PROPOSALS FOR DRAFT CPC DATA FACT-SHEETS

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Purpose

This paper provides participants to the 16th session of the WPDCS with updates on the development of CPC-specific *data fact-sheets* which were originally conceived as a preliminary way for the IOTC Secretariat to assess the quality of the statistical data sets submitted by any given CPC during the yearly data provision cycles.

These fact-sheets, initially developed for internal usage, turned out to be extremely helpful to:

1) provide feedback to the original data submitters about the quality of their metadata and data (including an estimation of the level of compliance with respect to IOTC Resolutions requirements, **Fig. 2a-b**) and simplify the drafting of the data analysis papers prepared prior to each working party
2) build a collection of historical, public *snapshots* on the status of the data provided by IOTC member states over the years, to be eventually disseminated through the IOTC website, and
3) identify issues common to several flag states (or fisheries) and therefore define priorities to drive the work of the scientific bodies of IOTC.

The data fact-sheets are still in the process of being finalized: the WPDCS is therefore invited to provide advice (and guidance) on their future developments, as well as suggest potential ways of using the information they contain to improve the scientific process of IOTC.

Background

IOTC CPCs are required, through a series of resolutions[1] that include Res. 15/02 *Mandatory statistical reporting requirements for IOTC Contracting Parties and Cooperating Non-Contracting Parties (CPCs)*, to submit a range of statistical information describing the status of their fisheries targeting tuna and tuna-like species in the Indian Ocean (**Fig. 1**).

To standardize the provisions of these data sets (**Table 1**), the IOTC Secretariat has developed a series of *recommended* data reporting forms that are available for download through the IOTC website and that cover all the major reporting requirements, including references to standard code lists and other reference data.

Notwithstanding the availability of standard forms and clear guidelines for the reporting of data to the IOTC, several CPCs still fail to provide all required statistical information in due course and with all the mandatory data fields in place. Moreover, even when the information is provided in full respect of all requirements, it is not uncommon to encounter inconsistencies and errors in the submitted data that - when not promptly identified - could hinder the quality of the information used for stock assessments and management purposes.

Furthermore, data submissions for longline fisheries are expected to be provided by two distinct yearly deadlines, with the preliminary submission expected by end June (as for all other fisheries) and potential revisions to be submitted by end December of the same year. In some cases, new submissions may also include updates of historical data, and it is essential in such cases to assess the differences between historical data and its revisions to ensure the consistency of the information incorporated in the IOTC databases.

[1] See also IOTC-2020-WPDCS16-15 *Review of conservation and management measures relating to data and statistics*

In recent years, the IOTC Secretariat has consistently worked in the consolidation of a series of manual data checking procedures in support of the various stages of the workflow that leads from the receipt of statistical data sets to their final incorporation in the IOTC databases and dissemination through the IOTC Working Parties web pages.

It is often frequent, during the yearly unrolling of this process, that concerned stakeholders (typically: national focal points and liaison officers) will regularly interact with staff members of the Data Section of the Secretariat to provide further details on the reasons causing (potential) data anomalies, or clarifications on the status of their submissions.

The *ad-hoc* nature of these e-mail exchanges ensures (generally) fast response times when attempting to sort out the cause of all potentially detected issues. Yet, this approach is not well suited when it comes to formally sharing - with the IOTC scientific community as well as with all other stakeholders - the peculiarity and characteristics of a given fishery (including catch or effort trends, as well as its most common data issues) if not when this is synthesized as short summaries embedded within the general working party papers produced by the Secretariat, and describing the overall range of standing inconsistencies or data gaps for several species and fleets.

A wealth of extremely valuable *knowledge* and *facts*, which would be of great relevance to scientists and policy makers, is therefore exploited only to a fraction of its full potential.

Rationale and potential sources of information

To standardize and streamline the internal validation and assessment work, and with a view to further increasing the transparency of the data management processes put in place by its Data Section, the IOTC Secretariat is currently engaged in the effort of *condensing* the results of the data analysis procedures into standard data fact-sheets that will initially be used to provide feedback to the data providers but that have also the potential of becoming regular outputs of the statistical data submission and validation process, to be publicly shared through the IOTC website so as to contribute to build an ever-evolving catalogue of fishery (meta)data complementing the regular IOTC data sets.

The data fact sheets will take the form of human-readable documents, containing general indicators as well as several fleet-specific ones (some of which might potentially be shared across different fleets which operate using comparable gears).

One of the main goal of this exercise is to design the data fact-sheets using *R-markdown*, an authoring framework for data science that ensures the final documents are fully reproducible and can intermix narrative text with code and data, and whose output can be shared as PDF and Microsoft Word documents, as well as a set of HTML pages.

Three main types of inputs are expected for the production of data fact-sheets, namely:

Inputs from the data providers

These correspond to the most recent submissions of IOTC mandatory statistical data sets (**Fig. 1**, **Table 1**): data fact-sheets for assessment purposes should ideally be produced as soon as new data submissions are received by the IOTC Secretariat from a given CPC.

Currently, the input data sets expected to be provided from IOTC CPCs (the *data providers*) all fall within any of the categories below[2]:

Total yearly / quarterly retained catches[3]

- Estimates of total annual retained catches (by quarter, if possible) in live weight by IOTC area, species and type of fishery (recommended form: 1-RC);

[2] The actual list of data submission requirements is subject to changes, so are the recommended IOTC data submission forms, and might differ by the time new Resolutions enter in force or existing Resolutions are superseded

[3] Mandatory for IOTC species and shark species, on a voluntary basis for all other species (see Res. 15/02, 17/05, and 18/02)

- Estimates of Yellowfin tuna annual retained catches[4] in live weight by IOTC area, type of fishery and vessel category (≥ 24m LOA or < 24m LOA and fishing outside the EEZ) (recommended form: 1-RC-YFT).

Total yearly discards[5]

- Estimates of total annual discard levels (by quarter, if possible) in live weight or number, by IOTC area, species and type of fishery (recommended form: 1-DI).

Zero-catches matrix[6]

- Summary of retained (positive) catches, with explicit indication of zero catches (discards and retained) for selected species and gear combinations, including IOTC species as well as the most commonly caught elasmobranch species (recommended form: 1-DR).

Time-area catches and efforts[7]

- Surface fisheries: catches by species in live weight and fishing efforts by type of fishery, by 1°x1° grid area and month strata (recommended form: 3-CE);
- Longline fisheries: catches by species in number or live weight, and fishing efforts in number of hooks set by 5°x5° grid[8] area and month strata (recommended form 3-CE);
- Coastal fisheries: catches by species and fishing efforts by type of fishery, geographic area and month strata (recommended form 3-AR).

FAD and supply vessel information (including FAD deployments and buoy positions)[9]

- Yearly interactions with Fish Aggregating Devices (FAD) set by purse seiners and supply vessels per fleet, 1°x1° grid area, and month (recommended form: 3-FA);
- Number of FADs deployed[10] in 2018 and 2019 by purse seine vessels and associated supply vessels per fleet and 1°x1° grid area (recommended form: 3-FD);
- Detailed monthly report of active buoys per fleet, vessel, buoy and day of month (recommended form: 3-BU);
- Number and characteristics of supply vessels and number of days-at-sea by type of supply vessel per fleet, 1°x1° grid area, and month (recommended form: 3-SU).

Size-frequency data[11]

Individual fish length (or weight) data by species, type of fishery, 5°x5° grid area and month strata (recommended form: 4-SF).

Fishing crafts data[12]

Total number of fishing crafts operated by type of fishery, type of craft and craft size by year (recommended form: 2-FC)

[4] See paragraph 26 of Res. 19/01 *On an interim plan for rebuilding the Indian Ocean yellowfin tuna stock in the IOTC area of competence*

[5] Mandatory for IOTC species, shark species, species subjects to retention bans (whale sharks, oceanic whitetip sharks, thresher sharks) as well as ETP species (seabirds, marine mammals, marine turtles and cetaceans), on a voluntary basis for all other species (see Res. 15/02, 12/04, 12/06, 13/04, 13/05, 17/05, and 19/03)

[6] See Res. 18/07 *On measures applicable in case of non-fulfilment of reporting obligations in the IOTC*

[7] See Res. 15/02 and 15/01 *On the recording of catch and effort data by fishing vessels in the IOTC area of competence*

[8] Spatial resolution can increase to 1°x1° for selected fleets and years, according to specific requirements from the IOTC Scientific Committee on a case-by-case basis. In these circumstances, data will be for the exclusive use of IOTC scientists and subject to IOTC confidentiality policy (Res. 12/02 *Data confidentiality and procedures*)

[9] See Res. 15/02 and 19/02 *Procedures on a Fish Aggregating Devices (FADs) Management Plan*

[10] See paragraph 19 of Res. 19/01

[11] Mandatory for IOTC species and shark species, on a voluntary basis for all other species (see Res. 15/02, 17/05, and 18/02)

[12] On a voluntary basis, in agreement with FSA-Annex I, Article 4

Scientific observers data[13]

To be provided to the flag state of the vessels with scientific observers deployed onboard within 30 days of completion of each trip. The CPCs shall then send this information to the IOTC Secretariat - initially in the form of an aggregated *observer trip report* and eventually in a detailed format suitable for proper data extraction and processing - within 150 days from the completion of the trip (at the latest). The information collected (and reported) shall include:

- Records of fishing activities, including verified positions of the vessel;
- Records of gear types, mesh size and attachments employed by the master;
- Estimate of catches, as far as possible detailed, with a view to identifying catch composition and monitoring discards, by-catches and size frequency;
- All information that will enable the cross-checking of entries made to the logbooks (species composition and quantities, live and processed weight and location, where available).

A recent revision of the data collection and reporting requirements was performed through a review workshop on standards for the IOTC ROS(2018) , which resulted in new, detailed guidelines on all information fields[14] to be reported to the IOTC Secretariat, including the procedures and methodologies for their collection.

