# SIMULATION TOOL FOR ALLOCATION CRITERIA: DATA, ASSUMPTIONS AND OUTPUTS (UPDATED VERSION)

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## Summary

This paper describes the data, assumptions and outputs underpinning the updated simulation tool developed by the IOTC Secretariat to support the work of the Technical Committee on Allocation Criteria (TCAC). It documents the analytical framework used to simulate alternative catch allocation scenarios, including the treatment of entities, historical catch data, national jurisdiction areas and allocation components.

The paper outlines the input datasets used in the simulations, notably the entity reference dataset and historical catch estimates by fishing area, and explains key assumptions applied for analytical consistency, including the treatment of disputed maritime areas and non-IOTC jurisdictions. While the simulation framework has been updated since TCAC15, the historical catch series currently used remain those considered at that session, pending the finalisation of ongoing data revisions.

The document also describes the interactive R Shiny application developed to allow TCAC members to configure and explore allocation scenarios, including options for setting Total Allowable Catch values, allocation weights, reference periods and transition periods. Finally, it summarises the types of outputs generated by the tool, including tables, charts and downloadable Excel and Word reports, provided either for all entities or individually.

## Purpose

This document provides the Technical Committee on Allocation Criteria (TCAC) of the Indian Ocean Tuna Commission (IOTC) with an overview of the data, assumptions and outputs used in the simulation of allocation criteria. It also briefly describes the Shiny application developed to run selected simulation scenarios interactively, highlighting updates made to the input parameters and application configuration since the previous version, and outlining the main options for setting up simulations and interpreting the results.

## Input Data

For the purpose of the simulations, entities are analytical units representing the 29 current Contracting Parties (CPs) and Cooperating non-Contracting Parties (CNPCs) of the IOTC, together with Taiwan,China, which participates in the Commission's work as an invited expert. In the simulations, Taiwan,China is included as a fishing entity strictly for modelling purposes. The two CNPCs (Liberia and Panama) are included in the reference file for completeness; however, they are not considered in the allocation process, as neither country has ever operated an active fishery in the IOTC Area of Competence.

## Entity Status

The values of all parameters characterising each entity in relation to the allocation criteria are provided in IOTC-2026-TCAC16-DATASET01. A detailed description of the fields included in this file is provided in Appendix 1.

This version of the simulations (see section Simulation Tool) requires information on:

- developing country status, according to United Nations classification (UN 2020)
- Least Developed Country (LDC) status, according to United Nations classification (UN 2026)
- Small Island Developing State (SIDS) status, according to United Nations classification (UN 2026)
- coastal State status within the IOTC Area of Competence.

It is noted that the distinction between developed and developing countries has been progressively de-emphasised within the United Nations system since 2021 in favour of more nuanced development classifications. However, these categories are retained in the present simulations solely for the purpose of implementing one of the allocation components, in line with previous TCAC discussions and agreed analytical approaches.

It is important to note that Seychelles is classified as a coastal developing country within the IOTC, consistent with its status as a SIDS recognised by the United Nations. Although Seychelles has a high level of human development and income per capita, it is not classified as a developed country under the UN system and therefore remains eligible for developing-country and SIDS-specific provisions within IOTC frameworks.

## Historical Catches

Historical catch data for albacore, bigeye tuna, skipjack tuna, swordfish and yellowfin tuna are available for the period 1950–2024. These data are provided in IOTC-2026-TCAC16-DATASET02. A detailed description of the fields included in the file is provided in Appendix 2.

Catch data are stratified by year, entity, gear, school type, species, and assigned area (see Section National Jurisdiction Areas & High Seas) to support allocation analyses. The methodology used to assign catches to areas of operation was presented to the Technical Committee on Allocation Criteria at its twelfth session in October 2023 and endorsed by participants (IOTC-2023-TCAC12-INF02). For longline and surface fisheries operating on the high seas, catches were allocated to NJAs based on the proportion of spatial overlap between each regular grid cell and the corresponding NJA (see IOTC–2017–SC20–INF05). Work is ongoing to incorporate information on licensing agreements in the catch allocation procedure.

