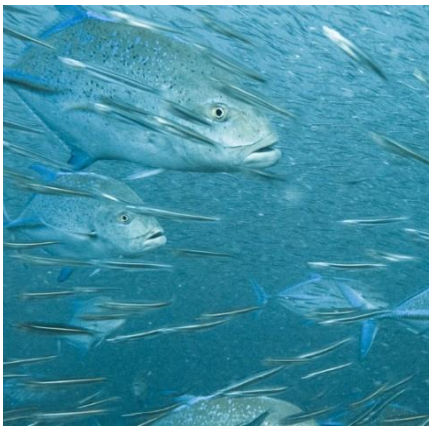

Monitoring of Artisanal Fisheries in the Indian Ocean

Indian Ocean Tuna Commission

Final Report

November 2019

Submitted by

MRAG

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Acronyms

ADNAP	General Directorate for Fisheries Administration (Mozambique)
AFRC	Albion Fisheries Research Centre (Mauritius)
AMFA	Australian Fisheries Management Authority
BMU	Beach Management Unit (Zanzibar)
CAS	Catch Assessment Surveys (Kenya)
CMFRI	Central Marine Fisheries Research Institute (India)
CNCP	Cooperating Non-Contracting Parties
CPC	Contracting Parties, encompassing members and CNCPs
CPC	Members and Co-operating Non-Contracting Parties
CPUE	Catch Per Unit Effort ()
DAFF	Department of Agriculture, Forestry and Fisheries (South Africa)
DEPI	Ministry, the Directorate of Studies, Plan and Infrastructures (Mozambique)
DFA	Department of Fisheries Administration (Mozambique
DFAR	Department for Fisheries and Aquatic Resources (Sri Lanka)
DOF	Department of Fisheries (Bangladesh)
DPMAIPs	Provincial Directorate of Sea, Inland waters and Fisheries (Mozambique)
E-monitoring	Electronic Monitoring
ETBF	Eastern Tuna and Billfish Fishery
ETP	Endangered, Threatened and Protected species
FADs	Fish Aggregating Devices
FAO	Food and Agriculture Organization of the United Nations
FDF and BE	State Department for Fisheries and Blue Economy () (Kenya)
FDIMS	Fisheries Data and Information Management System (). (Kenya)
FFPA	Fauna and Floral Protection Act (Sri Lanka)
FIREPLUS	Fisheries Recording System Plus (Maldives)
FMPs	Fisheries Management Plans
FRDD	Fisheries Resources Development Department (Eritrea)
FRSD	Fisheries Regulatory Services Department (Eritrea)
FRSS	Fisheries Resources Survey System (Bangladesh)
FSI	Fishery Survey India (India)
FSS	Fisheries Statistics Section (Oman)
GDP	Gross Domestic Product
GT	Gross Tonnage
IDEPA	National Institute for the Development of Fisheries and Aquaculture (formally known as the Institute for Small-Scale Fisheries Development (IDPPE) (Mozambique)
IFO	Iranian Fisheries Organisation
IFRO	Iranian Fisheries Research Organisation
IIP	National Fisheries Research Institute (Mozambique)
IM	Incidental Mortality

IOTC	Indian Ocean Tuna Commission
KCDP	Kenya Coastal Development Project
KMFRI	Kenya Marine and Fisheries Research Institute
LOA	Length Overall
LOV	Vessel Operation Report (Malaysia)
MFRF	Ministry of Fishery Resources and Fisheries (Madagascar)
MFW	Ministry of Fish Wealth (Yemen)
MIMAIP	Ministry of Sea, Inland waters and Fisheries (Mozambique)
MITP	Malaysian International Tuna Port
MMR	Ministry of Marine Resources (Eritrea)
MoFAR	Ministry of Fisheries and Agriculture (Maldives)
MPAs	Marine Protected Areas (MPAs)
MPEDA	Marine Products Export Development Authority (India)
NARA	The National Aquatic Resources Research and Development Agency (Sri Lanka)
nm	Nautical Miles
PNMM	The Marine Natural Park of Mayotte (PNMM)
SBTF	Southern Bluefin Tuna Fishery
SDMS	Statistics and Database Management Service (Maldives)
SFA	Seychelles Fisheries Association
SFC	Shehia Fisheries Committee (Zanzibar)
SIH	French Fisheries Information System (SIH)
SJF	Eastern and Western Skipjack Fisheries
SNAPA	Sistema Nacional de Amostragem da Pesca Artesanal (Mozambique)
URT	The United Republic of Tanzania
USTA	Unité Statistique Thonière d'Antsiranana (Madagascar)
VMS	Vessel Monitoring System
WTBF	Western Tuna and Billfish Fishery
WWF	World Wildlife Fund

1 Executive summary

This project appraised the current status of data collection systems in place for artisanal fisheries in the Indian Ocean by coastal States that are Indian Ocean Tuna Commission (IOTC) Members and Co-operating Non-Contracting Parties (CPCs). Improving awareness of the range of artisanal data collection systems in place throughout the region is needed to better understand the accuracy of current catch estimates, and support the development of general guidelines for data collection from artisanal fisheries at the landing place. To support this, the current work examined the methods used and range of data collected for artisanal fisheries, the format such data are collated and what procedures are used within Australia, Bangladesh, Comoros, Eritrea, European Union/France (OT), India, Indonesia, IR Iran, Kenya, Madagascar, Malaysia, Maldives, Mauritius, Mozambique, Oman, Pakistan, Seychelles, Somalia, South Africa, Sri Lanka, Tanzania, Thailand and Yemen.

The current definition of artisanal fisheries by the IOTC is too simplistic for the region, resulting in substantial differences in the terminology applied to artisanal fisheries between CPCs. It is suggested that the IOTC should develop a single, global definition of “small-scale fisheries”. In this respect, recent work by the FAO has examined developing a matrix approach to help countries define their small-scale fishing fleets. Utilising such an approach to define and classify artisanal fishing fleets across CPCs will substantially increase the ability to define the artisanal fisheries throughout the Indian Ocean, while also allowing managers to place their fishery in the context of other CPCs.

The majority of CPCs do not have a published methodology for all artisanal data collection. It is suggested that each CPC publish a detailed methodology for collection and processing of all data on artisanal fisheries. This methodology should include a full definition of artisanal fisheries by each CPC, a clear statement of the statistical methods used for the collection, processing and reporting data for artisanal fisheries (e.g. estimation of total catches, or raising to total fishing effort including clear reporting or raising factors), the methodology and temporal undertaking of national fishing craft frame surveys, and all logistic issues which may negatively impact effective data collection for artisanal fisheries.

Each CPC should develop or maintain an up-to-date data processing manual. The data processing manual should describe the processes used by the CPC to aggregate and raise catches, e.g. calculation of raising factors, levels of aggregation at each level (port, region, fleet). The manual should be available in all required local languages and include annotated examples for each data raising process. The manual should also be available in English or French for submission to IOTC by all CPCs.

Between CPCs, there is little similarity in the extent to which species level data is collected, with data for a range of taxa (e.g. sharks) predominantly aggregated when reported. To enhance CPCs ability to collect data at the species level it is suggested that published methodology manuals for each CPC should include species identification guides with such guides provided for all required species. In addition, although data on CITES species are not required as part of the mandatory IOTC data submission, IOTC reporting should ideally be expanded to cover CITES listed sharks and to species level for all sharks, seabirds, turtles and cetaceans.

Substantial differences exist in the collection of data on catch and effort between CPCs. It is suggested that each CPC should have a clear, defined and published methodology to estimate catch and effort data for all required species. CPCs should all have clear monthly estimates, at a minimum of effort by gear type. Size frequency sampling programmes should also be implemented for all species under the mandate of IOTC, including sharks, and be representative of all fleets, gears and species.

The data collection of incidental mortality is relatively low across the majority of CPCs, and improvements are needed to ensure consistency across CPCs in reporting. For example, data collection of species of sharks is particularly low across most CPCs and improvements are needed in terms of recording of incidental shark mortalities at species level. In addition, for ETP species including turtles, seabirds, cetaceans and whale sharks it is important that CPCs submit zero incidental mortalities in a NULL report if no catches or interactions have been observed in order to minimise non-reporting. For seabird interactions this is particularly valid for northern Indian Ocean States where seabird interactions are limited.

2 Introduction

Indian Ocean Tuna Commission (IOTC) Members and Co-operating Non-Contracting Parties (CPC's) fish for tuna and tuna-like species under IOTC mandate within the IOTC area of competence (IOTC Area) (Figure 1). Guidelines have been developed by IOTC to facilitate the reporting of fisheries data to IOTC[1], with a number of IOTC capacity building activities aimed at strengthening the collection and reporting of data for coastal fisheries in the Indian Ocean[2], in addition to other related studies which examine procedures for data collection or estimation of catches for artisanal fisheries (e.g. Moreno 2012, Stobberup 2012).

Nevertheless, there are still no formal IOTC guidelines on the data collection standards for artisanal coastal fisheries, and relatively little understanding of the range of data collection systems utilised by CPCs in assessing the extent and structure of artisanal fisheries within this region. More importantly, difficulties in reporting data for artisanal fisheries to IOTC, particularly by developing coastal states in the Indian Ocean, remains a fundamental issue which continues to undermine the quality and robustness of monitoring IOTC species and related bycatch listed under CITES appendices (Annex 1).

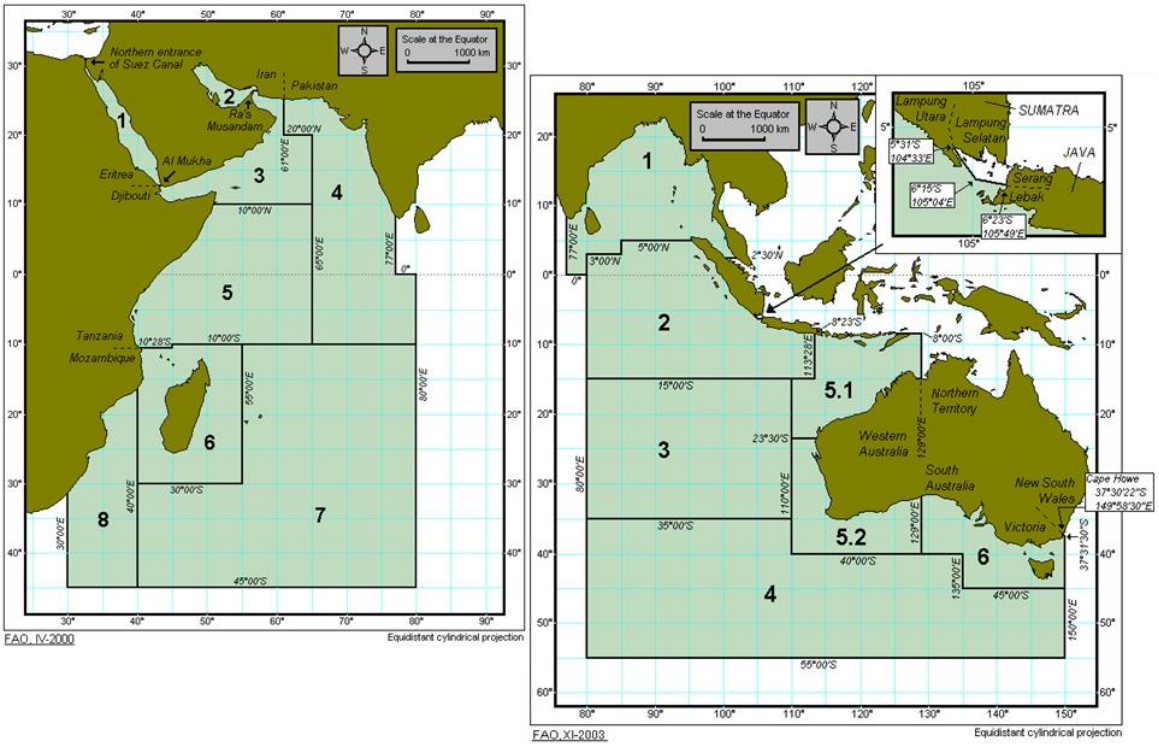

Figure 1 FAO Area 51 (Western Indian Ocean) and FAO Area 57 (Eastern Indian Ocean).

The importance of artisanal fisheries in the Indian Ocean should be placed in context, accounting for over two-thirds of the total catches of tunas and tuna-like species in the region (at around 1,100,000 t per annum). Within the Indian Ocean, catches from artisanal fisheries are also disproportionately concentrated in a relatively small number of CPCs. Over three quarters of artisanal catches in the Indian Ocean are accounted for by five CPCs (Indonesia, India, Maldives, I.R. Iran, and Sri Lanka).

[1] https://www.iotc.org/sites/default/files/documents/data/Guidelines%20Data%20Reporting%20IOTC.pdf.

[2] https://www.iotc.org/documents/iotc-data-capacity-building-activities-2016.

The contribution of catches from artisanal fisheries also varies significantly between species/species group (Table 1). The predominant species fished for (i.e., high % composition) are several tuna species (skipjack, longtail, yellowfin, kawakawa, frigate and bigeye), narrow-barred Spanish mackerel, Indo-Pacific king mackerel and black marlin. Importantly, this fishery also catches a substantial array of shark species/species groups. Estimates for artisanal fishing also include a substantial proportion of catches taken as bycatch, including a range of shark species/species groups that are recognised as vulnerable to overfishing. Such 'bycatch' species can include a number of species that are threatened or near threatened with extinction and listed under CITES Appendices.

Table 1 Average annual capture/catch of selected species across artisanal fishing in the Indian Ocean (2015 to 2017).

Species	Average of Catch/Capture(t) (+/-SE)	% composition	Grouping
Skipjack tuna	3549.2 +/- 728.6	12.614	TROP
Longtail tuna	2562.9 +/- 604.4	9.109	NERI
Yellowfin tuna	2557.1 +/- 379.2	9.088	TROP
Kawakawa	1925.2 +/- 297.3	6.842	NERI
Narrow-barred Spanish mackerel	1828.6 +/- 216.9	6.499	NERI
Thresher sharks nei	1500.1 +/- 655.2	5.332	BYCT
Blue shark	1352.1 +/- 668.7	4.805	BYCT
Frigate tuna	1322.9 +/- 225.5	4.702	NERI
Sharks various nei	1196.2 +/- 198.8	4.251	BYCT
Indo-Pacific king mackerel	1075.9 +/- 167.1	3.824	NERI
Bonnethead and hammerhead sharks	1046.4 +/- 311.1	3.719	BYCT
Milk shark	1032.0 +/- 458.8	3.668	BYCT
Finetooth shark	601.6 +/- 216.9	2.138	BYCT
Spot-tail shark	499.7 +/- 497.7	1.776	BYCT
Whitecheek shark	498.7 +/- 0	1.773	BYCT
Bigeye tuna	488.7 +/- 110.1	1.737	TROP
Hammerhead sharks nei	448.0 +/- 156.0	1.592	BYCT
Indo-Pacific sailfish	422.1 +/- 74.2	1.500	BILL
Mako sharks	396.0 +/- 113.2	1.407	BYCT
Graceful shark	354.7 +/- 111.7	1.261	BYCT
Hardnose shark	335.4 +/- 186.8	1.192	BYCT
Black Marlin	322.8 +/- 51.8	1.147	BILL
Bullet tuna	303.9 +/- 49.5	1.080	NERI
Blacktail reef shark	300.8 +/- 108.4	1.069	BYCT
Blacktip shark	292.0 +/- 84.1	1.038	BYCT
Swordfish	286.5 +/- 59.2	1.018	BILL
Sliteye shark	250.0 +/- 84.0	0.889	BYCT
Frigate and bullet tunas	162.9 +/- 99.7	0.579	NERI
Requiem sharks nei	145.4 +/- 43.0	0.517	BYCT

NB. All unclassified species/species groups taken out

The main aim of this report is to provide an appraisal of the current status of data collection systems in place for artisanal fisheries in the Indian Ocean by coastal states that are IOTC Members and Co-operating Non-Contracting Parties (CPCs), including:

- determining the methods used and range of data collected;
- in what format these data are collated;
- and what procedures are used.

Wherever possible MRAG has assessed existing data collection systems in place for examples of good practice, and recommended general and country-specific improvements in terms of the collection and reporting of catches and bycatch associated with artisanal fisheries.

Improving awareness of the range of artisanal data collection systems in place throughout the region is needed to better understand the accuracy of current catch estimates, and support the development of general guidelines for data collection from artisanal fisheries at the landing place. This includes the development of a set of standard indicators to assess the quality of data collection and management systems for artisanal fisheries. It is foreseen that the collection of artisanal fisheries information, preferably using a standard and agreed set of metrics, could provide countries and regional fisheries organisations with an opportunity to collate information of use in regional assessments of transboundary fish stocks.

2.1 Definitional issues of artisanal fisheries in the Indian Ocean

IOTC class fishing vessels into either artisanal or industrial by their length overall (LOA) and area of operation. Industrial vessels include all vessels over 24m LOA regardless of where they operate (i.e., within a CPC's Economic Exclusive Zone EEZ or on the high seas), as well as vessels below 24m LOA conducting fishing activities beyond their EEZ. In comparison, artisanal fisheries are defined as those carried out by vessels below 24m LOA, and which operate exclusively within the corresponding national EEZ.

There is a general acknowledgement that the current definition of artisanal fisheries is too simplistic for the IOTC area, where a large array of subsistence, semi-industrial and industrial fishing activities operate within CPC's EEZs. According to the current IOTC definition, artisanal vessels in the IOTC area encapsulate vessels from non-mechanised pirogues that fish for subsistence, through to longline, gillnet or purse seine vessels less than 24m LOA, including those which may have inboard motors, fish holds, hydraulic and electronic equipment, and preservation facilities. Thus, the 'artisanal fisheries' category encapsulates a substantial range of technical and economic characteristics, market niches, and fishing power. In addition, the definition of vessels undertaking artisanal fishing may cause confusion, as a vessel smaller than 24m LOA may be classified as artisanal or industrial depending on the area where it operates (i.e., inside or outside an EEZ).

There are also substantial differences in the terminology applied to artisanal fisheries between CPCs, even within the same template-type reports provided by countries to IOTC. For example, artisanal fisheries are variously described as 'coastal' (India, Mayotte, Mozambique, La Réunion, Sudan), 'traditional' (Bangladesh, Madagascar), 'minor line' (Australia), 'artisanal commercial' (Kenya), 'small-scale' (Madagascar, Mauritius), commercial line fisheries (South Africa). Such differences in terminology between CPCs increase the ambiguity of information available on artisanal fisheries, but also reduce the efficacy of any review of artisanal data collected between countries. In addition, for a number of CPCs (e.g. Bangladesh, Mayotte, Malaysia, India, Pakistan) there is no reported segregation of catch data by fleet (i.e., industrial versus artisanal), and therefore it is unclear whether the data reported to IOTC refers to artisanal fisheries or includes other parts of a CPC's fleet.

Differences in the definition of artisanal fisheries can lead to inconsistencies in the data reported to IOTC between CPCs or, in a few cases, no data being reported at all. In the case of Australia for example, catches classified as 'minor line' or 'recreational' are currently not reported to IOTC, contrary to Resolution 15/02 which mandates that all catches caught within the EEZ or high seas should be reported – including sports and recreational fisheries

(classified as artisanal fisheries according to current IOTC definitions). In comparison, Kenya, La Réunion, Mauritius, and South Africa have all reported catches for recreational fisheries periodically in previous years.

A second example concerns differences in how CPCs categorise their artisanal fishing fleet in terms of length and vessel size. Within Mozambique, the fishing fleets are divided into three segments: industrial, semi-industrial and artisanal. Semi-industrial refers to vessels between 10 - 20m LOA, while the artisanal fleet comprises vessels with engine power of up to 100 hp and a total length of less than 10m LOA (Moreno, 2013). In comparison, the EU fishing fleet utilises the term 'coastal' for their artisanal fleet in the Indian Ocean, but characterise these vessels as those less than 12m LOA. In the case of Thailand, the fishery sector consists of two main parts: the coastal and overseas fisheries[3]. Within the coastal sector, the commercial and artisanal fisheries are defined by the vessel's carrying capacity; artisanal vessels are those with a capacity of less than 10 gross tonnes, while vessels with a gross tonnage of over 10 are classified as commercial.

Ambiguity in the terminology describing artisanal fisheries between CPCs has flowed through into different reports regarding artisanal fishing. For example, the most recent assessment of data collection within artisanal fisheries throughout the Indian Ocean (Moreno, 2013) utilised a description of artisanal fisheries as those undertaken by vessels (or any other types of fishing crafts) with LOA less than 24m and operated full time within the EEZ of their flags (Moreno, 2013). However, even within this description the author does state that the description used for artisanal fishing would include boats from semi industrial and industrial fleets.

In developing a single, global definition of "small-scale fisheries", recent work by the FAO (led by Simon Funge-Smith[4]) has examined developing a matrix approach to help countries define their small-scale fishing fleets. This matrix method applies a range of elements related to fishing units: vessel size, motorization, gears active/passive, mechanization, storage/refrigeration, crew, type of ownership, time commitment, trip duration/distance, harvesting operation, disposal of catch, value adding, and integration in management system/economy. Each characteristic has four levels described across a range of scale from small to industrial, and is given a score (0 to 3). Such scores are then aggregated and the fishing unit is located on a continuum of small-scale fisheries to large scale fisheries. Although only recently proposed, utilising such an approach to defining and classifying the different artisanal fishing fleets across CPCs will substantially increase the ability to define the artisanal fisheries throughout the Indian Ocean, while also allowing managers to place their fishery in the context of other CPCs.

2.2 Objectives of the project and major outcomes

Within this project we provide both general recommendations and (where possible) country specific recommendations for increasing the veracity, validity and effectiveness of data collection for artisanal fisheries within Australia, Bangladesh, Comoros, Eritrea, European Union/ France (OT), India, Indonesia, IR Iran, Kenya, Madagascar, Malaysia, Maldives, Mauritius, Mozambique, Oman, Pakistan, Seychelles, Somalia, South Africa, Sri Lanka, Tanzania, Thailand, and Yemen.

To provide such recommendations we have examined the IOTC nominal catch database[5] and

[3] https://iotc.org/documents/WPM/09/15

[4] https://www.canr.msu.edu/people/simon-funge-smith

[5] https://www.iotc.org/documents/nominal-catch-species-and-gear-vessel-flag-reporting-country

fishing craft database[6], a broad range of literature available on artisanal fisheries throughout the Indian Ocean (predominantly utilising each CPC's country summaries and IOTC Compliance Reports), as well as data collection methods for such fisheries (predominantly found within Stobberup, 2012 and Moreno, 2013). We have focused on using a desk-based review of the information available, based on both published and grey literature. This review includes an evaluation of what information is required by national CITES Authorities on any CITES species, the data collection systems currently in place for artisanal fisheries monitoring and the results of a tailored questionnaire sent to each CPC as part of the review (Annex 2).

We critically assess the current status of data reported to IOTC and data collection systems currently in place for monitoring artisanal fisheries across the coastal states of the Indian Ocean. This includes the type of sampling programme being implemented, for which fleets, which species are being monitored (i.e., IOTC species and bycatch, also identifying those that are CITES listed species), and which organisation is responsible for its oversight and what level of coverage it provides.

[6] https://www.iotc.org/data/datasets

3 Recommendations on data collection systems for artisanal fisheries monitoring, data storage and distribution

The below section provides an overview of the data collection in place for artisanal fisheries within each country, and the main barriers or challenges that each country faces in the collection and reporting of data for artisanal fisheries.

Within this work we utilise our analysis of the existing literature, as well as information collated from a questionnaire sent out as part of this review of the current status of data collection for artisanal (or small-scale coastal) fisheries in the Indian Ocean. The purpose of the questionnaire was to further develop our understanding of the methods and challenges of data collection for artisanal fisheries for IOTC CPCs. Of the 24 CPCs which questionnaires were sent to, 15 CPCs responded (Bangladesh, Comoros, France-EU, Indonesia, I.R. Iran, Kenya, Madagascar, Malaysia, Mauritius, Oman, Seychelles, Somalia, South Africa, Sri Lanka and Thailand); while Australia, India, Mozambique, Pakistan, Sudan and Tanzania did not respond.

In-country missions to Indonesia and Tanzania were also conducted by MRAG to enhance the understanding of the data collection processes occurring within each country, to act as a verification of the general issues identified within the report, and also to provide specific country recommendations for alleviating such issues. Indonesia and Tanzania were specifically chosen for the following reasons[7] (Annex 3):

Indonesia: represents the largest fishery in the Indian Ocean – in terms of importance of catches of tuna and tuna-like species under the mandate of IOTC – of which over 90% of catches are reported as artisanal fisheries. Until recently, Indonesia's compliance with IOTC *Resolution 15/02 Mandatory statistical reporting requirements* has also been relatively low, and therefore provides a good case study of the difficulties of collecting data from coastal and particularly small-scale fisheries.

Tanzania: while catches from coastal fisheries are relatively minor, in terms of the contribution of total catches of artisanal fisheries in the Indian Ocean, Tanzania has recently undertaken a number of initiatives to improve the monitoring and reporting of data for coastal fisheries. For this reason, Tanzania was identified as a potential candidate for an example of best practice.

3.1 General Recommendations

From the review of the countries within the IOTC Area of Competence, several general recommendations have been identified to help improve data collection and reporting to IOTC. Artisanal fisheries, and their gears, need to be clearly defined to ensure that there are no missing fleet segments. CPC data collection manuals should include species identification guides and be provided for all required species. In relation to catch and effort, each CPC should have a system to estimate catch and effort data for all required species and have clear monthly estimates, at a minimum, of effort by gear type. Size frequency sampling programmes should be implemented for all species under the mandate of IOTC, including sharks, and be representative of all fleets, gears and species. To ensure sampling rates are maintained throughout the year there should be monthly tracking of total catch by species and fleet/gear,

[7] The two IOTC Members initially selected for missions were Indonesia and India, however due to logistical issues within the timeframe of the project, India was replaced by Tanzania at a late stage in the project.

with total size frequency sampling counts by species and fleet/gear. Data collection of species of sharks is particularly low across most of CPCs and improvements are needed in terms of recording of incidental shark mortalities at species level. Data checks should be undertaken to ensure consistency with nominal catch data and catch and effort data. It is also important to ensure that all artisanal fleet segments are covered, as often only longline and purse seine fleets are covered and not artisanal sector/gears. For ETP species including turtles, seabirds, cetaceans and whale sharks it is important that CPCs submit zero incidental mortalities in a NULL report if no catches or interactions have been observed in order to minimise non-reporting. For seabird interactions this is particularly valid for northern Indian Ocean States where seabird interactions are limited.

CPCs should ensure that their national fishing craft frame survey is updated every two years and submitted to IOTC using form 2FC. Where fleets are not shown to change greatly over time then longer intervals between frame surveys may be permitted.

Currently data on CITES species are not required as part of the mandatory IOTC data submission, but IOTC reporting should ideally be expanded to cover CITES listed sharks and to species level for all sharks, seabirds, turtles and cetaceans.

In order to ensure the validity and veracity of artisanal data collection between countries, each CPC should publish a broad, well written methodology for collection and processing of all data on artisanal fisheries. This needs to include:

i. a statement of the definition of artisanal fisheries by each CPC (and whether or not this conforms from the current IOTC definition);
ii. the extent to which each of the obligatory IOTC data requirements are currently being met by the CPC;
iii. a clear statement on the statistical methods used for the collection, processing and reporting data for artisanal fisheries (e.g. estimation of total catches, or raising to total fishing effort);
iv. as well as stating the logistical issues which may negatively impact effective data collection for artisanal fisheries.

Data collection manual

- Each CPC should develop or update a data collection manual that should detail the data collection process for enumerators. The manual should be available in local languages where required and include annotated examples for each data collection form, paper or electronic, with both blank and completed versions.

- Within such a manual, each country should provide a method statement, which, ideally, should then be assessed by external independent experts and validated for precision and accuracy and then periodically re-examined for efficacy. Such validation must also include assessing ambiguities in definitions of artisanal fisheries between CPCs, with all CPCs using and abiding by the IOTC definition of an artisanal fishery.

- In order to ensure a robust and standardised system it is recommended that all countries implement a digital data collection system. This, for example, could take the form of a mobile app which is used by enumerators and linked to a central cloud storage system where data can be validated and processed. Data should be collected at source (i.e., landing site) and sent directly to a central system to help minimise data entry errors and delays in submission. Enumerators should be well trained, qualified and adequately compensated to ensure robust and accurate data are collected, as well as to reduce the risk of turnover and disruption to data collection activities.

- Sampling should be based on a current vessel frame survey in order to ensure a good representation of the fleet (boat/gear/species combinations) is sampled and thus ensure sufficient coverage. The frame survey must be regularly updated (minimum every two years) to ensure accurate raising factors and representativeness of sampling.

- If limited enumerator or sampling resources are a critical factor, alternative mechanisms for data collection should be considered, including fisher self-sampling (conditional on fishers being well trained in species identification, education and literacy levels, and also familiarity with the types of data to be collected).

Species identification

- CITES species should be added to the sets of identification guides supplied by IOTC to CPCs and used by enumerators to enable identification at species level.