Inputs from other consolidated IOTC data repositories

These correspond to all historical data currently stored within the IOTC databases, and can also include the statistical data provided by all other CPCs as well as information generally used for compliance purposes, as included in the categories / sources of information below:

Previous years' mandatory statistical data sets

Including revisions provided by longline fleets on the deadline of 30th December each year;

IOTC Record of Authorized Vessels (RAV)

Under Res. 19/04 *Concerning the establishment of an IOTC record of vessels authorised to operate in the IOTC area*, IOTC Members and Cooperating non-Contracting Parties shall establish and maintain an IOTC Record of fishing vessels that are:

I. larger than 24 metres in length overall, or
II. in case of vessels less than 24m, those operating in waters outside the economic exclusive zone of the flag state.

and that are authorised to fish for tuna and tuna-like species in the IOTC area.

This data set, which is updated on a regular basis by all IOTC CPCs with fisheries employing vessels in the categories above, constitutes an important resource to assess the *maximum* (and not the *current*) capacity of industrial vessels' fleets operating in the Indian Ocean, as the presence of a vessel in the RAV does not necessarily imply that said vessel is actively fishing in the region. It is indeed quite common to have authorized vessels listed in the RAV that are currently known for not operating in the Indian Ocean.

All records in the RAV database, including historical information, are publicly available online.

IOTC Active Vessels' List (AVL)

Under Res. 10/08 *Concerning a record of active vessels fishing for tunas and swordfish in the IOTC area,* all IOTC Contracting Parties and Cooperating Non-Contracting Parties (CPCs) with vessels fishing for tunas and swordfish in the IOTC area of competence are required to submit to the IOTC Secretary, by 15 February every year, a list of their respective vessels that were active in the IOTC area during the previous year and that are:

[13] For fleet segments subject to Res. 11/04 *On a Regional Observer Scheme*

[14] See in particular: IOTC-2018-WPDCS14-INF03 Rev_1 *Outputs from the expert review workshop on standards for the IOTC ROS – data collection fields* (14th session of the IOTC Working Party on Data Collection and Statistics, 2018), and IOTC-2019-S23-10_Rev1 *Regional Observer Scheme - draft programme standards* (23rd session of the Indian Ocean Tuna Commission, 2019)

I. larger than 24 metres in length overall; or
II. in case of vessels less than 24m, those operating in waters outside the economic exclusive zone of the flag state.

Therefore, the IOTC AVL is *de-facto* a subset of the IOTC RAV that is updated less frequently (once a year) and that contains information on the vessels in the categories above, that are recognized as having been actively fishing in the Indian Ocean during the previous year. For this reason, the AVL represents an extremely important source of information to determine the *actual* fishing capacity of several industrial and semi-industrial fleets.

The AVL database can be downloaded as an Excel spreadsheet (containing historical records) from the section of the IOTC website dedicated to vessels-related information. The latest[15] AVL file is available for download here.

Port state measures (PSM) data[16]

The IOTC implementation of port state measures (PSM), entered into force on 1 March 2011 and is inspired by the 2009 FAO Agreement on Port State Measures although tailored to the context of the IOTC mandate. The port State competent authority (fisheries administration) of the Coastal CPCs of the IOTC, where foreign vessels offload tuna and tuna like species or call into port to use port services, are responsible for the implementation of the underlying Resolution.

An electronic tool (e-PSM) has been specifically designed with funds from the SWIOFISH2 project to support the implementation of the IOTC PSM is at the availability of CPCs (port states and flag states), as well as of the industry (vessel agents), and is constituted by three independent modules:

I. e-PSM forms and processes

a working and communication platform for the fishing industry, the port States CPCs, and the flag State CPCs to implement their responsibilities in terms of Res. 16/11. As the first step of the PSM process, this module allows the fishing industry to submit electronically to port State CPCs an advance request for entry into port (AREP) to decide whether to authorise or deny the entry of the vessel into its port and communicate this decision to the vessel or to its representative

II. e-PSM library

an information sharing platform to IOTC CPCs where PSM related information can be found, such as:

- Information on designated ports, designated competent authority in each port State CPC and prior notification period established by each CPC;
- e-PSM application user manuals (Industry manual, port State CPCs manual and flag State CPCs manual);
- PSM forms created in the Module 1: *Advance Request of Entry into Port* (AREP) and *Port Inspection Reports* (PIR) (Restricted access);
- Documents, technical reports, meeting reports, video on various fisheries topics (e.g. tuna fisheries management, fisheries Monitoring Control and Surveillance (MCS) and port State measures, etc.)
- Internet link to useful internet resources (e.g. vessel movement information, port information, etc.)

III. e-PSM reporting

a business-intelligence tool that CPCs can use to generate reports related to the activities of foreign vessels in their port, or activities of their flagged vessels in foreign ports. This module allows CPCs to generate the mandatory report required by Res. 05/03 *Relating to the establishment of an IOTC programme of inspection in port* (for what concerns the details of landing of foreign vessels in ports), as well as the mandatory report required by Res. 17/06 *On establishing a programme For transhipment by large-scale fishing vessels* (for what concerns the details of transhipments of flag vessels in foreign ports)

[15] Compiled on August 8th 2020

[16] See Res. 16/11 *On Port State Measures to prevent, deter and eliminate illegal, unreported and unregulated fishing*

All public information regarding the IOTC PSM, including links pointing to the electronic resources in support of its implementation, are available on a dedicated page of the IOTC website.

The information collected through the e-PSM platform (in particular the results of port inspections and the declared quantities of fish caught and transhipped by the vessels) are of particular importance to pre-emptively assess the accuracy of the regular statistical data submitted by the flag state and also to corroborate the actual species composition for the fisheries concerned. The e-PSM information is stored within a dedicated IOTC database and therefore could be successfully leveraged for the purpose of this analysis. Yet, as it represents a highly-confidential data set, it cannot be publicly disseminated unless it is aggregated according to the IOTC procedures for the safeguard of sensitive information.

Regional observer programme (ROP) data[17]

The IOTC ROP is aimed at preventing the laundering of fish through at-sea transhipments activities, which are banned in the IOTC Area except when they happen under special circumstances, i.e. when they take place under the IOTC programme to monitor such transhipments. Work under the ROP is outsourced, with the Compliance Section of the IOTC maintaining overall supervision of it.

The ROP information is highly sensitive in nature, and efforts are currently being made to determine how the records collected in its database could be effectively used in the future to support the assessment of all yearly statistical data submissions.

All public information regarding the IOTC ROP, including links pointing to the electronic resources in support of its implementation, are available on a dedicated page of the IOTC website.

Statistical document programme (STATDOC) data[18]

The STATDOC programme requires that all bigeye tuna, when imported into the territory of an IOTC Contracting Party, be accompanied by an IOTC Bigeye Tuna Statistical Document which meets the requirements described in Appendix 1 or an IOTC Bigeye Tuna Re-export Certificate which meets the requirements described in Appendix 2 of the underlying resolution.

The main differences between the data provided through the forms in support of the declarations of *export* and *re-export* of bigeye tuna, consist in the former including detailed information on the fishing vessel responsible for the capture of the exported fish.

Therefore, this dataset could be particularly important to cross-verify the regular statistical data submissions from concerned CPCs, as it was already the case in the past, when information from the STATDOC was crucial to identify misreporting of bigeye tuna catches from a fleet also operating in the Atlantic Ocean.

The use of STATDOC data for cross-verification purposes is partially limited by the underlying resolution specifying that bigeye tuna caught by purse seiners and pole and line (bait) vessels and destined principally for the canneries in the convention area is not subject to the requirement of the STATDOC programme, and therefore little to no information from these fisheries is currently available.

All public information regarding the IOTC STATDOC, including links pointing to the electronic resources in support of its implementation, are available on a dedicated page of the IOTC website.

Inputs from third parties

ISSF-affiliated cannery data

In 2009 the International Seafood Sustainability Foundation (ISSF) established an agreement with the tuna Regional Fisheries Management Organisation (tRFMOs) in order to provide detailed sales data from its associated canneries,

[17] See Res. 19/06 *On establishing a programme for transhipment by large-scale fishing vessels*

[18] See Res. 01/06 *Concerning the IOTC bigeye tuna statistical document programme* and Res. 03/03 *Concerning the amendment of the forms of the IOTC statistical documents*

recognizing the importance of such information to increase traceability of the products and furthermore as an alternative data source to complement the official catch statistics received by tRFMOs.

ISSF-affiliated canning companies report, on a quarterly basis, the amount of fish (by species and commercial size categories) bought by the different providers and offloaded at their processing facilities, including information on the underlying fishing operations (vessel details, gear type, area and time of operation, etc.).

It is worth noting that data submitted by ISSF-affiliated processing factories only cover part of the total landings of the fisheries concerned, and the extent of this coverage might vary in time and space. An estimation from ISSF indicated that, in 2020, data from their affiliated canneries can correspond to over 60%[19] of the total canned tuna from the Indian Ocean.

The IOTC Secretariat, starting from 2010, has been one of the recipients of this data exchange which is now in the process of being enhanced through the work of an ISSF-funded consultancy, and in collaboration with a student from the University of Seychelles enrolled in a MSc in Marine Science and Sustainability[20].

As a result of this work, cleaned-up and harmonized data from ISSF canneries that have received fish caught in the Indian Ocean since 2010 will become an integral asset of the IOTC Secretariat, and kept updated at the receipt of each new submission from all participating canneries.

The data stored in this new repository will represent an extremely valuable source of information to assess and cross-verify catch levels, species composition as well as trends in fish size (assessed through the commercial size categories reported by canneries).

FAO / FIRMS Global Tuna Atlas

The FAO / FIRMS Global Tuna Atlas is the result of several long-standing harmonisation efforts that have led to the demand and realisation of an online, publicly-available global atlas that incorporates harmonized data from the five tuna RFMOs (nominal catch as well as geo-referenced monthly catches[21]), and aims at serving as a transparent and objective interface of t-RFMO data to the general public and scientists[22].