### National Jurisdiction Areas & High Seas

The National Jurisdiction Areas (NJAs) of the IOTC CPCs were sourced from the Flanders Marine Institute (VLIZ) *maritime boundaries* geodatabase (https://doi.org/10.14284/628). The corresponding spatial layers are available for download from the IOTC Reference Data Catalogue (see Section Indian Ocean National Jurisdiction Areas).

For the purposes of allocating catches to NJAs within the simulations implemented in the TCAC application, the following assumptions were applied:

i. For historical reasons, the waters of the Chagos Archipelago, considered here as part of the NJAs of Mauritius, were treated as being under the sovereignty of the United Kingdom of

Great Britain and Northern Ireland (GBR), under the administration of the British Indian Ocean Territory prior to 2021. A full Marine Protected Area has been in place since April 2010 and, consequently, no official fisheries catches have been reported from these waters since that date, except for a coastal handline fishery;

ii. Disputed areas involving Mayotte, Tromelin, and the Glorioso Islands (Îles Glorieuses) were treated as follows: waters associated with Mayotte (France) with Comoros (FRA_COM_MYT) were attributed to France (FRA), while waters associated with Madagascar with France (MDG_FRA) and France with Madagascar and Mauritius (FRA_MDG_MUS) were attributed to the France Overseas Territories (ATF). This assumption was adopted to simplify the allocation procedure and to ensure internal consistency with long-standing IOTC statistical practices, whereby catches from these areas have historically been attributed accordingly in national submissions and Secretariat compilations. This treatment is applied solely for analytical purposes within the TCAC application and does not prejudice the positions of CPCs with respect to sovereignty or maritime claims;

iii. Although Mayotte became an overseas department of France in 2011, catches associated with Mayotte are attributed to France in IOTC datasets from 2014 onwards, corresponding to the point at which reporting practices and fleet attribution became consistently aligned with French national submissions. Accordingly, catches taken in the waters of Mayotte during the period 1995–2013 were allocated to the France Overseas Territories (ATF), and to France (FRA) thereafter;

iv. The NJA of the European Union (EUR) comprises the waters associated with the two French overseas departments of Réunion Island and Mayotte;

v. The NJA for the Islamic Republic of Iran (IRN) was defined as the combination of the Iranian NJA (IRN) and the maritime areas subject to dispute with the United Arab Emirates (ARE_IRN) and Iraq (IRQ_IRN);

vi. The NJA for Sudan (SDN) was defined as the combination of the Sudanese NJA (SDN) and the maritime area subject to dispute with Egypt (SDN_EGY);

vii. Catches estimated to have been taken in the NJAs of non-IOTC CPCs – United Arab Emirates (ARE), Bahrain (BHR), Djibouti (DJI), Egypt (EGY), Eritrea (ERI), Iraq (IRQ), Jordan (JOR), Kuwait (KWT), Myanmar (MMR), Qatar (QAT), Saudi Arabia (SAU), and Timor-Leste (TLS), including disputed areas (Eritrea with Djibouti (ERI_DJI) and Qatar with Saudi Arabia and the United Arab Emirates (QAT_SAU_ARE) – were aggregated under the assigned area OTH.

## Simulation Tool

The Secretariat has revised the interactive simulation tool presented at TCAC15, originally developed to facilitate the exploration of various configuration options for the components of catch allocation. The tool is an interactive R Shiny web application (App), available at https://foodandagricultureorganization.shinyapps.io/iotc-tcac-simulations-review/. The App is password-protected to support access control and monitoring, with login credentials provided to participating delegates. To ensure full transparency and reproducibility, all scripts and data used to generate the Shiny App are publicly available in the iotc-tcac-simulations repository, hosted on the IOTC Secretariat's GitHub.

**Total Allowable Catch Values**

The App allows users to set the TAC values, which are pre-filled by default in accordance with the most recent IOTC resolutions for bigeye and skipjack tunas, and with the Maximum Sustainable Yield (MSY) values derived from stock assessments for albacore, swordfish, and yellowfin tuna:

- Albacore: 45,000 t (IOTC-2025-SC28-ES01)

- Bigeye tuna: 92,670 t (IOTC Res. 25/04

- Skipjack tuna: 628,606 t (IOTC Res. 25/03)

- Swordfish: 30,000 t (IOTC-2025-SC28-ES16)

- Yellowfin tuna: 421,000 t (IOTC-2025-SC28-ES04)

