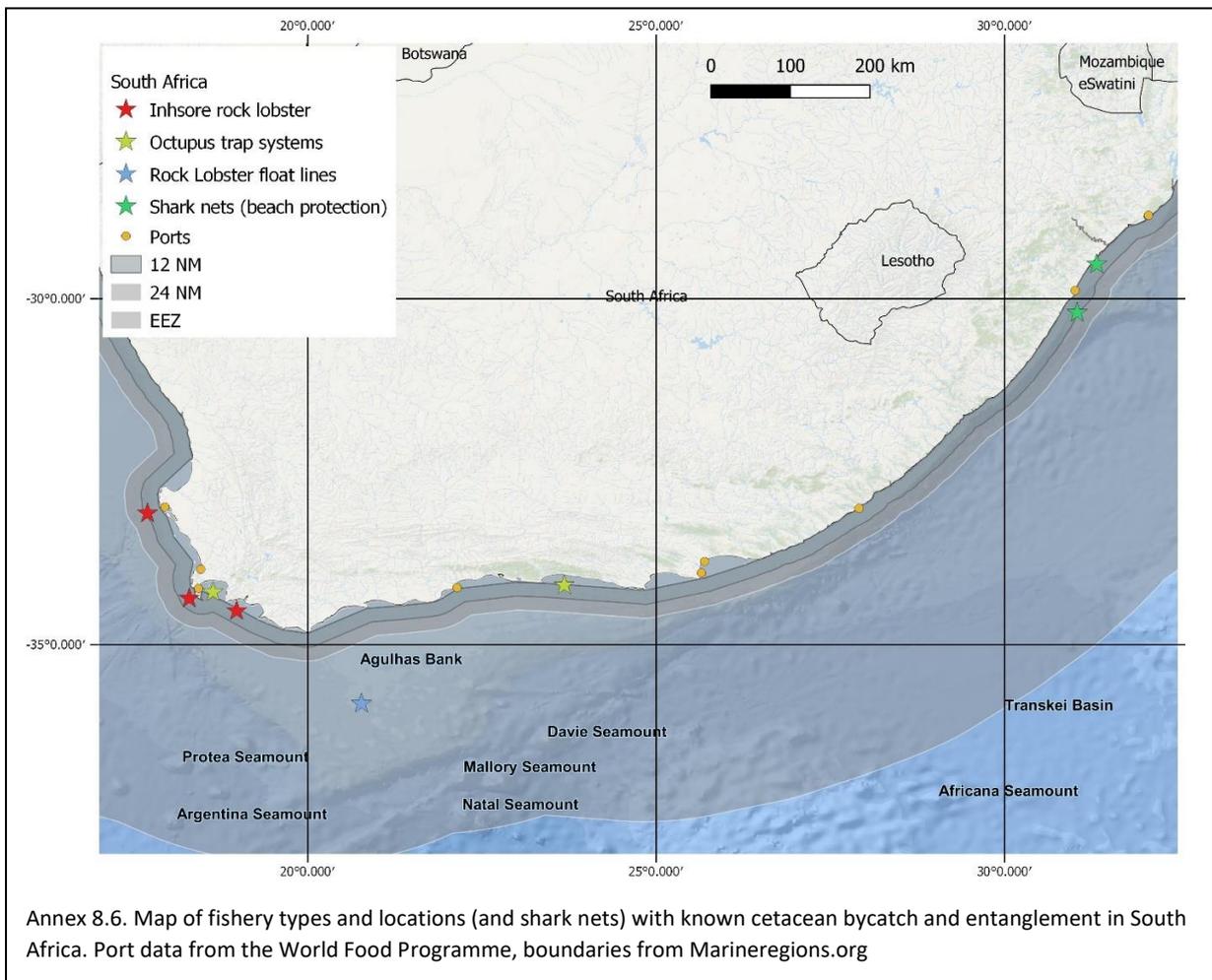
France - La Reunion.