The goal of the Tuna Atlas is to provide data services with high reliability and reproducible methodology, accompanied by clear explanations of the data sources, processing steps, and coverage. Hence, the Tuna Atlas provides a sound method to gauge the importance of Indian Ocean fisheries at global scale and compare the fisheries patterns and characteristics with other oceans (e.g. species composition, catch rates, importance of each school type in the purse seine fishery). The platform aims to be visually attractive and technically performant, with underlying data available for download, analysis, and integration with data from other domains. The Tuna Atlas will facilitate access to (and use of) these rich datasets, with a view to improve assessment and management of tuna fisheries and ecological research.

AIS data (Global Fishing Watch)

Automatic Identification System (AIS) data, initially implemented for ship-to-ship collision avoidance, have been shown to be instrumental to determine fishing vessels in operation, identify fishing gears, fishing grounds and transhipments at sea, and estimate nominal effort[23]. Augmented AIS data, as those provided by Global Fishing Watch, include information on the position of each vessel, the timestamp of this position with precision in seconds, and an indication of fishing activity based on the results provided by a neural network trained by fisheries experts. The neural network model classifies each position as *fishing* or *non-fishing*, indicating when active fishing is occurring (i.e., a fishing operation). Global Fishing Watch AIS data can then provide information to cross-check the AVL, the geo-referenced effort data as well as fishing intensity for both science and compliance.

[19] Actual figures might be subject to revisions following a first full analysis of the available data

[20] See also IOTC-2020-WPDCS16-11 *Research proposal: an evaluation of data from ISSF-affiliated canneries for use in tuna fisheries management*

[21] Next steps will include harmonization of effort and size-frequency data

[22] See the reports of the 11th session of the FIRMS Steering Committee Meeting

[23] See the Global Atlas of AIS-based Fishing Activity

VMS data

Following the entry in force of IOTC Res. 15/03, all industrial fishing vessels flagged by IOTC CPCs are requested to be equipped with a mandatory, tamper-proof Vessel Monitoring System (VMS) and monitored at sea by their respective national fisheries administrations.

Compared to AIS, VMS offers the major advantage of transmitting continuous positions of the fishing vessel, providing a synoptic and comprehensive view of vessels in activity, fishing grounds, fishing effort, and possibly fishing operations. However, access to VMS data is highly restricted and only available at the national level although Indonesia in 2017 has publicly released (through Global Fishing Watch) their proprietary VMS data collected for nearly 5,000 fishing vessels since 2014[24], with other countries (Ecuador, Chile, Panama, Costa Rica etc.) ready to follow along the same path. In line with IOTC Res. 12/02 on data confidentiality and procedures, the IOTC Secretariat can provide support to CPCs for the analysis of national VMS data, to develop and implement cross-checking procedures with logbook data so as to increase knowledge of fishing activities and fishing grounds and eventually improve the quality of the geo-referenced effort data (among others) to be submitted to the Secretariat.

Environmental data

Environmental conditions play a major role in the biology and ecology of all life-stages of tuna and tuna-like species, including metabolism, growth, reproduction, movements and migrations. The environment also affects the catchability of fisheries at both local and regional scales and oceanographic data have been included in the standardization process of time series of Catch Per Unit Effort to remove the effects of thermocline depth on catchability, for instance.

Sea surface temperature and currents have also been included as covariates in the movement parameterisation of the demographic model of Indian Ocean yellowfin tuna to incorporate seasonal movement dynamics for assessing the stock status[25]. Environmental data are also instrumental to delineate pelagic ecoregions or identify and characterize hotspots of occurrence of Endangered, Threatened and Protected (ETP) species.

There is a large range of environmental data and variables available from three main sources: i) *in situ* data, ii) remote sensing data collected from sensors placed on planes, drones, and spacecrafts, and iii) model outputs.

Environmental variables are characterized by their spatial and temporal resolution: in the case of satellite remote sensing data, spectral resolution is also another key aspect, while different levels of processing are available, ranging from raw to end-user, post-processed data.

Several public data repositories and portals[26] give access to a large range of environmental variables derived from different sensors, platforms, and processing procedures. Most *in situ* and gridded environmental data sets are freely available in NetCDF[27] files that can be extracted from THREDDS data servers, and which provide metadata and data access using OPeNDAP, OGC WMS and WCS, HTTP, and other remote data access protocols.

Environmental data have become a regular input data set for several stock assessments of IOTC species: with some of their key datasets becoming available to end-users in convenient data formats, it is definitely worth considering how the IOTC statistical data assessment process could benefit from their inclusion as one of the most complete and accurate third-party data sources to cross-verify, for instance, how environmental parameters might explain catch hotspots and changes in fishing patterns detected for some of the important IOTC fisheries.

Criteria for the analysis

Following is a non-exhaustive list of assessment processes currently used (or considered) for the production of draft CPC data fact-sheets, categorized by the nature of the datasets involved (standard statistical data sets / other IOTC

[24] See Global Fishing Watch agreement with Indonesia

[25] https://www.iotc.org/documents/WPTT/20/33

[26] For instance: https://scihub.copernicus.eu/

[27] See https://www.unidata.ucar.edu/software/netcdf/

data sets / data sets from third parties) and including details about the input data, the applied procedure and the expected outputs. Those marked as *in progress* have yet to be finalized.

Cross-verification of standard statistical data sets

These verification processes aim at assessing the accuracy and measuring the coherence of all provided standard statistical data submissions for a given CPC, taking into account the peculiarities of several CPCs as well as their well-known issues in fulfilling the IOTC data reporting requirements. Nevertheless, when available, the outputs of these processes represent a preliminary (yet powerful) assessment criterion to provide immediate feedback to the original data providers (see **Figs. 4a-g** and **Figs. 5a-f**)

Coherence between nominal catches / total discards and zero-catches matrix [IMPLEMENTED]

- **Inputs**: yearly nominal catches and (raised) discards (forms 1-RC, 1-DI), zero-catches matrix (form 1-DR)
- **Process**: verify that all species for which positive catches / discards appear in form 1-RC and 1-DI for a given fleet / gear are correctly accounted for in form 1-DR
- **Outputs**: indication of the level of completeness / accuracy of form 1-DR in terms of missing reports of positive catches or discards.

Consistency in reported species between nominal catches / total discards and catch-and-effort / size-frequencies [IMPLEMENTED]

- **Inputs**: yearly (or quarterly) nominal catches and (raised) discards (forms 1-RC, 1-DI), monthly time-area catch-and-effort and size-frequencies (forms 3-AR, 3-CE, and 4-SF)
- **Process**: assess the extent at which species with positive catches appearing in form 1-RC for a given gear are also reported through forms 3-CE and 4-SF. For discarded species, ensure that the species in form 1-DI also appear in form 4-SF. The experience shows that oftentimes detailed data for several species appear in forms 3-CE and 4-SF with no corresponding entries in form 1-RC (or 1-DI): this is generally due to the reporting of aggregated species in forms 1-RC and 1-DI, which has to be resolved at CPC level and is particularly sensitive to the type of gears

  When catch-and-effort data are reported in weight and known to be raised to total catches for a given fleet / gear combination, their level should be checked against form 1-RC to ensure that the reported totals are coherent. For fleets reporting catch-and-effort in numbers, the process can be implemented by using either an average (species-specific) weight, or the size-frequency data reported by the CPC for the same gear (to estimate the total weight of catches reported in numbers)

- **Outputs**: indication of the level of completeness / accuracy of form 3-CE, 3-AR and 4-SF in terms of reported species, and also that raised catches (from the catch-and-effort dataset) are coherent with the total catches reported by form 1-RC.

Analysis of fishing effort trends (including estimation of nominal CPUEs) [IMPLEMENTED]

- **Inputs**: yearly time-area catch-and-effort (forms 3-AR, 3-CE)
- **Process**: assess the extent of reporting fishing efforts using the most common units (by gear type, e.g. hooks deployed for longline fleets, number of sets for purse-seine fleets, etc.), verify trends in efforts and nominal CPUEs for important fisheries and species. Use geo-referenced data to derive heatmaps / density maps showing the evolution of fishing grounds over time, and the presence of productivity hotspots.

  This process targets mainly industrial or semi-industrial fleets, for which time-area catch-and-effort data are regularly and consistently reported. Catch-and-effort for artisanal fisheries, besides often lacking proper geospatial information, are also affected by changes in effort units from one year to the next that render impossible any analysis on effort trends across multiple years (for the same CPC / fishery)

- **Outputs**: identification of outliers and evaluation of trends in effort and nominal CPUEs, that could contribute to the identification of issues in data collection and reporting, or changes in fishing patterns and strategies that might require further feedback from the data providers. Spatial maps showing the effort distribution (current and over time) as well as the presence and extent of productivity hotspots for key species.

Comparison of fleet sizes with reported yearly catches trends [IMPLEMENTED]

- **Inputs**: yearly (or quarterly) nominal catches, details on the number of fishing crafts by type and category (forms 1-RC, 2-FC and potentially data from the RAV / AVL)
- **Process**: when consistent data on the number of vessels operating for a given fishery is available through form 2-FC (or through the RAV / AVL) an average yearly (or quarterly) catch by vessel could be computed on a species-by-species (or species-group) basis
- **Outputs**: qualitative evaluation of average catch by vessel trends, that could contribute to the identification of issues in data collection or reporting (of either catches or number of fishing crafts) as well as unexplained changes in fishing patterns and strategies.

Pre-filtering of size-frequency data [IMPLEMENTED]

- **Inputs**: monthly size-frequency data by fishery and species (form 4-SF), standard size measurement criteria by species (minimum / maximum length for the species, maximum length of size bins)
- **Process**: size-frequency data are assessed on a species-by-species basis to identify and remove the records not matching the standard size measurement criteria for the species (e.g. maximum length is higher than what expected, size bins exceed the maximum size bins, etc.)
- **Outputs**: the subset of the original size-frequency data that fully respects the standard size measurement criteria by species, plus the list of records / strata from the original inputs that are excluded.