- A forum should be set up within each CPC (e.g. using WhatsApp group or other alternative mobile-based apps) whereby enumerators and/or fishers can upload a picture of a species to get help from others regarding species identification. Members of the group should include all enumerators, fishers and members from the organisation responsible for data collection. At a higher level, additional confirmation should be available through a group consisting of members from each CPC and IOTC Secretariat staff.

- All enumerators should be equipped with IOTC species identification cards to ensure accurate identification.

Data processing manual

- Each CPC should develop or maintain an up-to-date data processing manual. The data processing manual should describe the processes used by the CPC to aggregate and raise catches, e.g. calculation of raising factors, levels of aggregation at each level (port, region, fleet). The manual should be available in English or French and in local languages where required and include annotated examples for each data raising process.

- Data should be collected by species and gear, but if this is not possible and the estimation of catches at species group level are generally considered reliable, methods should be developed within the data processing and reporting protocols to disaggregate species group catches by species (e.g. using fixed ratios based on empirical observations in the field).

Best practices across CPCs

To aid the further development of artisanal data collection throughout the CPCs, we have summarised a range of best practice examples. These examples have either come from our analysis of the available literature, or have been provided by the CPC in response to the questionnaire issued during the project (Table 2).

Table 2 Examples of best practice in artisanal data collection across CPCs

Country	Example of best practice
Bangladesh	In Bangladesh, a new World Bank funded project called 'Sustainable Coastal and Marine Fisheries Project' was initiated by the Department of Fisheries in 2018. This project aims to set up 65 landings station data collection centres along the coast line.

Country	Example of best practice
	Data will be collected by enumerators using electronic devices, which will be connected to a central data centre.
Comoros	In Comoros, data have been collected through smartphones since 2017. Data are collected daily through a control and verification interface and an effective validation phase is carried out between the database manager and the sampler. To improve data transmission to IOTC, a module has been developed that extracts data from the database from each sheet.
EU- France	Mayotte is in the process of deploying observers onboard coastal longlines. This should improve catch data for this fleet for 2019and following years.
Indonesia	Indonesia is implementing e-logbooks to monitor and record catch and effort as well piloting 'online scales' that can record the weight of fish directly when landed. Indonesia is also integrating data into a single database system for further analysis and reporting.
I.R. Iran	Examples of best practice in I.R. Iran include collecting data for artisanal fisheries via the use of electronic logbooks, online data coverage, and improvements in the equipment available for sampling and training of enumerators by IOTC.
Kenya	In recent years, Kenya has been trialling the use of electronic data capture by enumerators using mobile devices, which appear to show promising results.
Madagascar	In Madagascar, best practice examples include the training of investigators or field samplers on data collection, species identification and recording and collecting data on electronic tablets. In 2016, the FAO developed a generic distributable version of OPEN ARTFISH for small-scale fisheries data collection, which includes OPEN ARTFISH and the ODK mobile phone application. OPEN ARTFISH is a generic database that estimates total catch and cash value for small-scale sampling plans. In addition, it provides guidance on the use of appropriate statistical procedures and guidance on sampling plans given that only a limited number of landing sites can be covered for a certain number of days.
Oman	There are a range of examples of best practice from Oman for artisanal data collection. These include the use of statistical electronic forms for documenting artisanal landings, with all effort and landing data collected via tablet devices and electronic forms by data collectors. In addition, Oman utilises a substantial database and system management tool for artisanal fishing statistic surveys, which is able to collate all collected data (i.e., data from 1985 to present), as well as allowing managers to define the number of required samples, required days for landing and fishing effort, while also allowing supervisors to schedule and check the completion of all survey work.
Seychelles	In Seychelles, a new system has been developed and implemented for data capture for artisanal fisheries. This contains a module for the catch assessment survey, logbook and biological sampling. A similar system is being developed for the samplers to capture the data at landing sites and transfer data into a central database for verification and validation. VMS data is also being used to complement missing trips from observations by samplers.
Sri Lanka	In Sri Lanka, electronic data reporting (e-logbooks) are currently being implemented onboard gillnet and longline vessels <18m LOA which, combined with existing port sampling, is contributing to improvements in the timeliness and accuracy of catch estimates for small-scale vessels.

3.2 Summary of artisanal data collection throughout CPCs and country-specific challenges

In this section we provide a more detailed description and synopsis of the artisanal fleet at the country level, the data collection systems in place, and the main challenges facing each country and (where possible) provide a list of recommendations to enhance country-wide artisanal data collection (summarised in Annex 4).

3.3 Australia

Australia states that it has no artisanal fleet, instead categorising vessels as 'minor line'. According to the completed compliance questionnaire in 2017, Australia was assessed to be compliant against the majority of Resolutions in regards to Flag State Controls. As Australia is reported to have no artisanal vessels, such information is only relevant to industrial fisheries. However, within the 2017 IOTC artisanal Nominal Catch database, Australia is reported to have small landings of tuna and tuna-like species, including shark species. The predominant catch is of narrow-barred Spanish mackerel (Table 3).

Table 3 IOTC nominal catch data for artisanal fleets, 2017.

Common Name	Scientific Name	Artisanal fishing (t)
Australian spotted mackerel	*Scomberomorus munroi*	0.50
Australian bonito	*Sarda australis*	1.40
Broad-barred king mackerel	*Scomberomorus semifasciatus*	20.90
Guitarfishes, etc. nei	*Rhinobatidae*	0.50
Marine fishes nei	*Osteichthyes*	1.50
Queensland school mackerel	*Scomberomorus queenslandicus*	1.00
Narrow-barred Spanish mackerel	*Scomberomorus commerson*	283.50
Wahoo	*Acanthocybium solandri*	0.50
Copper shark	*Carcharhinus brachyurus*	0.50
Spinner shark	*Carcharhinus brevipinna*	0.30
Shark mackerel	*Grammatorcynus bicarinatus*	0.03
Various sharks nei	*Selachimorpha (Pleurotremata)*	1.00
Shortfin mako	*Isurus oxyrinchus*	0.50
Hammerhead sharks nei	*Sphyrna spp*	0.10
Albacore	*Thunnus alalunga*	0.20
Bigeye tuna	*Thunnus obesus*	0.06
Kawakawa	*Euthynnus affinis*	1.00
Longtail tuna	*Thunnus tonggol*	13.30
Southern bluefin tuna	*Thunnus maccoyii*	0.82
Skipjack tuna	*Katsuwonus pelamis*	1.53
Yellowfin tuna	*Thunnus albacares*	1.10

Artisanal data collection programme

As Australia has no artisanal fisheries there is no stated organisation responsible for artisanal data collection and no stated data collection system. Although Australia does have a recreational fishery, it does not submit data on recreational fishing to IOTC. This is despite Resolution 15/02, which refers to all catches caught within the EEZ or high seas in the Indian Ocean – including recreational or sports fisheries (which are classified under artisanal fisheries).

Country-specific challenges in artisanal fisheries data collection

As Australia do not currently classify their recreational or sports fisheries fleet as being 'artisanal', there is a need to clarify the composition of their fishing fleet and whether catches should be reported in the IOTC in the future as artisanal fisheries.

3.4 Bangladesh

In Bangladesh, the fishery sector is divided into two main segments: the industrial and artisanal sector. The artisanal sector plays a large role in marine fisheries production. In 2018, for example, the fishery accounted for approximately 528,997 MT of nominal catches[8]. The artisanal fishery (also termed 'traditional fisheries') is comprised of a mixture of mechanised and non-mechanised boats operating gillnets, set bag nets and trammel nets that fish in shallow depths close to the coastline.

There is no dedicated tuna fishery in Bangladesh and therefore the catch information provided in the 2018 National Report to IOTC does not include tuna or tuna-like species. There is a category for 'other fish' but it is not clear what species are included in this[9]. National catch assessment forms also do not list tuna or tuna-like species, apart from a mackerel group which could include narrow-barred Spanish mackerel and Indo-Pacific King mackerel. In this respect, the 2017 IOTC nominal catch database for artisanal vessels show no tuna species being caught, with the catch dominated by sharks (although no species level data have been provided). In addition, there is no bycatch in Bangladeshi fisheries, as discarding is banned and all fish landed are used in some form[10].

Table 4 IOTC nominal catch database for Bangladesh's artisanal fisheries, 2017.

Common name	Scientific name	Artisanal fishing (t)
Narrow-barred Spanish mackerel	*Scomberomorus commerson*	301.20
Indo-Pacific king mackerel	*Scomberomorus guttatus*	208.84
Various sharks nei	Selachimorpha (Pleurotremata)	753.68

Artisanal data collection programme

In Bangladesh, the Department of Fisheries (DOF) is responsible for routine data collection through its Fisheries Resources Survey System (FRSS), which is divided into two divisions for dealing with inland and marine data (Stobberup, 2012).

An FAO/UNDP fisheries project in the 1980s formed the foundation for Bangladesh's data collection protocol. In connection with the project, the '*Manual of Catch Assessment Survey*' was prepared and this is still used for data collection (Stobberup, 2012). This manual provides the procedures followed by all types of fisheries, including the artisanal sector, as well as for all estimation processes; estimations of total catches are calculated using sample data collected by officers at the field level (termed a 'catch assessment survey').

In order to identify sampling units (e.g. sampling villages) and calculate raising factors to estimate total catches by district, a frame survey is conducted prior to a catch assessment to provide a complete list of sampling units and information (e.g. total number of boats). This frame survey is embedded within a national data collection protocol. When sample villages are selected, they are fixed for several years in order to be able to identify annual and seasonal changes. When data are collected during the catch assessment surveys, they are checked at the field level before being processed at the DOF headquarters. The purpose of the catch assessment survey is to estimate total catch of different sectors of fisheries by: districts; months; gear used; species; producer's price; fixed sample village; fixed sample day; and

[8] IOTC-2018-SC21-NR32

[9] IOTC-2018-SC21-NR32

[10] IOTC-2018-SC21-NR32

monthly schedule. Estimated total catch is then calculated as:

Catch data from sample unit x Raising Factor (Raising Factor = Total Number/ Sample Number).

For artisanal fisheries, the purpose of the catch assessment survey is to collect sample data on catch and producer's price data, as well as corresponding fishing effort by districts, months, types of gear and species. For each gear type (gill net, set net bag, long line, jew fish long line, seine net, cast net and miscellaneous fishing gear), sampling landing centres are selected from larger centres.

For each type of gear, different sampling days are selected. For gillnet fisheries, four sample days are selected per month, with eight days between each sample day (e.g. 3rd, 11th, 19th and 27th), while for other gear types two sample days are selected in a month, with a gap of 15 days between each sample day. When an officer visits a sample landing centre, they must first connect with an informed fisher and ask for the expected number of boats arriving by a particular gear type during the sampling day. A maximum of five landings are selected from all expected landings during that day. For each fishing gear, the number of fishing units in operation will determine the number of sampling fishing units selected, with higher sampling fishing units selected as the number of fishing units in operation increase (Table 5).

Table 5 Sampling protocol for fishing units in Bangladesh.

Number of fishing units in operation	Number of sampling fishing units to be selected
10 and over	5
5-9	3
2-4	2
1	1

In general, the size of fish landed is estimated by eye but occasionally a portable balance should be used to check weights.

To scale up monthly total catches by types of fishing gear to the district level the following calculation is used:

Estimated monthly total catch = Average catch per fishing unit per month (obtained by the catch assessment survey) x Total number of fishing units by District (obtained by the Frame Survey). With average catch per fishing unit per month calculated as: *Average catch per trip obtained (as an average of observed sample catch data) x Average number of trips per fishing unit per month (obtained as an average of sample data on the number of trips per month).*

The Fisheries Resources Survey System (FRSS) unit through the DOF collects and compiles all the data and FRSS software processes the data using codes for the district, sample village, gear and species. In addition to fisheries catch data, a sampling frame survey was undertaken in 1985 and all fisheries data is processed on the basis of this frame survey. Other data are also available from surveys such as household income and expenditure which helps to identify per capita fish consumption (Stobberup, 2012).

There is no specific mention of CITES species in the data collection protocol, while in the Catch Assessment Forms there is only a combined category for sharks and rays. Although there are no sharks present in the Bay of Bengal that are on the IOTC list of species,

information on sharks caught are provided to species levels within the 2018 National Report[11]. Despite this, the 2018 Bangladesh Compliance Report only show shark data aggregated into species groups.

Country-specific challenges in artisanal fisheries data collection

The main barriers to estimating the size and composition of the Bangladeshi artisanal fleet include the country's irregular coastal landscape which can inhibit proper monitoring, in addition to a lack of legislative frameworks in place for artisanal vessels. With regards to the collection of nominal catch, catch and effort and size frequency data, issues including lack of manpower, access to landing sites and insufficient funding and logistical support were cited as barriers to collecting data. The main challenges to monitoring, collecting and reporting IOTC and CITES species for artisanal fisheries were similar to those barriers quoted above and included a lack of funding, capacity, logistical support and regulatory frameworks (Table 6).

Table 6 Main challenges to monitoring, collecting and reporting IOTC and CITES species for Bangladesh's artisanal fisheries

Lack of legislative or regulatory framework to monitor small-scale fisheries?	Regulatory frameworks not well develop in small-scale fisheries.
Financial (e.g. costs of routine data collection, funding for enumerators or port samplers)?	Insufficient funding, requires more funding and capacity for data collection.
Lack of technical expertise (e.g. staff training, expertise to design and implement data collection)?	Need staff and officer training for data collection and analysis.
Equipment (e.g. transport, equipment for sampling)?	Need transport facilities and modern equipment for sampling.
Logistical challenges (e.g. access to landing sites, high turnover of enumerators)?	A site office for the Marine Fisheries Survey Management Unit (MFSMU) needs to be set up in every coastal district. Currently, an MFSMU office is situated in only two coastal districts; Chattogram and Cox's Bazar.
Technological (e.g. lack of corporate data base or tools for electronic data capture/reporting)?	Data collection system is manual.
Lack of understanding of IOTC data reporting requirements?	Yes
Any other factors (please specify)?	-

3.5 Comoros

In the Comoros, fishing is entirely artisanal. While most fishers still use traditional wooden canoes, small motorised fibreglass vessels have been introduced over the last 20 years and now account for approximately a third of all vessels. Most boats are 3 - 9m in length and mainly exploit pelagic species[12].

Comoros fish for a range of species but focus predominantly on yellowfin and skipjack tuna, with relatively small catches of a range of marlin species and other tuna-like species (Table 7). In 2017, no catches of shark species were reported for the Comorian artisanal fleet according to the IOTC nominal catch database. However, according to the National Report for the Comoros, shark species caught are retained on board and make a relatively large

[11] IOTC-2018-SC21-NR32

[12] IOTC-2018-SC21-NR03

proportion of catches within the fishery. In 2017, for example, Comoros reportedly caught 10,324 kg of blue shark (*Prionace glauca*), 15,879 kg of silky shark (*Carcharhinus falciformis*) and 341 kg of tiger shark (*Galeocerdo cuvier*). However, these species do not appear in Comoros' nominal catch database from IOTC.

Table 7 2017 IOTC nominal catch data for Comorian artisanal fishing vessels

Common name	Scientific name	Artisanal fishing (t)
Black marlin	*Makaira indica*	191.27
Blue marlin	*Makaira nigricans*	11.58
Striped marlin	*Tetrapturus audax*	58.05
Indo-Pacific sailfish	*Istiophorus platypterus*	994.30
Swordfish	*Xiphias gladius*	310.16
Narrow-barred Spanish mackerel	*Scomberomorus commerson*	5.67
Indo-Pacific king mackerel	*Scomberomorus guttatus*	6.70
Albacore	*Thunnus alalunga*	81.27
Bigeye tuna	*Thunnus obesus*	1052.11
Bullet tuna	*Auxis rochei*	3.81
Frigate tuna	*Auxis thazard*	33.15
Kawakawa	*Euthynnus affinis*	42.31
Longtail tuna	*Thunnus tonggol*	37.36
Skipjack tuna	*Katsuwonus pelamis*	5231.46
Yellowfin tuna	*Thunnus albacares*	4806.01

Artisanal data collection programme

Data are collected across the three islands by the Government. A number of surveyors are dispatched across sampling sites, including 11 surveyors to cover the primary villages at a given time interval, and the secondary villages at a lower frequency (Toihir, 2017).

In 2011, the Comoros received financial support from IOTC to implement a fishery statistical data collection programme. Prior to this, no data were collected for more than 17 years for Comorian fisheries. Since receiving financial support, the Comoros now collect two types of fisheries data: fisheries statistics and census of fishing boats.

Due to the varied nature of landing sites, the data collection protocol adopted in the Comoros is a stratified sampling plan. Fisheries data are collected in the three islands that comprise the Comoros and each island has a number of survey sites which correspond to the number of fishers' villages. There are two types of villages depending on the importance of the fishery: primary villages, where catch is important and must be surveyed every time a fishing activity occurs, and secondary villages, where catch is less important and can be surveyed less frequently.

The sampling strategy was initially based on seven strata split across the three islands. However, this has now been condensed in an attempt to optimise costs, improve the management of surveyors, improve data collection and reduce the occurrence of errors in the database. As of 2015, there are now five strata across the Comoros: two on Grande Comore the largest of the islands (in the south-west and the east/north west), two on Anjouan (one in the east-north and one in the south west) and one in Mohéli (whole island).

Until 2016, the data collection system only covered pelagic fishes. However, this has now been expanded to cover demersal fish species and molluscs, while the number of surveyors has also been revised (Toihir, 2017). At present, data is collected on catch and effort for

tropical and temperate tuna, neritic tuna, sharks, reef fish and other pelagic fish. Since 2017, the statistical programme also collects information on demersal species (Toihir, 2017).

The data system has 11 data surveyors across the three islands; five in Grande-Comore; four in Anjouan and two in Mohéli. According to Toihir (2017), 11 data collectors is deemed to be sufficient. Managers are able to ask for feedback from surveyors if mistakes are identified and from 2015 every surveyor is required to use an android tablet for collecting and sending data. The tablets are configured to correct target errors and automatically send geographical coordinates (Toihir, 2017). Since 2017, smartphones have been introduced to collect data. Data are collected through a control and verification interface, with validation conducted by the database manager and sampler. To improve submission to IOTC, a data retrieval module has been developed to extract data from the database for each file and reduce any data entry errors.

Within the data collection protocol there is mention of an estimation application in order to produce national catch and effort statistics. This was brought in after 2011. In 2015, the estimation application was said to have been improved due to the reduced number of sampling strata and improved management. Despite this, there is no further detail available on how this estimation application works (Toihir, 2017). The Comoros also do not produce regular reports in order to be able to publish data at the national level (Toihir, 2017).

In 2006, the Comoros added new provisions to their monitoring and control centre including requirements for the transmission of VMS data to strengthen controls. Five boats are also in place, which have position transmission beacons, which fish within the EEZ. There are also seven trained observers but due to a lack of an industrial vessel they are not utilised[13].

The IOTC artisanal craft database also does not provide any data on Comorian artisanal vessels after 2008. However, the National Report in 2017 reported the number of vessels, type of mechanisation and gear type[14].

Country-specific challenges in artisanal fisheries data collection

The Comoros cited that there were no barriers affecting the collection of data to estimate the size and composition of their artisanal fleet. However, they are lacking a specialist in fisheries statistics to be able to collect and estimate total catch. With regards to catch and effort, funding was cited as a common problem when trying to collect data. The main challenges to monitoring, collecting and reporting IOTC and CITES species for artisanal fisheries include logistical challenges and a lack of understanding. Further information is provided in Table 8.

Table 8 Main challenges to monitoring, collecting and reporting IOTC and CITES species for the Comoros artisanal fisheries

Lack of legislative or regulatory framework to monitor small-scale fisheries?	There is a legislative framework to monitor small-scale fisheries
Financial (e.g. costs of routine data collection, funding for enumerators or port samplers)?	Financial routine data collection about €65,000, financing of enumerators €15,000
Lack of technical expertise (e.g. staff training, expertise to design and implement data collection)?	Training of a Fisheries Biologist and a Fishery Statistics Specialist is required.
Equipment (e.g. transport, equipment for sampling)?	Replacement of 20 calipers, 20 scales, 20 smartphones and 20 boxes

[13] IOTC-2018-SC21-NR03

[14] IOTC-2018-SC21-NR03

	Equipped samplers of 20 Motorcycles for transportation purposes.
Logistical challenges (e.g. access to landing sites, high turnover of enumerators)?	Some landing sites are very far from the interviewer's place of residence and with poor road conditions, the interviewer occasionally must spend the night at the village under investigation.
Technological (e.g. lack of corporate database, or tools for electronic data capture/reporting)?	There is no major difficulty in covering the transmission of electronic data.
Lack of understanding of IOTC data reporting requirements?	At the level of the investigators there is an understanding of IOTC reporting requirements but this understanding is often lacking amongst fishers.

3.6 Eritrea

The artisanal fishery in Eritrea is defined by fishers who possess small boats and provide their catch as a source of food to local markets. The fishery is categorised by cooperative associations along the coasts, the major of which are Massawa, Dahlak, Gal"allo, Ti"o and Asseb, in which 37 affiliate village cooperatives hold 1,174 member fishers, as per reported by the Ministry of Fisheries in 2000.

The IOTC annual catch output from 2017 (Table 9) show that Eritrea has a small catch of tuna and tuna-like species. However, Eritrea has failed to submit mandatory data to IOTC against the relevant reporting resolutions for artisanal fishing. Further, Eritrea did not submit a National Report to IOTC, which raises questions as to the source of IOTC catch output data stored in the IOTC database.

Table 9 IOTC annual catch output for artisanal fleet (tonnes) in Eritrea, 2017.

Sp. Group	English Name	Scientific Name	Tonnes
Billfish	Indo-Pacific sailfish	*Istiophorus platypterus*	2.00
Other nei	Tuna-like fishes nei	Scombroidei	123.00
Seerfish	Narrow-barred Spanish mackerel	*Scomberomorus commerson*	94.00
Sharks	Requiem sharks nei	Carcharhinidae	90.00

Artisanal data collection programme

The Ministry of Marine Resources' (MMR) two operational departments, namely the Fisheries Resources Development Department (FRDD) and the Fisheries Regulatory Services Department (FRSD) are the responsible organisations for the delivery of fisheries management under Fisheries Proclamation No. 104/1998. The Fisheries Regulatory Services Department (FRSD) focuses on fisheries management and is composed of three divisions: the Marine and Coastal Management Division, which is responsible for research, marine resources management, data collection and management, and environmental management; the Fish Inspection and Quality Control Division, which is involved in quality assurance and certification services including managing the quality control laboratory in Massawa and conducting post-harvest research and training; and the Fish Industry Development Division, responsible for fleet licensing, promotion of investment in the fishery sector, and MCS.

MMR operations are decentralized in two zoba (regional) branches; one is located in the north (Massawa) and the other in the south (Assab). Each branch has a licence, monitoring and

control unit, which issues fishing licences, ensures control and monitoring of fishing operations, provides marketing services and ensures data collection (FAD, 2010).

The University of Asmara and the Marine and Coastal Management Division of the FRSD carry out fisheries research activities in Massawa. Data from the industrial trawlers and artisanal fisheries are collected and analysed and their findings are released in reports. However, these reports are largely descriptive and do not meet the needs of providing scientific advice to adequately support fisheries management (Breuil and Grima, 2014).

Country-specific challenges in artisanal fisheries data collection

Catch and effort data recording systems in the artisanal fisheries of Eritrea are based on complete enumeration of catch and effort statistics. This, however, is deemed to be inefficient, as it is restricted to the collection of only catch and effort data only (Tsehay, 2007).

3.7 European Union/ France (OT)

The EU fishing fleet in the Indian Ocean is comprised of two main segments: an offshore and a coastal segment. The coastal segment consists of vessels less than 12m which fish for large pelagic species around Mayotte and La Réunion Island. The coastal segment of La Réunion usually fish within a zone 20 miles offshore during one-day tides, and in 2017 accounted for 90% of active vessels[15].

Within the IOTC nominal catch database, artisanal catches are provided for both EU, France (Mayotte) and La Réunion. According to the database in 2017 the following catches were made by artisanal vessels (Table 10).

Table 10 IOTC nominal catch database for artisanal fishing 2017.

Country	Common name	Scientific name	Artisanal fishing (t)
EU France	Indo-Pacific sailfish	*Istiophorus platypterus*	12.00
EU France	Swordfish	*Xiphias gladius*	0.14
EU France	Common dolphinfish	*Coryphaena hippurus*	3.85
EU France	Dogtooth tuna	*Gymnosarda unicolor*	6.34
EU France	Great barracuda	*Sphyraena barracuda*	3.61
EU France	Narrow-barred Spanish mackerel	*Scomberomorus commerson*	3.96
EU France	Wahoo	*Acanthocybium solandri*	10.04
EU France	Albacore	*Thunnus alalunga*	1.36
EU France	Bigeye tuna	*Thunnus obesus*	48.93
EU France	Kawakawa	*Euthynnus affinis*	3.58
EU France	Skipjack tuna	*Katsuwonus pelamis*	56.08
EU France	True tunas nei	*Thunnus spp*	3.34
EU France	Yellowfin tuna	*Thunnus albacares*	80.10
EU France Reunion	Black marlin	*Makaira indica*	7.44
EU France Reunion	Blue marlin	*Makaira nigricans*	100.79
EU France Reunion	Striped marlin	*Tetrapturus audax*	2.87
EU France Reunion	Indo-Pacific sailfish	*Istiophorus platypterus*	9.39

[15] IOTC-2018-SC21-NR06

Country	Common name	Scientific name	Artisanal fishing (t)
EU France Reunion	Shortbill spearfish	*Tetrapturus angustirostris*	1.43
EU France Reunion	Swordfish	*Xiphias gladius*	116.15
EU France Reunion	Common dolphinfish	*Coryphaena hippurus*	207.40
EU France Reunion	Wahoo	*Acanthocybium solandri*	59.81
EU France Reunion	Oceanic whitetip shark	*Carcharhinus longimanus*	0.04
EU France Reunion	Shortfin mako	*Isurus oxyrinchus*	2.33
EU France Reunion	Albacore	*Thunnus alalunga*	111.46
EU France Reunion	Bigeye tuna	*Thunnus obesus*	11.83
EU France Reunion	Skipjack tuna	*Katsuwonus pelamis*	59.36
EU France Reunion	Yellowfin tuna	*Thunnus albacares*	363.09

Artisanal data collection programme

The evaluation of effort and catch data are conducted by IFREMER and IRD in partnership with the Directorate of Maritime Fisheries and Aquaculture and for Mayotte, the PNMM managed by the Marine Protected Area Agency is responsible for managing fisheries (IOTC Secretariat, 2018b).

Nominal catch and catch and effort data of Mayotte's low powered Yamaha non-decked barges have been estimated for the coastal fleet in Mayotte since 2013, through sampling of landings. Daily landing observations are undertaken by field agents from the French Fisheries Information System (SIH) of which there were six field agents in 2017[16]. Although the declaration of catches has been obligatory since 2013, very little data is submitted. According to the National Reports submitted by the EU, a range of species are reported in groups, with e.g. yellowfin tuna and bigeye tuna combined[17]. This is different to the data provided in the IOTC nominal catch database, whereby data are provided by species; a larger range of species are provided in the IOTC database than provided by the National Report. Data is also provided on specific shark species in the IOTC nominal catch database, whereas in the National Report elasmobranch data are only available as an aggregated 'shark and ray' category.

Landing observation data are extrapolated on a métier-by-métier basis, based on an activity survey carried out annually by the owners of Mayotte vessels in accordance with Ifremer's ObsDeb protocol. All fishing vessels (with the exception of those only for recreational purposes) are subject to the annual activity survey. Annual activity surveys help define a fishing fleet and provide overall fishing effort in months, and the number of outings per metier. Landing observations determine the average composition in volume and value of catches per métier. The average basket is then extrapolated to the number of outputs estimated per metier.

For the three coastal longliners in Mayotte, catch data are based on analysis of sales from the main fishing cooperative in Mayotte, and since 2015 is supplemented by the analysis of fishing logbooks of the ship-owners no longer passing their catch through the cooperative (EU, Questionnaire Response, 2019). However, denominations of species caught remain at the commercial level, as data sources do no currently allow for catches at the specific level (EU,

[16] IOTC-2018-SC21-NR06

[17] IOTC-2018-SC21-NR05 - EU

Questionnaire Response, 2019). As many boats do not have on-board GPS, the spatialization of fishing activity is determined by the use of reference lists of fishing sites known and frequented by fishermen. The National Report references a 'Harmony database', held by Ifremer, but no further information could be found on this[18]. The activity data collected are used to produce summary sheets which detail indicators on the fishing vessels and on the characteristics of their fishing activities including: home ports, deployed techniques and number of seafarers. The landings observation data enable the production of summaries by métier, and estimates of landing volumes and yields fleet by fleet. However, the flow of data is unreliable and incomplete and therefore data are not available in a national database[19]. As of 2017, observers are now also deployed on Mahoran coastal longliners.