Depredation is considered a significant issue in the longline fisheries of La Reunion (Rabearisoa et al. 2018). Depredation is estimated between 10-40% of target catch, and thought to be predominantly by false killer whales and/or pilot whales) which is the issue, with the potential for associated bycatch (Rabearisoa et al. 2018). The map identifies the longline fishing areas, where depredation and potential bycatch could occur, rather than 'high risk' areas. The small-scale longline vessels (21 vessels) operate within the 12nm territorial seas surrounding the island of La Reunion and target tuna (yellowfin) and swordfish. The larger-scale vessels (19 vessels) operate offshore, beyond the territorial seas, targeting swordfish, tuna (yellowfin) and bigeye marlin.



Annex 8.6 South Africa

Areas of known bycatch were identified by workshop participants based on information from entanglement and stranding monitoring work. In the experimental octopus trap fishery, 14 cetaceans have been recorded as entangled between 2014-2019, including humpback whales (5), Bryde’s whale (4 - all dead), and southern right whale (4, 1 dead). In the inshore rock lobster trap fishery between 2006-2017 entanglement has been recorded of southern right whales (20 animals, 1 dead), humpback whales (36 animals, 1 dead), Bryde’s whale (4 animals) and unidentified whale species (4). Records from 2007-2016 of the offshore rock lobster fishery have recorded entanglements of nine cetaceans, including humpback whales (6 individuals) and southern right whales (2 individuals). In addition, trawl vessels are known to catch dolphin species, as well as seals (and seabirds). Shark nets for beach protection nets are also catching cetaceans, particularly in the KwaZulu-Natal including humpback dolphins (e.g. Atkins et al. 2013 reports 203 individuals between 1980-2009), southern right whales and humpback whales (Meyer et al.2011). Most bycatch information is from entangled and stranded animals.



Annex 9. Opportunities for the BMI to assist efforts in Indian Ocean

The following summarises the suggestions from the breakout groups for where the IWC, and its Bycatch Mitigation Initiative in particular, could assist efforts to understand, monitor and reduce cetacean bycatch across the region.

- Develop a regional road map for tackling cetacean bycatch, including through fisher exchange programs; through development of regional information sharing mechanisms; building awareness within fishing communities; develop agreed protocols and standards on bycatch management; assisting the IOTC in the development and implementation of a long term participatory regional monitoring plan; trials on gillnet mitigation initiatives in hot spot or high risk areas/high interaction areas; raise profile of cetacean bycatch at IOTC.
- Collaborate with others to develop a sustainable funding model for bycatch work across the region as part of the bycatch mitigation roadmap.
- The IWC and the BMI could assist in training (e.g. in necropsy analysis, fisher questionnaires, REM, analysis and extrapolation). This was seen as particularly relevant in India where there is a need for a long-term commitment to training so that India can develop the capacity internally including 'training the trainers'. The IWC can assist by providing recommendations to the government of India through scientific committee/conservation committee and Commission, and through engagement with the IOTC. The BMI can provide technical assistance in relation to rapid risk assessments, REM monitoring and mitigation measures.
- Provide support to countries in meeting their monitoring and reporting obligations on bycatch to IOTC
- Provide IWC recommendations and endorsements for projects engaged in bycatch monitoring and mitigation - these were considered to be very helpful in moving work forward
- Develop a toolbox of solutions (research and mitigation) which can be tailor made to a specific situation or country. The BMI expert panel and other initiatives (e.g. GWERN) could provide a lead person per tool (data collection, disentanglement, mitigation measures, analysis, assessment) to advise governments on solutions.
- Provide access to multi-disciplinary approaches and bring together experts (such as social, economics, psychology) to assist national efforts and develop capacity.
- Support exchange programmes for fishers.
- Draw attention to/ prioritise small-scale fisheries
- Assist South Africa in defining terms of reference and protocols for a planned bycatch monitoring programme to ensure that high quality data are collected that can be used for management.
- Collaborate with Indian Ocean countries (governments, scientists, fishing communities etc) to develop pilot projects, testing experimental approaches to bycatch reduction and share approaches that are effective across the region.