Level of size-sampling coverage [IMPLEMENTED]

- **Inputs**: yearly (or quarterly) nominal catches, yearly total discards, monthly size-frequency data by fishery and species (form 1-RC, 1-DI, and 4-SF)
- **Process**: total yearly retained plus discarded catches by fleet and species are calculated, and size-frequencies for the same fleet and species are compared with the total catches to determine those strata where the 1 fish / MT minimum criteria[28] is not met
- **Outputs**: an indication of the species / fisheries for a given fleet for which the 1 fish / MT criteria is not met. Ideally, all species for which total catches exist should be measured with at least one sample. Sometimes, species are reported as aggregates in the nominal catches / discards, while appearing as single species in the size-frequency data set. Also, national regulations for some CPCs might prevent - for safety reasons - to measure lengths of sharks' species when these are discarded alive. Therefore, caution should be taken when reporting back the results of this assessment criteria to the original CPCs.

Analysis of size-frequency trends [IMPLEMENTED]

- **Inputs:** monthly size-frequency data by fishery and species (form 4-SF)
- **Process**: size-frequency histograms are compared and summary statistics calculated to assess differences in fishing patterns between months and years
- **Outputs**: identification of identical size distributions suggesting some replication of data from one year to the other or detection of apparent major changes in the size composition that may require feedback from the CPC to assess whether the changes stem from issues in data collection or/and reporting or real changes in fishing practices or in the targeted stocks.

Determination of average weights from C-E / S-F data [IMPLEMENTED]

- **Inputs:** monthly geo-referenced catch-and-effort data in number and weight by fishery and species, when available, monthly size-frequency data by fishery and species (forms 3-AR, 3-CE, and 4-SF), length conversion equations (by species)
- **Process**: when catch-and-effort data is available both in number and in weight for the same stratum (as it happens, for instance, with the Taiwanese longliners for some years), an average weight can be computed by dividing reported weights by reported numbers. When only size-frequencies are available and they are not reported using the standard measure unit for the species / gear, they first are converted to standard measure units using one of the available length-length equations, and then converted to weight using one of the

[28] See para. 5 of Res. 15/02 *On mandatory statistical reporting requirements for IOTC CPCs*

available length-weight equations. Depending on the case, strata with little coverage (less than 1 fish / MT sampled) might be excluded
- **Outputs**: a spatial-temporal (or yearly aggregated) average weight by fleet, fishery and species.

Analysis of fishing ground distribution and extent [IMPLEMENTED]
- **Inputs**: monthly geo-referenced catch-and-effort data (forms 3-AR, 3-CE), ROS trip data (ROS trip reports or ROS e-tools data files). For surface fisheries, also monthly FAD activities data - including the spatial extent of FAD deployments for 2018 and 2019, daily buoy positions (3-FA, 3-FD, 3-BU)
- **Process**: the information from form 3-CE is used to determine a first estimate of the extent of fishing ground for the fleet which could be further corroborated through the analysis of ROS data for the same fleet during the concerned period (when available). Surface fisheries are also assessed through the reported FAD-related data, including daily buoy positions to further confirm the extent of reported fishing grounds for LS catches available through form 3-CE and 3-FA, although due to the time shift in reporting requirements, buoy data could be used only after June 30th 2021 (i.e. when statistical data for 2020 are available)
- **Outputs**: spatial distribution of catches and efforts, potentially overlapped (for surface fisheries) with the available information on FAD activities and operations.

Changes in species composition [IMPLEMENTED]
- **Inputs**: yearly (or quarterly) nominal catches and total discards (forms 1-RC, 1-DI), geo-referenced catch-and-effort data (forms 3-AR, 3-CE)
- **Process**: species composition from total catches and discards (% of reported catch by each species) is assessed against previous years, to determine any trend or discontinuity. Same approach is applied to catch-and-effort data, with the results compared with total catches for all those fleets / fisheries for which the C-E data are known to be either raised to total catches or a representative sample of the former (high logbook coverage)
- **Outputs**: yearly species composition trends, identification of strata for which there are marked differences between species composition from total catches / discards and catch-and-effort data.

Comparisons of size-frequencies reported by observers vs. logbook data [IMPLEMENTED]
- **Inputs**: monthly geo-referenced size-frequency data (form 4-SF), ROS trip data (ROS trip reports or ROS e-tools data files)
- **Process**: some fleets (e.g. JPN PS / LL, TWN LL) already report observer-sourced size measurements through forms 4-SF[29], although the majority only report size measurements made by fishermen at sea or at landing through said forms. When observer data are available in form 4-SF, it could effectively be used to identify differences with average sampled fish length between logbook and observer data. In all other cases, and when ROS data are available separately, the same type of analysis could be performed down to the maximum level of resolution permitted by the ROS datasets
- **Outputs**: comparison of logbook and observer size-frequency data for the same strata, identifying potential biases in the former (e.g. lack of measurements of fish discarded at sea). Identification of mismatching strata for which observer data exists but are not complemented by official logbook submissions.

Comparisons of size-frequencies between similar fleets [TO BE IMPLEMENTED]
- **Inputs:** monthly geo-referenced size-frequency data (form 4-SF), ROS trip data (ROS trip reports or ROS e-tools data files)
- **Process**: size-frequency histograms are compared and summary statistics calculated to assess differences between similar fleets having operated in the same strata (e.g. month / 5°x5° grid)
- **Output**: identify major differences in size distributions, which are unlikely to be major in case of fleets adopting similar fishing practices, in order to detect potential issues in data collection and/or reporting.

Comparisons of catch composition between similar fleets [TO BE IMPLEMENTED]
- **Inputs:** monthly geo-referenced catches (forms 3-AR, 3-CE), yearly (or quarterly) nominal catches (form 1-RC)

[29] See para. 5 of Res. 15/02 *On mandatory statistical reporting requirements for IOTC CPCs*

- **Process**: the relative species composition (proportion in numbers of biomass) are compared and summary statistics calculated to assess differences between similar fleets in the same strata (e.g. month / 5°x5° grid)
- **Output**: identify major differences in species composition unexpected by similar fishing practices in order to detect potential issues in data collection and/or reporting.

Additional verification using IOTC compliance information

These verification processes aim at providing another layer of assessment for all standard statistical data submissions for a given CPC, by using information that is specific to compliance reporting requirements of IOTC, such as the bigeye statistical document or the ROP / e-PSM data.

Advanced identification of species not reported in the catch [TO BE IMPLEMENTED]

- **Inputs:** monthly geo-referenced catches (forms 3-AR, 3-CE), yearly (or quarterly) nominal catches (form 1-RC), zero-catches matrix (form 1-DR), e-PSM and ROP data
- **Process:** compare the list of species reported to the Secretariat through the IOTC forms and recorded by the inspectors at unloading at ports and from the regional observers during transhipments at sea in the case of large-scale longliners
- **Outputs:** identify potential under- or mis-reporting of some species

Catch composition of billfish species caught by longline fisheries [TO BE IMPLEMENTED]

- **Inputs:** monthly geo-referenced catches (forms 3-AR, 3-CE), yearly (or quarterly) nominal catches (form 1-RC), zero-catches matrix (form 1-DR), e-PSM and ROP data
- **Process:** estimate the relative proportion of billfish species in the landings and transhipments of some major longline fisheries against the species composition derived from the standard catch data sets submitted to the Secretariat
- **Outputs:** detect inconsistencies between data sources and gain insight into the catch composition of fisheries where billfish species may be reported as aggregated

Complementary verification using non-IOTC data sources

As several independent data sources become available over the years, it is also worth considering their adoption as additional tools for further assessment of the quality of the statistical information submitted by CPCs to the IOTC Secretariat. Among these third-party, independent sources the Global Fishing Watch AIS data, the FIRMS Tuna Atlas, all publicly available VMS data as well as the ISSF-affiliated cannery sales data are by far the most promising ones.

Validation of species composition through cannery data [TO BE FINALIZED]

- **Inputs:** yearly (or quarterly) catch data of tropical tunas, albacore and other tuna species (form 1-RC), ISSF cannery data for the same fleet / gear and year
- **Process**: the species composition for a given species, fleet and gear determined from the reporting of total catches is compared with the species composition derived from ISSF cannery data (for the same strata)
- **Outputs**: a report on the accuracy of cannery data in representing the original species composition, that might help identifying, depending on the coverage level of the cannery data and on the differences in composition detected between the two data sets, potential issues with the reporting of statistical data from the CPCs

Identification of unreported fishing grounds and fishing activities [TO BE IMPLEMENTED]

- **Inputs:** publicly available Global Fishing Watch data including vessel positions by flag and gear, limited to the Indian Ocean region, with indication of efforts' location and extent, including the probability of fishing operations having taken place
- **Process:** for fisheries equipped with AIS transponders, the Global Fishing Watch data set could provide details about the area of operation and the exerted efforts (e.g. hours spent fishing, number of trips, number of sets) that will be used to i) cross-reference the C-E data, and detect inconsistencies with official submissions, ii) augment the information available to the IOTC Secretariat in terms of high resolution data (both in time and space) related to fishing grounds and standardized efforts

- **Output:** a report of detected anomalies, if any, and extended geospatial information on missing fishing grounds and fishing efforts data for concerned fleets (to be aggregated to the level of resolution required for the analysis)

Future developments and long-term goals

The main objective that inspired the implementation of the proposed CPC data-factsheets is the need to provide immediate and standardized feedback to IOTC data providers in terms of the quality of their submissions, their adherence to the standards and the internal coherence across multiple data sets (including historical ones) from the same CPC.

In light of this, the short-term goal is that the IOTC Secretariat timely responds to statistical data submissions from a given CPC with an updated version of their data fact-sheets determined on the basis of the newly submitted information.

CPCs will benefit from a rigorous third-party, holistic assessment of the information at their availability that would in turn trigger a positive feedback cycle leading to a measurable increase in the quality and accuracy of their fishery-related information.