For La Réunion, investigators at the docks under the ObsDev programme measure large pelagics landed by the small inshore fishery by tape and through random sampling. The system appears similar to that undertaken in Mayotte for estimating nominal catch and catch and effort. A landing observation programme called ObsDeb[20] is used to estimate fishing effort and catch. Only vessels less than 12m are tracked by landing surveys using ObsDeb[21]. Data for the low-powered vessels comes from landing observations and activity surveys, while longliner data is sourced from logbooks. SIH investigators are present at docks and measure all large pelagic fishes as they are landed. An effort to collect size data of large pelagic fish from coastal longliners under 12m was undertaken in 2017 for La Réunion. However, the recovery of size frequency data is made difficult by the lack of investigators involved in observational programmes for small-scale fisheries in Reunion and Mayotte. Overall, as in Mayotte the flow of data is unreliable and incomplete and therefore data are not available in a national database.

For both La Réunion and Mayotte, information on artisanal/coastal fishing vessels is collected through a national vessel registration scheme, whereby 100% of small-scale professional vessels which are less than 12m in length overall are registered in the EU fleet register. It was reported that the main constraint to updating Mayotte's non-professional vessels is associated with the large number of very small units, and the absence of fixed landing sites. For La Réunion, the same issues are expected to apply with data collection; an IOTC funded project is currently underway to estimate the catch volumes for the non-professional fishery in La Réunion.

Country-specific challenges in artisanal fisheries data collection

The EU state that the regular updating of Mayotte's non-commercial (non-professional) vessel census is constrained by the large number of very small units concerned and the absence of fixed landing sites. In regards to issues with collecting nominal catch and catch and effort data, although catch declaration obligations have been in place since 2013 for non-commercial vessels, they face trouble with being respected. A minority of ship owners however, do comply with reporting requirements for the vessels that are under 10m in length. The data collection is also constrained due to the absence of fixed landing sites in Mayotte. The main barriers to collecting size frequency data include the number and variety of vessels involved, the insufficient number of investigators involved in observer programmes and the absence of fixed landing sites in Mayotte. The main challenges to monitoring, collecting and reporting IOTC and CITES species for artisanal fisheries include lack of capacity, limited fixed landing sites

[18] IOTC-2018-SC21-NR06

[19] IOTC-2018-SC21-NR06

[20] For both Mayotte and Reunion no further information was available on the ObsDeb protocol and therefore it is unclear what this programme entails.

[21] IOTC-2018-SC21-NR06

and deficiencies in logbook data (Table 11).

Table 11 Main challenges to monitoring, collecting and reporting IOTC and CITES species for the EU artisanal fisheries

Lack of legislative or regulatory framework to monitor small-scale fisheries?	-
Financial (e.g. costs of routine data collection, funding for enumerators or port samplers)?	-
Lack of technical expertise (e.g. staff training, expertise to design and implement data collection)?	-
Equipment (e.g. transport, equipment for sampling)?	The recovery of size frequency data is made difficult by the lack of investigators involved in the observational programs for small-scale fisheries in La Réunion and Mayotte.
Logistical challenges (e.g. access to landing sites, high turnover of enumerators)?	The lack of fixed landing points in Mayotte constraints the monitoring and collection of catches data.
Technological (e.g. lack of corporate database, or tools for electronic data capture/reporting)?	-
Lack of understanding of IOTC data reporting requirements?	Data from logbook declarations are deficient for a majority of small-scale and coastal fishing segments in La Réunion and Mayotte. Declaration obligations are struggling to be completed by all fishermen. Improvement margins need to be found in this area.
Any other factors (please specify)?	-

3.8 India

India's coastline consists of nine maritime states, four maritime Union Territories, numerous ports, landing sites and boats (most of which are artisanal, according to the IOTC definition) (Moreno, 2013; Hornby et al., 2015). India's tuna fishery is divided into two segments, the coastal fishery and the oceanic fishery. The coastal fishery is comprised largely of artisanal/mechanised boats operating traditional gears, while the oceanic fleet is comprised of an artisanal pole and line fishery based at the Lakshadweep group of Islands, small longliners (mainly shrimp trawlers converted to tuna longliners) targeting fresh tuna within the EEZ, and the industrial longline fishery comprised of Indian owned tuna longline vessels and Letter of Permission (LOP) vessels[22]. Hornby et al. (2015) suggests that the tuna coastal fishery is artisanal whereas the tuna oceanic fishery is largely industrial. However, Moreno's (2013) does mention the oceanic fishery in describing India's artisanal fishery. Within the coastal segment there are large assemblages of small fishing boats including gillnets, small purse seines and hook and line boats, that although are not targeting tuna, contribute significantly to tuna landings.

In India's National Report in 2015 (Ramalingam et al., 2015), which is the last National Report submitted to IOTC by India, the tuna fishery was comprised of five species of neritic tuna and

[22] IOTC-2015-SC18-NR09

four oceanic species representing 68% and 32% of the catch respectively. Kawakawa, frigate, bullet and longtail tuna, and bonito represented the neritic tuna. The oceanic group was represented by yellowfin, skipjack, big-eye and dogtooth tuna. In comparison, the 2017 IOTC nominal catch database for artisanal fleets show that data submitted to the IOTC is dominated by narrow-barred Spanish mackerel, kawakawa, skipjack tuna and the Indo-Pacific king mackerel. Although sharks are also an important fishery, as these landings are aggregated, there is no understanding of the level of species identification undertaken when recording catch (Table 12).

Table 12 Indian nominal catch data by artisanal vessels (2017).

Common Name	Scientific Name	Artisanal fishing (t)
Black marlin	*Makaira indica*	7182.60
Indo-Pacific sailfish	*Istiophorus platypterus*	6194.60
Swordfish	*Xiphias gladius*	3491.50
Others	-	1141.00
Striped bonito	*Sarda orientalis*	478.00
Narrow-barred Spanish mackerel	*Scomberomorus commerson*	37677.00
Indo-Pacific king mackerel	*Scomberomorus guttatus*	17110.00
Wahoo	*Acanthocybium solandri*	223.00
Giant manta	*Manta birostris*	21.00
Various sharks nei	Selachimorpha (Pleurotremata)	22393.00
Bigeye tuna	*Thunnus obesus*	78.00
Bullet tuna	*Auxis rochei*	6689.80
Frigate tuna	*Auxis thazard*	7356.00
Kawakawa	*Euthynnus affinis*	35928.20
Longtail tuna	*Thunnus tonggol*	8090.00
Skipjack tuna	*Katsuwonus pelamis*	37124.00
Yellowfin tuna	*Thunnus albacares*	19138.00

Artisanal data collection programme

There are three main institutions responsible for data collection and processing in India: the Central Marine Fisheries Research Institute (CMFRI), Fishery Survey India (FSI) and the Marine Products Export Development Authority (MPEDA). In addition to these, State and Union Territories work with CMRFI in relation to fishery resources in the Indian EEZ and manage and regulate fishing vessels within 12 nautical miles (nm). States also have enumerators that can identify and record tuna (Stobberup, 2012; Moreno, 2013).

The CMFRI are the nodal marine fisheries research agency in India and are responsible for: monitoring and assessment of exploited and under-exploited marine fishery resources of coastal fisheries; tuna data collection from the coastal fisheries in all States (using its own enumerators); monitoring and assessing of exploited marine fishery resources and rendering policy to support Union and State Governments; acting as a repository of information on marine resources; and collecting species data for tuna, mackerel and seer fisheries (Moreno, 2013).

The FSI are the nodal institution of the IOTC and are responsible for: conducting exploratory surveys and stock assessments for deep-sea and oceanic resources in the EEZ and coastal fish stocks; collecting and processing private sector deep-ocean tuna catch data through ‘voyage reports’; monitoring fishery resources for fisheries regulation, management and

conservation; and maintaining data on deep sea fishery resources and dissemination of information to different user groups (Moreno, 2013).

The MPEDA works with customs to obtain documents and invoices for fish export data and are responsible for: monitoring the exports and imports of all marine fish products, and assisting exporters in fish product development and management; and conducting product research and development and providing reliable information on the species, volumes and values that are exported (Moreno, 2013).

In India, data are collected by several organisations including at the Ministry, State and Institutional level. However, data collection is predominantly collected by trained enumerators that travel to landing sites and fishing villages (Moreno, 2013). CMFRI methodology for data collection has been adopted by all parties involved in data collection for marine fisheries (Stobberup, 2012). Such sampling covers the entire mainland coast of India, and stratifies the area of sampling so that each maritime state is divided into suitable, non-overlapping zones on the basis of fishing intensity and geography. The zones are then further subdivided, again based on fishing intensity (Stobberup, 2012). However, it is unclear whether this sampling strategy applies to artisanal fleets or if there are different procedures in place for industrial and artisanal fleets.

Under CMFRI methodology, if within a zone there are 20 landing sites (termed 'centres' hereafter), there will be 20 * 30 = 600 landing centre days in that zone within a given month (using 30 days as the average number of days in a month). Sampling effort within this month will then be divided into three groups of 10 days. From the first five days in a month, a day is randomly selected and then the next five consecutive days are automatically selected. From this, three groups of two consecutive days are formed. For example, for a given zone, in a given month, if the day selected at random is four, then these groups are formed, (4, 5), (6, 7) and (8, 9) in the first 10-day group. In the remaining 10-day groups, the clusters are systematically selected with an interval of 10 days. For example, in the above case, the groups of observation days in the remaining groups are (14, 15), (16, 17), (18, 19) (24, 25), (26, 27) and (28, 29). Normally in a month there will be nine clusters of two days each. From among the total number of landing centres in the given zone, nine centres are selected with replacement and allotted to the nine cluster days (Srinath, *et al*., 2005). Within the CMFRI methodology, data collected by enumerators should include the total number of fishing units landed by actual count and time of their arrival; detailed species-wise dissemination at landings, as well as other ancillary information with regard to selected number of fishing units; and data on ‘night landings’ (Srinath et al., 2005).

The number of boats sampled is also described within the CMFRI methodology, and is determined by the number of units landed within each site within a day (Table 13). However, there is a discrepancy between CMFRI methodology and a recent review of the data collection systems (Moreno, 2013). Moreno (2013) notes that boats are sampled for each net type based on the order of arrival. If there are up to five boats, all boats are sampled; if there are 6-10 boats, every other boat is sampled; 11-20 boats and one from every four (25%) boats is sampled and if there are more than 20 boats one in every five boats (20%) is sampled.

CMFRI methodology also states that all shore seines should be recorded separately and all units examined in detail (Srinath et al., 2005). Moreno (2013) proceeds to state the FSI’s data collection coverage is 5-10% of landings and periodicity is 10 landing centre days (24 hours) or 20 calendar days for each enumerator. FSI also use time, space and multi-stage stratified random sampling. However, Moreno (2013) shows that State and Union Territories for the oceanic fishery convert nominal catch by using a raising factor of 1.15. Overall, such discrepancies between CMFRI reported methodology and the recent review of in-field methodology makes it unclear as to the exact sampling strategy that is employed at landing sites throughout India.

Table 13 Sampling strategy for fisheries data collection by CMFRI

Number of Units Landed	Fraction to be Examined
Less than or equal to 15	100%
Between 16 and 19	First 10 and the balance 50%
Between 20 and 29	1 in 2
Between 30 and 39	1 in 3
Between 40 and 49	1 in 4
Between 50 and 59	1 in 5 etc.

Source: Srinath et al., (2005).

Enumerators often collect data at ports by asking locals for the numbers of fishing vessels out at sea and then sample individual boats when they arrive (Moreno, 2013). However, there are potential issues with this method, as fleets move around during the monsoon season and visiting boats (launched from outside the region) may result in an under-estimation of total number of fishing vessels (Moreno, 2013).

Country-specific challenges in artisanal fisheries data collection

Moreno (2013) reports that fish are measured randomly, and total catch is currently estimated through counts of baskets, which are then multiplied by an average weight. However, CMFRI methodology specifies that actual weight of landings should be made and only in the case of heavy landings should one basket of various groups of fish be weighed and the total obtained by multiplying the weight by the total number of baskets (Srinath et al., 2005).

Different forms are available for collecting data depending on the fleet segment or gear type that has been used. One form is for non-mechanised boats that is divided into 'shore seines' and 'other'. The other form is for mechanised units, which includes trawlers, purse seiners, gillnetters, dolnetters and country craft fitted with outboard engines. A third form is available for consolidating the number of mechanised and non-mechanised units landed on all days of observation in a month. A further two forms are available for data collection, one for trawlers operating in major harbours, and another to record the time of landings (Srinath et al., 2005). It is unclear however, how the categories of motorised and unmotorized fit into IOTC's definition of an artisanal fishery.

According to the CMFRI data collection methodology, species names that are commercially important should be recorded, along with type of gear utilised to catch such species. However, if identification to species level is not possible a generic name should be used; common names (sharks, tunnies, ray etc) should be avoided. If in doubt CMFRI methodology states that specimens are to be collected and identified, either at nearby laboratories or sent to CMFRI headquarters (Srinath et al., 2005). Moreno (2013) reported that although all tuna species are monitored, up to 30% of tuna species are aggregated (and therefore are not reported at the species level).

Survey staff are immediately trained after recruitment; individuals are then posted to survey centres. At the end of every month survey staff receive a programme of work for the following month, containing information on the name of the landing centres and date and times of observation. Field staff are instructed to send the data collected every month to CMFRI headquarters by the end of the first week of the subsequent month (Srinath et al., 2005). Surprise inspections are conducted by the supervisory staff from CFMRI and enumerators are inspected in the field and their field books reviewed. Estimated zonal landings are compared with previous year's figures, and if a variation is observed which cannot be explained, a technique is adopted to detect observational errors (though detail on this was not provided). Zonal workshops are held to periodically review progress and update the sampling frame (Srinath et al., 2005).

All catch data is analysed at CFMRI headquarters and as a first step codes for commercially important species, gears, craft and major resource groups are applied. A four-digit code is given by field staff for individual species and a two-digit code is given by staff analysing the data to the major resource groups[23]. Within this document there are codes for species and for species groups. After coding, data are computerised and estimates of resource-wise and gear-wise landings for each zone for each month are made using specific software developed by the Fishery Resource Assessment Division of CMFRI. The processed data are counter checked for errors (Srinath et al., 2005).

In addition to fisheries data collection, efforts are made to carry out a census every five years whereby CMFRI is responsible for the mainland and FSI is responsible for Island Union Territories (Stobberup, 2012). According to Moreno (2013) the coverage of effort sampling is 5-10% of total landings.

FSI tuna longliners, which contribute more than 5% of vessels operating in the Indian EEZ, are posted with qualified scientists every month who collect data on board. A full programme of posting observers on board tuna vessels is also being considered by the Government of India[24]. It is unclear however, whether this applies to artisanal vessels.

3.9 Indonesia

The artisanal fleet in Indonesia is characterized by a large number of non-motorized or outboard-powered vessels of less than 10 GT, although there are large numbers of inboard powered vessels up to 25 GT. The primary fishing gears used for pelagic species are troll line, hand line, purse seine and drift gillnets.

Indonesia's artisanal fisheries are dominated frigate tuna, kawakawa, longtail tuna, skipjack tuna and yellowfin tuna. There are also relatively large catches of Indo-Pacific king mackerel and blue shark. In addition, there is aggregation of several groups of sharks, including hammerhead, thresher and mako species.

Table 14 Indonesian nominal catch data by artisanal vessels (2017).

Group	Common Name	Scientific Name	Artisanal fishing (t)
BILLFISH	Black marlin	*Makaira indica*	1662.58
BILLFISH	Blue marlin	*Makaira nigricans*	278.03
BILLFISH	Striped marlin	*Tetrapturus audax*	393.16
BILLFISH	Indo-Pacific sailfish	*Istiophorus platypterus*	1021.23
BILLFISH	Swordfish	*Xiphias gladius*	906.86
OTHERS	Dogtooth tuna	*Gymnosarda unicolor*	1266.14
SEERFISH	Narrow-barred Spanish mackerel	*Scomberomorus commerson*	42176.11
SEERFISH	Indo-Pacific king mackerel	*Scomberomorus guttatus*	13069.88
SHARKS	Blue shark	*Prionace glauca*	15452.56
SHARKS	Mako sharks	*Isurus spp*	800.31
SHARKS	Porbeagle	*Lamna nasus*	25.16
SHARKS	Hammerhead sharks nei	*Sphyrna spp*	1524.88
SHARKS	Thresher sharks nei	*Alopias spp*	4200.84
TUNAS	Albacore	*Thunnus alalunga*	1804.54

[23] Marine Living Resources of the Indian Seas, CMFRI Special Publication No.12, 2000

[24] IOTC-2015-SC18-NR09

Group	Common Name	Scientific Name	Artisanal fishing (t)
TUNAS	Bigeye tuna	*Thunnus obesus*	16402.12
TUNAS	Bullet tuna	*Auxis rochei*	2284.29
TUNAS	Frigate tuna	*Auxis thazard*	59390.23
TUNAS	Kawakawa	*Euthynnus affinis*	41586.55
TUNAS	Longtail tuna	*Thunnus tonggol*	24499.08
TUNAS	Skipjack tuna	*Katsuwonus pelamis*	79976.97
TUNAS	Yellowfin tuna	*Thunnus albacares*	19809.43

Artisanal data collection programme

Fisheries data collection and processing falls under the responsibility of the Directorate General of Wild Fisheries (DGCF), under the Ministry of Marine Affairs and Fisheries (MMAF) with support from Central Bureau of Statistics (BPS) and the Research Institute for Tuna Fisheries (RITF) (Stobberup, 2012; Moreno, 2013). Capture fisheries statistics (includes marine capture fisheries and inland open water capture fisheries) are handled by the Capture Fisheries Statistics Division under the Directorate General of Capture Fisheries (DGCF).

Capture fisheries statistics are produced by the DGCF in cooperation with the Provincial Fisheries Offices (PFO) and the District Fisheries Offices (DFO) (Moreno, 2013). The DGCF has the tasks of: providing survey methodology, guidance for implementation of survey and processing, analysing and publication of national capture fisheries statistics. The PFOs have the tasks of deciding design of sample survey in districts, processing, analysing and publishing of provincial capture fisheries statistics. Lastly, the DFOs have the task of collecting data. estimation/processing data and reporting statistics. Whether such tasks of the DFO and PFO remain under the One Data Frame is unknown at present.

Within the regulatory framework, landings data is collected from two major sources. The first is major fish landing places (e.g. Cilicap, Benoa etc), with data collection (last examined in 2011 and 2012, [BOBLME, 2012; Moreno, 2013]) encompassing a complete enumeration. Catches are also recorded from fishing companies, which are required to keep records and make monthly reports of fishing activity and catch of their vessels (Stobberup, 2012). Catch records are compiled from tally sheets from processing companies and from records from auction officers either daily after each auction session.

Major landing places typically have a central fish market or auctioning place (Tempat Pelelangan Ikan [TPI]) through which most of the landings are sold and these are required to complete monthly reports for each gear, including effort data given as fishing trips (BOBLME, 2012)[25]. The operation of the TPI is usually under the control of fishers' cooperatives (Koperasi Unit Desa [KUD]) or a company appointed by the provincial government. The actual administration of the auction centres is often the responsibility of sub-district or district level fisheries offices, but may also be managed by the local port authority (particularly if the TPI facility is owned by the port authority) (Stobberup, 2012).

The DGCF is responsible for licensing of larger vessels (≥ 30 GT) while Province and District Offices handle smaller vessels. In practice this means that there are numerous vessel registries in Indonesia. Considering the current requirement for all landing sites to report on activity on a monthly basis, it is assumed that this covers a total of approximately 510 larger

[25] Although Moreno (2013) found no form or consistent way of gathering information on catch landing data at auction places in a range of ports within Indonesia.

fishing ports and about the same number of “medium-sized” landing sites.

The final source of information on catch and landings is from fishing villages, which is in essence every site smaller in size than “major fish landing places” where fish are landed. Such ‘non-fishing ports’ are where landings from artisanal fisheries are characteristically brought to shore. Such sites predominantly encompass beaches (i.e., where no wharves or central port area are available), with the catch either wholly for subsistence or sold through local markets (Sobberup, 2012)[26], private company facilities (i.e., processing companies), or private land. There are estimates of at least 5,000 landing sites spread along the coast in fishing villages, with many holding no formal auction or market body - these are expected to be covered by quarterly interviews (censuses) (BOBLME, 2012).

The Indonesian fisheries data collection system was designed and implemented in the 1970s by an FAO/UNDP project (Stobberup, 2012). The system was designed to have two primary outcomes: 1) nation-wide statistics on annual marine and inland production for all species groups fished, both at the industrial and artisanal levels of fishing activity, and 2) annual inventories of the number of fishing units (households, companies, operators) and number, size, and gear-type of fishing vessels involved in the fishing activities at both levels in all provinces (Figure 2).

The development of the One Data programme initiative is to develop and support the use of one standard of data collection by using standardized instruments (questionnaires), standardized procedures, standardized analysis of meta data, as well as through training enumerators and automating processes for data input. Lastly, the collation of all fisheries data is to be held in one portal (https://satudata.kkp.go.id/dashboard_kusuka). Within this system the collection of scientific data serves to analyse and confirm the results of data collection and analysis by utilising the log sheet data, vessel monitoring systems, regional observers and port sampling; all collection of scientific data is expected to be only undertaken within the industrial fleet.

The most recent analysis of the artisanal fisheries within Indonesia showed that estimation of the size of the artisanal fleet is wholly undertaken by using household surveys (Moreno, 2013). BPS is primarily responsible for the annual census of fisheries households at the fishing village level, whereas DGCF is responsible undertaking routine weekly and monthly sampling of catch at all levels of landing places.

Production data is reported not by species but as aggregated, such as yellowfin, bigeye, southern bluefin, albacore and billfish are reported as tuna species. However, DGCF has recently introduced modifications in the reporting systems to provide a higher level of species separation for tunas and billfish.

Frame surveys (FS) are conducted at least once every five years although Districts are encouraged to conduct them more often. The FS (also called Village Potential Survey) aims to count the number of gears, fishing households, and vessels. Sampling at the village level takes places according to the number of Sub districts in the District (i.e. two Sub districts, two samples) without taking into account how many actual fishing villages exist or their relative importance in terms of catch (Moreno, 2013).

[26] Stobberup (2012) reports that such data collection will be a census of fishing activity, via interviews of all or some of the fishing households/establishments. Data is then requested on estimates for total number of fishing units and average number of trips, and average catch per trip on a quarterly basis. If the village has an auction place, the management (typically fishers’ cooperative/association) is required to complete monthly reports as above, regardless of whether this is a sampled village or not.

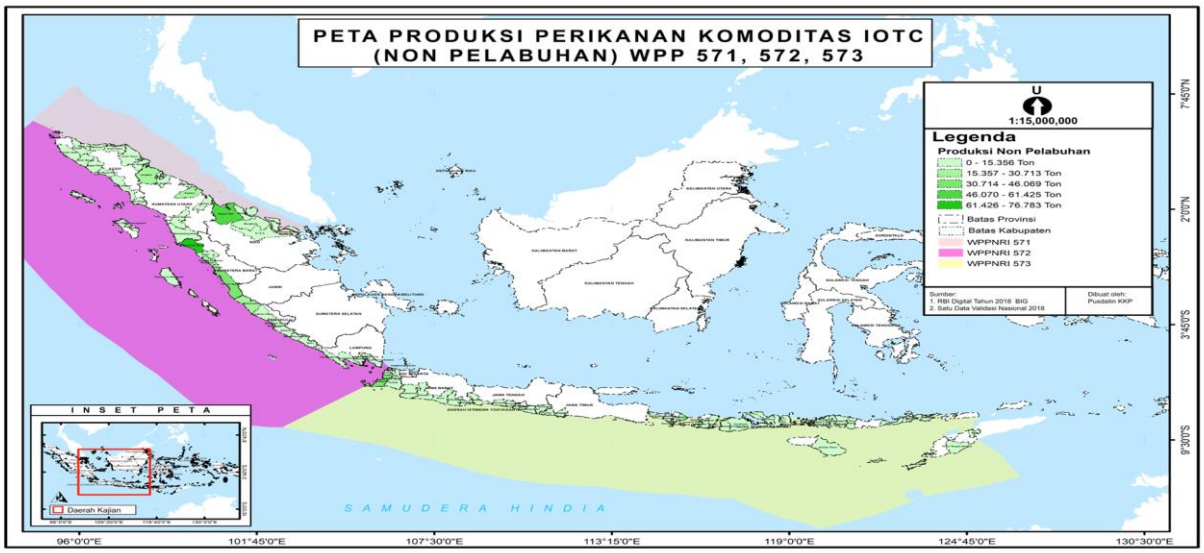

Figure 2 Areas where household surveys (i.e., non-fishing port sampling) is undertaken

One Data Programme

As the One Data policy is a near complete overhaul of the data collection, collation and analysis of Indonesian Fisheries data, a detailed explanation of the main processes encapsulated within this collection system is provided below.

The One Data system relies heavily on field officers (Enumerators) to collect and retrieve primary data using a landing questionnaire and structure of the fishing industry (company/family profile), with all data then inputted into the online SATU DATA Application (https://satudata.kkp.go.id/). Importantly, under the original data collection system (pre-One Data) data were collected by DFO officers with the use of data forms (Moreno, 2013). Such data collection is now undertaken by Enumerators.

All data once collected is inputted into the online application within three days. All data is then quality checked by a central validator for completeness and accuracy (accomplished within ten days following upload onto the online system). Once landings data passes verification it is utilised to estimate production ((N / n) • P, where N: population, n: sample, and P; sample production) with the day. Such production is again reviewed and validated by the central validator, which must be completed within eight days. All results validated by the central validator are then used as input for National Validation Meetings. The National Validation Meetings are jointly carried out with Central and Provincial Validators, with Final Production Values then agreed by Central and Provincial Validators. All final values are then agreed with the Center of Data, Statistic and Information, MMAF (Pusdatin) on a single day (Figure 3).

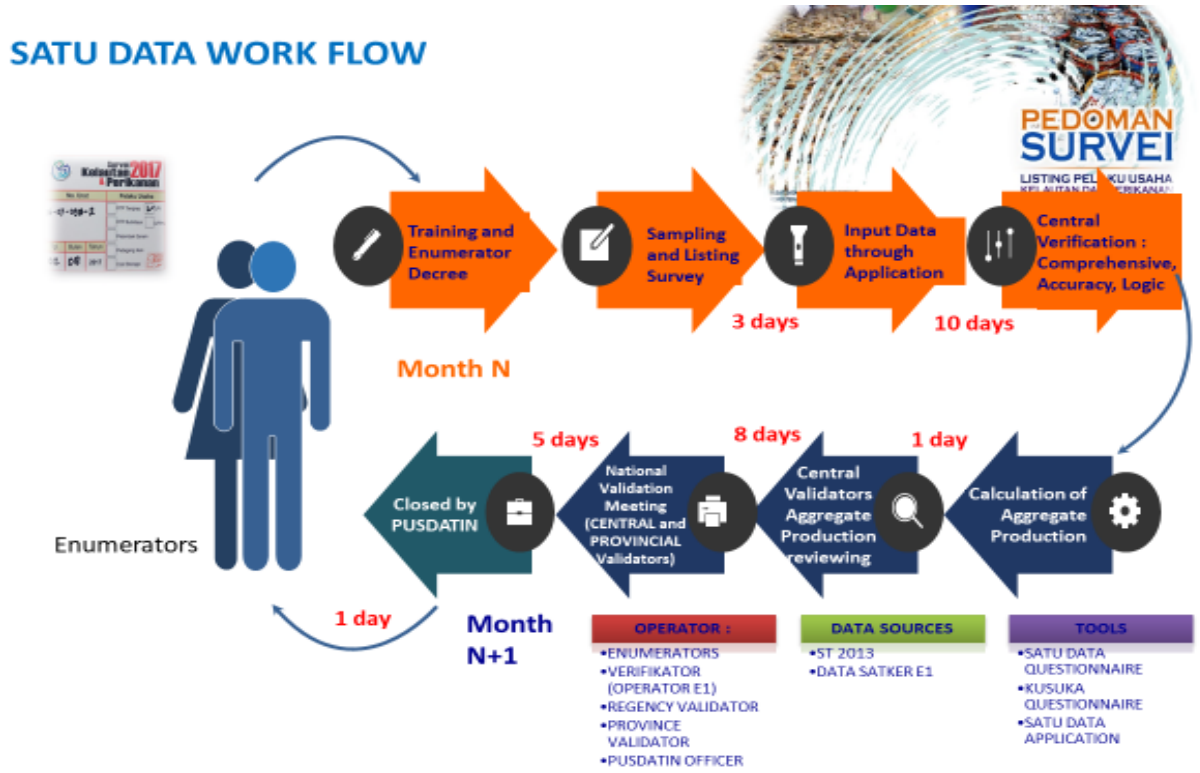

Figure 3 One Data (Satu Data) work flow
Source: IOTC-2018-WPDCS14-27

Indonesia cited that the main barrier to collecting vessel census data includes discrepancy in validation processes between the district and province level as not all districts conduct data collection and monitoring. For nominal catch data there are three main reasons why collecting and estimating data is restricted. The first reason is due to the large number of non-fishing ports which are widely dispersed, some of which are in remote areas. At these sites there are limited staff which have to multitask. At fishing ports again there are limited staff and a large number of dispersed landing sites but in addition there is often unrecorded data due to unloading of catch outside office hours. Finally, a general reason is that fish scales are not standardised between regions. In regards to catch and effort data the different characteristics of selected gear in terms of fishing strategy in every area makes it difficult to raise estimation for catch and effort. Currently collection of size frequency data relies only on research activity with a limited budget. The main challenge to monitoring, collecting and reporting IOTC and CITES species for artisanal fisheries is the distribution and number of landings sites. Further information is provided in Table 15.