**Baseline Allocation**

The baseline allocation represents the portion of the TAC allocated equally among the 29 IOTC Contracting Parties (CPs): Australia (AUS), Bangladesh (BGD), China (CHN), Comoros (COM), European Union (EUR), France Overseas Territories (ATF), India (IND), Indonesia (IDN), I.R. Iran (IRN), Japan (JPN), Kenya (KEN), Madagascar (MDG), Malaysia (MYS), Maldives (MDV), Mauritius (MUS), Mozambique (MOZ), Oman (OMN), Pakistan (PAK), Philippines (PHL), Republic of Korea (KOR), Seychelles (SYC), Somalia (SOM), South Africa (ZAF), Sri Lanka (LKA), Sudan (SDN), Thailand (THA), United Kingdom of Great Britain and Northern Ireland (GBR), United Republic of Tanzania (TZA), and Yemen (YEM).

In the App, users can adjust the baseline allocation or its weighting, expressed as a percentage (0–100%), using an interactive slider in the interface.

**Developing States Allocation**

The developing states allocation represents the portion of the TAC allocated among the 21 IOTC developing coastal States: Bangladesh (BGD), Comoros (COM), India (IND), Indonesia (IDN), I.R. Iran (IRN), Kenya (KEN), Madagascar (MDG), Malaysia (MYS), Maldives (MDV), Mauritius (MUS), Mozambique (MOZ), Oman (OMN), Pakistan (PAK), Seychelles (SYC), Somalia (SOM), South Africa (ZAF), Sri Lanka (LKA), Sudan (SDN), Thailand (THA), United Republic of Tanzania (TZA), and Yemen (YEM).

This allocation component comprises three sub-components, which can be adjusted interactively in the App using sliders to reflect different weighting schemes:

Equal Allocation

The equal-weight sub-component of the developing states allocation represents the portion of the TAC allocated evenly among the 21 IOTC developing coastal States: Bangladesh (BGD), Comoros (COM), India (IND), Indonesia (IDN), I.R. Iran (IRN), Kenya (KEN), Madagascar (MDG), Malaysia (MYS), Maldives (MDV), Mauritius (MUS), Mozambique (MOZ), Oman (OMN), Pakistan (PAK), Seychelles (SYC), Somalia (SOM), South Africa (ZAF), Sri Lanka (LKA), Sudan (SDN), Thailand (THA), United Republic of Tanzania (TZA), and Yemen (YEM).

Least-Developed Country Allocation

The least-developed country (LDC) sub-component of the developing states allocation represents the portion of the TAC allocated evenly among the eight IOTC least-developed coastal States: Bangladesh (BGD), Comoros (COM), Madagascar (MDG), Mozambique (MOZ), Somalia (SOM), Sudan (SDN), United Republic of Tanzania (TZA), and Yemen (YEM).

Small Island Developing State Allocation

The small island developing State (SIDS) sub-component of the developing states allocation represents the portion of the TAC allocated evenly among the four IOTC SIDS: Comoros (COM), Maldives (MDV), Mauritius (MUS), and Seychelles (SYC).

**Catch-Based Allocation**

The catch-based weight allocation represents the portion of the TAC allocated to each Contracting Party (CP) and to Taiwan,China, in proportion to its contribution to the total catch of the species by all IOTC CPs over a selected historical reference period.

To calculate this allocation component, historical catch data are averaged over a user-selected reference period using one of two alternative approaches:

- the annual average over the entire reference period; or
- the average of the best *n* years within the reference period.

Under the best *n* years approach, the *best years* are defined individually for each CP and species, based on the highest reported catches within the reference period.

**Transition Period for Implementation**

The TCAC proposed a stepwise approach for implementing the catch allocation scheme over a period of 6 to 10 years for each stock, using annual increments during this transition period. The App follows the schedule proposed in IOTC-2024-TCAC13-REF02, in which each annual percentage value defines the proportion of the catch taken by foreign fleets in the NJAs that is allocated to the quota.

## Simulation Results

Simulation results can be visualised in the App through tables and charts, either for all entities together or for each entity individually. The App also allows users to download configuration and output tables as Excel or Word files.