Eventually, should CPCs agree on the validity of this approach, the IOTC Secretariat will disseminate the CPC-specific data fact-sheets on a public section of its website: the information contained within this *curated* set of data fact-sheets will either be already publicly available by definition (e.g. levels of yearly nominal catches by gear and species) or aggregated according to the requirements of Res. 12/02.

In order to further streamline the work of the IOTC Secretariat as it stands now and as it will eventually be updated following the adoption of the e-MARIS platform, these same data fact-sheets could be a powerful tool for the automated compilation of compliance reports (for all statistical data-related aspects and beyond) in support of the work of the IOTC Compliance Committee.

Finally, the IOTC Secretariat is also considering the possibility of sharing the fact-sheets code (i.e. the underlying *.rmd* files) together with the publicly available statistical data and ancillary information (as *.RData* or *.csv* files) to enable full reproducibility of the results, in general, while also allowing CPCs to use these as a basis to further develop local capacity at national level.

Challenges

For these data fact-sheets to be effective and produced in due course, it is crucial that CPCs commit to provide their mandatory statistical data submissions roughly at the same time: this is a necessary requirement stemming from the interlocked nature of several of the assessment tasks, which by definition require the availability (for any given year) of multiple mandatory datasets to be performed.

Unfortunately, this requirement clashes with the current (harsh) reality of the IOTC, where a number of key data sets are often provided well past the data submission deadlines by several CPCs, including developed countries which are indeed expected to have all the capacity, at national level, to provide the required data in full respect of the currently standing data reporting requirements and timeline.

In such circumstances (i.e. when time-area catches are incomplete or have low coverage, inconsistent effort units are adopted for the same fishery across years, size-frequencies are not reported for several key species or are incomplete and not up to the standards) the production of data fact-sheets is severely limited, or requires ad-hoc procedures which are oftentimes fleet and fishery specific.

The IOTC Secretariat has therefore to ensure that all of its CPCs receive adequate support and enhance their capacity to provide timely and accurate information by the IOTC data submission deadlines.

Furthermore, novel datasets might become available in consequence of projects / regulations being implemented in the IOTC area, and new information assessment criteria might be developed over the course of time based on the

discussions held during the IOTC Working Parties: therefore, it is particularly important that all advancements in the extent and comprehensiveness of the assessment criteria is captured in the shortest time possible, included in the data fact-sheets and possibly applied retrospectively to their historical series.

Finally, the proposed CPC-specific data-factsheets are not meant to be seen as *static* reports whose structure and content is defined once and for all: it is therefore expected that discussions across all stakeholders in the IOTC scientific community contribute to their refinement and for this to happen, a regular revision cycle should be considered as part of the standard agenda of the IOTC Working Party on Data Collection and Statistics.

Tables and figures

Table 1. Details of current statistical data sets required for submissions by all IOTC CPCs, including the *recommended* forms provided by the IOTC for data reporting purposes

Form	Data set	Time resolution	Spatial resolution	Notes
1_RC	Retained catches in live weight	Year / Quarter	IO areas (W / E)	--
1_RC-YFT	Retained YFT catches in live weight	Year / Quarter	IO areas (W / E)	By vessel category
1_DI	Discard levels in live weight or numbers	Year / Quarter	IO areas (W / E)	Total discards (raised)
1_DR	Catch reporting status	Year	IO (all)	As per Res. 18/07
3_CE	Catch-and-effort in live weight or numbers	Month	1°x1° grids	Surface fisheries
3_CE	Catch-and-effort in live weight or numbers	Month	5°x5° grids	Longline fisheries
3_AR	Catch-and-effort in live weight or numbers	Month	Any	Other fisheries
3_FA	FAD numbers, interactions and catches	Month	1°x1° grids	Surface fisheries
3_FD	Number of yearly deployed FADs by grid	Yearly	1°x1° grids	For 2018 and 2019
3_BU	Daily buoy positions by owning vessel	Day	Coordinates	Monthly report
3_SU	Number of support vessels and effort	Month	1°x1° grids	Purse-seine fisheries
4_SF	Size-frequency data	Month	5°x5° grids	Min. 1 fish / MT
2_FC	Number of fishing crafts by type of fishery	Year	N/A	**Voluntary**
7_PR	Avg. prices per type of fish product	Year	N/A	**Voluntary**

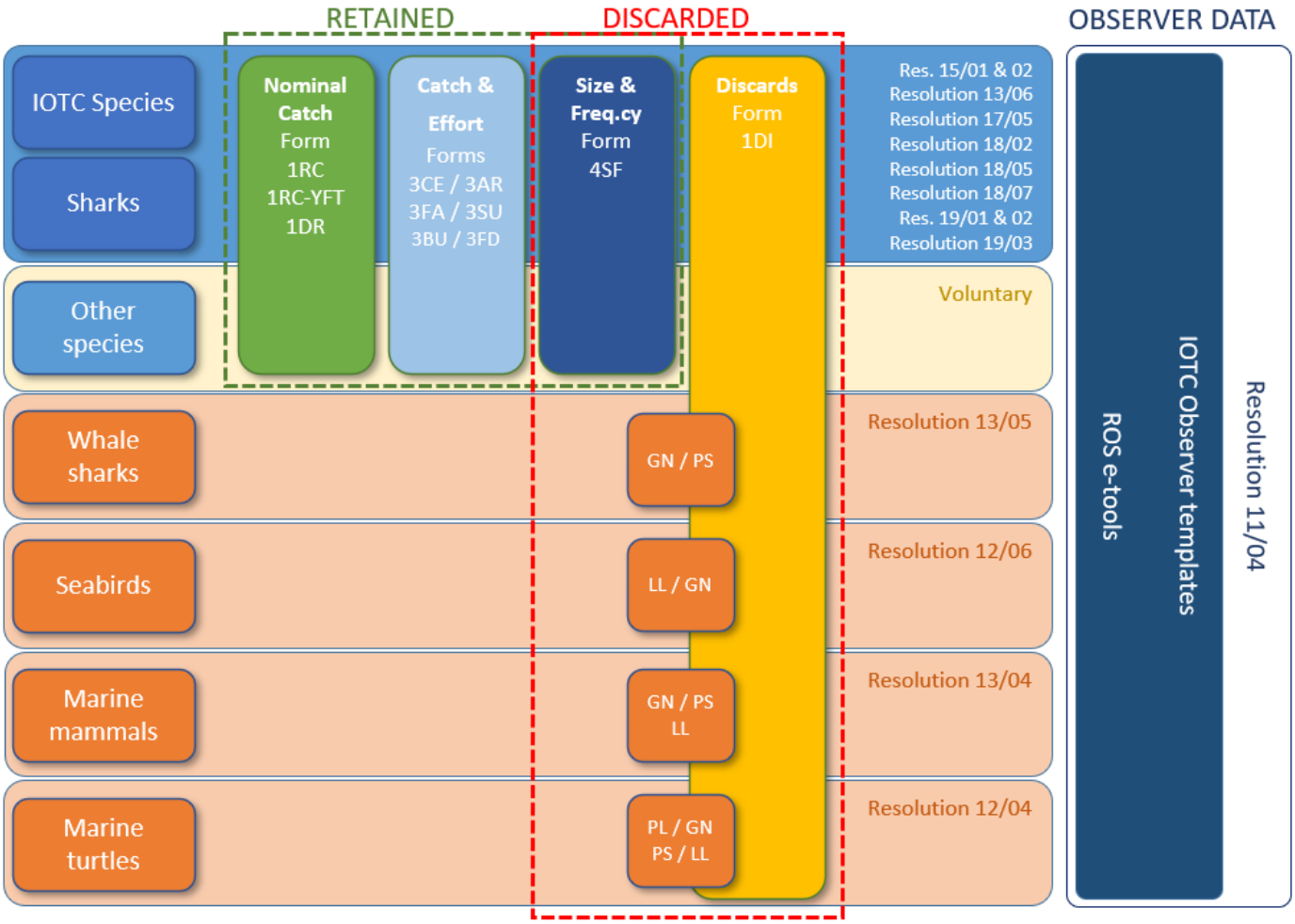

Fig. 1. Overview of IOTC statistical data reporting requirements and their corresponding Resolutions

Flag	Fleet	IOTC species					Sharks			Bycatch levels			DR
		TC	CE	SF	SUP	FAD	TC	CE	SF	Other species	BIRD	TURTLE	
EU-France	Reunion Longline (swordfish)	C	C	C	na	na	C	C	C	C	C	C	C
EU-France	Reunion coastal fisheries (handline and trolling)	C	P	C	na	na	C	P	N	C	na	C	C
EU-France	Purse seine	C	C	C	C	C	C	C	C	C	na	C	C
EU-France	Mayotte coastal fisheries	C	P	P	na	na	C	P	N	C	na	C	C
EU-Portugal	Longline (swordfish)	C	C	N	na	na	C	C	N	N	N	N	C
EU-Spain	Longline (swordfish)	C	P	C	na	na	N	N	C	N	N	N	N
EU-Spain	Purse seine	C	C	P	C	C	N	N	N	N	na	N	P
EU-United Kingdom	Longline (swordfish)	C	C	P	na	na	C	C	P	C	N	N	P
EU-Italy	Purse seine	N	N	N	na	N	N	N	N	N	na	N	N

Flag	Fleet	IOTC species					Sharks			Bycatch levels			DR
		TC	CE	SF	SUP	FAD	TC	CE	SF	Other species	BIRD	TURTLE	
EU-France	Reunion Longline (swordfish)	C	C	C	na	na	C	C	C	P	P	P	C
EU-France	Reunion coastal fisheries (handline and trolling)	C	P	C	na	na	C	P	C	C	na	C	C
EU-France	Purse seine	C	C	C	C	C	C	C	C	C	na	C	C
EU-France	Mayotte coastal fisheries	C	P	N	na	na	P	N	N	C	na	C	C
EU-Portugal	Longline (swordfish)	C	C	C	na	na	C	C	C	C	C	C	C
EU-Spain	Longline (swordfish)	C	P	C	na	na	C	N	C	N	N	N	N
EU-Spain	Purse seine	C	C	C	C	C	C	N	C	C	na	C	N
EU-United Kingdom	Longline (swordfish)	C	C	C	na	na	C	C	C	C	N	C	C
EU-Italy	Purse seine	C	N	N		N	N	N	N	N	na	N	N