Table 15 Main challenges to monitoring, collecting and reporting IOTC and CITES species for Indonesia's artisanal fisheries

Logistical challenges (e.g. access to landing sites, high turnover of enumerators)	A large number of landing sites which are widely dispersed. Some of these are difficult to access due to their remote locations.

Recommendations following country visit

Improvements in data collection and coverage of landings at non-fishing ports

Landings at fishing ports are generally considered to be well monitored by the combination of

landing slips, logbooks/e-logbooks, and census of landings and catches conducted by enumerators. However, the situation at non-fishing ports is considerably more challenging, and which in some cases account for up to 70% of the total catches within a District - albeit catches from non-fishing ports are generally considered to be of less importance for tuna and tuna-like species.

The main issue is the logistics and resources required to monitor the high number of sites and small-scale vessels landing at non-fishing ports, which include:

- sites where boats land directly to the company facilities;
- sites that may act as an unofficial auction area; and
- sites that have no official landing facility or auction, though may be associated with a buyer's private landing site.

A number of different, and complimentary, data sources currently exist collecting information on catches landed at non-fishing ports, including: bill and sales, fishing company declarations, and monthly household surveys. However, the following points are noted:

- Total catches at non-fishing ports are unlikely to being fully enumerated by existing data sources given the limited resources available to monitor all landing sites – although the magnitude of under-estimation is unknown.
- Of the catches which are recorded, there is the possibility that a proportion of the catches landed at non-fishing ports may be double-counted (e.g. landings at unofficial auction areas may also be partially or fully captured by monthly household surveys); although this issue requires further clarification with MMAF in terms of the existing data validation procedures.
- There is also the possibility that catches may, on occasion, be offloaded by vessels at non-fishing ports and fishing ports throughout a given period – which again suggests the possibility of double-counting by data collected by fishing ports and, e.g. household surveys.
- The recording of catches by household surveys is based on skipper/boat owners' recall of monthly catches – which may be relatively imprecise, and lead to under or over estimation of catches.

Recommendations:

- While there is a clear need for a comprehensive system for monitoring the landings and recording of catches at non-fishing landing sites, the complexity and scale of resources required makes it difficult to propose precise and practical recommendations.
- Within Indonesia fishing logbooks (either paper or electronic) are mandatory for fishing vessel >5GRT, or any fishing vessel fishing on high seas outside EEZ of Indonesia. Logbooks may also be used by owners of vessels <5GRT (although are not mandatory) that may export their catch, especially if the fishery is MSC certified.
- Extending the implementation of e-logbook by vessels <5GRT appears to be one suggestion; however current data collection mechanisms in place mean that data collection and submitted by small-scale vessels would be largely voluntary, and subject to minimal verification – raising issues over the quality of the data, and also adding an additional source of duplication of catches otherwise reported by existing data sources.

- The current data verification system in place for the e-logbook is generally designed for vessels >5GRT, and compares submitted e-logbook data against PIPP landing declarations; nevertheless, encouraging vessels <5GRT to record and submit catches using the e-logbook application may represent a significant step forward in improving and validating the catch production estimates for vessels landing at non-fishing ports.

One Data: Online Scales pilot study

Piloting of the online scales by One Data is currently being undertaken in a small number of landings sites. The initial results appear promising, and suggest an improvement in the accuracy of catches weighed compared to traditional scales – however the results appear to indicate a systematic increase in catches compared to the previous system for weighing catches.

Recommendations:

While the improvement in the accuracy in the measurement of catch weights is welcomed, the differences in catches between online/traditional scales needs to be fully understood in terms of the magnitude of differences (e.g. percentage difference in total catch weights), and also the reason for the apparent systematic increase in catches being recorded. Specifically:

- Whether the increase/change in catches is a direct result of measurement errors compared to the previous weight scales; or whether there are other contributing factors (e.g. changes to the routing and processing of catches to the factory prior/post weighing) that may account for the differences in total catch estimates.

- The pilot evaluation should ensure measurements are taken for the same baskets using the online and traditional scales to assess the extent of measurement error between the two systems; in addition to an assessment of other potential contributing factors such as changes to the offloading and processing of catches.

Development and publication of data collection methodology

Given the number of recent, and on-going, improvements to Indonesia's data collection, processing and dissemination systems, it is clear from the country visit that Indonesia needs to publish a clear and well written methodology for their artisanal fisheries data collection. Such methodology should clearly state each of the steps taken in collecting the data, and also provide a justification for each step taken.

This should also include a detailed methodology for analysis of the data, including the methods for aggregation at different levels, calculation of catch and effort, and how nominal catch totals are developed. Such methodology should then be provided to the IOTC in full to allow a critical assessment of such methods.

Implementation of e-logbooks

Issues: The implementation of e-logbooks appears to be a significant step forward in terms of improving the coverage and timeliness of submission of time-area catches. While processes are in place for the verification of submitted e-logbook data (e.g. based on landing slips), the potential for editing and correction of e-logbook data errors appears limited once the data is submitted.

In the case of inconsistencies between e-logbooks and landing slips, skippers/boat owners are notified and asked to explain the reason for the differences in catches. However there appears to be no procedure in place to accommodate corrections or resubmission of e-logbook data (e.g. in comparison to paper-logbooks which allow amendments to be made

directly on the data forms prior to data entry and submission to One Data).

This means that inconsistencies identified by e-logbooks are essentially treated equally – from minor data entry errors such as mis-recording of species, digit errors in catches which could otherwise be corrected, to more serious issues of deliberate misreporting of catches or fishing activities.

Recommendations:

- While the process of verifying e-logbook data appears sound – with the submission of accurate and timely data linked to the compliance and issue of fishing licenses – improvements could be made to verification/validation procedures to maximise data preservation while still ensuring the reliability of e-logbook data.

- Inconsistencies in the catch and effort currently potentially lead to two possible outcomes, both of which are sub-optimal:

- Inconsistencies in catches/fishing locations reported by e-logbooks cannot be corrected by current verification/validation procedures and are (inadvertently) incorporated into official statistics or data submissions to IOTC – although this is unlikely given current data validation protocols to remove erroneous records.

- Inconsistencies in catches/fishing locations reported by e-logbooks cannot be corrected by current verification/validation procedures and are potentially removed, leading to data loss of some records that could otherwise be salvaged.

- Current verification and validation procedures should be reviewed in order to ensure maximum data preservation while still maintaining the quality and reliability of e-logbook data submissions.

- Further work is also needed to understand the current verification rates of 60% of e-logbooks; specifically, the reasons for rejecting 40% of records (not fully compliant), and the magnitude of inconsistencies with landing slips or VMS data. This might enable One Data / port inspectors to provide guidance and briefing to skippers when submitting e-logbooks in order to minimise future inconsistencies.

- One Data should also ensure that any data rejection does not lead to any possible bias and loss in the representation of time-area catches – particularly if records are being systematically eliminated by certain gears/vessels/landing sites.

- A second suggestion would be to enable validation (and correction) of e-logbook data by port inspectors during the initial verification with landing slips at the port – prior to submission to One Data. However, this would likely mean significant changes to the current design and data-flow of the e-logbook data submission process.

Catch revisions and historical catch reconstructions

Issue: On-going improvements in the compilation and estimation of production statistics through One Data, implementation of the electronic log-books, and validation of logbook-based catch-and-effort, may lead to a number of significant changes to the current estimate of total catches, catch-by-species and time-area catches reported by official statistics to the IOTC Secretariat.

Recommendations:

- Any significant changes to Indonesia's production statistics should be thoroughly documented and presented to the IOTC technical Working Parties for endorsement to ensure transparency.

- Secondly, that significant changes to the production statistics should be accompanied by historical catch reconstructions (as far as possible) to ensure consistency in the historical time-series reported to IOTC and other RFMOs. The IOTC Secretariat to provide assistance and guidance for the reconstruction methodology, if required.

Technical Working Group to assist with the evaluation of logbook/catch and effort data

Issue: Significant progress has recently been made in improving the reporting coverage rates and reliability of paper-based logbooks, notably with the implementation of electronic logbooks. Indonesia has begun to submit time-area catches (catch-and-effort) for selected fisheries, to the IOTC Secretariat in July 2019 – although coverage rates are still well below 5% of total catches by gear. Furthermore, MMAF aims to fully meet IOTC data reporting requirements for the submission of time-area catches by 2020/2021.

Recommendations:

- Prior to the submission of (final) time-area catches to the IOTC, establishment of a specialist Technical Working Group to review the data collection protocols, verification, validation, and dissemination procedures of time-area catches.

- The Technical Working Group should include representation from key stakeholders (e.g. IOTC, WCPFC, etc.) to provide external peer review of time-area catches and ensure compliance with international data collection and reporting requirements.

Streamlining and simplification of validation and verification steps within data collection programs

Issue: While verification (i.e., checking for errors in data) and validation (i.e., signing off data as being collected properly) are important steps in providing a rigorous data collection system, there appears to be excessive verification and validation steps within the One Data program.

While procedures are in place for the verification and validation of data, the current workflows adopted by One Data appear excessive and in some cases to duplicates efforts (e.g. validation of catch data at then District level, which are then validated at the Province and National level). Furthermore, despite the extensive and potential overlapping validation processes, the quality of data submitted to the IOTC Secretariat in 2018 was still less than optimal (e.g. large fluctuations in catches between years, including multiple revisions to submitted catches).

Recommendations:

Consider rationalising and streamlining of data verification and data validation procedures. For example:

- We would propose that any efforts to verify data (i.e., basic checks for completeness and correct entry of data fields) are based solely at the local level (and be undertaken by the harbour master and staff at the time of the input of the data).

- Data validation of such data should then only occur at the Province and/or national level, and be undertaken by One Data staff using common standards and methods for validation and quality assurance of the data.

- Improvement in the documentation of data validation procedures, including list of checks, and the extent of comparisons to complimentary data sources (e.g. logbooks, VMS, observer data, landing census records).

3.10 I.R. Iran

The southern coastline of Iran is important for large pelagic species and these fisheries are one of the most significant marine activities in the Persian Gulf and Oman Sea (Nergi, 2018). Iran's tuna fleet is artisanal, according to Iran's National Report to IOTC, and targets a range of species in coastal and offshore area utilising a range of vessels[27]. In 2017, approximately 94% of tuna and tuna-like species were fished using gillnets, while 2.1% were fished using purse seines, 1.5% fished using trolling, while 2.8% were fished by small artisanal gillnetters, which act as seasonal and temporal longliners.

Iran's National Report states that the tuna fishery is artisanal; however, it also mentions that the fleet targets species in both coastal and offshore areas, which (in the IOTC definition of artisanal fishing) would then encompass industrial fishing. However, according to Iran's national regulation, offshore fisheries includes those vessels operating beyond 24 miles.

The following species (Table 16) are reported for Iran's artisanal fleet in 2017 according to the IOTC nominal catch database. Data is submitted to IOTC both at species level but is also aggregated for some species of sharks in particular. The most predominant catch is of narrow-barred Spanish mackerel, kawakawa and longtail tuna.

Table 16 2017 IOTC nominal catch data by artisanal vessels

Common Name	Scientific Name	Artisanal fishing (t)
Black marlin	*Makaira indica*	0.18
Blue marlin	*Makaira nigricans*	504.09
Striped marlin	*Tetrapturus audax*	248.69
Indo-Pacific sailfish	*Istiophorus platypterus*	2639.70
Swordfish	*Xiphias gladius*	348.17
Other	-	5495.57
Common dolphinfish	*Coryphaena hippurus*	5098.24
Narrow-barred Spanish mackerel	*Scomberomorus commerson*	20519.42
Indo-Pacific king mackerel	*Scomberomorus guttatus*	9401.17
Finetooth shark	*Carcharhinus isodon*	384.71
Blacktail reef shark	*Carcharhinus wheeleri*	192.35
Silky shark	*Carcharhinus falciformis*	0.31
Mako sharks	*Isurus spp*	0.02
Oceanic whitetip shark	*Carcharhinus longimanus*	0.02
Milk shark	*Rhizoprionodon acutus*	1145.75
Various sharks nei	*Selachimorpha (Pleurotremata)*	451.77
Hammerhead sharks nei	*Sphyrna spp*	0.01
Frigate tuna	*Auxis thazard*	8359.11
Kawakawa	*Euthynnus affinis*	34059.19
Longtail tuna	*Thunnus tonggol*	36330.78
Skipjack tuna	*Katsuwonus pelamis*	77.09

[27] IOTC-2018-SC21-NR10

Common Name	Scientific Name	Artisanal fishing (t)
Yellowfin tuna	*Thunnus albacares*	17163.62

Artisanal data collection programme

In the Islamic Republic of Iran, the Statistical Unit within the Department of Fisheries Management is responsible for collecting, processing, validating and disseminating fisheries statistics, as well as undertaking sampling for biological data. In each of the southern coastal provinces representative fisheries offices have been established (Moreno, 2013).

In Iran, data on artisanal fisheries are collected along the southern coastline through landing surveys at selected sites (Moreno, 2013). Port sampling is undertaken daily/weekly in order to collect data on nominal catch, catch and effort and size frequency. Sampling occurs across the four provinces in the south, and cover 43 out of a total of 63 landing sites. This sampling includes 10 landing sites in Khozestan Province, 8 landing sites in Bushehr Province, 20 landing sites in Hormozgan Province, and 5 landing sites in Sistan-Bluchestan Province[28]. Stratified random sampling is conducted, taking into account the range of boat types, fishing areas and gear types used in Iran, with sampling conducting on approximately 10% of the fleet. Sample data are raised to all active fishing vessels and total catches are estimated by vessel category, gear type, species composition and landing site each month.

During offloading, port samplers collect number and species, as well as length/weight measurements. The vessels chosen are meant to be representative of various categories and are meant to be consistently sampled after each fishing trip (Moreno, 2013). Fish are sampled using measuring boards and precise balance scales, supported by biometric equipment provided by the IOTC-OFCF project. Length and weight frequency of 10 species (including narrow-barred Spanish mackerel, longtail and albacore tuna, and kawakawa) have been regularly collected since 2001, and are carried out in 16 landing centres (Nergi, 2018). Size frequency coverage is estimated to be one fish per tonne for tropical tunas, while for coastal fisheries sampling of 500 fish per month and fishing method are undertaken throughout selected landing sites. For the oceanic gillnet fishery, a pilot plan is in progress and gradually all Iranian gillnetters in high seas will be equipped with logbook system and vessel position will be able to be derived through logbooks[29]. Logbooks were attempted to be introduced for artisanal gillnet fishers however, this has not yet been successful (Nergi, 2018).

At each landing site there is one enumerator who is responsible for data collection. Data are collected through use of a questionnaire, which covers vessel code and capacity, landing centre code, fishing ground code, dates of departure and arrival, fishing permit number, fishing methods and gear (number and duration of time in water), species name and amount of catch per species (Moreno, 2013). Six tuna and tuna-like species are predominantly identified during sampling, as well as two seerfish and five billfish species[30]. Data are not transcribed within 1 month of being collected.

Monthly reports are submitted to the provincial offices and then these are aggregated on a quarterly basis and sent to the data collection unit in Tehran (Moreno, 2013). A statistical scientific committee, which includes representatives from Shilat, IFRO and Fishermen Associations, meets on a quarterly basis to validate aggregated data (Moreno, 2013). Validation is also undertaken during and after data entry and is integrated into the database

[28] IOTC-2018-SC21-NR10

[29] IOTC-2018-SC21-NR10

[30] IOTC-2018-SC21-NR10

design, with information then crosschecked against independent sources and feedback provided to the collection teams (Moreno, 2013). Basic data are transmitted electronically and the catch estimation procedure is centralised. Size frequency are raised to total catch and the reports are prepared electronically. Verification of total enumeration is also undertaken and performed at the provincial level by the Head of the Statistical unit and the process is repeated in Tehran (Moreno, 2013). The data are then crosschecked occasionally in one or two landing sites in each province.

In Iran, a conventional approach is adopted for raising catches, which involves the estimation of mean catch per unit effort by strata (month, landing site, vessel type and gear) and then extrapolated to the whole fleet using the known effort (Moreno, 2013). Size frequency data are reported to the IOTC per fleet, year, gear, type of school, month and 5° square areas for purse seine fishery. Size data is reported for six species (yellowfin, skipjack, bigeye, kawakawa, longtail and narrow-barred Spanish mackerel). In addition to landings data, effort data is collected through fishing licenses via a national vessel registration scheme and is based on a complete enumeration system whereby 100% of effort is sampled (Moreno, 2013).

The IOTC National Report in 2018 provides an overview of annual catch by gear type and species, and predominantly provides data at the species level, including sharks which are landed by species and by weight since 2013[31]. However, within this report there are categories for 'other shark' and 'other billfish', so not all species may be identified to species level. Based on IFO Regulations, there are no licences for shark fishing, and sharks are only landed as bycatch. According to the National Report in 2017, 3,642 t of shark were caught as bycatch which equated to 1.2% of the total catch in tuna fisheries. However, this report also stated that the IOTC has not received any reports on the total number of released or discarded sharks by species from the national fleet due to a lack of onboard observers.

In 1997 a new software, AMAR, was created for the compiling, processing and presentation of statistics (Moreno, 2013). Raw data is processed through statistical software, for example SPSS, Excel, Minitab and FiStat. Biometry software is used to input the size frequency data into a database.

IFO usually arranges training workshops for fishermen who catch tuna and tuna-like species while they are landing in harbours. These workshops aim to make fishermen more familiar with IOTC Regulations and Resolutions, especially in relation to ecosystem and bycatch issues. IFO have also tried to train experts in species identification, especially for sharks and turtles. In 2017, IFO had reported to have trained more than 300 person/days of fishermen. In addition, IFO has distributed approximately 1000 species identification cards that have been translated into Persian[32].

In the 2018 National Report, Iran stated that 6,287 fishing craft were engaged in tuna and tuna-like fishing, of which 2,758 were gillnet boats (less than 3 GT), 557 were gillnet dhows of less than 50 GT, 316 were gillnet dhows of 51-100 GT, 326 were gillnet dhows of more than 100 GT, 1,820 were trolling boats of less than 3 GT, 324 were traditional long-line boats of less than 3 GT, 165 were traditional long-line dhows of less than 50 GT, 14 were traditional long-line dhows of 51- 100 GT, with 5 purse seiners also included in the national fleet. These number differ slightly to those quoted by Nergi (2018) who states that in 2017 there were 3,135 artisanal vessels (dhows) and 7,233 fishing boats engaged in the large pelagic fishery. Despite such extensive data on the Iranian fleet, according to the IOTC artisanal craft database no data has been submitted on national fleet statistics since before 1996. This therefore indicates

[31] IOTC-2018-SC21-NR10

[32] IOTC-2018-SC21-NR10

that the most complete and up-to-date data might not always be reported to IOTC.

Country-specific challenges in artisanal fisheries data collection

Iran state that the barrier to collecting vessel census data is collecting information on small-scale vessels. In regards to nominal catch data the main issues with collecting and estimating data include limited staff, limited budget and a lack of adequate facilities in a number of landing sites. Issues with collecting accurate catch and effort data in Iran include illegal fishing and multispecies and multi-gear fishing. Finally, for size frequency data there are a lack of adequate port samplers and lack of budget to effectively collect data. The main challenges to monitoring, collecting and reporting IOTC and CITES species for artisanal fisheries are limited funding available for enumerators, in addition to technological barriers. Further information is provided in Table 17.

Table 17 Main challenges to monitoring, collecting and reporting IOTC and CITES species for Iran's artisanal fisheries

Financial (e.g. costs of routine data collection, funding for enumerators or port samplers)	X
Lack of technical expertise (e.g. staff training, expertise to design and implement data collection))	X
Equipment (e.g. transport)	X
Logistical challenges (e.g. access to landing sites, high turnover of enumerators)	Low income of enumerators, lack of facilities to access to the landing sites
Technological (e.g. lack of corporate database, or tools for electronic data capture/reporting)	Satellite coverage issues, online data reporting

3.11 Kenya

Kenya's national tuna fleet consists of two segments; an artisanal commercial sector and a recreational fleet[33]. The Fisheries Management and Development Act 2016[34] defines artisanal fisheries as "small scale traditional fisheries that may be carried out for subsistence or commercial purposes, in which the owner is directly involved in the day-to-day running of the enterprise and relatively small amounts of capital are used" and artisanal vessels as a "canoe or un-decked vessel with a length overall of not more than ten meters, which is motorised or not motorised by an outboard or inboard engine not exceeding forty horsepower, or powered by sails or paddles, but does not include decked or undecked semi-industrial fishing vessels or vessels used for recreational fishing".

It is estimated that 414 artisanal vessels with an average size of 8m LOA were operating within the tuna fleet in 2017; the main gears used were artisanal long-lines, handlines, gillnets, trolling lines and monofilament nets[35]. There are data for a range of species within the IOTC nominal catch database; four species of tuna are recorded at species level, as are two species of seerfish and two species of billfish (Table 18). Sharks however, are aggregated to the species level, against IOTC recommendations.

[33] IOTC-2018-SC21-NR12

[34] http://extwprlegs1.fao.org/docs/pdf/ken160880.pdf

[35] IOTC-2018-SC21-NR12

Table 18: Catch data for Kenya submitted to the IOTC

Species Group	English name	Scientific name	Artisanal Fishing (t)
Billfish	Indo-Pacific sailfish	*Istiophorus platypterus*	97.14
Billfish	Swordfish	*Xiphias gladius*	65.86
Seerfish	Narrow-barred Spanish mackerel	*Scomberomorus commerson*	124.28
Seerfish	Seerfishes nei	*Scomberomorus spp*	124.72
Sharks	Various sharks nei	*Selachimorpha (Pleurotremata)*	343.00
Tunas	Frigate tuna	*Auxis thazard*	52.59
Tunas	Kawakawa	*Euthynnus affinis*	108.41
Tunas	Skipjack tuna	*Katsuwonus pelamis*	52.59
Tunas	Yellowfin tuna	*Thunnus albacares*	108.41

Artisanal data collection programme

The organisation responsible for enforcement of legislation is the Kenya Fisheries Council. The Government of the Republic of Kenya also have a State Department for Fisheries, Aquaculture and the Blue Economy[36], who are responsible for fisheries policies, licensing and coordination of regulatory and legal frameworks for the industry. The collection of coastal fisheries data is undertaken by the State Department for Fisheries and Blue Economy (FDF and BE)[37].

A biennial frame survey is conducted to obtain information on Kenya's fleets; these have been conducted since 2004 and provide estimates of the size of Kenya's artisanal fleets. Data collected include total enumeration of vessels, including size and type of gear.

The artisanal fleet does not currently have a log sheet data collection system in place; however, log sheets have been developed to allow for data collection when fisheries regulations are to be implemented. Log sheets are already required to be used by longline vessels; in addition, recreational and sport fishers generally maintain accurate records of catches, including length and weight measurements, although the information is currently not being reported to the national fisheries institutions in a systematic way.

To help overcome the current lack of data collection within artisanal tuna fisheries, the Kenya Fisheries Service have worked in collaboration with the World Wildlife Fund (WWF) and county governments to implement a pilot study on electronic data collection and submission methods. This pilot study ran from June to December 2018 and collected spatial distribution data (catch by county), overall catch, effort and length data (using measuring boards), species composition (by weight in kilograms; to the nearest 0.1g for small individuals) and length frequency distribution data (Mueni et al., 2018). Although there are no quantitative results available from this study, a representative from Kenya Marine and Fisheries Research Institute (KMFRI) answering the questionnaire for this project stated the results of this trial were promising.

Artisanal nominal catch data are collected through use of logbooks, fisher surveys, port sampling and at landing sites. Port sampling represents a coverage of approximately 30% of total vessels/catches, while total enumeration at major landing sites is conducted. To adjust for missing coverage and avoid underestimation, 10-15% of the total of each fish group within

[36] http://www.kilimo.go.ke/?page_id=376

[37] IOTC-2017-WPDCS13-36_Rev1

data collected at major landing sites is added to the total. Size-frequency data are also collected using both port and onboard sampling however the level of sampling coverage is not specified. Callipers, tape and measuring boards are used in the random sampling process within port and onboard sampling. Within landing sites enumerators calculate weight (estimated by eye), often by species.

Targets are set to gather information for 30 samples per gear/boat/landing site combination per month. Beach Management Units (composed of local fishers) collect data voluntarily in regions where enumerators are not present (Moreno, 2013).

Data collected by enumerators are compiled monthly, with the Division office aggregating the data and passing it onto the District office which sums the data and passes it to the Provincial office. In addition, according to the Fisheries Management and Development Act 2016[38] fisheries officers at markets may also collect information on the seller and country of origin, species and number of fishes being sold, total weight, price per kilogram and price of the shipment; although it is unsure whether such data are used in assessments of the artisanal fishery in Kenya.

A Catch Assessment Survey (CAS) was also conducted between 2014-2016, to improve estimates of catches by species for artisanal fisheries. The IOTC Secretariat has been providing technical assistance to Kenya in terms of review of the catch estimation methodology, and finalization of the CAS results which should be reported to IOTC in due course.

In addition, port sampling is used for vessels at the port of Mombasa, however it is uncertain as to whether artisanal vessel is included[39]. However, the 2018 National Report states that characterisation of the artisanal tuna fishery has been initiated by KMFRI, with support from the Kenya Coastal Development Project (KCDP). This characterisation focuses on collection of baseline data on catch composition and gear use, to support stock assessment. Such data also includes assessment of the species composition, catch per unit effort by gear type, as well as biological data on length, weight, sex and maturity of key selected species. The preliminary findings of this work indicate skipjack as the most common tuna species captured in the artisanal fishery. A monitoring programme has been developed to continue with data collection, but there was no information available on this at the time of writing.

Future developments in fisheries management within Kenya include recreational (and potentially artisanal) fisheries data being integrated into the Fisheries Data and Information Management System (FDIMS). In addition, training of vessels operators and vessel agents on electronic data reporting was undertaken in 2018; the results of such training are unknown.

Country-specific challenges in artisanal fisheries data collection

In Kenya, the main barrier to collecting vessel census data for artisanal fisheries is the limited financial resources available. This is also true for collecting catch and effort data, as there are limited funds for monitoring on a more frequent basis (i.e. monthly). For nominal catch data, limited staff inhibits data collection and estimation. In regards to collecting data on size frequency, the breakdown of equipment affects the accuracy of the measurements and facilities at some sites are also not conducive to data collection. The main challenges to monitoring, collecting and reporting IOTC and CITES species for artisanal fisheries can therefore be summarized as financial, equipment and technological constraints (Table 19).

[38] http://extwprlegs1.fao.org/docs/pdf/ken160880.pdf.

[39] IOTC-2018-SC21-NR12

Table 19 Main challenges to monitoring, collecting and reporting IOTC and CITES species for Kenya's artisanal fisheries

Financial (e.g. costs of routine data collection, funding for enumerators or port samplers)?	x
Equipment (e.g. transport, equipment for sampling)?	x
Logistical challenges (e.g. access to landing sites, high turnover of enumerators)?	x
Technological (e.g. lack of corporate database, or tools for electronic data capture/reporting)?	x
Lack of understanding of IOTC data reporting requirements?	x

3.12 Madagascar

With approximately 5,000 km of coastline, the fishing sector plays a vital role as one of the country's primary economic sources. The fisheries sector is split three-fold, and is comprised of the industrial fishery, traditional fishery, and artisanal (or small-scale) fishery. Industrial fishing is carried out mainly by foreign purse seiners and longliners, and by national fleets, predominantly focusing on tuna and tuna-like species in the Mozambique Channel (Moreno, 2013). Traditional fishing is done on foot or in a dugout canoe, while artisanal fishing is characterized by the use of motorized boats, using engines no greater than 50 hp. Most of Madagascar's artisanal boats and predominantly all traditional boats do not target tuna or sharks due to limitations of the fleets; traditional and artisanal fisheries production (mainly inshore small pelagic species) are generally destined for the local market and contribute to the food resource of the population.

Catches for 2017 taken from the IOTC nominal catch database indicate that that Madagascar captures a range of different billfish, tuna and sharks. Shark data is predominantly aggregated, with relatively little information on catches by species.