For the "All entities" tab:

- Users can download an Excel file via the 'Download' button, which contains the following worksheets:

  1. 'CPC_REFERENCES' containing the CPC configuration parameters as in CPC_CONFIGURATIONS.xlsx

  2. 'HISTORICAL_CATCHES' containing the historical catches for the selected species as extracted from HISTORICAL_CATCH_ESTIMATES.csv

  3. 'SIMULATION_CONFIGURATION' containing all the configuration parameters set by the users for the specific simulation round

  4. 'OUTPUT_QUOTAS' containing the outputs of the simulation expressed either as fraction of the annual TAC or as catches in metric tonnes by CPC and simulation year (depending on the chosen value of the 'output unit' parameter).

- Users can also download a Word file via the 'Download full report' button. This report includes the same tables as the Excel file, formatted for easier reading and presentation.

For the "By entity" tab:

- Results are displayed for each entity individually, including allocation values and a bar chart illustrating the transition period for the catch-based allocation;

- Only a Word report is available for download, via a drop-down list that allows selection of the desired entity;

- Reports include the scenario configuration, final results after the 10-year transition period, and stepwise values for:

  1. Baseline allocation

  2. Developing-State allocation, including all sub-components

  3. Catch-based allocation

# Appendices

## Appendix 1: Description of the entity dataset

**Tab. A1:** Description of the fields included in the entity simulation configuration file. NJA = National Jurisdiction Area

| Field name | Description | Example / Format |
|---|---|---|
| ISO3_CODE | Three-letter ISO 3166-1 alpha-3 country code | MDV |
| NAME_EN | Official name of the Contracting Party, Cooperating Non-Contracting Party, or Fishing Entity in English | Maldives |
| NAME_FR | Official name of the Contracting Party, Cooperating Non-Contracting Party, or Fishing Entity in French | Maldives |
| STATUS_CODE | IOTC membership status code: CP (Contracting Party), CNCP (Cooperating Non-Contracting Party), or FE (Fishing Entity) | CP |
| STATUS | Descriptive label corresponding to STATUS_CODE | Contracting Party |
| IS_DEVELOPING | Indicator of developing country status according to [United Nations classification (TRUE / FALSE) | TRUE |
| IS_LDC | Indicator of Least Developed Country (LDC) status according to United Nations classification (TRUE / FALSE) | FALSE |
| IS_SIDS | Indicator of Small Island Developing State (SIDS) status according to United Nations classification (TRUE / FALSE) | TRUE |
| IS_COASTAL | Indicator of coastal State status within the IOTC Area of Competence (TRUE / FALSE) | TRUE |
| NJA_SIZE | Surface area (in square kilometres) of the NJA within the Indian Ocean | 930,250 |

# Appendix 2: Description of the Historical Catch Dataset

**Tab. A2:** Description of the fields included in the historical catch dataset (1950-2024) considered for the simulations

| Field Name | Description | Example / Format | Code List |
|---|---|---|---|
| YEAR | Gregorian calendar year of the fishing activities | 1995 | |
| ENTITY_CODE | Code identifying the entity, i.e., CPC or the fishing fleet of Taiwan,China (TWN) | EUR | Entity |
| FISHERY_TYPE_CODE | Classification to define the scale of the fishing operations, separating fisheries composed of vessels less than 24 m and operating exclusively in National Jurisdiction Areas (ART = Artisanal/coastal) and surface and longline fisheries that may operate on the High Seas (IND = Industrial) | IND | Type of fishery |
| GEAR_CODE | Fishing gear used to catch the fish | PS | Gear |
| SCHOOL_TYPE_CODE | Code identifying the type of tuna school association: LS = school associated with a drifting floating object, natural or artificial; FS = free-swimming school; UNCL = unclassified | FS | Type of school |
| ASSIGNED_AREA | Area where the catch is assigned. Values include Areas Beyond National Jurisdiction (HIGH_SEAS) and NJAs, where the last three characters correspond to the relevant country code, or the European Union (EUR) in the case of France. NJA_OTH represents all non-IOTC coastal States of the Indian Ocean | NJA_SYC | Country |
| SPECIES_CODE | ASFIS alpha-3 code identifying the species: ALB (albacore), BET (bigeye tuna), SKJ (skipjack tuna), SWO (swordfish), YFT (yellowfin tuna) | YFT | Species |
| CATCH_MT | Amount of fish caught and retained in live-weight equivalent, expressed in metric tonnes | 5,200 | |