Fig. 2a-b. Examples of compliance assessment over different data-related requirements as determined for all EU fleets for the reference years 2019 (a) and 2018 (b)

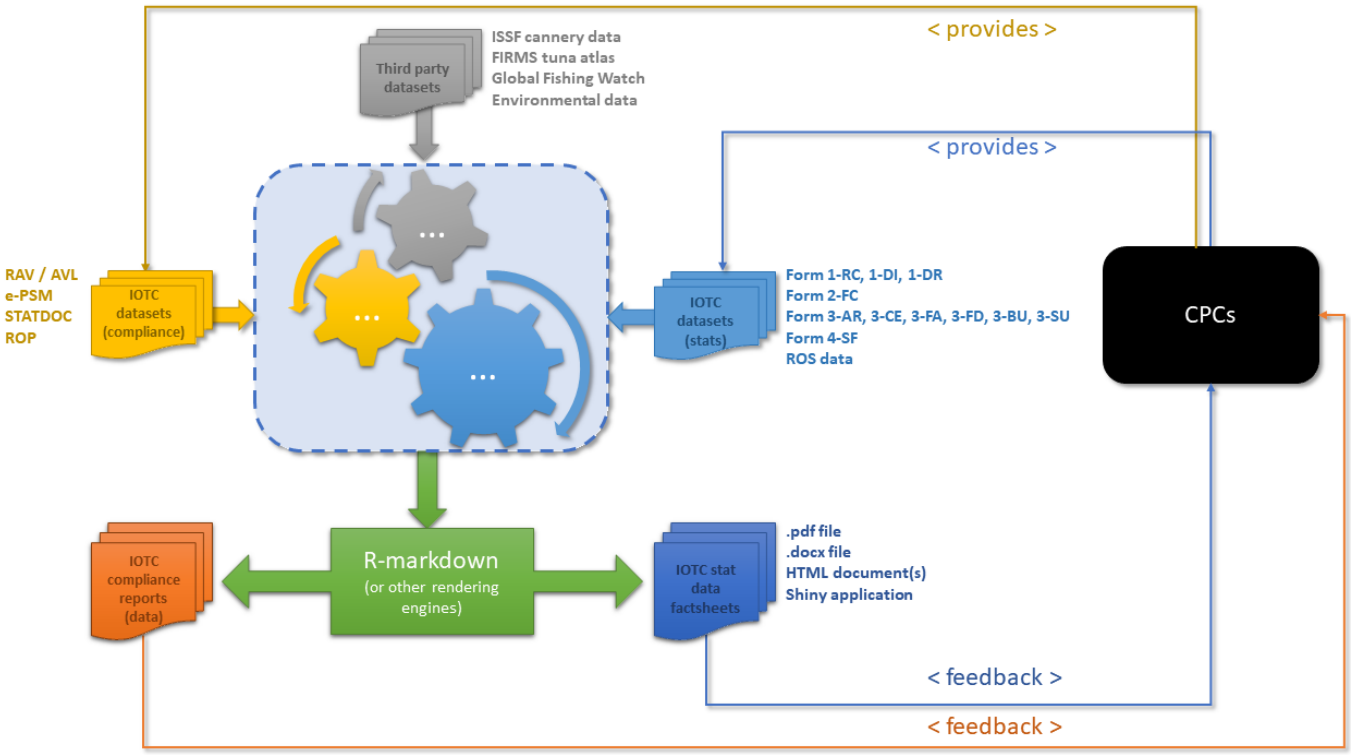

Fig. 3. High-level overview of data / compliance fact-sheets production process

SUMMARY

1. Data from the RAV indicates that 130 GT is a good threshold proxy to identify small-scale (FLL) from large-scale (LL) longliners
2. The nominal catch data submitted in 2019 for both FLL and LL appear consistent with the IOTC database for 2014-2018
3. The catch-effort and size-frequency data provided for 2019 for both FLL and LL appear consistent with the IOTC database for 2014-2018
4. The catch-effort and size-frequency data provided for 2017-2018 for FLL are identical to the data available in the IOTC database

FEEDBACK

- List of fishing vessels retrieved from the list of active vessels as the IOTC form 2FC for fishing crafts was not submitted to the Secretariat
- Nominal catch (NC) for both FLL and LL not submitted following IOTC Form 1RC
- No information provided on the FAO area of catch (i.e. IREASIO and IRWESIO) for NC for both FLL and LL
- Some species codes inconsistent with IOTC code list in NC for both FLL and LL, i.e. PEL (OTH) = OTHR, SBT = SBF
- Some English names inconsistent with IOTC code list in NC for LL, e.g. Bigeye = Bigeye tuna (see NC_ll_non_standard_species_names.xlsx)
- Catch-Effort (CE) for both FLL and LL not provided following IOTC form 3CE
- CE for FLL submitted in 2 separate files containing some common strata and including data for 2017, 2018, and 2019
- Some species codes inconsistent with IOTC code list in CE for both FLL and LL: BLZ = BUM, OTH = OTHR, SBT = SBF
- The following species reported in NC for FLL are missing from CE: SFA, SSP, SPN, BLT, COM, FRI, GUT, KAW, and LOT
- The species code BIL reported in CE and not NC for FLL seems to be an aggregate of SFA and SSP
- The following species reported in NC for LL are missing from CE: SFA, SSP, POR, SPN, BLT, COM, FRI, GUT, KAW, and LOT
- The species code BIL reported in both NC and CE for LL seems to be an aggregate of SFA and SSP
- The biomass of catch for yellowfin reported in CE for LL exceeds the catch reported in NC by >600 MT
- The biomass of catch for billfish reported in CE for LL systematically exceeds the values reported in NC
- The species code TUN is reported in CE but not in NC for LL: likely included in OTHR
- Size-frequency (SF) data for both FLL and LL not submitted following IOTC Form 4SF
- No size data reported for MAK caught with LL while present in NC and CE
- Some size data reported for SFA and SSP for FLL but missing from CE: might be included in the species groups SKH and BIL
- Some size data reported for MSK, SFA, SPN and SSP for LL but missing from CE: might be included in SKH and BIL

Fig. 4a. Sample data fact-sheet: summary of Taiwan,China data reporting quality status for 2019. FLL = Small-scale (fresh) longliners; LL = large-scale (deep-freezing) longliners

Report on mandatory statistical data submitted in 2020 by Taiwan,China

Resolution 15/02

IOTC Secretariat

28 September 2020

Table 1. Summary table of quality dimensions for the data sets submitted for reference year 2019 for small-scale longliners (FLL) from Taiwan,China

Dimension	Data set	Description	Compliance	Relevance
Timeliness	Submitted on 30th June 2020	Prior to deadline	Full	High
Data completeness	2FC: Active fishing crafts	Missing (voluntary)	-	Low
	1RC: Nominal catch	Non-standard format	-	Medium
	1DR: Species occurrence in NC	Missing	Non	High
	1DI: Discards estimates	Missing	Non	High
	3CE: Catch-Effort	Non-standard format	-	Medium
	4SF: Size-frequency	Non-standard format	-	Medium
Metadata completeness	1RC: Nominal catch	Missing fields	Partial	Medium
	3CE: Catch-Effort	Missing fields	Partial	Medium
	4SF: Size-frequency	Missing fields	Partial	Medium
Code lists	1RC & 3CE	Errors in species codes	Partial	Low
Consistency	3CE: Inconsistent with NC	Missing species	Partial	High
	4SF: Incomplete	No size for some species	Partial	High
	4SF: Inconsistent with NC/CE	Size for some species not in NC/CE	Partial	High
Sampling coverage	4SF: Target of 1 fish/MT	10/14 species with samples >1	Partial	High

Fig. 4b. Sample data fact-sheet: main findings and feedback for Taiwan,China data reporting for 2019

FISHING CRAFTS

Table 3: Annual number of active longliners by length class and targeted species reported by Taiwan,China during 2014-2019.

LOAclass	Targetsps	TargetSpecies	2014-2018	2018	2019
24+	AG01	Yellowfin tuna and bigeye tuna	112	159	152
24+	AG03	Yellowfin tuna, bigeye tuna and skipjack tuna	19	0	0
24+	AG14	Albacore, Swordfish	99	75	69
24+	AG18	Tropical tunas, swordfish, Albacore	9	0	0
<24	AG01	Yellowfin tuna and bigeye tuna	51	41	21
<24	AG03	Yellowfin tuna, bigeye tuna and skipjack tuna	21	0	0
<24	AG14	Albacore, Swordfish	30	10	18
<24	AG18	Tropical tunas, swordfish, Albacore	5	0	0
-	-	All	346	285	260

Table 4: Annual number of active small-scale longliners (FLL) and large-scale longliners (LL) reported by Taiwan,China during 2014-2018 derived from the Active Vessel List using a threshold of 130 GT.

Year	FLL	LL
2014	120	290
2015	117	250
2016	136	212
2017	137	177
2018	132	153
2019	125	135

Fig. 4c. Sample data fact-sheet: status of fishing craft statistics available for Taiwan,China (2014-2018 and 2019)

Table 6: Comparison of the nominal catch data set of large-scale longliners (LL) from Taiwan,China submitted in 2019 with the IOTC database.