Table 20 IOTC annual catch output for artisanal fleet (tonnes) in Madagascar, 2017

Sp. Group	English Name	Scientific Name	Tonnes
Billfish	Indo-Pacific sailfish	*Istiophorus platypterus*	842.26
Seerfish	Narrow-barred Spanish mackerel	*Scomberomorus commerson*	3761.86
Seerfish	Indo-Pacific king mackerel	*Scomberomorus guttatus*	99.22
Sharks	Silky shark	*Carcharhinus falciformis*	112.30
Sharks	Mako sharks	*Isurus spp*	505.35
Sharks	Various sharks nei	*Selachimorpha (Pleurotremata)*	3144.40
Sharks	Hammerhead sharks nei	*Sphyrnidae*	1628.35
Sharks	Thresher sharks nei	*Alopias spp*	224.60
Tunas	Bigeye tuna	*Thunnus obesus*	26.62
Tunas	Bullet tuna	*Auxis rochei*	179.28
Tunas	Frigate tuna	*Auxis thazard*	180.28
Tunas	Kawakawa	*Euthynnus affinis*	1076.61
Tunas	Longtail tuna	*Thunnus tonggol*	724.14
Tunas	Skipjack tuna	*Katsuwonus pelamis*	834.47
Tunas	Yellowfin tuna	*Thunnus albacares*	675.27

Artisanal data collection programme

The fisheries administration has been characterized by several changes over the last 20 years. Since 2010, the Ministry of Fishery Resources and Fisheries (MFRF) has been dedicated to fishery and aquaculture matters. Several technical sections are within the MFRF, including the Department of Fisheries and Fisheries resources, which deals with the exploitation of resources, and the Department of the Management of Fishery Resources, which deals with fisheries management.

At the field level, Regional Departments of Fisheries and Fishery Resources are mandated to implement the policy of the MFFR in each of the 15 administrative marine regions of the country. However, regional departments are faced with a substantial lack of resources, while functional links with the central administration are weak. Consequently, the functions of the regional departments mostly consist of collecting data and providing technical and administrative support to fisheries stakeholders.

The IOTC, acknowledging the need for improved artisanal fisheries reporting by the countries in the region, funded a 2011 study to investigate the issues affecting these countries and possible solutions to the problems. This work found no strategy in Madagascar for collection of artisanal fishing data. Only approximately 2 - 3% of landing sites across 25% of all marine districts were covered by enumerators, with catches logged extrapolated to the total number of sites. Additionally, tuna and shark species are aggregated when data is collected, limiting the species resolution of the data that is reported. Data from this pilot programme showed that the catch of tuna species was dominated by kawakawa, with wahoo, narrow-barred Spanish mackerel, shark, and swordfish also forming part of the catch.

The data reporting procedure involves fishers reporting to a collector or fishing association once a week with data pertaining to their catches. The exact detail of this data is unknown. Data collected by the collector or fishing association over the course of a month is then sent to the District office where further extrapolation takes place. A final catch estimate is produced within three months.

As a result of the highlighted issues highlighted with current data collection methods, in 2015, the Unité Statistique Thonière d'Antsiranana (USTA), through MFRF, initiated a pilot study to monitor catch landings of pelagic fish from artisanal and small-scale fisheries in two villages in northern Madagascar[40]. The study aimed to develop a network of catch and effort data collectors at artisanal and small-scale fishery landing sites[41]. This is reflected in the IOTC Agreement Article X Report of Implementation 2017, where Madagascar is reported to be partially compliant in implementing a sampling scheme for artisanal landings as required by Resolution 11/04. At landing sites, investigators conducted periodic sampling to collect: catch and effort; size frequency; composition of catch; weight of catch; vessel type; gear used; date of landing; time spent at sea; and the number of vessel crew members[6]. In 2016, monitoring was expanded to cover a total of 29 villages and, in 2017, the study covered nineteen landing sites across four regions in Madagascar (Diana, Sofia, Boeny and Analanjirofo)[5]. This data collection system is regarded as a step towards implementing a program to enhance the level of data collection at a national level and to improve reporting to the IOTC[42]. USTA has developed database management software to manage and process this data[5]. It is understood

[40] Ministère des Ressources Halieutiques et de la Pêche., Centre de Sureveillance de Pêche., Unité Statistique Thonière d'Antsiranana. 2018. Rapport National de Madagascar destine au Comité Scientifique de la Commission des thons de l'Océan Indien, 2018.

[41] IOTC Agreement Article X Report of Implementation for the year 2017. Deadline for Submission of the Report 16 March 2018.

[42] Report of the 14th Session of the IOTC Working Party on Data Collection and Statistics. IOTC.

that this application is being introduced in tablet form to facilitate data collection[6]. No data was available from this sampling programme.

Country-specific challenges in artisanal fisheries data collection

In Madagascar, several barriers are cited for estimating the size and composition of artisanal vessels through a vessel census. This includes a lack of human and financial resources, lack of public sensitisation and flaws in the application/integration of legislation. In addition, there has not been a vessel frame survey or base of ships register update. In regards to collecting nominal catch data access to landing sites, the main constraints are limited staff due to a lack of financial resources. In addition, most operators are not cooperative especially in the case of subsistence, sports or recreational fisheries are cited as issues. The main barriers to catch and effort data include limited staff due to a lack of financial resources and materials, access to landing sites, also that many vessels often land at the same time and the field sampler cannot cover all vessels. The main barriers to collecting size frequency data in Madagascar includes refusal of fishermen and fish collectors, non-cooperation of subsistence, sports and recreational operators and materials. The main challenges to monitoring, collecting and reporting IOTC and CITES species for artisanal fisheries include financial, technological and technical issues. Further information can be found in Table 21.

Table 21 Main challenges to monitoring, collecting and reporting IOTC and CITES species for Madagascar's artisanal fisheries

Lack of legislative or regulatory framework to monitor small-scale fisheries?	There is legislative or regulatory framework to monitor small-scale fisheries
Financial (e.g. costs of routine data collection, funding for enumerators or port samplers)?	Costs of routine data collection, funding for investigators/field samplers needed for the extension of the data collection in the south part of Madagascar Properly designed sampling and implemented survey appropriately can often produce accurate and reliable estimates at a cost significantly lower than that of complete enumeration.
Lack of technical expertise (e.g. staff training, expertise to design and implement data collection)?	Staff training to improve the data collection system
Equipment (e.g. transport, equipment for sampling)?	Vehicle (bicycle, motorcycle), equipment for sampling (electronic scale, measuring board, jacket, cap, boot…)
Logistical challenges (e.g. access to landing sites, high turnover of enumerators)?	Logistical challenges (access to some landing sites) Frequent resignation of field samplers due to non-motivating compensation or salary
Technological (e.g. lack of corporate database, or tools for electronic data capture/reporting)?	Lack of tools for electronic data capture/reporting : tablet and internet connexion
Lack of understanding of IOTC data reporting requirements?	Training about the IOTC data reporting requirements
Any other factors (please specify)?	None

3.13 Malaysia

Within Malaysian waters tuna species make up 5% of total marine catches in Malaysian waters and of this, 5% are caught by traditional gears including trolling, hook and line and gill nets (mainly neritic tuna, including longtail tuna, kawakawa and frigate tuna). The remaining 95% of tuna caught in Malaysian waters are taken by trawlers and purse seines[43]. Oceanic tunas are found in Malaysian waters, largely consisting of bigeye, yellowfin, albacore and skipjack. There is one large tuna purse seine that catches oceanic tuna, but most are caught using handline with small traditional inboard boats.

In the 2017 IOTC nominal catch database, Malaysia has reported to have landed a range of species by artisanal gear, with the catch dominated by kawakawa and narrow-barred Spanish mackerel (Table 22).

Table 22 2017 IOTC nominal catch data by Malaysian artisanal vessels

Common name	Scientific name	Artisanal fishing (t)
Black marlin	*Makaira indica*	10.88
Swordfish	*Xiphias gladius*	0.65
Narrow-barred Spanish mackerel	*Scomberomorus commerson*	4536.19
Indo-Pacific king mackerel	*Scomberomorus guttatus*	2203.34
Frigate tuna	*Auxis thazard*	385.27
Kawakawa	*Euthynnus affinis*	10541.05
Longtail tuna	*Thunnus tonggol*	1543.88
Skipjack tuna	*Katsuwonus pelamis*	17.87

Artisanal data collection programme

In Malaysia, the Department of Fisheries has the responsibility for routine fisheries data collection. This includes data on landings, value, fishing vessels, fishing effort and employment. Data are collected at the administrative district level, of which there are 84. Each district has a designated fishery officer who works for the Fisheries Administration (Stobberup, 2012). In particular, the sampling of neritic tuna and tuna-like species is the responsibility of the Fisheries Information Management Division. Their sampling programme covers all landing sites and fishing ports along the west coast of the Malaysian peninsular and focuses solely on vessels operating in Malaysian waters[44].

All vessels operating beyond 12nm of the Malaysian shoreline are required to record their landings in a Vessel Operation Report (LOV) (Figure 4). This is part of the vessel licensing regulation and forms must be submitted to the nearest Department of Fisheries office and be completed in order to renew their licence. This form must contain information on fishing areas, times/dates, catches by species, details of bycatch and the name of ports or any transhipment details. However, in relation to what fleet segment this applies to Stobberup (2012) suggests that only industrial fishermen have to submit LOV reports (Figure 5).

[43] IOTC-2018-SC21-NR15

[44] IOTC-2018-SC21-NR15

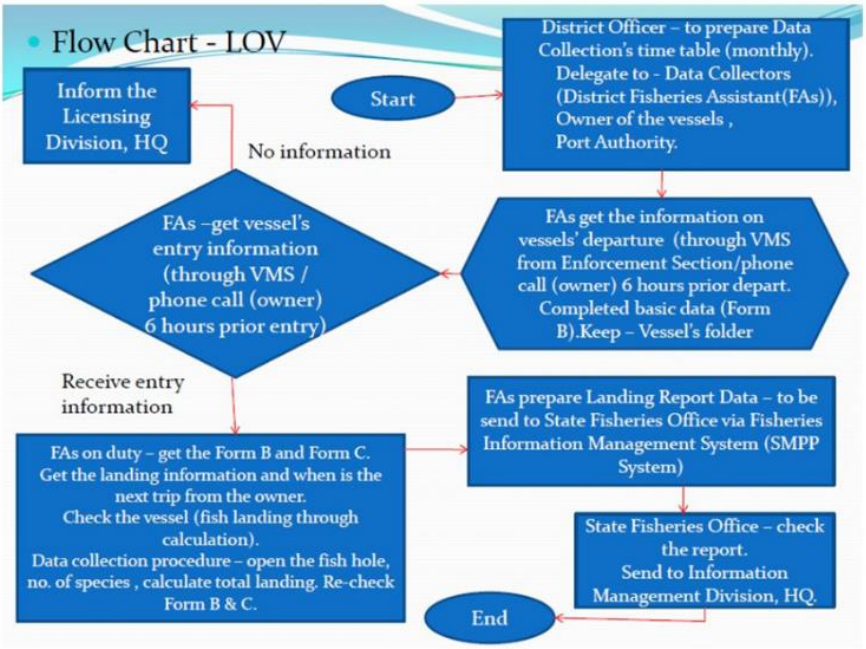

Figure 4 Flow chart demonstrating the Vessel Operation Report (LOV) scheme in Malaysia.
Source Stobberup, 2012

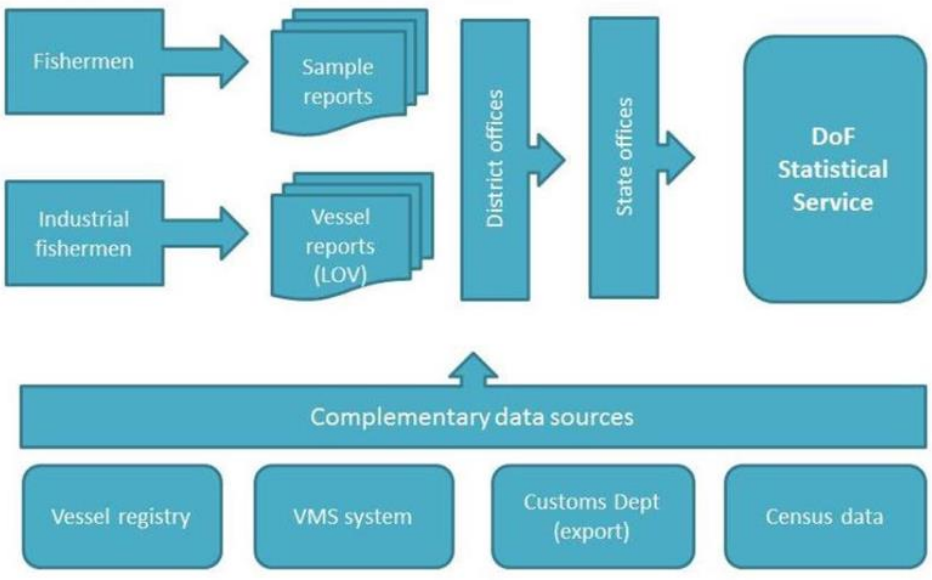

Figure 5 Flow of fisheries data in Malaysia.
Source Stobberup, 2012

From 2010, the Department of Fisheries has conducted regular sampling activities at the Malaysian International Tuna Port (MITP) in Penang. They are responsible for collecting, processing and assisting tuna scientists to analyse catch data. However, an issue arose between 2012 and 2016 when no Malaysian flagged vessels unloaded their catches in Malaysian ports and so no port sampling occurred. After 2016, the port sampling programme resumed when five new longline tuna vessels unloaded their catch. However, it is not clear if port sampling applies to artisanal vessels, as all longliners in Malaysia have been over 24m

LOA since 2012[45].

In Malaysia, a frame survey is established through the online Vessel Registration System which records every transaction of licensing activity for all boats (Stobberup, 2012). A vessel census is carried out annually and includes full enumeration (Malaysia, Questionnaire Response, 2019). A sampling plan is then defined which is based on categories including administrative district, fishing gear and size of the vessel. Data are collected through a combination of observations and enquiries (Stobberup, 2012).

Sampling is thought to be based on a methodology of random stratified sampling, with stratification by area (Stobberup, 2012); no further information could be identified. Malaysia has stated that collection of nominal catch data for artisanal/coastal fisheries occurs monthly through port sampling and at a private landing site (Malaysia, Questionnaire Response, 2019). In addition, in regards to catch and effort data collection for artisanal and coastal fisheries, Malaysia uses port sampling, with landing of species recorded from every sample. Finally, for size frequency data, data are only available for vessels more than 40GRT and collected by enumerators for researchers; there is currently no system in place for artisanal fisheries. Sampling coverage is defined below and was reiterated by Malaysia in their response to the compliance questionnaire which stated that port sampling occurs at District level.

Table 23 Sampling plan for fisheries data collection defined by the Department of Fisheries.

Units in operation	No of samples to collect
50	35
100	35
150	40
200	45
400	65
>500	75

Source: Stobberup, 2012

Data are collected through various forms. Data are entered at the district level which is connected to the database server in the State office. Data are then sent to the main server located in Kuala Lumpur. The data are produced in an Annual Fisheries Statistical Bulletin which is distributed throughout the department and to other agencies and industries (Stobberup, 2012).

Under the Department of Fisheries, the Fisheries Research Institute carries out data collection for scientific purposes. This is dependent on the availability of funding and as the Institute does not own a large research vessel, it is unable to carry out fisheries independent surveys limiting data collection. The Fisheries Development Board also collects data on all landings and their value. Over 502 enumerators cover 240 landings sites to collect value data however, there appears to be a duplication of effort as the Department of Fisheries also collects data on price (Stobberup, 2012).

In the National Report in 2018, Malaysia reported landings of longtail tuna, kawakawa, frigate tuna, skipjack tuna and narrow-barred Spanish mackerel from the Malacca straits[46]. However, the National Report does not specify by which vessels. The Report provides further information on catches of neritic tuna in 2017 by different gear types, which includes trawl net, purse seine, hook and line and drift/gillnet. However, such reporting of gear types does not indicate whether these vessels are artisanal; the information suggests that drift/gill net and hook-and-line gear

[45] IOTC-2018-SC21-NR15

[46] IOTC-2018-SC21-NR15

are artisanal. In addition to neritic tuna, the National Report also provides details on catches of sharks, but only by longliners, which are not artisanal. Data are predominantly aggregated into species groups, with no species-specific information available.

In general, there appears to be deficient coverage of small-scale fisheries in Malaysia and the country suffers from limited funding and capacity (Stobberup, 2012). However, between August 2015 and July 2016 a project was implemented to enhance human resource development in elasmobranch taxonomy to improve landings data by recording species level information as opposed to more generic 'sharks' and 'rays'. During this period recordings of landing data were conducted in eight districts. It is unclear how this projected has affected landings data submitted to the IOTC.

Data in the National Report only provides catch data in the Malacca Strait and it is unclear how this correlates with data in the IOTC nominal catch database[47]. In general, most of the information provided in the National Report relates to Malaysia's longline fleet, which are all over 24m LOA, and therefore are not classified by IOTC as being artisanal.

Country-specific challenges in artisanal fisheries data collection

In Malaysia, barriers to collecting vessel census, catch and effort and nominal catch data include lack of manpower to conduct inspections and a lack of cooperation from vessel owners/fishermen. No barriers were cited in regards to collecting data on size frequency. No best practice examples were cited but the main challenges to monitoring, collecting and reporting IOTC and CITES species for artisanal fisheries include financial and legislative issues. Further information can be found in Table 24.

Table 24 Main challenges to monitoring, collecting and reporting IOTC and CITES species for Malaysia's artisanal fisheries

Lack of legislative or regulatory framework to monitor small-scale fisheries?	X in term of data collection
Financial (e.g. costs of routine data collection, funding for enumerators or port samplers)?	X limited funding for enumerators or port samplers
Lack of technical expertise (e.g. staff training, expertise to design and implement data collection)?	
Equipment (e.g. transport, equipment for sampling)?	X
Logistical challenges (e.g. access to landing sites, high turnover of enumerators)?	X
Technological (e.g. lack of corporate database, or tools for electronic data capture/reporting)?	X

3.14 Maldives

Within the Maldives, the annual catch (t) data reported within the National Report does not include the full list of species caught that are listed within the IOTC nominal catch database. For example, the National Report only reports the following tuna species: skipjack, yellowfin, bigeye, kawakawa and frigate. However, the IOTC database contains data for 2017 (Table 25), showing that the artisanal fishery within the Maldives is completely dominated by catches of skipjack and yellowfin tuna. Interestingly, there are no aggregation of species (expect under

[47] IOTC-2018-SC21-NR15

billfish) and no sharks were apparently caught according to the 2017 data.

The reasons for unaccounted catch within the Maldives fishery could be that catch data is only recorded for the following seven tuna species categories: large and small skipjack, large and small yellowfin, dogtooth, frigate, and kawakawa tunas, billfish, sharks and 3 broad categories of 'reef fish'. These reef fish categories are size classes that do not list species identification.

Table 25 IOTC annual catch output for artisanal fleet (tonnes) in the Republic of Maldives, 2017.

Sp. Group	English Name	Scientific Name	Tonnes
Billfish	-	-	14.24
Billfish	Black marlin	*Makaira indica*	159.38
Billfish	Blue marlin	*Makaira nigricans*	30.90
Billfish	Striped marlin	*Tetrapturus audax*	2.36
Billfish	Indo-Pacific sailfish	*Istiophorus platypterus*	44.59
Billfish	Swordfish	*Xiphias gladius*	270.04
Others	-	-	37.98
Others	Common dolphinfish	*Coryphaena hippurus*	13.70
Others	Dogtooth tuna	*Gymnosarda unicolor*	1.86
Others	Rainbow runner	*Elagatis bipinnulata*	45.14
Seerfish	Wahoo	*Acanthocybium solandri*	34.14
Tunas	Albacore	*Thunnus alalunga*	3.49
Tunas	Bigeye tuna	*Thunnus obesus*	947.23
Tunas	Frigate tuna	*Auxis thazard*	344.05
Tunas	Kawakawa	*Euthynnus affinis*	159.57
Tunas	Skipjack tuna	*Katsuwonus pelamis*	88825.07
Tunas	Yellowfin tuna	*Thunnus albacares*	49141.04

Artisanal data collection programme

Ministry of Fisheries, Agriculture, and Marine Resources (MoFAMR) possess the responsibility for the collection of fishery data, carried out by the Statistics and Database Management Service (SDMS) (Stobberup, 2012). The Ministry of Atolls Administration maintains government offices on every inhabited island for the purpose of overseeing and facilitating all government activities in the atolls, including the collection of fisheries statistics. This is carried out by using the SDMS Daily Report Form, recording the catch from every boat that goes fishing (Stobberup, 2012).

Description of planned developments/improvements

A systematic port-sampling programme to monitor artisanal landings is not yet in place in the Maldives. However, there are several approaches taken to data collection. Size sampling of catch from artisanal fishers landed at ports is conducted regularly through Marine Resource Centre (MRC) samplers stationed at three main pole and line tuna landing ports. Further, MRC implements a program to self-report fishery information and size samples by contracting fishermen samplers from the artisanal fleet. Data recorded in these approaches includes: date; vessel name and registration number; name and address of vessel owner; type of and number of pieces of fishing gear used; catch (reported as a count of species); and number of days fished. Given fish catch is reported in numbers, the use of conversion factors is required to estimate the weight of catch. It has been noted that there is limited, if any, recording of size frequency from the troll fishery.

Data is recorded through MOFAR/SDMS daily and monthly report forms. One sheet is completed each day on every inhabited island, recording the catch from every boat that goes fishing.

SDMS processes the bulk of its tuna fisheries data using the computer system Fisheries Recording System Plus (FIREPLUS). SDMS has contracted a private company in Malé to design and produce a replacement fisheries database system for MoFAMR. Once the new database system is installed, it is planned to abandon the system of reporting island catches using Monthly Fishing Reports. Instead, revised Daily Report Forms will become the main means of reporting catch and effort data to SDMS.

3.15 Mauritius

Fish production in the Republic of Mauritius takes two forms: marine capture fisheries and commercial aquaculture. Marine capture fisheries consist of a combination of industrial, semi-industrial, sports, amateur and artisanal fishery. Artisanal fishery remains the main source of fresh fish supply to the local market. It also provides employment opportunities in the coastal regions, and thereby contributes significantly to poverty alleviation and food security.

The majority of tuna and tuna-like species fishing in the EEZ of Mauritius is carried out by distant water industrial fishing fleets from Europe (purse seiners) and countries of the East and South East Asia (longliners). The local semi-industrial pelagic fishery target swordfish primarily but also lands albacore tuna. As of March 2018, 1,900 artisanal fishers were registered at 15 out of the 61 ports around the island. These fishers are classified based on their fishing grounds: 4% of which is lagoon; 58% of which is lagoon/off lagoon, and 38% of which is off lagoon. These activities are carried out in predominantly wooden or fiberglass boats and propelled by outboard motors, oars or sails, averaging at 6-7m in length.

Lagoon fishermen fish within the reef area in small embarkations, while off lagoon fishermen fish outside the reef (up to 20 km from the reef). Lagoon/off lagoon fishers are registered to fish both inside and outside the reef. The off lagoon artisanal fishery mainly targets albacore tuna associated with anchored Fish Aggregating Devices (FADs). This is due to the initiative lead by the Ministry to target Sustainable Development Goal 14.B, to '*Provide access for small-scale artisanal fishermen to marine resources and markets*'[48].

The IOTC Data Collection and Statistics Report, prepared by the IOTC Secretariat, shows artisanal fishing landings for Mauritius for 2017 (Table 26). This analysis shows that for a range of tuna species reports from Mauritius are at the species level. However, shark species are not reported to species, instead as 'Requiem sharks nei'.

Table 26 IOTC catch output for 2017 artisanal fishing landings (tonnes) 2017 in Mauritius.

Sp. Group	English Name	Scientific Name	Tonnes
Others	Common dolphinfish	*Coryphaena hippurus*	16.30
Seerfish	Wahoo	*Acanthocybium solandri*	3.50
Sharks	Requiem sharks nei	*Carcharhinidae*	0.50
Tunas	Albacore	*Thunnus alalunga*	162.60
Tunas	Skipjack tuna	*Katsuwonus pelamis*	16.10
Tunas	Yellowfin tuna	*Thunnus albacares*	69.20

[48] Moving Towards Sustainable Artisanal Fishery in Mauritius – Ministry of Ocean Economy, Marine Resources, Fisheries and Shipping - 2018

Artisanal data collection programme

The Ministry of Ocean Economy, Marine Resources, Fisheries and Shipping has under its responsibilities all ocean-related activities and various industries related to the fishing industry. The Fisheries Division of the Ministry is responsible for the management and policy advice on the fisheries sector. The technical arm of this Division, The Albion Fisheries Research Centre (AFRC), is the authority responsible for data collection across all sections of the fleet.

Mauritius' National Report submitted to IOTC in 2018 details national data collection and processing systems. These include: log sheet data collection and verification; VMS data collection; the management of an observer programme, and port sampling. However, it is not distinguished to which fleet these specific management measures are in place for monitoring artisanal fisheries.

A data collection programme has been implemented since 1977 based on a Catch Assessment Survey (CAS) designed by FAO. This includes a port sampling programme which samples the catch composition, including recording the length and weight of all fish sampled. Such work is performed by AFRC officers upon the unloading of artisanal vessels, at the 15 landings sites in Mauritius. Annual catches from the artisanal fleet are then compiled annually, and published in annual reports by the Ministry. However, within the most recent Annual Report 2016/2017[49], there is little inclusion or mention of artisanal data. Therefore, the species, bycatch and CITES species being monitored within this sampling programme are unknown.

Country-specific challenges in artisanal fisheries data collection

Mauritius stated that there were no barriers to the collection of vessel census data but did not provide a response to issues with nominal catch or catch and effort data. For size frequency data, limited staff and the location that fishermen unload their catches in the evening were cited as barriers to collecting data. The main challenges to monitoring, collecting and reporting IOTC and CITES species for artisanal fisheries include technological and technical issues. Further information can be found in Table 27.

Table 27 Main challenges to monitoring, collecting and reporting IOTC and CITES species for Mauritius's artisanal fisheries

Lack of technical expertise (e.g. staff training, expertise to design and implement data collection)?	Technical expertise may be needed to enhance the system on data collection
Technological (e.g. lack of corporate database, or tools for electronic data capture/reporting)?	1. Lack of appropriate software for input and processing of data. 2. Reporting is actually paper-based. The introduction of electronic data capture through the use of mobile devices would be most welcomed.
Lack of understanding of IOTC data reporting requirements?	Not applicable
Any other factors (please specify)?	The reporting system to the IOTC is very time consuming. Template may be revised to facilitate the data reporting process. Presently, the actual template need to be zoomed out to in order to enter data. Hence the letters and figures are difficult to read. Errors can easily be made.

[49] http://oceaneconomy.govmu.org/English/Documents/Annual%20Report%20on%20Performance%2016-17%20-%20Min%20of%20Ocean%20Economy.pdf

3.16 Mozambique

Mozambique's fishing fleet is divided into three segments; industrial, semi-industrial and artisanal (Moreno, 2013). While semi-industrial refers to vessels between 10 - 20 m LOA, the artisanal fleet comprises vessels with engine power of up to 100 hp and a total length of less than 10 metres LOA. Mozambique's semi-industrial fleet is therefore incorporated in the IOTC's definition of artisanal (Moreno, 2013). Further, Mozambique's 2018 Compliance Report to the IOTC makes reference to coastal fisheries, which is understood to be synonymous with artisanal.

According to the IOTC nominal catch database, annual catch output from 2017 (Table 28) for the artisanal fleet show that the artisanal fishery in Mozambique are dominated by hammerhead shark species (reported as aggregated data), as well as catches of narrow-barred Spanish mackerel.

Table 28: Artisanal catch in tonnes recorded and submitted to the IOTC by Mozambique (2017)

Species group	English name	Scientific name	Artisanal catch (t)
Billfish	Billfish nei		123.24
Billfish	Indo-Pacific sailfish	*Istiophorus platypterus*	11.70
Others	Others nei		570.89
Others	Slender tuna	*Allothunnus fallai*	57.10
Seerfish	Narrow-barred Spanish mackerel	*Scomberomorus commerson*	3573.48
Seerfish	Kanadi kingfish	*Scomberomorus plurilineatus*	26.80
Sharks	Milk shark	*Rhizoprionodon acutus*	655.60
Sharks	Various sharks nei	*Selachimorpha (Pleurotremata)*	26.20
Sharks	Hammerhead sharks nei	*Sphyrna spp*	1653.90
Tunas	Bigeye tuna	*Thunnus obesus*	27.60
Tunas	Frigate and bullet tunas	*Auxis thazard, A. rochei*	950.20
Tunas	Kawakawa	*Euthynnus affinis*	39.50
Tunas	Skipjack tuna	*Katsuwonus pelamis*	49.30
Tunas	Yellowfin tuna	*Thunnus albacares*	79.50

Artisanal data collection programme

The collection of fisheries data falls under the mandate of the Ministry of Sea, Inland waters and Fisheries (MIMAIP)[50]. Within the Ministry, the Directorate of Studies, Plan and Infrastructures (DEPI) holds responsibility for publishing fisheries data that includes socio-economic, effort and catch data. At the provincial level, DEPI's mandate is delegated to Provincial Directorate of Sea, Inland waters and Fisheries (DPMAIPs). Mozambique's data monitoring system is therefore decentralized and, since 2015, is implemented by DEPI and DPMAIPs.

The General Directorate for Fisheries Administration (ADNAP) is the overall body responsible for fisheries administration, management, monitoring and control of fisheries; it has created departments to cater for each of these aspects (Moreno, 2013).