Large-scale longliners	IOTC-2014-2018	IOTC-2018	2019
Number of active vessels	216	153	135
Total catch (MT)	45,944	43,132	49,648
Total catch per active vessel (MT/vessel)	212	282	368
Number of species reported	27	25	25
Tropical tuna catch (MT)	17,433	14,063	16,213
Number of tropical tuna species	3	3	3
Predominant species in tropical tuna catch	BET	BET	BET
BET catch (MT) (share of tropical tuna)	11,474 (65.8%)	7,998 (56.9%)	10,886 (67.1%)
YFT catch (MT) (share of tropical tuna)	5,926 (34%)	6,030 (42.9%)	5,294 (32.7%)
SKJ catch (MT) (share of tropical tuna)	32 (0.2%)	35 (0.3%)	33 (0.2%)
Temperate tuna catch (MT)	5,758	8,008	9,733
Number of temperate tuna species	2	2	2
Predominant species in temperate tuna catch	ALB	ALB	ALB
ALB catch (MT) (share of temperate tuna)	4,668 (81.1%)	6,794 (84.8%)	8,507 (87.4%)
SBF catch (MT) (share of temperate tuna)	1,090 (18.9%)	1,213 (15.2%)	1,226 (12.6%)
Billfish catch (MT)	6,599	5,279	5,040
Number of billfish species	8	7	7
Predominant species in billfish catch	SWO	SWO	SWO
SWO catch (MT) (share of billfish)	3,434 (52%)	3,332 (63.1%)	3,362 (66.7%)
BUM catch (MT) (share of billfish)	2,394 (36.3%)	1,396 (26.4%)	1,262 (25%)
Other billfish catch (MT) (share of billfish)	771 (11.7%)	551 (10.4%)	415 (8.2%)
Neritic tuna catch (MT)	68	37	59
Number of neritic tuna soecies	6	6	6
Predominant species in neritic tuna catch	LOT	LOT	KAW
Bycatch species catch (MT)	4,100	3,523	4,126
Number of bycatch species	6	5	6
Predominant species in bycatch	BSH	BSH	BSH
BSH catch (MT) (share of bycatch)	3,045 (74.3%)	2,830 (80.3%)	2,832 (68.6%)
Other species bycatch (MT) (share of bycatch)	1,055 (25.7%)	694 (19.7%)	1,294 (31.4%)

Fig. 4d. Sample data fact-sheet: nominal catch data trends for Taiwan,China LL (2014-2018 and 2019)

Table 10: Comparison of the catch-effort data set of large-scale longliners (LL) from Taiwan,China submitted in 2019 with the IOTC database.

Large-scale longliners	IOTC-2014-2018	IOTC-2018	2019
Total effort (hooks)	89,838,175	93,070,520	97,308,263
Maximum effort in a stratum (hooks)	3,062,238	2,376,420	1,652,600
Strata with effort (hooks)	558	643	612
Strata with effort (hooks) but no catch	0	0	0
Strata with effort >500,000 hooks	48.2	52	50
Spatial strata with effort	113.6	126	127
Total catch (MT)	42,255	40,026	44,950
Total catch (number)	2,438,063	2,652,014	3,228,214
Number of species	16	16	16
Overall CPUE (kg/1,000 hooks)	474	430	462
Overall CPUE (fish/1,000 hooks)	27	28	33
Tropical tuna total catch (MT)	17,125	13,747	16,653
BET total catch (MT)	11,274	7,908	10,723
BET CPUE (kg/1,000 hooks)	129	85	110.2
YFT total catch (MT)	5,834	5,803	5,903
YFT CPUE (kg/1,000 hooks)	65.8	62.4	60.7
ALB total catch (MT)	4,468	6,204	7,799
ALB CPUE (kg/1,000 hooks)	50.1	66.7	80.1
Neritic tuna total catch (MT)	0	0	0
Billfish total catch (MT)	6,467	5,469	4,992
SWO total catch (MT)	3,374	3,323	3,303
SWO CPUE (kg/1,000 hooks)	37.8	35.7	33.9
BUM total catch (MT)	2,372	1,509	1,282
BUM CPUE (kg/1,000 hooks)	27.3	16.2	13.2
Bycatch total catch (MT)	3,598	3,400	3,529
Number of bycatch species	4	4	4
BSH total catch (MT)	2,432	2,739	2,898

Fig. 4e. Sample data fact-sheet: catch-and-effort data trends for Taiwan,China LL (2014-2018 and 2019)

Table 14: Comparison of the size-frequency data set of large-scale longliners (LL) from Taiwan,China submitted in 2019 with the IOTC database.

Large-scale longliners	IOTC-2014-2018	IOTC-2018	2019
Number of species sampled	14.8	15	14
Strata with size samples	517	603	563
Spatial strata with size samples	110.6	123	121
Total number of fish sampled	291,040	306,111	254,007
Number of tropical tunas sampled	135,816	122,027	108,349
Total weight of tropical tunas sampled (MT)	7,809	6,794	6,215
Number of BET sampled	88,005	66,866	76,066
Total weight of BET sampled (MT)	5,536	4,187	4,621
Mean weight of BET from SF (kg) across strata	55.5	56.9	53.8
Mean weight of BET from CE (kg) across strata	52.6	53.4	45.3
Number of YFT sampled	47,512	54,357	31,712
Total weight of YFT sampled (MT)	2,269	2,597	1,588
Mean weight of YFT from SF (kg) across strata	46.4	47.3	49.4
Mean weight of YFT from CE (kg) across strata	44.6	44.1	43.8
Number of ALB sampled	69,308	95,847	91,406
Total weight of ALB sampled (MT)	1,044	1,509	1,462
Mean weight of ALB from SF (kg) across strata	18.7	18.3	19.5
Mean weight of ALB from CE (kg) across strata	18.6	18.4	19
Number of billfish sampled	34,668	28,597	29,994
Total weight of billfish sampled (MT)	2,603	2,128	2,150
Mean weight of SWO from SF (kg) across strata	59.7	60.1	61.5
Mean weight of SWO from CE (kg) across strata	69.9	64.3	60
Mean weight of BUM from SF (kg) across strata	107.9	113	115.2
Mean weight of BUM from CE (kg) across strata	109.4	110.4	98.3
Number of sharks sampled	20,743	0	24,258
Total weight of sharks sampled (excl. MSK)	884	1,101	1,072
Mean weight of BSH from (SF) across strata	42	45	46.2
Mean weight of BSH from CE (kg) across strata	49.2	49.9	42.9

Fig. 4f. Sample data fact-sheet: size-frequency data summary for Taiwan,China LL (2014-2018 and 2019)

Table 15: Number of fish sampled (N), estimate of catch (MT), percentage of nominal catch (NC) and number of fish sampled per metric tonne (NperMT) included in the size-frequency data set for the large-scale longliners (LL) from Taiwan,China for 2019

Year	FlCde	GrCde	WorkParty	SpCde	EngName	N	Catch	NC	%NC	NperMT
2019	TWN	LL	TEMP	ALB	Albacore	91,406	1,462	8,507	17.2	10.7
2019	TWN	LL	TROP	BET	Bigeye tuna	76,066	4,621	10,886	42.4	7.0
2019	TWN	LL	BILL	BLM	Black Marlin	696	83	116	71.6	6.0
2019	TWN	LL	BYCT	BSH	Blue shark	20,432	974	2,832	34.4	7.2
2019	TWN	LL	BILL	BUM	Blue Marlin	7,909	889	1,262	70.4	6.3
2019	TWN	LL	BYCT	FAL	Silky shark	2,431	98	258	38.0	9.4
2019	TWN	LL	BILL	MLS	Striped marlin	1,795	136	128	106.2	14.0
2019	TWN	LL	BYCT	MSK	Sharks mackerel and porbeagles nei	1,390	0	NA		
2019	TWN	LL	BILL	SFA	Indo-Pacific sailfish	2,055	63	117	53.8	17.6
2019	TWN	LL	TROP	SKJ	Skipjack tuna	571	6	33	18.2	17.3
2019	TWN	LL	BYCT	SPN	Hammerhead sharks nei	5	0	3	0.0	1.7
2019	TWN	LL	BILL	SSP	Short-billed spearfish	172	2	34	5.9	5.1
2019	TWN	LL	BILL	SWO	Swordfish	17,367	977	3,362	29.1	5.2
2019	TWN	LL	TROP	YFT	Yellowfin tuna	31,712	1,588	5,294	30.0	6.0
2019	TWN	LL	-	-	All species	254,007	10,899	32,832	33.2	7.7

Fig. 4g. Sample data fact-sheet: assessment of size-frequency vs. total catches for Taiwan,China LL (2014-2018 and 2019)

Checking size frequency data for stock assessment inputs

Skipjack tuna, 2016-2019

IOTC Secretariat

25 September 2020

SUMMARY

Table 1. Description of size-frequency data sets for inclusing in the 2020 stock assessment of skipjack tuna.