[50] IOTC-2018-SC21-NR18

The Department of Fisheries Administration (DFA) is responsible for the annual licenses given to vessels, including artisanal, on an annual basis. The Department for Fisheries Management is responsible for collection, compilation and processing of fisheries data (Moreno, 2013).

The 2018 National Report submitted to IOTC states that *"*For artisanal fisheries, a landing sampling scheme is in place and to continue improving the coverage and the quality of fisheries data*"* (Chacate and Mutombene, 2018). Through the Sistema Nacional de Amostragem da Pesca Artesanal (SNAPA), artisanal fisheries are monitored through national stratified random sampling at landing sites by enumerators. These landing sites, defined as fishing centres, is where length frequency of dominant species and catch by species and effort is collected[51]. However, not all landing sites are sampled, e.g. in 2011 only four of Mozambique's provinces were sampled due to logistic limitations (Moreno, 2013).

Mozambique's data monitoring system currently relies on the PESCART database, from which statistics on catch and effort are produced (Moreno, 2013). Catch and effort data for artisanal fisheries are compiled each quarter at the provincial level and sent to central office. Catch by gear data is aggregated, although it is possible to separate this out by gear in the PESCART database. Similarly, catch by species data is aggregated into groups of species, though, again, it is possible to split this into species through the database. The unit of catch is determined by weight, which is measured with weighing scales. Despite this, within the 2018 compliance report partial compliance issues have been raised regarding the submission of size frequency data from both fish and shark capture. With regards to fish capture by artisanal fisheries data are not reported for all gear types. With regards to sharks, the species measured are not retained within catches. According to the CPC this issue arises due to the quality of species identification between observers and fishers filling in logbooks.

Data validation is carried out by hand and electronically in the PESCART database. In 2011, it was recommended that entering data electronically *in situ* would accelerate the reporting process and that an increase in the number of enumerators would enable a wider coverage of the number of landing sites sampled in Mozambique (Moreno, 2013).

According to Moreno (2013), the semi industrial fleet (some vessels of which fit within the IOTC definition of an artisanal fishery) utilise logbooks for data collection. Gear, effort and species data are collected but often aggregated by species group when submitted. However, this data collection system was reported to be one of the best in the region although, for tuna and large pelagic species, the system was acknowledged to be deficient and limited in coverage (Moreno, 2013).

On a five-year basis, the National Institute for the Development of Fisheries and Aquaculture (IDEPA) conducts a frame survey to count the artisanal fleet and the number of artisanal gears in order to estimate catches[52]. Data collected through the frame survey refers only to coastal provinces. IDEPA, formally known as the Institute for Small-Scale Fisheries Development (IDPPE), operates independently from MIMAIP. Other institutions that are autonomous from MIMAIP include the National Fisheries Administration (ADNAP) and the National Fisheries Research Institute (IIP). While ADNAP holds responsibility for fisheries administration, management, monitoring and control, and, through the Department of Fisheries Administration, the licensing of artisanal gears and vessels on a yearly basis, IIP undertakes fisheries research with the aim of proposing management measures (Table 29).

[51] IOTC-2018-SC21-NR18

[52] IOTC-2018-SC21-NR18

Table 29: Institutions involved and categories of data collected relevant to Mozambique's artisanal fleet.

Category of data	Responsible institution(s)
Fishing craft statistics/licenses	IDEPA/ADNAP
Catch and effort data	DEPI/DPMAIP
Length frequency data	IIP
Other scientific data	IIP
Socio-economic data	IDEPA/DEPI/DPMAIP

Source: Mozambique National Report to the Scientific Committee of the Indian Ocean Tuna Commission, 2018

Country-specific challenges in artisanal fisheries data collection

It is expected that Mozambique's PESCART database system will be replaced by the FAO ARTFISH data collection framework, which is currently being piloted in-country with a view to improving the quality and coverage of data. It is understood that ARTFISH does not hold biological data. Between 2015-2016, a pilot project was also implemented to improve the quality of data collected and reported to the IOTC on the impact of artisanal fisheries on IOTC species in the northern provinces of Nampula and Cabo Delgado[53]. In these provinces, artisanal fisheries land significant catches of billfish and tuna species. With funding from WWF, the pilot highlighted gaps in the data collection system and produced an action plan to improve data collection and reporting to align with IOTC requirements[54]. In 2016, landing site sampling was conducted with the aim of characterising the artisanal tuna fishery in the two provinces.

3.17 Oman

The fisheries sector can be classified into three segments: an artisanal fleet made up of two types of fishing vessel: Dhows (wooden or fiberglass) and fibreglass boats; a coastal fleet concentrated in the Arabian Sea; and an industrial fleet made up of vessels undertaking pelagic fishing representing only 0.1% of total fishery production in 2017. In 2017, the artisanal fleet reported a total of 23,913 vessels, while the coastal fishery totalled at 144 vessels in 2017, and the industrial fleet as one longliner.

The IOTC database contains data reflecting the IOTC annual catch output from 2017 for the artisanal fleet. This shows that the artisanal catch is dominated by longtail tuna, yellowfin tuna and kawakawa (Table 30).

The data reported in the IOTC catch output from the IOTC database reflects exactly the annual artisanal catches reported in the Oman National Report. In general, both data sets are reported to species level. However, an exception to this is the aggregation of 1109.05 tonnes of tuna, where species differentiation is not given. It is noted in the National Report that an investigation and review of the landing data for all tuna species from 2008 – 2017 are still ongoing. Additionally, shark species are not detailed and are similarly aggregated and listed as 'Various sharks nei'. It is noted that only a small fraction (10%) of the artisanal fleet are targeting the shark resource, with the remaining (90%) catching shark as by-catch of tuna and tuna-like species fishing activities.

Table 30 IOTC annual catch output for artisanal fleet (tonnes) in Oman, 2017.

Sp. Group	English Name	Scientific Name	Tonnes
Billfish	Indo-Pacific sailfish	*Istiophorus platypterus*	1621.93
Others	Striped bonito	*Sarda orientalis*	1691.68

[53] IOTC-2018-SC21-NR18

[54] IOTC-2018-SC21-NR18

Sp. Group	English Name	Scientific Name	Tonnes
Seerfish	Narrow-barred Spanish mackerel	*Scomberomorus commerson*	3333.39
Seerfish	Indo-Pacific king mackerel	*Scomberomorus guttatus*	3828.72
Sharks	Various sharks nei	Selachimorpha (Pleurotremata)	4964.59
Tunas	Frigate tuna	*Auxis thazard*	1184.31
Tunas	Kawakawa	*Euthynnus affinis*	7817.69
Tunas	Longtail tuna	*Thunnus tonggol*	20893.22
Tunas	Skipjack tuna	*Katsuwonus pelamis*	55.44
Tunas	Tunas nei	Thunnini	1109.05
Tunas	Yellowfin tuna	*Thunnus albacares*	19291.79

Artisanal data collection programme

The Directorate General of Agriculture, Animal and Fisheries Resources is the responsible party for the implementation of fish landing data initiatives in each Governorate or Region along on Omani coast. The survey design of data collection methods is the responsibility of the Fisheries Statistics Section (FSS), which included the number of visits to each landing site per month.

The data collection scheme for Oman's artisanal fleet is based upon port-based sampling, due to the fact that 99.1% of the total landings come from this fleet. The scheme surveys all major 50 landing sites in each Governorate and Region along the coast. However, the Ministry of Agriculture and Fisheries is planning to install a new VMS tracking system that will cover all the fishing fleet, including the small outboard motor-powered fishing skiffs (artisanal fleet).

Landing site samplers record the following for all fishing boats according to the order of their arrival to the site: date; landing site; landing time; vessel type; license number; and number of crew. In addition, the following information is sourced from every fifth to seventeenth vessel: fishing hours/days; fish species; number of fishes; average weight; total weight; fishing gear; and unit price by species.

Landing site samplers estimate number and average weight of each fish species landed only by eye observations. Effort data collected by landing site samplers are number of fishing boats and fishing hours/days and number of crew for each landing fishing boat.

Data on fleet statistics held by IOTC was last provided by Oman in 2015, and shows that their artisanal fleet in dominated by gillnet and handline vessels. However, the data reported on the numbers of fishing craft of the artisanal fleet within the IOTC database is fundamentally different to that of which is reported in the National Report. Table 31 shows the evolution and growth of the Omani artisanal fleets from 2012 – 2017, where the fleet grew by almost 4,000 vessels. This data set also disaggregates the number of fishing craft by vessel type, dhow or fibreglass, rather than gear type. When comparing the two datasets from 2015, there is a discrepancy of approximately 400 craft.

Table 31 The number of units of artisanal fleet operation in Omani waters from 2012 – 2017.

Years		2012	2013	2014	2015	2016	2017
Number of Units	Dhows	698	711	694	684	688	681
	Fiberglass	19,245	20,631	21,616	22,237	22,720	23,232
	Total	19,942	21,342	22,310	22,885	23,408	23,913

Country-specific challenges in artisanal fisheries data collection

In Oman there are thought to be no barriers to estimating the size and composition of artisanal vessels. For nominal catch data the main issues with collecting and estimating total catches includes the spacing and change of landing sites in the Arabian sea with no specific landing times or infrastructure. For issues with collecting catch and effort data, the fact that fishermen move between landings sites in open coastal areas and the irregular sailing and return time contribute to a constrain for collection of data, particularly for areas where no landing infrastructure is provided. No answer was provided in regards to issues with collecting size frequency data. The main challenges to monitoring, collecting and reporting IOTC and CITES species for artisanal fisheries include financial and technological issues. Further information can be found in Table 32.

Table 32 Main challenges to monitoring, collecting and reporting IOTC and CITES species for Oman's artisanal fisheries

Financial (e.g. costs of routine data collection, funding for enumerators or port samplers)?	To a certain extent, there is limitation of human resources to cover such requirement.
Technological (e.g. lack of corporate database, or tools for electronic data capture/reporting)?	NA as all enumerators to collect and report data through electronic tools.
Any other factors (please specify)?	There is a global monitoring, collecting, and reporting of all marine species, without specific focus on IOTC or CITES species. However other competent authorities do report data to CITES, namely import-export certificate.

3.18 Pakistan

In Pakistan, the small-scale tuna fishing fleet largely consists of locally made wooden boats that target neritic tuna species. These boats can undertake trips up to a maximum of five days, often use inboard engines, are between 7 - 11m LOA and utilise gillnets between 3 - 5km in length. These small-scale gillnet vessels may however, not always be targeting tuna or tuna-like species but instead may be targeting other pelagic or demersal species such as shark and Spanish mackerel.

According to the IOTC nominal catch database the following species were caught by the artisanal fleet of Pakistan (Table 33). From the below table it can be seen that all shark species are aggregated into one category.

Table 33 IOTC nominal catch data for Pakistan's artisanal fleet, 2017

Common Name	Scientific Name	Artisanal fishing (t)
Black marlin	*Makaira indica*	874.95
Blue marlin	*Makaira nigricans*	1602.45
Striped marlin	*Tetrapturus audax*	349.98
Indo-Pacific sailfish	*Istiophorus platypterus*	4471.95
Swordfish	*Xiphias gladius*	693.00
Narrow-barred Spanish mackerel	*Scomberomorus commerson*	5854.06
Indo-Pacific king mackerel	*Scomberomorus guttatus*	1832.84
Various sharks nei	Selachimorpha (Pleurotremata)	7011.00
Bullet tuna	*Auxis rochei*	420.64
Frigate tuna	*Auxis thazard*	2551.63
Kawakawa	*Euthynnus affinis*	13528.94

Common Name	Scientific Name	Artisanal fishing (t)
Longtail tuna	*Thunnus tonggol*	14041.40
Skipjack tuna	*Katsuwonus pelamis*	5483.32
Yellowfin tuna	*Thunnus albacares*	7533.16

Artisanal data collection programme

Data on tuna production is collected by provincial fisheries departments of the provinces of Sindh and Balochistan and are compiled by Marine Fisheries Department, Government of Pakistan and Ministry of Ports and Shipping[55].

The main issue for Pakistan is that, according to the IOTC compliance reports, data are aggregated for the coastal and surface fisheries and therefore the total catch of the artisanal gillnet vessels is unclear. The National Report also provide a breakdown on the number of small-scale vessels targeting tuna by province, however as no data are available through the IOTC artisanal fishing craft database it suggests that these data are not communicated to the IOTC.

Annual nominal catch by species group and annual species specific catch of tuna and tuna-like species is provided in the National Report to the Scientific Committee[56]. Based on the information provided in the IOTC compliance reports, it suggests that surface and coastal nominal catch data are aggregated. Catches of longtail tuna, kawakawa and frigate tuna by gillnet boats are the main catch during January, February, October and November however, no data of their contribution to tuna landings are available. It is estimated that they make up about less than 5% of tuna landings, which is a decline from 20% in the last 15 years as a major part of this fleet now catch Indian mackerel instead[57].

Sharks are currently targeted but are not consumed locally and instead the fins are dried for export for fishmeal. The oil is also extracted and used to smear local boats. Generally, sharks are recorded at the group level (i.e., sharks or rays) but a WWF-Pakistan crew-based data collection programme is helping to identify them to species level which currently includes four species of shark, i.e., shortfin mako, pelagic thresher shark, silky shark and shark nei; whereas two species of Mobulidae has been identified which includes Spinetail mobula and Mobula nei. The National Report to the Scientific Committee provides catch data of sharks by the gillnet fishery but it is unclear what vessels are catching shark species and whether this includes the small-scale gillnet fleet. However, based on the information provided in the IOTC compliance reports, it suggests that surface and coastal nominal catch data may be aggregated.

In regards to discards, Pakistan note that no shark or fish species are discarded at sea. Also, as there is no longline fishery in Pakistan there are no reports of interactions with birds and no seabirds are reported to be entangled in tuna gillnets.

Under Clause 13 of the Exclusive Fishery Zone (Regulation of Fishing) Rules, 1990 it is mandatory for licenced fishing vessel to provide to the licensing authority or the Fishery Officer in the first week of each month the activities of the fishing craft for the previous month. However, the National Report to the Scientific Committee states that no logbook data is

[55] IOTC-2018-SC21-NR20

[56] IOTC-2018-SC21-NR20

[57] IOTC-2018-SC21-NR20

maintained by the tuna gillnet vessels. Currently only tuna longliners need to carry VMS but a plan is being developed in collaboration with the Provincial Governments to make it mandatory to install VMS on all vessels longer than 15m. In addition, the Government of Balochistan made it mandatory that all vessels over 15m catching tuna and tuna-like species by drift or gill nets on the territorial waters of Balochistan must have VMS on board[58].

Data on tuna landings are regularly recorded at port, including length-weight frequency. Data are provided in the National Report to the Scientific Committee on the number of individuals measured in the gillnet fishery however, again is unclear whether this refers to all landings.

Country-specific challenges in artisanal fisheries data collection

Although the potential for high bycatch of important species such as sharks, cetaceans, turtles and whale sharks are common in gillnet fisheries, the extent to which this occurs in Pakistan is unknown. To rectify this, WWF Pakistan in 2012 initiated a study to assess the mortality of ETP species in gillnet tuna fisheries. Despite some initial failures, the project was finally able to assign data collection to a skipper, which helped provide much needed data on bycatch species as well as tuna and tuna-like species. Considering the quality and diversity of data generated through the use of these crew-based data collection, the number of crew collecting data was gradually increased to 75 observers in 2017. The crew-based observers are paid a monthly wage.

The type of data to be collected on each haul includes: quantity and estimated weight of all tuna species; quantity and estimated weight of all tuna like species; quantity and estimated weight of all bycatch fish species including sharks, rays, queenfish, trevallies, leather skin and other fish and shellfish species; quantity and estimated weight of all ETP species (including cetaceans, sea turtles, whale sharks, mobulids, queenfish, sunfish and other similar species); the length (fork length) of three specimens of dominant tuna and tuna like species; the length of each specimens of ETP species; the GPS location of the net deployment and net retrieval area; the date and time of net placement and retrieval; a photograph of the catch and selected specimens using digital camera; and a photograph of free-swimming schools of tuna, dolphins and whales (Moazzam and Khan, 2018).

In addition, at the start of each fishing voyage, a member of the crew is required to record: the date of departure; the quantity of ice, ration, water and fuel; the number of panels of the gillnets; the length of each panel; the possible fishing ground; the other details of vessel; and any important event or observation (such as harmful algal blooms, water spout). After each trip, the observers were interviewed in a debriefing session in which all details were obtained and data stored in the WWF-Office and both inn hard copy and digitally (Moazzam and Khan, 2018).

The data collected through the crew-based data collection includes landing data from artisanal fisheries and has been submitted to the IOTC by the Government of Pakistan. During the course of the study however, there was a large discrepancy in landings data of tuna species between the data reported by the Government and supplied to the IOTC and the data collected through the WWF programme. Therefore, an exercise of data reconciliation was undertaken. It was decided that the data be reconstructed and this was communicated to the IOTC. Based on the results of the study, WWF Pakistan and the Government of Pakistan have recommended the use of crew-based data collection as a possible alternative to onboard observers for the collection of scientific data (Moazzam and Khan, 2018).

[58] IOTC-2018-SC21-NR20

Across the two coastal provinces in Pakistan, there were 120 artisanal neritic tuna gillnet vessels in Balochistan and 80 in Sindh according to the 2018 National Report to the Scientific Committee. However, these numbers are only an estimate as exact information about registration was not available[59].

3.19 Seychelles

The Seychelles registered fishing fleet is comprised of purse seiners, supply vessels, industrial and semi-industrial longlines and artisanal fishers of which there are 13, 8, 48, 31 and 400 vessels respectively[60]. The artisanal fishery is characterized by a wide variety of vessels using different gears and catching various species within the Seychelles EEZ. Since the 1950s the fleet has transitioned from being comprised entirely of traditional wooden pirogues to a fleet of which 75% are using outboard engines and remaining 25% whalers or schooners powered by sails. The principal gears used by whalers and schooners are handlines, while the small boats use a multitude of gear combinations, including handlines, traps, encircling gill nets, beach seines and harpoons. All artisanal fishing vessels target a range of (predominantly coral or seagrass) fish resources. Catch from the artisanal fleet supplies the local market demand including hotels and restaurants, and some species such as groupers and snappers are designated for the export market.

The IOTC database contains data reflecting the IOTC annual catch output from 2017 (Table 34) for the artisanal fleet. Catches are not consistently reported to species level; for example, despite dogtooth tuna, kawakawa and yellowfin tuna are all reported at species level, while other tuna species landed are grouped into 'tuna-like fishes nei'. Furthermore, the species diversity of sharks landed by artisanal fishers is unknown, detailed as 'Various sharks nei', despite representing the second largest group by weight landed at 21.75 tonnes.

Table 34 IOTC catch output of 2017 artisanal fishing landings (tonnes) in the Seychelles.

Sp. Group	English Name	Scientific Name	Tonnes
Billfish	Marlins, sailfishes, etc. nei	Istiophoridae	0.15
Other Nei	Tuna-like fishes nei	Scombroidei	1.70
Others	Common dolphinfish	*Coryphaena hippurus*	0.29
Others	Dogtooth tuna	*Gymnosarda unicolor*	3.64
Seerfish	Wahoo	*Acanthocybium solandri*	2.90
Sharks	Various sharks nei	Selachimorpha (Pleurotremata)	21.75
Tunas	Kawakawa	*Euthynnus affinis*	69.60
Tunas	Tunas nei	Thunnini	4.11
Tunas	Yellowfin tuna	*Thunnus albacares*	0.10

Artisanal data collection programme

The Seychelles Fisheries Association (SFA) is a parastatal organisation that, since its establishment in 1984, has been implementing an 'Artisanal Fisheries Catch Assessment Survey'. The Seychelles Artisanal Fisheries Statistics Reports, published by the SFA on an annual basis[61], provide data to a lower species resolution to that reported in the IOTC Database, where species are aggregated. On the other hand, the Seychelles Artisanal Fisheries Statistics Reports do detail the number of fishing craft by gear type, however data

[59] IOTC-2018-SC21-NR20

[60] IOTC-2018-SC21-NR22

[61] https://www.oceandocs.org/handle/1834/151

on vessel numbers have only been reported to IOTC up to 2007.

The 'Artisanal Fisheries Catch Assessment Survey' is based on a creel-type survey methodology stratified geographically across 63 landing sites on Mahe, La Digue and Praslin Islands and by boat and gear type. In addition, data is collected from Oceana Fisheries Co. Ltd. The four surveys include:

Small boats survey - the main objective of the small boats survey is to collect catch, effort, and species composition data on small boats. This includes: (i) fishermen on foot; (ii) pirogues; (iii) outboard and; (iv) whalers with traps. Catch and effort data is collected for 18 boat/gear type categories and is entered into a PC using a Dbase III entry Programme, 'ARTFISH'.

Whaler handline survey - the main objective of this survey is to obtain catch, effort, species composition and economic data by vessel type. The gear types used are either handlines and or electric reels. Catch and effort data is collected for 31 species category and designed to provide monthly estimates on a stratum basis. Survey data is recorded daily at key sites on forms WHS1. The catch and effort data are recorded for a sample of whalers on WHS2. Boat numbers per sampling site is recorded on FS1.

Schooner fishery survey - the objective of this survey is to obtain catch and effort, species composition and economic data on the schooner fishery. Catch and effort data is collected for 30 species categories in addition to an 'others' category of unidentified species. The schooner fishery survey data is recorded daily. A number of boats are sampled and complete catch records are recorded for these vessels. For any boat sampled the enumerator must be present at the landing site so that the totality of that catch is estimated. The number days at sea and crew size for each boat sampled are recorded as a measure of the effort.

Sport fishery survey - this survey collects catch, effort and species composition data for the sport fishery. Data are collected regardless of fishing method employed, usually trolling, but some bottom fishing with handlines may be conducted. There is no geographical stratification owing the small number of boats involved. Thirteen species or species groups are considered in this survey. The output of the survey produces a monthly catch, effort and species composition for the fishery. The Sport Fishery Survey records fisheries data from vessels with a chartering license issued by the Seychelles Licensing Authority. Boats owners are issued each month with daily sport fishing catch and effort log sheet which they complete and collected by the enumerators.

Country-specific challenges in artisanal fisheries data collection

In the Seychelles, the lack of capacity to monitor the recreational and sports fishery is highlighted as a barrier to collecting vessel census data for artisanal fishing vessels. The main barrier to collecting nominal catch, catch and effort and size frequency data is staff availability outside normal working hours; for example, when a vessel lands its catch in the early morning before 7am. There is also a lack of staff to monitor sport and recreational fisheries for catch and effort and size frequency data. There are several challenges to monitoring, collecting and reporting IOTC and CITES species for artisanal fisheries which are highlighted in

Table 35.

Table 35 Main challenges to monitoring, collecting and reporting IOTC and CITES species for Seychelles' artisanal fisheries

Lack of legislative or regulatory framework to monitor small-scale fisheries?	Sport fishing vessels are registered under ministry of tourism
Financial (e.g. costs of routine data collection, funding for enumerators or port samplers)?	Cost of transportation to transfer samplers at landing sites during the early hours of the morning
Lack of technical expertise (e.g. staff training, expertise to design and implement data collection)?	Insufficient number of competent professional to design and implement data collection for sport and recreational fishery
Equipment (e.g. transport, equipment for sampling)?	Transport
Logistical challenges (e.g. access to landing sites, high turnover of enumerators)?	Enumerators are unable to be at landing sites in the early hours due to family constraints.
Technological (e.g. lack of corporate database, or tools for electronic data capture/reporting)?	A project is being implemented for electronic data reporting
Lack of understanding of IOTC data reporting requirements?	Lack of designated landing sites.

3.20 Somalia

Somalia does not have any vessels greater than 24m in length or fishing outside its EEZ[62]. The Somali artisanal fleet consists solely of small vessels between 3m and 10m in length made of fibreglass, plastic or wood. The artisanal fleet is the only fleet in Somalia known to target tuna and tuna-like species. In 2017 there were 4,300 artisanal vessels operating within the IOTC area of competence; 3,464 motorised boats and 836 houri vessels (wooden boats without engines); none of these vessels use purse seine or longline fishing gear.

Artisanal data collection programme

According to the Fisheries Law No 23 implemented in November 1985 the MFMR are responsible for compilation of fisheries data.

Information on artisanal vessels is collected through a national vessel registration scheme wherein there is full enumeration of small-scale vessels. Except for houris, all artisanal vessels (fibreglass skiffs with outboards, fibreglass skiffs with inboards, wooden boats without engines, sail, dhow motorized and wooden boats within in board engines) are covered by current data collection systems. Landing site and/or auction slips are used to collect artisanal data with coverage at landing sites at 30%. Data are collected on a monthly basis. According to the MFMR representative, there is no data collection system in place for collection of catch and effort data.

The National report details a partnership formed between the MFMR, FAO, Secure Fisheries and City University called "Project Kalluun"[63]. Their aim is to enhance data collection on pelagic fisheries and improve community engagement. Specific foci within this project are data collection, processing and reporting in addition to increasing coverage and representation

[62] IOTC-2018-SC21-NR24

[63] IOTC-2018-SC21-NR24

throughout the country.

There is no information for Somalia within the IOTC databases.

Country-specific challenges in artisanal fisheries data collection

In Somalia, the main barriers to collecting vessel census and catch and effort data include a lack of a legislative framework for monitoring, limited capacity and access to landing sites in remote areas. For collecting or estimating nominal catch data issues include limited staff, capacity and access to landing sites. For collecting data on size frequency there are issues with the capacity of statistical staff to collect and analyse data, develop manuals and design and conduct surveys. The census is also limited and there are issues with access to landing sites. There are several challenges to monitoring, collecting and reporting IOTC and CITES species for artisanal fisheries (Table 36).

Table 36 Main challenges to monitoring, collecting and reporting IOTC and CITES species for Somalia's artisanal fisheries

Lack of legislative or regulatory framework to monitor small-scale fisheries?	X
Financial (e.g. costs of routine data collection, funding for enumerators or port samplers)?	X
Lack of technical expertise (e.g. staff training, expertise to design and implement data collection)?	X
Equipment (e.g. transport, equipment for sampling)?	X
Logistical challenges (e.g. access to landing sites, high turnover of enumerators)?	X
Technological (e.g. lack of corporate database, or tools for electronic data capture/reporting)?	X
Lack of understanding of IOTC data reporting requirements?	X

3.21 South Africa

The commercial fishing industry within South Africa consists of two main sectors; (i) the large pelagic longline and (ii) the tuna pole and line (baitboats) sectors[64]. However, there is also a "commercial line fishery". This fishery, according to the 2018 National Report, constitutes the artisanal fishery of South Africa. However, it is unclear as to what exactly constitutes South Africa's artisanal fisheries. The 2018 National Report describes an effort-based managed commercial line fishery as being synonymous with an artisanal fleet[65]. Despite the fact that the national report states there are 154 permits for commercial longline (artisanal) vessels, the data submitted to the IOTC database shows that the artisanal fleet consists of only two vessels which utilise "sports fishing" gear.

According to the IOTC database, catches from artisanal fisheries reported by South Africa are negligible, with the most recent data in 2016 less than 15 MT for two species (Table 37),

[64] IOTC-2018-SC21-NR26

[65] IOTC-2018-SC21-NR26

raising questions regarding the coverage of these data.

Table 37: Most recent artisanal catch data within the IOTC database

Species group	English name	Scientific name	Year	Artisanal Fishing (t)
Other	Snoek	*Thyrsites atun*	2016	7.91
Tunas	Albacore	*Thunnus alalunga*	2016	5.78

Artisanal data collection programme

DAFF[66] is the regulatory body in charge of fisheries management.

Since 1973 port sampling for tuna, swordfish and "related species" has been conducted. Employees of the DAFF are responsible for collection of length-frequency data for albacore from pole-line vessels. Prior to addressing the catch, skippers are responsible for recording the length-frequency data of yellowfin tuna, however, this is not mandatory. Longline vessels depend on observers for length-frequency data collection. According to the 2018 National Report longline vessels are only able to unload their catch in the presence of a monitor of South African Fisheries Control Officer. Tuna pole-line vessels are also monitored when they are unloaded.

Log sheets are required to be filled in by "Vessels in the Large Pelagic Longline fishery and Tuna Pole-Line fishery"[67]. However, it is not clear as to whether artisanal (commercial line fisheries) are included within these fleets or are required to fill in the log sheets. Within these log sheets daily logs of catches are required. South African Fisheries Compliance Officers and Fisheries Monitors then cross-check the information in log sheets with landing declarations. Log sheets must be submitted once a month by rights holders.

Effort, weight and catch location data are collected for the industrial fishery, but it is not clear as to whether these data are collected for artisanal vessels.

There are problems with South Africa's recording of size frequency for both tuna and tuna-like species and sharks. No size-frequency data were provided for the catch of artisanal vessels according to both the 2017 and 2018 compliance reports. To justify the lack of submission the CPC has stated that:

> "*all large pelagic longline data was submitted and South Africa does not have coastal fisheries for large pelagics. In terms of our policies, coastal line fisheries are not a tuna sector, thus no data was provided. Because you have pointed out that South Africa has submitted CE for "coastal line fisheries", we now understand that you are referring to the Tuna Pole-Line sector (TPL). This sector predominantly operates in South Africa's ICCAT area. Of the over 2000 tons of total TPL catch, only 2.57 tons were taken in the IOTC area. This equates to 0.3% of the total Tuna Pole-line catch and less than 0.5% of the total effort. Recalling that the TPL sector is not permitted to catch and land any pelagic shark species or swordfish, no data is available for these species*".