Fleet	Gear	Year	Status	Rationale
IDN	PSS	2018	Not to be included	Low sample size and spatial distribution
IDN	PSS	2019	To be included	Representative sample
MDV	BB & BBOF	2016	Not to be included	Very small fish reported not seen during 2017-2019
MDV	BB & BBOF	2017	To be included	Representative sample
MDV	BB & BBOF	2018	To be included	Representative sample
MDV	BB & BBOF	2019	To be included	NB: Duplicate in data submitted; Data on FS missing?
LKA	GILL & GIOF	2016	Not to be included	Truncated to the right
LKA	GILL & GIOF	2017	Not to be included	Same distribution as 2016
LKA	GILL & GIOF	2019	Not to be included	Same distribution as 2016
LKA	RIN & RNOF	2016	Not to be included	Truncated to the left
LKA	RIN & RNOF	2017	To be included	Representative sample
LKA	RIN & RNOF	2018	Not to be included	No data for coastal ringnets
LKA	RIN & RNOF	2019	Not to be included	Same distribution as 2017
LKA	FLL & LLCO	2016	Not to be included	No sample during Jan-Jul
LKA	FLL & LLCO	2017	To be included	Representative sample
LKA	FLL & LLCO	2018	Not to be included	No data for coastal longliners
LKA	FLL & LLCO	2019	Not to be included	Too few samples

Fig. 5a. Sample data fact-sheet: assessment of skipjack size-frequency quality for several gears and fisheries (2019)

- **Indonesian small-scale purse seiners (PSS)**
  - Except for the absence of samples in January, sample size, spatio-temporal sampling design and size distribution seem good for 2019
- **Maldivian baitboats**
  - The FS data for 2019 seem to be missing as the SF data sets for unclassified (UNCL) school type for BB and free-swimming school (FS) for BBOF are the same (message sent to Maldives)
  - The similarity between size distributions by school type (FS, LA, UNCL) confirms that all data can be lumped together for the assessment
  - Small sized skipjack (<30 cm) were only observed in the catch in 2016: To discard?
  - Size data for BB in 2018 on anchored FADs include 45% of the fish between 45-50 cm: To discard?
  - Size data show some very similar patterns for 2017-2019: Possible data duplication?
- **Sri Lankan gillnetters**
  - Size distributions appear to be almost identical in 2016, 2017 and 2019
- **Sri Lankan ringnetters**
  - Size distribution left-truncated at 25.5 cm in 2016: Data should be discarded
  - Size distributions appear to be almost identical in 2017 and 2019
- **Sri-Lankan longliners**
  - The spatial distribution of the samples for the fresh longliners covers a small part of the distribution of the reported geo-referenced effort
  - Size distributions appear to be very similar between 2017 and 2019

Fig. 5b. Sample data fact-sheet: summary of issues detected with skipjack size-frequencies for several gears and fisheries (2019)

Indonesian small-scale purse seiners

Table 2: Monthly number of skipjack tunas sampled for length in the small-scale purse seine fishery of Indonesia

Year	1	2	3	4	5	6	7	8	9	10	11	12	TOTAL
2018	63	60	11	296	309	16	181	166	84	0	86	212	1484
2019	0	967	618	540	604	340	847	359	438	687	398	399	6197

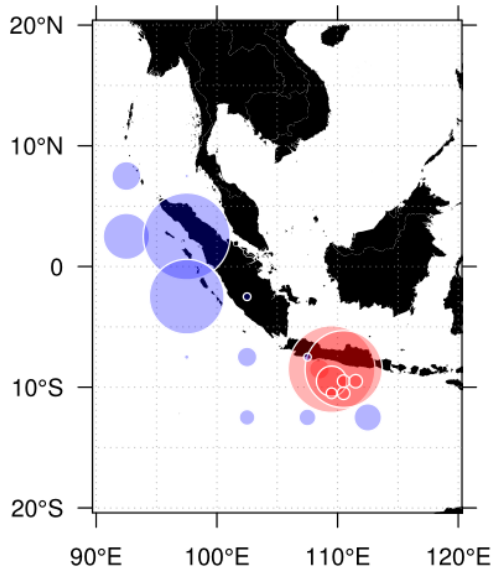

Figure 1: Distribution of skipjack length samples collected at landing sites from Indonesian small-scale purse seiners in 2018 (red) and 2019 (blue)

Fig. 5c. Sample data fact-sheet: spatial-temporal distribution of skipjack samples from the small-scale purse seine fisheries of Indonesia (2018-2019)

Table 3: Summary statistics of skipjack size data collected for Indonesian small-scale purse seiners during 2018-2019

Year	Min.	1st Qu.	Median	Mean	3rd Qu.	Max.	N
2018	20.5	35.5	41.5	40.3	45.5	56.5	1484
2019	17.5	30.5	34.5	34.6	38.5	68.5	6197

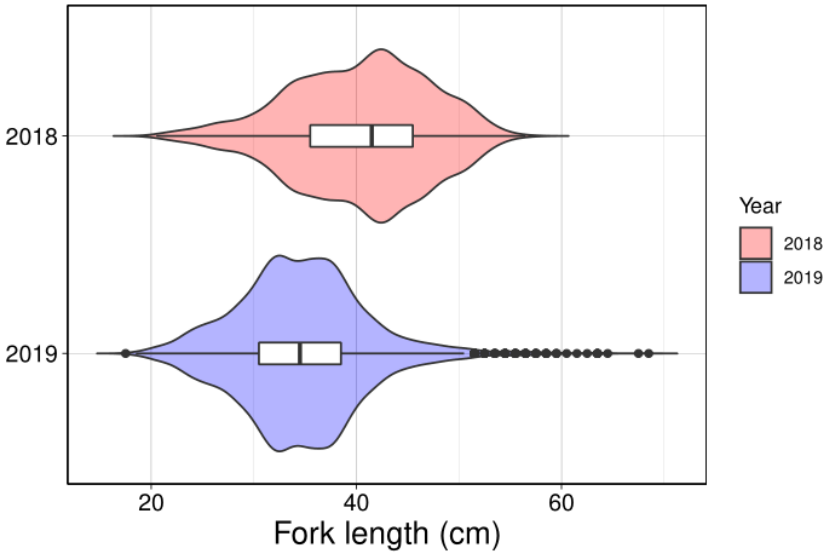

Figure 2: Violin plots of annual size-frequency distribution of skipjack caught by Indonesian small-scale purse seiners during 2018-2019 sampled for length at landing sites.

Fig. 5d. Sample data fact-sheet: size distribution of skipjack samples from the small-scale purse seine fisheries of Indonesia (2018-2019)

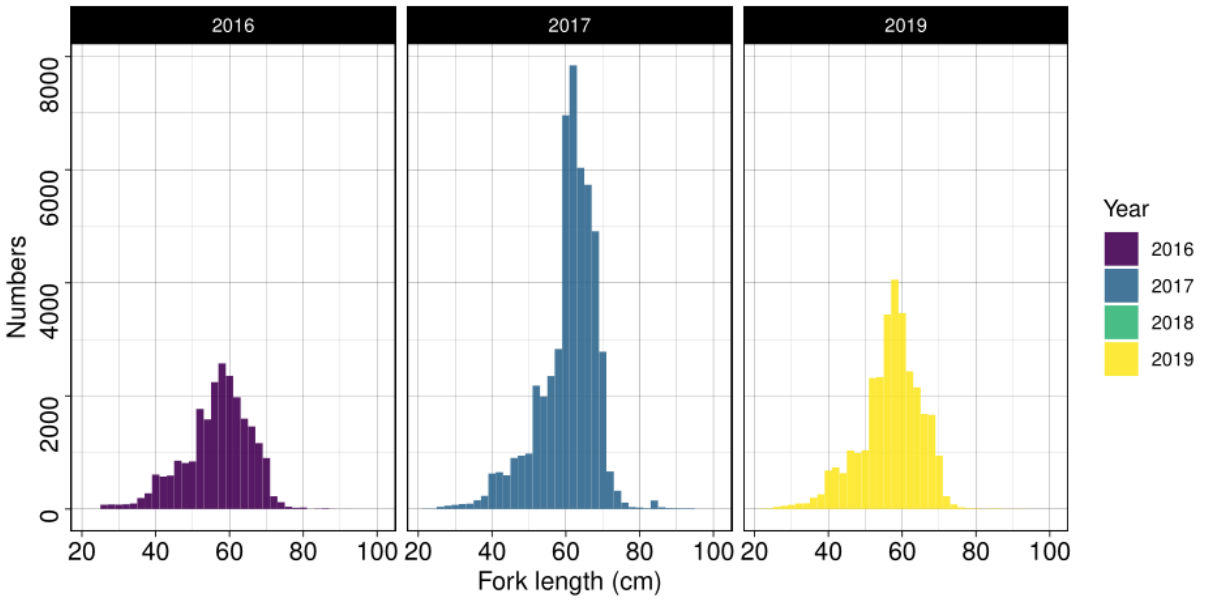

Figure 12: Annual size-frequency distributions of skipjack tuna caught by Sri Lankan gillnetters during 2016-2019

Fig. 5e. Sample data fact-sheet: size distribution of skipjack samples from the gillnet fisheries of Sri Lanka (2016-2019)

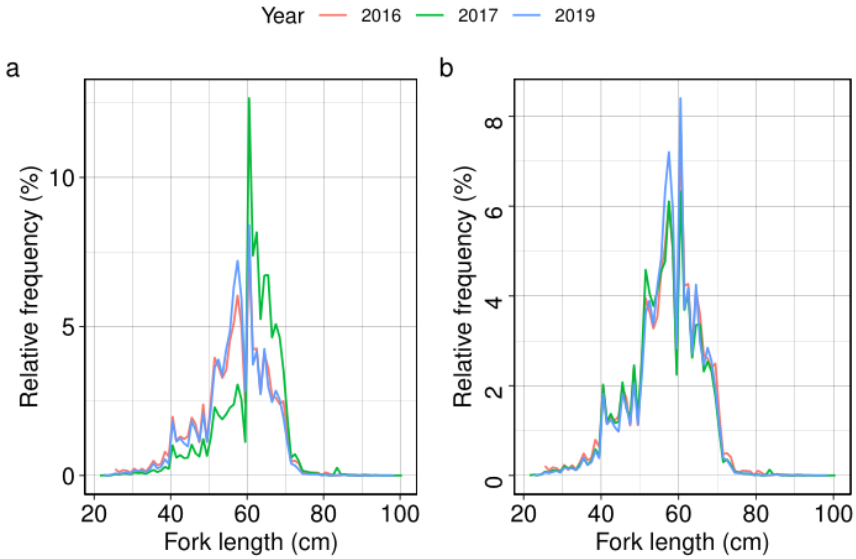

Figure 13: Annual size-frequency distributions of skipjack tuna caught by Sri Lankan gillnetters during 2016-2019. (a) Raw data, (b) Same data after multiplying relative numbers of fish sampled in 2017 by 2 for fish <60 cm and dividing by 2 for fish >60 cm

Fig. 5f. Sample data fact-sheet: comparison of raw vs. adjusted size distribution of skipjack samples from the gillnet fisheries of Sri Lanka (2016-2019)