Interestingly, the compliance report for 2018 shows that South Africa was partially compliant with the submission of size frequency data for shark; however, the number of samples were still below the recommended minimum sampling of 1 fish per MT of catch.

[66] More information on the DAFF can be found at https://www.daff.gov.za/ (last accessed 25/07/2019).

[67] IOTC-2018-SC21-NR26

Country-specific challenges in artisanal fisheries data collection

South Africa did not cite any issues with regards to collecting vessel census data but states that for nominal catch, catch and effort and size frequency data collection and estimation there are limited Fisheries Control Officers and monitors at landings sites. Port sampling is also currently ad hoc in regards to catch and effort and size frequency data collection. The census is also limited and there are issues with access to landing sites. Challenges to monitoring, collecting and reporting IOTC and CITES species for artisanal fisheries include financial and lack of technical expertise. Further detail is provided in Table 38.

Table 38 Main challenges to monitoring, collecting and reporting IOTC and CITES species for South Africa's artisanal fisheries

Lack of legislative or regulatory framework to monitor small-scale fisheries?	Vessels are relatively small and fishers are not willing to give up a berth to accommodate an observer. There is interest to moving towards video observation/EMS.
Financial (e.g. costs of routine data collection, funding for enumerators or port samplers)?	Lack of suitably trained FCOs employed.
Lack of technical expertise (e.g. staff training, expertise to design and implement data collection)?	Lack of suitably trained FCOs employed.
Logistical challenges (e.g. access to landing sites, high turnover of enumerators)?	The commercial fishers operate 24 hours per day, while overtime for FCOs has been limited. As such, offloading that may occur out of general work hours may not be observed by an FCO
Technological (e.g. lack of corporate database, or tools for electronic data capture/reporting)?	Resistance towards implementing video observation/EMS

3.22 Sri Lanka

Sri Lanka's fishing fleet is made up of almost 65,000 vessels, 93% of which operate within the EEZ[68]. Gillnets and longlines are the dominant gear type used (Moreno, 2013). The tuna fishing fleet consists largely of small-scale fishing boats with lengths between 5m and 24m, and over 99% of these do not have a mechanised haul. In 2017 the fleet consisted of 900 boats conducting one day fishing trips and 3500 boats conducting multi-day fishing trips within Sri Lanka's EEZ[69].

The IOTC nominal catch database contains catches for a mixture of species and species groups for Sri Lanka (Table 39), with catches dominated by skipjack and yellowfin tuna.

Table 39 IOTC Catch Records from 2017 for Sri Lanka.

Common Name	Scientific Name	Catch (tonnes)
Billfish nei		90.60
Black marlin	*Makaira indica*	3509.10
Blue marlin	*Makaira nigricans*	2650.00
Striped marlin	*Tetrapturus audax*	59.20
Indo-Pacific sailfish	*Istiophorus platypterus*	2611.00
Shortbill spearfish	*Tetrapturus angustirostris*	1.20

[68] IOTC-2016-WPDCS12-14-LKA

[69] IOTC-2018-SC21-NR25

Common Name	Scientific Name	Catch (tonnes)
Swordfish	*Xiphias gladius*	7803.00
Tuna-like fishes nei	*Scombroidei*	77.40
Bigeye scad	*Selar crumenophthalmus*	1730.20
Carangids nei	*Carangidae*	9243.10
Rough triggerfish	*Canthidermis maculata*	388.40
Common dolphinfish	*Coryphaena hippurus*	1069.00
Needle cuttlefish	*Sepia aculeata*	25.40
Mackerel scad	*Decapterus macarellus*	6203.30
Marine fishes nei	*Osteichthyes*	13995.50
Indian mackerels nei	*Rastrelliger spp*	3500.50
Rainbow runner	*Elagatis bipinnulata*	170.30
Indian scad	*Decapterus russelli*	7127.10
Narrow-barred Spanish mackerel	*Scomberomorus commerson*	1359.60
Seerfishes nei	*Scomberomorus spp*	225.50
Wahoo	*Acanthocybium solandri*	146.70
Blue shark	*Prionace glauca*	666.30
Spottail shark	*Carcharhinus sorrah*	2.00
Silky shark	*Carcharhinus falciformis*	554.60
Longfin mako	*Isurus paucus*	35.30
Mantas, devil rays nei	*Mobulidae*	670.90
Giant manta	*Manta birostris*	1.80
Devil fish	*Mobula mobular*	597.70
Various sharks nei	*Selachimorpha (Pleurotremata)*	186.90
Shortfin mako	*Isurus oxyrinchus*	41.10
Scalloped hammerhead	*Sphyrna lewini*	114.90
Smooth hammerhead	*Sphyrna zygaena*	11.40
Rays, stingrays, mantas nei	*Rajiformes*	239.50
Albacore	*Thunnus alalunga*	88.20
Bigeye tuna	*Thunnus obesus*	3890.30
Bullet tuna	*Auxis rochei*	1307.00
Frigate tuna	*Auxis thazard*	1831.60
Kawakawa	*Euthynnus affinis*	1739.60
Longtail tuna	*Thunnus tonggol*	12.70
Skipjack tuna	*Katsuwonus pelamis*	39507.70
Yellowfin tuna	*Thunnus albacares*	31523.90

Artisanal data collection programme

The Department for Fisheries and Aquatic Resources (DFAR) is the governmental body responsible for managing and directing development of the fisheries sector within Sri Lanka[70]. The DFAR's current focus is ensuring the industry's compliance with international conventions and driving sustainable development. It is legally required that all fish catch by Sri Lankan vessels is landed in the ports of Sri Lanka. This allows access to catch by the DFAR and NARA enumerators.

In 1987 The National Aquatic Resources Research and Development Agency (NARA) implemented a port sampling program to allow for generation of large pelagic fisheries statistics. Now NARA and the DFAR (the Department of Fisheries and Aquatic Resources) conduct sampling of offshore multiday boats and tuna targeting coastal vessels at Sri Lankas major landing sites. Artisanal long-line and gillnet are included in the types of vessels surveyed at landing sites. Port sampling is the only method used to collect size frequency data. For each boat five fish are randomly sampled and are measured for length using tape The 2018 national report states that port sampling covers between 15% and 18% of Sri Lankas total landings. Recreational and sports fisheries are not covered by this data collection system.

Landing site sampling is conducted by NARA, covers 13 out of the 15 fisheries districts (missing Mannar and Jaffna) and focuses on 23 major and 10 minor landing sites. However, there is no clarity regarding the coverage of Sri Lankas landings in terms of the artisanal fleet. Data collected at landing sites include catch by species (or species group), effort and the price of fish.

Fleet statistics are collected using a national vessel registration scheme which provides full enumeration or registration of small-scale vessels. The current vessel data collection system covers all artisanal / coastal vessels.

Country-specific challenges in artisanal fisheries data collection

Sri Lanka stated that the main barriers to collecting vessel census data included the large number of scattered landing sites and a lack of human resources to cover these sites. In regards to nominal catch data there is a lack of knowledge on proper sampling methods to ensure sampling is representative, particularly amongst newly recruited staff, limited numbers of staff available to conduct sampling, lack of transport to rural landing sites, and a lack of funds to provide means of transport (such as motor bikes) that inhibit data collection. In addition to these issues, seasonal operation of fishers and partial landings conducted at the sites creates problems for collecting data on catch and effort. The issues with collecting size frequency data for artisanal fisheries include direct loading to the vehicles at the harbours, resistance from fishers preventing access to the fish, lack of dedicated staff, time differences (day sampling versus night fishing), partial landings, in addition to landing sites not suitable to carry out such data collection. Further details on the challenges to monitoring, collecting and reporting IOTC and CITES species for artisanal fisheries are provided in Table 40.

Table 40 Main challenges to monitoring, collecting and reporting IOTC and CITES species for Sri Lanka's artisanal fisheries

Financial (e.g. costs of routine data collection, funding for enumerators or port samplers)?	Main Challenge

[70] More information of the DFAR can be found at https://www.fisheriesdept.gov.lk (last accessed 25/06/2019).

Lack of technical expertise (e.g. staff training, expertise to design and implement data collection)?	Yes, Modern proper sampling techniques with electronic data collection means is needed. A tablet is introduced only for mechanized multiday boats at present.
Equipment (e.g. transport, equipment for sampling)?	Main Challenge
Logistical challenges (e.g. access to landing sites, high turnover of enumerators)?	Main Challenge
Technological (e.g. lack of corporate database, or tools for electronic data capture/reporting)?	Main Challenge
Any other factors (please specify)?	Fishermen resistance for providing data and support for data collection.

3.23 Sudan

The marine fishing sub-sector within Sudan consists of three components; offshore, inshore industrial and coastal artisanal fisheries[71]. The artisanal sector fish from a variety of vessel types from dugout canoes known as houris (non-motorized, often powered using oars or bamboo poles) and sambouk (launches) to wooden and steel boats known as felucca. The artisanal gear types used vary but include pole and line, longline, castnets, gillnets and beach seines. These gears are used to target the main resources of finfish, crustaceans, molluscs and sea cucumbers[72].

Country-specific challenges in artisanal fisheries data collection

There is a significant lack of data collection and or submission to IOTC within Sudan. The IOTC have not received fisheries data from Sudan for the last 4 years[73]. The National Report, submitted by Sudan in 2013, states that statistical data are collected from the fish market in Port Sudan, however, when this occurs, all tuna species are recorded under the name of mackerel.

3.24 Tanzania

The Tanzanian fishing industry is divided into artisanal and commercial fisheries. The artisanal sector is characterised by traditional fishing gear and vessels such as dugout canoes between 3-5m in length and wooden planked boats from 6-15m (Sobo, 2004; Ministry of Agriculture, Livestock and Fisheries, 2016). In Tanzania, small-scale fisheries dominate and account for nearly 95% of the total marine fish catch (Jiddawi and Öhman, 2002).

The 2017 IOTC nominal catch database for artisanal fisheries provides the following data for the Tanzanian artisanal fleet (

[71] More information can be found at http://www.fao.org/fishery/facp/SDN/en (last accessed 25/07/2019).

[72] More information can be found at http://www.fao.org/fishery/facp/SDN/en (last accessed 25/07/2019).

[73] IOTC–2018–WPDCS14–07

Table 41). Shark species are aggregated into one group and therefore it is unclear what CITES or IOTC species are caught.

Table 41 IOTC nominal catch data for Tanzania's artisanal fisheries, 2017.

Common name	Scientific name	Artisanal fishing (t)
Indo-Pacific sailfish	*Istiophorus platypterus*	2682.30
Narrow-barred Spanish mackerel	*Scomberomorus commerson*	2223.82
Indo-Pacific king mackerel	*Scomberomorus guttatus*	2.48
Various sharks nei	*Selachimorpha (Pleurotremata)*	6459.60
Frigate tuna	*Auxis thazard*	370.98
Kawakawa	*Euthynnus affinis*	764.66
Skipjack tuna	*Katsuwonus pelamis*	370.98
Yellowfin tuna	*Thunnus albacares*	3903.59

Artisanal data collection programme

For fisheries, responsibility is devolved between the Tanzanian mainland and the semi-autonomous region of Zanzibar. This means that responsibility for fisheries within 12 nautical miles and territorial waters of both areas is the responsibility of the respective Ministry of Fisheries. As tunas are caught by the local fleet within 10nm of the shore, data are collected by a combination of District Fisheries Officers and BMUs on the mainland and beach recorders on Zanzibar. The difference between the two regions is that BMUs collect data voluntarily and are currently not paid, whereas beach recorders on Zanzibar are government employees and are paid. After data are collected, they are sent to the DSFA who collate and analyse the data before sending it to the IOTC.

In Tanzania, a modified Catch Assessment Survey Form (CAS) was introduced by the FAO in 2008 in order to sample data. Prior to this, Tanzania had difficulty in collecting data and some areas were so remote that they were unable to collect data from all landing sites. The modified CAS form was used until recently and only collected data for some species. However, the CAS was recently digitised (called e-CAS) and there is now a centralised database which uses a google cloud storage system. This cloud storage has been funded for 10 years and was developed by Tanzania Fisheries Research Institute (TAFIRI) in collaboration with other organisations including WWF-Tanzania. The centralised database cuts across all data collection systems in Tanzania allowing for better standardisation and allows information from different sources to be collated together. The system is also synchronised to the institutional databases for backup purposes. The hopes of this new digitised system are that the data required by various organisations, e.g. IOTC, can be exported directly from the database. Since June 2019, all coastal districts use the e-CAS system on the mainland. Data can be inputted by enumerators (often District Fisheries Officers and BMUs) using a mobile app called e-CAS which is able to work offline. Data to be entered into the system includes: Water body (e.g. Indian Ocean, Lake Victoria); Village; Landing site; District the fisher is from; Gear type; Craft type; Number of fishers; Number of gears; Fishing ground; Departure time; Return time; Type of fish; Weight of fish; Number of fish; Value; and Picture[74].

Data entry onto the app is restricted in order to increase the validity of the data. All data has to be selected from a prescribed drop-down list. Once a selection is made, subsequent options available are only relevant to your previous selection. For example, if the enumerator selects vessel type as dugout canoe, ring net will no longer appear as an option for gear type as these types of crafts are unable to support ring net. Alternatively, if a specific village is selected then only the landing sites in that village will appear for selection. However, this system is flexible and the options available can be altered based on feedback to TAFIRI. There is also a

[74] MRAG Tanzania country visit, 2019

WhatsApp group set up whereby enumerators can raise issues and also query species identification. Only approved enumerators can enter data into the app and it also requires the GPS on the phone to be turned on to ensure that data are collected in the correct location. If the GPS is incorrect, then an alert is sent to confirm that the enumerator still wishes to submit the data. If they select yes, these data appear in red on the database to show that they were collected in the wrong location. The app also contains targets, which shows the enumerator how many of each fishing unit (gear and boat type) should be sampled based on the number of fishing units currently fishing. Once they have collected the data, the app will let them know if the target has been reached.

The app is available in both English and Swahili and there are plans to also make it available in French. Data are required to be collected at species level and where possible both the local name and scientific name of species is available. However, currently there is only one category for 'sharks', but a pilot is currently underway to try and identify species at landing sites. Data is not currently collected on discards or bycatch, however research programmes (e.g. funded by WWF) have been undertaken to help collect data for turtles, marine mammals and endangered species.

On the mainland 32 out of 257 landings sites are sampled, which is the equivalent of two landing sites per district and data are collected for 10 days each month (Amir & Hamid, 2016). Landing sites are selected based on 3 main criteria:

- Sites have to be representative of a certain District
- Have to be accessible
- Have to be representative of species

Sample data collected are then raised using the frame survey which are conducted biennially and includes total enumeration. The latest surveys on the mainland were conducted in 2016 and 2018, of which the results of the most recent survey are still to be published. The sample catch data is then raised using the total number of fishing units for each district and then nationally. The frame survey data are also stored on e-CAS[75].

In addition to the e-CAS there are also research programmes underway by TAFIRI to collect length-weight, sex and other biometric data for tuna, tuna-like and shark species. These data are not currently collected by enumerators at landing sites. TAFIRI will also start to work on a new project to map effort in the water and attribute codes to fishing grounds which can be collected by the e-CAS to see where tuna is being caught.

On Zanzibar the e-CAS system has not yet been adopted but they are moving towards a web-based system with the long-term aim of also using a mobile application and hopefully adopting the e-CAS system to standardise data collection with the mainland. Currently six different Catch Assessment Forms are used to collect data. Each month data are collected over 16 days across 32 out of nearly 200 landing sites. Currently tuna species are aggregated and only recorded as yellowfin tuna and billfishes recorded as swordfish[76]. This is also the same for shark and ray species with data only currently recorded as one category of 'sharks and rays'. Data are first recorded by the beach recorder who then send data to the District Fisheries Officer (DFO). The DFO then raises the data, first by month and then by District and then send the data to the Department of Fisheries at the Ministry. As well as moving towards the web-based system, Zanzibar have also consolidated the five forms into one which will also collect data on effort which currently is not recorded. The number of species on the form will increase from 19 to 44, and which will include individual tuna and tuna-like species, billfish, ray and shark (including one hammerhead) species. In addition to the current data collection, a pilot

[75] MRAG Tanzania country visit, 2019
[76] MRAG Tanzania country visit, 2019

study has been implemented in two sites, one in Unguja and one in Pemba, to collect data specifically on tuna.

In both the mainland and Zanzibar data are not collected on discards or interactions with endangered, protected or threatened species (ETP). On Zanzibar there was a pilot study to collect data on discards however, this faced some challenges[77].

In addition to the data collected by both ministries on the mainland and in Zanzibar, DSFA also are starting a programme to collect morphometric data on tuna and sharks across seven different sites, five in the mainland and two in Zanzibar. This system in web-based and a mobile app is used by enumerators to collect length-weight data on tuna and shark species.

A frame survey is conducted on both the mainland and Zanzibar every two years and includes total enumeration of vessels, gears and other parameters. The latest frame survey on the mainland was conducted in 2018 and for Zanzibar it was last undertaken in 2016. The aim of the frame survey is to collect data on current fishing effort (i.e. number of fish landing sites, number of fishermen, fishing vessels, number of fishing gears by type and size and some social economic information on facilities at the landing sites). In addition, it aims to provide accurate raising factors for estimating total catch and to provide sampling frames for various surveys being conducted. However, due to the high seasonality of the fishery it has been recommended that a survey should be undertaken in each season to determine the fleet characteristic in each area (Moreno, 2013). Following the Tanzania country visit it was apparent that for the mainland the frame survey will be available via the e-CAS system for the DSFA to access. In Zanzibar, it is not mandatory for the Ministry of Fisheries to provide the DSFA with the results of the frame survey however, they stated that they do share the results as they are stakeholders.

According to the IOTC nominal catch database, catch of tuna species are disaggregated by species. However, according to the National Report, Moreno (2013) and information gained during MRAG's country visit data on tuna species in Zanzibar are aggregated and prior to the introduction of the e-CAS system not all data was collected for all tuna species either on the mainland. Currently tuna data in Zanzibar are all recorded as yellowfin tuna which may explain the much higher catches of this species.

The Tanzania fleet is composed of various different types of vessels, including unmotorized dugout canoes of 3m to 11m long boats with inboard engines. The main fishing gear utilised are bottom-set and drift gillnets, handlines, longlines, purse seine and trawls that are all manually hauled. Further to theses artisanal fleets, there are also three commercial longline vessels that operate in the EEZ and in the high seas under the IOTC Area of Competence.

In regards to effort the IOTC states that no artisanal craft data has been submitted since at least before 1996 however, frame surveys are undertaken on both the mainland (most recent 2018) and on Zanzibar (most recent 2016). Therefore, although these data are available they are not currently not being submitted to the IOTC.

Country-specific challenges in artisanal fisheries data collection

Although the introduction of the e-CAS system on the mainland and movement towards a web-based system on Zanzibar is helping to improve data collection in Tanzania, there are still a number of areas which could benefit from improvements to standardise the system and collect more data across the entire region. Below we provide more detail on the range of recommendations for further development of the Tanzanian data collection systems for their

[77] MRAG Tanzania country visit, 2019

artisanal fishery.

Development and publication of data collection and processing methodologies

Issue: Although a data collection system is in place to collect data on tuna, tuna-like species and sharks within Tanzania, no clear or published documentation is available to describe the data collection and processing methodology on either the mainland or Zanzibar.

Such methodologies should clearly state each of the steps taken in collecting the data, and also provide a justification for each step taken. The processing methodologies should also contain a detailed methodology for analysis of the data, including the methods for aggregation at different levels, calculation of catch and effort, validation methods and how catch totals are developed, including those for IOTC data submissions including NULL submissions. Such methodology should ideally be provided to the IOTC to allow a critical assessment of such methods and comparison between CPCs.

Recommendations:

- Develop a single national data collection manual, noting differences between the mainland and Zanzibar (e.g. in terms of data collection methods, data collected, spatio-temporal or species level aggregations, etc.).

- Develop a single national data processing manual, noting clearly any differences in data collection between the mainland and Zanzibar and how data are combined.

Nationwide adoption of e-CAS system

Issue: The new e-CAS system that has been tested on the mainland would provide an ideal opportunity to streamline data collection and provide at source data validation and verification.

The new e-CAS system is currently limited to the mainland, although alternative solutions may be available on Zanzibar. Zanzibar should adopt the e-CAS system employed on mainland with any small modifications that are needed. Although Zanzibar is currently moving towards a web-based system it would ultimately be beneficial for the e-CAS system that is used on the mainland to also be adopted. As in Tanzania, artisanal data are collected separately for the mainland and Zanzibar the benefits of using a single system, even if a replicated standalone system for Zanzibar are clear**,** with the data collated and submitted by the DSFA, having access via one system would help to standardise the data and make collection more efficient. The electronic system will also help with species identification, which is lacking in Zanzibar, minimise delays and help reduce entry errors. It is also possible to enable the increased automation of reporting of fisheries catch and effort data by allowing fishers to report their own data, verified randomly by fisheries officers, thereby increasing the accuracy of data submitted.

Recommendations:

- Adopt a comparable and standardized e-CAS system across the mainland and Zanzibar.

- Develop a fisher self-sampling application to enable logbook style data to be submitted by all fishers through the e-CAS.

Improvements to data collection

Issue: Species reporting by groups and some species are not reported.

Some species are not covered at the species level, and instead are not recorded at all or are only recorded at the level of species family group. The expansion of data collection to cover these additional species should be included into the next set of developments to the data collection programmes to be introduced. This would include all shark and CITES listed species**.** This is a common issue for many countries in the IOTC region and therefore a combined effort is required to enhance data collection for shark and CITES species. In Tanzania, sharks are reported just as one group and therefore providing training to enumerators to be able to identify sharks to species level is required. This is also the same for CITES species. This could also be facilitated through the e-CAS system where photos of species can be uploaded and other users can help with identification.

Recommendations:

- Training for enumerators to identify sharks and other IOTC species, such as the different tuna and billfish species, at species level.

- Ensure species can be recorded to species level through e-CAS or changes to existing systems (this may be a separate recording system to disaggregate the group sharks nei).

- Include reporting for all CITES species, turtles, seabirds and cetaceans.

Regularisation of data collection staff and protocols

Issue: Lack of regularisation between the mainland and Zanzibar in relation to data collection protocols (e.g. mainland data collection relies on volunteer staff, whose labour and therefore the entire data collection system for catch and effort data is reliant).

To ensure a consistent data set, it is important that data collection methods and protocols are standardised between the mainland and Zanzibar, which may include the need to formalise the role of BMUs on the mainland. Although data collection on Zanzibar is conducted by paid fisheries officers, the mainland is reliant on volunteer community members from the beach management units. This could pose some risk to the current system as there is currently no guarantee or incentive to ensure that BMU's will continue to collect data. Regularisation of data collection protocols will help to improve the accuracy of data being collected and help to promote long-term data collection.

Recommendations:

- Standardise data collection protocols and methods between the mainland and Zanzibar in order to ensure continued data collection and reduce the risk of cessation of data collection activities.

Awareness training

Issue: Many of the people involved in the fisheries data collection process do not know what the data are collected for and how they are used. Staff and fishers are much better engaged and staff retention rates higher when they know where they fit into a larger process.

Tanzania would therefore benefit from providing more education and awareness training to both fishers and enumerators to ensure that they are aware of not only what data are collected, but why these data are needed both at a national level and within the regional stock assessment process. This would help in encouraging fishers be more cooperative with enumerators and facilitate data collection and a willingness to participate.

Recommendations:

- Establish awareness programmes for data collection staff and fishing communities.

Review current protocols for size frequency sampling (port sampling)

Issue: Tanzania needs to ensure that size frequency sampling is conducted at appropriate rates (i.e. at least 1 fish per tonne) across all months, species, ports and gear types.

It is recommended that a monthly running total is kept of the catch by species, ports and gear types and the number of fish sampled according to each category. A centralised check (within Tanzanian mainland and Zanzibar) can then be maintained to ensure sampling rates are maintained at the correct levels over time.

Recommendations:

- Current sampling protocols for obtaining length measurements should be reviewed to ensure length frequencies are representative of the total catches. Ideally catches should be sampled at random, from unsorted catches – which may be possible if lengths are obtained onboard during hauling (e.g. first 20 fish, or every n^{th} fish);

- In the case of (sorted) catches unloaded at port, protocols should be adjusted appropriately, for example using stratified sampling of catches sorted by size.

- It is also recommended that a simple comparison of the catch to sampled fish, aggregated by month, region / port, fleet / gear and species be maintained to ensure the correct sampling rates are being met.

DSFA to take high level review approach to tuna data recording, sampling and research

Issue: To ensure consistency across the United Republic of Tanzania, both research needs and sampling advances should be reviewed at a high level within DSFA.

A high-level approach to ensure consistency between the mainland and Zanzibar both on research, data collection and processing would benefit the entire United Republic of Tanzania. Advances throughout Tanzania can be exploited and replicated,

Recommendations:

- Implement a high-level ongoing review of research and practical methodologies for data collection and processing.

Frame Survey of National Vessels

Issue: Ensure consistency and regularise the frame survey of national fishing vessels.

To provide an effective understanding of the fishing fleet across Tanzania, a regular updated and consistent frame survey should be conducted. To ensure consistency between the Tanzanian mainland and Zanzibar the frame survey for estimating boat numbers should be updated with potential additional parameters required to be added to the survey to meet the current FAO developments in the categorisation of artisanal fishing. We also recommend attempting to synchronise the regular updates conducted across the country, as at the moment these appear to be out of step. Specifically:

- Update frame survey including additional parameters required by FAO.

- Synchronise timings of the vessel census across all landing sites.
- Repeat the vessel census every two years.

3.25 Thailand

Thailand's fishery sector consists of two main parts; the coastal and oversea fisheries. Within the coastal sector, the commercial and artisanal fisheries are defined by the vessel's carrying capacity; artisanal vessels are those with a capacity less than 10 gross tonnes, while vessels with a gross tonnage of over 10 are classified as commercial.

Thailand's artisanal fishery is based predominantly on fishing tuna, with kawakawa and longtail tuna dominating catches (Table 42).

Table 42 Species and species groups caught and reported in Thailand's artisanal catch data.

Species Group	Common Name	Scientific Name	Weight caught (t)
Seerfish	Narrow-barred Spanish mackerel	Scomberomorus commerson	599.53
Seerfish	Indo-Pacific king mackerel	Scomberomorus guttatus	253.47
Tunas	Frigate tuna	Auxis thazard	1204.56
Tunas	Kawakawa	Euthynnus affinis	7399.44
Tunas	Longtail tuna	Thunnus tonggol	4164.00

Artisanal data collection programme

The Department of Fisheries (DOF) are responsible for collection fisheries data within Thailand. Collection of data is carried out by the DOF's Fishery Statistics Analysis and Research Group (FSARG) who are also in charge of methodology design in addition to input, processing and reporting of data (Stobberup, 2012) It is the role of the FSARG (based at Provincial Fisheries Offices) to design and plan surveys, enumerator requirements and implement data collection.

There was a comprehensive amount of information available regarding Thailand's fisheries data collection. Two types of fisheries data collection are undertaken in Thailand; (i) port sampling at landing sites by Fisheries Officers from the Department of Fisheries, and (ii) collection of fisheries data recorded during fishing trips in logbooks.

Port sampling

Port sampling at landing sites is used to collect fisheries data on a monthly basis for each sector (artisanal and commercial) in each area (there is no clarity on what area refers to) and covers different types of fishing gears and fishing areas[78]. This monitoring involves two stages; interviews and physical sampling of landed catches. There is no standard protocol for data collection other than the use of water-proof paper for recording, use of a measuring board and callipers for measuring length and a requirement to mark the appropriate size class of the fish.

[78] IOTC-2018-WPM09-15

The National Report states that the interviews are conducted by fisheries officers with the "fishing masters" of the vessels. Information requested during these interviews includes:

- Fishing effort;
- Total catch;
- Number of days per trip;
- Number of hauls during the trip;
- Which fishing grounds were used;
- The depth at which fish were caught;
- The species composition of the catch;
- The price at which fish are to be sold, and;
- What problems, if any, were encountered during fishing.

Sampling of fish, the second phase of port sampling at the landing sites, involves analysis of catch composition through separation into species and species groups. In these groups the size (in 1cm intervals for fish under 60cm in fork length) and weight of between 100 and 500 specimens are recorded for each "fishing area" used, time caught and gear-type[79]. The National Report highlights a specific focus on neritic tuna through port sampling where size sampling and data are collected on a monthly basis for each gear type. Further clarifying, the report states that over 30kg of fish per vessel are taken, the species identified, the total length (through "punching paper in centimetres") and the weight measured and recorded.

If data from the interview at the landing site is missing, fish sale tickets can be used to inform the enumerators; this information can be collected from fish traders (records of fish landings), brokers, Fish Marketing Organisations and Fishermen's Cooperatives (Stobberup, 2012).

Logbooks

In 2015 the DOF implemented a logbook system for recording catch data, this is now being transformed into an Electronic Report System (as of August 2017). Currently fishers are not able to log the weight of each individual species, just the total haul[80]; other details to be recorded include:

- Vessel name and ID;
- Vessel characteristics;
- Information on the fishing trip;
- Gear type used;
- Vessel position;
- Position of the fishing operation;
- The time of port-out and port-in;
- An estimation of the catch by species, and;
- Total catch.

On-board observers

The 2018 compliance report states that observers are now in place for purse seine artisanal vessels. The National Report states that in total 80 observers had been trained and provided with recording materials; however, there is no reference to artisanal vessels specifically, and the assumption is that these observers are deployed on vessels operating within the High Seas or Indian Ocean. Observer collected gillnet data has not been submitted by Thailand for

[79] IOTC-2018-WPM09-15

[80] IOTC-2018-WPM09-15

artisanal vessels since 2015, mostly as gillnets are only used to catch non-IOTC species.

Data collection coverage

The coverage of artisanal purse seine vessels by on-board observers is estimated to be <30%. Vessel coverage at landing sites varies depending on the time and number of catches made, as such it is estimated that between 20% and 80% of vessels are sampled at each site[81]. Stobberup (2012) estimated in 2012 that sampling intensity covers approximately 10% to 15% of the landing events; only 10 of the 24 provinces have enumerators employed on a full-time basis; others only hire enumerators when required or on a part-time basis.

Tuna data from Thailand between 2016 and 2017 comes from foreign tuna vessels and purse seine tuna-like fishers, as Thai tuna fishing vessels were not active during this period due to licensing issues [82].

Additional data collection

The National Report highlights that reports detailing the species composition (percentage) and length of fish are expected on a monthly basis from coastal purse seine vessels fishing in the Andaman Sea. The DOF is reported to use this data to analyse the "status", though this is not further explained.

Random selection of 400 (out of a total 3,700) fishing villages occurs on an annual basis. These villages are then investigated by enumerators who conduct interviews with fishers (focusing on certain gear types) to obtain estimates of the catch by species for the past year. This technique aims to sample 10% of the landing events.

The artisanal catch data provided by the IOTC is consistent with the Marine Turtles report and Compliance Report which all highlight a lack of reporting of interactions with marine turtles. The same applies to seabird data of which the IOTC dataset, Compliance Report and Seabird report all highlight a lack of reporting. The 2018 Compliance Report states that Thailand as a CPC have made progress towards conservation of marine turtles and seabirds through enforcement of laws which require logging of incidental catch. Given these laws it is expected that Thailand would have catch records for some seabird and marine turtle species.

The representative for Thailand, who answered the artisanal fisheries data collection survey for the purpose of this report stated that information on artisanal vessels is collected through a national registration scheme wherein full enumeration of vessels occurs. However, non-motorised vessels are not required to register.

Nominal catch data for the artisanal fleet is recorded through port sampling, however no indication of coverage was provided. These data are collected on a monthly basis. No data are collected for sports and recreational fisheries.

Catch and effort data are also recorded through port sampling; for each species a minimum of 100 individuals are sampled per vessel using a measuring board and random sampling. Representation of catch may be problematic as some non-target species can be discarded.

Country-specific challenges in artisanal fisheries data collection

The main barriers to implementation of data collection are lack of budget for surveys, lack of

[81] IOTC-2018-WPM09-15

[82] IOTC-2018-WPM09-15

training for enumerators and lack of technology for reporting of real-time catch. Low levels of cooperation of artisanal fishers can also cause problems for data collection as the fishers do not understand the purpose of collecting these data.

In Thailand collecting information on small scale vessels causes issues with collecting vessel census data. For nominal catch, catch and effort and size frequency data, artisanal fishers do not understand the purpose of data collection which results in low cooperation and therefore inhibit data collection. In addition, for nominal catch data there are also issues caused by limited staff and budget and a lack of training for enumerators (Table 43).

Table 43 Main challenges to monitoring, collecting and reporting IOTC and CITES species for Thailand's artisanal fisheries

Financial (e.g. costs of routine data collection, funding for enumerators or port samplers)?	Lack of budget for field survey
Lack of technical expertise (e.g. staff training, expertise to design and implement data collection)?	Lack of training for enumerator
Technological (e.g. lack of corporate database, or tools for electronic data capture/reporting)?	Lack of technology for real time reporting catch data

3.26 Yemen

The Yemeni fishing industry is dominated by the small-scale sector, with the artisanal fishing accountable for almost 90% of total production (IFAD 2013; Alabsi and Komatus, 2014).

The IOTC database contains data reflecting the IOTC annual catch output from 2017 for Yemen (Table 44). This data shows that the catch is dominated by yellowfin tuna, kawakawa and narrow-barred Spanish mackerel. The data also show that shark is an important catch. However, as these are aggregated there is no way of understanding which species are captured.

According to IOTC Compliance Reports for both 2017 and 2018, Yemen has failed to submit mandatory data to IOTC for artisanal fishing; instead catch estimates are taken from FAO are considered to be generally of low quality.

Table 44 IOTC annual catch output for artisanal fleet (tonnes) in Yemen, 2017.

Sp. Group	English Name	Scientific Name	Tonnes
Billfish	Indo-Pacific sailfish	*Istiophorus platypterus*	230.00
Seerfish	Narrow-barred Spanish mackerel	*Scomberomorus commerson*	3570.00
Seerfish	Indo-Pacific king mackerel	*Scomberomorus guttatus*	58.00
Sharks	Various sharks nei	Selachimorpha (Pleurotremata)	7820.00
Tunas	Frigate tuna	*Auxis thazard*	18.00
Tunas	Kawakawa	*Euthynnus affinis*	4050.00
Tunas	Longtail tuna	*Thunnus tonggol*	2850.00
Tunas	Skipjack tuna	*Katsuwonus pelamis*	61.00
Tunas	Tunas nei	Thunnini	360.00
Tunas	Yellowfin tuna	*Thunnus albacares*	21100.00

Artisanal data collection programme

MFW is the principal institution responsible for fisheries sector management with the main mandate of: planning and implementing national policies and projects linked to the sector;

fisheries research; collection of statistical data relevant to the fisheries sector; monitoring, control and surveillance and fisheries regulation; controlling the quality of fish production; supervise the activities of fishing cooperatives, research and education institutions; and supervise the activities of public corporations in the fisheries sector[83].

Country-specific challenges in artisanal fisheries data collection

No information is available on sampling programmes conducted by MFW.

[83] Republic of Yemen – Ministry of Fish Wealth – National Fisheries Srategy 2012 – 2025 https://www.undp.org/content/dam/yemen/PovRed/Docs/Yemen_Fisheries%20Strategy.pdf)

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Annex 1 List of IOTC and CITES species that should be identified within CPC fisheries data

Species Group	Common Name	Species Name
Temperate and tropical tunas	Albacore	*Thunnus alalunga*
	Bigeye tuna	*Thunnus obesus*
	Skipjack tuna	*Katsuwonus pelamis*
	Yellowfin tuna	*Thunnus albacares*
Billfish	Swordfish	*Xiphias gladius*
	Black marlin	*Makaira indica*
	Blue marlin	*Makaira nigricans*
	Striped marlin	*Tetrapturus audax*
	Indo-Pacific sailfish	*Istiophorus platypterus*
Neritic tunas and mackerels (seerfishes)	Bullet tuna	*Auxis rochei*
	Frigate tuna	*Auxis thazard*
	Kawakawa	*Euthynnus affinis*
	Longtail tuna	*Thunnus tonggol*
	Indo-Pacific king mackerel	*Scomberomorus guttatus*
	Narrow-barred Spanish mackerel	*Scomberomorus commerson*
Sharks	Blue shark	*Prionace glauca*
	Oceanic whitetip shark	*Carcharhinus longimanus*
	Scalloped hammerhead shark	*Sphyrna lewini*
	Shortfin mako shark	*Isurus oxyrinchus*
	Silky shark	*Carcharhinus falciformis*
	Bigeye thresher shark	*Alopias superciliosus*
	Pelagic thresher	*Alopias pelagicus*
	Bigeye thresher	*Alopias superciliosus*
	Thresher	*Alopias vulpinus*
	Oceanic whitetip shark	*Carcharhinus longimanus*
	Great white shark	*Carcharodon carcharias*
	Basking shark	*Cetorhinus maximus*
	Porbeagle	*Lamna nasus*
	Whale shark	*Rhincodon typus*
	Great hammerhead	*Sphyrna mokarran*
	Smooth hammerhead	*Sphyrna zygaena*
Turtles	Flatback turtle	*Natator depressus*
	Green turtle	*Chelonia mydas*
	Hawksbill turtle	*Eretmochelys imbricata*
	Leatherback turtle (N. East Indian Ocean subpopulation)	*Dermochelys coriacea*
	Leatherback turtle (S. West Indian Ocean subpopulation)	*Dermochelys coriacea*
	Loggerhead turtle (N. West Indian Ocean subpopulation)	*Caretta caretta*

Species Group	Common Name	Species Name
	Loggerhead turtle (S. East Indian Ocean subpopulation)	*Caretta caretta*
	Olive Ridley turtle	*Lepidochelys olivacea*
Albatross	Atlantic Yellow-nosed Albatross	*Thalassarche chlororynchos*
	Black-browed albatross	*Thalassarche melanophris*
	Indian yellow-nosed albatross	*Thalassarche carteri*
	Shy albatross	*Thalassarche cauta*
	Sooty albatross	*Phoebetria fusca*
	Light-mantled albatross	*Phoebetria palpebrata*
	Amsterdam albatross	*Diomedea amsterdamensis*
	Tristan albatross	*Diomedea dabbenena*
	Wandering albatross	*Diomedia exulans*
	White-capped albatross	*Thalassarche steadi*
	Grey-headed albatross	*Thalassarche chrysostoma*
Petrels	Cape/Pintado petrel	*Daption capense*
	Great-winged petrel	*Pterodroma macroptera*
	Grey petrel	*Procellaria cinerea*
	Southern giant petrel	*Macronectes giganteus*
	Northern giant-petrel	*Macronectes halli*
	White-chinned petrel	*Procellaria aequinoctialis*
	Cape gannet	*Morus capensis*
	Flesh-footed shearwater	*Puffinus carneipes*
Rays	Alfred manta	*Manta alfredi*
	Giant manta	*Manta birostris*
	Longhorned mobula	*Mobula eregoodootenkee*
	Spinetail mobula	*Mobula japanica*
	Shortfin devil ray	*Mobula kuhlii*
	Chilean devil ray	*Mobula tarapacana*
	Smoothtail mobula	*Mobula thurstoni*
Sawfish	Common sawfish	*Pristis pristis*
	Longcomb sawfish	*Pristis zijsron*

Annex 2 Questionnaire sent to CPCs

IOTC Questionnaire : Artisanal Fisheries Data Collection Survey

Part 1: Vessel Census or registration schemes for artisanal/coastal fishing vessels

1.1	How is information on artisanal/coastal fishing vessels collected (e.g. annual vessel census, or vessel registration)? Please mark with (X) below:	
	Annual or biennial vessel census	
	National vessel registration scheme	
	Other (please explain)	
	Currently no data collection system in place	
1.2	What is the coverage of the surveyed or licensed artisanal/coastal vessels (if applicable)? Please indicate below:	
	Full enumeration/registration of small-scale vessels	
	If not full enumeration, % of licensed or surveyed vessels covered:	
1.3	List any important artisanal/coastal fisheries not covered by current vessel data collection(s) systems?	
1.5	What are the main barriers to estimating the size and composition of artisanal/coastal vessels for your fisheries (e.g. lack of legislative framework for monitoring / collecting information on small-scale vessels)?	

Part 2: Nominal Catch Data: artisanal/coastal fisheries

2.1	What methods are used to collect artisanal/coastal catch data? Please mark with (X) below:	
	Logbook	
	Fisher survey	
	Port sampling	
	Landing site/auction slips	
	Other (please give details)	
2.2	What is the sampling coverage? Please provide details below:	
	Full enumeration (all landings, all vessels)?	
	Port sampling (if so, what % of catches or vessels sampled)?	
	Other (please explain)	
2.3	What is the frequency of data collection? Please mark (X) below:	
	Daily / Weekly	
	Monthly	
	Other (please explain)	
2.4	List any important artisanal/coastal fisheries not covered by current nominal catch data collection systems (e.g. subsistence fisheries, sports or recreational fisheries):	

2.5	What are the main issues to collecting or estimating total catches for artisanal/coastal fisheries for your fisheries? (e.g. limited staff or other resources issues, access to landing sites)?

Part 3: Catch and effort for artisanal/coastal fisheries

3.1	What data collection methods are used to collect catch and effort data for artisanal/coastal fisheries? Please mark with (X) below:		
	Logbook		
	Port sampling		
	Combination (please give details)		
	No data collection system currently in place		
3.2	If sampling, what is the level of sampling coverage? Please provide details below:		
	Details of sampling coverage (e.g. % of vessels or trips sampled):		
	Are all species, or selected species groups sampled? If selected species, please specify:		
3.3	List any important artisanal/coastal fisheries not covered by current catch and effort data collection (e.g. subsistence fisheries, sports or recreational fisheries):		
3.4	What are the main barriers to collecting catch and effort data on artisanal/coastal vessels for your fisheries?		

Part 4: Size frequency data for artisanal/coastal fisheries

4.1	What methods are used to collect size frequency data? Please mark with (X) below:		
	Logbook		
	Port sampling		
	Combination (please give details)		
	No data collection system currently in place		
4.2	What is the level of sampling coverage? Please provide details below:		
	Number of fish measured per set?		
	% of set(s) or vessels sampled?		
	Other (please specify)		
4.3	Please provide details of the sampling used to collect size frequency data:		
	Type of measuring tool (e.g. calipers, tape, measuring board):		
	Type of sampling (e.g. random sampling, systematic sampling such as every nth fish).		

4.4	List any important artisanal/coastal fisheries not covered by current size frequency sampling:
4.5	What are the main barriers to collecting size data for artisanal/coastal vessels for your fisheries?

Part 5: Challenges and best practices for data collection from artisanal/coastal fisheries:

5.1	What are the main challenges to monitoring, collecting and reporting IOTC and CITES species for artisanal/coastal fisheries in your country? Please tick below:		
	Lack of legislative or regulatory framework to monitor small-scale fisheries.		
	Financial (e.g. costs of routine data collection, funding for enumerators or port samplers)		
	Lack of technical expertise (e.g. staff training, expertise to design and implement data collection))		
	Equipment (e.g. transport)		
	Logistical challenges (e.g. access to landing sites, high turnover of enumerators)		
	Technological (e.g. lack of corporate database, or tools for electronic data capture/reporting)		
	Lack of understanding of IOTC data reporting requirements.		
	Any other factors (please specify)		
5.2	Describe any examples of data collection best practices in relation to artisanal/coastal vessels for your fisheries, e.g. use of new technologies such as electronic monitoring and data capture?		

Part 6. Data collection for bycatch and CITES species:

6.1	How do you record data for the following CITES species for artisanal/coastal fisheries (e.g. logbooks, port sampling) and what bycatch mitigation methods or devices are in place for each species?

	Species	How do you record data?	What bycatch mitigation methods or devices are used?	
	Sharks			
	Turtles			
	Seabirds			
	Cetaceans			
	Whale sharks			

Annex 3 In-country missions

Date and Time	Activity within Indonesia
Wed, 31 July 2019	Arrival of IOTC Technical Mission Team in Bali
Thu, 1 August 2019	
09.00-16.30	Venue: Tuna Research Center, Bali PIC: Mr. Zulakarnaen Fahmi Attendants: Mr. Trian Yunanda (DGCF) Ms. Riana Handayani (DGCF) One Data Team DGCF Team Inception and technical coordination meetings: Opening Presentation on IOTC Technical Mission Objective (Mr. Geehan) Welcome Remarks from Indonesian Focal Point to IOTC (TBC) Presentation Focusing on Research of Tuna (by Mr. Fahmi)
Fri, 2 August 2019	Field Visit: Visit Kedonganan to review tuna data collection for research purposes Visit Pengembangan Fishing Port to review tuna data collection (One Data), tuna research on the field, tuna landing from artisanal fisheries
Sat, 3 August 2019	Field Visit 1 Recap (IOTC team)
Sun, 4 August 2019	Depart to Jakarta
Mon, 5 August 2019	Technical Meeting in the Ministry of Marine Affairs and Fisheries Office
09.00-16.00	Venue: Meeting Room of SDI, GMB 2, KKP, 14th floor Presentation on: One Data (process for statistic) Observer Program E-Logbook Program Expanding Plan for Pelagos System Implementation PIC: Ms. Riana Handayani Attendants: One Data Team DGCF DG of Surveillance Tuna research Center
Tue, 6 August 2019	
08.00-17.30	Travel to Cilacap Fishing Port
Wed, 7 August 2019	Field Visit to Cilacap Fishing Port
08.00-10.00	Field Visit in Tuna Landing Place for Artisanal Fisheries
10.00-12.30	Technical Meeting and Discussion in Cilicap Fishing port Office Cilacap represented for artisanal tuna data PIC: Riana Attendants:

Date and Time	Activity within Indonesia
	One Data Team DGCF DG of Surveillance
Thu, 8 August 2019	Field Visit Recap Conclusion and Recommendation and Closing Venue: Meeting Room of SDI, GMB 2, KKP, 14th floor PIC: Ms. Riana Handayani Attendants: One Data Team DGCF DG of Surveillance Tuna research Center

Date	Activity undertaken within Tanzania
Mon 22nd July	Travel
Tues 23rd July	Travel, arrive in Dar es Salaam afternoon
Wed 24th July	Ministry of Fisheries- All day
Thursday 25th July	
Friday 26th July	Fish landings sites
Saturday 27th July / Sunday 28th July	Fly to Zanzibar
Monday 29th July	Ministry of fisheries- all day
Tuesday 30th	DSIZE FREQUENCYA and Fish landings sites
Wednesday 31st	Possible DSIZE FREQUENCYA meeting depending on flights.
Primary list of organisations visited.	• MLFD Ministry of Livestock and Fisheries Development (Mainland Tanzania)- specifically the statistics department and those involved in the management of the data collection process. • District fisheries officers – Involved in the direct collection of data. • Ministry of Fisheries and Livestock Development (Zanzibar)- specifically the statistics department • BMU/SIZE FREQUENCYCs (local bodies involved in data collection) might not be feasible in the timeframe • Would be good to see a landing site and BMU/ fisheries officer sampling though if possible, on the mainland and / or Zanzibar • Deep Sea Fishing Authority, Fumba Zanzibar* • *DFSA- All deep-sea fisheries, which occur outside the 12nm limit and inside the EEZ are managed and monitored by the Deep Sea Fishing Authority (DFSA) based in Zanzibar. Fishing within 12nm is the responsibility of the respective Fishery Department on the mainland and Zanzibar (Moreno, 2013). There is reportedly no local fleet in Tanzania that targets tuna outside the 12nm limit and it is unlikely that artisanal boats go beyond 10nm, though with ever changing fleets and patterns of fishing it would be good to confirm this.

Annex 4 Summary of issues encountered and recommendations.

Issue	Comments	General Recommendations
Total (nominal) catches for coastal fisheries not fully reported according to the requirements of IOTC Resolution 15/20 (Forms 1RC and 1DI). For example: Incomplete catches/species recorded for coastal fisheries. Catches recorded as species aggregates.	Australia - State they have no coastal (or artisanal) fishery Bangladesh - Missing gear information and catches aggregated by species group. Comoros – Nominal catch provided but submitted late Eritrea – No data provided India – Compliant but late submission Indonesia- Data provided but late submission Kenya – Catches aggregated by species Madagascar – No data provided. Maldives – Data submitted late Oman – Data late Pakistan – Coastal and surface aggregated. nominal catch aggregated for some species. Somalia – No data collection system in place Sri Lanka – Artisanal data absent Sudan – No data provided Tanzania –NC for coastal fishery only reported for G/L as gear type. Yemen – No data provided	Artisanal fisheries need to be clearly defined, to ensure no missing fleet segments, gears to be defined. Species identification guides provided for all required species, to ensure no missing species. CPC data collection manuals to include species identification guides.
Catch and effort data missing	Australia – State they have no coastal (or artisanal) fishery Bangladesh – No data provided Comoros – Data submitted but late submission Eritrea- No data provided India- No data provided Indonesia- Data only from sampling and not raised. Iran – Effort aggregated and not to IOTC standard. Kenya – No data provided Madagascar – No data submitted Maldives – Data submitted late.	Artisanal fisheries to be clearly defined, ensure no missing fleet segments, gears to be defined. Species identification guides provided for all required species, ensure no missing species. CPC data collection manuals to include species identification guides.

Issue	Comments	General Recommendations
	Oman – Not to IOTC standard Pakistan- No data provided Somalia- No data provided Sri Lanka – Artisanal data absent Sudan – No data provided Tanzania –C&E for coastal fishery only reported for G/L as gear type Yemen- No data provided	Data collection system to estimate catch and effort (as above for species but clear monthly (minimum) estimate of effort by gear.
Size frequency data missing	Australia- State they have no coastal (or artisanal) fishery Bangladesh- No data provided Comoros- Low rate, not to IOTC standards (including sharks) and late submission. Eritrea- No data provided EU- Not available for EU-FRA India- Sufficient data not provided and data submitted late. Indonesia- Only provided summary data. Iran- not to IOTC standard Kenya- Data submitted late, for the species measured no detail are provided for these species in nominal catch. Madagascar – No data submitted Malaysia- Not reported for all fisheries. Maldives- Partial completion - missing for some fisheries, Mauritius –Missing for handline gear. Mozambique – Missing for some gear types Oman – No data Pakistan- No SF data provided Seychelles – No SF data provided. Somalia- No SF provided South Africa – No data provided Sri Lank- Low rate, no data for artisanal. Sudan – No data provided Tanzania – No data provided and enumerators do not identify to species level.	Define and implement size frequency sampling programme that meets IOTC requirements for all species including sharks. Size frequency sampling programme should be representative of all fleets and gears. Size frequency sampling programme should be representative of all species. Monthly tracking of total catch by species and fleet / gear, with total size frequency sampling counts by species and fleet / gear to ensure rates are maintained throughout the year.

Issue	Comments	General Recommendations
	Thailand - Low sampling rate and different species reported fro NC and SF Yemen- No data provided	
Missing shark IM information	Australia- state they have no coastal (or artisanal) fishery Bangladesh- no data provided for catch and effort and size frequency. Nominal catch data missing gear and aggregated by species group. Comoros- data late and only partial data for size frequency as not to IOTC standard. Eritrea- No data provided EU- NC and C&E are not available for all fleets. SF not available for all fleets and not to IOTC standard India- Partial data, late, aggregation of nominal catch and mandatory data not provided for catch and effort and size frequency Indonesia- No data for catch and effort and only summary data for size frequency. Iran- data not provided for size frequency and effort aggregated. Kenya- Partial data as aggregated by species group for NC and submitted late. No data for C&E. For SF the species measured are not included in NC and submitted late. Madagascar- C&E data aggregated into one species and SF not to IOTC standard and also only for one species.NC only provided for industrial fishery. Data late. Malaysia- sharks aggregated and only for longline for NC and C&E. No data on SF. Maldives- Sharks reported as discard only for NC and C&E, no data for SF. Mauritius – Aggregated to one species code for semi-industrial fleet. Only reported as discard for purse seine. Mozambique – species measures are not in retained catch. Oman- Aggregated by group for longline and no SF data. Pakistan- NC aggregated for coastal and surface fisheries. No other data provided. Seychelles- Aggregated and no size frequency Somalia- No data provided South Africa- NC and C&E aggregated for some species. SF only provided for two species and not to IOTC standard. Sri Lanka –No data provided for artisanal fisheries. Sudan – No data provided	Ensure shark incidental mortalities are recorded at species level and ensure catch and effort are submitted to IOTC. Data checks established to ensure consistency with nominal catch data. Ensure all artisanal fleet segments are covered. Often only longline and purse seine covered and not artisanal sector / gears.

Issue	Comments	General Recommendations
	Tanzania- Shark catch only reported for LL, 1 shark species only. No SF provided. Thailand – No data for coastal fisheries Yemen- No data provided	
Missing turtle IM information	Australia- state they have no coastal (or artisanal) fishery Bangladesh- No data provided and no longliners or purse seines. Eritrea- no vessels on active IOTC RAV Comoros – partial data, illegal to catch turtles India- partial data and late Kenya- no data provided. Madagascar- Late and partial. Artisanal data not recorded. Malaysia- Late and partial. Oman – Recent data missing. Project based so may not continue. Pakistan- Data submitted late Seychelles – Partial and late submission Tanzania – Reported previously no interaction. No data provided. Yemen-No data provided	CPCs should submit zero incidental mortalities in a NULL report if no turtle catches or interactions have been observed.
Missing seabird IM information	Australia- State they have no coastal (or artisanal) fishery Bangladesh- No purse seines Comoros- No purse seine, bait boat, gillnet or longline vessels on IOTC RAV Eritrea- No vessels on active IOTC RAV. India – NULL report but data late Iran-Partial data Kenya- No data provided Madagascar- Data submitted late Malaysia- Late and partial. Seabirds protected but no data on interactions. Oman – No report but likely requires NULL report. Seychelles- partial, recorded in logbooks. Late submission Tanzania- No data provided Yemen- No data provided	CPCs should submit zero incidental mortalities in a NULL report if no seabird catches or interactions have been observed. This is particularly valid for northern Indian Ocean States where seabird interactions are limited.

Issue	Comments	General Recommendations
Missing cetacean IM information	Australia- State they have no coastal (or artisanal) fishery Bangladesh- No purse seine, bait boat, gillnet or longline vessels so do not provide data Eritrea- No vessels on active IOTC RAV India- No data provided but no PS vessels on IOTC RAV Kenya- No data provided Madagascar- Late and partial Malaysia- Late and partial. Protected but no data provided. No purse seine on RAV. Maldives- Data submitted late. Oman - High marine mammal presence, but no interactions reported. Pakistan- Data submitted late Seychelles – No data provided. Tanzania - No data provided Yemen- No data provided	CPCs should submit zero incidental mortalities in a NULL report if no cetacean catch or interaction has been observed.
Missing whale shark IM information	Australia- State they have no coastal (or artisanal) fishery Bangladesh-- No purse seine, bait boat, gillnet or longline vessels so do not provide data Eritrea- No vessels on active IOTC RAV India- No data provided but no PS vessels on IOTC RAV Kenya- No data provided Madagascar- No data provided Malaysia- Late and partial- no report of interactions. No purse seine on RAV. Maldives- Data submitted late. Oman- No data provided Pakistan- Data submitted late Tanzania, Seychelles – No data provided. Tanzania- No data provided Yemen- No data provided	CPCs should submit zero incidental mortalities in a NULL report if no whale shark catches or interactions have been observed.

Issue	Comments	General Recommendations
Missing fishing craft information (2FC)	Australia- State they have no coastal (or artisanal) fishery Bangladesh – Not updated since 1997. Comoros – last updated 2008. Eritrea – No vessel information submitted. EU - There are no data since 2006 for Mayotte though numbers noted in SC reports. India- No data since, at least, before 1996. Indonesia- No data since, at least, before 1996 Iran- No data since, at least, before 1996. Kenya- No data since, at least, before 1996. Madagascar- No data since, at least, before 1996. Malaysia- No data since, at least, before 1996. Madagascar-no data Maldives – Last updated in 2015 Mauritius- No data since, at least, before 1996. Mozambique – No data since, at least, before 1996. Oman- last updated 2015 Pakistan- No data since, at least, before 1996. Seychelles- last updated 2007 Somalia- No data since, at least, before 1996. South Africa- Last update 2016 Sri Lanka- Last update 2016 Sudan – No data provided. Somalia- No data since, at least, before 1996. Tanzania- No data since, at least, before 1996. Thailand- No data since, at least, before 1996. Yemen- Last updated 2002.	CPCs should ensure that national updated fishing craft frame survey are performed. CPCs should schedule frame survey to be updated every two years and submit the required form 2FC. Where fleets are not shown to change greatly over time and longer time period can be allowed
CITES species not reported as individual species	Not required as part of IOTC data submissions currently.	All IOTC reporting should be expanded to cover CITES listed sharks and to species

Issue	Comments	General Recommendations
		level for all sharks, seabirds, turtles and cetaceans.
Data collection manual	Bangladesh (Catch Assessment Survey manual exists but needs updating). India (last available updated 2005) Indonesia - no country-specific methodology available. Madagascar – Pilot 2015-2017 – no information since. Somalia (No manual) Sudan (No manual)	National data collection manuals to be developed and published by all CPCs.
Data processing manual	Bangladesh (Catch assessment manual exists but needs updating, India (unknown) Indonesia – no country-specific methodology available Somalia (No manual) Sudan (No manual) Yemen	National data processing manual developed by all CPCs and available to IOTC and other Members.

NB: Members listed and comments are those highlighted from the country summary reports and may not be an exhaustive list.